LEMBAR PENGESAHAN TUGAS AKHIR

PERENCANAAN STRUKTUR GEDUNG ADMINISTRASI UNIVERSITAS SANATA DHARMA YOGYAKARTA

Disusun oleh :

Nama : ENRICO ANNAS
No. Mhs : 96 310 164
NIRM : 960051013114120141

Nama : ANA
No. Mhs : 97 511 368
NIRM : 970051013114120297

Telah diperiksa dan disetujui oleh :

Dosen Pembimbing I

Ir. Tri Fajar Budiono, MT

Tanggal : 10 - 10 - 2002

Dosen Pembimbing II

Ir. H. Ilman Noor, MSCE.

Tanggal : 10 - 10 - 2002

KATA PENGANTAR

Assalamu'alaikum Wr.Wb

Puji syukur kami panjatkan kehadirat Allah SWT yang telah melimpahkan rahmat dan ridho-Nya serta shlawat dan salam dilimpahkan kepada Nabi besar Muhammad SAW, sehingga kami dapat menyelesaikan Tugas Akhir ini yang disusun guna melengkapi persyaratan untuk mencapai derajat srata satu (S-1) pada program Jurusan Teknil Sipil Fakultas Teknik Sipil dan Perencanaan Universitas Islam Indonesia Yogyakarta

Dalam penyelesaian Tugas Akhir ini tidak terlepas dari dukungan dan sumbangan pikiran serta saran dari berbagai pihak yang selalu memberikan motivasi dalam menghadapi hambatan yang terjadi selama penyusunan. Untuk itu dengan segala hormat dan keikhlasan hati kami haturkan terima kasih kepada :

1. Bapak Ir. Tri Fajar,MT, selaku Dosen Pembimbing I
2. Bapak Ir. H. Ilman Noor, MSCE, selaku Dosen Pembimbing II
3. Bapak Ir.M. Samsudin, MT , selaku dosen tamu
4. Bapak Ir. Widodo, MSCE, PhD, selaku Dekan Fakultas Teknik Sipil dan Perencanaan Universitas Islam Indonesia Yogyakarta
5. Bapak Ir. H. Munadhir, MS, selaku Ketua Jurusan Teknil Sipil Fakultas Teknik Sipil dan Perencanan Universitas Islam Indonesia Yogyakarta
6. Bapak Ir. M. Suseno MT, PhD selaku konsultan pengawas proyek Gedung Administrasi Universitas Sanata Dharma

4.5.4 Kuat Tumpuan Pondasi 22
4.5.5 Perencanaan Tulangan telapak pondasi 228
4.6 Perencanaan Tangga 23
4.6.1 Spesifikasi struktur 231
4.6.2 Pembebanan 232
4.6.3 Perhitungan Balok Bordes 233
4.6.4 Perhitungan Balok Induk 233
4.6.5 Perencanaan Pondasi Tangga 234
4.7 Tabel Hasil Perhitungan 239
BAB V PEMBAHASAN 250
5.1 Umum 250
5.2 Atap 251
5.3 Pelat 252
5.4 Balok Anak 253
5.5 Balok Induk 253
5.6 Kolom 254
5.7 Pondasi 254
5.8 Tangga 254
BAB IV KESIMPULAN DAN SARAN 255
6.1 Kesimpulan 255
6.2 Saran 256
DAFTAR PUSTAKA
LAMPIRAN

DAFTAR GAMBAR

NO.	NO.GAMBAR	KETERANGAN	HAL
1.	Gambar 3.1	Flow chart perencanaan balok bertulangan sebelah	41
2.	Gambar 3.2	Flow chart perencanaan balok bertulangan rangkap	42
3.	Gambar 3.3	Flow chart desain penulangan torsional dan geser	44
4.	Gambar 3.4	Pertemuan balok dan kolom dengan sendi plastis di kedua ujungnya	54
5.	Gambar 3.5	Daerah geser satu arah pada penampang pondasi	65
6.	Gambar 3.6	Daerah geser dua arah pada penampang pondasi	65
7.	Gambar 4.1	Kuda – kuda 1	66
8.	Gambar 4.2	Kuda – kuda 2	112
9.	Gambar 4.3	Kuda – kuda 3	112
10	Gambar 4.4	Kuda – kuda 3'	112
11	Gambar 4.5	Kuda – kuda 4	113
12	Gambar 4.6	Kuda – kuda JURAI	113
13	Gambar 4.7	Penampang balok grid	137
14	Gambar 4.8	Detail tulangan tumpuan balok grid	142
15	Gambar 4.9	Detail tulangan lapangan balok grid	144

16.	Gambar 4.10	Penampang balok anak lantai 6	145
17.	Gambar 4.11	Tipe – tipe pembebanan	161
18.	Gambar 4.12	Pembebanan lantai 1-4	164
19.	Gambar 4.13	Pembebanan lantai 5	165
20.	Gambar 4.14	Pembebanan atap	166
21.	Gambar 4.15	Grafik Mn-Pn untuk kolom 15	190
22.	Gambar 4.16	Grafik Mn-Pn untuk kolom 18	212
23.	Gambar 4.17	Diagram tegangan pondasi	222
24.	Gambar 4.18	Daerah geser satu arah pada penampang pondasi I	225
25.	Gambar 4.19	Daerah geser dua arah pada penampang pondasi I	227
26.	Gambar 4.20	Gambar tangga	234

DAFTAR TABEL

NO.	NO.TABEL	KETERANGAN	HAL
1.	Tabel 4.1	Gaya batang KK-1	90
2.	Tabel 4.2	Gaya batang KK-2	91
3.	Tabel 4.3	Gaya batang KK-3	92
4.	Tabel 4.4	Gaya batang KK3'	93
5.	Tabel 4.5	Gaya batang KK-4	94
6.	Tabel 4.6	Gaya batang KK-JURAI	95
7.	Tabel 4.7	Perencanaan dimensi KK-1	96
8.	Tabel 4.8	Perencanaan dimensi KK-2	96
9.	Tabel 4.9	Perencanaan dimensi KK-3	98
10.	Tabel 4.10	Perencanaan dimensi KK-3'	100
11.	Tabel 4.11	Perencanaan dimensi KK-4	102
12.	Tabel 4.12	Perencanaan dimensi KK-JURAI	104
13.	Tabel 4.13	Perencanaan sambungan KK-1	106
14.	Tabel 4.14	Perencanaan sambungan KK-2	106
15.	Tabel 4.15	Perencanaan sambungan KK-3	107
16.	Tabel 4.16	Perencanaan sambungan KK-3'	108
17.	Tabel 4.17	Perencanaan sambungan KK-4	109
18.	Tabel 4.18	Perencanaan sambungan KK-JURAI	110
19.	Tabel 4.19	Distribusi gaya geser horisontal akibat gempa	155
20.	Tabel 4.20	Pembebanan akibat gaya gravitasi	159

23.	Penulangan balok	lamp.9.30 - 9.52
24	Denah kolom	lamp.9.53
25.	Penulangan kolom	lamp.9.54 - 9.95
26.	Denah pondasi	lamp.9.96
27.	Penulangan pondasi	lamp.9.97 - 9.98
28.	Penulangan tangga	lamp.9.99 - 9.100

DAFTAR NOTASI

1. Perencanaan atap

a	: Jumlah sagrod dalam satu bentang	
A	: Luas profil baja	
Ag	: Luasan Bruto Profil	
Anetto	: Luasan bersih profil	
Aeffektif	: Luasan netto effektif	
B	: Lebar pelat kuda-kuda	
bf	: Lebar sayap	
b	: Lebar sayap	
C_1	: Gaya angin tekan	
C_2	: Gaya angin hisap	
Cc	:Perbandingan kelangsingan yang menjadi batas antara tekuk elastis dan tekuk inelastic	
D	: Diameter	
E	: Modulus elastisitas baja	
Fa	: Tegangan ijin pada luas bruto dalam kondisi beban bekerja	
fa	: Tegangan tarik yang terjadi	
fbx	: Tegangan lentur arah x	
fby	: Tegangan lentur arah y	
fc'	: Kuat tekan beton	
FS	: Faktor keamanan	
Fu	: Kuat tarik baja	
fy	: Tegangan leleh baja	
Ix	: Inersia arah X	

2. Perer

As

a

b

clx

ctx

cly

cty

d

fc'

fy

h

Iy

Ix

m

Mulx

Mutx

Muly

Muty

Mu

Mn

qD

qL

qU : Beban merata rencana

Rn : Koefisien tahanan untuk perencanaan kuat

: Rasio tulangan

b : Rasio tulangan pada keadaan seimbang

Ø : Koefisien reduksi kekuatan

3. Perencanaan Balok

As : Luas tulangan tarik

As` : Luas tulangan desak

b : Lebar balok

d : Tinggi efektif tulangan larik

d' : Tinggi efektif tulangan tekan

E : Modulus elastisitas beton

fc' : Kuat tekan beton

fy : Kuat tarik baja

h : Tinggi balok

I : Momen inersia balok

L : Panjang penampang

m : Perbandingan isi dari tulangan memanjang dari bentuk tertutup

Mn : Momen ominal balok

Mu : momen rencana balok

P_D : Beban mati terpusat

P_L : Beban hidup terpusat

P_u : Beban ultimit terpusat

R_A : Reaksi dukungan

Rn : Koefisien tahanan untuk perencanaan kuat

Vu : Gaya geser rencana

Vc : Kuat geser beton

Vs : Tegangan geser nominal yang disebabkan oleh tulangan

x : Reaksi perlawanan P

X : Jarak daerah geser ditinjau dari tengah bentang

1 : Konstanta yang berdasarkan mutu beton

: Rasio tulangan tarik

' : Rasio tulangan tekan

O : Faktor reduksi kekuatan

4. Perencanaan Kolom

a : Tinggi blok tegangan persegi ekivalen

As : Luas tulangan tarik

As' : Luas tulangan desak

Ast : Luas tulangan total

Ag : Luas bruto penampang

b : Lebar penampang kolom

Cc : Gaya tekan pada beton

Cs : Gaya pada tulangan tekan

Cm : Faktor untuk perbesaran momen

d : Jarak dari sisi tekan terluar ke pusat tulangan tarik

d' : Jarak dari sisi tekan terluar ke pusat tulangan tekan

e : Eksentrisitas actual

eb : eksentrisitas pada keadaan seimbang

Ec : Modulus elastisitas beton

Eg : Modulus elastisitas balok

Es : Modulus elastisitas baja tulangan

fc' : Kuat desak beton

fs : Tegangan tulangan tarik

fs' : Tegangan tulangan tekan

fy : tegangan leleh baja yang diisyaratkan

h : Tinggi penampang kolom

Ic : Momen inersia kolom

Icr : Momen inersia balok

Ig : Momen inersia dari penampang bruto balok

k : Faktor panjang efektif

In : Panjang batang bersih

lu : Panjang tak bertumpu

Lc : Panjang bersih kolom

Lg : Panjang bersih balok

m : Perbandingan isi dari tulangan memanjang dari bentuk tertutup

M_b : Momen akibat beban tetap

M_{1b} : momen factor terbesar pada ujung komponen akibat beban tetap

M_{2b} :Momen factor terbesar pada ujung komponen akibat beban sementara

M_D: Momen akibat beban mati

M_E : Momen akibat beban gempa

M_L : Momen akibat beban hidup

Mn : Momen nominal

M_{nx} : Momen nominal yang bekerja pada sb x

M_{ny} : Momen nominal yang bekerja di sb y

Mox : Mmomen uniaksial ekivalen perlu pada arah sb x

Ø : FAktor reeeduksi kekuatan

Pc : Penjumlahan beban tekuk euler pada kolom satu tingkat/lantai

Pu : Penjumlahan beban tekuk ultimit pada kolom satu tingkat/lantai

: Jarak titik berat penampang dari sisi penampang terluar

5. Perencanaan Gempa

Ag : Luas bruto penampang

Ajh : Luas tulangan total efektif tulangan geser horizontal

Ajv : Luas tulangan geser join vertikal

As : Luas tulangan geser join vertikal

As' : Luas tulangan desak

Asc : Luas tulangan longitudinal tarik

Asc' : Luas tulangan longitudinal tekan

bj : Lebar efektif join

C : Koefisien gempa dasar

Cki : Gaya tekan tulangan arah kiri

Fx : Beban horizontal tiap lantai pada arah x

fy : Tegangan leleh baja

fc' : Kuat tekan beton

Fy : Beban horizontal tiap lantai pada arah y

hx : Tinggi gedung arah x

hy : TInggi gedung arah y

hk : Tinggi kolom bruto

h'k : Tinggi kolom netto

hc : Tinggi total penampang kolom dalam arah geser yang ditinjau

hw : Tinggi bangunan

Mx : Momen terhadap sumbu x

My : Momen terhadap sumbu y

Mu : Momen rencana

Mn : Momen nominal

m_1 :Jarak geser dari tepi pondasi terhadap sumbu x

m : Perbandingan isi dari tulangan memanjang dari bentuk tertutup

n_1 : Jarak geser dari tepi pondasi terhadap sumbu y

P : Gaya tekan yang bekerja

Pb : Selimut beton

Pn : Gaya tekan nominal

Pp : Panjang pondasi telapak

Qu : Tegangan kontak yang terjadi di dasar pondasi

Rn : Koefisien tahanan untuk perencanaan kuat

Vc : Kuat beton menahan geser

tk : Lebar penampang kolom

x : Panjang bidang geser kritis

y : Lebar bidang geser kritis

□ : Rasio tulangan

□b : Rasio tulangan dalam keadaan seimbang

□$_1$: Rasio antara sisi panjang terhadap sisi pendek pondasi

□c : Rasio sisi panjang terhadap sisi pendek dari beban terpusat

BAB I

PENDAHULUAN

1.1 Latar Belakang

Perencanaan struktur merupakan tindak lanjut dari proses perwujudan gagasan baik hasil survei, penyelidikan tanah maupun perencanaan arsitektur. Kriteria dasar perencanaan struktur tersebut harus memenuhi persyaratan yang ditinjau dari segi kekakuan, kekuatan, kestabilan dan ekonomis.

Suatu hal yang sangat penting dalam perencanaan/perancangan suatu struktur adalah analisis struktur. Dari analisa struktur tersebut didapat gaya-gaya data struktur, yang selanjutnya digunakan untuk menentukan dimensi/ukuran dari elemen-elemen struktur.

Dalam melaksanakan analisis struktur tersebut dapat dilakukan secara manual maupun dengan menggunakan alat bantu komputer. Ada bermacam-macam metode analisis yang dapat digunakan dalam menganalisa struktur secara manual, seperti metode Cross, Clayperon, Muto, Takabeya, Slope Deflection, dan sebagainya. Tentu saja analisa secara manual akan memakan waktu yang lama. Seiring dengan kemajuan teknologi, komputer banyak digunakan sebagai alat bantu dalam menganalisa struktur, seperti program SAP 90 yang disusun oleh

Edward L.Wilson dan Ashraf Habibullah yang kemudian disempurnakan dengan SAP 2000, program Microfeap II yang disusun oleh Warsukh K.N., Somporn A., dan Sarun U., program PORBID yang disusun oleh Kardiyono Tjokrodimulyo, dan sebagainya.

Dalam tugas akhir ini penulis menggunakan program SAP 90 untuk analisa struktur 2 dimensi dan SAP 2000 untuk analisa struktur 3 dimensi. Adapun struktur yang ditinjau adalah Gedung Administrasi Universitas Sanata Dharma Yogyakarta

1.2 Tujuan

Tujuan dari penulisan TA ini adalah untuk merancang struktur yang ditinjau, yaitu berupa perancangan baik dimensi maupun jumlah tulangan yang dibutuhkan berdasarkan atas data-data yang ada di lapangan.

1.3 Manfaat

Manfaat dari Tugas Akhir ini adalah dapat merancang suatu gedung bertingkat dengan berpedoman pada standar acuan yang berlaku, sehingga dapat dihasilkan pekerjaan yang aman dan ekonomis

1.4 Batasan Masalah

Ruang lingkup yang diperhatikan dalam Tugas Akhir ini adalah sebagai berikut:

1. Objek perhitungan dan perencanaan adalah Gedung Administrasi Universitas Sanata Dharma Yogyakarta.
2. Beban pada portal yang diperhitungkan adalah beban gravitasi dan beban gempa, sedangkan beban atap memperhitungkan beban angin.
3. Lokasi gedung berada dalam wilayah gempa III.
4. Struktur dirancang dengan tingkat daktalitas penuh (K=1).
5. Perencanaan atap menggunakan baja dengan menggunakan program SAP 90 (2 dimensi).
6. Perencanaan pelat, kolom dan balok menggunakan beton bertulang.
7. Perencanaan pondasi menggunakan pondasi telapak.
8. Struktur portal dianalisis dengan menggunakan program SAP 2000 (3 dimensi).

1.5 Peraturan

Dasar perencanaan analisis struktur ini berpedoman pada :

1. Tata Cara Perhitungan Struktur Beton untuk Bangunan Gedung 1991 SK SNI T-15-1991-03
2. Peraturan Pembebanan Indonesia untuk Gedung 1987.
3. Pedoman Perancangan Ketahanan Gempa untuk Gedung 1987.

1.6 Data Teknis Proyek

1.6.1 Lokasi Bangunan

Gedung Administrasi Universitas Sanata Dharma Yogyakarta berlokasi di desa Paingan, Kelurahan Maguwoharjo, Kecamatan Depok, Kabupaten Sleman DIY. Lokasi ini terletak diantara gedung kampus yang telah ada sebelumnya dan termasuk dalam wilayah konsep pembangunan Kampus Terpadu.

1.6.2 Luas dan *Elevasi* tiap lantai

Gedung Administrasi Universitas Sanata Dharma terdiri dari 6 lantai (termasuk *basement* dan *ground floor*) dengan fungsi dan *elevasi* masing-masing sebagai berikut:

1. lantai *basement* (± 0.0 m):
   - *Store Room* = 311 m^2
   - *Office* = 78 m^2
   - *Workshop* = 156 m^2
2. lantai *ground floor* (+ 3.6 m):
   - *Hall* = 518 m^2
   - *Books Store* = 59 m^2
   - *Administrasi Office* = 52 m^2
   - *BAAK* = 104 m^2
   - *Campus Ministry Front office* = 59 m^2
   - *Bank* = 52 m^2

3. lantai 1 (+ 8.6 m) :
   - *Library* = 518 m^2
   - *Lobby* = 103 m^2
4. lantai 2 (+ 13.1 m) :
   - *Electronic Library* = 104 m^2
   - *Activity Room* = 104 m^2
   - *Campus Ministery* = 25 m^2
   - *Administration* = 52 m^2
   - *Councelin* = 26 m^2
   - *Lobby* = 156 m^2
   - *Information Departement* = 156 m^2
5. lantai 3 (+ 17.6 m) :
   - *Multimedia Development* = 104 m^2
   - *Meeting Room* = 156 m^2
   - *Lobby* = 104 m^2
   - *Receiving Room* = 26 m^2
   - *Security Room* = 36 m^2
6. lantai 4 (+ 22.6 m) :
   - *Lobby* = 34 m^2
   - *Preparation* = 52 m^2
   - *Multi Purpose Hall* = 635 m^2

Total Luas Lantai : 3519 m^2

1.6.3 Sistem Struktur

Sistem struktur berupa portal 6 lantai dengan kolom terjepit pada *poer / pile cap* dan didukung pondasi telapak serta dihubungkan dengan balok menerus.

1.6.4 Mutu Bahan

Pada struktur ini digunakan mutu beton dengan f'c = 25 MPa dan dengan mutu baja tulangan yang ditentukan sebagai berikut :

1. Baja tulangan dengan Fy = 240 MPa (BJTP) untuk diameter < 12 mm
2. Baja tulangan dengan Fy = 400 MPa (BJTD) untuk diameter ≥ 12 mm

Penentuan nilai kuat tekan beton f'c menurut SK SNI T-15-1991-03 didasarkan pada hasil pengujian tekan benda uji berbentuk silinder diameter 150 mm dan 300mm. Bila benda uji berbentuk kubus, maka nilai f'c diharuskan dengan menggunakan rumus berikut:

$fc' = (0{,}76+0{,}2\ ^{10}\log (f_{ck}'/15).\ f_{ck}'$

Dimana:

fc'= kuat tekan beton yang disyaratkan (MPa)

f_{ck}'= kuat tekan beton yang didapat dari hasil pengujian tekan beton berbentuk kubus dengan sisi 150 mm (MPa)

1.6.5 Fondasi

Secara umum, kondisi tanah yang ada cukup baik walaupun terdapat variasi, baik arah vertikal maupun horisontal. Dengan kondisi tersebut, untuk bangunan Gedung Administrasi Universitas Sanata Dharma dimungkinkan penggunaan fondasi dangkal (langsung) yang berupa individual spread footing atau continuous footing. Penggunaan fondasi tersebut disarankan untuk

meletakkan dasar fondasi pada kedalaman antara 3.50 – 4.0 meter di bawah muka tanah setempat.

Kapasitas dukung tanah yang diperbolehkan untuk jenis fondasi dan kedalaman sebagaimana disebutkan di atas dapat diambil :

qa = 2.5-3.0 kg/cm2 = 250 – 300 kN/m2

Penggunaan fondasi langsung lebih dalam lagi tidak disarankan karena air tanah yang mengalir pada lapisan air cukup deras.Jenis fondasi lain mungkin mengalami masalah. Tiang pancang akan sulit dipancang dan menimbulkan kebisingan. Tiang sumuran akan mengalami kesulitan pada pengeringan lubang dan tiang bor juga akan mengalami kesulitan dalam pengeboran maupun mengontrol air tanah dalam lapisan pasir.

BAB II

TINJAUAN PUSTAKA

2.1. Struktur Atas

Yang dimaksud dengan struktur atas (upper-structure) adalah elemen bangunan yang berada di atas permukaan tanah. Dalam proses perencanaan ulang (*redesign*) Gedung Administrasi Universitas Sanata Dharma ini meliputi : kuda-kuda atap, pelat lantai, kolom , balok, dan portal.

2.1.1. Atap

Atap adalah elemen struktur yang berfungsi melindungi bangunan beserta apa yang ada didalamnya dari pengaruh panas dan hujan. Bentuk atap tergantung dari beberapa faktor, misalnya : iklim, arsitektur, utilitas bangunan, dan sebagainya, dan kemudian menyerasikannya dengan rangka bangunan atau bentuk denah agar dapat menambah indah dan anggun serta menambah nilai harga bangunan itu.

2.1.2. Plat

Plat merupakan panel-panel beton bertulang yang mungkin bertulangan satu atau dua arah saja, tergantung sistem strukturnya. Kontinuitas penulangan plat diteruskan masuk ke dalam balok-balok dan diteruskan ke dalam kolom. Dengan demikian, sistem plat secara keseluruhan menjadi satu kesatuan

monolit membentuk rangka struktur bangunan kaku statis tak tentu yang sangat komplek sehingga mengakibatkan timbulnya momen, gaya geser, dan lendutan (*Istimawan,1994*).

Berdasarkan perbandingan bentang panjang dan pendek, plat dibedakan menjadi dua, yaitu plat satu arah dan plat dua arah.

1. **Plat Satu Arah**

Plat satu arah adalah plat yang didukung pada dua tepi yang berhadapan sedemikian sehingga lenturan timbul hanya dalam satu arah saja, yaitu pada arah yang tegak lurus terhadap arah dukungan tepi. Atau dengan kata lain plat satu arah adalah plat yang mempunyai perbandingan antara sisi panjang terhadap sisi pendek yang saling tegak lurus lebih besar dari dua, dengan lenturan utama pada sisi yang lebih pendek (*Istimawan,1994*).

2. **Plat Dua Arah**

Plat dua arah adalah plat yang didukung sepanjang keempat sisinya, dengan lenturan yang akan timbul pada dua arah yang saling tegak lurus, atau perbandingan antara sisi panjang dan sisi pendek saling tegak lurus kurang dari dua (*Istimawan,1994*).

2.1.3. Balok

Balok adalah batang struktural yang hanya menerima beban vertikal, beban lentur dari plat, berat dinding dan beban gempa. Selain itu juga berfungsi sebagai pengikat kolom-kolom dan menambah kekakuan horisontal pada struktur.

2.1.4. Kolom

Kolom adalah komponen struktur yang berfungsi menahan kombinasi beban tekan aksial dan momen lentur akibat berat sendiri, berat balok dan kolom diatasnya dan meneruskannya ke pondasi serta menahan beban gempa.mengalami gaya tekan.

Kolom merupakan komponen struktur dengan rasio tinggi terhadap dimensi lateral terkecil sama dengan tiga atau lebih digunakan terutama untuk mendukung beban aksial tekan. (SK SNI T-15-1991-03).

2.1.5. Portal

Portal adalah suatu rangka struktur pada bangunan gedung yang harus mampu menahan beban-beban yang bekerja, baik beban mati, beban hidup, maupun beban sementara.

1. Portal Tak Bergoyang (braced framed)

Portal tak bergoyang didefinisikan sebagai portal dimana tekuk goyangan dicegah oleh elemen-elemen topangan struktur tersebut dan bukan oleh portal itu sendiri. (*Salmon & Johnson, 1996*).

Sebuah portal dikatakan tak bergoyang jika :

- Portal tersebut simetris dan bekerja beban yang simetris
- Portal yang mempunyai kaitan dengan konstruksi lain yang tidak dapat bergoyang.

2. Portal Bergoyang

Portal dikatakan bergoyang jika:

- Beban yang tidak simetris yang bekerja pada portal yang simetris atau tidak simetris.
- Dapat pula disebabkan beban simetris yang bekerja pada portal yang tidak simetris.

2.1.6. Tangga

Tangga merupakan bangunan non struktur yang berfungsi sebagai sarana penghubung antar lantai pada gedung bertingkat.

2.2. Struktur Bawah (Pondasi)

Pondasi didefinisikan sebagai komponen struktur pendukung bangunan terbawah dan telapak pondasi berfungsi sebagai elemen terakhir yang meneruskan beban ke tanah, sehingga telapak pondasi harus memenuhi persyaratan untuk mampu dengan aman menebar beban yang diteruskan sedemikian rupa sehingga kapasitas atau daya dukung tanah tidak terlampaui (*Istimawan,1994*).

Pondasi adalah bagian dari suatu sistem rekayasa yang meneruskan beban yang ditopang oleh pondasi dan beratnya sendiri kepada dan kedalam tanah dan batuan yang terletak dibawahnya (*Bowles,1991*).

Secara umum, kondisi tanah yang ada cukup baik walaupun terdapat variasi, baik arah vertikal maupun horisontal. Dengan kondisi tersebut, untuk bangunan Gedung Administrasi Universitas Sanata Dharma dimungkinkan penggunaan fondasi dangkal (langsung) yang berupa individual spread footing atau continuous footing. Penggunaan fondasi tersebut disarankan untuk

meletakkan dasar fondasi pada kedalaman antara 3.50 – 4.0 meter di bawah muka tanah setempat.

Kapasitas dukung tanah yang diperbolehkan untuk jenis fondasi dan kedalaman sebagaimana disebutkan di atas dapat diambil :

qa = 2.5-3.0 kg/cm2 = 250 – 300 kN/m2

Penggunaan fondasi langsung lebih dalam lagi tidak disarankan karena air tanah yang mengalir pada lapisan air cukup deras.Jenis fondasi lain mungkin mengalami masalah. Tiang pancang akan sulit dipancang dan menimbulkan kebisingan. Tiang sumuran akan mengalami kesulitan pada pengeringan lubang dan tiang bor juga akan mengalami kesulitan dalam pengeboran maupun mengontrol air tanah dalam lapisan pasir.

2.3. Dasar Pengoperasian SAP 2000

1. Perintah *File*

   Perintah ini digunakan untuk memulai bentuk model baru yang akan keluar pada layar/display. Membuat model baru dengan memilh *File Menu* kemudian pilih *New Model* dan pilih *Template* untuk membuat suatu model dari program yang telah disediadakan SAP 2000. Keluaran suatu model SAP 2000 juga dapat diperoleh dari analisis SAP 2000 text file, import SAP 90 yang mempunyai ekstensi file .$2K atau dari AutoCAD (hanya bentuk geometrinya saja) yang akan disimpan dalam .DXF file.

2. Perintah *Editing*

Editing digunakan untuk membuat pilihan/merubah suatu model. Perintah ini tinggal mengaktifkan *Edit Menu* kemudian memilih salah satu menu yang tersedia misalnya :

- *Add To Model From Template*, digunakan untuk menambah model dari template.
- *Replicate*, digunakan untuk menggenerasikan model yang besar seperti "Linear Array", "Arrial Array", dan lain-lain.
- *Divide Frames*, digunakan untuk membagi elemen shell menjadi beberapa elemen yang diinginkan.
- *Change Label*, digunakan untuk mengubah label joint dan elemen.

3. Perintah *Viewing*

Perintah ini digunakan untuk melihat beberapa pilihan tampilan struktur yaitu dengan memilih *View Menu* pada menu bar atau memilih tombol view pada main toolbar yang memuat :

- Tampilan model 2-D yang dapat diubah bidang koordinatnya seperti bidang X-Y, X-Z, atau Y-Z dan 3D.
- Tampilan prospektif strukturnya
- Perintah zoom, pan (tampilan keseluruhan dengan menggeser mouse), limits.

- Pada item menu *Refresh Window*, digunakan untuk membersihkan jendela layar dari joint yang tidak digunakan atau jika sebelumnya telah dilakukan penghapusan elemen.
- Pada menu *Refresh View*, digunakan untuk menampilkan model secara penuh setelah adanya penambahan grid dan sebagainya yang sebelumnya tidak nampak di layar.

4. Perintah *Defining*

Perintah *defining* digunakan untuk membuat satu kesatuan nama dari suatu geometri pada model. Perintah defining meliputi:

- Material properties
- Tampang bahan frame dan shell
- Kondisi beban tetap
- Joint dengan beban temperatur dan tekan
- Analisis dan fungsi response-spectrum
- Analisis dan fungsi time-history
- Kombinasi Beban
- Obyek group

5. Perintah *Drawing*

Untuk menggambar penambahan/ modify obyek yang baru pada suatu model yang meliputi elemen frame, shell, dan joint dengan memilih *Draw Menu* atau mengaktifkan tombol-tombol *Draw Mode* pada floating toolbar.

6. Perintah *Selecting*

   SAP 2000 memiliki kelebihan untuk menyeleksi suatu obyek atau beberapa obyek yaitu dengan memilih *Select Menu* pada menu bar atau memilih salah satu tombol *Select* Mode pada Floating Toolbar.

7. Perintah Assigning

   Perintah *Assigning* digunakan untuk membuat pilihan atau menunjuk material/bahan dan beban yang bekerja pada joint atau elemen. Operasi perintah ini dengan memilih *Assign Menu* pada menu bar.

8. Perintah *Analyzing*

   Setelah selesai membuat struktur yang komplit sehingga dapat dioperasikan dan dapat dianalisa model tersebut untuk menentukan hasil displacement, tegangan dan reaksi. Sebelum menjalankan *Analyzing* sebaiknya mengatur dan mengecek terlebih dahulu agar tidak terjadi kesalahan (error) atau peingatan (warning) yaitu menu pilihan set option pada menu bar *Analyze Menu.*

9. Perintah *Displaying*

   Tampilan digunakan untuk melihat model dan hasil analisis berupa tampilan grafik, tampilan datar, dan fungsi plot.

   - *Graphycal display* digunakan dalam model meliputi geometri sebelum terjadi deformasi, beban dan joint yang dikenai beban temperatur dan tekanan.
   - *Tabular Display* berfungsi untuk menampilkan hasil analisis yang lebih detail.

- Fungsi Plot merupakan hsil analisis dari *Respose-Spectrum* atau *time history* berupa kurva-kurva pada tiap-tiap joint yang akan ditampilkan.

10. Perintah *Designing*

Designing digunakan untuk mengecek elemen frame baja/beton dengan perancangan yang beda tetapi masih pantas/sesuai dengan keperluan dan biasanya perancangan ini setelah dianalyzing.

- Elemen baja frame/truss dapat secara otomatis memilih dengan baik berat minimum tampang dari beberapa pilihan kemudian dicek kembali.
- Elemen frame beton dapat memberikan penulangan baja arah memanjang dan baja geser secara otomatis dapat memilih sesuai kode seleksi perancangan dan hal ini tidak dapat dianalisis ulang.

11. Perintah *Optioning*

Menu Option pada SAP 2000 digunakan untuk menentukan/mengubah parameter-parameter sebagai berikut :

- Item Menu *Preferences*, digunakan untuk menentukan parameter desain struktur baja dan beton. Pada menu ini dilengkapi juga penentuan dimensi font yang ngin ditampilkan.
- Item menu *Colors*, digunakan untuk mengubah warna layar sesuai keinginan pengguna, misalnya warna background, poits, line, springs, restrains, dan juga warna materialnya.
- Item menu *Show Areal View*, digunakan untuk menampilkan model yang utuh dengan jendela kecil.

2.4. Perencanaan Konstruksi

2.4.1. Dasar Perencanaan

Beban-beban yang akan diperhitungkan dalam analisis struktur yang ditinjau adalah beban gravitasi dan beban gempa sedangkan beban horisontal angin tidak diperhitungkan.

Semua beban yang ditinjau akan terangkum dalam beban tetap dan beban sementara. Dengan kondisi pembebanan yang ditinjau sebagai berikut :

Beban Tetap = Beban Mati + Beban hidup

Beban Sementara = Beban Tetap + Beban Gempa , dimana :

BEBAN MATI : berat dari semua bagian dari suatu gedung yang bersifat tetap, termasuk segala unsur tambahan, penyelesaian-penyelesaian, mesin-mesin serta peralatan tetap yang merupakan bagian yang tak terpisahkan dari gedung itu.

BEBAN HIDUP : semua beban yang terjadi akibat penghunian atau penggunaan suatu gedung, dan ke dalamnya termasuk beban-beban pada lantai yang berasal dari barang-barang yang dapat berpindah, mesin-mesin serta peralatan yang tidak merupakan bagian yang tak terpisahkan dari gedung dan dapat diganti selama masa hidup dari gedung itu, sehingga mengakibatkan perubahan dalam pembebanan lantai dan atap itu.

BEBAN GEMPA: semua beban statik ekuivalen yang bekerja pada gedung atau bagian gedung yang menirukan pengaruh dari gerakan tanah akibat gempa itu.

Dalam perencanaan ini menggunakan metode kekuatan batas, dimana beban kerja dinaikkan dengan memberikan suatu faktor beban sehingga diperoleh suatu beban pada akhir keruntuhan.

Menurut SK-SNI-T-15-1991-03 ayat 3.3.2 faktor beban ditentukan sebagai berikut :

1. $U = 1{,}2\ D + 1{,}6\ L$
2. $U = 0{,}75\ (\ 1{,}2\ D + 1{,}6\ L + 1{,}6\ W\ )$ atau $U = 0{,}9\ D + 1{,}3\ W$
3. $U = 1{,}05\ (\ D + LR \pm E\ )$ atau $U = 0{,}9\ (\ D \pm E\ )$

Dimana :

U = Kuat perlu adalah kekuatan suatu komponen struktur atau penampang yang diperlukan untuk menahan beban berfaktor atau momen dan gaya dalam yang berkaitan dengan beban tersebut dalam suatu kombinasi.

D = Beban Mati adalah berat dari semua bagian dari suatu gedung yang bersifat tetap, termasuk segala tambahan, penyelesaian mesin –mesin serta peralatan tetap yang merupakan bagian yang tak terpisahkan dari gedung tersebut.

L = Beban Hidup adalah semua beban yang terjadi akibat pemakaian dan penghunian suatu gedung, termasuk beban –beban pada lantai yang berasal dari barang –barang yang dapat berpindah dan atau beban akibat air hujan.

BAB III

LANDASAN TEORI

3.1 Perencanaan Kuda -kuda

Ketentuan umum perencanaan kuda – kuda baja berdasarkan rumus –rumus AISC :

3.1.1 Perencanaan Batang Tarik :

$$Ag_{1perlu} = \frac{T}{0{,}60.Fy} \qquad \textbf{(3.1.1)}$$

$$Ag_{2perlu} = \frac{T}{0{,}50.Fu.\mu} + \text{Alubang} \qquad \textbf{(3.1.2)}$$

$$A_{lub\ ang} = \left(\frac{1}{8}" + \phi baut\right).tp.n \qquad \textbf{(3.1.3)}$$

$$r_{min} = \frac{L}{240} \qquad \textbf{(3.1.5)}$$

Dipakai profil yang luasnya (A) lebih besar dari nilai Ag_{min} terpakai

$$A_{netto} = A_{brutto} - A_{lubang} \qquad \textbf{(3.1.6)}$$

$$A_{effektif} = \mu \, . \, A_{netto} \qquad \textbf{(3.1.7)}$$

$\mu = 0{,}75$ s/d 1

Kontrol Tegangan Tarik yang terjadi

- Tampang tanpa lubang = $fa = \frac{T}{A_{profil}} \leq 0{,}6.Fy$ **(3.1.8)**

- Tampang ada lubang = $fa = \frac{T}{A_{effektif}} \leq 0{,}5.Fy$ **(3.1.9)**

3.1.2 Perencanaan Batang Desak

1. Kontrol Tekuk

$$\frac{bf}{tw} \leq \frac{76}{\sqrt{fy}} \qquad \textbf{(3.1.10)}$$

2. Kontrol Kelangsingan

- $Kl / r_{min} \leq Cc = \sqrt{\frac{2\pi^2 E}{Fy}}$ **(3.1.11)**

$$Cc = \frac{756}{\sqrt{Fy}} \quad ; (\text{Fy dalam Ksi}) \qquad \textbf{(3.1.12)}$$

$$Cc = \frac{6400}{\sqrt{Fy}} \quad ; (\text{Fy dalam kg/cm}^2) \qquad \textbf{(3.1.13)}$$

$$Fs = \frac{5}{3} + \frac{3kl/r}{8Cc} - \frac{(kl/r)^3}{8Cc^3} \qquad \textbf{(3.1.14)}$$

$$Fa = \frac{Fy}{Fs}\left[1 - \frac{(kl/r^2)}{2Cc^2}\right] \qquad \textbf{(3.1.15)}$$

- $kl / r_{min} > Cc$ **(3.1.16)**

$$Fa = \frac{12}{23}\frac{\pi^2.E}{(KL/r)^2} \qquad \textbf{(3.1.17)}$$

3. Kontrol Beban

$$T = Fa.A > P \qquad \textbf{(3.1.18)}$$

Keterangan :

L = panjang batang (cm)

T = gaya tarik (kg)

R = jari-jari inersia tekecil profil (cm)

Anetto = luas bersih penampang (cm2)

Ag = luas kotor penampang (cm2)

fa = tegangan tarik yang terjadi (kg/cm2)

n = jumlah batang

∅ = diameter (cm)

μ = faktor reduksi luas netto dengan kriteria :

- lebar sayap ≥ 2/3.x kedalaman sambungan pada sayap-sayap minimal 3 ikatan per garis dalam garis tekanan μ = 0,90
- minimum 3 ikatan pergaris tekanan yang tidak sama dengan kriteria (a) μ = 0,85
- ikatan pergaris tekanan μ = 0,75

Fa = tegangan ijin pada luas brutto dalam kondisi beban kerja (kg/cm2)

KL/r = angka kelangsingan elemen desak

Fs = faktor kemanan

T = beban ijin (kg)

3.1.3 Perencanaan Gording

1. Tegangan

$$\frac{f_b\perp}{0{,}60.F_y} + \frac{f_b//}{0{,}75F_y} \le 1 \qquad \textbf{(3.1.19)}$$

$$fbx = \frac{M\perp \max}{Sx} \qquad \textbf{(3.1.20)}$$

$$fby = \frac{M// \max}{Sy} \qquad \textbf{(3.1.21)}$$

2. Lendutan

$$\delta_\perp = \frac{5}{384}\frac{q\perp.L^4}{E.I_x} \le \frac{L}{360} \qquad \textbf{(3.1.22)}$$

$$\delta = \frac{5}{384}\frac{q_{//}.\left(\frac{L}{(a+1)}\right)^4}{E.I_y} \le \frac{L}{360} \qquad \textbf{(3.1.23)}$$

$$\delta = \sqrt{\delta_\perp^{\,2} + \delta_{//}^{\,2}} \qquad \textbf{(3.1.24)}$$

3.1.4 Perencanaan Sagrod dan Tierod

1. Sagrod

$$P = 0{,}33.\ Fu.\ A_{sagrod} \qquad \textbf{(3.1.25)}$$

$$P = P.\sin\alpha.Ss \qquad \textbf{(3.1.26)}$$

$$A_{sagrod} = \frac{P}{0{,}33.Fu} = \frac{1}{4}\pi\ D^2{}_{sagrod} \qquad \textbf{(3.1.27)}$$

Dipakai $= D_{sagrod} + 3$ mm **(3.1.28)**

2. Tierod

$T = P. \cos \alpha$ **(3.1.29)**

$T = 0{,}33 . Fu. A_{tierod}$ **(3.1.30)**

$$A_{tierod} = \frac{T}{0{,}33.Fu} = \frac{1}{4}\pi\ D^2_{tierod} \quad \textbf{(3.1.31)}$$

$$D_{tierod} = \sqrt{\frac{4.T}{0{,}33.Fu.\pi}} \quad \textbf{(3.1.32)}$$

Dipakai $= D_{tierod} + 3$ mm **(3.1.33)**

Keterangan :

$fb_{\perp}$ = tegangan lentur arah sumbu x (kg/cm^2)

$fb_{//}$ = tegangan lentur arah sumbu y (kg/cm^2)

fy = tegangan leleh baja (kg/cm^2)

Sx = modulus elastisitas tampang arah sumbu x (cm^3)

Sy = modulus elastisitas tampang arah sumbu y (cm^3)

$M_{\perp}$ = momen tegak lurus sumbu batang (kg.cm)

$M_{//}$ = momen sejajar sumbu batang (kg.cm)

δ = resultan lendutan (mm)

$\delta_{\perp}$ = lendutan tegak lurus sumbu batang (mm)

$\delta_{//}$ = lendutan sejajar (mm)

Ix = inersia arah sumbu x (mm^4)

Iy = inersia arah sumbu y (mm^4)

E = modulus elastisitas baja (Mpa)

P = gaya yang bekerja (kg)

$P_{//}$ = gaya sejajar sumbu batang (kg)

Fu = kuat tarik baja (kg/cm^2)

Ss = jarak beban sagrod (cm)

T = tegangan yang bekerja (kg/cm^2)

A = luas penampang baja (cm^2)

D = diameter baja (cm)

3.1.5 Perencanaan Sambungan

$$P_{tumpuan} = tp.\ D_{baut}\ .\ 1{,}2\ .\ Fu\ .\ N \qquad \textbf{(3.1.34)}$$

$$D_{baut} = \frac{P_{tumpuan}}{1{,}2\ tp.\ Fu\ .\ N} \qquad \textbf{(3.1.35)}$$

$$P_{geser} = A_{baut}.\ 0{,}33.\ Fu.2n = \tfrac{1}{4}\ \pi\ D^2_{baut}\ .0{,}33\ .\ Fu.2n \qquad \textbf{(3.1.36)}$$

$$D_{baut} = \sqrt{\frac{4.P_{geser}}{\pi.0{,}33.Fu.2n}} \qquad \textbf{(3.1.37)}$$

3.2 Perencanaan Pelat

3.2.1 Menentukan tebal minimum pelat (h)

Pada SK SNI T-15-1991-03 pasal 3.2.5 butir 3.3 memberikan pendekatan empiris mengenai batasan defleksi dilakukan dengan tebal pelat minimum sebagai berikut :

$$h \le \frac{Ln.\left(0{,}8 + \frac{fy}{1500}\right)}{36 + 5.\beta.\left[\alpha_m - 0{,}12.\left(1 + \frac{1}{\beta}\right)\right]} \qquad \textbf{(3.2.1)}$$

tetapi tidak boleh kurang dari : $h \le \frac{Ln.\left(0{,}8 + \frac{fy}{1500}\right)}{36 + 9.\beta}$ **(3.2.2)**

dan tidak perlu lebih dari : $h \le \frac{Ln.\left(0{,}8 + \frac{fy}{1500}\right)}{36}$ **(3.2.3)**

Dalam segala hal tebal minimum pelat tidak boleh kurang dari harga berikut :

- Untuk $\alpha_m < 2{,}0$ digunakan nilai h minimal 120 mm
- Untuk $\alpha_m \ge 2{,}0$ digunakan nilai h minimal 90 mm

Dimana : Ln = bentang bersih pada pelat dihitung dari muka kolom (mm)

α_m = rasio kekakuan balok terhadap pelat

β = rasio panjang terhadap lebar pelat

3.2.2 Menentukan momen lentur terjadi

Besar momen lentur dalam arah bentang panjang :

$$Mtx = 0{,}001.qu.Lx^2.Xtx \qquad \textbf{(3.2.4)}$$

$$Mlx = 0{,}001.qu.Lx^2.Xlx \qquad \textbf{(3.2.5)}$$

$$Mty = 0{,}001.qu.Lx^2.Xty \qquad \textbf{(3.2.6)}$$

$$Mly = 0{,}001.qu.Lx^2.Xly \qquad \textbf{(3.2.7)}$$

Dimana : qu = beban merata

Lx = panjang bentang pendek

Xtx = koefisien momen tumpuan arah x

Xlx = koefisien momen lapangan arah x

Xty = koefisien momen tumpuan arah y

Xly = koefisien momen lapangan arah y

Nilai koefisien momen (x) diambil dari tabel 13.3.1 dan 13.3.2 PBBI 1971

3.2.3 Menentukan Tinggi Manfaat (d) arah x dan y

$$\rho_b = \frac{0{,}85.f'c.\beta_1}{fy}\left\{\frac{600}{600+fy}\right\} \quad \textbf{(3.2.8)}$$

$$\rho_{max} = 0{,}75\ \rho_b \quad \textbf{(3.2.9)}$$

$$\rho_{min} = \frac{1{,}4}{fy} \quad \textbf{(3.2.10)}$$

Dimana :

ρ_b = rasio tulangan terhadap luas beton efektif dalam keadaan seimbang

ρ_{maks} = rasio tulangan maksimum

ρ_{pakai} = rasio tulangan yang dipakai dalam perencanaan

Pada pelat dua arah, tulangan momen positif untuk kedua arah dipasang saling tegak lurus. Karena momen positif arah bentang pendek (x) lebih besar dari bentang panjang (y), maka tulangan bentang pendek diletakkan pada lapis bawah agar memberikan d (tinggi manfaat) yang besar.

$$dx = h - Ph - \frac{1}{2}\phi tul.x \qquad (3.2.11)$$

$$dy = h - Ph - \phi tul.x - \frac{1}{2}\phi tul.y \qquad (3.2.12)$$

3.2.4 Menentukan Luas Tulangan (As) arah x dan y

$$Rn = \frac{Mu/\phi}{b.d^2} \qquad (3.2.13)$$

$$m = \frac{fy}{0{,}85.f'c} \qquad (3.2.14)$$

$$\rho_{ada} = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2.m.Rn}{fy}}\right) \qquad (3.2.15)$$

- Jika pada $\rho_{ada} > \rho_{maks}$ → tebal minimum (h) diperbesar
- Jika pada $\rho_{min} < \rho_{ada} < \rho_{maks}$ → dipakai nilai $\rho_{pakai} = \rho_{ada}$
- Jika $\rho_{ada} < \rho_{maks}$ dan juga $< \rho_{min}$, maka
  - $1{,}33.\ \rho_{ada} > \rho_{min}$ → dipakai nilai : $\rho_{perlu} = \rho_{min}$
  - $0{,}002 < 1{,}33.\ \rho_{ada} < \rho_{min}$ → dipakai nilai : $\rho_{perlu} = 1{,}33.\ \rho_{ada}$
  - $1{,}33.\rho_{ada} < \rho_{min}$, $1{,}33.\rho_{ada} < 0{,}002$ → dipakai nilai : $\rho_{perlu} = 0{,}002$

Setelah didapatkan nilai ρ_{perlu}, maka :

$As_{perlu} = \rho_{perlu}\ b.d$

Nilai lebar (b), diambil tiap 1 meter (1000 mm) (3.2.16)

Jarak antar tulangan : $s \leq \frac{A_1.b}{As_{perlu}}$ (3.2.17)

$$s \leq 2.h \quad (3.2.18)$$

$$s \leq 250mm \quad (3.2.19)$$

Diambil nilai jarak antar tulangan (s) yang terkecil, sehingga didapatkan nilai As ada :

$$As_{ada} = \frac{A_1.b}{s} \quad (3.2.20)$$

3.2.5 Kontrol kapasitas lentur pelat yang terjadi

Tinggi blok tekan beton :

$$a = \frac{As_{ada}.fy}{0,85.f'c.b} \quad (3.2.21)$$

Kapasitas lentur nominal pelat :

$$Mn = As_{ada}.fy.\left(d - \frac{a}{2}\right) \geq \frac{Mu}{\phi} \quad (3.2.22)$$

3.3 Perencanaan Balok

3.3.1 Perencanaan Balok dengan Tulangan Sebelah

1. Menentukan Rasio Tulangan

$$\rho_b = \frac{0,85.f'c.\beta_1}{fy} \left\{\frac{600}{600+fy}\right\} \quad (3.3.1)$$

$$\rho_{max} = 0,75\ \rho_b \quad (3.3.2)$$

$$\rho_{min} = \frac{1.4}{f_y} \quad (3.3.3)$$

Dalam perencanaan dipakai nilai ρ; $\rho_{pakai} = 0{,}5.\rho_{maks}$ (3.3.4)

2. Menentukan tinggi efektif (d) dan lebar (b) penampang beton

$$m = \frac{fy}{0{,}85.f'c} \quad (3.3.5)$$

$$Rn = \rho.f_y\left[1 - \frac{1}{2}\rho.m\right] \quad (3.3.6)$$

$$b.d_{perlu}^2 = \frac{Mn}{Rn} \quad (3.3.7)$$

$$d_{perlu} = \sqrt{\frac{Mn}{Rn.b}} \quad (3.3.8)$$

- Tentukan ϕ tulangan rencana dan penutup beton (Pb)

  d = h – Pb - ϕ sengkang – (1/2) ϕ tul. Rencana

  Apabila d ≥ d_{perlu} maka dipakai tulangan sebelah

  Apabila d < d_{perlu} maka dipakai tulangan rangkap

- Menentukan ρ_{baru} dan Rn_{baru}

$$Rn_{baru} = \frac{Mn}{b.d^2} \quad (3.3.9)$$

$$\rho_{baru} = \frac{Rn_{baru}}{Rn}.\rho \quad (3.3.10)$$

- Menentukan luas tulangan (As)

$$As_{perlu} = \rho_{baru}.b.d \quad (3.3.11)$$

$$Jumlah \quad tulangan \quad (n) = \frac{As}{A.\phi_{tul}} \tag{3.3.12}$$

Kontrol Mn :

$$a = \frac{As.fy}{0{,}85.f'c.b} \tag{3.3.13}$$

$$Mn = As.fy.\left(d - \frac{a}{2}\right) \geq \frac{Mu}{\phi} \tag{3.3.14}$$

3.3.2 Perencanaan Balok dengan Tulangan Rangkap

1. **Menentukan As_1 dan Mn_1 :**

$$\rho_1 = (\rho - \rho') \tag{3.3.15}$$

$$As_1 = \rho_1.b.d \tag{3.3.16}$$

$$a = \frac{As_1.fy}{0{,}85.f'c.b} \tag{3.3.17}$$

$$Mn_1 = As_1.fy.\left(d - \frac{a}{2}\right) \tag{3.3.18}$$

2. **Menentukan Mn_2**

$$Mn_2 = \frac{Mu}{\phi} - Mn_1 \tag{3.3.19}$$

3. **Menentukan tulangan desak :**

$$fs' = 600\left(1 - \frac{0{,}85.f'c.\beta_1.d'}{(\rho - \rho').fy.d}\right) \tag{3.3.20}$$

jika fs` ≤ fy, maka tulangan desak belum leleh, dipakai fs` = fs`

fs ` > fy, maka tulangan desak sudah leleh, dipakai fs` = fy

4. Menentukan tulangan tarik

$$As_{ada} = As_1 + As' \qquad \textbf{(3.3.21)}$$

5. Kontrol kapasitas lentur yang terjadi

$$\rho = \frac{As_{ada}}{b.d} \qquad \textbf{(3.3.22)}$$

$$\rho' = \frac{As'_{ada}}{b.d} \qquad \textbf{(3.3.23)}$$

$$\rho - \rho' = \ldots\ldots \textbf{(3.3.2)}$$

- $fs' = 600\left(1 - \frac{0{,}85.f'c.\beta_1.d'}{(\rho - \rho').fy.d}\right) \leq fy \longrightarrow$ belum leleh **(3.3.24)**

$$a = \frac{As.fy - As'.fs'}{0{,}85.f'c.b} \qquad \textbf{(3.3.25)}$$

$$Mn_1 = (As.fy - As'.f's)\left(d - \frac{a}{2}\right) \qquad \textbf{(3.3.26)}$$

$$Mn_2 = As'.fs'(d - d') \qquad \textbf{(3.3.27)}$$

- $fs' = 600\left(1 - \frac{0{,}85.f'c.\beta_1.d'}{(\rho - \rho').fy.d}\right) > fy \longrightarrow$ leleh **(3.3.28)**

$$a = \frac{(As - As').fy}{0{,}85.f'c.b} \qquad \textbf{(3.3.29)}$$

$$Mn_1 = (As - As').fy.\left(d - \frac{a}{2}\right) \qquad \textbf{(3.3.30)}$$

$$Mn_2 = As'.fy.(d - d') \quad \textbf{(3.3.31)}$$

$$Mn_1 + Mn_2 > Mn \quad \textbf{(3.3.32)}$$

3.3.3 Perencanaan Tulangan Geser

1. Bila Vu ≤ 0,5 ϕ Vc → tidak perlu tulangan geser
2. Bila 0,5 ϕ Vc < Vu ≤ ϕ Vc
   a. Untuk pelat lantai, pelat atap, pondasi dan balok, dengan d ≤ 25 cm → tidak perlu tulangan geser
   b. Selain point a, dipakai tulangan geser minimum, sebesar :

$$s \le \frac{3.Av.fy}{b_w} \quad \textbf{(3.3.33)}$$

$$s \le d / 2 \quad \textbf{(3.3.34)}$$

$$s \le 600 \text{ mm} \quad \textbf{(3.3.35)}$$

3. Bila ϕ Vc < Vu ≤ (ϕ Vu + ϕ Vs_{min})

$$Vs_{min} = \frac{1}{3}.\sqrt{f'c}.b.d \quad \textbf{(3.3.36)}$$

Dipakai sengkang dengan jarak sebesar :

$$s \le \frac{Av.fy.d}{Vs} \quad ; \qquad Vs = Vu - \phi.Vc \quad \textbf{(3.3.37)}$$

$$s \le d / 2 \quad \textbf{(3.3.38)}$$

$$s \le 600 \text{ mm} \quad \textbf{(3.3.39)}$$

4. Bila (ϕ Vu + ϕ Vs_{min}) < Vu ≤ 3 ϕ Vc

dipakai sengkang dengan jarak sebesar :

$$s \leq \frac{Av.fy.d}{Vs} \quad ; \qquad Vs = Vu - \phi.Vc \tag{3.3.40}$$

$$s \leq d / 2 \tag{3.3.41}$$

$$s \leq 600 \text{ mm} \tag{3.3.42}$$

5. Bila 3 ϕ Vc < Vu < 5 ϕ Vc

Dipakai sengkang dengan jarak sebesar :

$$s \leq \frac{Av.fy.d}{Vs} \quad ; \qquad Vs = Vu - \phi.Vc \tag{3.3.43}$$

$$s \leq d / 4 \tag{3.3.44}$$

$$s \leq 300 \text{ mm} \tag{3.3.45}$$

6. Bila Vu > 5 ϕ Vc

Dimensi balok diperbesar atau dirubah

3.3.4 Perencanaan Torsi :

1. Kriteria tulangan geser dan torsi

   a. Jarak tulangan sengkang

$$s \leq \frac{x_1 + y_1}{4} \tag{3.3.46}$$

$$s \leq 300 \; mm$$

   b. Tulangan memanjang disebar merata ke semua sisi dengan jarak tulangan memanjang ≤ 300 mm

c. ϕ tulangan memanjang ≥ 12 mm

d. fy tulangan torsi ≤ 400 Mpa

e. Tulangan torsi harus ada paling tidak sejauh (b + d) dari titik ujung teoritis torsi yang diperlukan.

2. Identifikasi jenis torsi

   a. Diketahui gaya geser (Vu), momen torsi (Tu), momen lentur (Mn), gaya aksial (Nu).

   b. Diketahui penampang material : lebar badan (bw), tinggi (h), tinggi efektif (d), penutup beton (pb), luas sengkang kaki (Ask), luas tulangan struktur (As), kuat desak beton (f'c), tegangan leleh baja (fy).

   c. Untuk struktur statis tertentu : torsi keseimbangan

      Pengaruh torsi diperhitungkan apabila momen torsi terfaktor :

$$Tu \geq \phi\left(\frac{1}{20}.\sqrt{f'c}.\sum x^2.y\right) \qquad \textbf{(3.3.47)}$$

   d. Untuk struktur statis tak tentu : torsi kompabilitas

      Pengaruh torsi diperhitungkan apabila momen torsi terfaktor

$$Tu \geq \phi\left(\frac{1}{9}.\sqrt{f'c}.\sum x^2.y\right) \qquad \textbf{(3.3.48)}$$

3. Menghitung kuat momen torsi nominal $Tn = \dfrac{Tu}{\phi}$ **(3.3.49)**

4. Menghitung kuat torsi nominal (Tc) yang disumbangkan oleh beton

   a. Bila Puntir Murni + Geser

$$Tc = \frac{\left(\frac{1}{15}\sqrt{f'c}\Sigma x^2 y\right)}{\sqrt{1+\left(\frac{0,4.Vu}{Ct.Tu}\right)^2}} \qquad (3.3.50)$$

Faktor yang menghubungkan sifat tegangan geser

$$Ct = \frac{bw.d}{\sum x^2.y} \qquad (3.3.51)$$

b. Bila Puntir Murni + Geser + Gaya Aksial

$$Tc = \frac{\left(\frac{1}{15}\sqrt{f'c}\Sigma x^2 y\right)}{\sqrt{1+\left(\frac{0,4.Vu}{Ct.Tu}\right)^2}}.\left(1+0,3.\frac{Nu}{Ag}\right) \qquad (3.3.52)$$

$$Vc = \left(\frac{\frac{1}{6}\sqrt{f'c}.bw.d}{\sqrt{1+\left(2,5.Ct.\frac{Tu}{Vu}\right)^2}}\right).\left(1+0,3.\frac{Nu}{Ag}\right) \qquad (3.3.53)$$

5. Menghitung kuat momen torsi nominal yang disumbangkan oleh tulangan torsi (Ts), → Ts = Tn – Tc (3.3.54)

6. Kontrol Torsi yang terjadi

   a. Jika $\frac{Tu}{\phi} \le Tc$ ⟶ torsi diabaikan (3.3.55)

   b. Jika $\frac{Tu}{\phi} > Tc$ ⟶ perlu tulangan torsi (3.3.56)

- Torsi keseimbangan : $Ts = \frac{Tu}{\phi} - Tc$ **(3.3.57)**

- Torsi Kompabilitas : $Ts = \frac{1}{9}\sqrt{f'c}.\sum x^2.y.\frac{1}{3} - Tc$ **(3.3.58)**

c. Jika $\frac{Tu}{\phi} > 4.Tc$ tampang diperbesar **(3.3.59)**

Dimana :

Tn = kekuatan nominal tampang torsi (N.mm)

Tu = kekuatan torsi terfaktor akibat beban geser (N.mm)

Ts = kekuatan baja nominal menahan torsi (N.mm)

Tc = kekuatan beton nominal menahan torsi (N.mm)

Nu = gaya aksial terfaktor, (+) untuk tekan, (-) untuk tarik (N)

7. Menghitung perbandingan luas tulangan torsi dan jarak sengkang

$$\frac{At}{s} = \frac{Ts}{\alpha_1.x_1.y_1.fy} \quad \textbf{(3.3.60)}$$

$$\alpha_1 = \frac{1}{3}.\left(2 + \frac{y_1}{x_1}\right) \leq 1{,}5 \quad \textbf{(3.3.61)}$$

8. Menentukan tulangan geser + torsi

Bila $Vc < \frac{Vu}{\phi}$, maka diperlukan tulangan geser $Vs = \frac{Vu}{\phi} - Vc$ **(3.3.62)**

Perbandingan antara luas tulangan geser dan jarak :

$$\frac{Av}{s} = \frac{Vs}{fy.d} \quad \textbf{(3.3.63)}$$

Luas total sengkang (tulangan torsi + geser)

$$\frac{Avt}{s} = \frac{2.At}{s} + \frac{Av}{s} \geq \frac{bw.s}{3.fy} \qquad \textbf{(3.3.64)}$$

9. Merencanakan tulangan torsi memanjang

$$A_l = \frac{2.At}{s} \quad (x_1 + y_1) \qquad \textbf{(3.3.65)}$$

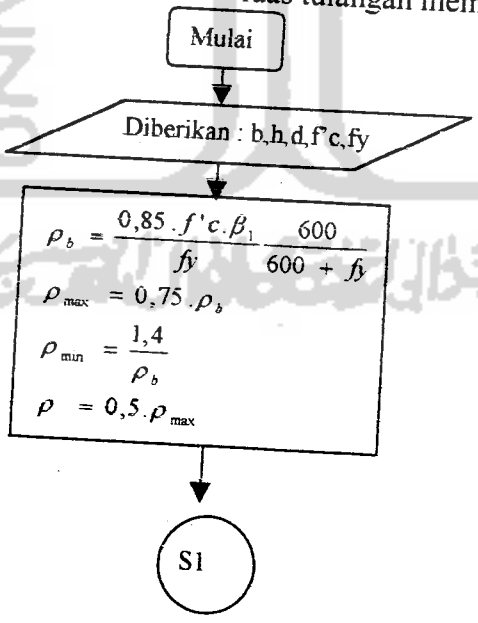
atau

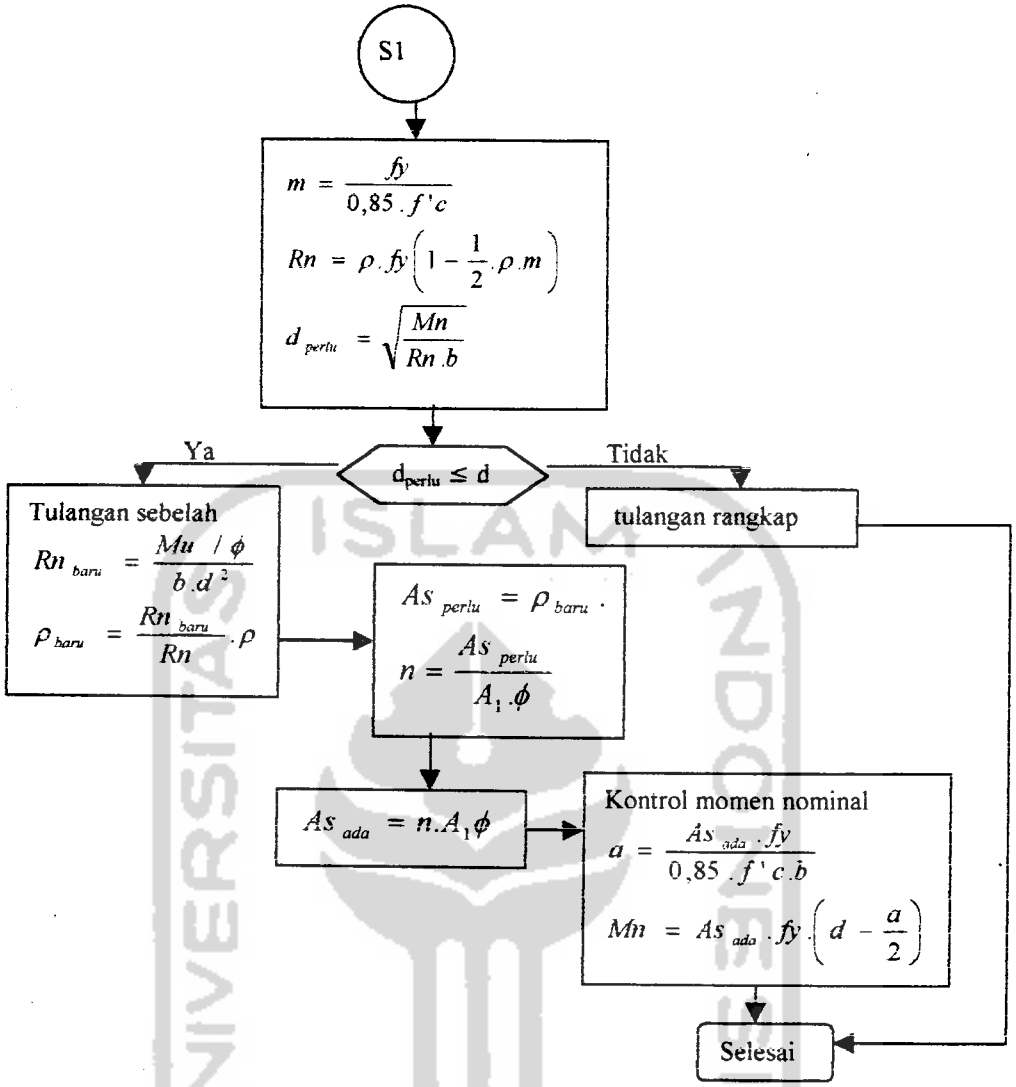
$$A_1 = \left[\frac{2{,}8 .x.s}{fy} \left[\frac{Tu}{Tu + \frac{Vu}{3.Ct}} \right] - 2.At \right] \frac{x_1 + y_1}{s} \qquad \textbf{(3.3.66)}$$

harga A_l dipilih yang terbesar dan harga 2 At dipilih yang terbesar juga dari $\frac{1}{3}\frac{bw.s}{fy} < 2.At$ dimana : Av = luas sengkang menahan geser (mm^2)

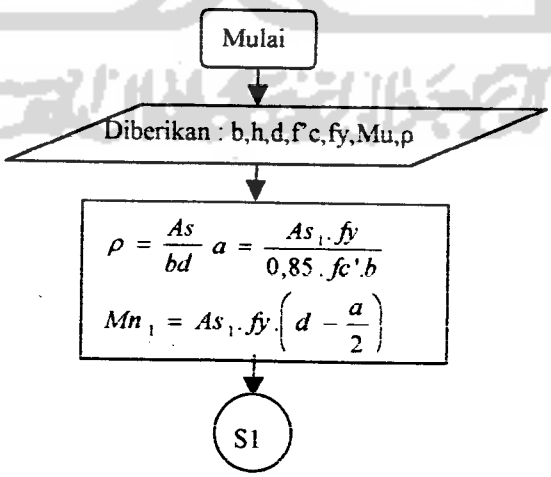
At = luas sengkang menahan torsi (mm^2)

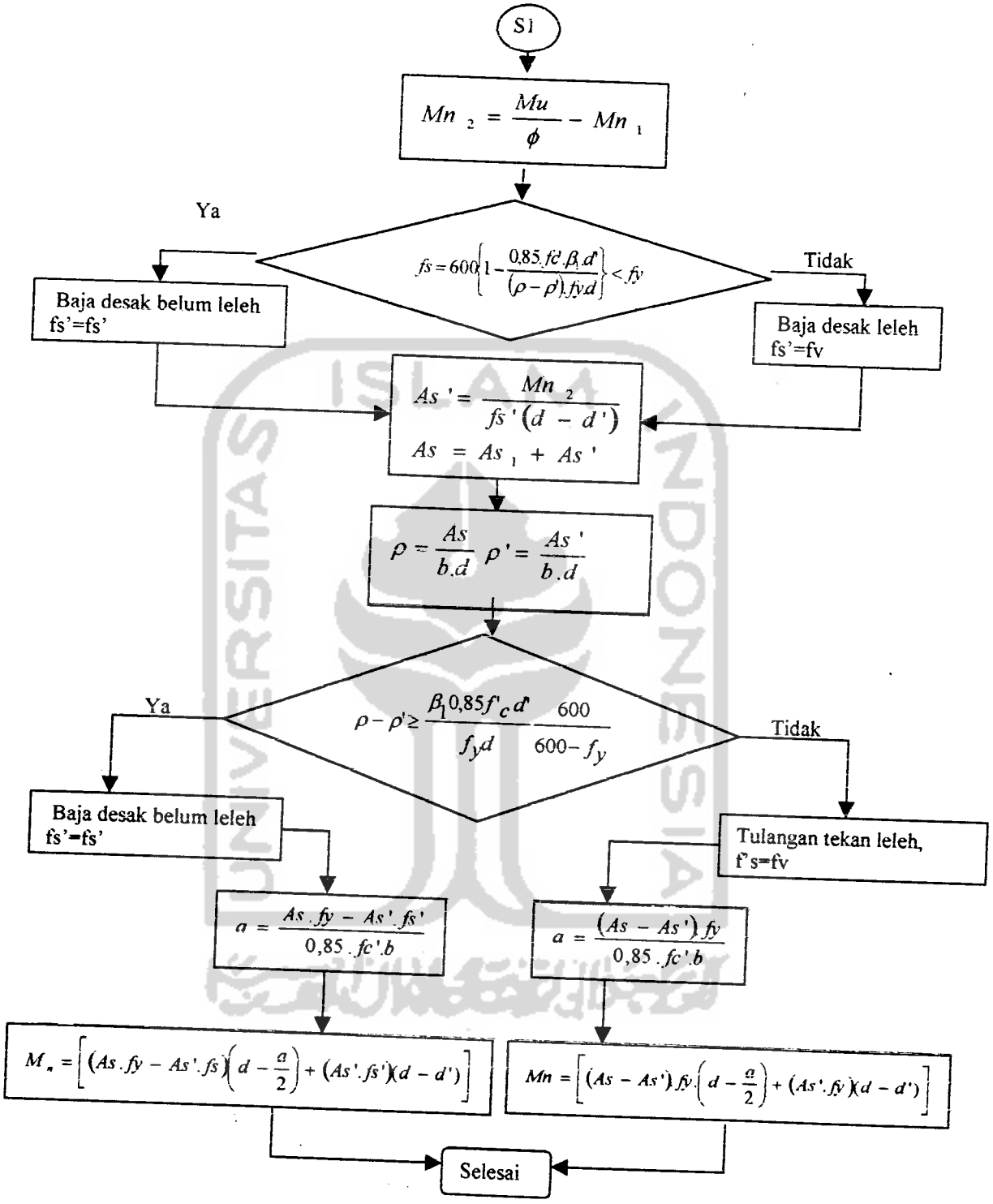
Al = luas tulangan memanjang pada torsi (mm^2)



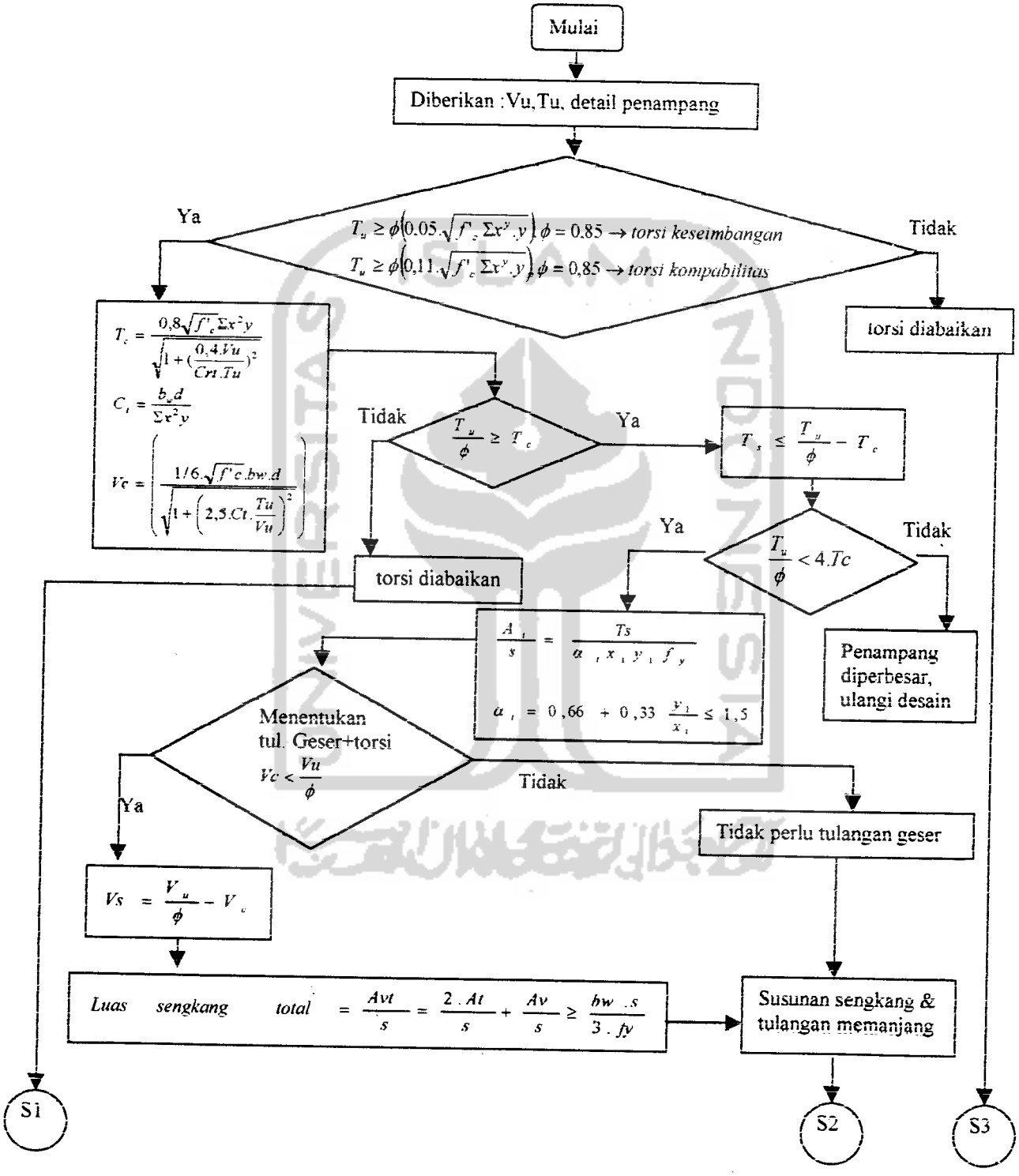


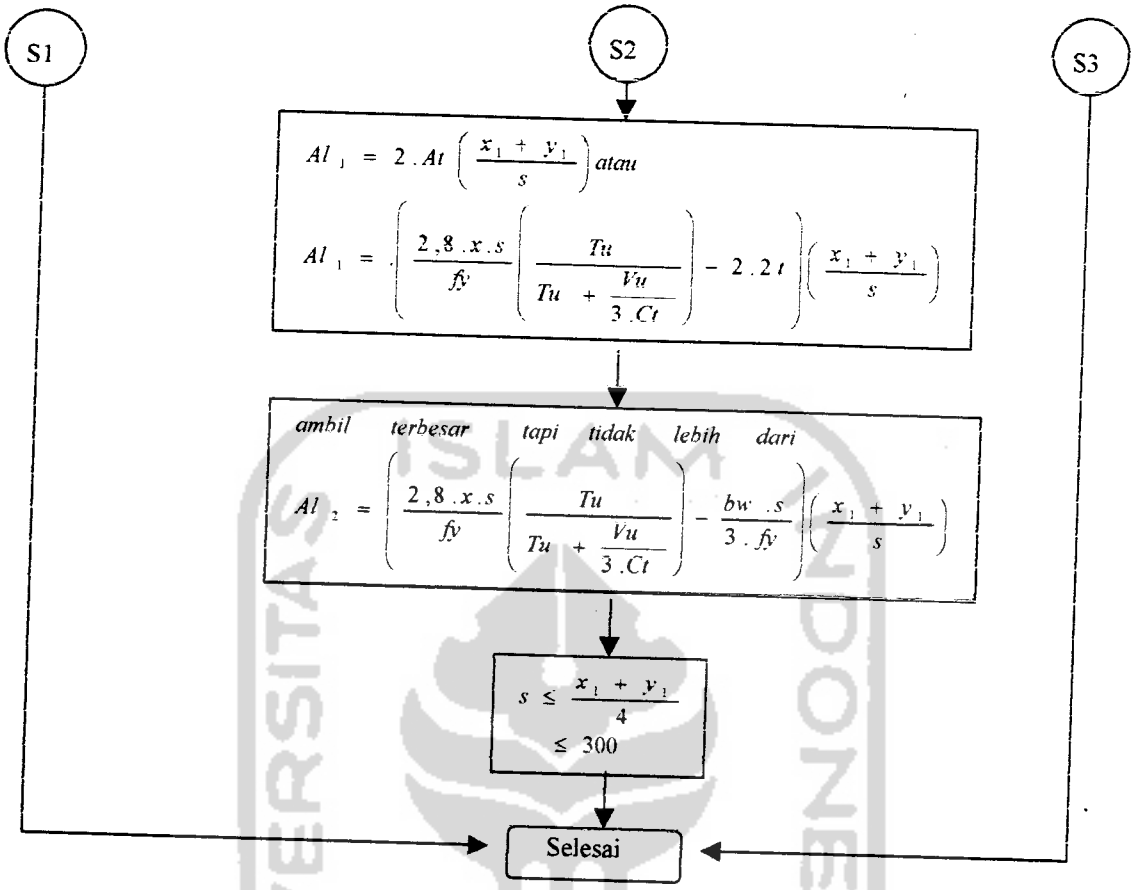
Gambar 3.1 *Flow Chart* Perencanaan Balok Bertulangan Sebelah





Gambar 3.2 *Flow Chart* Perencanaan Balok Bertulangan Rangkap


Mulai
Diberikan :Vu,Tu, detail penampang
Ya
$T_u \geq \phi\left(0.05.\sqrt{f'_c}.\Sigma x^2.y\right)\ \phi = 0.85 \rightarrow$ torsi keseimbangan
$T_u \geq \phi\left(0,11.\sqrt{f'_c}.\Sigma x^2.y\right)\ \phi = 0,85 \rightarrow$ torsi kompabilitas
Tidak
torsi diabaikan
$T_c = \frac{0,8\sqrt{f'_c}\Sigma x^2 y}{\sqrt{1+(\frac{0,4.Vu}{Crt.Tu})^2}}$
$C_t = \frac{b_w d}{\Sigma x^2 y}$
$Vc = \left(\frac{1/6.\sqrt{f'c}.bw.d}{\sqrt{1+\left(2,5.Ct.\frac{Tu}{Vu}\right)^2}}\right)$
Tidak
$\frac{T_u}{\phi} \geq T_c$
Ya
$T_s \leq \frac{T_u}{\phi} - T_c$
Ya
$\frac{T_u}{\phi} < 4.Tc$
Tidak
torsi diabaikan
$\frac{A_t}{s} = \frac{Ts}{\alpha_t x_1 y_1 f_y}$
$\alpha_t = 0,66 + 0,33\ \frac{y_1}{x_1} \leq 1,5$
Penampang diperbesar, ulangi desain
Menentukan tul. Geser+torsi
$Vc < \frac{Vu}{\phi}$
Ya
Tidak
Tidak perlu tulangan geser
$Vs = \frac{V_u}{\phi} - V_c$
Luas sengkang total $= \frac{Avt}{s} = \frac{2.At}{s} + \frac{Av}{s} \geq \frac{bw.s}{3.fy}$
Susunan sengkang & tulangan memanjang
S1
S2
S3



Gambar 3.3 *Flow Chart* Desain Penulangan Torsional dan Geser

3.4 Perencanaan Kolom

3.4.1 Perencanaan Kolom Pendek

Langkah-langkah perencanaan kolom pendek :

1. **Menentukan nilai b, h, fc', fy, d', d**
2. **Menghitung kapasitas kolom pendek**

$$Po = 0,85.fc'.(Ag - Ast) + Ast.fy \qquad \textbf{(3.4.1)}$$

- Untuk sengkang biasa :

$$\phi Pno = 0,8.\phi Po \qquad \textbf{(3.4.2)}$$

karena Pu ≤ ∅Pn, maka untuk kolom sehingga diperoleh Ag_{perlu} :

$$Ag_{perlu} = \frac{Pu}{0{,}8.\phi.(0{,}8.fc'.(1-\rho g)+fy.\rho g)} \quad (3.4.3)$$

- Untuk sengkang spiral

$$\phi Pno = 0{,}85.\phi Po \quad (3.4.4)$$

karena Pu ≤ ∅Pn, maka untuk kolom sehingga diperoleh Ag_{perlu} :

$$Ag_{perlu} = \frac{Pu}{0{,}85.\phi.(0{,}8.fc'.(1-\rho g)+fy.\rho g)} \quad (3.4.5)$$

Sehingga setelah nilai Ag diperoleh, panjang dan lebar sisi kolom persegi atau diameter kolom bulat dapat ditentukan :

$$Ag = b.h = \frac{1}{4}.\pi.D^2 \quad (3.4.6)$$

$$Ast = n\%.Ag = As + As' \quad (3.4.7)$$

$$As = As' = \frac{Ast}{2} \quad (3.4.8)$$

$$Po = 0{,}85.fc'.(Ag - Ast) + Ast.fy \quad (3.4.9)$$

$Pno = 0{,}8.Po$; untuk sengkang biasa (3.4.10)

Dimana :

Po = kuat desak aksial nominal pada eksentrisitas nol (N)

Pu = gaya desak aksial terfaktor pada eksentrisitas tertentu (N)

Pn = kuat desak aksial pada pada eksentrisitas tertentu (N)

Ast = luas tulangan total pada kolom (mm2)

As' = luas tulangan tekan pada kolom (mm2)

As = luas tulangan tarik pada kolom (mm2)

3. Tentukan nilai x yang akan digunakan :

Jika x >xb ; kolom ditinjau terhadap kegagalan akibat desak

Jika x < xb ; kolom ditinjau terhadap kegagalan akibat tarik

Dengan $xb = \frac{600}{600 + fy}.d$ **(3.4.11)**

Syarat kegagalan :

- Runtuh seimbang

x = xb

- Runtuh desak

Mn < Mnb ; e < eb ; Pn >Pnb

- Runtuh tarik

Mn < Mnb ; e > eb ; Pn < Pnb

$$fs' = \frac{x - d'}{x} \qquad \textbf{(3.4.12)}$$

Jika fs' > fy ⟶ fs' = fy

$$Cc = 0{,}85.fc'.b\,(xb.\beta_1) \qquad \textbf{(3.4.13)}$$

$$Cs = As'.(fs' - 0{,}85.fc') \qquad \textbf{(3.4.14)}$$

$$T = As.\,fy \qquad \textbf{(3.4.15)}$$

$$Pn = Cc + Cs - T \tag{3.4.16}$$

$$Mn = Cc.\left(\bar{y} - \frac{a}{2}\right) + Cs\left(\bar{y} - d'\right) + T\left(d - \bar{y}\right) \tag{3.4.17}$$

$$\bar{y} = \frac{h}{2} \tag{3.4.18}$$

$$e = \frac{Mn}{Pn} \tag{3.4.19}$$

Dimana :

Mn = kapasitas lentur kolom dalam keadaan seimbang

Pn = kuat desak aksial kolom

e = eksentrisitas gaya pada kolom

x = jarak serat terluar beton ke titik yang ditinjau

fs' = tegangan leleh baja tulangan

4. **Pada saat Pn = 0 ; Mn dihitung dengan menghitung seperti balok bertulangan sebelah**

$$a = \frac{As.fy}{0{,}85.fc'.b} \tag{3.4.20}$$

$$Mn = As.fy.\left(d - \frac{a}{2}\right) \tag{3.4.21}$$

3.4.2 Perencanaan Kolom Langsing

Tahap – tahap perencanaan kolom langsing adalah sebagai berikut :

1. Menentukan tingkat kelangsingan kolom

$$\text{Kelangsingan} = \frac{k.lu}{r} \qquad \textbf{(3.4.22)}$$

$$r = \sqrt{\frac{I}{A}} \qquad \textbf{(3.4.23)}$$

r = 0,3 . h (untuk kolom tampang persegi)

r = 0,25. D (untuk kolom tampang bulat)

Dimana :

k = faktor panjang efektif

lu = panjang bersih kolom (m)

r = radius girasi (mm)

I = inersia penampang (mm2)

A = luas tampang (mm2)

Mencari nilai k untuk kolom yang merupakan bagian portal

Sebagai langkah awal adalah menentukan nilai kekakuan relatif (ψ)

$$\Psi = \frac{\sum\left(\frac{EI}{l}\right).kolom}{\sum\left(\frac{EI}{l}\right)balok} \qquad \textbf{(3.4.24)}$$

kemudian ψ diplotkan ke dalam grafik nomogram sehingga didapat nilai k.

Batasan - batasan kolom disebut langsing adalah :

$\frac{k.l}{r} > 34 - 12\frac{Mb_1}{Mb_2}$, untuk rangka dengan pengaku lateral (tak bergoyang)

> 22, untuk rangka/ portal bergoyang

Dimana : M_{b1} dan M_{b2} adalah momen-momen ujung terfaktor pada kolom yang posisinya berlawanan ($M_{b1} \leq M_{b2}$)

2. Momen rencana

$$Mrencana = \delta_b . M_{b2}.M + \delta_b . M_{b2} \quad \textbf{(3.4.25)}$$

$$\delta_b = \frac{Cm}{\left(1 - \frac{Pu}{\phi.Pc}\right)} \geq 1 \quad \textbf{(3.4.26)}$$

$$\delta_s = \frac{1}{\left(1 - \frac{\sum.Pu}{\phi.\sum.Pc}\right)} \geq 1 \quad \textbf{(3.4.27)}$$

$$Pc = \pi^2.\frac{(Ec.Ik)}{(k.lk)^2} \quad \textbf{(3.4.28)}$$

Dalam peraturan SK SNI T-15-1991-03 pasal 3.3.11 ayat 5.2 memberikan ketentuan untuk memperhitungkan EI sebagai berikut :

$$EI = \frac{\frac{1}{5}(Ec.Ig) + Es.I_{se}}{1 + \beta_d} \quad \textbf{(3.4.29)}$$

Bila Ast $\leq$ 3 % . Ag, maka :

$$EI = \frac{Ec.Ig}{2{,}5.(1 + \beta.d)} \quad \textbf{(3.4.30)}$$

Dimana :

δ_b = pembesaran momen pada pembebanan tetap

δ_s = pembesaran momen pada pembebanan sementara

M_{b2}=Momen terfaktor terbesar pada ujung komponen tekan akibat pembebanan tetap

M_{s2}=Momen terfaktor terbesar pada ujung komponen tekan akibat pembebanan sementara

Pu = beban aksial kolom akibat gaya luar

ϕ = 0,65 = faktor reduksi

Pc = beban tekuk

Ec = modulus elastis beton

Es = modulus elastis baja tulangan

Ig = momen inersia beton dkotor (penulangan diabaikan)

I_{sc} = momen inersia terhadap sumbu pusat penampang komponen struktur

$$\beta_d = \frac{momen\ akibat\ beban\ mati\ rencana}{momen\ akibat\ beban\ total}$$

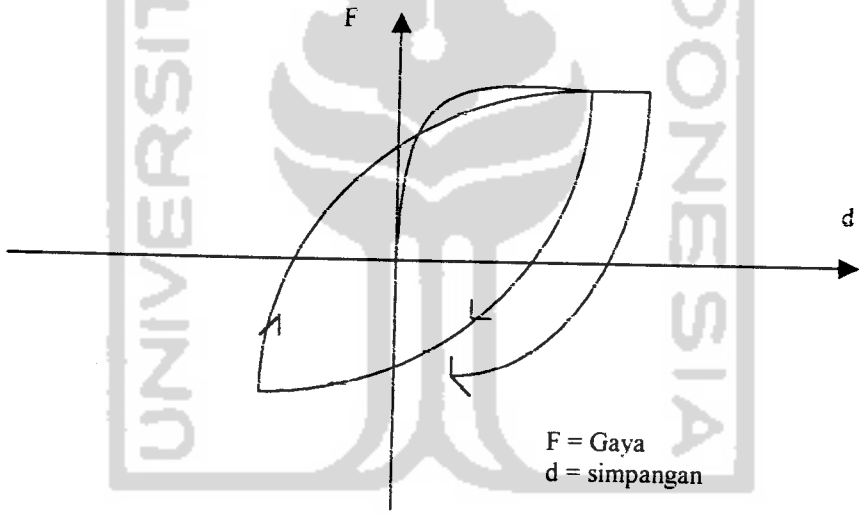
3. Mencari Mn dan Pn

$$Pn = \frac{Pu}{\phi} \qquad \textbf{(3.4.31)}$$

$$Mn = \frac{Mu}{\phi} \qquad \textbf{(3.4.32)}$$

3.5 Analisis Portal dengan Daktilitas Penuh

Daktilitas adalah kemampuan suatu struktur atau komponennya untuk melakukan deformasi inelastik bolak-balik berulang diluar batas titik leleh pertama, sambil mempertahankan sejumlah besar kemampuan daya dukung bebannya. Menurut Widodo, perencanaan tingkat daktilitas penuh memungkinkan struktur memberikan respon inelastik terhadap beban siklik yang bekerja dan mampu menjamin pengembangan mekanisme terbentuknya sendi-sendi plastis dengan kapasitas perencanaan energi yang diperlukan tanpa mengalami keruntuhan ($\mu = 4$, $K_{min} = 1$).



Gambar 3.1. Hubungan simpangan lawan gaya berulang yang besar.

(Pengantar Kuliah Gempa, Widodo,Ir.,MSCE.,Ph.D.)

Besarnya beban gempa menurut Pedoman Ketahanan Gempa untuk Rumah Tinggal Gedung [3] adalah:

$$V = C \cdot I \cdot K \cdot W \qquad (3.5.1)$$

dengan: V = gaya geser dasar horisontal total akibat gempa

C = koefisien gempa dasar (spektrum respon percepatan)

I = faktor keutamaan

K = faktor jenis struktur

W = berat total bangunan

3.5.1 Perencanaan Balok Portal Terhadap Beban Lentur

$$M_{u,b} = 1{,}2\ M_{D,b} + 1{,}6\ M_{L,B} \qquad \textbf{(3.5.2)}$$

$$M_{u,b} = 1{,}05\ (M_{D,b} + 1{,}6\ M_{L,B} \pm M_{E,b}) \qquad \textbf{(3.5.3)}$$

$$M_{u,b} = 0{,}9\ M_{D,b} \pm 1{,}6\ M_{E,Br} \qquad \textbf{(3.5.4)}$$

dimana: $M_{u,b}$ = kuat lentur balok portal

$M_{D,b}$ = momen lentur balok portal akibat beban mati tak terfaktor

$M_{L,B}$ = momen lentur balok portal akibat beban hidup tak terfaktor

$M_{E,B}$ = momen lentur balok portal akibat beban gempa tak terfaktor

Untuk Portal dengan daktilitas penuh, maka perlu pula dihitung kapasitas lentur sendi plastis balok yang ditentukan sebagai berikut :

$$M_{kap,b} = \phi\ .\ M_{nak,b} \qquad \textbf{(3.5.5)}$$

dengan : $M_{kap,b}$ = kapasitas lentur balok

ϕ = faktor penambah kekuatan

= 1,25 untuk fy < 400 Mpa

= 1,4 untuk fy > 400 Mpa

3.5.2 Perencanaan Balok Portal Terhadap Beban Geser

Persamaan yang terjadi adalah :

$$V_{u,b} = 0,7\frac{M_{kap} + M'_{kap}}{\ln} + 1,05.V_g \qquad (3.5.6)$$

Tetapi tidak perlu lebih besar dari:

$$V_{u,b} = 1,05\left(V_{o,b} + V_{L,b} \pm 4,0 / K.V_{E,b}\right) \qquad (3.5.7)$$

dimana: M_{kap} = momen kapasitas balok berdasrkan tulangan yang sebenarnya terpasang pada salah satu ujung balok atau bidang muka kolom

M'_{kap} = momen kapasitas balok berdasarkan tulangan yang sebenarnya terpasang pada ujung balok atau bidang muka kolom yang lain

$V_{u,b}$ = gaya geser rencan balok portal

$V_{o,b}$ = gaya geser balok akibat beban mati

$V_{L,b}$ = gaya geser balok akibat beban hidup

$V_{E,b}$ = gaya geser balok akibat beban gempa

K = faktor jenis struktur (K > 1,0)

3.5.3 Perencanaan Kolom Terhadap Geser

Untuk kolom atas dan bawah :

$$V_{u,k} = \frac{M_{u,katas} + M_{u,kbawah}}{h'_k} \qquad (3.5.8)$$

dengan syarat tidak boleh lebih dari

$$V_{u,k} = 1,05\left(V_{o,k} + V_{L,k} + \frac{4}{K}.V_{E,k}\right) \qquad (3.5.9)$$

dengan :

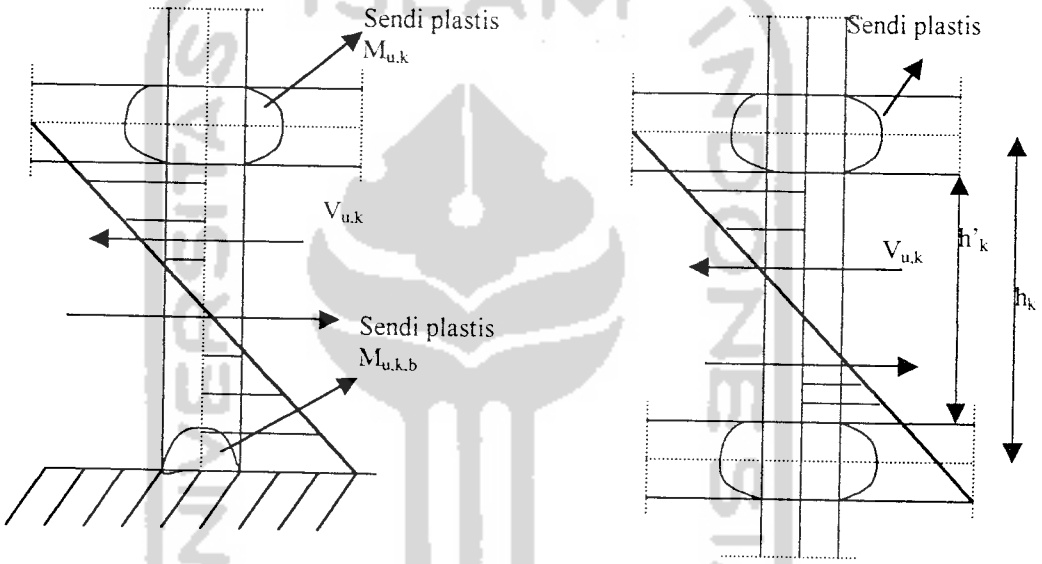
$V_{u,k}$ = kuat geser rencana kolom portal

$V_{o,k}$ = gaya geser kolom akibat beban mati tak terfaktor

$V_{L,k}$ = gaya geser kolom akibat beban hidup tak terfaktor

$V_{E,k}$ = gaya geser kolom akibat beban gempa tak terfakto

h'_k = tinggi bersih kolom



Gambar 3.4 Pertemuan Balok Kolom dengan Sendi Plastis di Kedua Ujungnya

3.5.4 Perencanaan Kolom Portal Terhadap Beban Lentur dan Aksial

Kuat lentur kolom portal dengan daktilitas penuh yang ditentukan pada bidang muka balok $M_{u,b}$ harus dihitung berdasarkan terjadinya kapasitas lentur sendi plastis pada kedua ujung balok yang bertemu dengan kolom tersebut, yaitu :

$$M_{u,k} = 0{,}7.\omega_d.\alpha_k\left(M_{kap,ki} + M_{kap,ka}\right) \qquad \textbf{(3.5.10)}$$

Tetapi dalam segala hal tidak perlu lebih besar dari :

$$M_{u,k} = 1{,}05_k\left(M_{o,k} + M_{l,k} \pm 4 / K.M_{E,k}\right) \qquad \textbf{(3.5.11)}$$

dengan:

$M_{u,k}$ = kuat lentur kolom portal

$M_{o,k}$ = momen kolom akibat beban mati

$M_{L,k}$ = momen kolom akibat beban hidup

$M_{E,k}$ = momen kolom akibat beban gempa

ω_d = faktor pembesar dinamis

α_k = faktor distribusi momen kolom

Beban aksial rencana $N_{U,k}$

$$N_{u,k} = \frac{0{,}7.Rn.\Sigma M_{kap.b}}{L_b} + 1{,}05.N_{g,k} \qquad \textbf{(3.5.12)}$$

Tetapi dalam segala hal tidak perlu lebih besar dari :

$$N_{u,k} = (1{,}05.N_{g,k} + 4 / K.N_{E,k}) \qquad \textbf{(3.5.13)}$$

dengan :

$N_{g,k}$ = gaya aksial kolom akibat beban gravitasi

$N_{E,k}$ = gaya aksial kolom akibat beban gempa

l_b = bentang balok

Rn = faktor reduksi yang ditentukan sebesar :

1,0 untuk 1 < n < 4

1,1 – 0,025.n untuk 4 < n < 20

-0,6 untuk n > 20

n = jumlah lantai diatas kolom yang ditinjau

3.5.5 Perencanaan Panel Pertemuan Balok Kolom

Gaya-gaya yang terjadi pada join rangka harus membentuk keseimbangan sebagai berikut :

$$V_{jh} = C_{ki} + T_{ka} - V_{kol} \qquad \textbf{(3.5.14)}$$

$$C_{ki} = T_{ki} = 0{,}7\frac{M_{kap,ki}}{Z_{ki}} \qquad \textbf{(3.5.15)}$$

$$C_{ka} = T_{ka} = 0{,}7\frac{M_{kap,ka}}{Z_{ka}} \qquad \textbf{(3.5.16)}$$

$$V_{koli} = \frac{0{,}7\left(\frac{ki}{'ka}M_{kap,ki} + \frac{ka}{'ka}M_{kap,ka}\right)}{\frac{1}{2}\left(h_{k,a} + k_{k,b}\right)} \qquad \textbf{(3.5.17)}$$

Tegangan geser nominal dalam join adalah :

$$V_{jh} = \left(\frac{b_j}{h_j}\right)V_{jvi} \le 1{,}5\sqrt{fc'} \quad (MPa) \qquad \textbf{(3.5.18)}$$

dengan : b_j = lebar efektif join (mm)

h_c= tinggi total penampang kolom arah geser yang ditinjau (mm)

Gaya geser horisontal V_{jh} ini ditahan oleh dua mekanisme kuat geser inti join yaitu :

a. Strat beton diagonal yang melewati daerah tekan ujung join yang memikul gaya geser V_{hc}.

b. Mekanisme panel rangka yang terdiri dari sengkang horisontal dan strat beton diagonal daerah tarik join yang memikul beban geser V_{sh}

Besarnya V_{ch} harus diambil sama dengan nol kecuali bila :

a. Tegangan tekan rata-rata minimal pada penampang bruto kolom beton di atas join, termasuk tegangan prategang, apabila ada, melebihi nilai 0,1 f'c, maka :

$$V_{ch} = \frac{2}{3}\left\{\sqrt{\frac{N_{n,k}}{A_g} - 0{,}1.f_c'}\right\} b_j.h_j \qquad \textbf{(3.5.19)}$$

b. balok diberi gaya prategang yang melewati join, maka :

$$V_{ch} = 0{,}7.P_{cs} \qquad \textbf{(3.5.20)}$$

P_{cs} : gaya permanen dalam baja prategang yang terletak di sepertiga bagian tengah tinggi kolom.

c. Seluruh balok pada join dirancang sehingga penampang kritis dari sendi plastis terletak pada jarak yang lebih kecil dari tinggi penampang balok diukur dari muka kolom, maka :

$$V_{ch} = 0{,}5\left(\frac{A_s'}{A_s}\right)V_{jh}\left(1 + \frac{N_{n,k}}{0{,}4.A_g.f_c'}\right) \text{ di mana rasio } \frac{A_s'}{A_s} \le 1 \qquad \textbf{(3.5.21)}$$

Bila tegangan tekan rata-rata minimum pada penampang bruto kolom di atas joint kurang dari $0{,}1f_c'\ (\rho_c < 0{,}1.f_c')$ maka :

$$V_{sh} = V_{jh} - \frac{2}{3}\sqrt{\frac{N_{u,k}}{A_g}} - (0{,}1.fc').b_{jh} \qquad \textbf{(3.5.22)}$$

Pada join rangka dengan melakukan relokasi sendi plastis

$$V_{sh} = V_{jh} - 0{,}5\frac{A_s'}{A_s}V_{jh}\left(1 + \frac{N_{u,k}}{0{,}4.A_g.f_c'}\right) \qquad \textbf{(3.5.23)}$$

Luas total efektif dari tulangan geser horisontal yang melewati bidang kritis diagonal dengan yang diletakkan di daerah tekan joint efektif b_j tidak boleh kurang dari :

$$A_{jh} = \frac{V_{jh}}{f_y} \qquad \textbf{(3.5.24)}$$

Geser join vertikal V_{jv} dapat dihitung dari :

$$V_{jv} = V_{jh}\frac{h_c}{b_j} \qquad \textbf{(3.5.25)}$$

Tulangan join geser vertikal didapat dari :

$$V_{sv} = V_{jv} - V_{cv} \qquad \textbf{(3.5.26)}$$

menjadi $V_{cv} = A_{sc}'\frac{V_{sh}}{V_{sc}}\left(0{,}6 + \frac{N_{u,k}}{A_g.f_c'}\right)$ **(3.5.27)**

dengan : A_{sc}' = luas tulangan longitudinal tekan

A_{sc} = luas tulangan longitudinal tarik

Luas tulangan join vertikal : $A_{vj} = \frac{V_{sv}}{f_y}$ **(3.5.28)**

3.6 Perencanaan Pondasi

Beban-beban yang bekerja pada pondasi telapak (foot plate) diperhitungkan dari beban kolom yang dipikul ditambah beban sendiri pondasi dan tanah diatasnya.

3.6.1 Tinjauan Terhadap Beban Tetap

Kombinasi beban yang bekerja

1. Dimensi Luas Telapak Pondasi

   Tebal Pondasi < 150 mm

$$A_{perlu} = \frac{P}{\sigma netto \tan ah - \left(\frac{My}{1/6.By^2.Bx}\right) - \left(\frac{Mx}{1/6.Bx^2.By}\right)} \qquad \textbf{(3.6.1)}$$

$$\sigma_{netto\ \tan ah} = \sigma_{\tan ah} - \sum(h.\gamma_{beton}) - \sum(h.\gamma_{\tan ah}) \qquad \textbf{(3.6.2)}$$

   Kemudian lebar (L) dan panjang (P) sisi telapak pondasi diketahui dan diperoleh nilai Aada :

$$A_{ada} = PxL > A_{perlu} \qquad \textbf{(3.6.3)}$$

2. Kontrol tegangan kontak yang terjadi di dasar pondasi

$$\sigma = \frac{P}{A_{ada}} + \frac{My}{1/6.P^2.L} + \frac{Mx}{1/6.L^2P} < \sigma_{netto\ \tan ah} \qquad \textbf{(3.6.4)}$$

   Jarak pusat tulangan tarik ke serat tekan beton :

$$d = h - Pb - 1/2.\phi_{tul\ pokok} \qquad \textbf{(3.6.5)}$$

   Keterangan :

   - Nilai P, Mx, My dari hasil analisis SAP 2000

- γ'_{tanah} = berat volume tanah (kN/m^3)
- h = tebal pelat telapak pondasi
- Pb = selimut beton

3.6.2 Tinjauan Terhadap Beban Sementara

Eksentrisitas yang terjadi :

$$e_x = \frac{Mx}{P}; e_y = \frac{My}{P} \qquad \textbf{(3.6.6)}$$

Kontrol tegangan yang terjadi :

$$\sigma = \frac{P}{\left(L.\left(P - 2.e.x\right)\right) + \left(P.\left(L - 2.e.y\right)\right)} < 1{,}5.\sigma_{netto\ tanah} \qquad \textbf{(3.6.7)}$$

3.6.3 Perencanaan Geser Satu Arah

1. Arah – X

$$m = \frac{P - hk - 2.d}{2} \qquad \textbf{(3.6.8)}$$

Tegangan kontak yang terjadi :

$$q = \frac{P}{A_{pela}} + \frac{My}{1/6.P^2.L} + \frac{Mx}{1/6.L^2 P} \qquad \textbf{(3.6.9)}$$

Gaya geser akibat beban luar yang bekerja pada penampang kritis pondasi :

$$Vu = qux_{terjadi}.m.L \qquad \textbf{(3.6.10)}$$

Kekuatan beton menahan geser pada arah – X :

$$Vc = 1/6.\sqrt{f'c}.L.d \geq \frac{Vu}{\phi} \qquad \textbf{(3.6.11)}$$

2. Arah – Y

$$n = \frac{L - tk - 2.d}{2} \quad \textbf{(3.6.12)}$$

Gaya geser akibat beban luar yang bekerja pada penampang kritis pondasi :

$$Vu = quy_{terjadi}.n.P \quad \textbf{(3.6.13)}$$

Kekuatan beton menahan geser pada arah – X :

$$Vc = 1/6.\sqrt{f'c}.P.d \geq \frac{Vu}{\phi} \quad \textbf{(3.6.14)}$$

3.6.4 Perencanaan Geser Dua Arah

$x = hk + d$ **(3.6.15)**

$y = tk + d$ **(3.6.16)**

Gaya geser akibat beban luar yang bekerja pada penampang kritis pondasi :

$Vu = qu.((P.L) - (x.y))$ **(3.6.17)**

Kekuatan beton menahan geser :

$$\beta c = \frac{sisi\ panjang}{sisi\ pendek} \quad \textbf{(3.6.18)}$$

$$bo = 2.(x + y) \quad \textbf{(3.6.19)}$$

$$Vc_1 = \left(1 + \frac{2}{\beta c}\right).\left(2\sqrt{f'c}\right)bo.D \quad \textbf{(3.6.20)}$$

$$Vc_2 = 4.\sqrt{f'c}.bo.D \quad \textbf{(3.6.21)}$$

Kontrol gaya geser (digunakan nilai yang terkecil dari Vc_1 dan Vc_2) :

$$Vc \geq \frac{Vu}{\phi} \qquad \textbf{(3.6.22)}$$

3.6.5 Kuat Tumpuan Pondasi

Kuat Tumpuan Pondasi

$$\phi.Pn = \phi.\left(0{,}8.f'c.A_1.\sqrt{\frac{A_2}{A_1}}\right) \qquad \textbf{(3.6.23)}$$

Luas pelat pondasi (A_2) = P.L **(3.6.24)**

Luas penampang kolom (A_2) = hk . tk **(3.6.25)**

$\sqrt{\frac{A_2}{A_1}} > 2$ (jika lebih besar dari 2, dipakai nilai 2) **(3.6.26)**

$$\phi..Pn = \phi.(0{,}85.f'c.A_1.2) \qquad \textbf{(3.6.27)}$$

Kuat tumpuan kolom :

$$\phi..Pn = \phi.(0{,}85.f'c.A_1) \qquad \textbf{(3.6.28)}$$

Kontrol kuat tumpuan :

$$\phi.Pn_{pondasi} > \phi.Pn_{kolom} \qquad \textbf{(3.6.29)}$$

3.6.6 Perencanaan Tulangan Lentur Pondasi

Momen yang terjadi :

Tulangan arah – x

$$l_1 = \frac{P - hk}{2} \qquad \textbf{(3.6.30)}$$

$$Mux = Mu_1 = 0{,}5qux.l_1^{\,2} \tag{3.6.31}$$

Tulangan arah - y :

$$l_2 = \frac{L - tk}{2} \tag{3.6.32}$$

$$Muy = Mu_2 = 0{,}5qux.l_2^{\,2} \tag{3.6.33}$$

Luas tampang 1 tulangan pokok : $A_{1\phi} = 1/4.\pi.D^2$ (3.6.34)

Tebal pelat (h) diasumsikan terlebih dahulu, sehingga nilai d dapat dicari :

$$d = h - Pb - 0{,}5.\phi_{tul.pokok} \tag{3.6.35}$$

$$m = \frac{fy}{0{,}85.f'c} \tag{3.6.36}$$

Koefisien ketahanan (Rn), diambil nilai b tiap 1000 mm :

$$Rn = \frac{Mu/\phi}{b.d} \tag{3.6.37}$$

Rasio tulangan :

$$\rho_{\min} = \frac{1{,}4}{fy} \tag{3.6.38}$$

$$\rho b = \frac{0{,}85.f'c.\beta_1}{fy}.\left(\frac{600}{600 + fy}\right) \tag{3.6.39}$$

$$\rho_{maks} = 0{,}75.\rho b \tag{3.6.40}$$

$$\rho_{ada} = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2m.Rn}{fy}}\right) \qquad \textbf{(3.6.41)}$$

Jika $\rho_{ada} > \rho_{maks}$, digunakan : $\rho_{perlu} = \rho$

Jika $\rho_{ada} < \rho_{\min}$, digunakan : $\rho_{perlu} = 1{,}33.\rho$

Jika $\rho < \rho_{\min}$, digunakan : $\rho_{perlu} = \rho_{\min}$

Jarak antar tulangan :

$$s \le \frac{A_{1\phi}.b}{As_{perlu}} \quad ; \quad s \ge 25\ mm \qquad \textbf{(3.6.42)}$$

Kontrol kapasitas lentur pelat pondasi :

$$As_{aktual} = \frac{A_{1\phi}.1000}{s} \qquad \textbf{(3.6.43)}$$

$$a = \frac{As_{aktual}.fy}{0{,}85.f'c.b} \qquad \textbf{(3.6.44)}$$

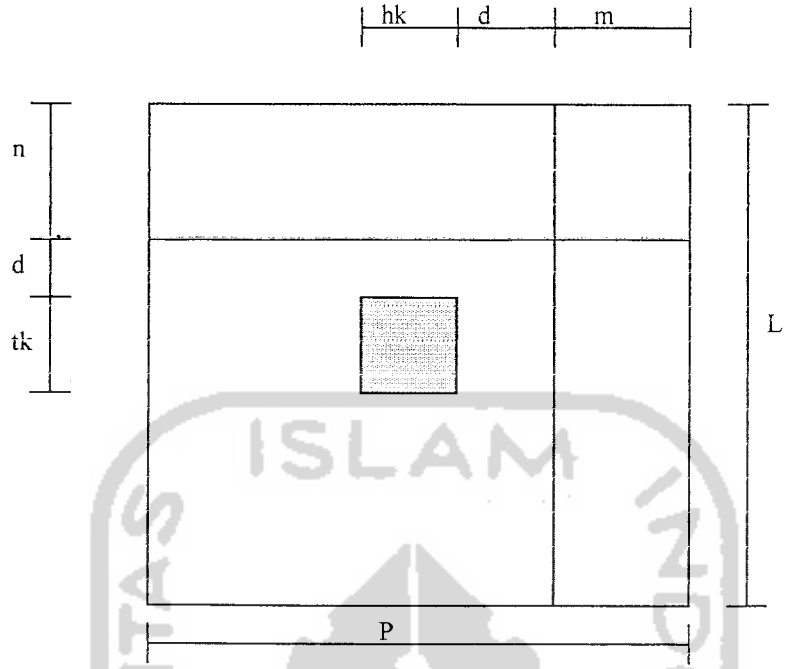
$$Mn = As_{aktual}.fy.\left(d - \frac{a}{2}\right) \ge \frac{Mu}{\phi} \qquad \textbf{(3.6.45)}$$

3.6.7 Perencanaan Tulangan Susut Pondasi

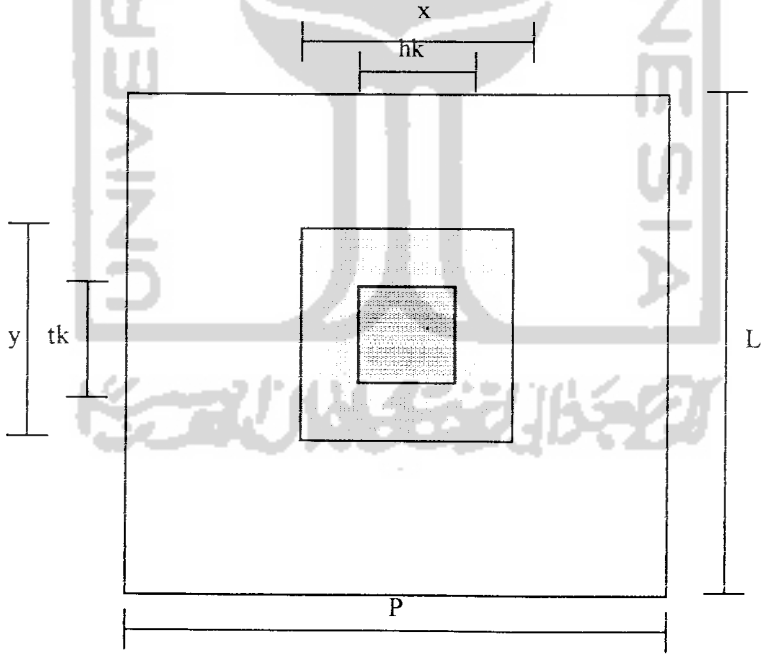
$$As_{susut} = 0{,}002.b.h \qquad \textbf{(3.6.46)}$$

Luas tampang 1 tulangan susut : $A_{1\phi} = 1/4.\pi.D^2$ **(3.6.47)**

Jarak antar tulangan susut : $s \le \frac{A_{1\phi}.b}{As_{susut}}$ **(3.6.48)**



Gambar 3.5 Daerah Geser Satu Arah pada Penampang Pondasi



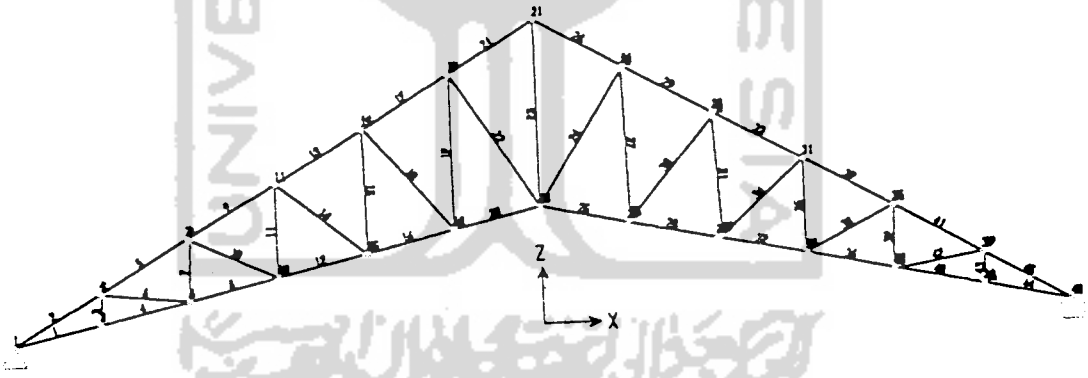
Gambar 3.6 Daerah Geser Dua Arah pada Penampang Pondasi

BAB IV

PERHITUNGAN KONSTRUKSI

4.1 Perencanaan Atap

4.1.1 Perencanaan Kuda-kuda 1



Gambar 4.1 Kuda-kuda 1

1. Perhitungan Panjang Batang

a. Batang Atas (A)

A1 = A2 s/d A12

$$A = \frac{1.8}{\cos 30°} = 2.078m \rightarrow \Sigma = 24.936m$$

b. Batang Bawah (B)

B1 = B2 s/d B12

$$B = \frac{1.8}{\cos 12.5°} = 1.844m \rightarrow \Sigma = 22.128m$$

c. Batang Vertikal

$$V_1 = V_{11} = (1.8.tg30° - 1.8.tg12.5) = 0.640m$$

$$V_2 = V_{10} = (3.6.tg30° - 3.6.tg12.5) = 1.280m$$

$$V_3 = V_9 = (5.4 . tg30° - 5.4.tg12.5) = 2.340m$$

$$V_4 = V_8 = (7.2.tg30° - 7.2.tg12.5) = 2.561m$$

$$V_5 = V_{71} = (9.tg30° - 9.tg12.5) = 3.201m$$

$$V_6 = (10.8.tg30° - 10.8.tg12.5) = 3.841m$$

Σ = 23.885 m

d. Batang Diagonal

$$D_1 = D_{10} = \sqrt{1.8^2 + (0.640 - 1.8.tg12.5°)^2} = 1.816m$$

$$D_2 = D_9 = \sqrt{1.8^2 + (1.28 - 1.8.tg12.5°)^2} = 2.004m$$

$$D_3 = D_8 = \sqrt{1.8^2 + (2.340 - 1.8.tg12.5°)^2} = 2.647m$$

$$D_4 = D_7 = \sqrt{1.8^2 + (2.561 - 1.8.tg12.5°)^2} = 2.813m$$

$$D_5 = D_6 = \sqrt{1.8^2 + (3.201 - 1.8.tg12.5°)^2} = 3.330m$$

Σ = 25.22 m

2. Pembebanan Gording

a). Beban Tetap

- berat penutup atap = 50 kg/m^2 x jarak gording = 50 x 2.078 = 103.9 kg/m`
- berat hidup = 20 kg/m^2 x jarak gording = 20 x 2.078 = 41.56 kg/m`
- berat gording = 10 kg/m`

q = 155.46 kg/m`

$q\perp = q \cdot \cos \alpha = 134.632$ kg/m^1

$q// = q \cdot \sin \alpha = 77.73$ kg/m^1

b). Beban Angin (W)

Bangunan berada di daerah darat → w = 25 kg/m^2

- Angin tekan (Wt) → $\alpha < 65^0$

C1 = 0.02 . α - 0.4

= 0.02 . 30 – 0.4 = 0.2

Wt = C1 x W x jarak gording

= 0.2 x 25 x 2.078 = 10.39 kg/m^1

- Angin hisap (Wh)

C2 = - 0.4

Wh = C2 x W x jarak gording

= - 0.4 x 25 x 2.078 = - 20.78 kg/m^1

3. Perhitungan Momen

a. Akibat beban tetap

$$q\perp : M_{max} = \frac{1}{8}.q\perp.b^2 = \frac{1}{8}.134.632.10^{-2}.360^2 = 21810.384\,kg.cm$$

$$q// : M_{max} = \frac{1}{32}.q\perp.b^2 = \frac{1}{32}.77.73.10^{-2}.360^2 = 3148.065\,kg.cm$$

b. Akibat beban angin

$$M_{max} = \frac{1}{8}.W.b^2 = \frac{1}{8}.20.78.10^{-2}.360^2 = 3366.36\,kg.cm$$

4. Dimensi Gording

Profil Light Up Channels 150 x 50 x 20 x 2.3

Data : A = 6.322 cm Sx = 28 cm

Ix = 210 cm Sy = 6.33 cm

Iy = 21.9 cm w = 4.96 kg/m < 10 kg/m^1

a. Kontrol tegangan

$$fbx = \frac{M\perp}{Sx} = \frac{21810.384}{28} = 778.942$$

$$fby = \frac{M//}{Sy} = \frac{3148.065}{33} = 497.325$$

$$\frac{fbx}{0.66\,.Fy}+\frac{fby}{0.75.Fy}<1.0$$

$$\frac{778.942}{0.66\,.2400}+\frac{497.325}{0.75.2400}<1.0$$

$$0.768<1.0$$

b. Kontrol lendutan

$$\delta\perp=\frac{5}{384}.\frac{q\perp.b^4}{E.Ix}<\frac{b}{360}$$

$$\delta\perp=\frac{5}{384}.\frac{134.632.10^{-2}.360^4}{2.1.10^6.210}=0.668cm<\frac{360}{360}=1cm$$

$$\delta//=\frac{5}{384}.\frac{q//.\left\{\frac{b}{(a+1)}\right\}^4}{E.Iy}<\frac{b}{360}$$

$$\delta//=\frac{5}{384}.\frac{7.73.10^{-2}.\left\{\frac{360}{(1+1)}\right\}^4}{2.10.10^6.21.9}=0.231cm<\frac{360}{360}=1$$

Profil Light Up Channels 150 x 50 x 20 x 2.3 dapat digunakan.

Digunakan mutu baja Fy = 2400 ; Fu = 3700

5. Perencanaan Sagrod dan Tierod

a. Beban sagrod

$$-berat\ penutup\ atap x\left(\frac{1}{2}.\frac{L}{\cos\alpha}\right)=50x\left(\frac{1}{2}.\frac{21.6}{\cos30°}\right)=623.538kg/m$$

$$-beban\ hidup x\left(\frac{1}{2}.\frac{L}{\cos\alpha}\right)=20.x\left(\frac{1}{2}.\frac{21.6}{\cos30°}\right)=249.415kg/m$$

$-$ *jumlah gording satu sisi x berat gording* $= 7x6.13 = 42.91 kg/m$

Ptotal = 623.538 kg/m + 249.415 kg/m + 42.91 kg/m = 915.863 kg/m

$P// = P.\sin\alpha.Ss = 915.863 .\sin 30°.1.8 = 824.277 kg$

b. Dimensi sagrod

$$Asagrod = \frac{P//}{0.33.Fu} = \frac{824.277}{0.33.3700} = 0.7806 = \frac{1}{2}.\pi.d^2 \rightarrow d = 0.7051$$

Dipakai d sagrod = 0.7051 + 0.3 = 1.0051 cm ~1.27 cm (ϕ ½'')

c. Dimensi tierod

Beban tierod = T = P// . cos α = 824.277 . cos 30^0 = 713.845 kg

$$Asagrod = \frac{P//}{0.33.Fu} = \frac{824.277}{0.33.3700} = 0.7806 = \frac{1}{2}.\pi.d^2 \rightarrow d = 0.7051$$

Dipakai d tierod = 0.6562 + 0.3 = 0.9562 cm ~1.27 cm (ϕ ½'')

6. Perencanaan kuda-kuda

Pembebanan

a. Beban tetap

- berat gording = 4.96 kg/m^1
- berat eternit + penggantung = 18 kg/m^2
- berat penutup atap = 50 kg/m^2
- beban hidup = 20 kg/m^2
- taksiran berat kuda – kuda = 93.6 kg/m^1

$$Taksiran\ berat\ kuda2 = \left\{10 + \left(\frac{L-12}{3}\right).5\right\} x\ jarak\ kuda2$$

$$Taksiran\ berat\ kuda2 = \left\{10 + \left(\frac{21.6 - 12}{3}\right).5\right\}.x3.6 = 93.6\,kg/m$$

Beban masing-masing joint

P1 = P13 → berat gording = 4.96 x 3.6 = 17.856 kg

berat penutup atap = 50 x 3.6 x (½.2.078)= 187.02 kg

beban hidup = 20 x 3.6 x (½.2.078)= 74.808 kg +

P = 279.684 kg ≈ 280 kg

P2 = P3 = P4 = P5 = P6 =P8 = P9 = P10 = P11 = P12

→ berat gording = 4.96 x 3.6 = 17.856 kg

berat penutup atap = 50 x 3.6 x 2.078 = 374.04 kg

beban hidup = 20 x 3.6 x 2.078 = 149.616 kg +

P = 541.512 kg ≈ 542 kg

P7 → berat gording = 2 x 4.96 x 3.6 = 35.712 kg

berat penutup atap = 50 x 3.6 x 2.078 = 374.04 kg

beban hidup = 20 x 3.6 x 2.078 = 149.616 kg +

P = 559.368 kg ≈ 560 kg

P1' = P13' → berat eternit + plafond = 18 x 3.6 x (½.1.844)= 59.746 kg

berat taksiran kuda-kuda = 93.6 x (½.1.844) = 86.299 kg +

P = 146.045 kg ≈ 147 kg

P2' = P3' = P4' = P5' = P6' = P7' = P8' = P9' = P10' = P11' = P12'

→ berat eternit + plafond = 18 x 3.6 x 1.844 = 119.491 kg

berat taksiran kuda-kuda = 93.6 x 1.844 = 172.598 kg

P = 292.089 kg ≈ 293 kg

b. Beban Angin

Muatan angin = 35 kg/m^2

1). Koefisien angin menurut PBI 1983 untuk $\alpha < 65^0$

Tekan : C1 = 0.02 . α - 0.4 = 0.2

Tarik : C2 = - 0.4

2). Beban yang bekerja

Wt = C1 x W = 0.2 x 25 = 5 kg/m^2

Wh = C2 x W = -0.4 x 25 = -10 kg/m^2

3). Angin kiri

a). sisi kiri

W1=W7= Wt x (½ . s') x jarak kuda-kuda

= 5 x (½ . 2.078) x 3.6

= 18.702 kg ≈ 19 kg

W2=W3=W4=W5=W6= Wt x s' x jarak kuda-kuda

= 5 x 2.078 x 3.6

= 37.404 kg ≈ 38 kg

b). sisi kanan

W1'=W7'= Wh x (½ . s') x jarak kuda-kuda

= 10 x (½ . 2.078) x 3.6

= 37.404 kg ≈ 38 kg

W2'=W3'=W4'=W5'=W6'= Wh x s' x jarak kuda-kuda

= 10 x 2.078 x 3.6

= 74.808 kg ≈ 75 kg

4). Angin kanan

a). sisi kiri

W1=W7= Wh x (½ . s') x jarak kuda-kuda

= 10 x (½ . 2.078) x 3.6

= 37.404 kg ≈ 38 kg

W2=W3=W4=W5=W6= Wh x s' x jarak kuda-kuda

= 10 x 2.078 x 3.6

= 74.808 kg ≈ 75 kg

b). sisi kanan

W1'=W7'= Wt x (½ . s') x jarak kuda-kuda

= 5 x (½ . 2.078) x 3.6

= 18.702 kg ≈ 19 kg

W2'=W3'=W4'=W5'=W6'= Wt x s' x jarak kuda-kuda

= 5 x 2.078 x 3.6

= 37.404 kg ≈ 38 kg

Coba profil kuda-kuda 60 x 60 x 6

$$W = \frac{W x 2 x \Sigma L}{L} x 1.2$$

$$W = \frac{5.42 x 2 x 96.169}{.6} x 1.2 = 57.915 kg/m < 93.6 kg/m$$

7. Perencanaan Dimensi Batang

a. Batang Atas

1). Gaya tekan max = 15167.87 kg

Panjang batang = 2.078 m = 207.8 cm

Fy = 2400 kg/cm^2 ; Fu = 3700 kg/cm^2

K = 1 (dianggap sendi – sendi)

2). Syarat batang tekan

$$\frac{Kl}{r} \leq 200 \rightarrow r_{min} = \frac{1.207.8}{200} = 1.309 cm$$

3). Dicoba profil 2L 70x70x7

A = 9.4 cm^2

r = 2.12 cm > r_{min} = 1.039 cm

Dipakai r = 2.12 cm

W = 7.38 kg/m

Ix = 42.4 cm^4

e = 1.97

x = e + ½ .tp = 1.97 + ½ . 1 = 2.47 cm

Ix gab. = 2 . Ix = 2 x 42.4 = 84.8 cm^4

Iy gab. = Ix gab. + 2 . A.x = 84.8 + 2 . 9.4 . 2.47 =131.236 cm^4

$$ix\ gab = \sqrt{\frac{Ix_{gab.}}{2.A}} = \sqrt{\frac{84.8}{2.9.4}} = 2.12cm$$

$$iy\ gab = \sqrt{\frac{Iy_{gab.}}{2.A}} = \sqrt{\frac{131.236}{2.9.4}} = 2.642cm$$

Syarat :

$$\frac{Kl}{r} \le Cc = \sqrt{\frac{2\pi^2.E}{Fy}}$$

$$\frac{1.207.8}{2Ar} \le \sqrt{\frac{2\pi^2.2.1.10^6}{2400}}$$

$$98.019 \le 131.356$$

$$Fs = \frac{5}{3} + \frac{3}{8}.\frac{Kl/r}{Cc} - \frac{1}{8}\frac{(Kl/r)^3}{Cc^3}$$

$$Fs = \frac{5}{3} + \frac{3}{8}.\frac{98.019}{131356} - \frac{1}{8}\frac{(98.019)^3}{131.356^3}$$

$$Fs = 1.895$$

$$Fa = \left[1 - \frac{(Kl/r)^2}{2.Cc^2}\right].\frac{Fy}{Fs}$$

$$Fa = \left[1 - \frac{(98.019)^2}{2.(131.356)^2}\right].\frac{2400}{1.895}$$

$$Fa = 913.88kg/cm^2$$

Kontrol Kapasitas

$P = Fa.\ A_{total} > P_{terjadi}$

P = 913.8823 . 18.8 > 15 . 167.87 kg

P = 17180.987 kg > 15167.89 kg

b. Batang Bawah

1). Gaya tarik max = 13489.26 kg

Panjang batang = 1.844 m =184.4 cm

Fy = 2400 kg/cm^2 ; Fu = 3700 kg/cm^2

K = 1 (dianggap sendi – sendi)

2). Syarat batang tekan

$$\frac{Kl}{r} \le 240\, s/d\, 300 \rightarrow r_{min} = \frac{1.184.4}{240} = 0.768\, cm$$

3). Luas tampang perlu :

ϕ baut = 5/8" tp =10 mm

$$Ag_1 = \frac{T}{0.6.Fy} = \frac{13489.26}{0.6\,.2400} = 9.3675\, cm^2$$

$$Ag_2 = \frac{T}{0.5.Fu.0.85} + \left(\frac{1}{8}" + \frac{5}{8}"\right).tp.n$$

$$Ag_2 = \frac{13489.26}{0.5.3700.0.85} + \left(\frac{1}{8}" + \frac{5}{8}"\right).1.2$$

$$Ag_1 = 12.388\, cm^2$$

Dicoba profil 2L 70 x 70 x7

A = 9.4 cm^2

r = 2.12 cm > r_{min} = 0.768 cm

$$A_{\text{lub ang}} = \left(\frac{1}{8}" + \phi baut\right) tp.n = \left(\frac{1}{8}" + \frac{5}{8}"\right).1.2 = 3.81 cm^2$$

$A_{netto} = A_{brutto} - A_{lubang}$

$= 18.8 - 3.81$

$= 14.99 \text{ cm}^2 > 9.3675 \text{ cm}^2$

$A_{effektif} = 0.85 \,.\, A_{netto}$

$= 0.85 \,.\, 14.99$

$= 12.742 \text{ cm}^2$

4). Kontrol tegangan

$$\frac{T}{Aprofil} \le 0.6.Fy$$

$$\frac{13489.26}{18.8} \le 0.6.2400$$

$$717.514 kg/cm^2 \le 1440 kg/cm^2$$

$$\frac{T}{Aeffektif} \le 0.5.Fu$$

$$\frac{13489.26}{12.742} \le 0.5.3700$$

$$1058.645 \, kg/cm^2 \le 1850 kg/cm^2$$

c. Batang Vertikal

1). Gaya tarik max = 7622.73 kg

Panjang batang = 3.3841 m = 338.41 cm

Fy = 2400 kg/cm^2 ; Fu = 3700 kg/cm^2

K = 1 (dianggap sendi – sendi)

2). Syarat batang tekan

$$\frac{Kl}{r} \le 240 s/d 300 \rightarrow r_{min} = \frac{1.338.41}{240} = 1.41 cm$$

3). Luas tampang perlu :

ϕ baut = 5/8" tp =10 mm

$$Ag_1 = \frac{T}{0.6.Fy} = \frac{7622.73}{0.6\ .2400} = 5.294 cm^2$$

$$Ag_2 = \frac{T}{0.5.Fu.0.85} + \left(\frac{1}{8}" + \frac{5}{8}"\right).tp.n$$

$$Ag_2 = \frac{7622.73}{0.5.3700.0.85} + \left(\frac{1}{8}" + \frac{5}{8}"\right).1.2$$

$$Ag_2 = 8.658 cm^2$$

Dicoba profil 2L 60 x 60 x 6

A = 6.91 cm^2

r = 1.82 cm > r_{min} = 1.41 cm

$$A_{lub\ ang} = \left(\frac{1}{8}" + \phi baut\right).tp.n = \left(\frac{1}{8}" + \frac{5}{8}"\right).1.2 = 3.81 cm^2$$

A_{netto} = A_{brutto} - A_{lubang}

= 13.82 – 3.81

= 10.01 cm^2 > 5.294 cm^2

$A_{effektif} = 0.85 \cdot A_{netto}$

$= 0.85 \cdot 10.01$

$= 8.509\ cm^2$

4). Kontrol tegangan

$$\frac{T}{Aprofil} \leq 0.6.Fy$$

$$\frac{7622.73}{13.82} \leq 0.6.2400$$

$$551.572\,kg/cm^2 \leq 1440\,kg/cm^2$$

$$\frac{T}{Aeffektif} \leq 0.5.Fu$$

$$\frac{7622.73}{8.509} \leq 0.5.3700$$

$$895.843\,kg/cm^2 \leq 1850 kg/cm^2$$

d. Batang Diagonal

1). Gaya tekan max = 2180.56 kg

Panjang batang = 3.3 m = 330 cm

Fy = 2400 kg/cm^2 ; Fu = 3700 kg/cm^2

K = 1 (dianggap sendi – sendi)

2). Syarat batang tekan

$$\frac{Kl}{r} \leq 200 \rightarrow r_{min} = \frac{1.330}{200} = 1.65\,cm$$

Dicoba profil 2L 60 x 60 x 6

A = 6.91 cm^2 2A = 13.82 cm^2

r = 1.82 cm > r_{min} = 1.65 cm

Ix = Iy = 22.8 cm^4 ; e = 1.69

x = e + ½ . tp = 1.69 + ½.1 =2.19 cm

Ix gab. = 2 . Ix = 2 x 22.28 = 45.6 cm^4

Iy gab. = Ix gab. + 2 . A.x = 45.6 + 2 . 6.91 . 2.19 =75.869 cm^4

$$ix\ gab = \sqrt{\frac{Ix_{gab.}}{2.A}} = \sqrt{\frac{45.6}{13.82}} = 1.816 cm$$

$$iy\ gab = \sqrt{\frac{Iy_{gab.}}{2.A}} = \sqrt{\frac{75.869}{13.82}} = 2.34 cm$$

Syarat :

$$\frac{Kl}{r} \le Cc = \sqrt{\frac{2\pi^2.E}{Fy}}$$

$$\frac{1.330}{1.82} \le \sqrt{\frac{2\pi^2.2.1.10^6}{2400}}$$

$181.319 \ge 131.356$

$$Fa = \frac{12}{23}.\frac{\pi^2.E}{(Kl/r)^2}$$

$$Fa = \frac{12}{23}.\frac{\pi^2.2.1^6}{(181.319)^2}$$

$$Fa = 328.583 kg/cm^2$$

3). Kontrol Kapasitas

$P = Fa \,.\, A_{total}total > P_{terjadi}t$

$= 328.583 \,.\, 10.84 > 2180.56$

$= 3561.842 \text{ kg} > 2180.56 \text{ kg}$

8. Perencanaan Sambungan

a. Perhitungan sambungan dilakukan ½ bentang pada tiap joint.

b. Mutu pelat : $fy = 2800 \text{ kg/cm}^2$

$Fu = 4200 \text{ kg/cm}^2$

c. Mutu baut non full drat : $fy = 2050 \text{ kg/cm}^2$

$Fu = 8250 \text{ kg/cm}^2$

d. Diameter baut = ½ " = 1.27 cm

e. Tebal plat sambung = 1 cm

f. Jumlah baut tiap sambungan = n

g. Tegangan ijin tarik

Fa geser = 0.33 x Fu = 0.33 x 8250 = 2772.5 kg/cm

Fa tumpuan = 1.2 x Fu plat = 1.2 x 4200 = 5040 kg/cm

h. P tumpuan = tp x ϕbaut x Fa tumpuan x n

= 1 x 1.27 x 5040 x n

= 6408.8 n kg

Pgeser = ¼ x π x D^2 x Fa geser x 2.n

= ¼ x π x $(1.27)^2$ x 2772.5 x 2.n

= 7020.67 . n kg

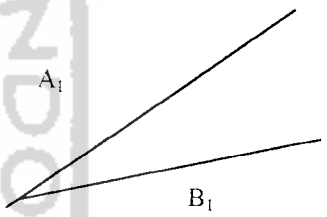
Dipakai P terkecil → P tumpuan = 6400.8 . n kg

Maka jumlah baut $n = \frac{P_{batang}}{6400.8}$

1) Joint 1 = Joint 13

$$n\ A_1 = \frac{15167.87}{6400.8} = 2.37 \approx 3\ buah$$

$$n\ B_1 = \frac{13489.26}{6400.8} = 2.11 \approx 3\ buah$$

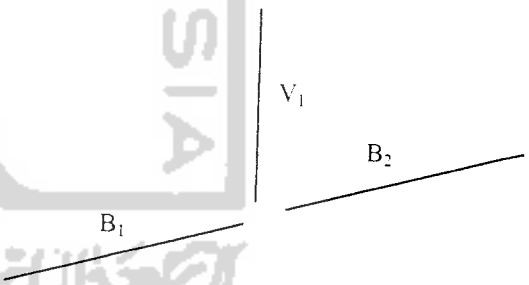


2) Joint 2 = Joint 12

$$n\ B_1 = \frac{13489.26}{6400.8} = 2.11 \approx 3\ buah$$

$$n\ B_2 = \frac{13489.26}{6400.8} = 2.11 \approx 3\ buah$$

$$n\ V_1 = \frac{293}{6400.8} = 0.046 \approx 3\ buah$$

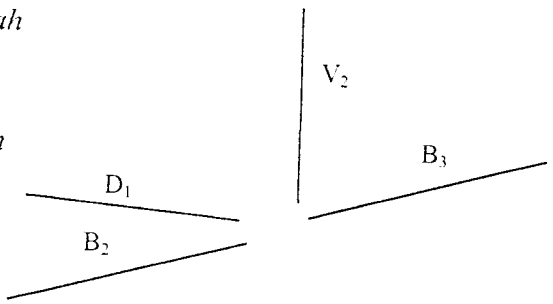


3) Joint 3 = Joint 11

$$n\ B_3 = \frac{12147.56}{6400.8} = 1.898 \approx 3\ buah$$

$$n\ D_1 = \frac{1320.31}{6400.8} = 0.206 \approx 3\ buah$$

$$n\ V_2 = \frac{750..69}{6400.8} = 0.117 \approx 3\ buah$$



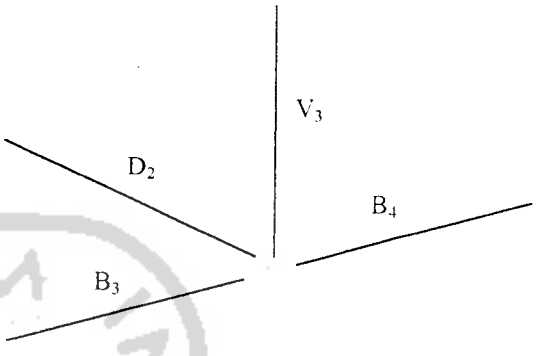
4) Joint 4 = Joint 10

$$n\ B_3 = \frac{12147.56}{6400.8} = 1.898 \approx 3\ buah$$

$$n\ B_4 = \frac{10900.52}{6400.8} = 1.703 \approx 3\ buah$$

$$n\ D_2 = \frac{1352.14}{6400.8} = 0.211 \approx 3\ buah$$

$$n\ V_3 = \frac{1152.04}{6400.8} = 0.179 \approx 3\ buah$$



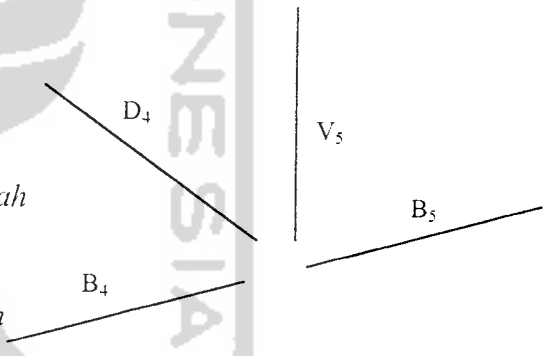
5) Joint 5 = Joint 9

$$n\ B_4 = \frac{10900.52}{6400.8} = 1.703 \approx 3\ buah$$

$$n\ B_5 = \frac{9676.8}{6400.8} = 1.52 \approx 3\ buah$$

$$n\ D_3 = \frac{1559.84}{6400.8} = 0.244 \approx 3\ buah$$

$$n\ V_4 = \frac{1561.5}{6400.8} = 0.244 \approx 3\ buah$$

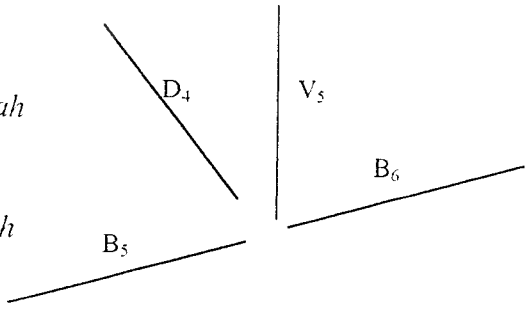


6) Joint 6 = Joint 8

$$n\ B_5 = \frac{9676.8}{6400.8} = 1.52 \approx 3\ buah$$

$$n\ B_6 = \frac{8462.36}{6400.8} = 1.322 \approx 3\ buah$$

$$n\ D_4 = \frac{1848.1}{6400.8} = 0.289 \approx 3\ buah$$



$$n\,V_5 = \frac{1974.2}{6400.8} = 0.308 \approx 3\ buah$$

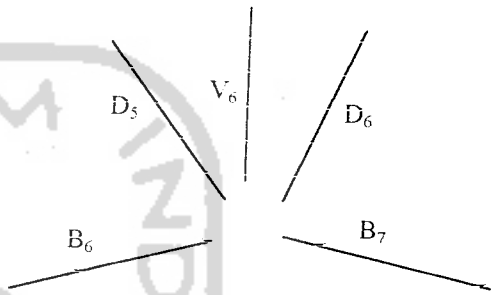
7) Joint 7

$$n\,B_6 = \frac{8462.36}{6400.8} = 1.322 \approx 3\ buah$$

$$n\,B_7 = \frac{8457.07}{6400.8} = 1.321 \approx 3\ buah$$

$$n\,D_5 = \frac{2180.56}{6400.8} = 0.341 \approx 3\ buah$$

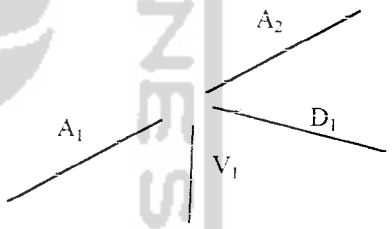
$$n\,V_6 = \frac{7622.73}{6400.8} = 1.191 \approx 3\ buah$$



8) Joint 14 = Joint 24

$$n\,A_1 = \frac{15167.87}{6400.8} = 2.37 \approx 3\ buah$$

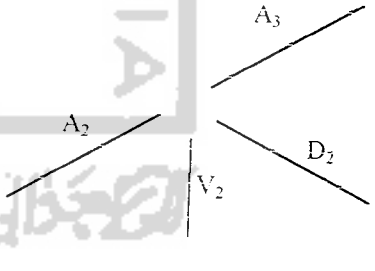
$$n\,A_2 = \frac{13699.27}{6400.8} = 2.14 \approx 3\ buah$$



9) Joint 15 = Joint 23

$$n\,A_2 = \frac{13699.27}{6400.8} = 2.14 \approx 3\ buah$$

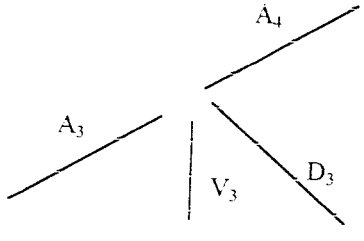
$$n\,A_3 = \frac{12292.93}{6400.8} = 1.921 \approx 3\ buah$$



10) Joint 16 = Joint 22

$$n\,A_3 = \frac{12292.93}{6400.8} = 1.921 \approx 3\ buah$$

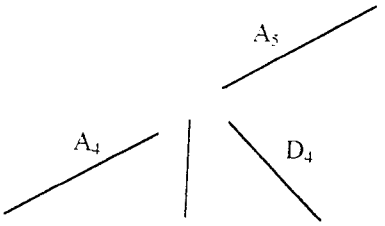
$$n\,A_4 = \frac{10912.9}{6400.8} = 1.705 \approx 3\ buah$$



11) Joint 17 = Joint 21

$$n\ A_4 = \frac{10912.9}{6400.8} = 1.705 \approx 3\ buah$$

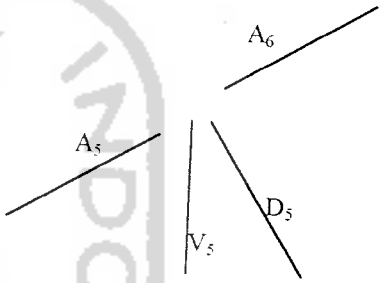
$$n\ A_5 = \frac{9543.33}{6400.8} = 1.491 \approx 3\ buah$$



12) Joint 18 = Joint 20

$$n\ A_5 = \frac{9543.33}{6400.8} = 1.491 \approx 3\ buah$$

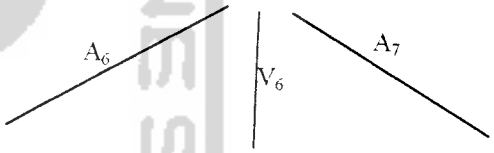
$$n\ A_6 = \frac{8178.98}{6400.8} = 1.278 \approx 3\ buah$$



13) Joint 19

$$n\ A_6 = \frac{8178.98}{6400.8} = 1.278 \approx 3\ buah$$

$$n\ A_7 = \frac{8175.04}{6400.8} = 1.277 \approx 3\ buah$$



9. Perencanaan Plat Kuda – kuda

RA = P = 5028.5 kg

fc' = 25 Mpa = 250 kg/cm^2

$$A_{perlu} = \frac{P}{0.33.f'c} = \frac{5028.5}{0.33.250} = 60.952\ cm^2$$

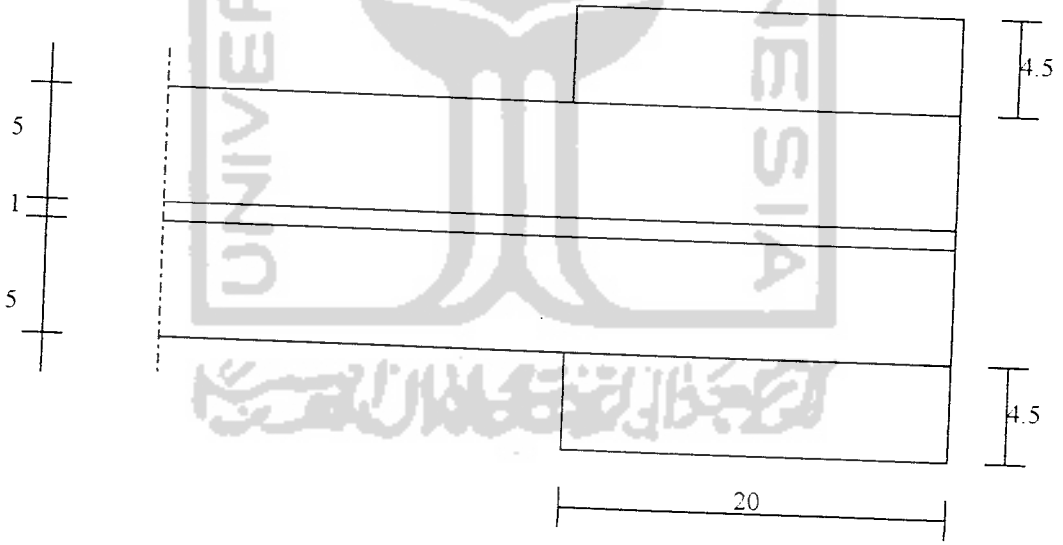
Dicoba plat B = 20 cm ; L = 20 cm → A = 400 cm^2 > A perlu

$$g = \frac{P}{A} = \frac{5028.5}{400} = 12.571\ kg/cm^2$$

$$x = \frac{L - (5+5+1)}{2} = 4.5\ cm$$

$$M = \frac{1}{2}.g.x^2 = \frac{1}{2}.12.571.4.5^2 = 127.2814\ kg.cm$$

$$tp = \sqrt{\frac{10.M}{fy}} = \sqrt{\frac{10.127.2814}{2400}} = 0.728\ cm \approx 1\ cm^2$$



10. Perencanaan Dukungan Arah Lateral

Lb = Jarak antar gording = 2.078 m

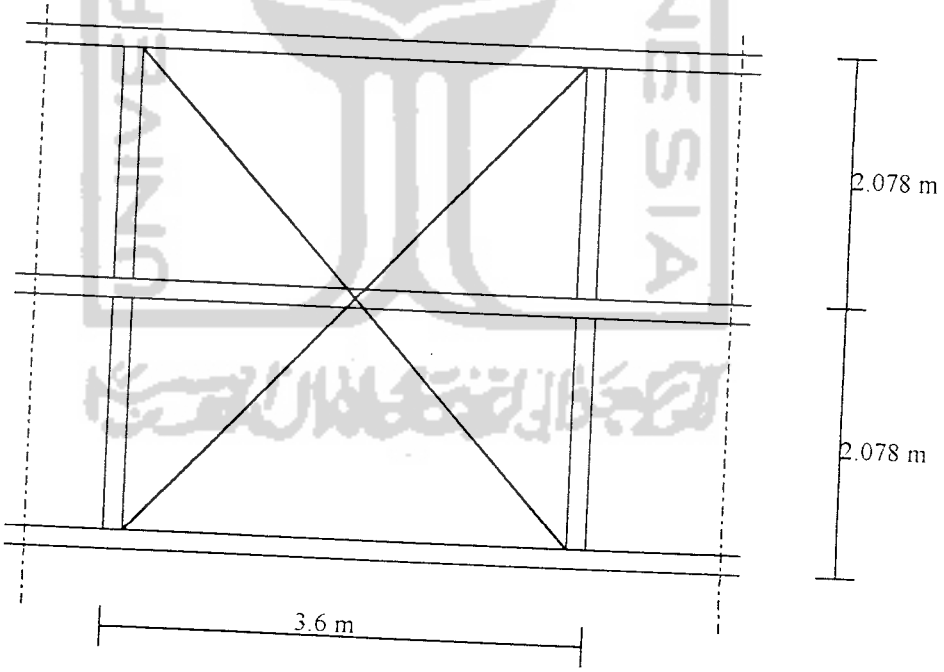
Lc = Jarak antar kuda – kuda = 3.6 m

$$L = \sqrt{Lb^2 + Lc^2} = \sqrt{2.078^2 + 3.6^2} = 4.157\ m$$

Keterangan :

- L ≤ 3 m → Dipakai baja tulangan ϕ12 mm
- L ≥ 3 m → Dipakai baja tulangan ϕ19 mm
- 3 m < L ≤ 5 m → Dipakai baja tulangan ϕ16 mm

Jadi dipakai baja tulangan ϕ 16 mm.



11. Kontrol kuda - kuda

Perhitungan berat kuda – kuda

Batang	Profil	Berat Profil	Panjang (m)	Berat Total (kg)
Atas	2L 70 x 70 x 7	2 x 7.38	24.936	368.055
Bawah	2L 70 x 70 x 7	2 x 7.38	22.128	326.609
Vertikal	2L 60 x 60 x 6	2 x 7.38	23.885	258.913
Diagonal	2L 60 x 60 x 6	2 x 7.38	25.22	273.385
				Σ = 1226,962

Kontrol

- berat kuda – kuda = 1226.962 kg
- berat baut plat sambung ϕ baut (20% . berat kuda – kuda) = 245.392 kg +

Berat Kuda – kuda Total = 1472.354 kg

$$\frac{berat\ kuda-kuda}{panjang\ bentang} < berat\ taksiran\ kuda-kuda$$

$$\frac{1472.354}{21.6} = 68.165\ kg/m < 93.6\ kg/m \qquad \text{Ok.....}$$

tabel 4.1 Gaya batang kuda-kuda 1

BATANG	GAYA (KG)			B.RENCANA (KG)
	BEBAN TETAP	B. ANGIN KIRI	B. ANGIN KANAN	
A1	-15167.87	-178.44	623.39	-15167.87
A2	-13699.27	-127.33	520.69	-13699.27
A3	-12292.93	-77.3	42.1	-12292.93
A4	-10912.90	-27.67	322.72	-10912.90
A5	-9543.33	21.8	224.83	-9543.33
A6	-8178.98	71.19	127.18	-8178.98
A7	-8175.04	38.25	171.04	-8175.04
A8	-9532.77	135.75	73.54	-9532.77
A9	-10890.58	233.26	-23.97	-10890.58
A10	-12248.56	330.77	-121.47	-12248.56
A11	-13606.97	428.3	-218.99	-13606.97
A12	-14966.37	525.87	-316.54	-14966.37
B1	13489.26	477.28	-997.5	13489.26
B2	13489.26	477.28	-997.5	13489.26
B3	12147.56	412.03	-846.4	12147.56
B4	10900.52	348.2	-719.68	10900.52
B5	9676.80	284.73	-594.03	9676.80
B6	8462.36	221.4	-468.81	8462.36
B7	8457.07	33.23	-218.9	8457.07
B8	9661.66	-91.69	-93.98	9661.66
B9	10866.41	-216.62	30.94	10866.41
B10	12071.53	-341.55	155.87	12071.53
B11	13278.16	-466.56	280.84	13278.16
B12	13278.16	-466.56	280.84	13278.16
V1	293.00	0	0	293.00
V2	750.69	22.62	-44.72	750.69
V3	1152.04	43.97	-87.3	1152.04
V4	1561.50	65.79	-130.25	1561.50
V5	1974.20	87.67	-173.34	1974.20
V6	7622.73	-38.31	-149.19	7622.73
V7	1963.18	-137.2	173.2	1963.18
V8	1545.76	-129.9	129.9	1545.76
V9	1128.39	-86.61	86.6	1128.39
V10	711.15	-43.32	43.31	711.15
V11	293.00	0	0	293.00
D1	-1320.31	-64.21	129.01	-1320.31
D2	-1352.14	-69.2	137.4	-1352.14
D3	-155.84	-80.91	160.16	-155.84
D4	-1848.10	-96.38	190.55	-1848.10
D5	2180.56	-144.02	225.31	2180.56
D6	-2172.12	225.26	-225.26	-2172.12
D7	-1835.12	190.3	-190.3	-1835.12
D8	-1538.19	159.5	-159.49	-1538.19
D9	-1308.97	135.71	-135.69	-1308.97
D10	-1188.24	123.09	-123.07	-1188.24

tabel 4.2 Gaya batang kuda-kuda 2

BATANG	GAYA (KG)			B.RENCANA (KG)
	BEBAN TETAP	B. ANGIN KIRI	B. ANGIN KANAN	
A1	-14,691.55	-239.81	656.68	-14,691.55
A2	-13,217.96	-188.18	553.42	-13,217.96
A3	-11,810.54	-137.98	453.67	-11,810.54
A4	-10,430.99	-88.32	355.31	-10,430.99
A5	-9,827.46	-19.57	268.12	-9,827.46
A6	-10,094.37	54.79	193.76	-10,094.37
A7	-10,094.37	54.79	193.76	-10,094.37
A8	-9,827.46	129.15	119.4	-9,827.46
A9	-10,430.99	194.73	72.26	-10,430.99
A10	-11,810.54	292.81	22.88	-11,810.54
A11	-13,217.96	391.99	-26.76	-13,217.96
A12	-14,691.55	494.07	-77.19	-14,691.55
B1	13,065.66	440.69	-811.42	13,065.66
B2	13,065.66	440.68	-811.42	13,065.66
B3	11,717.57	374.71	-679.6	11,717.57
B4	10,469.91	310.81	-552.76	10,469.91
B5	9,026.76	241.43	-416.98	9,026.76
B6	9,827.46	167.07	-342.62	9,827.46
B7	9,827.46	18.35	-193.9	9,827.46
B8	9,026.76	-56.01	-119.54	9,026.76
B9	10,469.91	-182.74	-59.21	10,469.91
B10	11,717.57	-309.08	4.26	11,717.57
B11	13,065.66	-439.39	68.65	13,065.66
B12	13,065.66	-439.39	68.65	13,065.66
V1	293	0	0	293
V2	752.86	22.48	-44.97	752.86
V3	1,153.24	44.1	-87	1,153.24
V4	3,583.16	119.54	-223.02	3,583.16
V5	-851	105.59	-105.59	-851
V6	-472	0	0	-472
V7	-851	-105.59	105.59	-851
V8	3,582.16	-142.55	39.07	3,582.16
V9	1,153.24	-87.11	43.76	1,153.24
V10	756.86	-44.45	21.97	756.86
V11	293	0	0	293
D1	-1,326.60	-64.86	129.72	-1,326.60
D2	-1,353.15	-69.37	137.56	-1,353.15
D3	-1,559.83	-80.98	160.21	-1,559.83
D4	1,390.65	-129.15	129.15	1,390.65
D5	463.55	-129.15	129.15	463.55
D6	463.55	129.15	-129.15	463.55
D7	1,390.65	129.15	-129.15	1,390.65
D8	-1,559.83	159.9	-80.66	-1,559.83
D9	-1,353.15	137.02	-68.83	-1,353.15
D10	-1,326.60	128.23	-63.37	-1,326.60

tabel 4.3 Gaya batang kuda-kuda 3

BATANG	GAYA (KG)			B.RENCANA (KG)
	BEBAN TETAP	B. ANGIN KIRI	B. ANGIN KANAN	
A1	-13,790.59	-108.88	344.53	-13,790.59
A2	-12,845.89	-61.44	255.22	-12,845.89
A3	-15,160.82	-48.55	251.11	-15,160.82
A4	-17,830.33	-43.16	260.62	-17,830.33
A5	-19,468.03	-37.76	270.13	-19,468.03
A6	-20,013.93	-32.37	297.64	-20,013.93
A7	-20,013.93	-32.37	297.64	-20,013.93
A8	-19,468.03	-26.91	289.67	-19,468.03
A9	-17,830.33	-21.58	298.67	-17,830.33
A10	-15,100.82	-16.18	308.18	-15,100.82
A11	-12,845.89	-12.29	341.88	-12,845.89
A12	-13,790.59	-11.89	378.99	-13,790.59
B1	12,235.01	116.06	-325.13	12,235.01
B2	12,235.01	116.06	-325.13	12,235.01
B3	11,279.51	53.95	-205.6	11,279.51
B4	15,100.82	48.55	-215.11	15,100.82
B5	17,830.33	43.16	-224.62	17,830.33
B6	19,468.03	37.76	-234.13	19,468.03
B7	19,468.03	26.97	-253.16	19,468.03
B8	17,830.33	21.58	-262.67	17,830.33
B9	15,100.82	16.18	-272.18	15,100.82
B10	11,279.51	10.79	-281.69	11,279.51
B11	12,235.01	10.55	-336.24	12,235.01
B12	12,235.01	10.55	-336.24	12,235.01
V1	293	0	0	293
V2	3,050.33	33.06	-85.38	3,050.33
V3	-2,304	3.66	6.45	-2,304
V4	-1,564.00	3.66	6.45	-1,564.00
V5	-824	3.66	6.45	-824
V6	-454	0	0	-454
V7	-824	-3.66	-6.45	-824
V8	-1,564	-3.66	-6.45	-1,564
V9	-2,304	-3.66	-6.45	-2,304
V10	3050.33	-3.66	-6.45	3050.33
V11	293	0	0	293
D1		-59.87	112.7	
D2	4,616.33	-6.52	-11.49	4,616.33
D3	3,297.38	-6.52	-11.49	3,297.38
D4	1,978.43	-6.52	-11.49	1,978.43
D5	659.48	-6.52	-11.49	659.48
D6	659.48	6.52	11.49	659.48
D7	1,978.43	6.52	11.49	1,978.43
D8	3,297.38	6.52	11.49	3,297.38
D9	4,616.33	6.52	11.49	4,616.33
D10	-669.98	0.49	46.95	-669.98

tabel 4.4 Gaya batang kuda-kuda 3'

BATANG	GAYA (KG)			B.RENCANA (KG)
	BEBAN TETAP	B. ANGIN KIRI	B. ANGIN KANAN	
A1	-5,162.25	31.23	195.61	-5,162.25
A2	-4,410.41	53.27	151.28	-4,410.41
A3	-3,667.47	75.16	107.54	-3,667.47
A4	-2,930.84	97.03	64.1	-2,930.84
A5	-2,930.84	64.1	97.03	-2,930.84
A6	-3,667.47	107.54	75.16	-3,667.47
A7	-4,410.41	151.28	53.27	-4,410.41
A8	-5,162.25	195.61	31.23	-5,162.25
B1	4,481.63	170.88	-367.82	4,481.63
B2	4,481.63	170.88	-367.82	4,481.63
B3	3,816.67	132.9	-291.41	3,816.67
B4	3,173.75	94.96	-216.06	3,173.75
B5	3,173.75	-18.06	-103.04	3,173.75
B6	3,816.67	-93.41	-65.1	3,816.67
B7	4,481.63	-169.82	-27.12	4,481.63
B8	4,481.63	-169.82	-27.12	4,481.63
V1	280	0	0	280
V2	588.14	21.72	-43.68	588.14
V3	947.84	43.66	-86.71	947.84
V4	2,413.39	-64.28	-64.28	2,413.39
V5	947.84	-86.71	43.66	947.84
V6	588.14	-43.68	21.72	588.14
V7	280	0	0	280
D1	-765.95	-43.75	88.01	-765.95
D2	980.16	-57.84	114.88	980.16
D3	-1,273.70	-75.78	150.04	-1,273.70
D4	-1,273.70	150.04	-75.78	-1,273.70
D5	-980.16	114.88	-57.84	-980.16
D6	-765.95	88.01	-43.75	-765.95

tabel 4.5 Gaya batang kuda-kuda 4

BATANG	GAYA (KG)			B.RENCANA (KG)
	BEBAN TETAP	B. ANGIN KIRI	B. ANGIN KANAN	
A1	-2,042.19	32.44	63.84	-2,042.19
A2	-1,361.46	54.09	21.09	-1,361.46
A3	-1,361.46	21.09	54.09	-1,361.46
A4	-2,042.19	63.84	32.44	-2,042.19
B1	1,764	56.98	-140.14	1,764
B2	1,764	56.98	-140.14	1,764
B3	1,764	-55.14	-28.02	1,764
B4	1,764	-55.14	-28.02	1,764
V1	162	0	0.00	162
V2	848	-21.42	-21.42	848
V3	162	0	0.00	162
D1	-680.73	-43.65	86.16	-680.73
D2	-680.73	86.16	-43.65	-680.73

tabel 4.6 Gaya batang kuda-kuda jurai

BATANG	GAYA (KG)			B.RENCANA (KG)
	BEBAN TETAP	B. ANGIN KIRI	B. ANGIN KANAN	
A1	0	0	0	0
A2	-1,483.78	132.46	-67.12	-1,483.78
A3	-2,956.05	263.86	-133.7	-2,956.05
A4	-4,437.80	396.2	-200.76	-4,437.80
A5	-5,921.88	528.78	-267.93	-5,921.88
A6	-7,396.35	660.3	-334.57	-7,396.35
A7	-8,879.08	792.73	-401.68	-8,879.08
A8	-10,365.46	925.55	-468.98	-10,365.46
A9	-11,834.25	1,056.58	-535.37	-11,834.25
B1	1,389.60	141.58	-71.73	1,389.60
B2	2,770.48	-19.53	9.9	2,770.48
B3	4,158.99	-181.51	91.98	4,158.99
B4	5,548.58	-343.6	174.11	5,548.58
B5	6,932.02	-504.96	255.87	6,932.02
B6	8,321.24	-667.01	337.97	8,321.24
B7	9,714.07	-829.43	420.27	9,714.07
B8	11,091.33	-990.25	501.76	11,091.33
B9	11,090.75	-990.2	501.74	11,090.75
V1	0	0	0	0
V2	2,615.87	-280.98	142.37	2,615.87
V3	2,269.49	-240.69	121.95	2,269.49
V4	1,926.99	-200.63	101.66	1,926.99
V5	1,587.31	-160.91	81.53	1,587.31
V6	1,236.67	-120.2	60.9	1,236.67
V7	895.79	-80.32	40.7	895.79
V8	553.86	-40.41	20.7	553.86
V9	203.3	0.33	-0.17	203.3
D1	-2,884.06	336.42	-170.46	-2,884.06
D2	-2,583.20	301.43	-152.73	-2,583.20
D3	-2,301.50	268.47	-136.03	-2,301.50
D4	-2,036.58	237.56	-120.37	-2,036.58
D5	-1,794.53	209.32	-106.06	-1,794.53
D6	-1,597.16	186.28	-94.39	-1,597.16
D7	-1,454.88	169.66	-85.96	-1,454.88
D8	-1,366.17	159.55	-80.84	-1,366.17

tabel 4.8 Perencanaan dimensi KK- 2

Batang Tarik	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tarik maksimal (P)	-	13065.66	3582.16	463.55
Panjang Batang Maks	-	184.4	256.1	333
Fy	-	2400	2400	2400
Fu	-	3700	3700	3700
r min	-	0.768	1.067	1.388
Alubang	-	3.81	3.81	3.81
Ag1	-	9.073	2.488	0.322
Ag2	-	12.119	6.088	4.105
Dicoba profil 2L70x70x7				
Dicoba profil 2L60x60x6				
A	-	9.40	6.91	6.91
r	-	2.12	1.82	1.82
W	-	7.38	5.42	5.42
Abruto	-	18.80	13.82	13.82
Anetto	-	14.99	10.01	10.01
Aeffektif	-	12.742	8.509	8.509
Kontrol Tegangan:	-			
T/Aprofil	-	694.982	259.201	33.542
0.6 fy	-	1440	1440	1440
T/Aprofil < 0,6 Fy	-	Aman	Aman	Aman
T/Aeffektif	-	1025.441	421.010	54.481
0,5.Fu	-	1850	1850	1850
T/Aeffektif < 0.5Fu	-	Aman	Aman	Aman

Tabel Perencanaan Dimensi Batang (KK-2)

Batang Tekan	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tekan maksimal(P)	14691.55	-	851	1559.83
Panjang Batang Maks	207.8	-	256.1	235.7
Fy	2400	-	2400	2400
Fu	3700	-	3700	3700
E	2100000	-	2100000	2100000
K (Sendi - Sendi)	1	-	1	1
r min	1.039	-	1.2805	1.1785
Dicoba Profil 2L 70x70x7				
Dicoba Profil 2L 60x60x6				
A	9.4	-	6.91	6.91
r	2.12	-	1.82	1.82
W	7.38	-	5.42	5.42
Ix=Iy	42.4	-	22.8	22.8
ix=iy	2.12	-	1.82	1.82
e	1.97	-	1.69	1.69
tp	1	-	1	1
x	2.47	-	2.19	2.19
Ix gabungan	84.8	-	45.6	45.6
Iy gabungan	131.236	-	75.866	75.866
ix gabungan	2.124	-	1.816	1.816
iy gabungan	2.642	-	2.343	2.343
Dipakai r	2.12	-	1.82	1.82
Syarat :				
K.L / r	98.019	-	140.714	129.505
Cc	130.639	-	130.639	130.639
	K.L/r <Cc	-	K.L/r > Cc	K.L/r < Cc
Fs	1.895	-	0.000	1.917
Fa	909.893	-	545.576	636.918
Kontrol kapasitas		-		
P	17106	-	7539.867	8802.208
P > P terjadi	Aman	-	Aman	Aman

tabel 4.9 Perencanaan dimensi KK- 3

Batang Tekan	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tekan maksimal(P)	20013.93	-	2304	669.98
Panjang Batang Maks	180	-	128	181.6
Fy	2400	-	2400	2400
Fu	3700	-	3700	3700
E	2100000	-	2100000	2100000
K (Sendi - Sendi)	1	-	1	1
r min	0.9	-	0.64	0.908
Dicoba Profil 2L 75x75x7				
Dicoba Profil 2L 60x60x6				
A	10.10	-	6.91	6.91
r	9.67	-	1.82	1.82
W	7.94	-	5.42	5.42
Ix=Iy	52.4	-	22.8	22.8
ix=iy	2.28	-	1.82	1.82
e	2.09	-	1.69	1.69
tp	1	-	1	1
x	2.59	-	2.19	2.19
Ix gabungan	104.8	-	45.6	45.6
Iy gabungan	157.118	-	75.866	75.866
ix gabungan	2.278	-	1.816	1.816
iy gabungan	2.789	-	2.343	2.343
Dipakai r	2.28	-	1.82	1.82
Syarat :				
K.L / r	78.947	-	70.330	99.780
Cc	130.639	-	130.639	130.639
	K.L/r <Cc	-	K.L/r < Cc	K.L/r < Cc
Fs	1.866	-	1.849	1.897
Fa	1051.491	-	1711.064	895.948
Kontrol kapasitas		-		
P	21240.11	-	23646.898	12381.999
P > P terjadi	Aman	-	Aman	Aman

Tabel Perencanaan Dimensi Batang (KK-3)

Batang Tarik	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tarik maksimal (P)	-	19468.03	3050.33	4616.33
Panjang Batang Maks	-	180	128	220.9
Fy	-	2400	2400	2400
Fu	-	3700	3700	3700
r min	-	0.75	0.533	0.920
Alubang	-	3.81	3.81	3.81
Ag1	-	13.519	2.118	3.206
Ag2	-	16.190	5.750	6.746
Dicoba profil 2L 70x70x7				
Dicoba profil 2L60x60x6				
A	-	9.40	6.91	6.91
r	-	2.12	1.82	1.82
W	-	7.38	5.42	5.42
Abruto	-	18.8	13.82	13.82
Anetto	-	14.99	10.01	10.01
Aeffektif	-	12.742	8.509	8.509
Kontrol Tegangan:	-			
T/Aprofil	-	1035.534	220.719	334.033
0.6 fy	-	1440	1440	1440
T/Aprofil < 0,6 Fy	-	Aman	Aman	Aman
T/Aeffektif	-	1527.923	358.504	542.555
0,5.Fu	-	1850	1850	1850
T/Aeffektif < 0.5Fu	-	Aman	Aman	Aman

tabel 4.10 Perencanaan dimensi KK- 3'

Batang Tekan	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tekan maksimal(P)	5162.25	-	-	1273.7
Panjang Batang Maks	207.8	-	-	360
Fy	2400	-	-	2400
Fu	3700	-	-	3700
E	2100000	-	-	2100000
K (Sendi - Sendi)	1	-	-	1
r min	1.039	-	-	1.8
Dicoba Profil 2L 50x50x5				
A	4.8	-	-	4.8
r	1.51	-	-	1.51
W	3.77	-	-	3.77
Ix=Iy	11	-	-	11
ix=iy	1.51	-	-	1.51
e	1.4	-	-	1.4
tp	1	-	-	1
x	1.9	-	-	1.9
Ix gabungan	22	-	-	22
Iy gabungan	40.24	-	-	40.24
ix gabungan	1.514	-	-	1.514
iy gabungan	2.047	-	-	2.047
Dipakai r	1.51	-	-	1.51
Syarat :				
K.L / r	137.616	-	-	238.411
Cc	130.639	-	-	130.639
	K.L/r >Cc	-	-	K.L/r > Cc
Fs	0	-	-	0
Fa	570.420	-	-	190.056
Kontrol kapasitas		-	-	
P	5476.033	-	-	1824.534698
P > P terjadi	Aman	-	-	Aman

Tabel Perencanaan Dimensi Batang (KK-3')

Batang Tarik	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tarik maksimal (P)	-	4481.63	2413.39	980.16
Panjang Batang Maks	-	180	415.7	274.9
Fy	-	2400	2400	2400
Fu	-	3700	3700	3700
r min	-	0.75	1.732	1.145
Alubang	-	3.81	3.81	3.81
Ag1	-	3.112	1.676	0.681
Ag2	-	6.660	5.345	4.433
Dicoba profil 2L50x50x5				
A	-	4.8	4.8	4.8
r	-	1.51	1.51	1.51
W	-	3.77	3.77	3.77
Abruto	-	9.6	9.6	9.6
Anetto	-	5.79	5.79	5.79
Aeffektif	-	4.922	4.922	4.922
Kontrol Tegangan:	-			
T/Aprofil	-	466.836	251.395	102.100
0.6 fy	-	1440	1440	1440
T/Aprofil < 0,6 Fy	-	Aman	Aman	Aman
T/Aeffektif	-	910.623	490.377	199.159
0,5.Fu	-	1850	1850	1850
T/Aeffektif < 0.5Fu	-	Aman	Aman	Aman

tabel 4.11 Perencanaan dimensi KK- 4

Batang Tekan	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tekan maksimal(P)	2042.19	-	-	680.73
Panjang Batang Maks	207.8	-	-	207.8
Fy	2400	-	-	2400
Fu	3700	-	-	3700
E	2100000	-	-	2100000
K (Sendi - Sendi)	1	-	-	1
r min	1.039	-	-	1.039
Dicoba Profil 2L 50x50x5				
A	4.8	-	-	4.8
r	1.51	-	-	1.51
W	3.77	-	-	3.77
Ix=Iy	11	-	-	11
ix=iy	1.51	-	-	1.51
e	1.4	-	-	1.4
tp	1	-	-	1
x	1.9	-	-	1.9
Ix gabungan	22	-	-	22
Iy gabungan	40.24	-	-	40.24
ix gabungan	1.514	-	-	1.514
iy gabungan	2.047	-	-	2.047
Dipakai r	1.51	-	-	1.51
Syarat :				
K.L / r	137.616	-	-	137.616
Cc	130.639	-	-	130.639
	K.L/r >Cc	-	-	K.L/r > Cc
Fs	0	-	-	0
Fa	554.579	-	-	570.420
Kontrol kapasitas		-	-	
P	5323.959	-	-	5476.033
P > P terjadi	Aman	-	-	Aman

Tabel Perencanaan Dimensi Batang (KK-4)

Batang Tarik	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tarik maksimal (P)	-	1764	848	-
Panjang Batang Maks	-	180	207.7	-
Fy	-	2400	2400	-
Fu	-	3700	3700	-
r min	-	0.75	0.865	-
Alubang	-	3.81	3.81	-
Ag1	-	1.225	0.589	-
Ag2	-	4.932	4.349	-
Dicoba profil 2L50x50x5				
A	-	4.8	4.8	-
r	-	1.51	1.51	-
W	-	3.77	3.77	-
Abruto	-	9.6	9.6	-
Anetto	-	5.79	5.79	-
Aeffektif	-	4.922	4.922	-
Kontrol Tegangan:	-			-
T/Aprofil	-	183.75	88.33	-
0.6 fy	-	1440	1440	-
T/Aprofil < 0,6 Fy	-	Aman	Aman	-
T/Aeffektif	-	358.427	172.305	-
0,5.Fu	-	1850	1850	-
T/Aeffektif < 0.5Fu	-	Aman	Aman	-

tabel 4.12 Perencanaan dimensi KK- jurai

Batang Tekan	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tekan maksimal(P)	11834.25	-	-	2884.06
Panjang Batang Maks	183.6	-	-	356.8
Fy	2400	-	-	2400
Fu	3700	-	-	3700
E	2100000	-	-	2100000
K (Sendi - Sendi)	1	-	-	1
r min	0.918	-	-	1.784
Dicoba Profil 2L 70x70x7				
Dicoba Profil 2L 60x60x6				
A	9.4	-	-	6.91
r	2.12	-	-	1.82
W	7.38	-	-	5.42
Ix=Iy	42.4	-	-	22.8
ix=iy	2.12	-	-	1.82
e	1.97	-	-	1.69
tp	1	-	-	1
x	2.47	-	-	2.19
Ix gabungan	84.8	-	-	45.6
Iy gabungan	131.236	-	-	75.866
ix gabungan	2.124	-	-	1.816
iy gabungan	2.642	-	-	2.343
Dipakai r	2.12	-	-	1.82
Syarat :				
K.L / r	86.604	-	-	196.044
Cc	130.639	-	-	130.639
	K.L/r <Cc	-	-	K.L/r > Cc
Fs	1.879	-	-	0
Fa	996.698	-	-	281.077
Kontrol kapasitas		-	-	
P	#########	-	-	3884.482
P > P terjadi	Aman	-	-	Aman

Tabel Perencanaan Dimensi Batang (KK-JURAI)

Batang Tarik	Btg Atas	Btg Bawah	Btg Vertikal	Btg Diagonal
Gaya tarik maksimal (P)	-	11090.75	2615.87	-
Panjang Batang Maks	-	172.1	340.8	-
Fy	-	2400	2400	-
Fu	-	3700	3700	-
r min	-	0.717	1.42	-
Alubang	-	3.81	3.81	-
Ag1	-	7.702	1.817	-
Ag2	-	10.863	5.474	-
Dicoba profil 2L70x70x7				
Dicoba profil 2L60x60x6				
A	-	9.4	6.91	-
r	-	2.12	1.82	-
W	-	7.38	5.42	-
Abruto	-	18.8	13.82	-
Anetto	-	14.99	10.01	-
Aeffektif	-	12.742	8.509	-
Kontrol Tegangan:	-			-
T/Aprofil	-	589.934	189.281	-
0.6 fy	-	1440	1440	-
T/Aprofil < 0,6 Fy	-	Aman	Aman	-
T/Aeffektif	-	870.443	307.442	-
0,5.Fu	-	1850	1850	-
T/Aeffektif < 0.5Fu	-	Aman	Aman	-

tabel 4.14 Perencanaan sambungan KK-2

JOINT	BATANG	GAYA BATANG	JUMLAH BAUT	BAUT YANG DIPAKAI
1 = 13	A1 = A24	14691.55	2.295267779	3
	B1 = B12	13065.66	2.041254218	3
2 = 12	B1 = B12	13065.66	2.041254218	3
	B2 = B11	13065.66	2.041254218	3
	V1 = V11	293	0.045775528	3
3 = 11	B2 = B11	13065.66	2.041254218	3
	B3 = B10	11717.57	1.830641482	3
	V2 = V10	752.86	0.117619673	3
	D1 = D10	1326.6	0.207255343	3
4 = 10	B3 = B10	11717.57	1.830641482	3
	B4 = B9	10469.91	1.635718973	3
	D2 = D9	1353.15	0.211403262	3
	V3 = V9	1153.24	0.180171229	3
5 = 9	B4 = B9	10469.91	1.635718973	3
	B5 = B8	9026.76	1.410254968	3
	V4 = V8	3583.16	0.559798775	3
	D3 = D8	1559.83	0.243692976	3
6 = 8	B5 = B8	9026.76	1.410254968	3
	B6 = B7	9827.47	1.535350269	3
	V5 = V7	851	0.132952131	3
	D4 = D7	1390.65	0.217261905	3
7	B6 = B7	9827.47	1.535350269	3
	D5 = D6	463.55	0.072420635	3
	V6	472	0.073740782	3
14 = 24	A1 = A12	14691.55	2.295267779	3
	A2 = A11	13217.96	2.065048119	3
	V1 = V11	293	0.045775528	3
	D1 = D10	1326.6	0.207255343	3
15 = 23	A2 = A23	13217.96	2.065048119	3
	A3 = A10	11810.54	1.845166229	3
	V2 = V10	752.86	0.117619673	3
	D2 = D9	1353.15	0.211403262	3
16 = 22	A3 = 10	11810.54	1.845166229	3
	A4 = A9	10430.99	1.629638483	3
	V3 = V9	1153.24	0.180171229	3
	D3 = D8	1559.83	0.243692976	3
17 = 21	A4 = A9	10430.99	1.629638483	3
	A5 = A8	9827.46	1.535348706	3
	V4 = V8	3583.16	0.559798775	3
	D4 = D7	1390.65	0.217261905	3
18 = 20	A5 = A8	9827.46	1.535348706	3
	A6 = A7	10094.37	1.577048181	3
	V5 = V7	851	0.132952131	3
	D5 = D6	463.55	0.072420635	3
19	A6 = A7	10094.37	1.577048181	3
	V6	472	0.073740782	3

tabel 4.15 Perencanaan sambungan KK-3

JOINT	BATANG	GAYA BATANG	JUMLAH BAUT	BAUT YANG DIPAKAI
1 = 13	A1 = A24	13790.59	2.154510374	3
	B1 = B12	12235.01	1.911481377	3
2 = 12	B1 = B12	12235.01	1.911481377	3
	B2 = B11	12235.01	1.911481377	3
	V1 = V11	293	0.045775528	3
3 = 11	B2 = B11	12235.01	1.911481377	3
	B3 = B10	11279.51	1.762203162	3
	V2 = V10	3050.33	0.476554493	3
	D1 = D10	669.98	0.104671291	3
4 = 10	B3 = B10	11279.51	1.762203162	3
	B4 = B9	15100.82	2.359208224	3
	D2 = D9	4616.33	0.721211411	3
	V3 = V9	2304	0.359955006	3
5 = 9	B4 = B9	15100.82	2.359208224	3
	B5 = B8	17830.33	2.785640857	3
	V4 = V8	1564	0.244344457	3
	D3 = D8	3297.38	0.515151231	3
6 = 8	B5 = B8	17830.33	2.785640857	3
	B6 = B7	19468.03	3.0414995	3
	V5 = V7	824	0.128733908	3
	D4 = D7	1978.43	0.309091051	3
7	B6 = B7	19468.03	3.0414995	3
	D5 = D6	659.48	0.103038071	3
	V6	454	0.070928634	3
14 = 24	A1 = A12	13790.59	2.154510374	3
	A2 = A11	12845.89	2.006919448	3
	V1 = V11	293	0.045775528	3
	D1 = D10	669.98	0.104671291	3
15 = 23	A2 = A11	12845.89	2.006919448	3
	A3 = A10	15160.82	2.368582052	3
	V2 = V10	3050.33	0.476554493	3
	D2 = D9	4616.33	0.721211411	3
16 = 22	A3 = 10	15160.82	2.368582052	3
	A4 = A9	17830.33	2.785640857	3
	V3 = V9	2304	0.359955006	3
	D3 = D8	3297.38	0.515151231	3
17 = 21	A4 = A9	17830.33	2.785640857	3
	A5 = A8	19468.03	3.0414995	3
	V4 = V8	1564	0.244344457	3
	D4 = D7	1978.43	0.309091051	3
18 = 20	A5 = A8	19468.03	3.0414995	3
	A6 = A7	20013.93	3.126785714	3
	V5 = V7	824	0.128733908	3
	D5 = D6	659.48	0.103038071	3
19	A6 = A7	20013.93	3.126785714	3
	V6	454	0.070928634	3

tabel 4.16 Perencanaan sambungan KK-3'

JOINT	BATANG	GAYA BATANG	JUMLAH BAUT	BAUT YANG DIPAKAI
1 = 9	A1 = A8	5162.25	0.80650075	3
	B1 = B8	4481.63	0.700167167	3
2 = 8	B1 = B8	4481.63	0.700167167	3
	B2 = B7	4481.63	0.700167167	3
	V1 = V7	208	0.032495938	3
3 = 7	B2 = B7	4481.63	0.700167167	3
	B3 = B6	3816.67	0.596280152	3
	V2 = V6	588.14	0.091885389	3
	D1 = D6	765.95	0.119664729	3
4 = 6	B3 = B6	3816.67	0.596280152	3
	B4 = B5	3173.75	0.495836458	3
	V3 = V5	947.84	0.14808149	3
	D2 = D5	980.16	0.153130859	3
5	B4 = B5	3173.75	0.495836458	3
	D3 = D4	1273.7	0.198990751	3
	V4	947.84	0.14808149	3
10 = 16	A1 = A8	5162.25	0.80650075	3
	A2 = A7	4410.41	0.689040432	3
	V1 = V7	208	0.032495938	3
	D1 = D6	765.95	0.119664729	3
11 = 15	A2 = A7	4410.41	0.689040432	3
	A3 = A6	3667.47	0.572970566	3
	V2 = V6	588.14	0.091885389	3
	D2 = D5	980.16	0.153130859	3
12 = 14	A3 = A6	3667.47	0.572970566	3
	A4 = A5	2930.84	0.457886514	3
	V3 = V5	947.84	0.14808149	3
	D3 = D4	1273.7	0.198990751	3
13	A4 = A5	2930.84	0.457886514	3
	V4	947.84	0.14808149	3

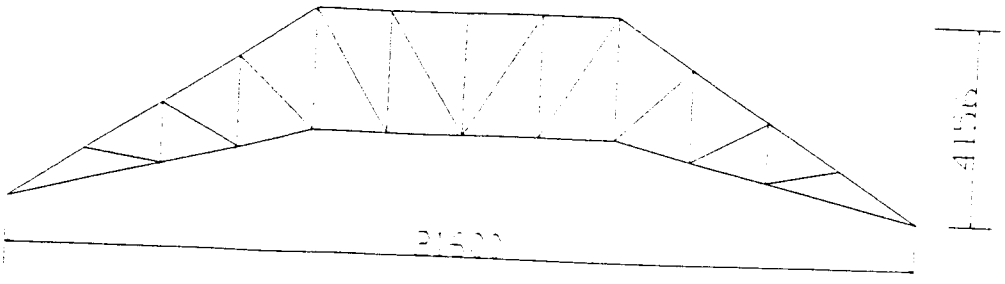
tabel 4.17 Perencanaan sambungan KK-4

JOINT	BATANG	GAYA BATANG	JUMLAH BAUT	BAUT YANG DIPAKAI
1 = 5	A1 = A4	2042.19	0.319052306	3
	B1 = B4	1764	0.275590551	3
2 = 4	B1 = B4	1764	0.275590551	3
	B2 = B3	1764	0.275590551	3
	V1 = V3	162	0.025309336	3
3	B2 = B3	1764	0.275590551	3
	V2	848	0.13248344	3
	D1 = D2	680.73	0.106350769	3
6 = 8	A1 = A4	2042.19	0.319052306	3
	A2 = A3	1361.46	0.212701537	3
	V1 = V3	162	0.025309336	3
	D1 = D2	680.73	0.106350769	3
7	A2 = A3	1361.46	0.212701537	3
	V2	848	0.13248344	3

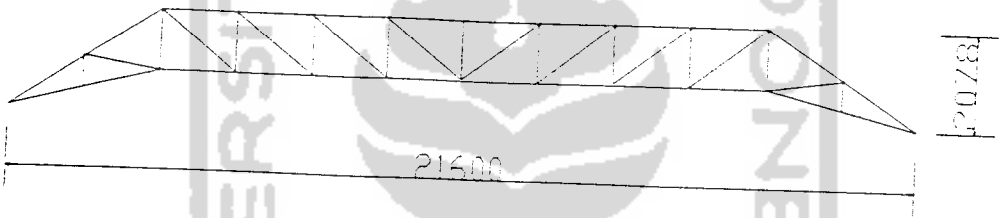
tabel 4.18 Perencanaan sambungan KK-JURAI

JOINT	BATANG	GAYA BATANG	JUMLAH BAUT	BAUT YANG DIPAKAI
1	B1	1389.6	0.217097863	3
	V1	0	0	3
	D1	2884.06	0.450578053	3
2	B1	1389.6	0.217097863	3
	B2	2770.48	0.432833396	3
	V2	2615.87	0.408678603	3
	D2	2583.06	0.403552681	3
3	B2	2770.48	0.432833396	3
	B3	4158.99	0.649760967	3
	V3	2269.49	0.354563492	3
	D3	2301.5	0.359564429	3
4	B3	4158.99	0.649760967	3
	B4	5548.58	0.866857268	3
	V4	1926.99	0.301054556	3
	D4	2036.58	0.318175853	3
5	B4	5548.58	0.866857268	3
	B5	6932.02	1.082992751	3
	V5	1587.31	0.247986189	3
	D5	1794.53	0.280360267	3
6	B5	6932.02	1.082992751	3
	B6	8321.24	1.300031246	3
	V6	1236.67	0.193205537	3
	D6	1597.16	0.249525059	3
7	B6	8321.24	1.300031246	3
	B7	9714.04	1.517629046	3
	V7	895.79	0.139949694	3
	D7	1454.88	0.227296588	3
8	B7	9714.04	1.517629046	3
	B8	11091.33	1.732803712	3
	V8	553.86	0.086529809	3
	D8	1366.17	0.213437383	3
9	B8	11091.33	1.732803712	3
	B9	11090.75	1.732713098	3
	V9	203.3	0.031761655	3
10	A9	11834.25	1.848870454	3
	B9	11090.75	1.732713098	3
11	A1	0	0	3
	V1	0	0	3
12	A1	0	0	3
	A2	1483.78	0.231811649	3
	V2	2615.87	0.408678603	3
	D1	2884.06	0.450578053	3
13	A2	1483.78	0.231811649	3
	A3	2956.05	0.461825084	3
	V3	2269.49	0.354563492	3
	D2	2583.06	0.403552681	3

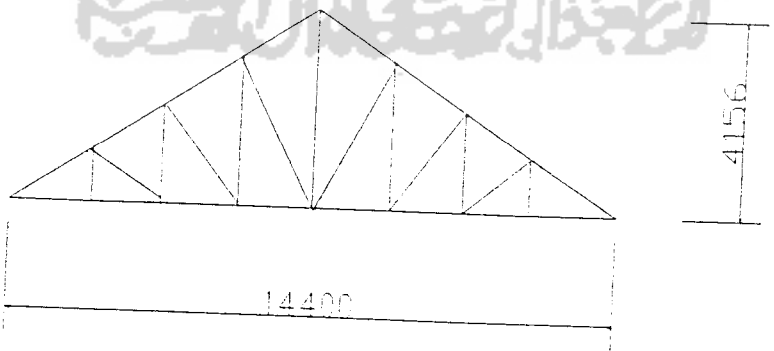
JOINT	BATANG	GAYA BATANG	JUMLAH BAUT	BAUT YANG DIPAKAI
14	A3	2956.05	0.461825084	3
	A4	4437.8	0.693319585	3
	V4	1926.99	0.301054556	3
	D3	2301.5	0.359564429	3
15	A4	4437.8	0.693319585	3
	A5	5921.88	0.925178103	3
	V5	1587.31	0.247986189	3
	D4	2036.58	0.318175853	3
16	A5	5921.88	0.925178103	3
	A6	7396.35	1.155535246	3
	V6	1236.67	0.193205537	3
	D5	1794.53	0.280360267	3
17	A6	7396.35	1.155535246	3
	A7	8879.08	1.387182852	3
	V7	895.79	0.139949694	3
	D6	1597.16	0.249525059	3
18	A7	8879.08	1.387182852	3
	A8	10365.46	1.6194007	3
	V8	553.86	0.086529809	3
	D7	1454.88	0.227296588	3
19	A8	10365.46	1.6194007	3
	A9	11834.25	1.848870454	3
	V9	203.3	0.031761655	3
	D8	1366.17	0.213437383	3



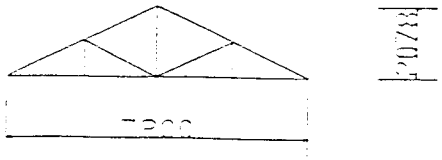
Gambar 4.2 kuda-kuda 2



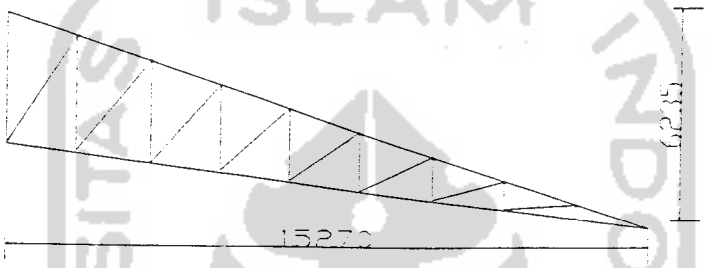
Gambar 4.3 kuda-kuda



Gambar 4.4 kuda-kuda 3'



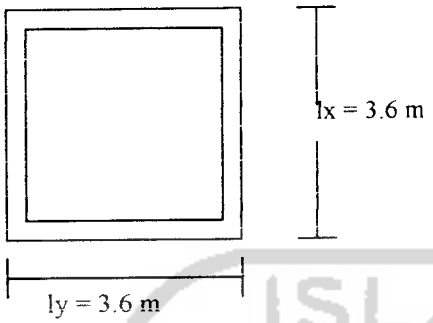
Gambar 4.5 kuda-kuda 4



Gambar 4.6 kuda-kuda jurai

4.2 Perencanaan Pelat

4.2.1 Pelat Lantai A (Kantor)



$$\frac{l_y}{l_x} = \frac{3.6}{3.6} = 1$$

Tumpuan dianggap jepit elastis

(Tabel PBI '71)

$$C_{tx} = C_{lx} = 36$$
$$C_{ty} = C_{ly} = 36$$

Tebal pelat h = 120 mm

ϕ tulangan diperkirakan 10 mm

$$d' = h - \rho_b - \frac{1}{2}.\phi_{tul}$$
$$= 120 - 20 - \frac{1}{2}.10$$
$$= 95\,mm$$

Menentukan beban pelat

- Berat pelat = 0.12 x 24 = 2.88 kN/m^2
- Pasir (5 cm) = 0.05 x 18 = 0.9 kN/m^2
- Spesi (2 cm) = 0.02 x 24 = 0.48 kN/m^2
- Keramik (1 cm) = 0.01 x 20 = 0.2 kN/m^2 +

Beban mati q_D = 4.46 kN/m^2

Beban hidup q_L = 2.5 kN/m^2

$q_U = 1.2\ q_D + 1.6\ q_L$

$= 1.2 \cdot 4.45 + 1.6 \cdot 2.5$

$= 9.352$ kN/m^2

Cek persyaratan geser

$$V_u = 1.15\frac{(qu.lx)}{2} = 1.15\frac{9.352 \cdot 3.6}{2} = 19.359\ kN$$

$$Vc = 0.6\left(\frac{\sqrt{f'c}}{6}\right).b.d = 0.6\left(\frac{\sqrt{25}}{6}\right).1000.95 = 47.5\ kN$$

$Vc > Vu$

Menghitung momen distribusi

$$M = 0.001.q_u.l_x^{\ 2}.x$$

$$Mu\ l_x = +0.001 \cdot 9.352 \cdot 3.6^2 \cdot 36 = +4.363\ kN.m$$

$$Mu\ t_x = -4.363\ kN.m$$

$$Mu\ l_y = +4.363\ kN.m$$

$$Mu\ t_y = -4.363\ kN.m$$

Perencanaan Tulangan

- Tulangan Pokok arah x = Tulangan pokok arah y
- Tulangan tumpuan = Tulangan lapangan

$$Mu = 4.363\ kN.m$$

$$\frac{Mu}{\phi} = \frac{4.363}{0.8} = 5.454\ kN.m$$

$$\rho_b = \frac{0.85.f_c'}{f_y}.0.85\left(\frac{600}{600+f_y}\right) = \frac{0.85.25}{240}.0\ 85\left(\frac{600}{600+240}\right) = 0.0538$$

$$\rho_{maks} = 0.75.\ \rho_b = 0.0403$$

$$\rho_{\min} = \frac{1.4}{f_y} = \frac{1.4}{240} = 0.00583$$

$$Rn = \frac{Mu/\phi}{b.d^2} = \frac{5.454.10^6}{1000.95^2} = 0.6043\ MPa$$

$$M = \frac{Fy}{0.85.\ fc'} = \frac{240}{0.85.25} = 11.294$$

$$\rho = \frac{1}{m}\left(1-\sqrt{\frac{1-2m.Rn}{fy}}\right) = \frac{1}{11.294}\left(1-\sqrt{\frac{1-2.11.294.0.6043}{240}}\right) = 0.00256$$

Jadi :

$$\rho = 0.00256 < \rho_{maks}$$

$$\rho = 0.00256 < \rho_{\min}$$

$$1.33\rho = 0.003341 < \rho_{\min}$$

Dipakai :

$$1.33\rho = 0.003341 < \rho_{\min}$$

$$As = \rho.b.d = 0.00341.1000.95 = 323.95\,mm^2$$

Dipakai tulangan diameter 8 mm , Aϕ =50.24 mm2

$$Jarak\ tulangan \leq \frac{A_1.\phi.b}{As}$$

$$x \leq \frac{50.24.1000}{323.95}$$

$$x \leq 155.089\ mm$$

Dipakai tulangan P8 – 150 mm

$$As = \frac{A_1\phi.b}{150} = \frac{50.24.1000}{150} = 334.93\,mm^2 > As\ perlu = 323.95\,mm^2$$

Kontrol Mn :

$$a = \frac{As.fy}{0.85.fc'.b} = \frac{334.93.240}{0.85.25.1000} = 3.783\,mm$$

$$Mn = As.fy\left(d - \frac{a}{2}\right) = 334.93.240\left(95 - \frac{3.783}{2}\right)$$

$$= 7.484\,kN.m > 1.33\frac{Mu}{\phi} = 7.254\,kN.m$$

Menghitung tulangan bagi

Arah x = arah y

As bagi = 0.002 x b x h = 0.002 x 1000 x 120 = 240

Dipakai tulangan bagi ϕ 8, A1 ϕ = 50.24 mm

Jarak tulangan bagi

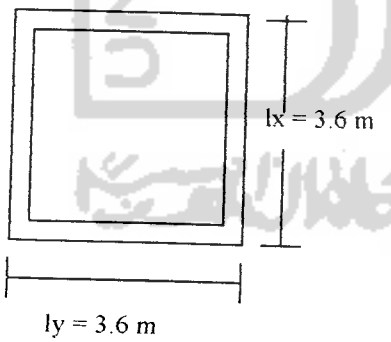
$$= \frac{A_1\phi .1000}{As\ bagi} = \frac{50.24 .1000}{240} = 209.333\ mm$$

Dipakai ϕ 8-200 mm

Kontrol

$$As = \frac{50.24 .1000}{200} = 251.2\ mm^2 > 200\ mm^2$$

4.2.2 Pelat Lantai A (Perpustakaan)



$$\frac{l_y}{l_x} = \frac{3.6}{3.6} = 1$$

Tumpuan dianggap jepit elastis

(Tabel PBI "71)

$$C_{tx} = C_{lx} = 36$$
$$C_{ty} = C_{ly} = 36$$

Tebal pelat h = 120 mm

ϕ tulangan diperkirakan 10 mm

$$d' = h - \rho_b - \frac{1}{2}.\phi_{tul}$$
$$= 120 - 20 - \frac{1}{2}.10$$
$$= 95\ mm$$

Menentukan beban pelat

- Berat pelat	= 0.12 x 24	=	2.88	kN/m^2
- Pasir (5 cm)	= 0.05 x 18	=	0.9	kN/m^2
- Spesi (2 cm)	= 0.02 x 24	=	0.48	kN/m^2
- Keramik (1 cm)	= 0.01 x 20	=	0.2	kN/m^2 +
Beban mati q_D		=	4.46	kN/m^2
Beban hidup q_L		=	4	kN/m^2

$q_U = 1.2\ q_D + 1.6\ q_L$

$= 1.2 . 4.46 + 1.6 . 4$

$= 11.752$ kN/m^2

Cek persyaratan geser

$$V_u = 1.15\frac{(qu.lx)}{2} = 1.15\frac{11.752.3.6}{2} = 24.327\ kN$$

$$Vc = 0.6\left(\frac{\sqrt{f'c}}{6}\right).b.d = 0.6\left(\frac{\sqrt{25}}{6}\right).1000.95 = 47.5\ kN$$

$$Vc > Vu$$

Menghitung momen distribusi

$$M = 0.001.q_u.l_x^2.x$$

$$Mu\ l_x = +0.001\ .11.752.3.6^2\ .36 = +5.483\ kN.m$$

$$Mu\ l_x = -5.483\ kN.m$$

$$Mu\ l_y = +5.483\ kN.m$$

$$Mu\ t_y = -5.483\ kN.m$$

Perencanaan Tulangan

- Tulangan Pokok arah x = Tulangan pokok arah y
- Tulangan tumpuan = Tulangan lapangan

$$Mu = 5.483\ kN.m$$

$$\frac{Mu}{\phi} = \frac{.483}{0.8} = 6.854\ kN.m$$

$$\rho_b = \frac{0.85.f_c'}{f_y}.0.85\left(\frac{600}{600+f_y}\right) = \frac{0.85.25}{240}.0.85\left(\frac{600}{600+240}\right) = 0.0538$$

$$\rho_{maks} = 0.75.\ \rho_b = 0.0403$$

$$\rho_{\min} = \frac{1.4}{f_y} = \frac{1.4}{240} = 0.00583$$

$$Rn = \frac{Mu/\phi}{b.d^2} = \frac{6.854.10^6}{1000.95^2} = 0.7594\ MPa$$

$$M = \frac{Fy}{0.85\ .\ fc'} = \frac{240}{0.85.25} = 11.294$$

$$\rho = \frac{1}{m}\left(1-\sqrt{\frac{1-2m.Rn}{fy}}\right) = \frac{1}{11.294}\left(1-\sqrt{\frac{1-2.11.294.0.7594}{240}}\right) = 0.00323$$

$$\rho = 0.00323 < \rho_{maks}$$

$$\rho = 0.00323 < \rho_{\min}$$

$$1.33\rho = 0.0043 < \rho_{\min}$$

Dipakai :

$$1.33\rho = 0.0043 < \rho_{\min}$$

$$As = \rho.b.d = 0.0043.1000.95 = 408.5\ mm^2$$

Dipakai tulangan diameter 10 mm , Aϕ =78.5 mm2

$$Jarak\ tulangan \leq \frac{A_1 \phi . b}{As}$$

$$x \leq \frac{78.5.1000}{408.5}$$

$$x \leq 192.17\ mm$$

Dipakai tulangan P10 – 190 mm

$$As = \frac{A_1 \phi . b}{190} = \frac{78.5.1000}{190} = 413.158\ mm^2 > As\ perlu = 408.5\ mm^2$$

Kontrol Mn :

$$a = \frac{As.fy}{0.85.fc'.b} = \frac{413.158.240}{0.85.25.1000} = 4.666\ mm$$

$$Mn = As.fy\left(d - \frac{a}{2}\right) = 413.158.240\left(95 - \frac{4.666}{2}\right)$$

$$= 9.189\ kN.m > \frac{Mu}{\phi} = 6.854\ kN.m$$

Menghitung tulangan bagi

Arah x = arah y

As bagi = 0.002 x b x h = 0.002 x 1000 x 120 = 240

Dipakai tulangan bagi ϕ 8 - A1 ϕ = 50.24 mm

Jarak tulangan bagi

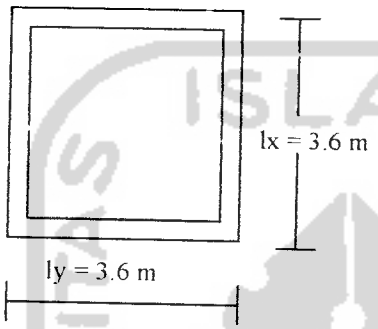
$$= \frac{A_1 \phi .1000}{As\ bagi} = \frac{50.24.1000}{240} = 209.333\ mm$$

Dipakai ϕ 8-200 mm

Kontrol

$$As = \frac{50.24.1000}{200} = 251.2\,mm^2 > 200\,mm^2$$

4.2.3 Pelat Lantai Atap



$$\frac{l_y}{l_x} = \frac{3.6}{3.6} = 1$$

Tumpuan dianggap jepit elastis

(Tabel PBI '71)

$C_{tx} = C_{lx} = 36$

$C_{ty} = C_{ly} = 36$

Tebal pelat h = 100 mm

ϕ tulangan diperkirakan 10 mm

$$d' = h - \rho_b - \frac{1}{2}.\phi_{tul}$$

$$= 100 - 20 - \frac{1}{2}.10$$

$$= 75\,mm$$

Menentukan beban pelat

- Berat pelat	= 0.1 x 24	=	2.4	kN/m^2
- Aspal	= 0.04 x 0.14	=	0.0056	kN/m^2
- Penggantung langit + eternit		=	0.18	kN/m^2
- Finishing	= 0.03 x 24	=	0.18	kN/m^2 +
Beban mati q_D		=	3.3056	kN/m^2
Beban hidup q_L + hujan		=	1.2	kN/m^2

$q_U = 1.2\ q_D + 1.6\ q_L$

$= 1.2\ .\ 3.3056 + 1.6\ .\ 1.2$

$= 5.887$ kN/m^2

Cek persyaratan geser

$$V_u = 1.15\frac{(qu.lx)}{2} = 1.15\frac{5.887.3.6}{2} = 12.186\,kN$$

$$Vc = 0.6\left(\frac{\sqrt{f'c}}{6}\right).b.d = 0.6\left(\frac{\sqrt{25}}{6}\right).1000.95 = 47.5\,kN$$

$Vc > Vu$

Menghitung momen distribusi

$$M = 0.001.q_u.l_x^{\,2}.x$$

$$Mu\ l_x = +0.001\ .\ 5.887.3.6^2\ .36 = +2.594\ kN.m$$

$$Mu\ t_x = -2.594\ kN.m$$

$$Mu\ l_y = +2.594\ kN.m$$

$$Mu\ t_y = -2.594\ kN.m$$

Perencanaan Tulangan

- Tulangan Pokok arah x = Tulangan pokok arah y
- Tulangan tumpuan = Tulangan lapangan

$Mu = 2.594\ kN.m$

$$\frac{Mu}{\phi} = \frac{.2.594}{0.8} = 3.243\ kN.m$$

$$\rho_b = \frac{0.85.f_c'}{f_y}.0.85\left(\frac{600}{600+f_y}\right) = \frac{0.85.25}{240}.0.85\left(\frac{600}{600+240}\right) = 0.0538$$

$$\rho_{maks} = 0.75.\ \rho_b = 0.0403$$

$$\rho_{\min} = \frac{1.4}{f_y} = \frac{1.4}{240} = 0.00583$$

$$Rn = \frac{Mu/\phi}{b.d^2} = \frac{3.243.10^6}{1000.95^2} = 0.5765\ MPa$$

$$M = \frac{Fy}{0.85\,.\,fc'} = \frac{240}{0.85.25} = 11.294$$

$$\rho = \frac{1}{m}\left(1 - \sqrt{\frac{1-2m.Rn}{fy}}\right) = \frac{1}{11.294}\left(1 - \sqrt{\frac{1-2.11.294.0.5765}{240}}\right) = 0.00244$$

$$\rho = 0.00244 < \rho_{maks}$$

$$\rho = 0.00244 < \rho_{\min}$$

$$1.33\rho = 0.00325 < \rho_{\min}$$

Dipakai :

$$1.33\rho = 0.00325 < \rho_{\min}$$

$$As = \rho.b.d = 0.00325.1000.75 = 243.75\,mm^2$$

Dipakai tulangan diameter 8 mm , Aϕ –50.24 mm2

$$Jarak\ tulangan \leq \frac{A_1\phi.b}{As}$$

$$x \leq \frac{50.24.1000}{243.75}$$

$$x \leq 206.11\,mm$$

Dipakai tulangan P8 – 200 mm

$$As = \frac{A_1\phi\,.\,b}{320} = \frac{50.24.1000}{200} = 251.2\,mm^2 > As\ perlu = 243.75\,mm^2$$

Kontrol Mn :

$$a = \frac{As.fy}{0.85.fc'.b} = \frac{251.2.240}{0.85.25.1000} = 2.837\,mm$$

$$Mn = As.fy\left(d - \frac{a}{2}\right) = 251.2.240\left(95 - \frac{2.837}{2}\right)$$

$$= 5.642\,kN.m > 1.33.\frac{Mu}{\phi} = 4.313\,kN.m$$

Menghitung tulangan bagi dan tulangan susut

Arah x = arah y

As bagi = 0.002 x b x h = 0.002 x 1000 x 100 = 200

Dipakai tulangan bagi ϕ 8 - A1 ϕ = 50.24 mm

Jarak tulangan bagi

$$= \frac{A_1\phi.1000}{As\,bagi} = \frac{50.24.1000}{200} = 251.2\,mm$$

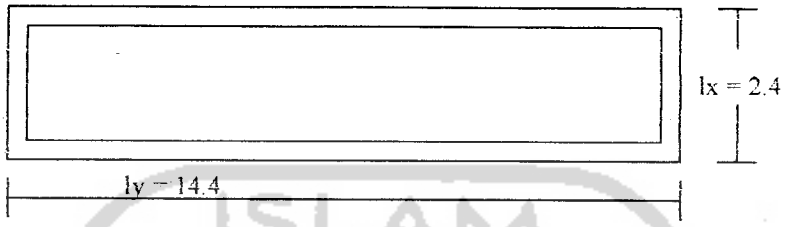
Dipakai ϕ 8-250 mm

Kontrol

$$As = \frac{50.24.1000}{250} = 200.96\,mm^2 > 200\,mm^2$$

4.2.4 Pelat Lantai B (Ruang Pertemuan)

Tumpuan dianggap jepit elastis



$$\frac{l_y}{l_x} = \frac{14.4}{2.4} = 6$$

(Tabel PBI '71)

$$C_{tx} = C_{lx} = 63$$

$$C_{ty} = 38 \quad Cly = 13$$

Tebal pelat h = 120 mm

ϕ tulangan diperkirakan 10 mm

$$d' = h - \rho_b - \frac{1}{2}.\phi_{tul}$$

$$= 120 - 20 - \frac{1}{2}.10$$

$$= 95\ mm$$

Menentukan beban pelat

- Berat pelat	= 0.12 x 24	=	2.88	kN/m^2
- Pasir (5 cm)	= 0.05 x 18	=	0.9	kN/m^2

- Spesi (2 cm) = 0.02 x 24 = 0.48 kN/m^2
- Keramik (1 cm) = 0.01 x 20 = 0.2 kN/m^2

Beban mati q_D = 4.46 kN/m^2

Beban hidup q_L = 4 kN/m^2

$q_U = 1.2\ q_D + 1.6\ q_L$

$= 1.2 \cdot 4.46 + 1.6 \cdot 4 = 11.752$ kN/m^2

Cek persyaratan geser

$$V_u = 1.15\frac{(qu.lx)}{2} = 1.15\frac{11.752.2.4}{2} = 14.1024\ kN$$

$$Vc = 0.6\left(\frac{\sqrt{f'c}}{6}\right).b.d = 0.6\left(\frac{\sqrt{25}}{6}\right).1000.95 = 47.5\ kN$$

$Vc > Vu$

Menghitung momen distribusi

$$M = 0.001.q_u.l_x^2.x$$

$$Mu\ l_x = +0.001\ .11.752.2.4^2\ .63 = +4.265\ kN.m$$

$$Mu\ l_y = +0.001.11.752.2.4^2.13 = 0.88\ kN.m$$

$$Mu\ t_x = -0.001\ .11.752.2.4^2\ .63 = +4.265\ kN.m$$

$$Mu\ t_y = +0.001\ .11.752.2.4^2\ .38 = +2.572\ kN.m$$

Perencanaan Tulangan

- Tulangan Pokok arah x = Tulangan pokok arah y
- Tulangan tumpuan = Tulangan lapangan

$$Mu = 4.263\ kN.m$$

$$\frac{Mu}{\phi} = \frac{4.263}{0.8} = 5.329\ kN.m$$

$$\rho_b = \frac{0.85.f_c'}{f_y}.0.85\left(\frac{600}{600+f_y}\right) = \frac{0.85.25}{240}.0.85\left(\frac{600}{600+240}\right) = 0.0538$$

$$\rho_{maks} = 0.75.\ \rho_b = 0.0403$$

$$\rho_{\min} = \frac{1.4}{f_y} = \frac{1.4}{240} = 0.00583$$

$$Rn = \frac{Mu/\phi}{b.d^2} = \frac{5.329.10^6}{1000.95^2} = 0.5905\ MPa$$

$$m = \frac{Fy}{0.85\ .\ fc'} = \frac{240}{0.85.25} = 11.294$$

$$\rho = \frac{1}{m}\left(1-\sqrt{1-\frac{2.m.Rn}{fy}}\right) = \frac{1}{11.294}\left(1-\sqrt{1-\frac{2.11.294\ .0.5905}{240}}\right) = 0.0025$$

Jadi :

$$\rho = 0.0025 < \rho_{maks}$$

$$\rho = 0.0025 < \rho_{\min}$$

$$1.33\rho = 0.003325 < \rho_{\min}$$

Dipakai :

$$1.33\rho = 0.003325 < \rho_{min}$$

$$As = \rho.b.d = 0.003325.1000.95 = 315.875\ mm^2$$

Dipakai tulangan diameter 8 mm , Aϕ =50.24 mm2

$$Jarak\ tulangan \leq \frac{A_1\phi.b}{As}$$

$$x \leq \frac{50.24.1000}{315.875}$$

$$x \leq 159.05\ mm$$

$$x \leq 2h = 240\ mm$$

$$x \leq 250\ mm$$

Dipakai tulangan P8 – 150 mm

$$As = \frac{A_1\phi.b}{As} = \frac{50.24.1000}{150} = 334.933\ mm^2 > As\ perlu = 315.875\ mm^2$$

Kontrol Mn :

$$a = \frac{As.fy}{0.85.fc'.b} = \frac{334.933.240}{0.85.25.1000} = 3.783\ mm$$

$$Mn = As.fy\left(d - \frac{a}{2}\right) = 334.933.240\left(95 - \frac{3.783}{2}\right)$$

$$= 7.484 kN.m < 1.33.\frac{Mu}{\phi} = 7.087\ kN.m$$

- Tulangan tumpuan y

$Mu = 2.572 kN.m$

$$\frac{Mu}{\phi} = 3.215\, kN.m$$

$$\rho_b = \frac{0.85.f_c'}{f_y}.0.85\left(\frac{600}{600+f_y}\right) = \frac{0.85.25}{240}.0.85\left(\frac{600}{600+240}\right) = 0.0538$$

$$\rho_{maks} = 0.75.\ \rho_b = 0.0403$$

$$\rho_{\min} = \frac{1.4}{f_y} = \frac{1.4}{240} = 0.00583$$

$$Rn = \frac{Mu/\phi}{b.d^2} = \frac{3.215.10^6}{1000.95^2} = 0.356\ MPa$$

$$m = \frac{Fy}{0.85\ .\ fc'} = \frac{240}{0.85.25} = 11.294$$

$$\rho = \frac{1}{m}\left(1-\sqrt{\frac{1-2m.Rn}{fy}}\right) = \frac{1}{11.294}\left(1-\sqrt{\frac{1-2.11.294.0.356}{240}}\right) = 0.0015$$

$\rho = 0.0015 < \rho_{maks}$

$\rho = 0.0015 < \rho_{\min}$

$1.33\rho = 0.0019 < \rho_{\min}$

$1.33\rho < 0.002$

Dipakai :

$$\rho = 0.002$$

$$As = \rho.b.d = 0.002.1000.95 = 190\,mm^2$$

Dipakai tulangan diameter 8 mm , Aϕ =50.24 mm^2

$$Jarak\ tulangan \leq \frac{A_1\phi.b}{As}$$

$$x \leq \frac{50.24.1000}{190}$$

$$x \leq 264.42\ mm$$

$$x \leq 2h = 240\ mm$$

$$x \leq 250\ mm$$

Dipakai tulangan P10 – 200 mm

$$As = \frac{A_1\phi.b}{200} = \frac{50.24.1000}{200} = 251.2\,mm^2 > As\ perlu = 190\,mm^2$$

Kontrol Mn :

$$a = \frac{As.fy}{0.85.fc'.b} = \frac{251.2.240}{0.85.25.1000} = 2.837\,7mm$$

$$Mn = As.fy\left(d - \frac{a}{2}\right) = 251.2.240\left(95 - \frac{2.837}{2}\right)$$

$$= 5.641\,kN.m > 1.33\frac{Mu}{\phi} = 4.276\,kN.m$$

- Tulangan tumpuan y

$$Mu = 0.88 kN.m$$

$$\frac{Mu}{\phi} = 1.1 kN.m$$

$$\rho_b = \frac{0.85.f_c'}{f_y}.0.85\left(\frac{600}{600+f_y}\right) = \frac{0.85.25}{240}.0.85\left(\frac{600}{600+240}\right) = 0.0538$$

$$\rho_{maks} = 0.75.\ \rho_b = 0.0403$$

$$\rho_{\min} = \frac{1.4}{f_y} = \frac{1.4}{240} = 0.00583$$

$$Rn = \frac{Mu/\phi}{b.d^2} = \frac{1.1.10^6}{1000.95^2} = 0.122\ MPa$$

$$m = \frac{Fy}{0.85\ .\ fc'} = \frac{240}{0.85.25} = 11.294$$

$$\rho = \frac{1}{m}\left(1-\sqrt{\frac{1-2m.Rn}{fy}}\right) = \frac{1}{11.294}\left(1-\sqrt{\frac{1-2.11.294.0.122}{240}}\right) = 0.0051$$

$$\rho = 0.0051 < \rho_{maks}$$

$$\rho = 0.0051 < \rho_{\min}$$

$$1.33\rho = 0.00067919 < \rho_{\min}$$

$$1.33\rho = 0.000678 < 0.002$$

Dipakai :

$$\rho = 0.002$$

$$As = \rho.b.d = 0.002.1000.95 = 190\,mm^2$$

Dipakai tulangan diameter 8 mm , Aϕ =50.24 mm^2

$$Jarak\ tulangan \le \frac{A_1\phi.b}{As}$$

$$x \le \frac{50.24.1000}{190}$$

$$x \le 264.42\ mm$$

$$x \le 2h = 240\ mm$$

$$x \le 250\ mm$$

Dipakai tulangan P8 – 200 mm

$$As = \frac{A_1\phi.b}{200} = \frac{50.24.1000}{200} = 251.2\,mm^2 > As\ perlu = 190\,mm^2$$

Kontrol Mn :

$$a = \frac{As.fy}{0.85.fc'.b} = \frac{251.2.240}{0.85.25.1000} = 2.837\,mm$$

$$Mn = As.fy\left(d - \frac{a}{2}\right) = 251.2.240\left(95 - \frac{2.837}{2}\right)$$

$$= 5.641\,kN.m > 1.33\frac{Mu}{\phi} = 1.463\,kN.m$$

Menghitung tulangan bagi

Arah x = arah y

As bagi = 0.002 x b x h = 0.002 x 1000 x 120 = 240

Dipakai tulangan bagi ϕ 8, A1 ϕ = 50.24 mm

Jarak tulangan bagi

$$= \frac{A_1 \phi .1000}{As\ bagi} = \frac{50.24 .1000}{240} = 209.333\ mm$$

Dipakai ϕ 8-200 mm

Kontrol

$$As = \frac{50.24 .1000}{200} = 251.2\ mm^2 > 200\ mm^2$$

4.3. Perencanaan Balok Anak

Balok anak terbentuk dari balok – balok grid yang didukung oleh balok induk sehingga perhitungan mekanikanya diambil untuk setiap tipe balok grid. Perhitungan mekanika balok grid menggunakan program SAP 2000 dengan asumsi balok grid tertumpu pada balok induk.

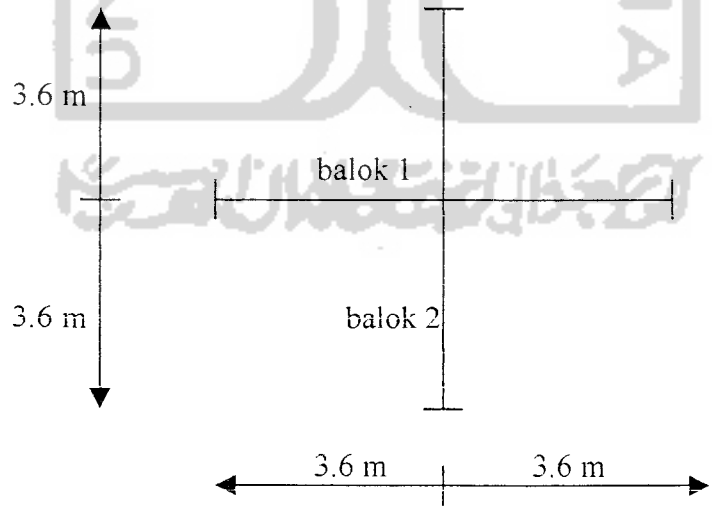
Data : - perkiraan ukuran balok

$h = \frac{1}{12} . l = = \frac{1}{12} .7.2 = 0.6$ m

b = diambil 0.3 m

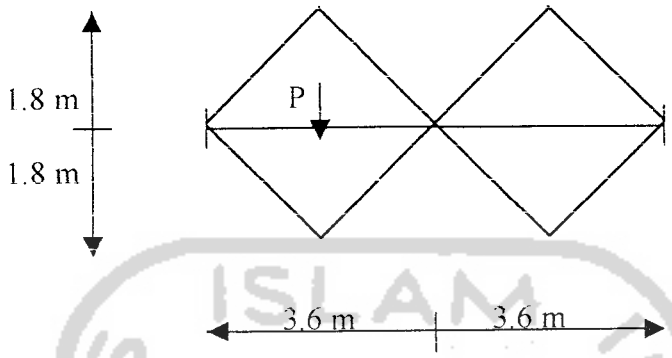
- mutu beton f'c = 25 MPa

4.3.1 Penampang Balok Grid



Gambar 4.7 Penampang balok grid

1. Data beban



a. Akibat beban mati lantai :

RA = RB = 2 x (1/2 x 3.6 x 1.8) x 4.46 = 28.901 KN

M maks = RA x 3.6 – P x 1.8 = 52.022 KN.m

M maks = 1/8 x q x L^2 ⟶ q eq $= \frac{52.022 \times 8}{7.2^2}$ = 8.028 KN/m

b. Akibat beban hidup lantai :

RA = RB = 2 x (1/2 x 3.6 x 1.8) x 2.5 = 16.2 KN

M maks = RA x 3.6 – P x 1.8 = 29.16 KN/m

M maks = 1/8 x q x L^2 ⟶ q eq $= \frac{29.16 \times 8}{7.2^2}$ = 4.5 KN/m

c. Akibat beban mati atap :

RA = RB = 2 x (1/2 x 3.6 x 1.8) x 3.3 = 21.384 KN

M maks = RA x 3.6 – P x 1.8 = 38.491 KN/m

M maks = 1/8 x q x L^2 ⟶ eq $= \frac{38.491 \times 8}{7.2^2}$ = 5.94 KN/m

d. Akibat beban hidup atap :

RA = RB = 2 x (1/2 x 3.6 x 1.8) x 1 = 6.48 KN

M maks = RA x 3.6 – P x 1.8 = 11.664 KN/m

M maks = 1/8 x q x L^2 ⟶ q eq $= \frac{11.664 \times 8}{7.2^2}$ = 1.8 KN/m

e. Pembebanan Balok Grid Tiap Lantai

1). lantai 1

- beban mati : -q eq = = 8.028 KN/m

-partisi = 1 x 3.6 = 3.6 KN/m +

qM = 11.628 KN/m

- beban hidup qH = 4.5 KN/m

2). lantai 2

- beban mati : -q eq = = 8.028 KN/m

-partisi = 1 x 5 = 5.0 KN/m +

qM = 13.628 KN/m

- beban hidup qH = 4.5 KN/m

3). lantai 3

- beban mati : -q eq = = 8.028 KN/m

-partisi = 1 x 4.5 = 4.5 KN/m +

qM = 12.528 KN/m

- beban hidup qH = 4.5 KN/m

4). lantai 4

- beban mati : -q eq = = 8.028 KN/m

-partisi = 1 x 4.5 = 4.5 KN/m +

qM = 12.528 KN/m

- beban hidup qH = 4.5 KN/m

5). lantai 5

- beban mati : -q eq = = 8.028 KN/m

-partisi = 1 x 5 = 5.0 KN/m +

qM = 13.628 KN/m

- beban hidup qH = 4.5 KN/m

6). lantai 6

- beban mati : -q eq = = 8.028 KN/m

-partisi = 1 x 6 = 6.0 KN/m +

qM = 14.628 KN/m

- beban hidup qH = 4.5 KN/m

2. Perhitungan Tulangan balok grid tipe 1

a. Tulangan tumpuan Balok 1 :

Mu maks pada balok atas = 248,801 KNm

Perencanaan balok dipakai 30/60

d = h – pb - ∅ sengkang balok panjang -1/2 ∅ tul tumpuan balok 1

d = 600-40-8-(22/2) = 542,5 mm

Mn = Mu/ϕ =311,001 KNm

$$\rho b = \frac{0{,}85.f'c.\beta}{fy}\left(\frac{600}{600+fy}\right) = \frac{0{,}85.25.0{,}85}{400}\left(\frac{600}{600+400}\right) = 0{,}0271$$

ρ maks = 0,75 . ρb = 0,75 . 0,0271 = 0,0203

rasio tulangan rencana = ρ = 0,5 . ρ maks = 0,5 . 0,0203 = 0,0102

$$\rho \text{ min} = \frac{1{,}4}{fy} = \frac{1{,}4}{400} = 0{,}0035$$

$$m = \frac{fy}{0{,}85.f'c} = \frac{400}{0{,}85.25} = 18{,}824$$

$$Rn = \rho.fy.\left(1-\frac{1}{2}.\rho.m\right) = 0{,}0102.400.\left(1-\frac{1}{2}.0{,}0102.18{,}824\right) = 3{,}688\,\text{Mpa}$$

$$b.d_{perlu}^{\,2} = \frac{Mn}{Rn}$$

$$d_{perlu} = \sqrt{\frac{Mn.10^6}{Rn.b}} = \sqrt{\frac{311{,}001.10^6}{3{,}688.300}} = 530 \text{ mm}$$

d pakai = 542 mm

$d_{ada} > d_{perlu}$ dipakai tulangan sebelah

$$\text{Rn baru} = \frac{Mu/\phi.}{b.d^2} = \frac{311{,}001.10^6}{300.542^2} = 3{,}528 \text{ Mpa}$$

$$\rho \text{ baru} = \frac{3{,}528}{3{,}688} \times 0{,}0102 = 0{,}0097$$

ρ min < ρ baru < ρ maks

As perlu = ρ baru . b . d = 0,0097 . 300 . 542 = 1577,22 mm^2

dipakai D_{22} ⇒ As = 380 mm^2

Jumlah tulangan terpakai = $\frac{1577,22}{380}$ = 4,15 ≈ digunakan $5D_{22}$

As ada = 1900 > As perlu

Kontrol :

$$a = \frac{Asada.fy}{0,85.f'c.b} = \frac{1900.400}{0,85.25.300} = 119,216$$

$$Mn = As\ ada.fy.\left(d - \frac{a}{2}\right) = 1900.400.\left(542 - \frac{119,216}{2}\right)$$

= 366,612 KNm > Mn = 311,011 KNm



Gambar 4.8 Detail tulangan tumpuan balok grid

b. Tulangan Lapangan balok 1

Mu maks = 134,249 KNm

Mn = Mu/ϕ = 167,811 KNm

$$\rho b = \frac{0,85.f'c.\beta}{fy}\left(\frac{600}{600 + fy}\right) = \frac{0,85.25.0,85}{400}\left(\frac{600}{600 + 400}\right) = 0,0271$$

ρ maks = 0,75 . ρb = 0,75 . 0,0271 = 0,0203

rasio tulangan rencana = ρ = 0,5 . ρ maks = 0,5 . 0,0203 = 0,0102

$$\rho \text{ min } = \frac{1,4}{fy} = \frac{1,4}{400} = 0,0035$$

$$m = \frac{fy}{0,85.f'c} = \frac{400}{0,85.25} = 18,824$$

$$Rn = \rho.fy.\left(1 - \frac{1}{2}.\rho.m\right) = 0,0102.400.\left(1 - \frac{1}{2}.0,0102.18,824\right) = 3,866 \text{ Mpa}$$

$$b.d_{perlu}^{\ 2} = \frac{Mn}{Rn}$$

$$d_{perlu} = \sqrt{\frac{Mn.10^6}{Rn.b}} = \sqrt{\frac{167,811.10^6}{3,688.300}} = 389,45 \text{ mm}$$

d_{ada} = h – pb - ∅ sengkang balok pendek - ∅ balok 2 – ½ ∅ tul lap balok 1

d_{ada} = 500 – 40 -8 -19 – 1/2 .19 = 423,5 mm > d_{perlu} = 389,45 mm

pakai tulangan sebelah

$$\text{Rn baru} = \frac{Mu/\phi.}{b.d^2} = \frac{167,811.10^6}{300.423,5^2} = 3,119 \text{ Mpa}$$

$$\rho \text{ baru} = \frac{3,119}{3,688} \times 0,0102 = 0,00863$$

ρ min < ρ baru < ρ maks

As perlu = ρ baru . b . d = 0,00863 . 300 . 423,5 = 1096,442 mm^2

dipakai D_{19} ⇒ As = 283 mm^2

$$\text{Jumlah tulangan terpakai} = \frac{1096,442}{283} = 3,87 \approx \text{digunakan 4 } D_{19}$$

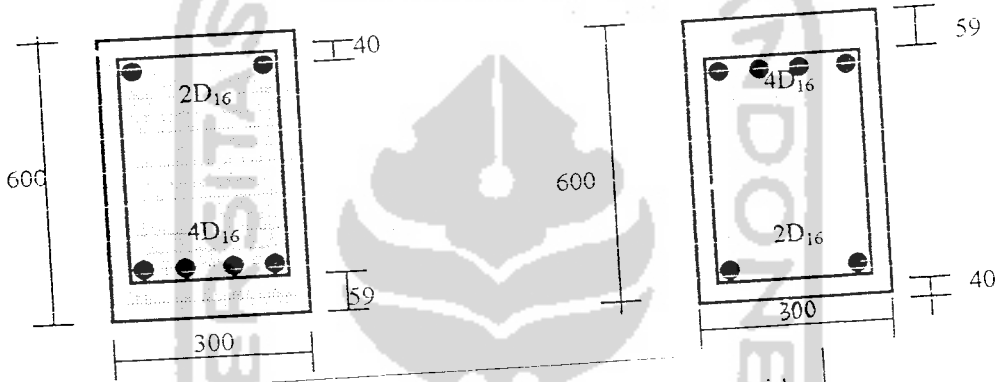
As ada = 1132 > As perlu

Kontrol :

$$a = \frac{Asada.fy}{0{,}85.f'c.b} = \frac{1132.400}{0{,}85.25.300} = 71{,}0275$$

$$Mn = As\ ada.fy.\left(d - \frac{a}{2}\right) = 1132.400.\left(423{,}5 - \frac{71{,}0275}{2}\right)$$

$$= 175{,}68\ KNm > Mn = 167{,}811\ KNm$$



Gambar 4.9 Detail tulangan lapangan balok grid

3. Perhitungan Sengkang Geser

Vu = 136,701 KN

d = 425,5 mm

$$Vc = \frac{1}{6} \cdot \sqrt{f'c} \cdot b \cdot d = \frac{1}{6} \cdot \sqrt{25} \cdot 300 \cdot 423{,}5 \cdot 10^{-3} = 105{,}875\ KN$$

ϕ 3Vc = 190,575 KN

ϕ Vc = 63,525 KN

ϕ Vc < Vu < ϕ 3Vc dipakai sengkang minimum.

Vs perlu = Vu - ϕ Vc = 163,701 – 63,525 = 100,176

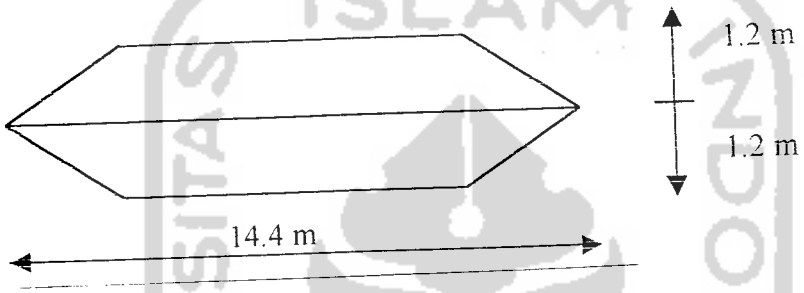
dipakai sengkang minimum.

$$s \le \frac{Av.fy.d}{Vsperlu} = \frac{.(2.1/4.\pi.8^2).240.425,5}{100,176.10^3} = 102,43 \text{ mm}$$

$s \le d/2 = 212,75$ mm

$s \le 600$ mm $\Rightarrow$ dipakai tulangan $P_8 - 100$ mm

4.3.2 Penampang Balok Anak Lantai 6



Gambar 4.10 Penampang balok anak lt.6

1. Data Beban

$$- h = t - \frac{4}{3}\cdot\frac{l^3}{l^2}$$

$$= 1.2 - \frac{4}{3}\cdot\frac{1,2^3}{14,4^2}$$

$= 1.189$

- diambil ukuran balok 30/ 70
- beban mati : -q eq = 2h x q mati

2 x 1.189 x 4.46 = 10.606 KN/m

-partisi = 1 x 6 = 6.0 KN/m +

qM = 16.606 KN/m

- beban hidup : q eq = 2h x q hidup

2 x 1.89 x 2.5 x0.9 = 5.351 KN/m

qH = 5.351 KN/m

2. Perhitungan Tulangan balok

a. Tulangan tumpuan Balok :

Mu maks pada balok = 68,202 KNm

d = h – pb - ∅ sengkang balok -1/2 ∅ tul tumpuan balok

d = 700-40-8-(16/2) = 644 mm

Mn = Mu/ϕ =85,253 KNm

$$\rho b = \frac{0,85.f'c.\beta}{fy}\left(\frac{600}{600+fy}\right) = \frac{0,85.25.0,85}{400}\left(\frac{600}{600+400}\right) = 0,0271$$

ρ maks = 0,75 . ρb = 0,75 . 0,0271 = 0,0203

rasio tulangan rencana = ρ = 0,5 . ρ maks = 0,5 . 0,0203 = 0,0102

$$\rho \text{ min} = \frac{1,4}{fy} = \frac{1,4}{400} = 0,0035$$

$$m = \frac{fy}{0,85.f'c} = \frac{400}{0,85.25} = 18,824$$

$$Rn = \rho.fy.\left(1-\frac{1}{2}.\rho.m\right) = 0,0102.400.\left(1-\frac{1}{2}.0,0102.18,824\right) = 3,688 \text{ Mpa}$$

$$b.d_{perlu}{}^2 = \frac{Mn}{Rn}$$

$$d_{perlu} = \sqrt{\frac{Mn.10^6}{Rn.b}} = \sqrt{\frac{85,252.10^6}{3,688.300}} = 277,585 \text{ mm}$$

d pakai = 644 mm

$d_{ada} > d_{perlu}$ dipakai tulangan sebelah

$$\text{Rn baru} = \frac{Mu/\phi.}{b.d^2} = \frac{85,252.10^6}{300.644^2} = 0,689 \text{ Mpa}$$

$$\rho \text{ baru} = \frac{0,689}{3,688} \times 0,0102 = 0,002$$

ρ baru $< \rho$ min $< \rho$ maks

0,002 $<$ 1,33 ρ baru $=$ 0,0027 $< \rho$ min

As perlu $= \rho$ baru . b . d $= 0,0027 \cdot 300 \cdot 644 = 520,02$ mm^2

dipakai $D_{16} \Rightarrow$ As $= 200$ mm^2

Jumlah tulangan terpakai $= \frac{520,02}{200} = 2,6 \approx$ digunakan $3D_{16}$

As ada $= 600$ mm$^2 >$ As perlu

$$a = \frac{Asada.fy}{0,85.f'c.b} = \frac{600.400}{0,85.25.300} = 37,647$$

$$Mn = \text{As ada.fy.}\left(d - \frac{a}{2}\right) = 600.400.\left(644 - \frac{37,647}{2}\right)$$

$= 149,562$ KNm $>$ Mn $= 85,252$ KNm

b. Tulangan Lapangan balok

Mu maks $= 218,516$ KNm

Mn $=$ Mu/ϕ $= 273,145$ KNm

$$\rho b = \frac{0,85.f'c.\beta}{fy}\left(\frac{600}{600+fy}\right) = \frac{0,85.25.0,85}{400}\left(\frac{600}{600+400}\right) = 0,0271$$

ρ maks $= 0,75 \cdot \rho b = 0,75 \cdot 0,0271 = 0,0203$

rasio tulangan rencana $= \rho = 0,5 \cdot \rho$ maks $= 0,5 \cdot 0,0203 = 0,0102$

$$\rho \text{ min} = \frac{1,4}{fy} = \frac{1,4}{400} = 0,0035$$

$$m = \frac{fy}{0{,}85.f'c} = \frac{400}{0{,}85.25} = 18{,}824$$

$$Rn = \rho.fy.\left(1 - \frac{1}{2}.\rho.m\right) = 0{,}0102.400.\left(1 - \frac{1}{2}.0{,}0102.18{,}824\right) = 3{,}866\ \text{Mpa}$$

$$b.d_{perlu}{}^2 = \frac{Mn}{Rn}$$

$$d_{perlu} = \sqrt{\frac{Mn.10^6}{Rn.b}} = \sqrt{\frac{273{,}516.10^6}{3{,}688.300}} = 497{,}205\text{mm}$$

d_{ada} = h – pb - ∅ sengkang balok – ½ ∅ tul lapangan balok

d_{ada} = 700 – 40 -8 – 1/2 .16 = 644 mm > d_{perlu} = 497,205 mm

pakai tulangan sebelah

$$\text{Rn baru} = \frac{Mu/\phi.}{b.d^2} = \frac{273{,}516.10^6}{300.644^2} = 2{,}198\ \text{Mpa}$$

$$\rho\ \text{baru} = \frac{2{,}198}{3{,}688} \times 0{,}0102 = 0{,}00608$$

ρ min < ρ baru < ρ maks

As perlu = ρ baru . b . d = 0,00608 . 300 . 644 = 1174,656 mm^2

dipakai D_{19} ⇒ As = 283 mm^2

$$\text{Jumlah tulangan terpakai} = \frac{1174{,}656}{283} = 4{,}15 \approx \text{digunakan 5 } D_{19}$$

As ada =1415 mm^2 > As perly

$$a = \frac{Asada.fy}{0{,}85.f'c.b} = \frac{1415.400}{0{,}85.25.300} = 88{,}784$$

$$Mn = \text{As ada.fy}.\left(d - \frac{a}{2}\right) = 1415.400.\left(644 - \frac{88{,}784}{2}\right)$$

$$= 339{,}378\ \text{KNm} > Mn = 273{,}516\ \text{KNm}$$

3. Perhitungan Sengkang Geser

Vu = 76,465 KN

d = 644 mm

$$Vc = \frac{1}{6} \cdot \sqrt{f'c} \cdot b \cdot d = \frac{1}{6} \cdot \sqrt{25} \cdot 300 \cdot 644 \cdot 10^{-3} = 161 \text{ KN}$$

$\frac{1}{2} \phi$ Vc = 48,3 KN

ϕ Vc = 96,6 KN

$\frac{1}{2} \phi$ Vc < Vu < ϕ Vc dipakai sengkang minimum.

$$s \leq \frac{3Av.fy}{bw} = \frac{3.(2.1/4.\pi.8^2).240}{300} = 241{,}152 \text{ mm}$$

s ≤ d/2 = 322 mm

s ≤ 600 mm ⇒ dipakai tulangan P_8 – 240 mm

4.4 Perhitungan Portal Dengan Daktilitas Penuh

4.4.1 Perhitungan Gaya-gaya yang Bekerja pada Struktur

1. Perhitungan gaya geser horisontal akibat gempa dan distribusinya ke sepanjang tinggi gedung

a. Berat Total Bangunan :

1). Berat Lantai :

a). Beban Mati Lantai

- pelat lantai = 36 x 36 x 0.12 x 24 = 3732.48 KN
- pasir = 36 x 36 x 0.16 = 207.36 KN
- tegel = 36 x 36 x 0.24 = 311.04 KN
- spesi = 36 x 36 x 0.21 = 272.16 KN

\+

= 4523.04 KN

b). Beban Hidup Lantai

Menurut Peraturan Pembebanan Indonesia Untuk Gedung 1983

qH lantai : 2.5 KN/m^2

koefisien reduksi : 0.5

WH = 0.5 x (36 x 36 x 2.5) =1620 KN

(1) Berat lantai 1 :

- dinding = 432 x 4.3 x 2.5 = 4644 KN
- balok induk = (0.4 x 0.65) x 432 x 24 = 2695.68 KN
- balok anak = (0.3 x 0.6) x 432 x 24 = 1866.24 KN
- kolom = (0.65 x 0.65) x 26 x 4.3 x 24= 1133.652 KN
- kolom kecil = (0.35 x 0.35) x 10 x 4.3 x 24= 126.42 KN

- WM = 4523.04 KN

= 15265.092 KN

Berat Total : W2 = WM + WH = 16885.092 KN

(2) Berat lantai 2

- dinding = 432 x 4.75 x 2.5 = 5130 KN
- balok induk = (0.4 x 0.65) x 432 x 24 = 2695.68 KN
- balok anak = (0.3 x 0.6) x 432 x 24 = 1866.24 KN
- kolom = (0.65x0.65)x 26 x 4.75x 24 = 1253.29 KN
- kolom kecil = (0.35x0.35)x 10 x 4.75x 24 = 139.65 KN
- WM = 4523.04 KN

= 15912.85 KN

Berat Total : W3 = WM + WH = 17532.85 KN

(3) Berat lantai 3 :

- dinding = 432 x 4.5 x 2.5 = 4860 KN
- balok induk = (0.4 x 0.65) x 432 x 24 = 2695.68 KN
- balok anak = (0.3 x 0.6) x 432 x 24 = 1866.24 KN
- kolom = (0.65 x 0.65)x 26 x 4.5 x 24= 1186.38 KN
- kolom kecil = (0.35 x 0.35)x 10 x 4.5 x 24= 132.3 KN
- WM = 4523.04 KN

= 15552.54 KN

Berat Total : W4 = WM + WH = 17172.54 KN

(4) Berat lantai 4 :

- dinding	= 432 x 4.75 x 2.5	= 5130	KN
- balok induk	= (0.4 x 0.65) x 432 x 24	= 2695.68	KN
- balok anak	= (0.3 x 0.6) x 432 x 24	= 1866.24	KN
- kolom	= (0.65 x 0.65)x 26 x 4.5 x 24	= 1186.38	KN
- kolom kecil	= (0.35 x 0.35)x 10 x 4.5 x 24	= 132.3	KN
- WM		= 4523.04	KN
			+
		= 15912.85	KN

Berat Total : W5 = WM + WH = 17532.85 KN

(5) Berat lantai 5 :

- dinding	= 432 x 5.5 x 2.5	= 5940	KN
- balok induk	= (0.4 x 0.65) x 432 x 24	= 2695.68	KN
- balok anak	= (0.3 x 0.6) x 432 x 24	= 1866.24	KN
- kolom	= (0.65 x 0.65)x 26 x 5.5 x 24	= 1450.02	KN
- kolom kecil	= (0.35 x 0.35)x 10 x 5.5 x 24	= 161.7	KN
- WM		= 4523.04	KN
			+
		= 16989.78	KN

Berat Total : W5 = WM + WH = 18609.78 KN

2). Berat atap :

a). Beban Mati Atap

- dinding	= 432 x 3 x 2.5	= 3240	KN
- balok induk	= (0.4 x 0.65) x 432 x 24	= 2695.68	KN

- balok anak = (0.3 x 0.6) x 432 x 24 = 1866.24 KN
- kolom = (0.65 x 0.65) x 26 x 3 x 24 = 790.92 KN
- kolom kecil = (0.35 x 0.35) x 10 x 3 x 24 = 88.2 KN
- Berat atap :
  - pelat atap = 207.36 x 0.1 x 24 = 497.664 KN
  - plafond = 1088.64 x 0.5 = 544.32 KN
  - kuda – kuda =
    - kk 1 = 678.848 KN
    - kk 2 = 642.06 KN
    - kk 3 = 280.08 KN
    - kk3` = 27.44 KN
    - kk 4 = 224.82 KN
    - kk jurai = 125.82 KN

    = 11894.692 KN

b). Beban Hidup Atap

Menurut Peraturan Pembebanan Indonesia Untuk Gedung 1983

qH = 1 KN/m^2

Koefisien reduksi = 0.5

WH = 0.5 x (36 x 36 x 1) = 648 KN

Berat Total Atap / W atap = WM – WH = 12542.692 KN

➢ Berat Total Bangunan = W1 + W2 + W3 + W4 + W5 +W6 +W atap

= 100275.804 KN

b. Waktu Getar Bangunan (T)

$Tx = Ty = 0.06\ H^{3/4}$: H=30.4 m

$Tx = Ty = 0.06\ 28.6^{3/4} = 0.742$ detik

c. Koefesien Gempa Dasar

Untuk Tx = Ty =0.742 detik , dengan wilayah gempa 3 dan jenis tanah lunak didapat c = 0.07

d. Faktor Keutamaan I dan Faktor Jenis Struktur K

Untuk bangunan dengan struktur rangka beton bertulang dengan daktalitas penuh didapat I =1.0 dan K=1.0

e. Gaya Geser Horisontal Total Akibat Gempa

Vx = Vy = C x I x K x Wt

= 0.07 x 1.0 x 1.0 x 100275.804

= 7019.306 KN

f. Distribusi Gaya Geser Horisontal Total Akibat Gempa Sepanjang Tinggi Gedung

1. Arah X

H / A = 28.6 / 36 = 0.794 < 3

$$Fi,x = \frac{Wi \times Hi}{\Sigma\ Wi \times Hi} \cdot Vx$$

2. Arah Y

H / A = 28.6 / 36 = 0.794 < 3

$$Fi,x = \frac{Wi \times Hi}{\Sigma\ Wi \times Hi} \cdot Vy$$

tabel 4.19 Distribusi gaya geser dasar horisontal akibat gempa

DISTRIBUSI GAYA GESER DASAR HORISONTAL TOTAL AKIBAT GEMPA
KE SEPANJANG TINGGI GEDUNG DALAM ARAH X DAN Y UNTUK TIAP PORTAL

LANTAI	Hi	Wi	Hi x Wi	Fi x,y Total	Tiap Portal KN	
	m	KN	KN.m	KN	1/6 . Fi,x	1/6 . Fi,x
ATAP	28.6	12542.692	358720.991	1651.769	275.295	275.295
5	22.6	18609.78	420581.028	1936.610	322.768	322.768
4	17.6	17532.85	308578.160	1420.881	236.814	236.814
3	13.1	17172.54	224960.274	1035.854	172.642	172.642
2	8.6	17532.85	150782.510	694.294	115.716	115.716
1	3.6	16885.092	60786.331	279.897	46.650	46.650
			Total			
			1524409.294			

2. Perhitungan beban akibat gaya gravitasi

a. PORTAL A

1). Pembebanan lantai 1

a). Beban Mati :

- pelat (q eq)= 1.65 x 4.46 = 7.359 KN/m
- dinding = 3.6 x 2.5 = 9 KN/m

\+

q eq = 16.359 KN/m

b). Beban Hidup

Menurut Peraturan Pembebanan Indonesia Untuk Gedung 1983 :

- qH = 2.5 KN/m
- Koefisien reduksi = 0.9

Jadi q eq =1.65 x 2.5 x 0.9 = 3.713 KN/m

2). Pembebanan lantai 2

a). Beban Mati :

- pelat (q eq)= 1.65 x 4.46 = 7.359 KN/m
- dinding = 5 x 2.5 = 12.5 KN/m

\+

q eq = 19.859 KN/m

b). Beban Hidup :

- q eq =1.65 x 2.5 x 0.9 = 3.713 KN/m

3). Pembebanan lantai 3

a). Beban Mati :

- pelat (q eq)= 1.65 x 4.46 = 7.359 KN/m
- dinding = 4.5 x 2.5 = 11.25 KN/m

q eq = 18.609 KN/m

b). Beban Hidup :

- q eq =1.65 x 2.5 x 0.9 = 3.713 KN/m

4). Pembebanan lantai 4

a). Beban Mati :

- pelat (q eq) = 1.65 x 4.46 = 7.359 KN/m
- dinding = 4.5 x 2.5 = 11.25 KN/m

+

q eq = 18.609 KN/m

b). Beban Hidup :

- q eq = 1.65 x 2.5 x 0.9 = 3.713 KN/m

5). Pembebanan lantai 5

a). Beban Mati :

- pelat (q eq) = 1.65 x 4.46 = 7.359 KN/m
- dinding = 5 x 2.5 = 12.5 KN/m

+

q eq = 19.859 KN/m

b). Beban Hidup :

- q eq =1.65 x 2.5 x 0.9 = 3.713 KN/m

−

6). Pembebanan lantai 6

a). Beban Mati :

- pelat (q eq)	= 1.189 x 4.46	=	5.303	KN/m
- dinding	= 6 x 2.5	=	15	KN/m
	q eq	=	20.303	KN/m

- pelat (q eq)	= 1.65 x 4.46	=	7.359	KN/m
- dinding	= 6 x 2.5	=	15	KN/m
	q eq	=	22.359	KN/m

2. Beban Hidup

q eq	=1.65 x 2.5 x 0.9	=	3.713	KN/m

Untuk pembebanan portal – portal lainnya akan disajikan dalam bentuk tabel.

tabel 4.20 Pembebanan akibat gaya gravitasi

PORTAL	BALOK	BEBAN MATI EQIVALEN (KN.m)						BEBAN HIDUP EQIVALEN (KN.m)					
		lantai 1	lantai 2	lantai 3	lantai 4	lantai 5	lantai 6	lantai 1	lantai 2	lantai 3	lantai 4	lantai 5	lantai 6
A	A0 - A1	19,859	18,609	18,609	19,859	20,303	0	3,713	3,713	3,713	3,713	2,675	0
	A1 - A3	19,859	18,609	18,609	19,859	20,303	0	3,713	3,713	3,713	3,713	2,675	0
	A3 - A5	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
	A5 - A7	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
	A7 - A8	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
B	B0 - B1	27,218	25,968	25,968	27,218	25,606	0	7,425	7,425	7,425	7,425	5,351	0
	B1 - B3	27,218	25,968	25,968	27,218	25,606	0	7,425	7,425	7,425	7,425	5,351	0
	B3 - B5	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	B5 - B7	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	B7 - B8	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
C	C0 - C1	27,218	25,968	25,968	27,218	25,606	0	7,425	7,425	7,425	7,425	5,351	0
	C1 - C3	27,218	25,968	25,968	27,218	25,606	0	7,425	7,425	7,425	7,425	5,351	0
	C3 - C5	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	C5 - C7	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	C7 - C8	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
D	D0 - D1	27,218	25,968	25,968	27,218	27,515	5,445	7,425	7,425	7,425	7,425	6,314	1,485
	D1 - D3	27,218	25,968	25,968	27,218	27,515	0	7,425	7,425	7,425	7,425	6,314	0
	D3 - D5	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	D5 - D7	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	D7 - D8	27,218	25,968	25,968	27,218	29,718	5,445	7,425	7,425	7,425	7,425	7,425	1,485
E	E0 - E1	27,218	25,968	25,968	27,218	29,718	10.89	7,425	7,425	7,425	7,425	7,425	2.97
	E1 - E3	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	E3 - E5	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	E5 - E7	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	E7 - E8	27,218	25,968	25,968	27,218	29,718	10.89	7,425	7,425	7,425	7,425	7,425	2.97
F	F0 - F1	19,859	18,609	18,609	19,859	22,359	5,445	3,713	3,713	3,713	3,713	3,713	1,485
	F1 - F3	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
	F3 - F5	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
	F5 - F7	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
	F7 - F8	19,859	18,609	18,609	19,859	22,359	5,445	3,713	3,713	3,713	3,713	3,713	1,485

TABEL PEMBEBANAN AKIBAT GAYA GRAVITASI

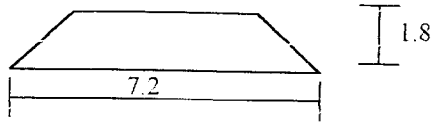
PORTAL	BALOK	BEBAN MATI EQIVALEN (KN.m)						BEBAN HIDUP EQIVALEN (KN.m)					
		lantai 1	lantai 2	lantai 3	lantai 4	lantai 5	lantai 6	lantai 1	lantai 2	lantai 3	lantai 4	lantai 5	lantai 6
0	0A - 0B	19,859	18,609	18,609	19,859	20,156	0	3,713	3,713	3,713	3,713	2,601	0
	0B - 0C	19,859	18,609	18,609	19,859	20,156	0	3,713	3,713	3,713	3,713	2,601	0
	0C - 0D	19,859	18,609	18,609	19,859	20,156	0	3,713	3,713	3,713	3,713	3,173	0
	0D - 0E	19,859	18,609	18,609	19,859	22,359	5,445	3,713	3,713	3,713	3,713	3,173	1,485
	0E - 0F	19,859	18,609	18,609	19,859	22,359	5,445	3,713	3,713	3,713	3,713	3,173	1,485
1	1A - 1B	27,218	25,968	25,968	27,218	0	0	7,425	7,425	7,425	7,425	0	0
	1B - 1C	27,218	25,968	25,968	27,218	0	0	7,425	7,425	7,425	7,425	0	0
	1C - 1D	27,218	25,968	25,968	27,218	0	0	7,425	7,425	7,425	7,425	0	0
	1D -- 1E	27,218	25,968	25,968	27,218	29,718	5,445	7,425	7,425	7,425	7,425	7,425	1,485
	1E - 1F	27,218	25,968	25,968	27,218	29,718	5,445	7,425	7,425	7,425	7,425	7,425	1,485
3	3A - 3B	27,218	25,968	25,968	27,218	34,802	0	7,425	7,425	7,425	7,425	9.99	0
	3B - 3C	27,218	25,968	25,968	27,218	34,802	0	7,425	7,425	7,425	7,425	9.99	0
	3C - 3D	27,218	25,968	25,968	27,218	34,802	0	7,425	7,425	7,425	7,425	9.99	0
	3D - 3E	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	3E - 3F	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
5	5A - 5B	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	5B - 5C	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	5C - 5D	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	5D - 5E	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	5E - 5F	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
7	7A - 7B	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	7B - 7C	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	7C - 7D	27,218	25,968	25,968	27,218	29,718	0	7,425	7,425	7,425	7,425	7,425	0
	7D - 7E	27,218	25,968	25,968	27,218	29,718	5,445	7,425	7,425	7,425	7,425	7,425	1,485
	7E - 7F	27,218	25,968	25,968	27,218	29,718	5,445	7,425	7,425	7,425	7,425	7,425	1,485
8	8A - 8B	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
	8B - 8C	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
	8C - 8D	19,859	18,609	18,609	19,859	22,359	0	3,713	3,713	3,713	3,713	3,713	0
	8D - 8E	19,859	18,609	18,609	19,859	22,359	5,445	3,713	3,713	3,713	3,713	3,713	1,485
	8E - 8F	19,859	18,609	18,609	19,859	22,359	5,445	3,713	3,713	3,713	3,713	3,713	1,485

3. Perhitungan beban merata

a. Lantai

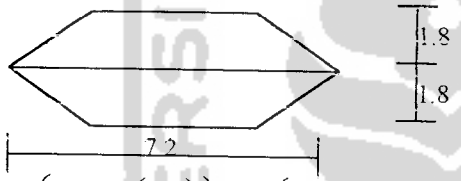
Gambar 4.11 Tipe-tipe pembebanan

1). Tipe A



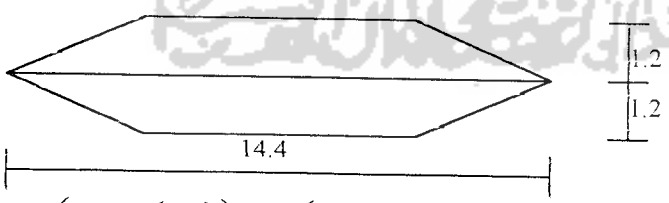
$$H = t - \frac{4}{3}.\left(\frac{t^3}{l^2}\right) = 1.8 - \frac{4}{3}\left(\frac{1.8^3}{7.2^2}\right) = 1.65$$

2). Tipe B



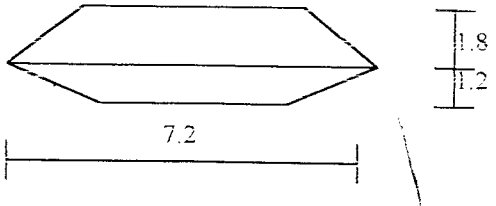
$$H = 2\left(t - \frac{4}{3}.\left(\frac{t^3}{l^2}\right)\right) = 2\left(1.8 - \frac{4}{3}\left(\frac{1.8^3}{7.2^2}\right)\right) = 3.3\ m$$

3). Tipe C



$$H = 2\left(t - \frac{4}{3}.\left(\frac{t^3}{l^2}\right)\right) = 2.\left(1.2 - \frac{4}{3}\left(\frac{1.2^3}{14.4^2}\right)\right) = 2.378\ m$$

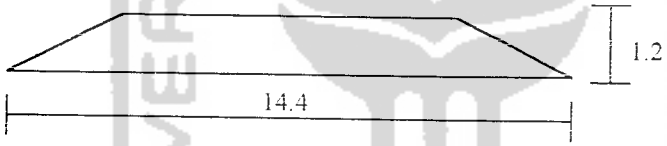
4). Tipe D



$$H_1 = 1.8 - \frac{4}{3}.\left(\frac{1.8^3}{7.2^2}\right) = 1.65\ m$$

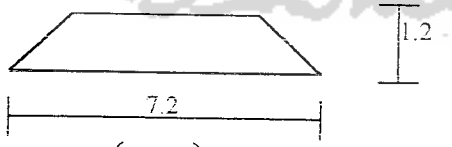
$$H_1 = 1.2 - \frac{4}{3}.\left(\frac{1.2^3}{7.2^2}\right) = 1.156\ m$$

5). Tipe E



$$H = 1.2 - \frac{4}{3}.\left(\frac{1.2^3}{14.4^2}\right) = 1.189\ m$$

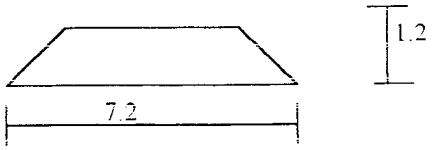
6). Tipe F



$$H = 1.2 - \frac{4}{3}.\left(\frac{1.2^3}{7.2^2}\right) = 1.156\ m$$

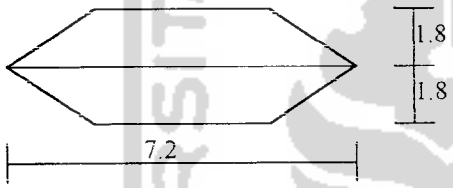
b. Atap

1). Tipe A



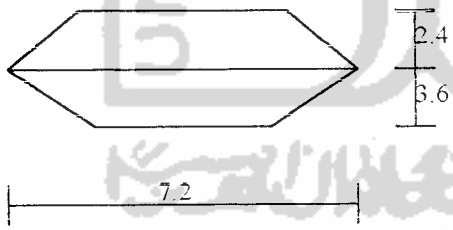
$$H = 1.8 - \frac{4}{3}.\left(\frac{1.8^3}{7.2^2}\right) = 1.65\ m$$

2). Tipe B



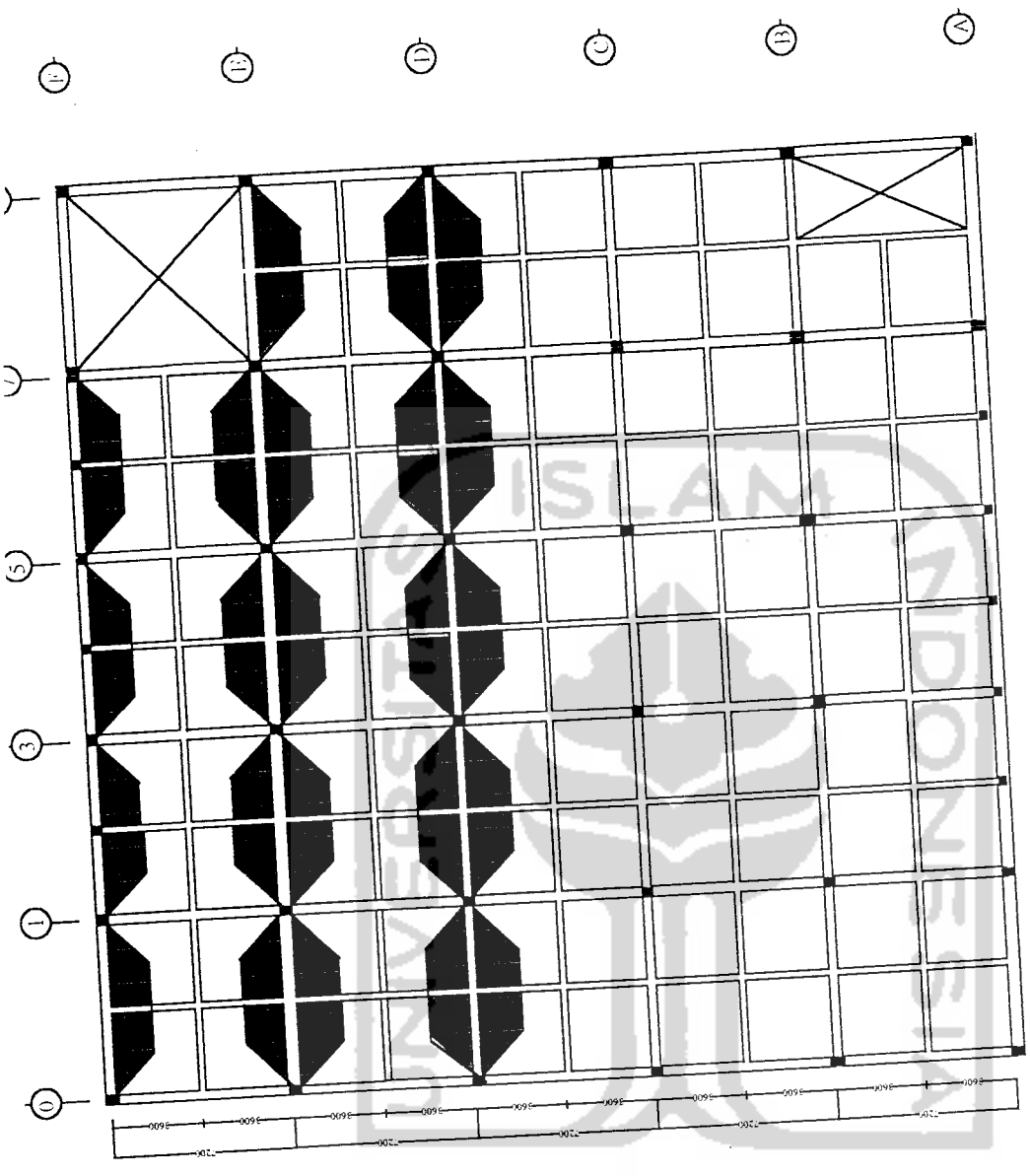
$$H = 2\left(t - \frac{4}{3}.\left(\frac{t^3}{l^2}\right)\right) = 2\left(1.8 - \frac{4}{3}\left(\frac{1.8^3}{7.2^2}\right)\right) = 3.3\ m$$

3). Tipe G

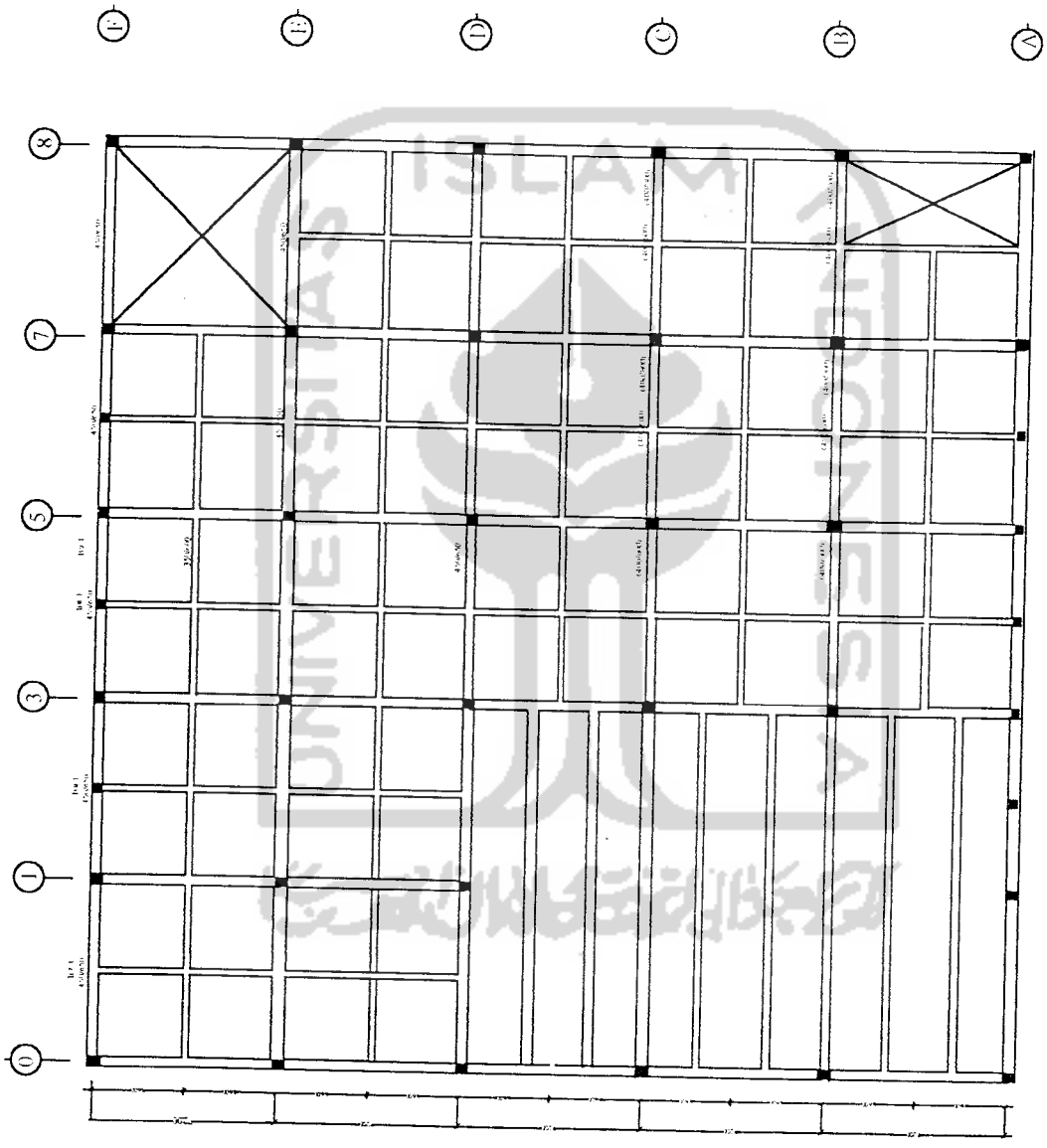


$$H_1 = 2.4 - \frac{4}{3}.\left(\frac{2.4^3}{7.2^2}\right) = 2.04\ m$$

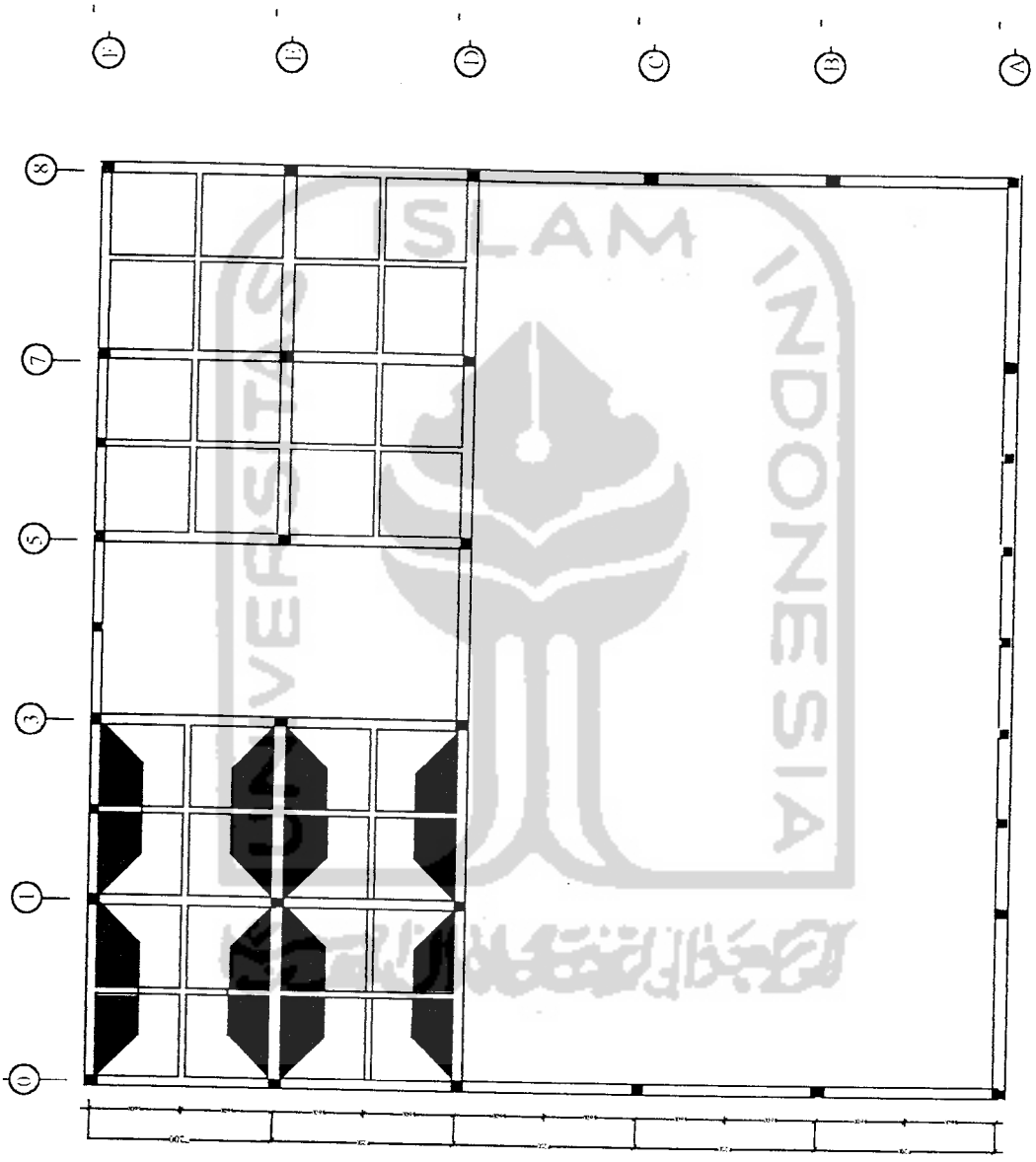
$$H_2 = 3.6 - \frac{4}{3}.\left(\frac{3.6^3}{7.2^2}\right) = 2.4\ m$$



Gambar 4.12 Pembebanan lt 1-4



Gambar 4.13 Pembebanan lt - 5



Gambar 4.14 Pembebanan atap

4.4.2 Perencanaan Balok Induk

1. Penulangan Lentur Balok

Portal A – A (Balok 3 – 4, Lantai 3)

M⁻ = 355.016 kN.m b = 400 mm f'c = 25 Mpa

M⁺ = 294.668 kN.m h = 650 mm fy = 400 Mpa

d' diambil 80 mm

$$d = 650 - 80 = 570\ mm$$

a. Tulangan Tumpuan

Mu⁻ = 355.016 kN.m

$$Mn = \frac{Mu}{\phi} = \frac{355.016}{0.8} = 443.77$$

$$\rho_b = \frac{0.85.f'c}{fy}.\beta_1\left(\frac{600}{600+fy}\right) = \frac{0.85\,.\,25}{400}.\,0.85\left(\frac{600}{600+400}\right) = 0.0271$$

$$\rho_{maks} = 0.75\,.\,\rho_b = 0.75\,.\,0.0271 = 0.020325$$

$$\rho_{\min} = \frac{1.4}{fy} = \frac{1.4}{400} = 0.0025$$

$$\rho = 0.5\,.\,\rho_{maks} = 0.5\,.\,0.020325 = 0.0102$$

$$m = \frac{fy}{0.85\,.\,f'c} = \frac{400}{0.85\,.\,25} = 18.8235$$

$$Rn = \rho\,.\,fy\left(1 - \frac{1}{2}.\rho.m\right) = 0.0102\,.\,400\left(1 - \frac{1}{2}0.0102\,.\,18.8235\right) = 3.676 MPa$$

$$d_{perlu} = \sqrt{\frac{Mu/\phi}{Rn \,.\, b}} = \sqrt{\frac{355.016.10^6 / 0.8}{3.676 \,.\, 400}} = 549.365\ mm^2$$

$$d_{ada} = 670\ mm > d_{perlu} \rightarrow tulangan \quad sebelah$$

$$Rn_{baru} = \frac{Mn}{b \,.\, d^2} = \frac{443.77 \,.\, 10^6}{400 \,.\, 570^2} = 3.415$$

$$\rho_{baru} = \frac{Rn_{baru}}{Rn}.\rho = \frac{3.415}{3.676}.0.0102 = 0.00947 > \rho_{min}$$

$$As = \rho_{baru}.b.d = 0.00947 \,.\, 400.570 = 2160.3\ mm^2$$

$$n = \frac{As}{\Delta\phi_{22}} = \frac{2160.3}{380} = 5.685 \approx 6$$

Dipakai 6 D 22

$$As_{ada} = 2280\ mm^2 > As_{perlu}$$

Kontrol :

$$a = \frac{As_{ada} \,.\, fy}{0.85 \,.\, f'c \,.\, b} = \frac{2280.400}{0.85 \,.\, 25 \,.\, 400} = 107.294$$

$$Mn = As_{ada} \,.\, fy\left(d - \frac{a}{2}\right) = 2280 \,.\, 400\left(570 - \frac{107.294}{2}\right) = 470.914\ kN.m$$

$$Mn > \frac{Mu}{\phi} = 443.77\ kN.m$$

Mnak$^-$ = 470.914 kN.m

Mkap$^-$ = 1.25. Mnak$^-$ = 588.643 kN.m

b. Tulangan Lapangan

$Mu^{-} = 294.668$ kN.m

$$Mn = \frac{Mu}{\phi} = \frac{294.668}{0.8} = 368.335\ kN.m$$

$$\rho_b = 0.0271$$

$$\rho_{mks} = 0.020325$$

$$\rho_{\min} = 0.0035$$

$$\rho = 0.0102$$

$$m = 18.8235$$

$$Rn = 3.676\ Mpa$$

$$d_{perlu} = \sqrt{\frac{Mu/\phi}{Rn\,.\,b}} = \sqrt{\frac{294.668.10^6/0.8}{3.676\,.\,400}} = 500.499\ mm^2$$

$$d_{ada} > d_{perlu} \rightarrow tulangan \quad sebelah$$

$$Rn_{baru} = \frac{Mn}{b\,.\,d^2} = \frac{368.335\,.\,10^6}{400\,.\,570^2} = 2.834$$

$$\rho_{baru} = \frac{Rn_{baru}}{Rn}.\rho = \frac{2.834}{3.676}.\ 0.0102 = 0.00786 > \rho_{\min}$$

$$As = \rho_{baru}.b.d = 0.00786\,.\,400.570 = 1792.91\ mm^2$$

$$n = \frac{As}{\Delta\phi_{22}} = \frac{1792.91}{380} = 4.718 \approx 5$$

Dipakai 5 D22

$$As_{ada} = 1900\ mm^2 > As_{perlu}$$

Kontrol :

$$a = \frac{As_{ada}.fy}{0.85\,.\,f'c\,.\,b} = \frac{1900.400}{0.85\,.\,25\,.\,400} = 89.41$$

$$Mn = As_{ada}.fy\left(d - \frac{a}{2}\right) = 1900\,.\,400\left(570 - \frac{89.41}{2}\right) = 399.224\ kN.m$$

$$Mn > \frac{Mu}{\phi} = 368.335\ kN.m$$

$Mnak^+ = 399.224$ kN.m

$Mkap^+ = 1.25.\ Mnak^+ = 499.03$ kN.m

2. Penulangan Geser Balok

VD = 53.15 Mn akt b- = 470.914

VL = 8.26 Mn akt b+ = 399.224

VE = 161.72

$$Vu, b_1 = 0.7.\phi_o\left(\frac{Mnakt\ b^- + Mnakt\ b^+}{\ln}\right) + 1.05.Vgab.$$

$$Vu, b_1 = 298.748\ kN$$

tidak lebih besar dari

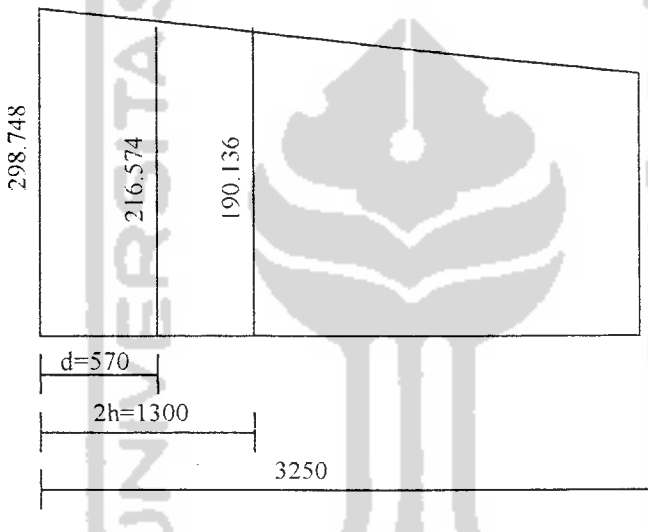
$$Vu, b_2 = 1.05\left(V_D + V_L + \frac{4}{K}V_E\right)$$

$$Vu, b_2 = 1.05\left(53.15 + 8.26 + \frac{4}{1}161.72\right)$$

$$Vu, b_2 = 743.705\,kN$$

$$Vu, b_{pak} = \left(1.05V_{gab} - 0.7\phi_o\left(\frac{Mn_{bk}b^- + Mn_{bk}b^+}{\ln}\right)\right) + \frac{\ln - d}{\ln}\left(Vu, b_1 - 0.7\phi_o\left(\frac{Mn_{bk}b^- + Mn_{bk}b^+}{\ln}\right)\right)$$

$$Vu, b_{pak} = 216.574\,kN$$



a. di dalam sendi plastis

$$Vu, b_{pakai} = 216.574\ kN$$

$$Vc = 0$$

$$Vs = \frac{Vu, b_{pakai}}{\phi} = 360.957$$

$$s \le \frac{Av.fy.d}{Vs} = \frac{157.240.570}{360.957.10^3} = 59.502$$

$$\le \frac{d}{4} = 142.5$$

Dipakai 2P10-100

b. Di luar sendi plastis

$$Vu, b = \left(\frac{Vu, b_{pakai}}{5.98} \right).5.25 = 190.136\ kN$$

$$Vc = \frac{1}{6}\sqrt{fc'}.b.d = \frac{1}{6}\sqrt{25}.400.570.10^{-3} = 190\ kN$$

$$Vs = \frac{Vu,b}{\phi} - Vc = \frac{190.136}{0.6} - 190 = 126.894\ kN$$

$$s \le \frac{Av.fy.d}{Vs} = \frac{157.240.570}{126.894.10^3} = 169.256\ kN$$

$$s \le \frac{d}{2} = 285\ kN$$

Dipakai P10 - 160

4.4.3 Perencanaan Kolom

1. Kolom 15

a. Perhitungan Momen dan Gaya Aksial Rencana (Mc).

1). Momen untuk portal arah x.

Data momen :

$M_{Dy\ atas}$ = -78,93 KNm

$M_{Dy\ bawah}$ = 37,41 KNm

$M_{Ly\ atas}$ = -14,89 KNm

$M_{Ly\ bawah}$ = 7,16 KNm

$M_{Ey\ atas}$ = -45,45 KNm

$M_{Ey\ bawah}$ = 509,01 KNm

Atas

$1,2\ M_{Dy} + 1,6\ M_{Ly}$ = 1,2. (-78,93) + 1,6. (-14,89)

= -118,684 KNm

$1,05\ (M_{Dy} + M_{Ly})$ = 1,05. ((-78,93) + (-14,89) . 0,6)

Mby = -92,314 KNm

$1,05\ M_{Ey}$ = 1,05. (-45,45) = -47,723 KNm

Msy = -47,723 KNm

Mby + Msy = -140,037 KNm

$$1,05\ (M_{Dy} + M_{Ly} + \frac{4}{k} M_{Ey}) = 1,05\ (78,93 + 14,89 + \frac{4}{1} 45,45)$$

= 289,496 KNm

Bawah

$1{,}2\ M_{Dy} + 1{,}6\ M_{Ly}$ $= 1{,}2.\ 37{,}93 + 1{,}6.\ 7{,}16$

$= 56{,}348$ KNm

$1{,}05\ (\ M_{Dy} + M_{Ly}\ )$ $= 1{,}05.\ (37{,}41 + 7{,}16\ .\ 0{,}6)$

Mby $= 43{,}791$ KNm

$1{,}05\ M_{Ey}$ (kiri) $= 1{,}05.\ 509{,}01 = 534{,}461$ KNm

Msy $= 534{,}461$ KNm

Mby + Msy $= 578{,}252$ KNm

$1{,}05\ (\ M_{Dy} + M_{Ly} + \frac{4}{k}\ M_{Ey}\ ) = 2184{,}641$ KNm

M pakai : Atas $= -140{,}037$ KNm

Bawah $= 578{,}252$ KNm

b. Momen untuk portal arah Y

Data momen

$M_{Dx\ atas}$ $= -79{,}73$ KNm

$M_{Dx\ bawah}$ $= 37{,}07$ KNm

$M_{lx\ atas}$ $= -15{,}21$ KNm

$M_{Lx\ bawah}$ $= 7{,}09$ KNm

$M_{Ex\ atas}$ $= -25{,}23$ KNm

$M_{Ex\ bawah}$ $= 288{,}75$ KNm

Atas

$1{,}2\ M_{Dx} + 1{,}6\ M_{Lx}$ $= 1{,}2.\ (-79{,}73) + 1{,}6.\ (-15{,}21)$

$= 120{,}012$ KNm

$1{,}05\ (\ M_{Dx} + M_{Lx,r}\ )$ $= 1{,}05.\ ((-79{,}73) + (-15{,}21)\ .\ 0{,}6)$

Mbx $= -93{,}299$ KNm

$1{,}05\ M_{Ex} = 1{,}05.\ (-25{,}23)$

Msx $= -26{,}492$ KNm

Mbx + Msx $= -119{,}791$ KNm

$1{,}05\ (\ M_{Dx} + M_{Lx} + \frac{4}{k}\ M_{Ex}\ ) = 205{,}653$ KNm

Bawah

$1{,}2\ M_{Dx} + 1{,}6\ M_{Lx} = 1{,}2.\ 37{,}07 + 1{,}6.\ 7{,}09$

$= 55{,}828$ KNm

$1{,}05\ (\ M_{Dx} + M_{L,rx}\ ) = 1{,}05.\ (37{,}07 + 7{,}09\ .\ 0{,}6)$

Mbx $= 43{,}39$ KNm

$1{,}05\ M_{Ex} = 1{,}05.\ 288{,}75$

Msx $= 303{,}188$ KNm

Mbx + Msx $= 346{,}578$ KNm

$1{,}05\ (\ M_{Dx} + M_{Lx} + \frac{4}{k}\ M_{Ex}\ ) = 1259{,}118$ KNm

M pakai : Atas $= -119{,}791$ KNm

Bawah $= 346{,}578$ KNm

c. Gaya aksial

Data Gaya Aksial

$P_{D\ atas} = -1502{,}86$ KN

$P_{D\ bawah} = -1538{,}69$ KN

$P_{l\ atas} = -189{,}53$ KN

$P_{L\ bawah}$ = - 189,53 KN

$P_{E\ atas}$ = - 597,42 KN

$P_{E\ bawah}$ = - 597,42 KN

Atas

$1,2\ P_D + 1,6\ P_L$ = 1,2. (-1502,86) + 1,6. (-189,53)

= -2106,68 KN

$1,05\ (\ P_D + P_L\ )$ = 1,05.((-1502,86) + (-189,53) . 0,6)

Pb =- 1697,407 KN

$1,05\ P_E$ = 1,05. (-597,42)

Ps = -627,291 KN

Pb + Ps = -2324,698 KN

$1,05\ (\ P_D + P_L + 4\ .P_E)$ = 4286,174 KN

Bawah

$1,2\ P_D + 1,6\ P_L$ = 1,2. (-1538,69) + 1,6. (-189,53)

= -2149,676 KN

$1,05\ (\ P_D + P_L\ )$ = 1,05.((-1538,69) + (-189,53) . 0,6)

Pb =- 1735,028 KN

$1,05\ P_E$ = 1,05. (-597,42)

Ps = -627,291 KN

Pb + Ps = -2362,319 KN

$1,05\ (\ P_D + P_L + 4\ .P_E)$ = 4323,795 KN

Pu pakai : Atas =- 2324,698 KN

Bawah =- 2362,319 KN

2. Kriteria Kolom dan Pembesaran Momen

Menghitung kekakuan kolom

a. Arah X

$$Ec = Eg = 4700.\sqrt{f'c}$$

$$= 4700.\sqrt{25}$$

$$= 23500 \text{ Mpa}$$

$$Ic \text{ (inersia kolom)} = \frac{1}{12}.650.650^3 = 1{,}488.10^{10} \text{ mm}^4$$

$$\beta_d = \frac{1{,}2M_D}{1{,}2M_D + 1{,}6M_L} = \frac{1{,}2.78{,}93}{1{,}2.78{,}93 + 1{,}6.14{,}9} = 0{,}798$$

$$EI = \frac{E_c.I_c}{2{,}5(1+\beta_d)}$$

$$= \frac{23500.1.488.10^{10}}{2{,}5(1+0{,}798)}$$

$$= 7{,}779.10^{13} \text{ Nmm}^2$$

Menghitung momen inersia balok di kanan kiri kolom. Dengan menganggap momen inersia penampang retak balok sebesar setengah dari momen inersia penampang bruto, maka ;

1. Momen inersia balok dikanan kiri ujung atas kolom yaitu :

$$I_{cr} = \frac{I_g}{2} = \frac{1}{2}\left[\frac{1}{12}.400.(650)^3\right]$$

$$= 457{,}708.10^7 \text{ mm}^4$$

2. Momen inersia balok dikanan kiri ujung bawah kolom = 0, karena ujung jepit

Lc (panjang kolom) = 3,275 m

Lg (panjang bersih balok) = 6,55 m

Beban tekuk Euler yang terjadi adalah: $\psi_{atas} = \psi_{bawah} = \dfrac{\sum\left(\frac{EI}{Lc}\right)}{\sum\left(\frac{E_c I_{cr}}{Lg}\right)}$

$$\psi_{atas} = \frac{\left(\frac{7,779.10^{13}}{3275}\right)+\left(\frac{7,779.10^{13}}{4350}\right)}{\left(\frac{23500.457,708.10^{7}}{6550}\right)} = 2,54$$

ψ_{bawah} = 0 (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,34

$$\frac{k.lu}{r} = \frac{1,34.3275}{(0,3.650)}$$

= 24,352 > 22 (termasuk kolom panjang)

beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.7,779.10^{13}}{(1,34.3272)^2}$$

= 39824548,63 N

menghitung faktor pembesaran momen δ_{by}

$$\delta b_y = \frac{Cm}{1-\left(\frac{Pu}{\phi Pc}\right)} \geq 1$$

cm = 1 (portal tanpa pengaku)

$$\delta b_y = \frac{1}{1-\left(\frac{2362319}{0,65.39824548.63}\right)}$$

$= 1,1 > 1$

menghitung faktor pembesaran δ_{sy}

kolom elemen 16 As-A

$$\psi_{atas} = \frac{\left(\frac{7,97.10^{13}}{3275}\right)+\left(\frac{7,97.10^{13}}{4350}\right)}{\left(\frac{23500.457.708.10^{7}}{6550}\right)+\left(\frac{23500.457.708.10^{7}}{3100}\right)} = 0.834$$

$\psi_{bawah} = 0$ (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,15

Beban tekuk Euler yang terjadi adalah:

$$P_e = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.7,94.10^{13}}{(1,15.3275)^2}$$

$= 55190141,71$ N

kolom elemen 17 As-A

$$\psi_{atas} = \frac{\left(\frac{6,71.10^{12}}{3275}\right)+\left(\frac{6,71.10^{12}}{4350}\right)}{\left(\frac{23500.457,708.10^{7}}{3250}\right)+\left(\frac{23500.457,708.10^{7}}{3250}\right)} = 0,054$$

$\psi_{bawah} = 0$ (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1

Beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2 . 6{,}710^{12}}{(1.3275)^2}$$

$$= 6168210{,}804 \text{ N}$$

kolom elemen 18 As-A

$$\psi_{atas} = \frac{\left(\frac{6{,}708.10^{12}}{3275}\right) + \left(\frac{6{,}708.10^{12}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{3250}\right) + \left(\frac{23500.457{,}708.10^{7}}{3250}\right)} = 0{,}05$$

$\psi_{bawah} = 0$ (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1

Beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2 . 6{,}708.10^{12}}{(1.3275)^2}$$

$$= 6166372{,}291 \text{ N}$$

kolom elemen 19 As-A

$$\psi_{atas} = \frac{\left(\frac{6{,}72.10^{12}}{3275}\right) + \left(\frac{6{,}72.10^{12}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{3250}\right) + \left(\frac{23500.457{,}708.10^{7}}{3250}\right)} = 0{,}054$$

$\psi_{bawah} = 0$ (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1

beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2 .6,72.10^{23}}{(1.3272)^2}$$

$$= 6170049,316 \text{ N}$$

$$\Sigma Pc = 2.39824548,63 + 2.55190141,71 + 2.6168210,804$$

$$+ 2. \quad 6166372,291 + 6170049,316$$

$$= 208535851,6 \text{ N}$$

$$\Sigma Pu = 2.2362,319 - 2.2567,96 + 2.1683,786 + 2.1707,42 + 1080,776$$

$$= 17723746 \text{ N}$$

$$\delta_{sy} = \frac{1}{1-\left(\frac{\sum Pu}{\sum Pc}\right)} \geq 1$$

$$= \frac{1}{1-\left(\frac{17723746}{0,65.208535851,6}\right)} = 1,15$$

Momen akibat pembesaran momen :

Muy, bawah $= \delta_{by}$ Mby $+ \delta_{sy}$ Msy

$= 1,1\ 43,791 + 1,15.\ 534,461$

$= 581,755$ KNm

Muy, atas $= \delta_{by}$ Mby $+ \delta_{sy}$ Msy

$= 1,1.\ 92,314 + 1,15.\ 47,723$

$= 156,428$ KNm

b.Arah Y

$$Ec = Eg = 4700.\ \sqrt{f'c}$$

$$= 4700.\ \sqrt{25}$$

$$= 23500 \text{ MPa}$$

$$Ic \text{ (inersia kolom)} = \frac{1}{12}.650.650^3$$

$$= 1{,}488.10^{10} \text{ mm4}$$

$$\beta_d = \frac{1{,}2M_D}{1{,}2M_D + 1{,}6M_L}$$

$$= \frac{1{,}2.79{,}73}{1{,}2.79{,}73 + 1{,}6.15{,}21}$$

$$= 0{,}797$$

$$EI = \frac{E_c.I_c}{2{,}5(1+\beta_d)}$$

$$= \frac{23500.1{,}488.10^{10}}{2{,}5(1+0{,}797)}$$

$$= 7{,}784.\ 10^{13} \text{ Nmm}^2$$

Menghitung momen inersia balok di kanan kiri kolom. Dengan menganggap momen inersia penampang retak balok sebesar setengah dari momen inersia penampang bruto, maka

1. Momen inersia balok dikanan kiri ujung atas kolom yaitu :

$$I_{cr} = \frac{I_g}{2} = \frac{1}{2}\left[\frac{1}{12}.400.(650)^3\right]$$

$$= 457{,}708.\ 10^7 \text{ mm}^4$$

2. Momen inersia balok dikanan kiri ujung bawah kolom = 0, karena ujung jepit

Lc (panjang kolom) = 3,275 m

Lg (panjang bersih balok) = 6,55 m

$$\psi_{atas} = \psi_{bawah} = \frac{\sum\left(\frac{EI}{Lc}\right)}{\sum\left(\frac{E_c I_{cr}}{Lg}\right)}$$

$$\psi_{atas} = \frac{\left(\frac{7,784.10^{13}}{3275}\right)+\left(\frac{7,784.10^{13}}{4350}\right)}{\left(\frac{23500.457,708.10^{7}}{6550}\right)} = 2,54$$

ψ_{bawah} = 0 (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,34

$$\frac{k.lu}{r} = \frac{1,34.3275}{(0,3.650)}$$

= 24,352 > 22 (termasuk kolom panjang

beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.7,784.10^{13}}{(1,34.3275)^2}$$

= 39850146,11 N

menghitung faktor pembesaran momen δ_{by}

$$\delta b_y = \frac{Cm}{1-\left(\frac{Pu}{\phi Pc}\right)} \geq 1$$

$$\delta b_y = \frac{1}{1-\left(\frac{2362319}{0{,}65.39850146.11}\right)} = 1{,}1 > 1$$

menghitung faktor pembesaran δ_{sy}

kolom elemen 265 As-0

$$\psi_{atas} = \frac{\left(\frac{7{,}784.10^{13}}{3275}\right)+\left(\frac{7{,}784.10^{13}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{6550}\right)+\left(\frac{23500.457{,}708.10^{7}}{6550}\right)} = 1{,}27$$

ψ_{bawah} = 0 (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,18

beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.7{,}784.10^{13}}{(1{,}18.3275)^2}$$

= 44364140,58 N

kolom elemen 482 As-0

$$\psi_{atas} = \frac{\left(\frac{7{,}784.10^{13}}{3275}\right)+\left(\frac{7{,}784.10^{13}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{6550}\right)+\left(\frac{23500.457{,}708.10^{7}}{6550}\right)} = 1{,}27$$

ψ_{bawah} = 0 (ujung jepit)

menghitung momen rancang kolom :

$$\text{Mu,k}_x \text{ atas} = \frac{h}{hn}\,\omega d.\alpha.0{,}7.\left(\frac{l_{ki}}{l'_{ki}}Mkap,ki + \frac{l_{ka}}{l'_{ka}}Mkap,ka\right)$$

$$= \frac{3{,}6}{3{,}275}\,1.\,0{,}131.\,0{,}7.\left(0 + \frac{7{,}2}{6{,}55}588{,}643\right)$$

$$= 65{,}223 \text{ KNm}$$

Mu,k_x bwh = 509,01 kNm

tidak perlu melebihi :

$\text{Mu,k}_x = 1{,}05\ (M_D + M_L + 4.M_E)$

$= 1{,}05\ (78{,}93 + 14{,}98 + 4.\ 509{,}01)$

$= 2236{,}448$ KNm

Mu,k_x pakai = 509,01 kNm

4. Perencanaan Penulangan Kolom

Pu = 2362,319 KN

$$\text{Pn} = \frac{Pu}{\theta} = \frac{2362{,}319}{0{,}65} = 3634{,}337$$

Mux =509,01 KNm

$$\text{Mnx} = \frac{Mux}{\theta} = \frac{509{,}01}{0{,}65} = 783{,}092 \text{ KNm}$$

Muy =581,755 KNm

$$\text{Mny} = \frac{Muy}{\theta} = \frac{581{,}755}{0{,}65} = 895{,}01 \text{ KNm}$$

$$\frac{Mny}{Mnx} = \frac{895{,}01}{783{,}092} = 1{,}1 > \frac{b}{h} = 1{,}0$$

Digunakan Moy untuk perencanaan .

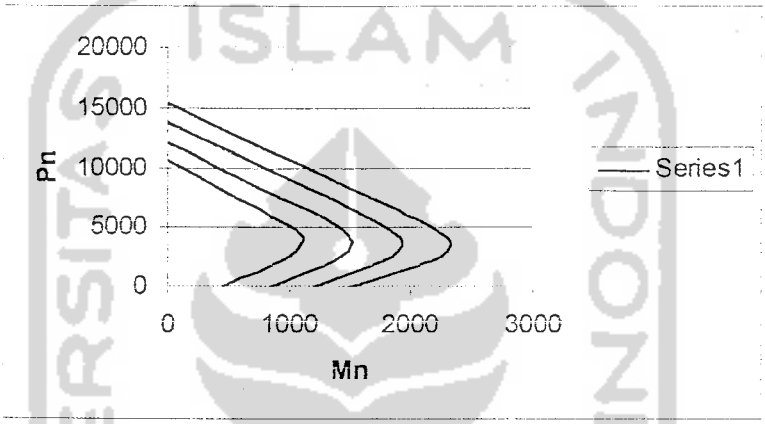
$$\text{Moy perlu} = \text{Mny} + \text{Mnx}\left(\frac{b}{h}\right)\left(\frac{1-0{,}65}{0{,}65}\right)$$

$$= 895{,}01 + 783{,}092 \left(\frac{0{,}65}{0{,}65}\right)\left(\frac{1-0{,}65}{0{,}65}\right)$$

$$=1316{,}675 \text{ KNm}$$

$$e = \frac{Moy}{Pn} = \frac{1316{,}675}{3634{,}34} = 0{,}36 \text{ m}$$

Kontrol kapasitas Pn pada penampang :



Gambar 4.15 Grafik Mn-Pn

Dari grafik Mn vs Pn didapat 1,3 % Ag

Ast = 0,012.650.650 = 5492,5 mm^2

As = As' = 0,5.Ast = 2746,25 mm^2

dipakai tulangan D22 dengan As_{tul} = 380 mm^2

jumlah tulangan (n) = $\frac{2746{,}25}{380}$

= 7,3

dipakai n = 8 buah

As pakai = 8 380

= 3040 > As perlu = 2746,25

$$\delta b_y = \frac{Cm}{1-\left(\frac{Pu}{\phi Pc}\right)} \geq 1$$

$$\delta b_y = \frac{1}{1-\left(\frac{2362319}{0{,}65.39850146.11}\right)} = 1{,}1 > 1$$

menghitung faktor pembesaran δ_{sy}

kolom elemen 265 As-0

$$\psi_{atas} = \frac{\left(\frac{7{,}784.10^{13}}{3275}\right)+\left(\frac{7{,}784.10^{13}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{6550}\right)+\left(\frac{23500.457{,}708.10^{7}}{6550}\right)} = 1{,}27$$

ψ_{bawah} = 0 (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,18

beban tekuk Euler yang terjadi adalah:

$$P_e = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.7{,}784.10^{13}}{(1{,}18.3275)^2}$$

$$= 44364140{,}58 \text{ N}$$

kolom elemen 482 As-0

$$\psi_{atas} = \frac{\left(\frac{7{,}784.10^{13}}{3275}\right)+\left(\frac{7{,}784.10^{13}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{6550}\right)+\left(\frac{23500.457{,}708.10^{7}}{6550}\right)} = 1{,}27$$

ψ_{bawah} = 0 (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,18

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2 . 7{,}784 . 10^{13}}{(1{,}18 . 3275)^2}$$

$$= 44364140{,}58 \text{ N}$$

$$\Sigma Pc = 2.39850146{,}11 + 4.4436140{,}58$$

$$= 97444854{,}54 \text{ N}$$

$$\Sigma Pu = 2.2362{,}319 + 2.3650{,}16 + 2.3644{,}632$$

$$= 19314222 \text{ N}$$

$$\delta_{sy} = \frac{1}{1 - \left(\frac{\sum Pu}{\sum Pc} \right)} \geq 1$$

$$= \frac{1}{1 - \left(\frac{19314222}{0{,}65 . 97444854{,}54} \right)}$$

$$= 1{,}44$$

Momen akibat pembesaran momen :

Mux, bawah $= \delta_{bx}$ Mbx + δ_{sx} Msx

$= 1{,}1 . 43{,}39 + 1{,}44 . 303{,}188$

$= 484{,}32$ KNm

Mux, atas $= \delta_{bx}$ Mbx + δ_{sx} Msx

$= 1{,}1 . 93{,}299 + 1{,}44 . 26{,}492$

$= 140{,}777$ KNm

Mux =484,32 KNm

$$Mnx = \frac{Mux}{\theta} = \frac{484,32}{0,65} = 745,108 \text{ KNm}$$

Muy =605,078 KNm

$$Mny = \frac{Muy}{\theta} = \frac{605,078}{0,65} = 930,889 \text{ KNm}$$

$$Moy\ perlu = Mny + Mnx \left(\frac{b}{h}\right)\left(\frac{1-0,65}{0,65}\right)$$

$$= 930,889 + 745,108 \left(\frac{0,65}{0,65}\right)\left(\frac{1-0,65}{0,65}\right)$$

$$= 1297,57 \text{ KNm}$$

3. Analisis Gaya Aksial dan Momen akibat balok

h = 3,6 m

hn = 3,275 m

Rv = 1,1 – 0,025.5 = 0,975 (jumlah lantai diatasnya; n> 4)

ωd = 1 (untuk lantai dasar)

k = 1

a. Perhitungan Arah Y

$Mkap_{(kiri)}$ = 0

$Mkap_{(kanan)}$= 588.643 KNm

menghitung gaya aksial rencana :

$$Nu,k_y = 0,7.Rv. \frac{Mkap_{kiri} + Mkap_{kanan}}{l} + 1,05\ Ng$$

$$= 0,7.0,975.\ \frac{0+588,643}{7,2} + 1,05(\ 538,69 + 189,53\ )$$

$$=1870,429\ \text{KN}$$

tidak perlu melebihi :

$Nu,k_y = 1,05\ (N_D + N_L + 4.N_E)$

$= 1,05\ (\ 1538,69 + 189,53 + 4.\ 597,42\ )$

$= 4323,795$ KN

dipakai $Nu,k_y = 1870,429$ KN

menghitung α :

Lantai 1

$M_{E,K\ atas} = 25,23$ KNm

$M_{E,K\ bawah} = -$

Lantai 2

$M_{E,K\ atas} = 164,63$ KNm

$M_{E,K\ bawah} = 210,87$ KNm

$$\alpha\ ka = \frac{M_{E,k(lti+1atas)}}{M_{E,k(lti+1atas)} + M_{E,k(ltibawah)}} = 0,11$$

$$\alpha\ ka = \frac{M_{E,k(ltibawah)}}{M_{E,k(lti+1atas)} + M_{E,k(ltibawah)}} = -$$

menghitung momen rancang kolom :

$$Mu,k_y atas = \frac{h}{hn}\omega d.\alpha.0,7.\left(\frac{l_{ki}}{l'_{ki}}Mkap,ki + \frac{l_{ka}}{l'_{ka}}Mkap,ka\right)$$

$$= \frac{3,6}{3,275}1.0,11.\ 0,7.\left(0 + \frac{7,2}{6,55}.588,643\right) = 54,768\ \text{KNm}$$

$Mu,k_y baw = 288,75$ kNm

tidak perlu melebihi :

$Mu,k = 1,05\ (M_D + M_L + 4.M_E) = 1,05\ (79,73 + 15,21 + 4\ .\ 288,75)$

$= 1312,437$ KNm

Mu,k_y pakai $= 288,75$ KNm

2. Perhitungan Arah X

$Mkap_{(kiri)} = 588,643$ KNm

$Mkap_{(kanan)} = 0$ KNm

menghitung gaya aksial rencana :

$$Nu,k_x = 0,7.Rv.\frac{Mkap_{kiri} + Mkap_{kanan}}{l} + 1,05\ Ng$$

$$= 0,7.1.\frac{0 + 588,643}{7,2} + 1,05(\ 1538,69 + 189,53\ )$$

$= 1870,429$ KN

tidak perlu melebihi :

$Nu,k_y = 1,05\ (Nd + Nl + 4.Ne)$

$= 1,05\ (\ 1538,69 + 189,53 + 4.597,42\ )$

$= 4323,795$ KN

dipakai $Nu,k_x = 1870,429$ KN

menghitung α :

α atas $= 0,131$

α bawah $=$ -

menghitung momen rancang kolom :

$$Mu,k_x \text{ atas} = \frac{h}{hn}\,\omega d.\alpha.0{,}7.\left(\frac{l_{ki}}{l'_{ki}}Mkap,ki + \frac{l_{ka}}{l'_{ka}}Mkap,ka\right)$$

$$= \frac{3{,}6}{3{,}275}\,1.\,0{,}131.\,0{,}7.\left(0 + \frac{7{,}2}{6{,}55}588{,}643\right)$$

$$= 65{,}223 \text{ KNm}$$

Mu,k_x bwh = 509,01 kNm

tidak perlu melebihi :

$Mu,k_x = 1{,}05\,(M_D + M_L + 4.M_E)$

$= 1{,}05\,(78{,}93 + 14{,}98 + 4.\,509{,}01)$

$= 2236{,}448$ KNm

Mu,k_x pakai = 509,01 kNm

4. Perencanaan Penulangan Kolom

Pu = 2362,319 KN

$$Pn = \frac{Pu}{\theta} = \frac{2362{,}319}{0{,}65} = 3634{,}337$$

Mux =509,01 KNm

$$Mnx = \frac{Mux}{\theta} = \frac{509{,}01}{0{,}65} = 783{,}092 \text{ KNm}$$

Muy =581,755 KNm

$$Mny = \frac{Muy}{\theta} = \frac{581{,}755}{0{,}65} = 895{,}01 \text{ KNm}$$

$$\frac{Mny}{Mnx} = \frac{895{,}01}{783{,}092} = 1{,}1 > \frac{b}{h} = 1{,}0$$

Digunakan Moy untuk perencanaan .

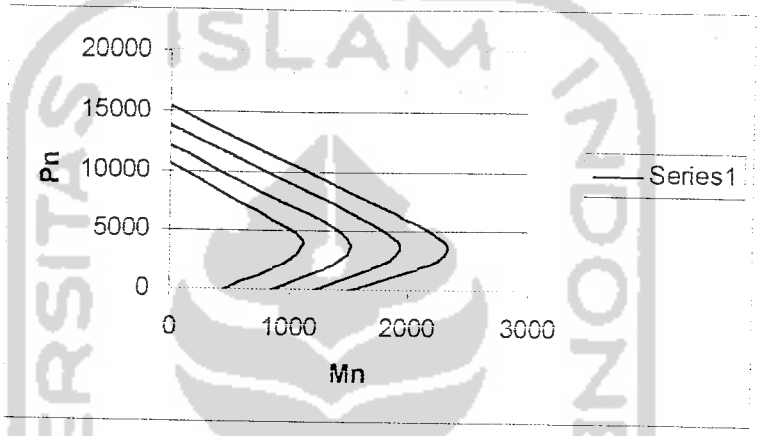
$$\text{Moy perlu} = Mny + Mnx\left(\frac{b}{h}\right)\left(\frac{1-0{,}65}{0{,}65}\right)$$

$$= 895{,}01 + 783{,}092 \left(\frac{0{,}65}{0{,}65}\right)\left(\frac{1-0{,}65}{0{,}65}\right)$$

$$= 1316{,}675 \text{ KNm}$$

$$e = \frac{Moy}{Pn} = \frac{1316{,}675}{3634{,}34} = 0{,}36 \text{ m}$$

Kontrol kapasitas Pn pada penampang :



Gambar 4.15 Grafik Mn-Pn

Dari grafik Mn vs Pn didapat 1,3 % Ag

Ast = 0,012.650.650 = 5492,5 mm^2

As = As' = 0,5.Ast = 2746,25 mm^2

dipakai tulangan D22 dengan As_{tul} = 380 mm^2

jumlah tulangan (n) = $\frac{2746{,}25}{380}$

= 7,3

dipakai n = 8 buah

As pakai = 8 380

= 3040 > As perlu = 2746,25

Cek eksentrisitas balance (e_b)

$$c_b = \frac{600.d}{600 + fy} = 354 \text{ mm}$$

$$a_b = \beta_1 . c_b = 0,85 . 354 = 300,9 \text{ mm}$$

$$f's = 600\frac{(c_b - d')}{c_b} = 600\frac{(264 - 60)}{264} = 463,636 \text{ MPa} > fy = 400 \text{ MPa}$$

Dengan demikian digunakan f's = fy = 400 MPa

Pnb = 0,85 .f'c .b. a_b + A's (fs'-0,85.fc') – As fy

= 4091,581KN

$$Mnb = 0,85 .f'c .b. a_b \left(\frac{h}{2} - \frac{a_b}{2}\right) + A's (f's-0,85.fc') \left(\frac{h}{2} - d'\right) + As\ fy .\left(d - \frac{h}{2}\right) = 1352,822$$

$$eb = Mnb/Pnb = 1352,822/4091,581 = 0,33 < e=0,36$$

karena $e_b < e$ runtuh tarik

$$\rho = \frac{As_{pakai}}{b.d}$$

$$= \frac{3040}{650.590}$$

$$= 0,008$$

$$Pn=0,85.f'c.b.d\left[\left(\frac{h-2e}{2d}\right)+\sqrt{\left(\left(\frac{h-2e}{2d}\right)^2+2\left(\frac{fy}{0,85.f'c}\right)\rho\left(1-\left(\frac{d'}{d}\right)\right)\right)}\right]$$

$$= 10484,391 \text{ KN} > \frac{Pu}{\theta} = 3634,34 \text{ KN}$$

Hitung Moxn

$$a = \frac{Pn}{0{,}85.f'c.b} = \frac{3634{,}34}{0{,}85.25.650} = 263{,}12 \text{ mm}$$

$$c = \frac{263{,}12}{0{,}85} = 309{,}553$$

$$f's = 600.\left(\frac{309{,}553 - 60}{309{,}553}\right) = 483{,}703 > fy = 400 \text{ Mpa}$$

$$Moxn = 0{,}85.f'c.b.a.\left(\frac{h}{2} - \frac{a}{2}\right) + As'.fs'\left(\frac{h}{2} - d'\right) + As.\,Fy.\left(d - \frac{h}{2}\right)$$

$$= 1347{,}51 \text{KNm}$$

Penampang diasumsikan bujur sangkar sehingga :

Moxn= Moyn = 1347,51KNm > Moy perlu= 1316,675 KNm

$$\frac{Mny}{Moyn} = \frac{895{,}01}{1347{,}51} = 0{,}64$$

Dari diagram factor lentur : $\frac{Mny}{Moyn} = 0{,}64$; □ =0,65 didapat

$$\frac{Mnx}{Moxn} = 0{,}66$$

Mnx = 0,66 . 1347,51 =889,357KNm>Mnx perlu= 783,072 KNm

5. Perencanaan Penulangan Geser

$$V_{u,k} = \frac{Mu,k_{atas} + Mu,k_{bawah}}{h'_k}$$

$$= \frac{65{,}223 + 509{,}01}{3{,}275}$$

$$= 175{,}338 \text{ KN}$$

tidak perlu melebihi

$$V_{u,k} = 1{,}05\ (V_{D,k} + V_{L,k} + \frac{4}{K}\ V_{E,k}\ )$$

$$= 1{,}05\ (\ 32{,}32 + 6{,}15 + 4.\ 104{,}58\ )$$

$$= 479{,}63\ \text{KN}$$

$V_{u,k}$ terpakai = 175,338 KN

1). Daerah sendi plastis

d = 0,59 m

Vc = 0 (pada daerah sendi plastis, Vc dianggap 0)

$$V_{u,k}\ \text{terhitung} = \frac{h'k - d}{h'k} V_{u,k}terpakai$$

$$= \frac{3{,}275 - 0{,}59}{3{,}275}.175{,}338$$

$$= 143{,}75\ \text{KN}$$

$$Vs = \frac{V_{u,k}terhitung}{\phi}$$

$$= \frac{143{,}75}{0{,}6}$$

$$= 239{,}584\ \text{KN}$$

Dipakai sengkang 2D10 dengan Av = 157 mm^2

$$\text{Jarak}\ (\ S\ ) < \frac{Av.fy.d}{Vs}$$

$$= \frac{157.240.590}{239{,}584.10^3}$$

$$= 52{,}79\ \text{mm} < d/4 = 147{,}5\ \text{mm}$$

maka dipakai 2P10- 100 mm

2). Daerah luar sendi plastis

$V_{u,k}$ terhitung = 143,75 KN

$$\frac{\text{Vu, b terhitung}}{0,6} = \frac{143,75}{0,6}$$

$$= 239,583 \text{ KN}$$

Nu,k = 1870,429 KN

$$Vc = \left(1 + \frac{Nu,k}{14.Ag}\right) \frac{1}{6} \sqrt{f'c}.b.d$$

$$= \left(1 + \frac{1870,429}{14.650.650}\right) \frac{1}{6} \sqrt{25}.650.590$$

$$= 159,962 \text{ KN}$$

$$Vs = \frac{\text{Vu, b terhitung}}{0,6} - Vc$$

$$= 79,621 \text{ KN}$$

Dipakai sengkang 2D10 dengan Av = 157 mm^2

$$\text{Jarak (S)} < \frac{Av.fy.d}{Vs}$$

$$= \frac{157.240.590}{79,621.10^3}$$

$$= 279,2 \text{ mm}$$

$$< d/2 = 295 \text{ mm}$$

maka dipakai P10 –270 mm

2. Perhitungan kolom elemen 18

a. Perhitungan Momen dan Gaya Aksial Rencana (Mc)

1). Momen untuk portal arah X.

Data momen :

$M_{Dy\ atas}$ = -38,975 KNm

$M_{Dy\ bawah}$ = 19,071 KNm

$M_{Ly\ atas}$ = -9,593 KNm

$M_{Ly\ bawah}$ = 4,7 KNm

$M_{Ey\ atas}$ = -61,272 KNm

$M_{Ey\ bawah}$ = 75,084 KNm

Atas

$1,2\ M_{Dy} + 1,6\ M_{Ly} = 1,2.\ (-38,975) + 1,6.\ (-9,573)$

$= -62,119$ KNm

$1,05\ (M_{Dy} + M_{Ly}) = 1,05.\ ((-38,975) + (-9,573)\ .\ 0,6)$

Mby = -46,967 KNm

$1,05\ M_{Ey} = 1,05.\ (-61,272) = -64,336$ KNm

Msy = -64,336 KNm

Mby + Msy = -111,303 KNm

$$1,05\ (M_{Dy} - M_{Ly} + \frac{4}{k} M_{Ey}) = 1,05\ (38,975 + 9,573 - \frac{4}{1} 61,272)$$

$= 308,339$ KNm

Bawah

$1,2\ M_{Dy} + 1,6\ M_{Ly} = 1,2.\ 19,071 + 1,6.\ 4,7$

$= 30,405$ KNm

$1{,}05\ (\ M_{Dy} + M_{Ly}\ )$ $= 1{,}05.\ (19{,}0711 + 4{,}7\ .\ 0{,}6)$

Mby $= 22{,}986$ KNm

$1{,}05\ M_{Ey}$ (kiri) $= 1{,}05.\ 75{,}084 = 78{,}838$ KNm

Msy = 78,838 KNm

Mby + Msy = 101,824 KNm

$1{,}05\ (\ M_{Dy} + M_{Ly} + \frac{4}{k}\ M_{Ey}\ ) = 340{,}312$ KNm

M pakai : Atas $= -111{,}303$ KNm

Bawah $= 101{,}824$ KNm

2). Momen untuk portal arah Y

Data momen

$M_{Dx\ atas} = -1{,}05$ KNm

$M_{Dx\ bawah} = 0{,}55$ KNm

$M_{lx\ atas} = -0{,}22$ KNm

$M_{Lx\ bawah} = 0{,}11$ KNm

$M_{Ex\ atas} = -78{,}344$ KNm

$M_{Ex\ bawah} = 83{,}038$ KNm

Atas

$1{,}2\ M_{Dx} + 1{,}6\ M_{Lx}$ $= 1{,}2.\ (-1{,}05) + 1{,}6.\ (-0{,}22)$

$= 1{,}612$ KNm

$1{,}05\ (\ M_{Dx} + M_{Lx,r}\ )$ $= 1{,}05.\ ((-1{,}05) + (-0{,}22)\ .\ 0{,}6)$

Mbx $= -1{,}241$KNm

$1{,}05\ M_{Ex} = 1{,}05.\ (-78{,}344)$

Msx =- 82,261 KNm

Mbx + Msx = -83,502 KNm

$1{,}05\ (M_{Dx} + M_{Lx} + \frac{4}{k} M_{Ex}) = 330{,}378$ KNm

Bawah

$1{,}2\ M_{Dx} + 1{,}6\ M_{Lx} = 1{,}2.\ 0{,}55 + 1{,}6.\ 0{,}11$

$= 0{,}836$ KNm

$1{,}05\ (M_{Dx} + M_{L,rx}) = 1{,}05.\ (0{,}55 + 0{,}11\ .\ 0{,}6)$

Mbx = 0,647 KNm

$1{,}05\ M_{Ex} = 1{,}05.\ 83{,}038$

Msx = 87,19 KNm

Mbx + Msx = 87,878 KNm

$1{,}05\ (M_{Dx} + M_{Lx} + \frac{4}{k} M_{Ex}) = 349{,}453$ KNm

M pakai : Atas = -83,502 KNm

Bawah = 87,878 KNm

3).Gaya aksial

Data Gaya Aksial

$P_{D\ atas}$ = -1127,16 KN

$P_{D\ bawah}$ = -1137,55 KN

$P_{l\ atas}$ = - 199.204 KN

$P_{L\ bawah}$ = - 199,204 KN

$P_{E\ atas}$ = - 290,363 KN

$P_{E\ bawah}$ = - 290,363 KN

Atas

$1{,}2\ P_D + 1{,}6\ P_L = 1{,}2.\ (-1127{,}16) + 1{,}6.\ (-199{,}204)$

$= -1671{,}318$ KN

$1{,}05\ (\ P_D + P_L\ ) = 1{,}05.((-1127{,}16) + (\ -199{,}204)\ .\ 0{,}6)$

Pb =- 1309,017 KN

$1{,}05\ P_E = 1{,}05.\ (-290{,}363)$

Ps = -304.881KN

Pb + Ps = -1613,898 KN

$1{,}05\ (\ P_D + P_L + 4\ .P_E) = 2487{,}816$ KN

Bawah

$1{,}2\ P_D + 1{,}6\ P_L = 1{,}2.\ (-1137{,}55) + 1{,}6.\ (-199{,}204)$

$= -1683{,}876$KN

$1{,}05\ (\ P_D + P_L\ ) = 1{,}05.((-1137{,}55) + (\ -199{,}204)\ .\ 0{,}6)$

Pb =- 11319,926KN

$1{,}05\ P_E = 1{,}05.\ (-290{,}363)$

Ps = -304,881 KN

Pb + Ps = -1624,807 KN

$1{,}05\ (\ P_D + P_L + 4\ .P_E) = 2623{,}116$ KN

Pu pakai : Atas =- 1671,318 KN

Bawah =- 1683,786 KN

b. Kriteria Kolom dan Pembesaran Momen

Menghitung kekakuan kolom

1). Arah X

$Ec = Eg = 4700.\sqrt{f'c}$

$= 4700.\sqrt{25}$

$= 23500$ MPa

Ic (inersia kolom) $= \frac{1}{12}.350.350^3 = 1{,}251.10^9$ mm^4

$\beta_d = \frac{1{,}2M_D}{1{,}2M_D + 1{,}6M_L} = \frac{1{,}2.65{,}54}{1{,}2.65{,}54 + 1{,}6.15{,}82} = 0{,}753$

$EI = \frac{E_c.I_c}{2{,}5(1+\beta_d)}$

$= \frac{23500.1{,}251.10^9}{2{,}5(1+0{,}753)}$

$= 6{,}708.10^{12}$ Nmm^2

Menghitung momen inersia balok di kanan kiri kolom. Dengan menganggap momen inersia penampang retak balok sebesar setengah dari momen inersia penampang bruto, maka ;

a). Momen inersia balok dikanan kiri ujung atas kolom yaitu :

$I_{cr} = \frac{I_g}{2} = \frac{1}{2}\left[\frac{1}{12}.400.(650)^3\right]$

$= 457{,}708.10^7$ mm^4

b). Momen inersia balok dikanan kiri ujung bawah kolom = 0, karena ujung jepit

Lc (panjang kolom) = 3,275 m

Lg (panjang bersih balok) = 3,25 m

$$\psi_{atas} = \psi_{bawah} = \frac{\sum\left(\frac{EI}{Lc}\right)}{\sum\left(\frac{E_c.I_{cr}}{Lg}\right)}$$

$$\psi_{atas} = \frac{\left(\frac{6,708.10^{12}}{3275}\right)+\left(\frac{6,708.10^{12}}{4350}\right)}{\left(\frac{23500.457,708.10^{7}}{3250}\right)+\left(\frac{23500.457,708.10^{7}}{3250}\right)} = 0,05$$

$\psi_{bawah} = 0$ (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1

$$\frac{k.lu}{r} = \frac{1.3275}{0,3.350} = 31,19 > 22$$ (termasuk kolom panjang)

Beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.6,708.10^{12}}{(1.3275)^2}$$

$$= 6166372,291 \text{ N}$$

menghitung faktor pembesaran momen δ_{by}

$$\delta b_y = \frac{Cm}{1-\left(\frac{Pu}{\phi Pc}\right)} \geq 1$$

cm = 1 (portal tanpa pengaku)

$$\delta b_y = \frac{1}{1-\left(\frac{1683,786}{0,65.6166372,291}\right)}$$

$$= 1,001 > 1$$

menghitung factor pembesaran $\square_{sy}$

kolom elemen 15 As-A

$$\psi_{atas} = \frac{\left(\frac{7,779.10^{13}}{3275}\right)+\left(\frac{7,779.10^{13}}{4350}\right)}{\left(\frac{23500.457,708.10^{7}}{6550}\right)} = 2,54$$

ψ_{bawah} = 0 (ujung jepit)

beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.7,779.10^{13}}{(1,34.3272)^2}$$

= 39824548,63 N

kolom elemen 16 As A

$$\psi_{atas} = \frac{\left(\frac{7,97.10^{13}}{3275}\right)+\left(\frac{7,97.10^{13}}{4350}\right)}{\left(\frac{23500.457.708.10^{7}}{6550}\right)+\left(\frac{23500.457.708.10^{7}}{3100}\right)} = 0.834$$

ψ_{bawah} = 0 (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,15

Beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2 .7{,}94.10^{13}}{(1{,}15.3275)^2}$$

$$= 55190141{,}71 \text{ N}$$

kolom elemen 17 As A

$$\psi_{atas} = \frac{\left(\frac{6{,}71.10^{12}}{3275}\right) + \left(\frac{6{,}71.10^{12}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{3250}\right) + \left(\frac{23500.457{,}708.10^{7}}{3250}\right)} = 0{,}054$$

$\psi_{bawah} = 0$ (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1

Beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2 .6{,}710^{12}}{(1.3275)^2}$$

$$= 6168210{,}804 \text{ N}$$

kolom elemen 19 As A

$$\psi_{atas} = \frac{\left(\frac{6{,}72.10^{12}}{3275}\right) + \left(\frac{6{,}72.10^{12}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{3250}\right) + \left(\frac{23500.457{,}708.10^{7}}{3250}\right)} = 0{,}054$$

$\psi_{bawah} = 0$ (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1

beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2 .6{,}72.10^{2.5}}{(1.3272)^2}$$

$$= 6170049{,}316 \text{ N}$$

ΣPc $= 2.39824548{,}63 + 2.55190141{,}71 + 2..6168210{,}804$

$+2.\ 6166372{,}291 + 6170049{,}316$

$= 208535851{,}6$ N

ΣPu $= 2.2362{,}319 + 2.2567{,}96 + 2.1683{,}786 + 2.1707{,}42$

$+1080{,}776$

$= 17723746$ N

$$\delta_{sy} = \frac{1}{1-\left(\frac{\sum Pu}{\sum Pc}\right)} \geq 1$$

$$= \frac{1}{1-\left(\frac{17723746}{0{,}65.208535851{,}6}\right)} = 1{,}15$$

Momen akibat pembesaran momen :

Muy, bawah $= \delta_{by}\ Mby + \delta_{sy}\ Msy$

$= 1{,}001.46{,}967 + 1{,}15.64{,}336$

$= 121$ KNm

Muy, atas $= \delta_{by}\ Mby + \delta_{sy}\ Msy$

$= 1{,}001.22{,}986 + 1{,}15.78{,}838$

$= 113{,}673$ KNm

2). Arah Y

$$Ec = Eg = 4700.\sqrt{f'c}$$

$$= 4700.\sqrt{25}$$

$$= 23500 \text{ MPa}$$

$$Ic \text{ (inersia kolom)} = \frac{1}{12}.300^3.350$$

$$= 1{,}251.10^9 \text{ mm}^4$$

$$\beta_d = \frac{1{,}2M_D}{1{,}2M_D + 1{,}6M_L}$$

$$= \frac{1{,}2.1{,}05}{1{,}2.1{,}05 + 1{,}6.0{,}22}$$

$$= 0{,}782$$

$$EI = \frac{E_c.I_c}{2{,}5(1+\beta_d)}$$

$$= \frac{23500.1{,}251.10^9}{2{,}5(1+0{,}782)}$$

$$= 6{,}6.10^{12} \text{ Nmm}^4$$

Menghitung momen inersia balok di kanan kiri kolom. Dengan menganggap momen inersia penampang retak balok sebesar setengah dari momen inersia penampang bruto, maka

a). Momen inersia balok dikanan kiri ujung atas kolom yaitu :

$$I_{cr} = \frac{I_g}{2} = \frac{1}{2}\left[\frac{1}{12}.400.(650)^3\right]$$

$$= 457{,}708.\ 10^7 \text{ mm}^4$$

b). Momen inersia balok dikanan kiri ujung bawah kolom = 0, karena ujung jepit

Lc (panjang kolom) = 3,275 m

Lg (panjang bersih balok) = 6,55 m

$$\psi_{atas} = \psi_{bawah} = \frac{\sum\left(\frac{EI}{Lc}\right)}{\sum\left(\frac{E_c I_{cr}}{Lg}\right)}$$

$$\psi_{atas} = \frac{\left(\frac{6,6.10^{12}}{3275}\right)+\left(\frac{6,6.10^{12}}{4350}\right)}{\left(\frac{23500.457,708.10^{7}}{6550}\right)} = 0,22$$

$\psi_{bawah} = 0$ (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,05

$$\frac{k.lu}{r} = \frac{1,05.3275}{(0,3.350)}$$

= 32,75 >22 (termasuk kolom panjang)

Beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.6,6.10^{12}}{(1,05.3275)^2}$$

= 5503031,831 N

menghitung faktor pembesaran momen δ_{by}

$$\delta b_y = \frac{Cm}{1-\left(\frac{Pu}{\phi Pc}\right)} \geq 1$$

cm = 1 (portal tanpa pengaku)

$$\delta b_y = \frac{1}{1-\left(\frac{1683,786}{0,65.5503031,831}\right)}$$

$$= 1,001 > 1$$

menghitung factor pembesaran δ_{sy}

kolom elemen 267 As 3

$$\psi_{atas} = \frac{\left(\frac{8,529.10^{13}}{3275}\right)+\left(\frac{8,529.10^{13}}{4350}\right)}{\left(\frac{23500.457,708.10^{7}}{6550}\right)+\left(\frac{23500.457,708.10^{7}}{6550}\right)} = 1,39$$

ψ_{bawah} = 0 (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,2

Beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.8,5290^{13}}{(1,2.3275)^2}$$

= 54446793,7 N

Kolom Elemen 484

$$\psi_{atas} = \frac{\left(\frac{7{,}52.10^{13}}{3275}\right)+\left(\frac{7{,}52.10^{13}}{4350}\right)}{\left(\frac{23500.457{,}708.10^{7}}{6550}\right)+\left(\frac{23500.457{,}708.10^{7}}{6550}\right)} = 1{,}23$$

ψ_{bawah} = 0 (ujung jepit)

Dari nomogram portal tanpa pengaku, didapat k = 1,18

Beban tekuk Euler yang terjadi adalah:

$$P_c = \frac{\pi^2 EI}{(kLc)^2}$$

$$= \frac{\pi^2.7{,}52^{13}}{(1{,}18.3275)^2}$$

$$= 49646714{,}53 \text{ N}$$

□ Pc = 2.5503031,831 + 2.54446793,7 +2.49646714,53

= 219193080,1 N

□ Pu= 2.1683,786 +2.6357,1 + 2.6158,18

= 28398132 N

$$\delta_{sx} = \frac{1}{1-\left(\frac{\sum Pu}{\sum Pc}\right)} \geq 1$$

$$= \frac{1}{1-\left(\frac{28398132}{0{,}65.219193080{,}1}\right)} = 1{,}25$$

Momen akibat pembesaran momen :

Mux bawah $= \delta_{bx}$ Mbx+ δ_{sy} Msx

$= 1,001.0,647 + 1,25.87,19$

$= 109,635$ KNm

Mux atas $= \delta_{by}$ Mbx+ δ_{sy} Msx

$= 1,001.1,241 + 1,25.82,261$

$= 104,068$ KNm

c. Analisis Gaya Aksial dan Momen akibat balok

h = 3,6 m

hn = 3,275 m

Rv = 1,1 – 0,025.5 = 0,975 (jumlah lantai diatasnya; n> 4)

ωd = 1 (untuk lantai dasar)

k = 1

1). Perhitungan Arah Y

$Mkap_{(kiri)} = 0$

$Mkap_{(kanan)} = 588.643$ KNm

menghitung gaya aksial rencana :

$$Nu,k_y = 0,7.Rv. \frac{Mkap_{kiri} + Mkap_{kanan}}{l} + 1,05\ Ng$$

$$= 0,7.0,975. \frac{0 + 588,643}{3,6} + 1,05(\ 1137,55 + 199,204\ )$$

$= 1515,189$ KN

tidak perlu melebihi :

$Nu,k_y = 1,05\ (N_D + N_L + 4.N_E)$

= 1,05 (11137,55 +199,204 +4.290,363)

= 2498,204 KN

dipakai Nu,k_y = 1515,159 KN

menghitung α :

Lantai 1

$M_{E,K\ atas}$ = 78,344 KNm

$M_{E,K\ bawah}$ = -

Lantai 2

$M_{E,K\ atas}$ = 119,54 KNm

$M_{E,K\ bawah}$ = 116,77 KNm

$$\alpha\ ka = \frac{M_{E,k(lti+1atas)}}{M_{E,k(lti+1atas)} + M_{E,k(ltibawah)}} = 0,4$$

$$\alpha\ kb = \frac{M_{E,k(ltibawah)}}{M_{E,k(lti+1atas)} + M_{E,k(ltibawah)}} = -$$

menghitung momen rancang kolom :

$$Mu,k_y atas = \frac{hn}{h}\ \omega d.\alpha.0,7.\left(\frac{l_{ki}}{l'_{ki}}Mkap,ki + \frac{l_{ka}}{l'_{ka}}Mkap,ka\right)$$

$$= \frac{3,275}{3,6}\ 1.0,4\ 0,7.\left(0 + \frac{7,2}{6,7}.588,643\right) = 26,103\ KNm$$

$Mu,k_y baw$ = 83,038 KNm

tidak perlu melebihi :

$Mu,k = 1,05\ (M_D + M_L - 4.M_E) = 1,05\ (1,05 + 0,22 + 4\ .\ 83,038)$

= 350,093 KNm

Mu,k_y pakai = 83,083 KNm

2). .Perhitungan Arah X

$Mkap_{(kiri)}$ = 588,643 KNm

$Mkap_{(kanan)}$ = 588,643 KNm

menghitung gaya aksial rencana :

$$Nu,k_x = 0,7.Rv.\ \frac{Mkap_{kiri} + Mkap_{kanan}}{l} + 1,05\ Ng$$

$$= 0,7.0,975.\frac{588,643 + 588,643}{7,2} + 1,05(\ 1137,55+199,204)$$

= 1515,189KN

tidak perlu melebihi :

Nu,k_y = 1,05 (Nd + Nl + 4.Ne) = 1,05 (1435,9 + 223,56 + 4.142)

= 2338,833 KN

dipakai Nu,k_x = 1515,189 KN

menghitung α :

α atas = 0,03

α bawah = -

menghitung momen rancang kolom :

$$Mu,k_x \text{ atas} = \frac{hn}{h}\omega d.\alpha.0,7.\left(\frac{l_{ki}}{l'_{ki}}Mkap,ki + \frac{l_{ka}}{l'_{ka}}Mkap,ka\right)$$

$$= \frac{3,275}{3,6}1.\ 0,03.0,7.\left(\frac{3,6}{2,95}588,643 + \frac{3,6}{2,95}588,643\right)$$

= 65.911 KNm

Mu,k_x bwh = 75,084 KNm

tidak perlu melebihi :

$Mu,k_x = 1,05\ (M_D + M_L + 4.M_E)$

$= 1,05\ (38,975 + 9,593 + 4.\ 75,074\ )$

$= 366,349$ KNm

Mu,k_x pakai = 165,911 KNm

d. Perencanaan Penulangan Kolom

Pu = 1683,786 KN

$$Pn = \frac{Pu}{\theta} = \frac{1683,786}{0,65} = 2590,44$$

Mux =121 KNm

$$Mnx = \frac{Mux}{\theta} = \frac{121}{0,65} = 186,154 \text{ KNm}$$

Muy =109,635 KNm

$$Mny = \frac{Muy}{\theta} = \frac{109,635}{0,65} = 168,67 \text{ KNm}$$

$$\frac{Mnx}{Mny} = \frac{186,154}{168,67} = 1,1 > \frac{h}{b} = 1,0$$

Digunakan Moy untuk perencanaan .

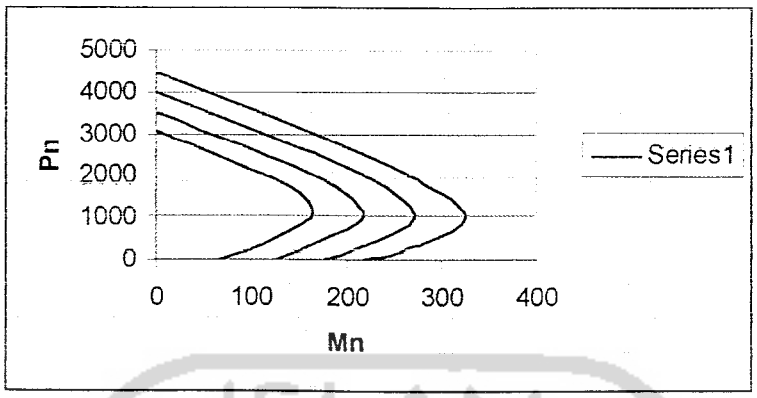
$$Moxperlu = Mnx + Mny\left(\frac{b}{h}\right)\left(\frac{1-0,65}{0,65}\right)$$

$$= 186,154 + 168,67\left(\frac{0,65}{0,65}\right)\left(\frac{1-0,65}{0,65}\right)$$

$$= 276,976 \text{ KNm}$$

$$e = \frac{Mox}{Pn} = \frac{276,976}{1683,786} = 0,16 \text{ m}$$

kontrol penampang Pn



Gambar 4.16 Grafik Mn-Pn

Dari grafik Mn vs Pn didapat 3,8%Ag

Ast = 0,038.350.350= 4655 mm^2

As = As' = 0,5.Ast = 2327,5 mm^2

dipakai tulangan D22 dengan As_{1tul} = 380 mm^2

jumlah tulangan (n) = $\frac{2327,5}{380}$

= 6,1

dipakai n = 7 buah

As pakai = 7 380

= 2660 > As perlu = 2327,5 mm^2

Cek eksentrisitas balance (e_b)

$c_b = \frac{600.d}{600 + fy}$ = 174 mm

$a_b = \beta_1 . c_b = 0,85 . 174 = 147,9$ mm

$f's = 600\frac{(c_b - d')}{c_b} = 600\frac{(174 - 60)}{174}$ = 393,103 MPa < fy = 400 MPa

Dengan demikian digunakan f's = 393,103 MPa

Pnb $= 0,85 \cdot f'c \cdot b \cdot a_b + A's\,(fs'-0,85.fc') - As\ fy$

$= 1025,135$ KN

$$Mnb = 0,85 \cdot f'c \cdot b \cdot a_b \left(\frac{h}{2}-\frac{a_b}{2}\right) + A's\,(f's-0,85.fc') \left(\frac{h}{2}-d'\right) + As\ fy \left(d-\frac{h}{2}\right) = 326,481 \text{ KNm}$$

$$eb = Mnb/Pnb = 326,481/1025,135 = 0,31 > e = 0,16$$

karena $e_b < e$ runtuh desak

$$Pn = \frac{As'.fy}{\frac{e}{d-d'}+0,5} + \frac{b.h.f'c}{\frac{3.h.e}{d^2}+1,18}$$

$= 17219,92 > Pn = 1683,786$ KN

Hitung Moyn

$$a = \frac{Pn}{0,85.f'c.b} = \frac{1683,786}{0,85.25.350} = 226,391 \text{mm}$$

$$c = \frac{226,391}{0,85} = 266,343 \text{ mm}$$

$$f's = 600.\left(\frac{266,343-60}{266,343}\right) = 464,836 > fy = 400 \text{ Mpa}$$

$$Moyn = 0,85.f'c.b.a.\left(\frac{h}{2}-\frac{a}{2}\right) + As'.fs' \left(\frac{h}{2}-d'\right) + As.\ Fy.\left(d-\frac{h}{2}\right)$$

$= 327,505$ KNm

Penampang diasumsikan bujur sangkar sehingga :

Moxn= Moyn = 327,505 KNm>Mox perlu= 276,976 KNm

$$\frac{Mnx}{Moxn} = \frac{186,154}{327,505} = 0,57$$

Dari diagram factor lentur : $\frac{Mnx}{Moxn} = 0,57$; □ =0,65 didapat

$$\frac{Mny}{Moyn} = 0,73$$

Mny= 0,73 . 327,505 =239,079KNm>Mny perlu= 168,669 KNm

e. Perencanaan Penulangan Geser

$$V_{u,k} = \frac{Mu,k_{atas} + Mu,k_{bawah}}{h'_k}$$

$$= \frac{65,911 + 75,084}{3,275}$$

$$= 43,052 \text{ KN}$$

tidak perlu melebihi

$$V_{u,k} = 1,05 \left(V_{D,k} + V_{L,k} + \frac{4}{K} V_{E,k}\right)$$

$$= 1,05 \left(16,124 + 3,97 + 4 . 44,83 \right)$$

$$= 209,385 \text{ KN}$$

$V_{u,k}$ terpakai = 43,052 KN

Daerah sendi plastis

d = 0,29 m

Vc = 0 (pada daerah sendi plastis,Vc dianggap 0)

$$V_{u,k} \text{ terhitung} = \frac{h'k - d}{h'k} V_{u,k} terpakai$$

$$= \frac{3,275 - 0,29}{3,275} .43,052$$

$= 39{,}241 KN$

$$Vs = \frac{V_{u.k}terhitung}{\phi}$$

$$= \frac{39{,}241}{0{,}6}$$

$= 65{,}40$ KN

Dipakai sengkang D10 dengan Av = 157 mm^2

$$\text{Jarak (S)} < \frac{Av.fy.d}{Vs}$$

$$= \frac{157.240.270}{65{,}40.10^3}$$

$= 167$ mm

$< d/4 = 72{,}5$ mm

maka dipakai 2P10- 140 mm

Daerah luar sendi plastis

$V_{u,k}$ terhitung = 65,4 KN

$$\frac{Vu,b\ terhitung}{0{,}6} = \frac{65{,}4}{0{,}6}$$

$= 109$ KN

Nu,k = 1683,786 KN

$$Vc = \left(1 + \frac{Nu,k}{14.Ag}\right)\frac{1}{6}.\sqrt{f'c}.b.d$$

$$= \left(1 + \frac{1683{,}786}{14.350.350}\right)\frac{1}{6}.\sqrt{25}.350.350$$

$= 84{,}66$ KN

$$Vs = \frac{Vu, b\ terhitung}{0,6} - Vc$$

$$= 24,34\ KN$$

Dipakai sengkang D10 dengan Av = 157 mm^2

$$\text{Jarak (S)} < \frac{Av.fy.d}{Vs}$$

$$= \frac{157.240.270}{24,341.10^3}$$

$$= 449\ mm$$

$$< d/2 = 145\ mm$$

maka dipakai P10 –145 mm

4.4.4 Pertemuan Balok Kolom

1. Pertemuan Balok Kolom Luar

a. Perhitungan Gaya- gaya Dalam

Mnak, b = 470,914 kNm

Mkap,b = 589,625 kNm

$$V_{kol} = \frac{0,7.\left(\frac{Lki}{Lki'}.Mkap,ki + \frac{Lka}{Lka'}.Mkap,ka\right)}{\frac{1}{2}.(hk,a + hk,b)}$$

$$V_{kol} = \frac{0,7.\left(0 + \frac{7,2}{6,875}.588,625\right)}{\frac{1}{2}.(3,6+5)} = 100,352\,\text{kN}$$

$$T = \frac{0,7.Mkap,ka}{zka}$$

Zka diambil 425 mm = 0,425 m

$$T = \frac{0,7.588,625}{0,425} = 969,5\ kN$$

Vj,h = T – Vkol = 969,5 – 100,352 = 869,148 kN

$$Vj,v = \frac{d}{hc}.Vjh = \frac{0,65}{0,65}.869,148 = 869,148\ kN$$

b. Kontrol tegangan geser horisontal minimal

$$Vj,h = \frac{Vj,h}{bj.hc} < 1,5\sqrt{fc'}$$

bb = 400mm bc = 650 mm

bj = bb + 0,5. hc = 400 + 0,5 . 650 = 725 mm

bj = bc = 650 mm ; pakai bj = 650 mm

$$Vj,h = \frac{969,5}{0,65.0,65} = 2294,675\ kN/m^2 = 2,295\ N/mm^2 < 1,5.\sqrt{25} = 7,5\ N/mm^2$$

c. Penulangan geser horizontal

Nu = 2362,319 kN

$$\frac{Nu}{Ag} = \frac{2362,319}{0,65\ .\ 0,65} = 5591,288\ kN/mm^2 = 5,591 N/mm^2 > 0,1.fc' = 2,5\ N/mm^2$$

$$Vc,h = \frac{2}{3}.\sqrt{\left\{\left(\frac{Nu,k}{Ag}\right) - 0,1.fc'\right\}}.bj.hc$$

$$Vc,h = \frac{2}{3}.\sqrt{\left\{\left(\frac{2362319}{650\ .\ 650}\right) - 0,1.25\right\}}.650.650$$

$$Vc,h = 495228N = 495,228kN$$

Vs,h + Vc,h = Vj,h

Vs,h = 869,148 – 495,228 = 373,92 kN

$$Aj,h = \frac{Vs,h}{fy} = \frac{373,92.10^3}{400} = 934,8mm^2$$

Digunakan sengkang P10 dengan Av = 157 mm^2

Jumlah lapis sengkang = $\frac{934,8}{157} = 5,9 = 6 lapis$

d. Penulangan geser vertikal

$$Vc,v = \frac{Asc'}{Asc} Vj,h.\left(0,6 + \frac{Nu,k}{Ag.fc'}\right)$$

$$Vc,v = 1\,.\,869{,}148.\left(0{,}6 + \frac{2362{,}319{,}10^3}{650.650.25}\right)$$

$$Vc,v = 715875{,}057\,N = 715{,}875\,kN$$

$$Vs,v = Vj,v - Vc,v = 869{,}148 - 715{,}875 = 153{,}273\,kN$$

$$Aj,v = \frac{Vs,v}{fy} = 383{,}183\,mm^2 \quad Dipakai\ 2D25$$

2. Pertemuan Balok Kolom Dalam

a. Perhitungan Gaya-gaya dalam

Mnak,b kiri = 399,224 kNm

Mnak,b kanan = 542,494 kNm

Mkap,b kiri = 1,25 . 399,224 = 499,155 kNm

Mkap,b kanan = 1,25 . 542,494 = 678,118 kNm

$$V_{kol} = \frac{0{,}7.\left(\frac{Lki}{Lki'}.Mkap,ki + \frac{Lka}{Lka'}.Mkap,ka\right)}{\frac{1}{2}.(hk,a + hk,b)}$$

$$V_{kol} = \frac{0{,}7.\left(\frac{7{,}2}{6{,}875}.499{,}155 + \frac{7{,}2}{6{,}875}.678{,}1175\right)}{\frac{1}{2}.(3{,}6 + 5)} = 200{,}709\,kN$$

$$Cki = \frac{0{,}7.Mkap,b\,ki}{zki} = \frac{0{,}7.499{,}155}{0{,}425} = 822{,}138\,kN$$

$$Tka = \frac{0{,}7.Mkap,b\,ka}{zka} = \frac{0{,}7.678{,}118}{0{,}425} = 1116{,}899\,kN$$

$$Vj,h = Cki + Tka - Vkol = 822{,}138 + 1116{,}899 - 200{,}709 = 1738{,}328\,kN$$

$$Vj,v = \frac{d}{hc}.Vj,h = \frac{0{,}65}{0{,}65}.1738{,}328 = 1738{,}328\,kN$$

b. Kontrol Tegangan Geser Horizontal Nominal

$$Vj,h = \frac{Vj,h}{bj.hc} =< 1{,}5.\sqrt{fc'}$$

$$Vj,h = \frac{1738{,}328}{0{,}65.0{,}65} = 4114{,}387kN/m^2 = 4{,}114N/mm^2 < 1{,}5.\sqrt{25} = 7{,}5/N/mm^2$$

c. Penulangan Geser Horizontal

Nu,k = 2785,713 kN

$$\frac{Nu}{Ag} = \frac{2785{,}713}{0{,}65.0{,}65} = 6593{,}4\,kN/m^2 = 6{,}593\,N/mm^2 > 0{,}1.fc' = 2{,}5MPa$$

$$Vc,h = \frac{2}{3}.\sqrt{\left\{\left(\frac{Nu,k}{Ag}\right) - 0{,}1.fc'\right\}}.bj.hc$$

$$Vc,h = \frac{2}{3}.\sqrt{\{6{,}593 - 0{,}1.25\}}650.650 = 569244{,}455\,N = 569{,}844\,kN$$

Vs,h + Vc,h = Vj,h

Vs,h = 1738,328 – 569,844 = 1168,484 kN

$$Aj,h = \frac{Vs,h}{fy} = \frac{1168{,}484.10^3}{400} = 2921{,}21mm^2$$

Dipakai sengkang rangkap P10 dengan Av = 314,159 mm^2

$$Jumlah\ lapis\ sengkang = \frac{2921{,}21}{314{,}159} = 9{,}299\ dipakai\ 10\ lapis$$

d. Penulangan geser vertikal

$$Vc,v = \frac{Asc'}{Asc}.Vj,h.\left(0{,}6 + \frac{Nu,k}{Ag}.fc'\right)$$

$$Vc,v = 1.1738{,}328.(0{,}6 + 6{,}593.25) = 287562{,}909\,N = 287{,}563\,kN$$

Vs,v =Vj,h - Vc,v = 1738,328 – 287,563 = 1450,765 kN

$$Aj,v = \frac{Vs,v}{fy} = \frac{1450{,}765.10^3}{400} = 3626{,}913\,mm^2$$

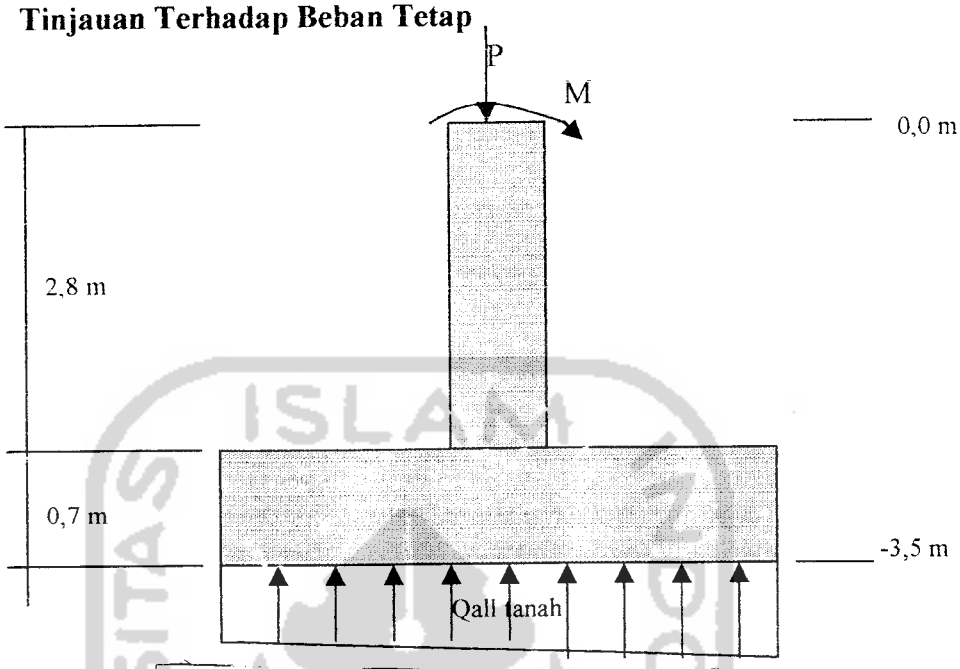
Dipakai sengkang rangkap P10 dengan Av = 314,159 mm^2

$$Jumlah\ lapis\ sengkang = \frac{3626{,}913}{314{,}159} = 11{,}545\ dipakai\ 12\ lapis$$

4.5 Perencanaan Pondasi

4.5.1 Perencanaan Dimensi Pondasi

1. Tinjauan Terhadap Beban Tetap



Gambar 4.17 Diagram tegangan pondasi

σ tanah = 300 KN/m^2 γ'tanah = 21,4 KN/m^3

F'c = 25 Mpa γbeton = 24 KN/m^3

Fy = 400 Mpa Asumsi tebal pondasi (h) = 700 mm

Ukuran kolom : 650/650 mm P = 2362,319 KN

My = 581,7551 kN.m Mx = 509,01 kN.m

$\sigma_{netto\ tanah} = \sigma_{tanah} - \Sigma(h.\gamma_{beton}) - \Sigma(h.\gamma_{tanah})$

$= 300 - (0,7.24) - (2,8.21,4)$

$= 223,28\ KN/m^2$

Dimensi luas pelat pondasi: (terdapat momen yang bekerja pada arah x dan y)

$$\sigma_{netto\ tanah} = \frac{P}{A_{perlu}} + \frac{My}{1/6.Bx^2.By} + \frac{Mx}{1/6.By^2.Bx}$$

dicoba dengan nilai B = 4,3 m

$$A_{perlu} = \frac{P}{\sigma netto \tan ah - \left(\frac{My}{1/6.By^2.Bx}\right) - \left(\frac{Mx}{1/6.Bx^2.By}\right)}$$

$$= \frac{2362,319}{223,28 - \left(\frac{581,7551}{1/6.4,3^2.4,3}\right) - \left(\frac{509,01}{1/6.4,3^2.4,3}\right)} = 16,758 \text{ m}^2$$

Digunakan penampang bujur sangkar dengan :

P = 4,3 m dan L = 4,3 m

Luas penampang pelat pondasi : A_{ada} = P x L = 4,3 x 4,3 = 18,49 m^2

Kontrol luas pelat pondasi dan tegangan yang terjadi :

A_{ada} = 18,49 m^2 > A_{perlu} = 16,758 m^2 .....Ok.

Tegangan kontak yang terjadi di dasar pondasi :

$$\sigma_{\text{netto tanah}} = \frac{P}{A_{ada}} + \frac{My}{1/6.P^2.L} + \frac{Mx}{1/6.L^2.P}$$

$$\sigma_{\text{netto tanah}} = \frac{2362,319}{18,49} + \frac{581,755}{1/6.4,3^2.4,3} + \frac{509,01}{1/6.4,3^2.4,3}$$

= 210,077 KN/m^2 < $\sigma_{nettotanah}$ = 223,28 KN/ m^2 .....Aman.

Jarak pusat tulangan tarik ke serat tekan beton :

d = h – Pb – ½.$\varnothing_{tul.\ pokok}$ = 700 – 70 - ½. 22 = 619 mm

Tinjauan Terhadap Beban Sementara

Eksentrisitas yang terjadi :

P = 2362,319 KN

Mx = 509,01 KNm

My = 581,755 KNm

$$ey = \frac{My}{P} = \frac{581,755}{2362,319} = 0,2463 \text{ m} \quad : \quad ex = \frac{Mx}{P} = \frac{509,01}{2362,319} = 0,2155 \text{ m}$$

Kontrol tegangan yang terjadi :

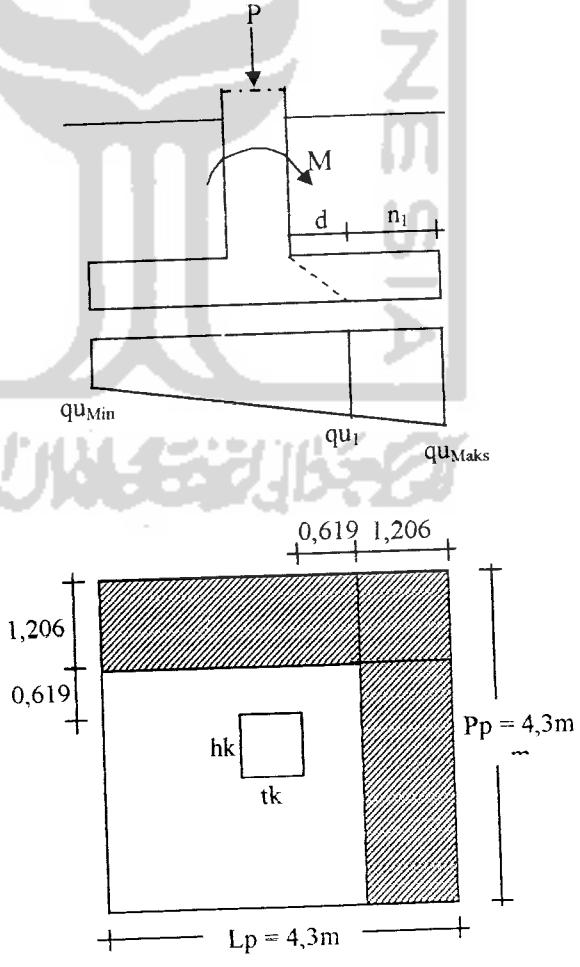
$$\sigma = \frac{P}{(L.(P - 2.ex)) + (P.(L - 2.ey))}$$

$$= \frac{2362,319}{(4,3.(4,3 - 2.0,2155)) + (4,3.(4,3 - 2.0,2463))}$$

$= 71,88$ KNm $< 1,5.\sigma_{netto} = 1,5.\ 223,38 = 318,056$ KNm .....Aman.

4.5.2 Perencananaan Geser Satu Arah

→ Ditinjau pada arah momen terbesar .



Gambar 4.18 Pondasi dengan geser satu arah

$$n_1 = \frac{Lp - tk - 2.d}{2} = \frac{4{,}3 - 0{,}65 - 2.0{,}619}{2} = 1{,}206 \text{ m}$$

- Tegangan kontak yang terjadi :

$$qu = \frac{P}{A_{ada}} + \frac{My}{1/6.Pp^2.Lp} + \frac{Mx}{1/6.Lp^2.Pp}$$

$$qu_{maks} = \frac{2362{,}319}{18{,}49} + \frac{581{,}755}{1/6.4{,}3^2.4{,}3} + \frac{509{,}01}{1/6.4{,}3^2.4{,}3} = 210{,}077 \text{ KN/m}^2$$

$$qu_{min} = \frac{2362{,}319}{18{,}49} - \frac{581{,}755}{1/6.4{,}3^2.4{,}3} - \frac{509{,}01}{1/6.4{,}3^2.4{,}3} = 45{,}4473 \text{ KN/m}^2$$

$$qu_1 = qu_{min} + (qu_{maks} - qu_{min}) \left(\frac{Lp - n_1}{Lp} \right)$$

$$= 45{,}4473 + (210{,}077 - 45{,}4473) \left(\frac{4{,}3 - 1{,}206}{4{,}3} \right)$$

$$= 163{,}904 \text{ KN/m}^2$$

- Gaya geser akibat beban luar yang bekerja pada penampang kritis pondasi :

$$Vu = qu_{terjadi} . m . L = 163{,}904 . 1{,}206 . 4{,}3 = 849{,}973 \text{ KN}$$

$$Vu/\phi = 849{,}973/0{,}6 = 1416{,}622 \text{ KN}$$

- Kekuatan beton menahan geser:

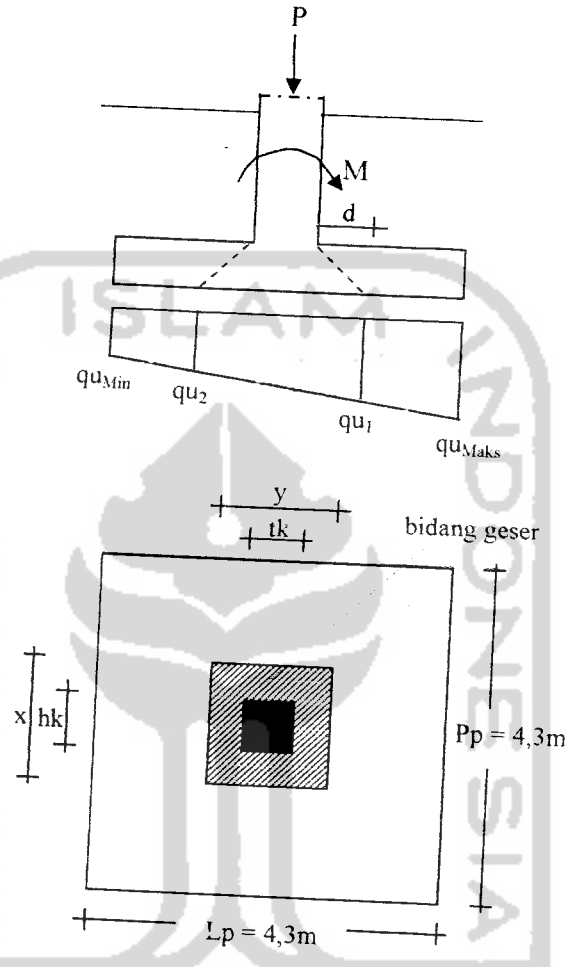
$$Vc = 1/6. \sqrt{f'c} . L. d = 1/6. \sqrt{25}\ 4{,}3. 0{,}619 . 10^3 = 2218{,}0833 \text{ KN}$$

- Kontrol gaya geser :

$Vc = 2218{,}0833 \text{ KN} \geq Vu/\phi = 1416{,}622 \text{ KN}$ .....Aman.

4.5.3 Perencananaan Geser Dua Arah

→ Ditinjau pada arah momen terbesar.



Gambar 4.19 Pondasi dengan geser dua arah

x = hk + d = 650 + 619 = 1269 mm = 1,269 m

y = tk + d = 650 + 619 = 1269 mm = 1,269 m

- Tegangan kontak yang terjadi :

$qu_1 = 163{,}904\ KN/m^2$

$$qu_2 = qu_{min} + (qu_{maks} - qu_{min}) \left(\frac{n_1}{Lp} \right)$$

$$qu_2 = qu_{min} + (qu_{maks} - qu_{min}) \left(\frac{n_1}{Lp} \right)$$

$$qu_2 = 45,4473 + (210,077 - 45,4473) \left(\frac{1,206}{4,3} \right) = 91,6202 \text{ KN/m}^2$$

$$qu_T = \tfrac{1}{2} (qu_1 + qu_2) = \tfrac{1}{2} (163,904 + 91,6202) = 127,7621 \text{ KN/m}^2$$

- Gaya geser akibat beban luar yang bekerja pada penampang kritis pondasi :

$$Vu = qu_T . ((Pp . Lp) - (x.y))$$

$$= 127,7621 . ((4,3.4,3) - (1,269 . 1,269)) = 23006,719 \text{ KN}$$

$$Vu/\phi = 2306,719/0,6 = 3934,518 \text{ KN}$$

- Kekuatan beton menahan geser :

$$\beta c = \frac{sisipanjang}{sisipendek} = \frac{Pp}{Lp} = \frac{4,3}{4,3} = 1$$

$$bo = 2 . (x + y) = 2 . (1269 + 1269) = 5076 \text{ mm}$$

$$Vc_1 = (1 + 2/\beta c) . (2 . \sqrt{f'c}) . bo . d$$

$$= (1 + 2/1) . (2 . \sqrt{25}) . 5076 . 619 . 10^{-3} = 942621,32 \text{ KN}$$

$$Vc_2 = 4 . \sqrt{f'c} . bo . d$$

$$= 4 . \sqrt{25} . 5076 . 619 . 10^{-3} = 62840,88 \text{ KN}$$

- Kontrol gaya geser :

Digunakan nilai yang terkecil dari Vc_1 dan Vc_2, yaitu $Vc_2 = 67792,88$ KN

$Vc_2 = 67792,88 \text{ KN} \geq Vu/\phi = 3934,518 \text{ KN}$.....Aman.

4.5.4 Kuat Tumpuan Pondasi

• Kuat tumpuan Pondasi :

$\phi.Pn = \phi.\ (0{,}85.\ f'c.\ A_1.\ \sqrt{A_2/A_1}\ )$

Luas pelat pondasi (A_2) = P . L = 4,3 . 4,3 = 18,49 m^2

Luas penampang kolom (A_1) = hk . tk = 0,65 . 0,65 = 0,4225 m^2

$\sqrt{\frac{A_2}{A_1}} = \sqrt{\frac{18{,}49}{0{,}4225}} = 6{,}615 > 2$ (jika lebih besar dari 2, dipakai nilai 2)

$\phi.Pn = \phi.\ (0{,}85.\ f'c.\ A_1.2)$

$= 0{,}7.\ (0{,}85.\ 25.\ 422500.2).10^{-3} = 12569{,}375$ KN

• Kuat tumpuan kolom :

$\phi.Pn = \phi.\ (0{,}85.\ f'c.\ A_1)$

$= 0{,}7.\ (0{,}85.\ 25.\ 422500).10^{-3} = 6284{,}6875$ KN

• Kontrol kuat tumpuan :

$\phi.Pn_{pondasi} = 12569{,}375$ KN $> \phi.Pn_{kolom} = 6284{,}6875$ KN .....Aman.

4.5.6 Perencanaan Tulangan Telapak Pondasi

Momen yang terjadi :

$l = \frac{Lp - tk}{2} = \frac{4{,}3 - 0{,}65}{2} = 1{,}825$ m

$qu_{maks} = 210{,}077$ KN/m^2

$Mu = 0{,}5.\ qu_{maks}.\ l^2 = 0{,}5\ .\ 210{,}077\ .\ 1{,}825^2 = 349{,}844$ KNm

$Mu/\phi = \frac{349{,}844}{0{,}8} = 437{,}305$ KNm

- Digunakan tulangan bagi $\varnothing_{22}$ mm, sehingga luas tampang 1 tulangan pokok :

  $A_{1\varnothing} = \frac{1}{4}.\ \pi.\ D^2 = \frac{1}{4}.\ \pi.\ 22^2 = 379{,}94\ mm^2$

- Tebal pelat pondasi : h = 700 mm, selimut beton (Pb) = 70 mm

  $d = h - Pb - 0{,}5.\ \varnothing_{tul.\ pokok} = 700 - 70 - 0{,}5.\ 22 = 619$ mm

  $$m = \frac{fy}{0{,}85.f'c} = \frac{400}{0{,}85.25} = 18{,}8235$$

Koefisien ketahanan (Rn), diambil nilai b tiap 1000 mm :

$$Rn = \frac{Mu/\phi}{b.d} = \frac{437{,}305.10^6}{1000.619^2} = 1{,}141\ MPa$$

Rasio Tulangan :

$$\rho_{min} = \frac{1{,}4}{fy} = \frac{1{,}4}{400} = 0{,}00350$$

$$\rho b = \frac{0{,}85.f'c.\beta_1}{fy}\left(\frac{600}{600+fy}\right) = \frac{0{,}85.25.0{,}85}{400}\left(\frac{600}{600+400}\right) = 0{,}02709$$

$$\rho_{maks} = 0{,}75.\ \rho b = 0{,}75.\ 0{,}02709 = 0{,}02032$$

$$\rho_{aktual} = \frac{1}{m}\left(1-\sqrt{1-\frac{2m.Rn}{fy}}\right)$$

$$= \frac{1}{18{,}8235}\left(1-\sqrt{1-\frac{2.18{,}8235.1{,}141}{400}}\right) = 0{,}0029 < \rho_{maks} = 0{,}02032$$

$$> \rho_{min} = 0{,}00350$$

$\rho_{min} < \rho_{aktual} < \rho_{max}$ .....sehingga dipakai : $\rho_{perlu} = 0{,}0029$

$As_{perlu} = \rho_{perlu}\ .\ b\ .\ d = 0{,}0029\ .\ 1000\ .\ 619 = 1795{,}1\ mm^2$

Jarak antar tulangan :

$$s \leq \frac{A_{\theta 1}.b}{As_{perlu}} = \frac{379{,}94.1000}{1795{,}1} = 211{,}64 \text{ mm}$$

$$s \leq 2.h = 2 .700 = 1400 \text{ mm}$$

$$s \leq 250 \text{ mm}$$

→ Dipakai Tulangan Pokok : D_{22} – 200 mm

$$As_{aktual} = \frac{A_{1\theta}.1000}{s} = \frac{379{,}94.1000}{200} = 1899{,}7 \text{ mm}^2$$

- Kontrol Kapasitas Lentur Pelat pondasi :

$$a = \frac{As_{aktual}.fy}{0{,}85.f.c.b} = \frac{1899{,}7.400}{0{,}85.25.1000} = 35{,}759 \text{ mm}$$

$$Mn = As_{aktual}.fy.\ (d - {}^{a}/_{2})$$

$$= 1899{,}7 \ .\ 400\ (619 - {}^{35{,}759}/_{2})$$

$$= 456{,}779 \text{ KNm} \geq {}^{Mu}/_{\phi} = 437{,}305 \text{ KNm} \ldots\ldots\ldots\ldots\ldots\text{Aman.}$$

Perencanaan Tulangan Susut Pondasi

$$As_{susut} = 0{,}002.\ b.\ h = 0{,}002.\ 1000.\ 700 = 1400 \text{ mm}^2$$

- Digunakan tulangan bagi ∅12 mm, sehingga luas tampang 1 tulangan susut :

$$A_{1\varnothing} = \tfrac{1}{4}.\ \pi.\ D^2 = \tfrac{1}{4}.\ \pi.\ 12^2 = 113{,}04 \text{ mm}^2$$

Jarak antar tulangan susut :

$$s \leq \frac{A_{\theta 1}.b}{As_{susut}} = \frac{113{,}04.1000}{1400} = 80{,}7428 \text{ mm} \approx 80 \text{ mm}$$

→ Dipakai Tulangan Susut : P_{12} – 80 mm

4.6 Perencanaan Tangga

4.6.1 Spesifikasi Struktur

1. Tinggi antar lantai = 3,6 m = 360 cm
2. Lebar bordes = 2,0 m = 200 cm
3. Lebar tangga = 2,4 m =240 cm
4. Beban sandaran tangga :

   Tinggi sandaran = 1m

   Tebal sandaran = 0,12 m

   Berat sandaran total = (0,12. 1. 24.2)/2,4 = 2,40 KN/m^2
5. Tinggi optrade rencana diambil 18 cm

   Jumlah optrade = 360/18 = 20 buah

   Tinggi optrade pakai = 360/20 = 18 cm

   Jumlah antrade = 20 – 2 = 18 buah

   Diambil panjang antrade = 30 cm
6. Sudut kemiringan tangga = 18/30 = arc tg $\alpha \rightarrow \alpha = 30{,}96^0$
7. Dimensi tangga

   Panjang tangga = (Panjang antrade x jml antrade/2) + lebar border

   = (30 x 18/2) + 200 = 470 cm

   Lebar bersih tangga = 240 cm
8. Tebal pelat bordes diambil 20 cm

4.6.2 Pembebanan

1. Pembebanan bordes

Beban mati

- Berat sendiri pelat = 0,2.24 = 4,80 KN/m^2
- Berat spesi = 3. 0,24 = 0,72 KN/m^2
- Berat keramik = 1.0,20 = 0,20 KN/m^2
- Sandaran = (0,12.1.24.2)/3,6 = 0,80 KN/m^2 +

Q_D = 5,34 KN/m^2

Beban hidup

Q_L = 250 Kg/m^2 = 2,5 KN/m^2

$Qu = 1,2.Q_D + 1,6.Q_L = 1,2.5,34 + 1,6.2,5 = 10,408$ KN/m^2

Untuk lebar bordes = 3,6 m → qu = 10,408.3,6 = 37,47 KN/m

2. Pembebanan Tangga

Beban mati

- Berat sendiri tangga $= \left(\frac{0,2}{\cos 30,96^0} + \frac{0,18}{2}\right).24 = 6,33$ KN/m^2
- Spesi = 3. 0,24 = 0,72 KN/m^2
- Lantai keramik = 1.0,20 = 0,20 KN/m^2
- Sandaran = (0,12.1.24.2)/2,4 = 2,40 KN/m^2 +

Q_D = 9,67 KN/m^2

Beban hidup

$Q_L = 250$ Kg/m^2 = 2,5 KN/m^2

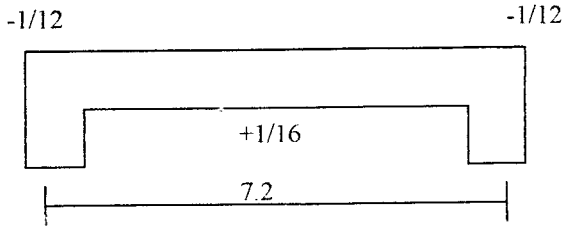
$Qu = 1,2\ Q_D + 1,6\ Q_L = 1,2.9,67 + 1,6.2,5 = 15,604$ KN/m^2

Untuk lebar tangga 2,4 m → qu = 15,604.2,4 = 37,45 KN/m

4.6.3 Perhitungan Balok Bordes

Dicoba balok ukuran 30/60

Ht = 600 mm



Pembebanan

• berat akibat pelat bordes	=	=	4619,722	kg/m
• berat tembok diatas bordes	= 1,8. 250	=	450	kg/m
• berat sendiri balok bordes	= 0,3.0,6 .2400	=	432	kg/m +
		qD =	4919,722	kg/m
		=	49,197	kN/m

Momen :

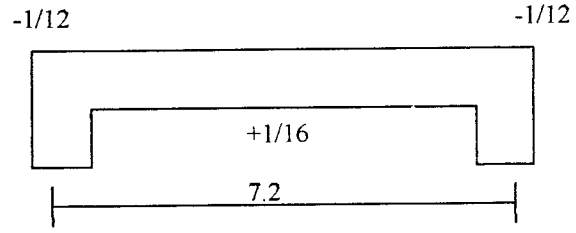
$M^+ = 1/16.qu.L^2 = 1/16 . 49,197 .7,2^2$ = 159,398 KNm

$M^- = 1/12.qu.L^2 = 1/12. 49,197 .7,2^2$ = 212,531 KN.m

4.6.4 Perhitungan Balok Induk

Dicoba balok ukuran 30/60

Ht = 600 mm



Pembebanan

- berat akibat pelat bordes = = 3439,72 kg/m
- berat sendiri balok bordes = 0,3.0,6 .2400 = 432 kg/m

qD = 3871,72 kg/m

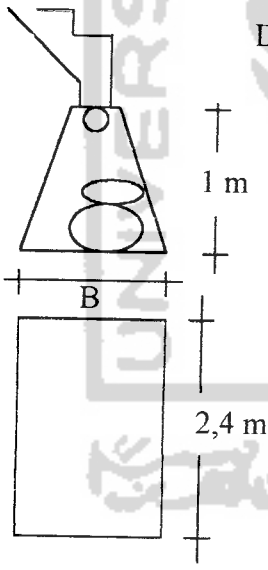
= 38,717 kN/m

Momen :

$M^+ = 1/16.qu.L^2 = 1/16 . 38,717.7,2^2 = 125,443$ KNm

$M^- = 1/12.qu.L^2 = 1/12. 38,717.7,2^2 = 167,257$ KN.m

4.6.4 Perencanaan pondasi tangga



Diketahui : σ tanah = 100 KN/m^2

γ batu = 22 KN/m^3

Balok diatas pondasi 20/40

Tinjauan untuk lebar 2,4 m (Lebar tangga)

Pembebanan

- Akibat beban tangga R1 = 152,19 KN
- Berat balok di atas pondasi = (0,4.0,3.24.1)+(0,2.0,5.24.1) = 5,280 KN

→ diperoleh beban Pu = 152,19 + 5,280 = 157,47 KN

Tegangan ijin tanah pakai:

$\sigma = \sigma$ tanah – σpondasi

$= 300 - 1.22 = 278$ KN/m^2

Diketahui pada kondisi kritis = $\sigma = \frac{Pu}{A}$

$$A = \frac{Pu}{\tau} = \frac{157,47}{278} = 0,566 \text{ m}^2$$

$$B = \frac{A}{L} = \frac{0,566}{2,4} = 0,236\text{m} \longrightarrow 30 \text{ cm}$$

Kontrol tegangan tanah:

$$\sigma = \frac{Pu}{A} = \frac{157,57}{0,3.2,4} = 218,847 \text{ KN/m}^2 < \sigma \text{ tanah} = 278 \text{ ...OK..}$$

PERHITUNGAN TANGGA

PELAT BORDES	
Mu	204,36
Mu/Ø	255,45
dipakai tul. Ø(mm)	19
A1Ø	283,385
tebal pelat (mm)	200
selimut beton (mm)	20
d	220,5
m	18,824
b (mm)	3600
Rn	1,45943991
ρ min	0,0035
ρb	0,0271
ρ maks	0,020325
ρ aktual	0,0153537
As perlu	12187,7671
s ≤	83,705735
	400
	250
dipakai tul pokok	D19-80
Kontrol	
As aktual	12752,325
a	66,6788235
Mn	954,693059
Mu/Ø	255,45
ok...	

PELAT TANGGA ATAS	
Mu	84,97
Mu/Ø	106,2125
dipakai tul. Ø(mm)	16
A1Ø	200,96
tebal pelat (mm)	200
selimut beton (mm)	20
d	172
m	18,824
b (mm)	2400
Rn	1,495916993
ρ min	0,0035
ρb	0,0271
ρ maks	0,020325
ρ aktual	0,003881601
As perlu	1602,325094
s ≤	301,0025878
	400
	250
dipakai tul pokok	D16-250
Kontrol	
As aktual	1929,216
a	15,13110588
Mn	126,8918265
Mu/Ø	106,2125
ok...	

PELAT TANGGA BAWAH	
Mu	33,2
Mu/Ø	41,5
dipakai tul. Ø(mm)	16
A1Ø	200,96
tebal pelat (mm)	150
selimut beton (mm)	20
d	122
m	18,824
b (mm)	2400
Rn	1,161762071
ρ min	0,0035
ρb	0,0271
ρ maks	0,020325
ρ aktual	0,002988463
As perlu	875,0219394
s ≤	551,1907511
	300
	250
dipakai tul pokok	D16-250
Kontrol	
As aktual	1929,216
a	15,13110588
Mn	88,30750649
Mu/Ø	41,5
ok...	

BALOK BORDES

TULANGAN TUMPUAN	
Mu	221.486
Mu/Ø	276.8575
dipakai tul. Ø(mm)	19
A1Ø	283.385
lebar balok (mm)	300
tinggi balok (mm)	600
selimut beton (mm)	20
d	570.5
ρ min	0.0035
ρb	0.0271
ρ maks	0.020325
ρ rencana	0.0101625
m	18.824
Rn	3.28736997
d perlu	529.838152
d pakai	529.838152
d ada > d perlu tulangan sebelah	
Rn baru	3.28736997
ρ baru	0.0101625
ρ baru > ρmin	
ρ pakai	0.0101625
As perlu	1615.34407
n (D19)	5.70017491
	6
kontrol	
As	1700.31
a	106.686118
Mn	324.075749
Mu/Ø	276.8575
ok	

TULANGAN LAPANGAN	
Mu	166.115
Mu/Ø	207.64375
dipakai tul. Ø(mm)	19
A1Ø	283 385
lebar balok (mm)	300
tinggi balok (mm)	600
selimut beton (mm)	20
d	570.5
ρ min	0.0035
ρb	0.0271
ρ maks	0.020325
ρ rencana	0.0101625
m	18.824
Rn	3.287369972
d	458.85399
d pakai	458.85399
d ada > d perlu tulangan sebelah	
Rn baru	3.287369972
ρ baru	0.0101625
ρ baru > ρmin	
ρ pakai	0.0101625
As perlu	1398.931102
n (D19)	4.936503704
	5
kontrol	
As	1416.925
a	88.90509804
Mn	234.8703047
Mu/Ø	207.64375
ok	

TULANGAN GESER	
qu	49,197
Vu	177109.2
dipakai tul. Ø(mm)	10
bt	240
bt+ d	698.85399
Vu(bt+d)	159918.4401
Vc	114.7134975
1/2ØVc	34.41404925
Vu>1/2ØVc perlu tulangan geser	
s≤	376.8
	229.426995
	600
dipakai tulangan geser	P10-220

BALOK INDUK TANGGA

TULANGAN TUMPUAN	
Mu	167.257
Mu/Ø	209.07125
dipakai tul. Ø(mm)	19
A1Ø	283.385
lebar balok (mm)	300
tinggi balok (mm)	600
selimut beton (mm)	20
d	570.5
ρ min	0.0035
ρb	0.0271
ρ maks	0.020325
ρ rencana	0.0101625
m	18.824
Rn	3.28736997
d perlu	460.428543
	460.428543
d ada > d perlu tulangan sebelah	
Rn baru	3.28736997
ρ baru	0.0101625
ρ baru > ρmin	
ρ pakai	0.0101625
As perlu	1403.73152
n (D19)	4.95344327
	5
kontrol	
As	1416.925
a	88.905098
Mn	235.762714
Mu/Ø	209.07125
ok	

TULANGAN LAPANGAN	
Mu	125.443
Mu/Ø	156.80375
dipakai tul. Ø(mm)	19
A1Ø	283.385
lebar balok (mm)	300
tinggi balok (mm)	600
selimut beton (mm)	20
d	570.5
ρ min	0.0035
ρb	0.0271
ρ maks	0.020325
ρ rencana	0.0101625
m	18.824
Rn	3.287369972
d	398.7432122
d pakai	398.7432122
d ada > d perlu tulangan sebelah	
Rn baru	3.287369972
ρ baru	0.0101625
ρ baru > ρmin	
ρ pakai	0.0101625
As perlu	1215.668368
n (D19)	4.289811981
	5
kontrol	
As	1416.925
a	88.90509804
Mn	200.8013192
Mu/Ø	156.80375
ok	

TULANGAN GESER	
qu	38.717
Vu	139.3812
dipakai tul. Ø(mm)	10
bt	240
bt+ d	638.7432122
Vu(bt÷d)	127.0160895
Vc	99.68580305
1/2ØVc	29.90574091
Vu>1/2ØVc perlu tulangan geser	
s≤	376.8
	199.3716061
	600
dipakai tulangan geser	P10-190

4.7 TABEL HASIL PERHITUNGAN

tabel 4.21 Hasil perhitungan pelat

TYPE	TULANGAN LAPANGAN		TULANGAN TUMPUAN		TULANGAN BAGI	
	ARAH X	ARAH Y	ARAH X	ARAH Y	ARAH X	ARAH Y
A (kantor)	P10-240	P10-240	P10-240	P10-240	P8-200	P8-200
A (perpustakaan)	P10-190	P10-190	P10-190	P10-190	P8-200	P8-200
A (atap)	P10-320	P10-320	P10-320	P10-320	P8-250	P8-250
B (pertemuan)	P10-240	P10-240	P10-240	P10-240	P8-200	P8-200

tabel 4.22 Hasil pehitungan balok anak

LT	TYPE	DIMENSI	TULANGAN TUMPUAN			TULANGAN LAPANGAN		
			As	As'	keterangan	As	As'	keterangan
1	I	30/60	5D22	2D22	sebelah	4D19	2D19	sebelah
2	II	30/60	6D22	2D13	rangkap	4D19	2D19	sebelah
3	III	30/60	6D22	2D13	rangkap	4D19	2D19	sebelah
4	1V	30/60	4D22	2D22	sebelah	4D19	2D19	sebelah
5	V	30/60	5D22	2D22	sebelah	4D19	2D19	sebelah
6	VI	25/45	2D16	2D16	sebelah	3D16	2D16	sebelah

tabel 4.23 Hasil perhitungan balok induk

TIPE	DIMENSI	TULANGAN TUMPUAN			TULANGAN LAPANGAN			TULANGAN GESER	
		As	As'	KETERANGAN	As	As'	KETERANGAN	SENDI PLASTIS	LUAR SENDI PLASTIS
B 1	400/650	6D22	2D22	sebelah	3D22	2D22	sebelah	2P10-100	P10-140
B 2	400/650	5D22	2D22	sebelah	4D22	2D22	sebelah	2P10-120	P10-240
B 3	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-120	P10-240
B 4	400/650	7D22	2D22	sebelah	6D22	2D22	sebelah	2P10-60	P10-70
B 5	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-80	P10-80
B 6	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-80	P10-80
B 7	400/650	7D22	2D22	sebelah	5D22	2D22	sebelah	2P10-60	P10-60
B 8	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-60	P10-80
B 9	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-60	P10-60
B 10	400/650	6D22	2D22	sebelah	6D22	2D22	sebelah	2P10-60	P10-60
B 11	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-100	P10-120
B 12	400/650	5D22	2D22	sebelah	4D22	2D22	sebelah	2P10-100	P10-140
B 13	400/650	6D22	2D22	sebelah	4D22	2D22	sebelah	2P10-100	P10-130
B 14	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-120	P10-160
B 15	400/650	7D22	2D22	sebelah	6D22	2D22	sebelah	2P10-100	P10-130
B 16	400/650	7D22	2D22	sebelah	5D22	2D22	sebelah	2P10-80	P10-80
B 17	400/650	6D22	2D22	sebelah	4D22	2D22	sebelah	2P10-80	P10-80
B 18	400/650	7D22	2D22	sebelah	5D22	2D22	sebelah	2P10-60	P10-70
B 19	400/650	7D22	2D22	sebelah	3D22	2D22	sebelah	2P10-80	P10-70
B 20	400/650	7D22	2D22	sebelah	5D22	2D22	sebelah	2P10-70	P10-60
B 21	400/650	8D22	2D22	sebelah	5D22	2D22	sebelah	2P10-70	P10-70
B 22	400/650	6D22	2D22	sebelah	4D22	2D22	sebelah	2P10-120	P10-70
B 23	400/650	5D22	2D22	sebelah	5D22	2D22	sebelah	2P10-100	P10-140
B 24	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-80	P10-95
B 25	400/650	5D22	2D22	sebelah	5D22	2D22	sebelah	2P10-80	P10-80
B 26	400/650	6D22	2D22	sebelah	4D22	2D22	sebelah	2P10-80	P10-80
B 27	400/650	6D22	2D22	sebelah	6D22	2D22	sebelah	2P10-70	P10-70
B 28	400/650	5D22	2D22	sebelah	4D22	2D22	sebelah	2P10-120	P10-200
B 29	400/650	8D22	2D22	sebelah	6D22	2D22	sebelah	2P10-70	P10-60
B 30	400/650	6D22	2D22	sebelah	5D22	2D22	sebelah	2P10-70	P10-70
B 31	400/650	5D22	2D22	sebelah	3D22	2D22	sebelah	2P10-70	P10-80

B 32	400/650	5D22	2D22	sebelah	3D22	2D22	sebelah	2P10-140	P10-280
B 33	400/650	4D22	2D22	sebelah	2D22	2D22	sebelah	2P10-160	P10-280
B 34	400/650	4D22	2D22	sebelah	3D22	2D22	sebelah	2P10-140	P10-280
B 35	300/1200	8D22	2D22	sebelah	5D22	2D22	sebelah	2P10-40	P10-80
B 36	400/650	9D22	3D22	rangkap	6D22	2D22	sebelah	2P10-60	2P10-100
B 37	400/650	8D22	2D22	sebelah	6D22	2D22	sebelah	2P10-60	2P10-100
B 38	400/650	8D22	3D22	rangkap	5D22	2D22	sebelah	2P10-60	P10-60
B 39	400/650	5D22	2D22	sebelah	4D22	2D22	sebelah	2P10-80	2P10-100
B 40	400/650	5D22	2D22	sebelah	3D22	2D22	sebelah	2P10-100	P10-110
B 41	400/650	5D22	2D22	sebelah	6D22	2D22	sebelah	2P10-100	2P10-120
B 42	400/650	5D22	2D22	sebelah	5D22	2D22	sebelah	2P10-100	2P10-140
B 43	400/650	6D22	2D22	sebelah	3D22	2D22	sebelah	2P10-60	2P10-100
B 44	300/550	3D22	2D22	sebelah	2D22	2D22	sebelah	P10-110	P10-280
B 45	300/550	3D22	2D22	sebelah	2D22	2D22	sebelah	P10-110	P10-280
B 46	300/550	3D22	2D22	sebelah	2D22	2D22	sebelah	P10-110	P10-280
B 47	300/550	3D22	2D22	sebelah	2D22	2D22	sebelah	P10-90	P10-230
B 48	300/550	2D22	2D22	sebelah	2D22	2D22	sebelah	P10-110	P10-230
B 49	300/550	5D22	2D22	sebelah	4D22	2D22	sebelah	2P10-120	P10-230
B 50	300/550	2D22	2D22	sebelah	2D22	2D22	sebelah	P10-100	P10-200
B 51	300/550	4D22	2D22	sebelah	3D22	2D22	sebelah	P10-100	P10-200
B 52	300/550	4D22	2D22	sebelah	3D22	2D22	sebelah	P10-80	P10-230

tabel 4.24 Hasil perhitungan kolom

TIPE	LANTAI	DIMENSI	TULANGAN POKOK	TULANGAN GESER	
				SENDI PLASTIS	LUAR SENDI PLASTIS
K1	lt 1	650/650	28D22	2P10-100	P10-270
	lt 2	650/650	20D22	2P10-140	P10-250
	lt 3	650/650	20D22	2P10-130	P10-195
	lt 4	650/650	20D22	2P10-140	P10-160
	lt 5	650/650	20D22	2P10-80	P10-100
	lt 6	650/650	20D22	2P10-100	P10-230
K2	lt 1	650/650	36D22	2P10-80	P10-200
	lt 2	650/650	40D22	2P10-120	P10-200
	lt 3	650/650	28D22	2P10-120	P10-160
	lt 4	650/650	28D22	2P10-100	P10-100
	lt 5	650/650	20D22	2P10-70	P10-90
	lt 6	650/650	40D22	2P10-95	P10-200
K3	lt 1	350/350	16D22	2P10-140	P10-145
	lt 2	350/350	24D22	2P10-140	P10-145
	lt 3	350/350	28D22	2P10-140	P10-145
	lt 4	350/350	24D22	2P10-140	P10-145
	lt 5	350/350	16D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145
K4	lt 1	350/350	24D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	28D22	2P10-140	P10-145
	lt 4	350/350	24D22	2P10-140	P10-145
	lt 5	350/350	24D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145
K5	lt 1	350/350	20D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	24D22	2P10-140	P10-145
	lt 4	350/350	20D22	2P10-140	P10-145
	lt 5	350/350	20D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145
K6	lt 1	350/350	24D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	28D22	2P10-140	P10-145
	lt 4	350/350	24D22	2P10-140	P10-145
	lt 5	350/350	16D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145
K7	lt 1	350/350	16D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	28D22	2P10-140	P10-145
	lt 4	350/350	24D22	2P10-140	P10-145
	lt 5	350/350	20D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145

K8	lt 1	650/650	32D22	2P10-140	P10-145
	lt 2	650/650	40D22	2P10-120	P10-200
	lt 3	650/650	24D22	2P10-120	P10-180
	lt 4	650/650	24D22	2P10-130	P10-200
	lt 5	650/650	24D22	2P10-100	P10-100
	lt 6	650/650	24D22	2P10-90	P10-90
K9	lt 1	650/650	24D22	2P10-90	P10-100
	lt 2	650/650	20D22	2P10-140	P10-280
	lt 3	650/650	20D22	2P10-130	P10-195
	lt 4	650/650	20D22	2P10-140	P10-200
	lt 5	650/650	20D22	2P10-170	P10-170
	lt 6	650/650	20D22	2P10-115	P10-230
K10	lt 1	650/650	32D22	2P10-140	P10-280
	lt 2	650/650	28D22	2P10-100	P10-155
	lt 3	650/650	20D22	2P10-100	P10-270
	lt 4	650/650	20D22	2P10-110	P10-280
	lt 5	650/650	36D22	2P10-120	P10-280
	lt 6	650/650	36D22	2P10-95	P10-95
K11	lt 1	650/650	32D22	2P10-140	P10-145
	lt 2	650/650	40D22	2P10-120	P10-200
	lt 3	650/650	24D22	2P10-120	P10-180
	lt 4	650/650	24D22	2P10-130	P10-200
	lt 5				
	lt 6				
K12	lt 1	650/650	40D22	2P10-100	P10-220
	lt 2	650/650	32D22	2P10-90	P10-170
	lt 3	650/650	20D22	2P10-90	P10-250
	lt 4	650/650	20D22	2P10-100	P10-260
	lt 5	650/650	40D22	2P10-90	P10-220
	lt 6				
K13	lt 1	650/650	36D25	2P10-100	P10-220
	lt 2	650/650	32D22	2P10-95	P10-165
	lt 3	650/650	20D22	2P10-90	P10-250
	lt 4	650/650	20D22	2P10-100	P10-260
	lt 5	650/650	28D22	2P10-125	P10-280
	lt 6				
K14	lt 1	650/650	36D22	2P10-100	P10-220
	lt 2	650/650	32D22	2P10-90	P10-165
	lt 3	650/650	20D22	2P10-90	P10-250
	lt 4	650/650	20D22	2P10-100	P10-270
	lt 5	650/650	28D22	2P10-125	P10-280
	lt 6				
K15	lt 1	650/650	28D22	2P10-140	P10-280
	lt 2	650/650	32D22	2P10-100	P10-150
	lt 3	650/650	20D22	2P10-100	P10-280
	lt 4	650/650	20D22	2P10-120	P10-280
	lt 5	650/650	28D22	2P10-95	P10-95

	lt 6	650/650	20D22	2P10-110	P10-110
	lt 2	650/650	28D22	2P10-100	P10-160
	lt 3	650/650	20D22	2P10-100	P10-270
	lt 4	650/650	20D22	2P10-110	P10-280
	lt 5	650/650	32D22	2P10-125	P10-280
	lt 6	650/650	44D22	2P10-95	P10-95
K17	lt 1	650/650	32D22	2P10-130	P10-280
	lt 2	650/650	24D22	2P10-100	P10-165
	lt 3	650/650	20D22	2P10-95	P10-270
	lt 4	650/650	32D22	2P10-110	P10-280
	lt 5				
	lt 6				
K18	lt 1	650/650	36D22	2P10-110	P10-220
	lt 2	650/650	32D22	2P10-95	P10-170
	lt 3	650/650	20D22	2P10-95	P10-245
	lt 4	650/650	20D22	2P10-85	P10-270
	lt 5	650/650	36D22	2P10-100	P10-245
	lt 6				
K19	lt 1	650/650	44D22	2P10-120	P10-220
	lt 2	650/650	28D22	2P10-90	P10-170
	lt 3	650/650	20D22	2P10-95	P10-245
	lt 4	650/650	20D22	2P10-85	P10-270
	lt 5	650/650	20D22	2P10-140	P10-250
	lt 6				
K20	lt 1	650/650	44D22	2P10-120	P10-220
	lt 2	650/650	28D22	2P10-95	P10-170
	lt 3	650/650	20D22	2P10-95	P10-245
	lt 4	650/650	20D22	2P10-85	P10-260
	lt 5	650/650	20D22	2P10-140	P10-250
	lt 6				
K21	lt 1	650/650	28D22	2P10-140	P10-280
	lt 2	650/650	28D22	2P10-100	P10-155
	lt 3	650/650	20D22	2P10-100	P10-280
	lt 4	650/650	20D22	2P10-120	P10-280
	lt 5	650/650	24D22	2P10-140	P10-140
	lt 6	650/650	20D22	2P10-110	P10-110
K22	lt 1	650/650	28D22	2P10-140	P10-280
	lt 2	650/650	28D22	2P10-110	P10-160
	lt 3	650/650	20D22	2P10-100	P10-270
	lt 4	650/650	20D22	2P10-115	P10-280
	lt 5	650/650	20D22	2P10-140	P10-270
	lt 6	650/650	20D22	2P10-100	P10-100
K23	lt 1	650/650	36D22	2P10-80	P10-200
	lt 2	650/650	40D22	2P10-120	P10-200
	lt 3	650/650	28D22	2P10-120	P10-160

	lt 4	650/650	28D22	2P10-100	P10-100
	lt 5	650/650	20D22	2P10-70	P10-90
	lt 6	650/650	40D22	2P10-95	P10-200
K24	lt 1	650/650	40D22	2P10-110	P10-220
	lt 2	650/650	28D22	2P10-95	P10-170
	lt 3	650/650	20D22	2P10-95	P10-245
	lt 4	650/650	20D22	2P10-100	P10-270
	lt 5	650/650	20D22	2P10-130	P10-240
	lt 6	650/650	20D22	2P10-110	P10-110
K25	lt 1	650/650	44D22	2P10-110	P10-250
	lt 2	650/650	28D22	2P10-95	P10-170
	lt 3	650/650	20D22	2P10-95	P10-245
	lt 4	650/650	20D22	2P10-100	P10-270
	lt 5	650/650	20D22	2P10-130	P10-240
	lt 6	650/650	20D22	2P10-110	P10-110
K26	lt 1	650/650	44D22	2P10-120	P10-280
	lt 2	650/650	32D22	2P10-95	P10-175
	lt 3	650/650	20D22	2P10-90	P10-250
	lt 4	650/650	20D22	2P10-100	P10-265
	lt 5	650/650	20D22	2P10-130	P10-240
	lt 6	650/650	20D22	2P10-110	P10-110
K27	lt 1	650/650	28D22	2P10-140	P10-280
	lt 2	650/650	28D22	2P10-100	P10-155
	lt 3	650/650	20D22	2P10-100	P10-275
	lt 4	650/650	20D22	2P10-110	P10-280
	lt 5	650/650	20D22	2P10-140	P10-270
	lt 6	650/650	20D22	2P10-100	P10-100
K28	lt 1	650/650	32D22	2P10-140	P10-280
	lt 2	650/650	28D22	2P10-100	P10-155
	lt 3	650/650	20D22	2P10-100	P10-260
	lt 4	650/650	20D22	2P10-110	P10-280
	lt 5	650/650	20D22	2P10-140	P10-255
	lt 6	650/650	24D22	2P10-100	P10-100
K29	lt 1	650/650	40D22	2P10-110	P10-200
	lt 2	650/650	36D22	2P10-95	P10-160
	lt 3	650/650	20D22	2P10-90	P10-250
	lt 4	650/650	20D22	2P10-100	P10-265
	lt 5	650/650	20D22	2P10-130	P10-220
	lt 6	650/650	20D22	2P10-100	P10-100
K30	lt 1	650/650	36D22	2P10-120	P10-230
	lt 2	650/650	32D22	2P10-95	P10-160
	lt 3	650/650	20D22	2P10-90	P10-245
	lt 4	650/650	20D22	2P10-100	P10-270
	lt 5	650/650	20D22	2P10-140	P10-245
	lt 6				
K31	lt 1	650/650	36D25	2P10-120	P10-220

	lt 2	650/650	32D22	2P10-95	P10-160
	lt 3	650/650	20D22	2P10-90	P10-245
	lt 4	650/650	20D22	2P10-100	P10-270
	lt 5	650/650	20D22	2P10-140	P10-250
	lt 6				
K32	lt 1	650/650	36D25	2P10-110	P10-200
	lt 2	650/650	32D22	2P10-95	P10-160
	lt 3	650/650	20D22	2P10-95	P10-250
	lt 4	650/650	20D22	2P10-100	P10-265
	lt 5	650/650	20D22	2P10-130	P10-220
	lt 6	650/650	20D22	2P10-100	P10-100
K33	lt 1	650/650	32D22	2P10-140	P10-280
	lt 2	650/650	28D22	2P10-100	P10-150
	lt 3	650/650	20D22	2P10-100	P10-270
	lt 4	650/650	20D22	2P10-140	P10-280
	lt 5	650/650	20D22	2P10-140	P10-260
	lt 6	650/650	20D22	2P10-100	P10-100
K34	lt 1	650/650	24D22	2P10-100	P10-270
	lt 2	650/650	20D22	2P10-140	P10-250
	lt 3	650/650	20D22	2P10-130	P10-195
	lt 4	650/650	20D22	2P10-140	P10-160
	lt 5	650/650	20D22	2P10-80	P10-100
	lt 6	650/650	20D22	2P10-100	P10-230
K35	lt 1	650/650	36D22	2P10-80	P10-200
	lt 2	650/650	40D22	2P10-120	P10-200
	lt 3	650/650	24D22	2P10-120	P10-160
	lt 4	650/650	20D22	2P10-100	P10-100
	lt 5	650/650	20D22	2P10-70	P10-90
	lt 6	650/650	40D22	2P10-95	P10-200
K36	lt 1	350/350	16D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	28D22	2P10-140	P10-145
	lt 4	350/350	24D22	2P10-140	P10-145
	lt 5	350/350	16D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145
K37	lt 1	350/350	20D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	28D22	2P10-140	P10-145
	lt 4	350/350	20D22	2P10-140	P10-145
	lt 5	350/350	16D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145
K38	lt 1	350/350	16D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	24D22	2P10-140	P10-145
	lt 4	350/350	20D22	2P10-140	P10-145
	lt 5	350/350	16D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145

K39	lt 1	350/350	20D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	28D22	2P10-140	P10-145
	lt 4	350/350	20D22	2P10-140	P10-145
	lt 5	350/350	16D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145
K40	lt 1	350/350	16D22	2P10-140	P10-145
	lt 2	350/350	28D22	2P10-140	P10-145
	lt 3	350/350	28D22	2P10-140	P10-145
	lt 4	350/350	24D22	2P10-140	P10-145
	lt 5	350/350	16D22	2P10-140	P10-145
	lt 6	350/350	12D22	2P10-140	P10-145
K41	lt 1	650/650	32D22	2P10-140	P10-145
	lt 2	650/650	40D22	2P10-120	P10-200
	lt 3	650/650	24D22	2P10-120	P10-180
	lt 4	650/650	20D22	2P10-130	P10-200
	lt 5	650/650	24D22	2P10-100	P10-100
	lt 6	650/650	20D22	2P10-90	P10-90
K42	lt 1	650/650	24D22	2P10-90	P10-100
	lt 2	650/650	20D22	2P10-140	P10-280
	lt 3	650/650	20D22	2P10-130	P10-195
	lt 4	650/650	20D22	2P10-140	P10-200
	lt 5	650/650	20D22	2P10-170	P10-170
	lt 6	650/650	20D22	2P10-115	P10-230

tabel 4.25 Hasil perhitungan pondasi

TIPE	DIMENSI	KEDALAMAN	TULANGAN POKOK		TULANGAN SUSUT	
			ARAH X	ARAH Y	ARAH X	ARAH Y
P1	430/430	3,5 m	D22-210	D22-190	P12-80	P12-80
P2	440/440	3,8 m	D22-125	D22-125	P12-85	P12-85
P3	540/540	2,8 m	D22-100	D22-100	P12-85	P12-85
P4	1700/300	4,5m	D22-300	D22-300	P12-160	P12-160
P5	430/430	3,5 m	D22-145	D22-145	P12-85	P12-85

tabel 4.26 Hasil perhitungan tangga

TYPE	PELAT		BALOK BORDES			BALOK INDUK		
(tinggi m)	BORDES	TANGGA	TUMPUAN	LAPANGAN	GESER	TUMPUAN	LAPANGAN	GESER
3,6	D19-80	D19-160	6D19	5D19	P10-220	5D19	5D19	P10-190
4	D19-80	D19-160	6D19	5D19	P10-220	5D19	5D19	P10-190
5	D19-80	D19-160	6D19	5D19	P10-220	5D19	5D19	P10-190
6	D19-80	D19-160	6D19	5D19	P10-220	5D19	5D19	P10-190

tabel 4.27 tabel komparasi penulangan
di lapangan dengan hasil perencanaan

(diambil untuk rencana balok dan kolom lantai 3)

	LAPANGAN	PERENCANAAN
BALOK ANAK		
1 Dimensi	250/600	300/600
2 Tulangan pokok		
* tumpuan	4D22	5D22
* lapangan	2D22	4D22
3 Tulangan geser		
* tumpuan	P10-100	P8-100
* lapangan	P10-120	P8-100
BALOK INDUK		
1 Dimensi	450/700	400/650
2 Tulangan pokok		
* tumpuan	7D22	6D22
* lapangan	4D22	5D22
3 Tulangan geser		
* tumpuan	2P12-75	2P10-60
* lapangan	P12-120	P10-60
KOLOM		
1 Dimensi	700/700	650/650
2 Tulangan pokok	24D25	20D22
3 Tulangan geser		
* tumpuan	2P10-100	2P10-130
* lapangan	P10-100	P10-195

BAB V

PEMBAHASAN

5.1 Umum

Pada perencanaan gedung bertingkat secara umum dapat direncanakan dalam sistem struktur yang meliputi 3 langkah utama yaitu : a. analisis struktur

b. perencanaan struktur

c. gambar kerja.

Perhitungan analisis struktur pada Tugas Akhir ini menggunakan program SAP 2000, sehingga akan dihasilkan momen – momen yang nantinya akan digunakan pada tahap perencanaan struktur. Hasil yang diperoleh pada perencanaan struktur kemudian akan divisualisasikan pada gambar kerja.

Spesifikasi bahan yang digunakan dalam perencanaan pada Tugas Akhir ini, untuk beton dipakai f'c = 25 MPa dan untuk baja tulangan dengan diameter kurang dari atau sama dengan 12 mm dapakai mutu baja fy = 240 MPa dan untuk diameter lebih dari 12 mm dipakai mutu baja fy = 400 MPa.

Dalam bab ini akan dibahas mengenai hasil – hasil yang telah diperoleh dari perhitungan untuk masing – masing bagian struktur yang telah direncanakan.

5.2 Atap

Atap pada gedung ini menggunakan rangka baja sebagai kuda - kuda atap. Perhitungan mengacu pada metode *allowable stress design* dasi AISC, dimana elemen struktural harus direncanakan sedemikian rupa agar tegangan yang dihiung akibat beban kerja tidak melampaui tegangan ijin yang telah ditetapkan.

Pada perencanaan atap gedung ini digunakan program SAP 90 dan kemudian hasilnya dicek menggunakan SAPSTL. Macam atau tipe kuda – kuda yang digunakan pada gedung ini antara lain :

1. Kuda –kuda 1
   - Bentang 21,6 m
   - Batang luar digunaka profil baja 2L 70 X 70 X 7
   - Batang dalam digunakan profil baja 2L 60 X 60 X 6
2. Kuda –kuda 2
   - Bentang 21,6 m
   - Batang luar digunaka profil baja 2L 70 X 70 X 7
   - Batang dalam digunakan profil baja 2L 60 X 60 X 6
3. Kuda –kuda 3
   - Bentang 21,6 m
   - Batang luar digunaka profil baja 2L 75 X 75 X 7
   - Batang dalam digunakan profil baja 2L 60 X 60 X 6
4. Kuda –kuda 3'
   - Bentang 14,4 m

- Batang luar digunaka profil baja 2L 50 X 50 X 5
- Batang dalam digunakan profil baja 2L 50 X 50 X 5

5. Kuda –kuda 4

- Bentang 7,2 m
- Batang luar digunaka profil baja 2L 50 X 50 X 5
- Batang dalam digunakan profil baja 2L 50 X 50 X 5

6. Kuda –kuda jurai

- Bentang 15,27 m
- Batang luar digunaka profil baja 2L 70 X 70 X 7
- Batang dalam digunakan profil baja 2L 60 X 60 X 6

5.3 Pelat

Pelat pada gedung ini terdiri dari pelat atap dan pelat lantai. Penentuan tipe pelat berdasarkan perbandingan sisi – sisinya dan dukungan pelat. Perencanaan mengacu pada PBI'71 tabel 13.3.2 sedangkan untuk penentuan tebal pelat berdasarkan panjang bentang sesuai dengan rumus pada SK SNI T-15-1991-03.

Pelat Atap

- Terdapat 1 macam tipe pelat yakni pelat 2 arah
- Tebal pelat: 100 mm
- Tulangan yang digunakan : - tulangan pokok : Ø 10 mm
  - tulangan bagi : Ø 8 mm

Pelat Lantai

- Terdapat 2 macam tipe pelat yakni pelat 1 arah dan pelat 2 arah

- Tebal pelat: 120 mm
- Tulangan yang digunakan : - tulangan pokok : Ø 10 mm
  - tulangan bagi : Ø 8 mm

5.4 Balok Anak

Balok anak pada gedung ini direncanakan secara grid dan perhitungannya dilakukan bersamaan dengan analisis portal. Untuk kemudahan, perencanaan balok anak dilakukan untuk setiap lantai sehingga terdapat 6 tipe balok anak .

Balok Anak lantai

- Dimensi 30/60
- Tulangan yang digunakan : - tulangan tumpuan : Ø 22 mm
  - tulangan lapangan : Ø 19 mm

Balok Anak atap

- Dimensi 25/45
- Tulangan yang digunakan : - tulangan tumpuan : Ø 16 mm
  - tulangan lapangan : Ø 16 mm

5.5 Balok Induk

Balok induk merupakan struktur portal sehingga direncanakan berdasarkan hasil analisis portal . Pada perhitungan balok induk dilakukan redistribusi momem, hal ini dimaksudkan untuk mengurangi besarnya momen maksimum tumpuan dan mengalihkannya ke lapangan sehingga didapatkan distribusi kekuatan lentur yang lebih rata.

Pada akhirnya perhitungan penulangan didapatkan sebagian besar menggunakan tulangan sebelah. Penulangan rangkap terjadi pada balok dengan bentang 14,4 m.

Tulangan pokok yang digunakan adalah Ø 22 mm sedangkan tulangan geser menggunakan Ø 10 mm .

5.6 Kolom

Kolom merupakan struktur portal sehingga direncanakan berdasarkan hasil analisis portal. Lebar kolom disesuaikan dengan lebar balok, hal ini dimaksudkan untuk mempermudah penulangan dilapangan. Terdapat 2 macam tipe kolom yakni kolom dengan penampang 650 x 650 mm dan kolom dengan penampang 350 x 350 mm. Tulangan pokok yang digunakan adalah Ø 22 mm dan tulangan geser Ø 10 mm.

5.7 Pondasi

Pondasi yang digunakan pada gedung ini adalah pondasi telapak (*foot plate*) karena dari data tanah menunjukkan kondisi tanah yang cukup baik untuk perletakan dasar pondasi pada kedalaman sekitar 3,5 - 4 m dibawah muka tanah. Tulangan pokok yang digunakan adalah Ø 22 mm sedangkan tulangan susut Ø 12 mm.

5.8 Tangga

Tangga merupakan bangunan non-struktur yang berfungsi sebagai sarana penghubung antar lantai pada gedung bertingkat. Pada perencanaan gedung ini terdapat 4 macam tangga berdasar tinggi elevasi, yaitu: 3,6 m, 4 m, 5 m, dan 6 m. Tulangan pokok yang digunakan adalah Ø 16 mm dan tulangan geser Ø 10 mm.

BAB VI

KESIMPULAN DAN SARAN

6.1 Kesimpulan

Berdasarkan hasil perhitungan dan pembahasan pada bab – bab sebelumnya dapat diambil kesimpulan sebagai berikut :

1. Objek perhitungan dan perencanaan dalan Tugas Akhir ini adalh Gedung Administrasi Universitas Sanata Dharma Yogyakarta yang direncanakan dengan program SAP 2000 dengan memperhitungkan beban sendiri, beban kerja dan beban gempa.
2. Struktur bangunan gedung dibagi menjadi dua yaitu struktur atas (*upper structure*) yang merupakan elemen bangunan yang berada diatas permukaan tanah dan struktur bawah (*sub structure*) yang terletak di bawah permukaan tanah.
3. Perhitungan konstruksi meliputi :
    - Perencanaan atap menggunakan *Allowable stress design* dari AISC.

- Perencanaan pelat menggunakan metode koefisien momen dengan menganggap tumpuan tepi jepit elastis sehingga didapat koefisien momen dari PBI'71 tabel 13.3.2
- Perencanaan balok anak menggunakan sistem grid dan perencanaannya dilakukan bersamaan dengan analisis portal.
- Perencanaan portal meliputi kolom dan balok dirancang dengan daktalitas penuh berdasarkan SK – SNI – T-15-1991-03.

6.2 Saran

Dengan mempertimbangkan hal – hal tersebut di atas, maka dapat diberikab beberapa saran antara lain :

1. Perlu adanya perhitungan re-desain untuk Tugas Akhir ini dengan spesifikasi bahan yang berbeda
2. Perlu adanya perhitungan Rencana Anggaran Biaya (RAB) untuk mengetahui jumlah biaya yang dibutuhkan dalam pembangunan gedung.

DAFTAR PUSTAKA

1. _____ ,1983, ***PERATURAN PEMBEBANAN INDONESIA UNTUK GEDUNG 1983,*** *Departemen Pekerjaan Umum, Bandung*

2. _____ , 1987, ***PEDOMAN PERENCANAAN KETAHANAN GEMPA UNTUK RUMAH DAN GEDUNG SKBI-1.3.53. 1987,*** Departemen Pekerjaan Umum, Bandung

3. _____ , 1979, ***PERATURAN BETON BERTULANG INDONESIA 1971 N.I.-2***, Departemen Pekerjaan Umum, Bandung

4. _____ , 1991, ***TATA CARA PERHITUNGAN STRUKTUR BETONUNTUK BANGUNAN GEDUNG SK SNI T-15-1991-03***, Departemen Pekerjaan Umum, Bandung

5. Istimawan Dipohusodo, 1994, ***STRUKTUR BETON BERTULANG***, Gramedia Pustaka Utama, Jakarta

6. Fakturrahman. NS, Ir. MT, ***DIKTAT KULIAH STRUKTUR BETON***

7. Ilman Noor, Ir. MSCE, ***CATATAN KULIAH STRUKTUR BETON 1-2***

8. A. Kadir Aboe, Ir. MS, ***DIKTAT KULIAH STRUKTUR BETON -1***

9. Sudarmoko, Ir. M.Sc, 1995-1996, ***PERANCANGAN DAN ANALISIS KOLOM BETON BERTULANG***, Universitas Gajah Mada

10. Ign. Benny Puspantoro, Ir. M.Sc, 1993, ***TEORI DAN ANALISIS BALOK GRID,*** Andi Offset, Yogyakarta

11. Gideon Kusuma, Takim Adriono, 1993, ***DESAIN STRUKTUR RANGKA BETON BERTULANG DI DAERAH RAWAN GEMPA,*** Erlangga, Jakarta

12. W. C. Vis, Gideon Kusuma, 1997, ***DASAR-DASAR PERENCANAANBETON BERTULANG,*** Erlangga, Jakarta

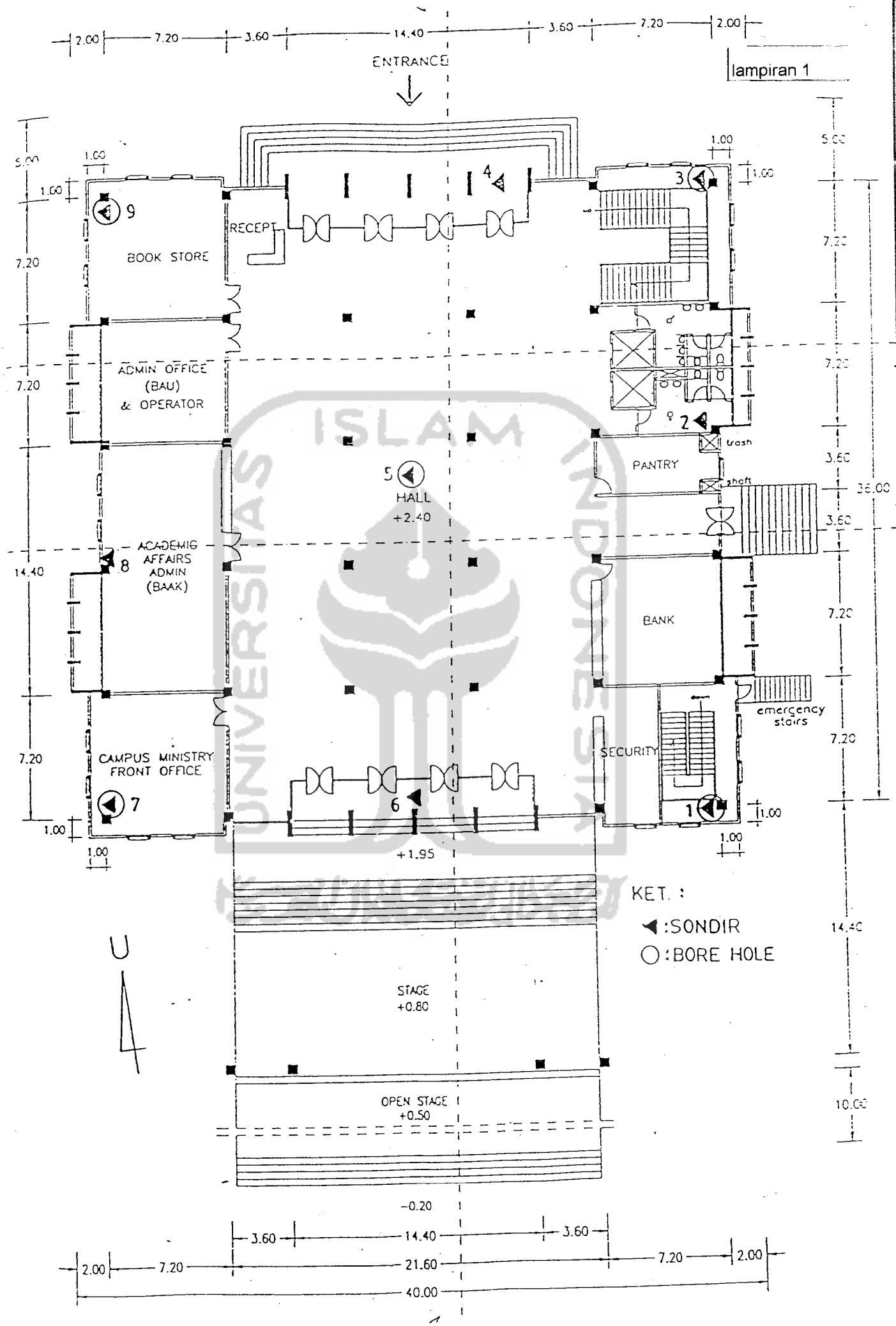
13. Edward. G. Nawi, 1998, ***BETON BERTULANG***, Refika Aditama, Bandung

14. Chu-Kia Wang, Charles G. Salmon, 1989, ***DISAIN BETON BERTULANG,*** Edisi Keempat, Jilid 2, Erlangga, Jakarta

15. Chu-Kia Wang, Charles G. Salmon, 1993, ***DISAIN BETON BERTULANG,*** Edisi Keempat Jilid 1, Erlangga, Jakarta

LAMPIRAN 1

lampiran 1


ENTRANCE
RECEPT
BOOK STORE
ADMIN OFFICE (BAU) & OPERATOR
HALL +2.40
ACADEMIC AFFAIRS ADMIN (BAAK)
CAMPUS MINISTRY FRONT OFFICE
PANTRY
BANK
SECURITY
trash
shaft
emergency stairs
+1.95
STAGE +0.80
OPEN STAGE +0.50
-0.20
KET. :
:SONDIR
:BORE HOLE
U
2.00
7.20
3.60
14.40
21.60
40.00
5.00
1.00
7.20
14.40
36.00
10.00

SOIL MECHANICS LABORATORY - CIVIL ENGINEERING DEPARTMENT - GADJAH MADA UNIVERSITY - YOGYAKARTA

SUMMARY OF LABORATORY TEST RESULTS

Project : Universitas Sanata Dharma
Location : Maguwoharjo, Depok - Sleman

Made by : gig
Checked by : ada

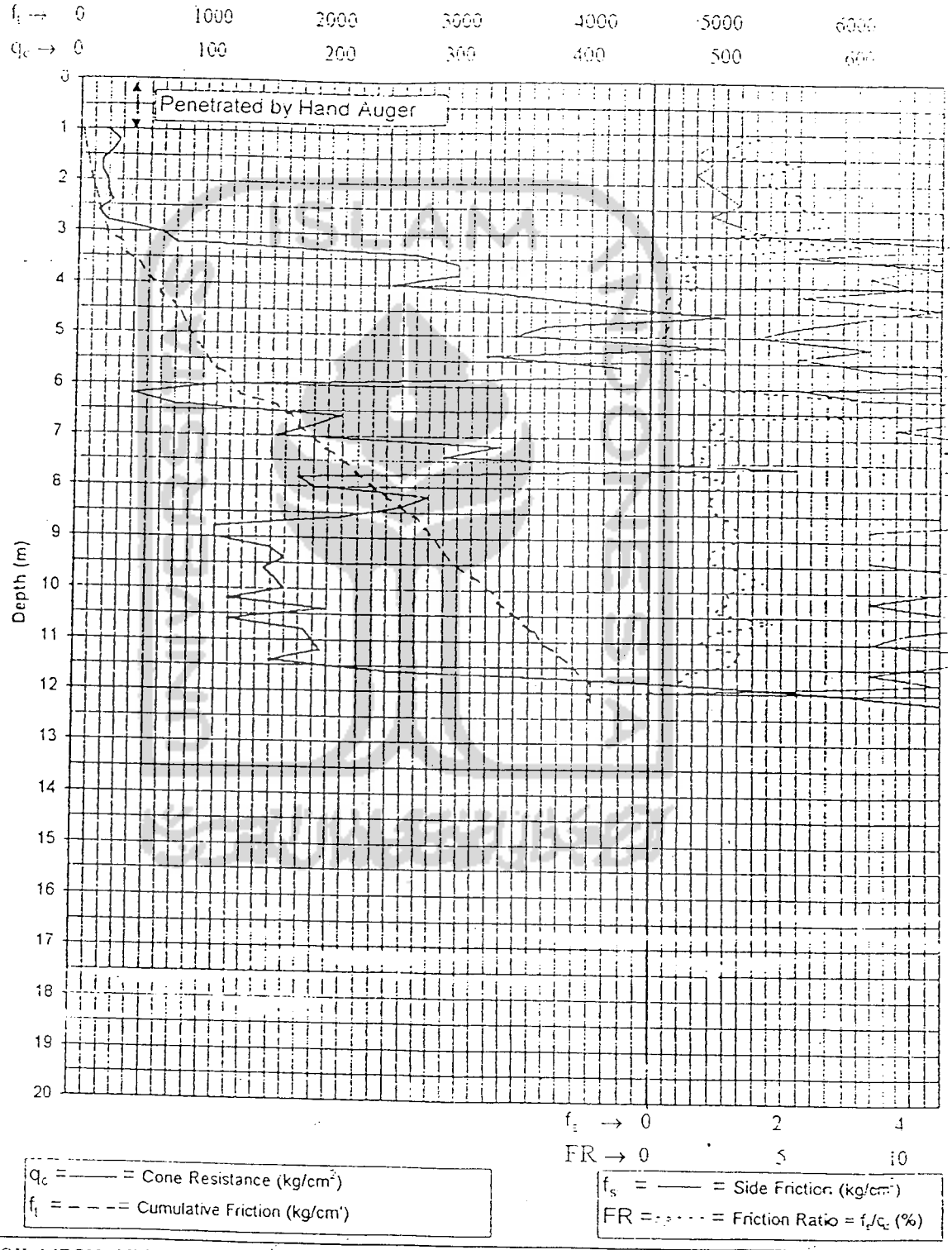
Test Point No	Depth m	Bulk density*, ρ_b g/cm^3	Dry density*, ρ_d g/cm^3	Moisture content w_N, %	Specific Gravity G_s	Liquid Limit LL, %	Plastic Limit PL, %	Plasticity Index PI, %	Liquidity Index LI	Shrinkage Limit SL, %	Void Ratio e	Degree of Saturation S_r, %	Finer # 200 %	Coef. of Gradation Cc	Coef. of Gradation Cu	Symbol	Strength Parameters* φ (°)	Strength Parameters* c kg/cm^2
BH-1 (SB-1)	1.10 - 2.10	1.61	1.28	25.37	2.67	non plastic					1.08	62.77	49.42	-	-	SM	36.50	0.00
BH-1 (SB-1)	3.60 - 4.00	1.95	1.69	15.67	2.82	non plastic					0.67	65.68	14.27	-	-	SM	35.75	0.00
BH-2 (SB-3)	3.00 - 4.00	1.81	1.62	11.65	2.76	non plastic					0.70	45.77	14.79	-	-	SM	39.01	0.00
BH-2 (SB-3)	6.50 - 7.00	1.81	1.52	19.10	2.63	non plastic					0.73	68.76	33.12	-	-	SM	37.60	0.00
BH-3 (SB-5)	1.50 - 2.00	2.06	1.86	10.58	2.79	non plastic					0.50	59.31	14.82	-	-	SM	34.22	0.00
BH-3 (SB-5)	7.50 - 8.00	1.69	1.22	37.98	2.59	50.33	36.57	10.76	-0.15	38.07	1.11	88.23	71.93	-	-	MH/OH	37.60	0.00
BH-4 (SB-7)	6.00 - 7.00	2.14	1.90	12.51	2.84	non plastic					0.49	72.05	12.82	-	-	SM	38.66	0.00
BH-4 (SB-7)	9.00 - 10.00	2.09	1.88	11.07	2.83	non plastic					0.50	62.16	8.56	1.23	7.30	SW/SM	36.87	0.00
BH-5 (SB-9)	3.70 - 4.00	2.06	1.84	12.19	2.70	non plastic					0.47	69.96	19.44	-	-	SM	35.37	0.00
BH-5 (SB-9)	6.20 - 7.00	2.06	1.64	25.74	2.71	non plastic					0.65	106.63	58.22	-	-	ML	35.37	0.00

NOTE : * = direct shear test

ka ~ terbesar
φ ~ terkecil

CONE PENETRATION TEST (10 TON)

Project	: Universitas Sanata Dharma	Weather	: Sunny
Location	: Maguwoharjo, Depok - Sleman	Date	: 22 May 2009
Test no	: SB-1	Tested by	: Ks
Elevation	: + 100.67 m		

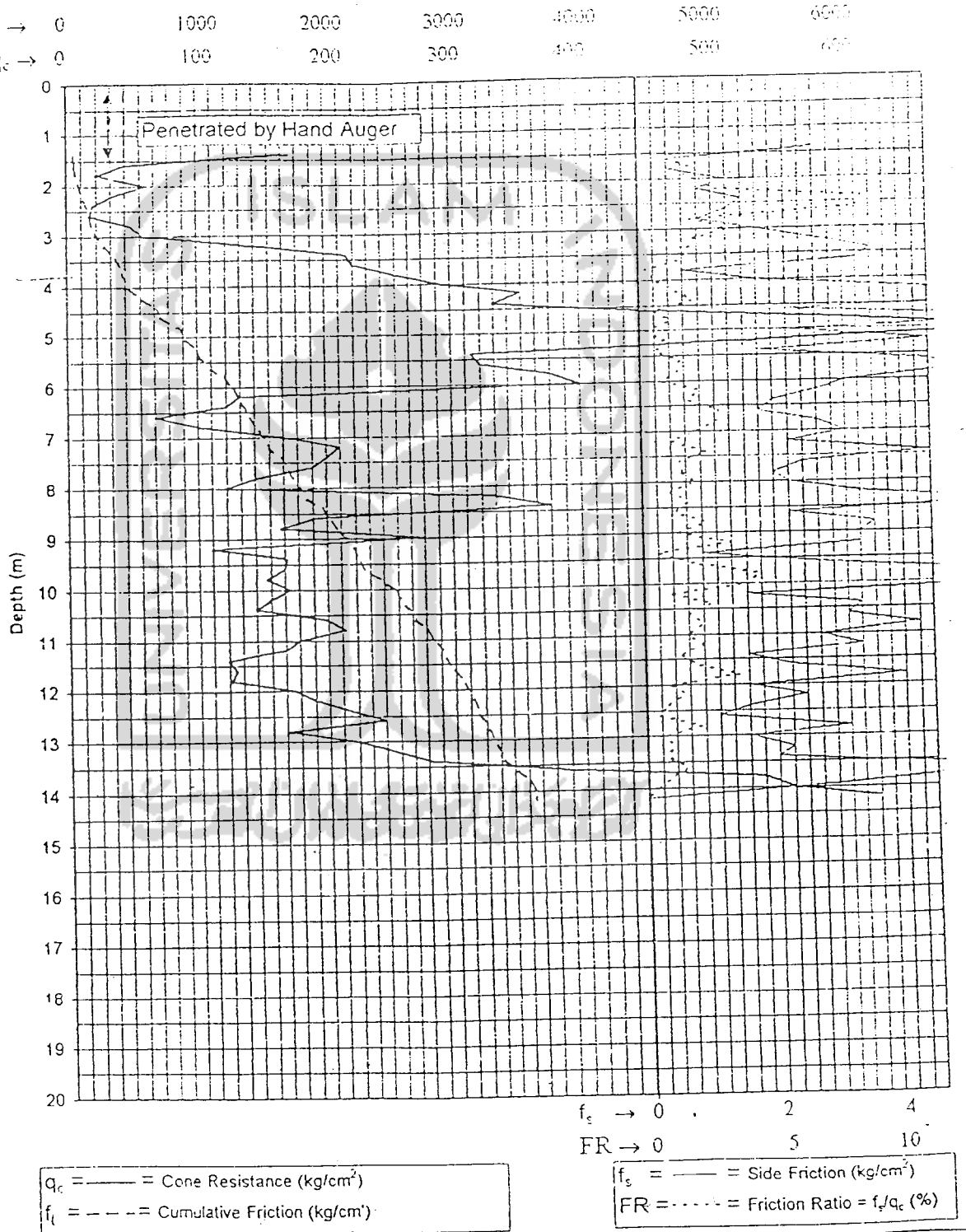


SOIL MECHANICS LABORATORY - CIVIL ENGINEERING DEPT. - GADJAH MADA UNIVERSITY

CONE PENETRATION TEST (10 TON)

Project : Universitas Sanata Dharma
Location : Maguwoharjo, Depok - Sleman
Test no. : SB-2
Elevation : + 100.67 m

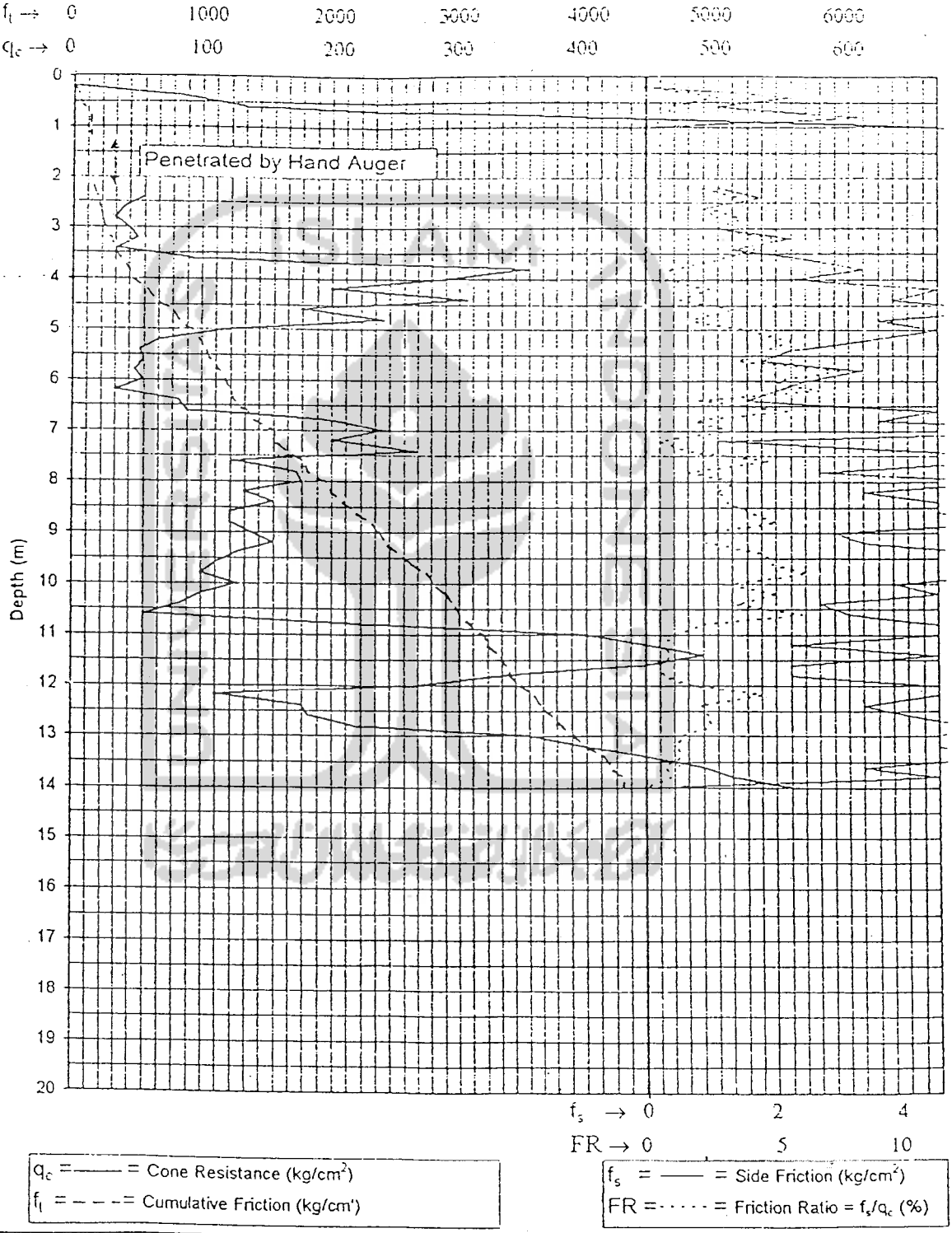
Weather : Sunny
Date : 3 June 2006
Tested by : Es



SOIL MECHANICS LABORATORY - CIVIL ENGINEERING DEPT. - GADJAH MADA UNIVERSITY

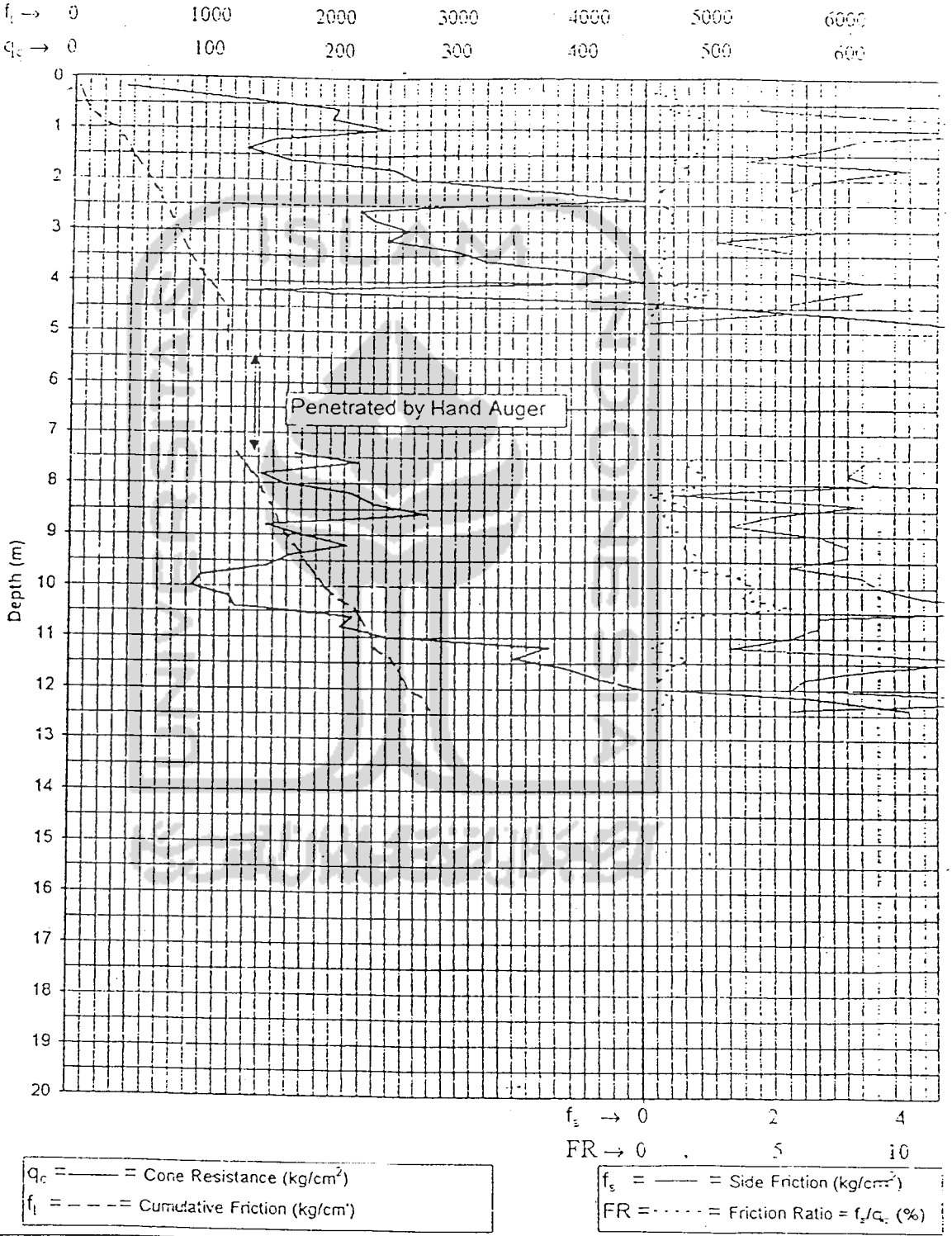
CONE PENETRATION TEST (10 TON)

Project	: Universitas Sanata Dharma	Weather	: Sunny
Location	: Maguwoharjo, Depok - Sleman	Date	: 23 May 2000
Test no.	: SD-3	Tested by	: Ks
Elevation	: + 101.03 m		



CONE PENETRATION TEST (10 TON)

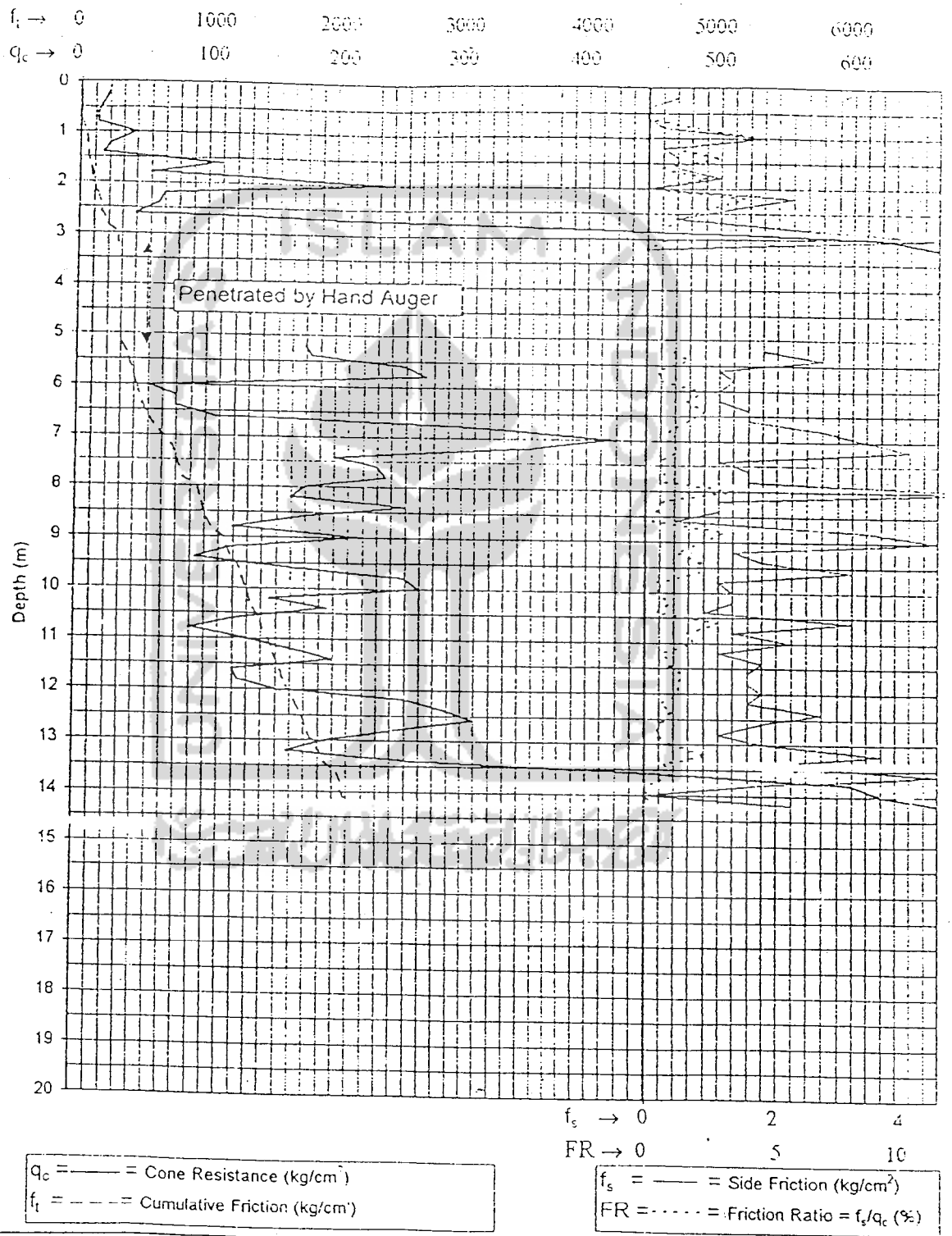
Project	: Universitas Sanata Dharma	Weather	: Sunny
Location	: Maguwoharjo, Depok - Sleman	Date	: 29 May 2000
Test no.	: SB-4	Tested by	: Ks
Elevation	: + 101.02 m		



CONE PENETRATION TEST (10 TON)

Project : Universitas Sanata Dharma
Location : Maguwoharjo, Depok - Sleman
Test no. : SB-5
Elevation : + 100.87 m

Weather : Sunny
Date : 31 May 2000
Tested by : Ks

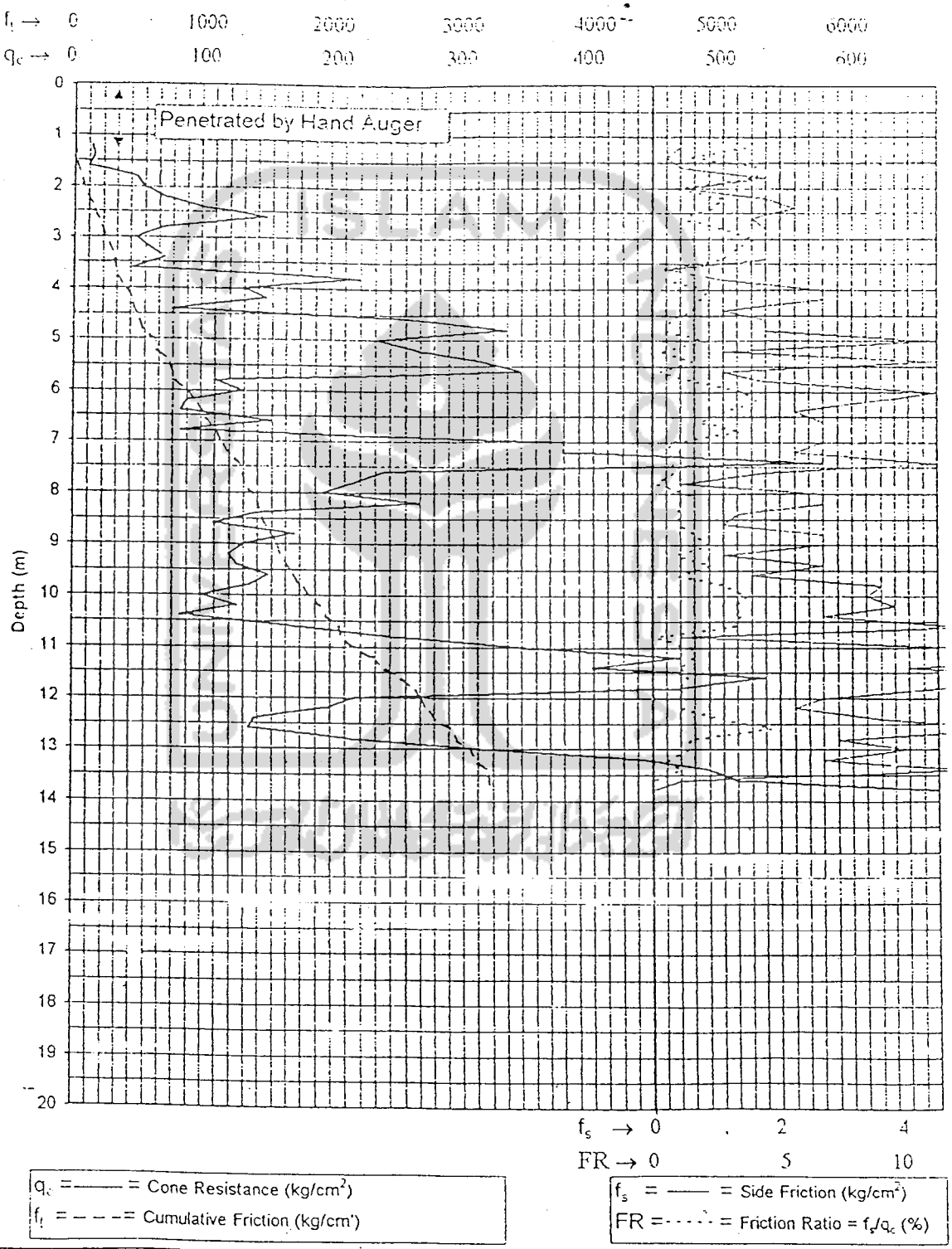


q_c = ——— = Cone Resistance (kg/cm^2)
f_t = – – – = Cumulative Friction (kg/cm^2)

f_s = ——— = Side Friction (kg/cm^2)
FR = - - - - = Friction Ratio = f_s/q_c (%)

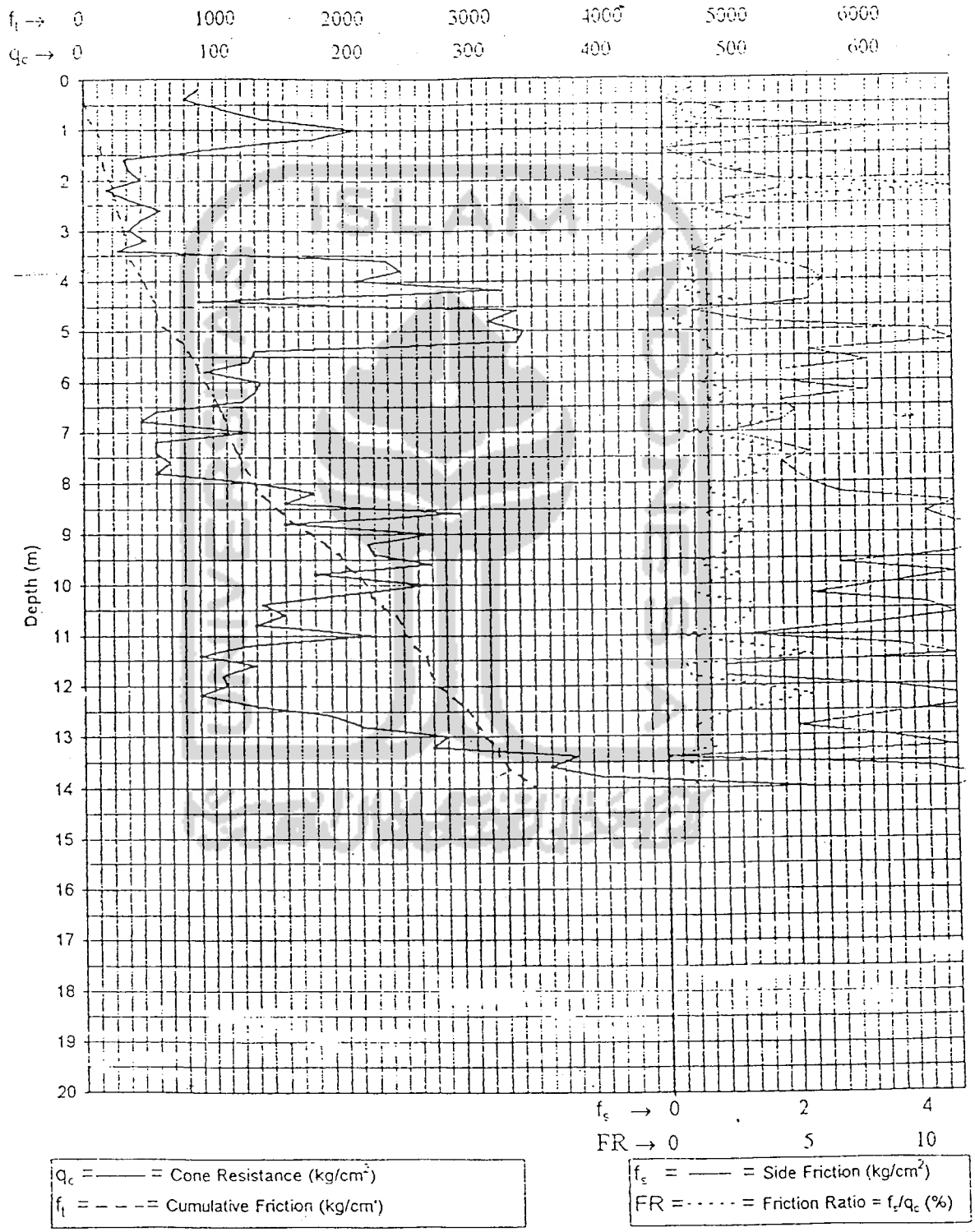
CONE PENETRATION TEST (10 TON)

Project	: Universitas Sanata Dharma	Weather	: Sunny
Location	: Maguwoharjo, Depok - Sleman	Date	: 2 June 2000
Test no.	: SB-6	Tested by	: Ks
Elevation	: + 100.67 m		



CONE PENETRATION TEST (10 TON)

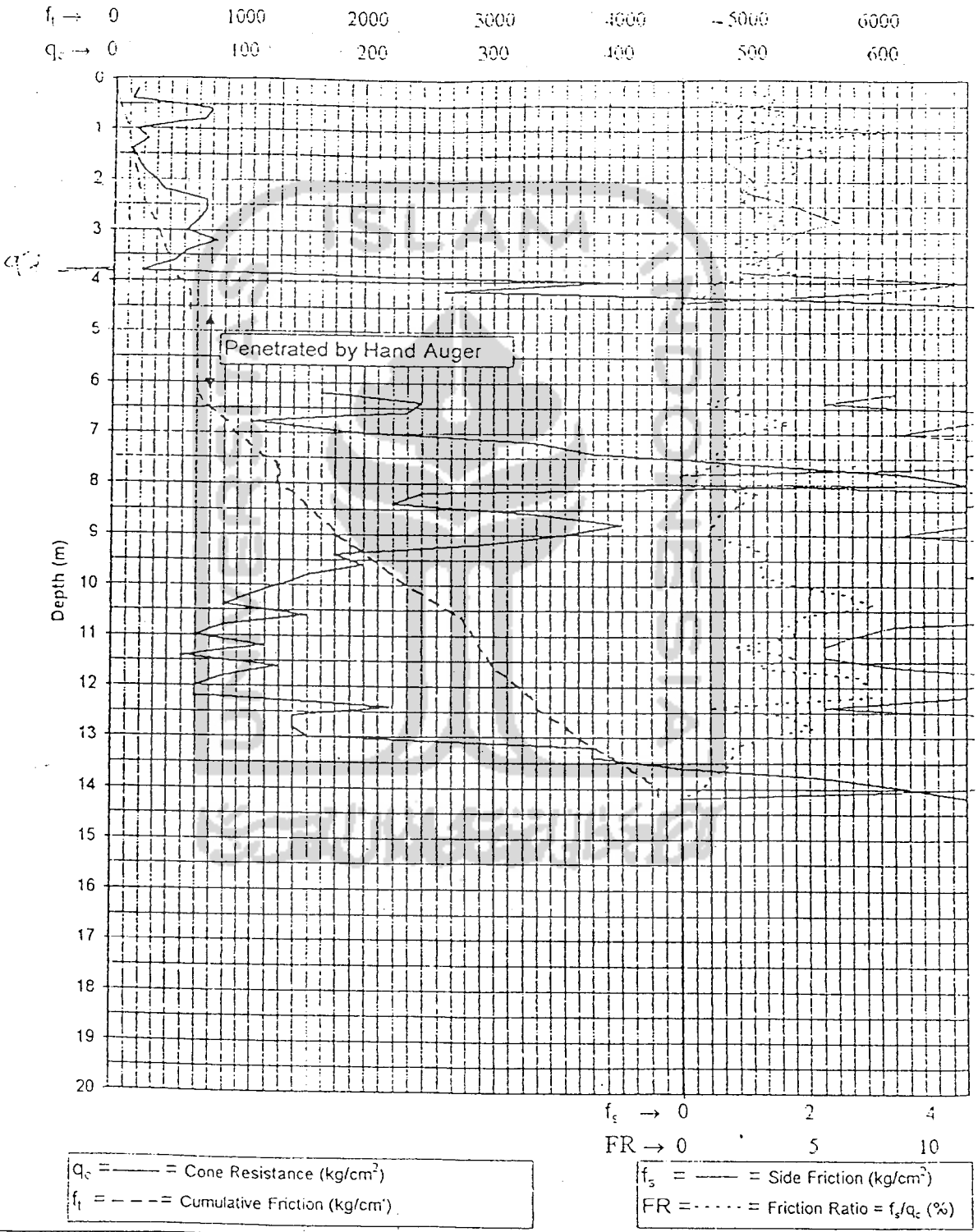
Project	: Universitas Sanata Dharma	Weather	: Sunny
Location	: Maguwoharjo, Depok - Sleman	Date	: 27 May 2000
Test no.	: SB-7	Tested by	: Ks
Elevation	: + 100.75 m		



SOIL MECHANICS LABORATORY - CIVIL ENGINEERING DEPT. - GADJAH MADA UNIVERSITY

CONE PENETRATION TEST (10 TON)

Project	: Universitas Sanata Dharma	Weather	: Sunny
Location	: Maguwoharjo, Depok - Sleman	Date	: 25 May 2000
Test no.	: SB-8	Tested by	: Ks
Elevation	: +100.85 m		

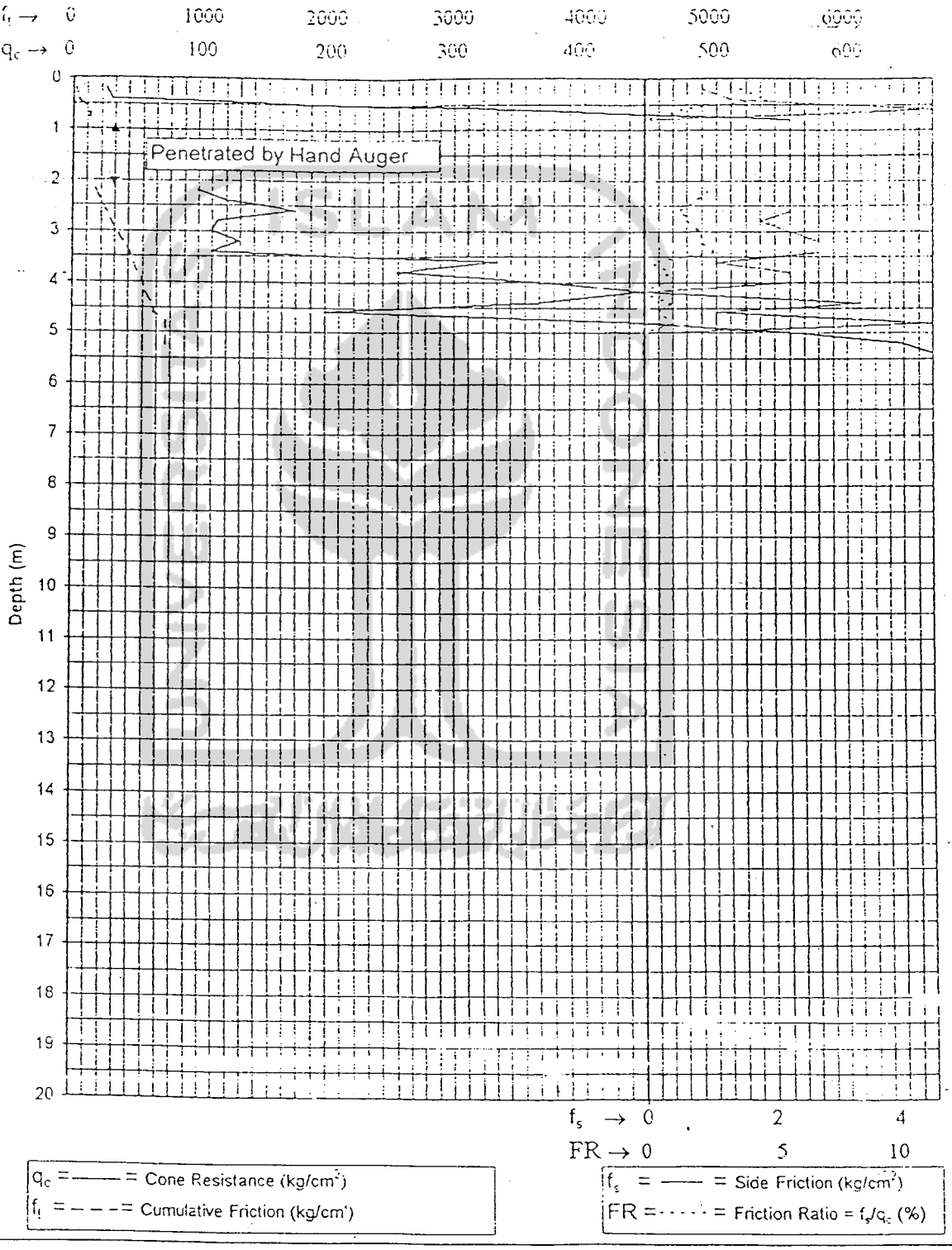


q_c = —— = Cone Resistance (kg/cm²)
f_t = – – – = Cumulative Friction (kg/cm²)

f_s = —— = Side Friction (kg/cm²)
FR = · · · · · = Friction Ratio = f_s/q_c (%)

CONE PENETRATION TEST (10 TON)

Project	: Universitas Sanata Dharma	Weather	: Sunny
Location	: Maguwoharjo, Depok - Sleman	Date	: 24 May 2000
Test no.	: SB-9	Tested by	: Ks
Elevation	: + 100.91 m		



BORE-HOLE LOG
(HAND AUGER)

Bore Hole No : BH-1 (SB-1)
Project : Universitas Sanata Dharma
Location : Maguwoharjo, Depok, Sleman

Elevation : + 100.67 m
Date :
Made by : Ks

Scale (m)	Depth (m)	Log	Description of Soil	Sample	Water Table (m)	Note
	0.50		Pasir sedang kasar, kerikil, coklat			
1.00	1.00		Cadas pasir sedang, berlanau, berkerikil, coklat			
2.00	2.10		Lanau, pasir halus, coklat tua			
	2.60		Pasir sedang halus, lanau, berkerikil			
3.00	3.00		Lanau, berpasir halus, coklat			
	3.60		Cadas pasir sedang kasar, berkerikil, coklat		-4.00 m	
4.00	4.00		Pasir sedang kasar, berkerikil, coklat			
5.00	5.00		Cadas, pasir sedang, berkerikil, coklat abu-abu			
	5.50		Pasir sedang berkerikil, coklat abu-abu			
6.00	6.20		Pasir halus lanau, coklat kehitaman			
7.00	7.00		Pasir senag, berkerikil, kerakal, coklat abu-abu			
	7.90		Pasir sedang kasar, kerikil, kerakal, coklat abu-abu			
8.00	8.50		Cadas pasir, lanau, berkerikil, coklat tua			
9.00			Akhir Pemboran			
10.0						

BORE-HOLE LOG
(HAND AUGER)

Bore Hole No. : BH-2 (SB-3)
Project : Universitas Sanata Dharma
Location : Maguwoharjo, Depok, Sleman

Elevation : + 100.67 m
Date :
Made by : Ks

Scale (m)	Depth (m)	Log	Description of Soil	Sample	Water Table (m)	Note
	0.50		Pasir sedang , berkerikil, coklat			
1.00			Cadas, pasir, berlanau, berkerikil, coklat			
2.00	2.00					
			Cadas, pasir, berlanau, berkerikil, coklat			
3.00	3.00					
			Cadas, pasir, berlanau, berkerikil, coklat abu-abu			
4.00	4.00				-4.50 m	
	4.40		Pasir sedang kasar, berlanau, berkerikil, coklat			
5.00	5.00		Cadas, pasir sedang, berlanau, berkerikil			
	5.60		Pasir sedang kasar, sedikit berlanau, kerikil, coklat			
6.00			Lanau, pasir halus, coklat tua			
	7.30					
7.00			Pasir, lanau, coklat			
8.00	8.50					
9.00			Pasir sedang halus, sedikit berlanau, kerikil, coklat abu-abu			
	9.60					
10.0	10.60		Pasir halus, berlanau, coklat			
			Akhir Pemboran			

BORE-HOLE LOG
(HAND AUGER)

Bore Hole No. : BH-3 (SB-5)
Project : Universitas Sanata Dharma
Location : Maguwoharjo, Depok, Sleman

Elevation : + 101.03 m
Date :
Made by : Ks

Scale (m)	Depth (m)	Log	Description of Soil	Sample	Water Table (m)	Note
	0.50		Pasir sedang kasar, berkerikil, coklat			
1.00	1.50		Cadas, pasir sedang, kerikil, coklat sedikit berlanau			
2.00	2.00		Pasir, lanau, coklat tua, berkerikil			
	3.00		Cadas, pasir, berlanau, berkerikil, coklat			
3.00	3.40		Cadas, pasir, sedang kasar, berlanau		-4.00 m	
4.00	4.50		Cadas, pasir, sedang kasar, berlanau, berkerikil, coklat			
	5.00		Cadas, pasir sedang, berlanau, berkerikil			
5.00	5.50		Cadas, pasir sedang, berlanau, berkerikil, coklat			
6.00	6.00		Cadas, pasir halus sedang, sedikit berlanau, coklat			
7.00	7.00		Pasir halus, lanau, coklat (padat)			
8.00			Cadas, lanau, coklat kemerahan			
9.00	9.00					
10.0	10.00		Pasir sedang, kasar, kerikil, sedikit krakal, coklat			
			Akhir Pemboran			

BORE-HOLE LOG
(HAND AUGER)

Bore Hole No : BH 4 (SB-7)
Project : Universitas Sanata Dharma
Location : Maguwoharjo, Depok, Sleman

Elevation : + 101.02 m
Date :
Made by : Ks

Scale (m)	Depth (m)	Log	Description of Soil	Sample	Water Table (m)	Note
	0.80		Pasir sedang ,berkerikil, sedikit berlanau, coklat			
1.00	1.60		Pasir sedang kasar, kerikil, coklat			
2.00	2.70		Pasir halus, berlanau, coklat			
3.00	4.00		Cadas, pasir sedang, berlanau, berkerikil, coklat			
4.00	4.40		Berkerikil, coklat (agak basah)			
5.00	5.50		Cadas, pasir sedang halus, berlanau, coklat		-5.50 m	
6.00	7.00		Pasir sedang, kerikil, coklat			
7.00	8.00		Cadas, pasir sedang halus, berlanau, coklat			
8.00	9.00		Pasir sedang kasar, berkrikil, sedikit berlanau, coklat, abu-abau (padat)			
9.00	10.00		Pasir sedang kasar, berlanau, berkerikil, coklat			
10.0			Akhir Pemboran			

BORE-HOLE LOG
(HAND AUGER)

Bore Hole No. : BH-5 (SB-9)
Project : Universitas Sanata Dharma
Location : Maguwoharjo, Depok, Sleman

Elevation : + 100.87 m
Date :
Made by : Ks

Scale (m)	Depth (m)	Log	Description of Soil	Sample	Water Table (m)	Note
1.00	1.50		Pasir sedang, berlanau, berkerikil, coklat tua			
2.00	2.00		Pasir sedang kasar, berlanau, kerikil, coklat			
3.00	3.50		Cadas, pasir, berlanau, berkerikil, coklat			
4.00	5.00		Cadas, pasir berlanau, berkerikil, coklat		-4.50 m	
5.00	5.70		Cadas, pasir sedang, kasar, sedikit berlanau, berkerikil, coklat			
6.00	6.20		Cadas, pasir kasar, kerikil, coklat, berlanau			
7.00	7.00		Pasir halus, lanau, coklat			
	7.50		Lanau berpasir halus, coklat kemerahan (padat)			
8.00	8.00		Cadas, lanau, berpasir halus, coklat			
	9.00		Cadas, pasir, kerikil, berlanau, coklat			
9.00			Akhir Pemboran			
10.0						

DIRECT SHEAR TEST

Project	: Universitas Sanata Dharma	Location	: Maguwoharjo, Depok, Sleman
Bore No.	: BH-1 (SB-1)	Date	:
Depth	: 1.10 - 2.10 m	Made by	: Pn

Description of soil : _____

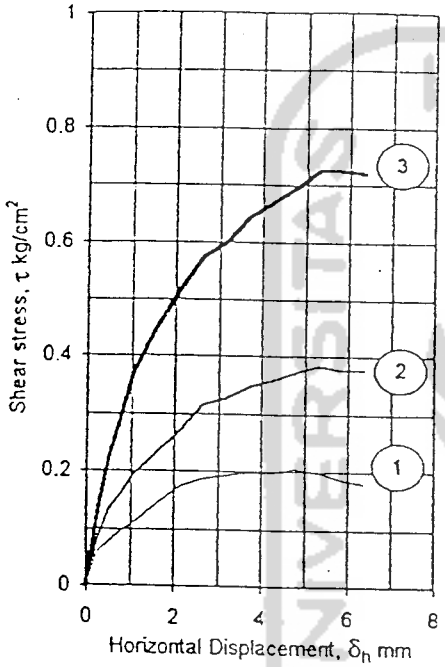
Dimensions of sample :

Diameter = 6.35 cm

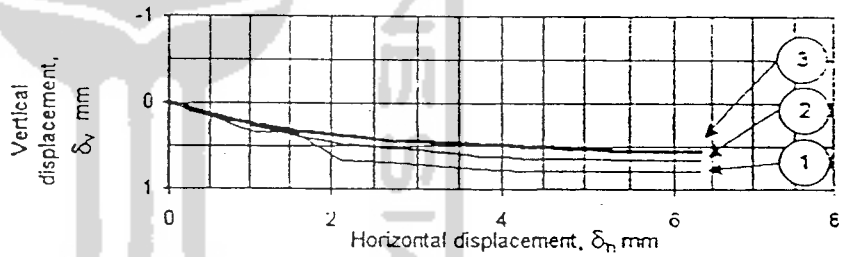
Area = 31.67 cm^2

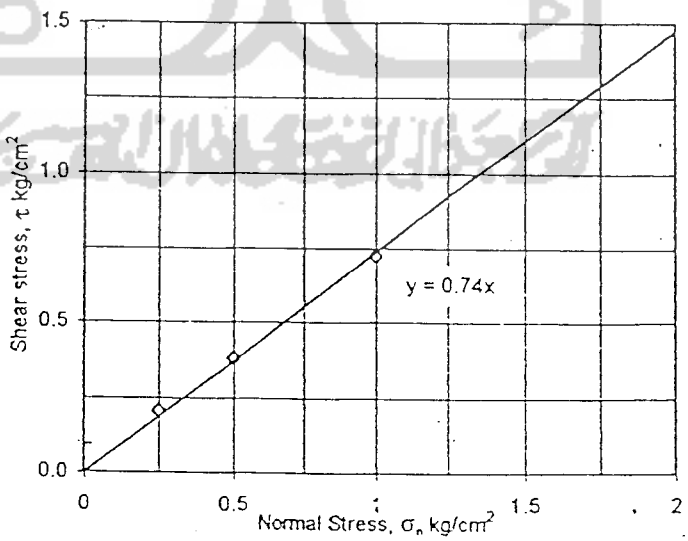
Ht. = 2.00 cm

Volume = 63.34 cm^3



Specimen no.		1	2	3
Mass of soil + ring	g	190.22	242.56	247.15
Mass of ring	g	88.06	145.30	143.78
Mass of soil	g	101.70	97.26	101.70
Initial water content	w_N (%)		25.37	
Bulk density	γ_b (g/cm^3)	1.61	1.61	1.61
Dry density	γ_d (g/cm^3)	1.28	1.28	1.28
Final water content	w_N (%)			
Normal stress	σ_n (kg/cm^2)	0.25	0.50	1.00
Shear stress at failure	τ (kg/cm^2)	0.21	0.38	0.72
Shear displacement at failure	δ_h (%)	7.51	8.35	8.35





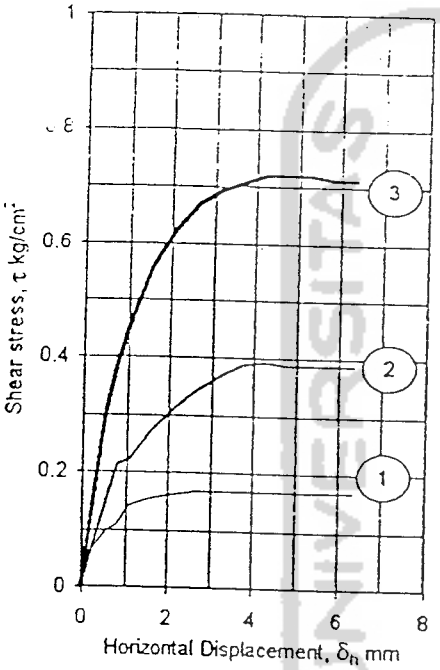
Angle of Internal Friction	ϕ	=	36.50 °
Cohesion	c	=	0.00 kg/cm^2

DIRECT SHEAR TEST

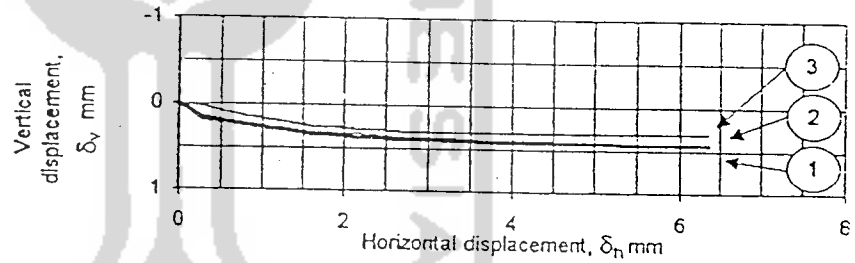
Project : Universitas Sanata Dharma
Bore No. : BH-1 (SB-1)
Depth : 3.60 - 4.00 m

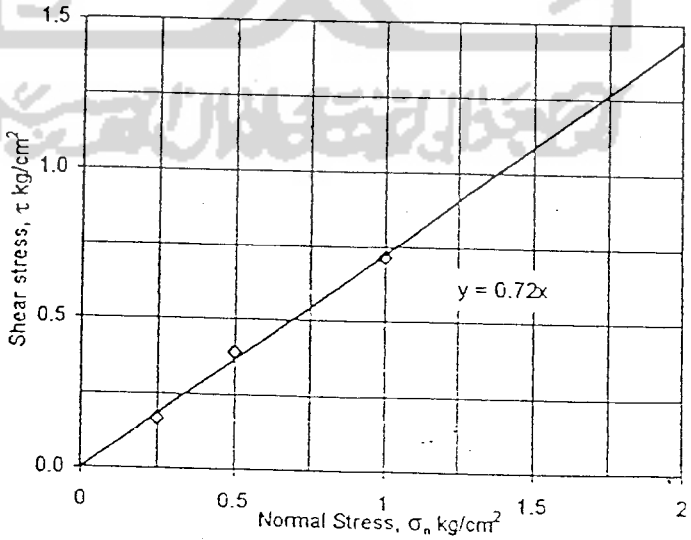
Location : Maguwoharjo, Depok, Sleman
Date :
Made by : Pn

Description of soil :
Dimensions of sample :
Diameter = 6.35 cm
Area = 31.67 cm^2
Ht. = 2.00 cm
Volume = 63.34 cm^3



Specimen no.		1	2	3
Mass of	a	166.03	185.64	205.16
Mass of ring	c	65.36	65.86	65.93
Mass of soil	g	101.70	123.48	101.70
Initial water content	w_N (%)		15.67	
Bulk density	γ_b (g/cm^3)	1.95	1.95	1.95
Dry density	γ_d (g/cm^3)	1.68	1.69	1.68
Final water content	w_N (%)			
Normal stress	σ_n (kg/cm^2)	0.25	0.50	1.00
Shear stress at failure	τ (kg/cm^2)	0.17	0.39	0.71
Shear displacement at failure	δ_h (%)	4.17	6.68	6.68



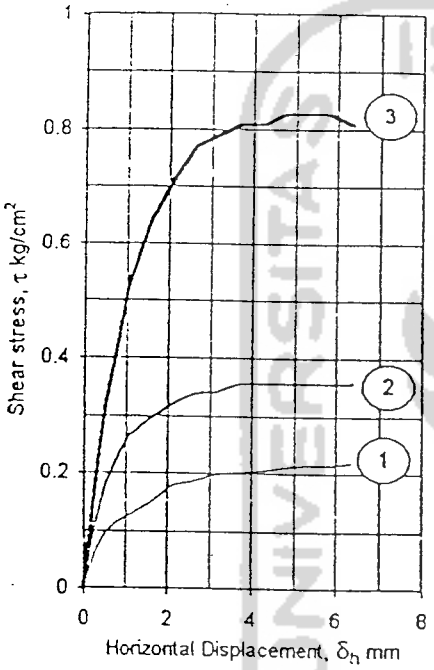


Angle of Internal Friction	ϕ	=	35.75 °
Cohesion	c	=	0.00 kg/cm^2

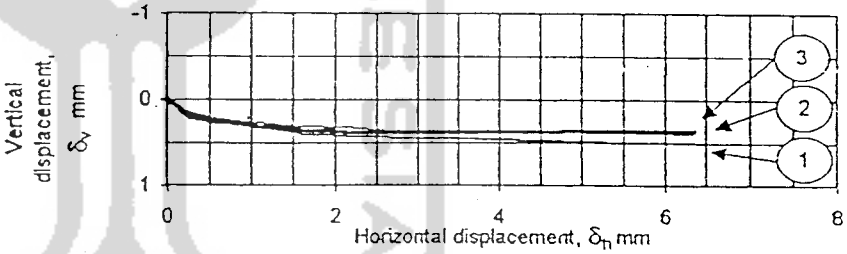
DIRECT SHEAR TEST

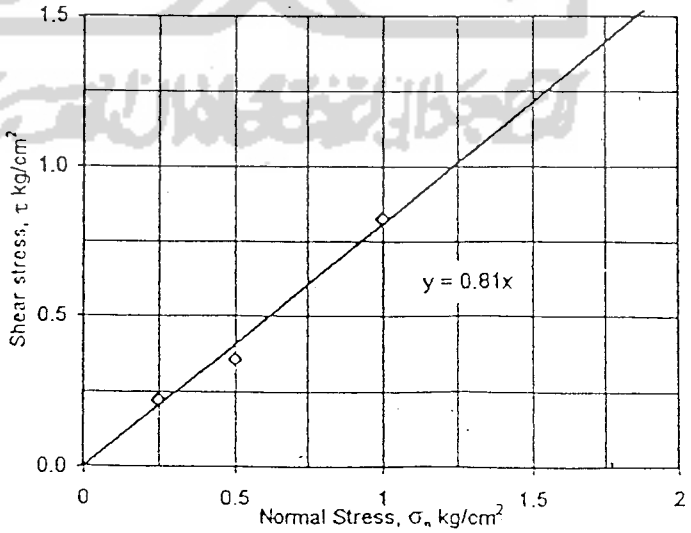
Project : ...sitas Sanata Dharma
Bore No. : BH-2 (SB-3)
Depth : 3.00 - 4.00 m
Location : Maguwoharjo, Depok, Sleman
Date :
Made by : Pn

Description of soil : _____
Dimensions of sample :
Diameter = 6.35 cm
Area = 31.67 cm^2
Ht. = 2.00 cm
Volume = 63.34 cm^3



Specimen no.		1	2	3
Mass of soil + ring	g	203.26	258.14	259.92
Mass of ring	g	88.06	143.75	145.30
Mass of soil	g	101.70	114.39	101.70
Initial water content	w_N (%)		11.65	
Bulk density	γ_b (g/cm^3)	1.81	1.81	1.81
Dry density	γ_d (g/cm^3)	1.62	1.62	1.62
Final water content	w_N (%)			
Normal stress	σ_n (kg/cm^2)	0.25	0.50	1.00
Shear stress at failure	τ (kg/cm^2)	0.22	0.36	0.83
Shear displacement at failure	δ_h (%)	10.02	10.02	7.51





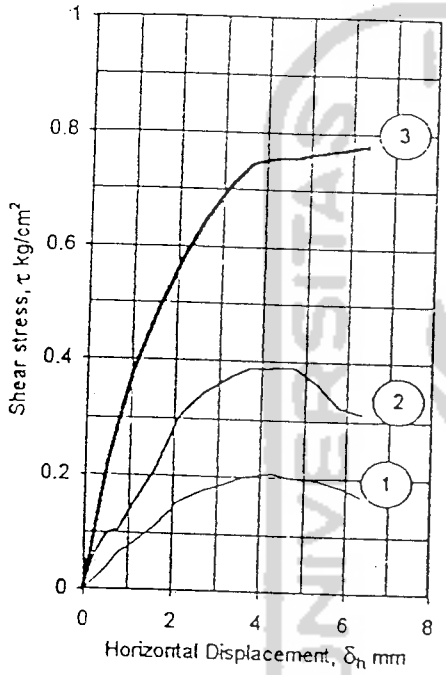
Angle of Internal Friction	ϕ	=	39.01 °
Cohesion	c	=	0.00 kg/cm^2

DIRECT SHEAR TEST

Project : Universitas Sanata Dharma
Bore No. : BH-2 (SB-3)
Depth : 6.50 - 7.00 m

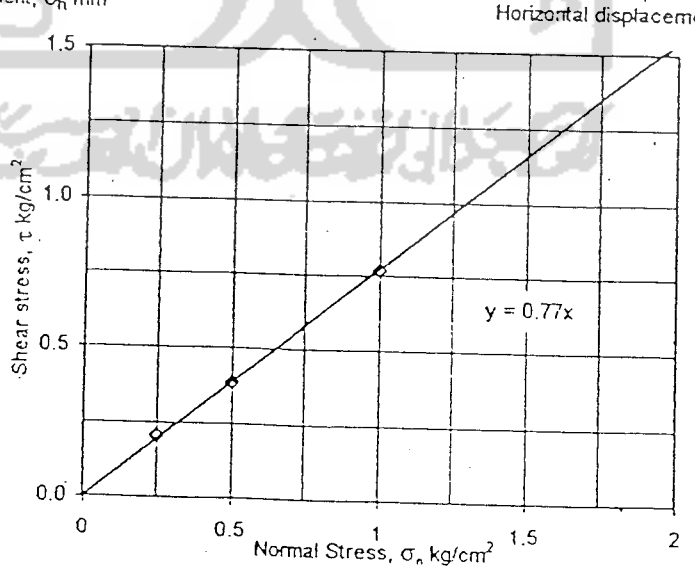
Location : Maguwoharjo, Depok, Sleman
Date :
Made by : Pn

Description of soil : _____
Dimensions of sample :
Diameter = 6.35 cm
Area = 31.67 cm^2
Ht. = 2.00 cm
Volume = 63.34 cm^3



Specimen no.		1	2	3
Mass of soil + ring	g	191.40	256.14	259.92
Mass of ring	g	65.06	143.75	145.30
Mass of soil	g	101.70	114.39	101.70
Initial water content	w_N (%)		19.10	
Bulk density	γ_b (g/cm^3)	1.81	1.81	1.81
Dry density	γ_d (g/cm^3)	1.52	1.52	1.52
Final water content	w_N (%)			
Normal stress	σ_n (kg/cm^2)	0.25	0.50	1.00
Shear stress at failure	τ (kg/cm^2)	0.21	0.39	0.77
Shear displacement at failure	δ_h (%)	6.68	6.68	10.02





Angle of Internal Friction	ϕ	=	37.60 °
Cohesion	c	=	0.00 kg/cm^2

DIRECT SHEAR TEST

Project	: Universitas Sanata Dharma	Location	: Maguwoharjo Depok,Sleman
Bore No.	: BH-3 (SB-5)	Date	:
Depth	: 1.50 - 2.00 m	Made by	: Pn

Description of soil : _____

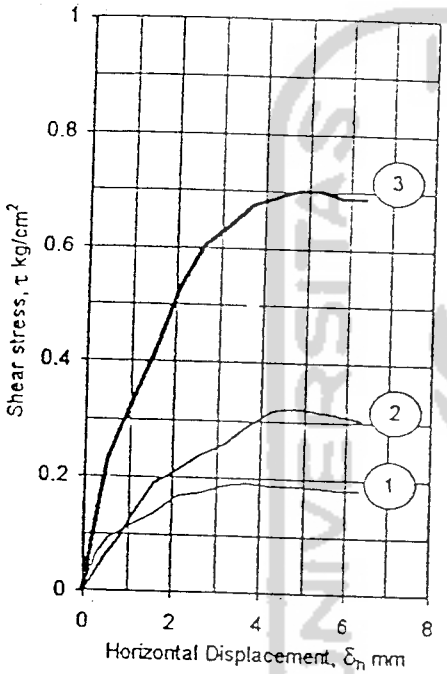
Dimensions of sample :

Diameter = 6.35 cm

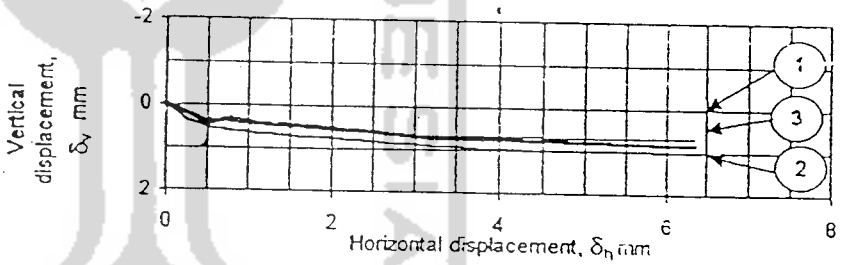
Area = [illegible] cm^2

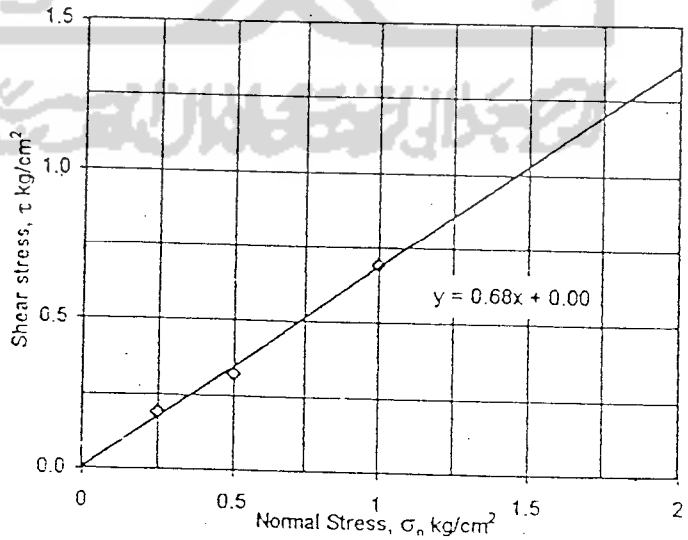
Ht. = 2.00 cm

Volume = 63.34 cm^3



Specimen no.		1	2	3
Mass of soil + ring	g	214.32	274.12	276.12
Mass of ring	g	88.08	143.75	145.30
Mass of soil	g	101.70	130.37	101.70
Initial water content	w_N (%)		10.58	
Bulk density	γ_b (g/cm³)	2.06	2.06	2.06
Dry density	γ_d (g/cm³)	1.86	1.86	1.86
Final water content	w_N (%)			
Normal stress	σ_n (kg/cm²)	0.25	0.50	1.00
Shear stress at failure	τ (kg/cm²)	0.19	0.32	0.69
Shear displacement at failure	δ_h (%)	5.84	7.51	171.65





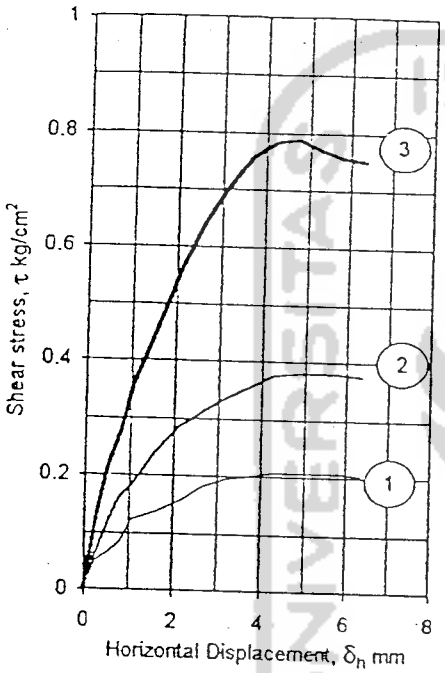
Angle of Internal Friction	ϕ	=	34.22 °
Cohesion	c	=	0.00 kg/cm²

DIRECT SHEAR TEST

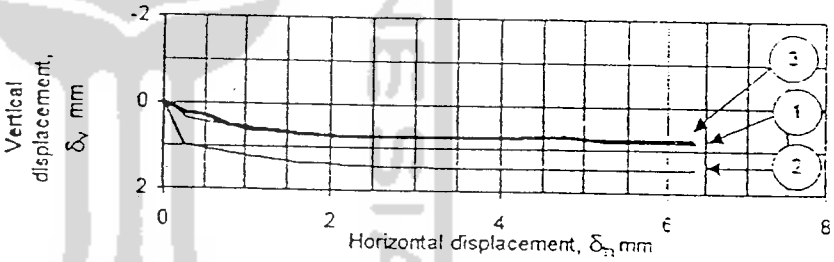
Project : Universitas Sanata Dharma
Bore No. : BH-3 (SB-5)
Depth : 7.50 - 8.00 m

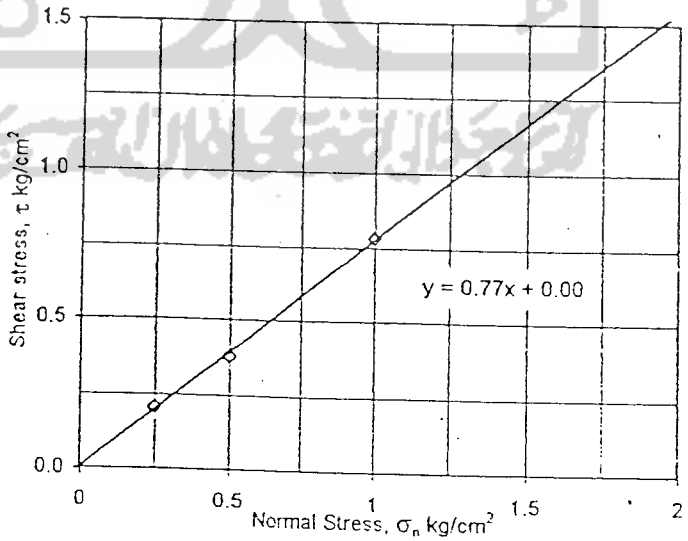
Location : Maguwoharjo, Depok, Sleman
Date :
Made by : Pn

Description of soil : _____
Dimensions of sample :
Diameter = 6.35 cm
Area = 31.67 cm^2
Ht. = 2.00 cm
Volume = 63.34 cm^3



Specimen no.		1	2	3
Mass of soil + ring	g	172.86	171.50	191.70
Mass of ring	g	65.06	64.75	85.93
Mass of soil	g	101.70	106.75	101.77
Initial water content	w_N (%)		37.56	
Bulk density	γ_b (g/cm³)	1.69	1.69	1.69
Dry density	γ_d (g/cm³)	1.23	1.22	1.23
Final water content	w_N (%)			
Normal stress	σ_n (kg/cm²)	0.25	0.50	1.00
Shear stress at failure	τ (kg/cm²)	0.21	0.38	0.76
Shear displacement at failure	δ_h (%)	6.68	7.51	7.51





Angle of Internal Friction	ϕ	=	37.60 °
Cohesion	c	=	0.00 kg/cm²

DIRECT SHEAR TEST

Project	: Universitas Sanata Dharma	Location	: Maguwoharjo, Depok, Sleman
Bore No.	: BH-4 (SB-7)	Date	:
Depth	: 6.00 - 7.00 m	Made by	: Pn

Description of soil : _____

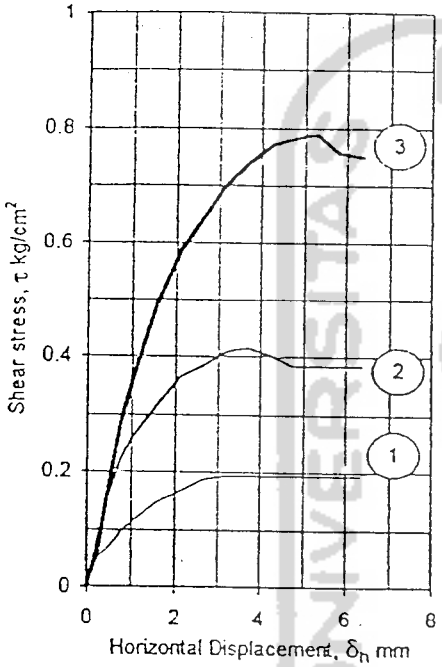
Dimensions of sample :

Diameter = 6.35 cm

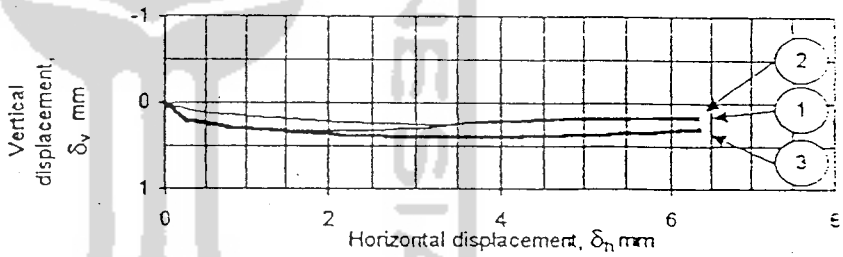
Area = 31.67 cm^2

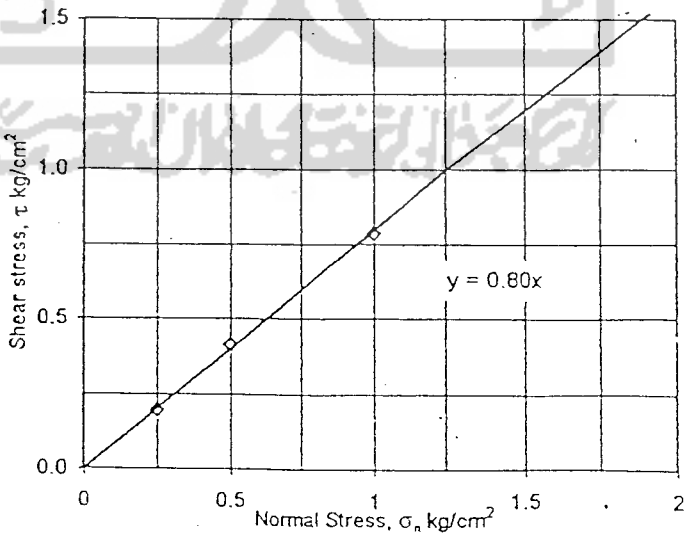
Ht. = 2.00 cm

Volume = 63.34 cm^3



Specimen no.		1	2	3
Mass of soil + ring	g	279.27	279.27	279.27
Mass of ring	g	143.80	143.80	143.80
Mass of soil	g	135.47	135.47	135.47
Initial water content	w_N (%)		12.51	
Bulk density	γ_b (g/cm^3)	2.14	2.14	2.14
Dry density	γ_d (g/cm^3)	1.90	1.90	1.90
Final water content	w_N (%)			
Normal stress	σ_n (kg/cm^2)	0.25	0.50	1.00
Shear stress at failure	τ (kg/cm^2)	0.19	0.42	0.79
Shear displacement at failure	δ_h (%)	5.01	5.84	8.35





Angle of Internal Friction	ϕ	=	38.66 °
Cohesion	c	=	0.00 kg/cm^2

DIRECT SHEAR TEST

Project	: Universitas Sanata Dharma	Location	: Maguwoharjo, Depok, Sleman
Bore No.	: BH 4 (SB-7)	Date	:
Depth	: 9.00 - 10.00 m	Made by	: Pn

Description of soil : _____

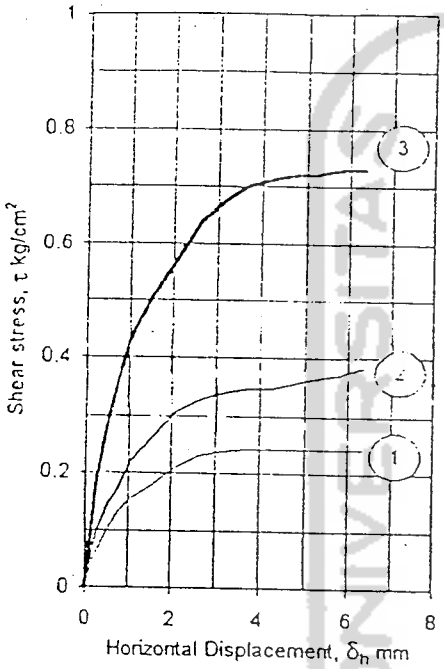
Dimensions of sample :

Diameter = 6.35 cm

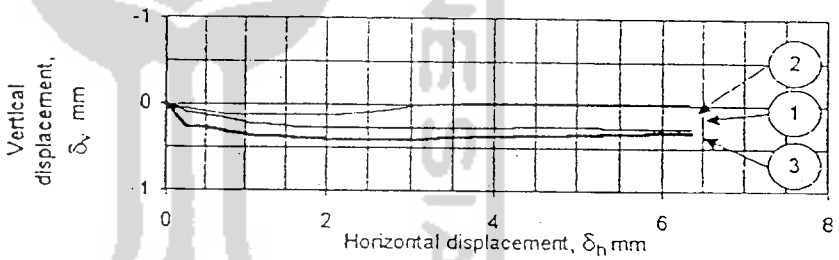
Area = 31.67 cm^2

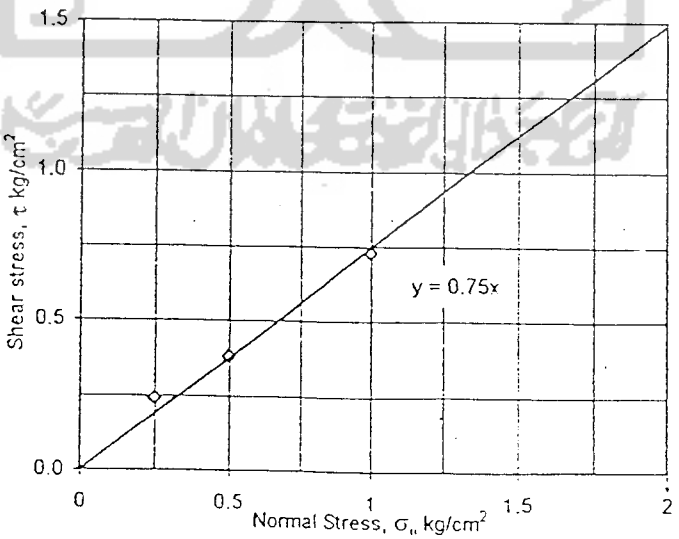
Ht. = 2.00 cm

Volume = 63.34 cm^3



Specimen no.		1	2	3
Mass of soil + ring	g	276.04	276.04	276.04
Mass of ring	g	143.80	143.80	143.80
Mass of soil	g	132.24	132.24	132.24
Initial water content	w_o (%)		11.07	
Bulk density	γ_b (g/cm^3)	2.09	2.09	2.09
Dry density	γ_d (g/cm^3)	1.88	1.88	1.88
Final water content	w_f (%)			
Normal stress	σ_n (kg/cm^2)		0.50	1.00
Shear stress at failure	τ_f (kg/cm^2)	0.24	0.38	0.73
Shear displacement at failure	δ_h (%)	5.84	10.02	9.18





Angle of Internal Friction	ϕ	=	36.87 °
Cohesion	c	=	0.00 kg/cm^2

DIRECT SHEAR TEST

Project	: Universitas Sanata Dharma	Location	: Maguwoharjo, Depok, Sleman
Bore No.	: BH-5 (SB-9)	Date	:
Depth	: 6.20 - 7.00 m	Made by	: Pn

Description of soil : _____

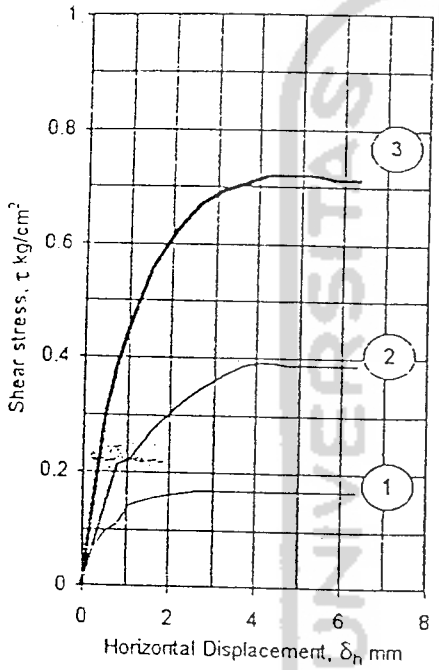
Dimensions of sample :

Diameter = 6.35 cm

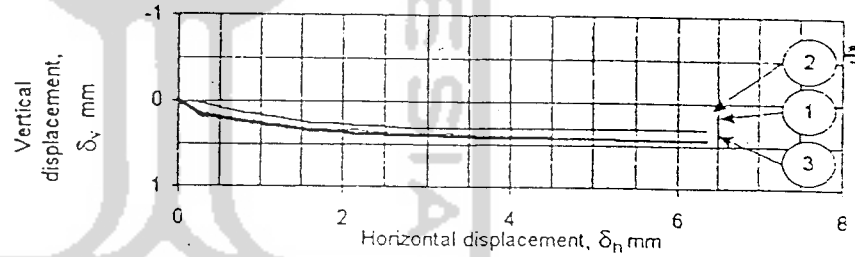
Area = 31.67 cm^2

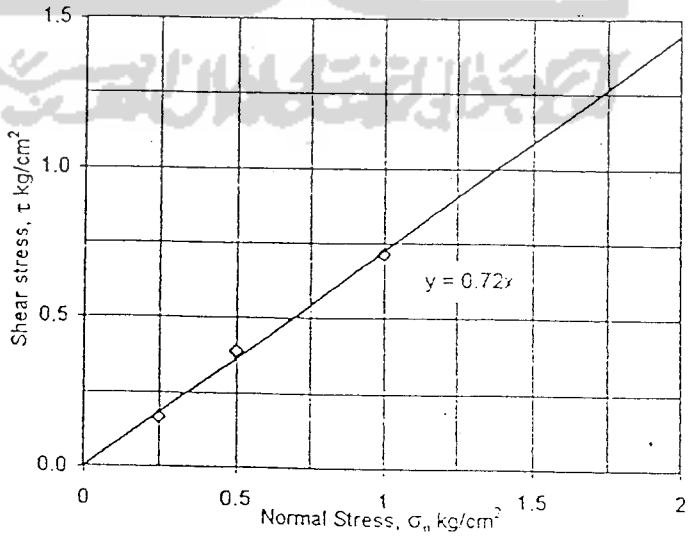
Ht. = 2.00 cm

Volume = 63.34 cm^3



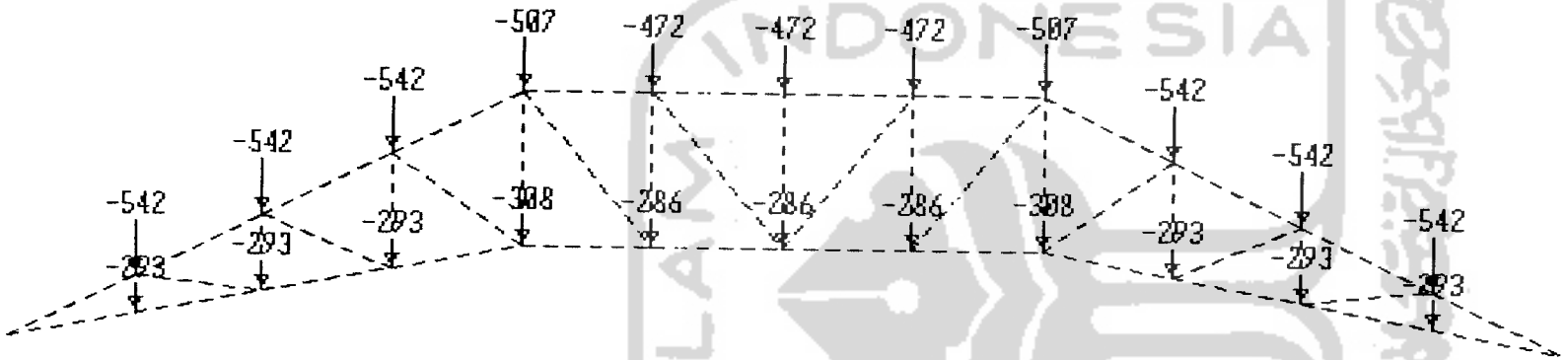
Specimen no.		1	2	3
Mass of soil + ring	g	195.53	195.53	195.53
Mass of ring	g	65.30	65.30	65.30
Mass of soil	g	130.23	130.23	130.23
Initial water content	w_o (%)		25.74	
Bulk density	γ_b (g/cm³)	2.06	2.06	2.06
Dry density	γ_d (g/cm³)	1.64	1.64	1.64
Final water content	w_f (%)			
Normal stress	σ_n (kg/cm²)	0.25	0.50	1.00
Shear stress at failure	τ (kg/cm²)	0.17	0.39	0.71
Shear displacement at failure	δ_h (%)	4.17	6.68	6.68





Angle of Internal Friction	ϕ	=	35.75 °
Cohesion	c	=	0.00 kg/cm²

LAMPIRAN 2



X

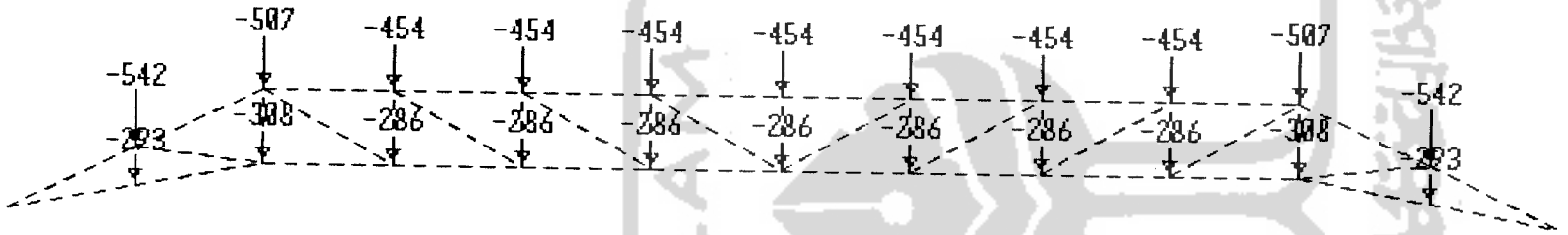
kk-2

JOINT
LOADS

LOAD 1

MINIMA
P-0.5420E+03
MAXIMA
P-0.2860E+03

SAP90



lampiran 2.2

Y

X

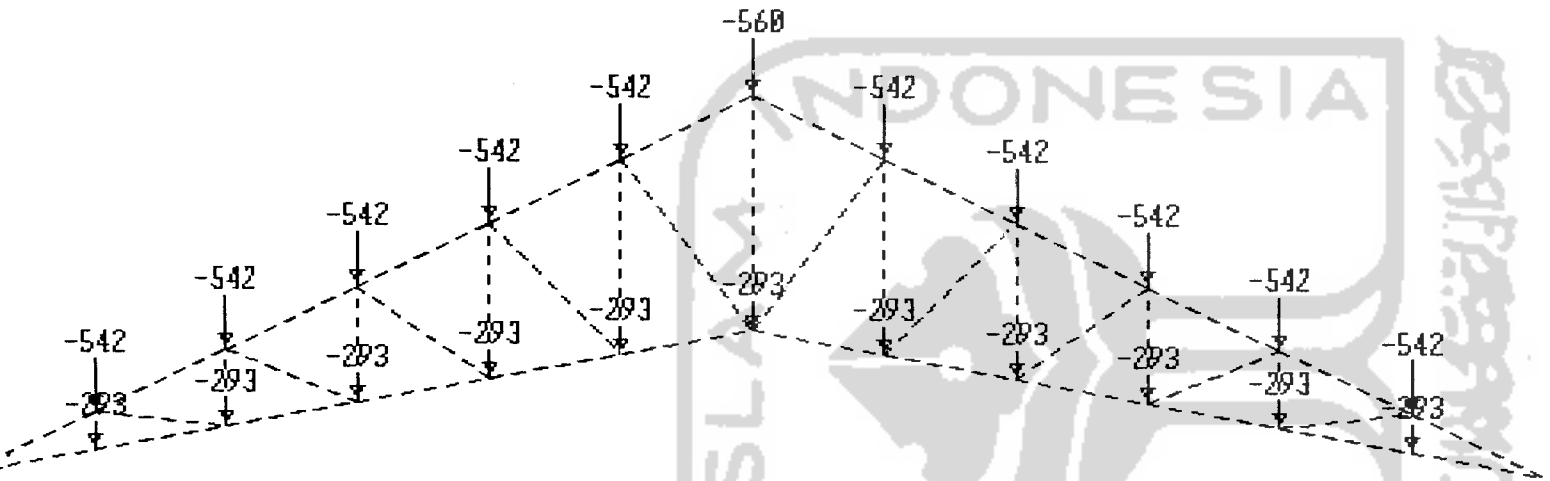
kk-3

JOINT
LOADS

LOAD 1

MINIMA
P-0.5420E+03
MAXIMA
P-0.2860E+03

SAP90



X

kk-1

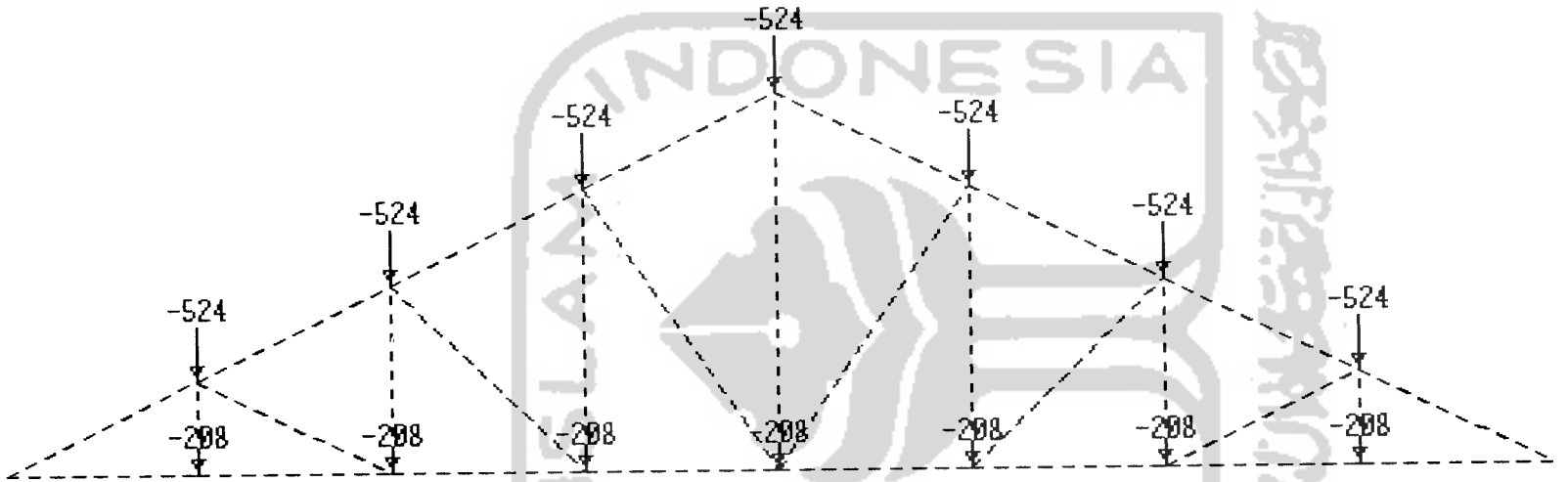
JOINT
LOADS

LOAD 1

MINIMA
P-0.5600E+03
MAXIMA
P-0.2930E+03

SAP90

ISLAM INDONESIA UNIVERSITAS



kk-3'

JOINT
LOADS

LOAD

MINIMA
P-0.5240E+0
MAXIMA
P-0.2080E+0

SAP90

```
SA KK 1
EBAN TETAP II=BEBAN ANGIN KIRI III=BEBAN ANGIN KANAN
M

S
0 Y=0
10.8 Y=2.4  G=1,7,1
21.6  Y=0  G=7,13,1
:1.8   Y=1.029
:10.8  Y=6.235   G=14,19,1
:19.8  Y=1.039   G=19,24,1

E

TA PENAMPANG
I=T T=0.07,0.14,0.007,0.014 E=2E10 I=0.0 W=0.0
I=T T=0.060,0.12,0.006,0.012 E=2E10 I=0.0 W=0.0
ATA LOKASI FRAME
 2 M=1 G=5,1,1,1  LP=1,0  LR=1,1,0,1,1,1
 8 M=1 G=5,1,1,1  LP=1,0  LR=1,1,0,1,1,1
1 14 M=1 LP=1,0 LR=1,1,0,1,1,1
14 15 M=1 G=4,1,1,1  LP=1,0  LR=1,1,0,1,1,1
19 20 M=1 G=4,1,1,1  LP=1,0   LR=1,1,0,1,1,1
24 13 M=1 LP=1,0 LR=1,1,0,1,1,1
2 14 M=2 G=10,1,1,1  LP=1,0  LR=1,1,0,1,1,1
14 3  M=2 G=4,1,1,1 LP=1,0  LR=1,1,0,1,1,1
7 20 M=2 G=4,1,1,1  LP=1,0 LR=,1,1,0,1,1,1

ADS
12 1 L=1 F=0,-293
18 1 L=1 F=0,-542
L=1 F=0,-560
24 1 L=1 F=0,-542
18 1 L=2 F=19,-32.91
L=2 F=28.5,16.46
24 1 L=2 F=37.5,64.95
18 1 L=3 F=-37.5,64.95
L=3 F=-28.53,16.46
L=3 F=-9.5,-16.45
24 1 L=3 F=-37.5,-64.95

STRAINTS
24 1  R=0,0,1,1,1,0
  R=1,1,1,1,1,0
  R=0,1,1,1,1,0

MBO
)=1,0,0
)=0,1,0
)=0,0,1
```

NALISA KK 1

R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
1								
	1	0.000			13489.264			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			13489.264			
	2	0.000			477.281			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			477.281			
	3	0.000			-977.502			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			-977.502			
2								
	1	0.000			13489.264			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			13489.264			
	2	0.000			477.281			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			477.281			
	3	0.000			-977.502			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			-977.502			
3								
	1	0.000			12147.560			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			12147.560			
	2	0.000			412.027			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			412.027			
	3	0.000			-846.402			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			-846.402			
4								
	1	0.000			10900.518			

: A M E E L E M E N T F O R C E S

:LT	LOAD ID	COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
	2		0.000			33.225			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			33.225			
	3		0.000			-218.897			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			-218.897			
8	----------								
	1		0.000			9661.661			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			9661.661			
	2		0.000			-91.692			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			-91.692			
	3		0.000			-93.983			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			-93.983			
9	----------								
	1		0.000			10866.407			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			10866.407			
	2		0.000			-216.616			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			-216.616			
	3		0.000			30.936			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			30.936			
10	----------								
	1		0.000			12071.530			
			0.000	0.000	0.000				
			1.844	0.000	0.000				
			1.844			12071.530			
	2		0.000			-341.555			
			0.000	0.000	0.000				

ISA KK 1

A M E E L E M E N T F O R C E S

T	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		AXIAL
D	COMB	ENDI	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	TORQ
		1.844	0.000	0.000				
		1.844			-341.555			
	3	0.000			155.865			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			155.865			
11	----------							
	1	0.000			13278.164			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			13278.164			
	2	0.000			-466.555			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			-466.555			
	3	0.000			280.837			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			280.837			
12	----------							
	1	0.000			13278.164			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			13278.164			
	2	0.000			-466.555			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			-466.555			
	3	0.000			280.837			
		0.000	0.000	0.000				
		1.844	0.000	0.000				
		1.844			280.837			
13	----------							
	1	0.000			-15167.865			
		0.000	0.000	0.000				
		2.073	0.000	0.000				
		2.073			-15167.865			
	2	0.000			-178.442			
		0.000	0.000	0.000				
		2.073	0.000	0.000				
		2.073			-178.442			

A M E E L E M E N T F O R C E S

LT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
	3	0.000			623.385			
		0.000	0.000	0.000				
		2.073	0.000	0.000				
		2.073			623.385			
14								
	1	0.000			-13699.266			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			-13699.266			
	2	0.000			-127.327			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			-127.327			
	3	0.000			520.689			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			520.689			
15								
	1	0.000			-12292.930			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			-12292.930			
	2	0.000			-77.300			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			-77.300			
	3	0.000			421.099			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			421.099			
16								
	1	0.000			-10912.898			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			-10912.898			
	2	0.000			-27.670			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			-27.670			
	3	0.000			322.725			
		0.000	0.000	0.000				

A M E E L E M E N T F O R C E S

LT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		2.079	0.000	0.000				
		2.079			322.725			
17								
	1	0.000			-9543.329			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			-9543.329			
	2	0.000			21.801			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			21.801			
	3	0.000			224.834			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			224.834			
18								
	1	0.000			-8178.975			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			-8178.975			
	2	0.000			71.194			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			71.194			
	3	0.000			127.184			
		0.000	0.000	0.000				
		2.079	0.000	0.000				
		2.079			127.184			
19								
	1	0.000			-8175.039			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			-8175.039			
	2	0.000			38.251			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			38.251			
	3	0.000			171.036			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			171.036			

A M E E L E M E N T F O R C E S

LT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
20								
	1	0.000			-9532.768			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			-9532.768			
	2	0.000			135.753			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			135.753			
	3	0.000			73.536			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			73.536			
21								
	1	0.000			-10890.581			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			-10890.581			
	2	0.000			233.258			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			233.258			
	3	0.000			-23.966			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			-23.966			
22								
	1	0.000			-12248.564			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			-12248.564			
	2	0.000			330.770			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			330.770			
	3	0.000			-121.473			
		0.000	0.000	0.000				
		2.078	0.000	0.000				
		2.078			-121.473			
23								
	1	0.000			-13606.974			

FRAME ELEMENT FORCES

ELT	LOAD ID	COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
			0.000	0.000	0.000				
			2.078	0.000	0.000				
			2.078			-13606.974			
	2		0.000			428.300			
			0.000	0.000	0.000				
			2.078	0.000	0.000				
			2.078			428.300			
	3		0.000			-218.991			
			0.000	0.000	0.000				
			2.078	0.000	0.000				
			2.078			-218.991			
24	----------								
	1		0.000			-14966.366			
			0.000	0.000	0.000				
			2.078	0.000	0.000				
			2.078			-14966.366			
	2		0.000			525.874			
			0.000	0.000	0.000				
			2.078	0.000	0.000				
			2.078			525.874			
	3		0.000			-316.543			
			0.000	0.000	0.000				
			2.078	0.000	0.000				
			2.078			-316.543			
25	----------								
	1		0.000			293.000			
			0.000	0.000	0.000				
			0.629	0.000	0.000				
			0.629			293.000			
	2		0.000			0.000			
			0.000	0.000	0.000				
			0.629	0.000	0.000				
			0.629			0.000			
	3		0.000			0.000			
			0.000	0.000	0.000				
			0.629	0.000	0.000				
			0.629			0.000			
26	----------								
	1		0.000			750.686			
			0.000	0.000	0.000				
			1.270	0.000	0.000				
			1.270			750.686			

RAME ELEMENT FORCES

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
	2	0.000			22.259			
		0.000	0.000	0.000				
		1.270	0.000	0.000				
		1.270			22.259			
	3	0.000			-44.721			
		0.000	0.000	0.000				
		1.270	0.000	0.000				
		1.270			-44.721			
27	----------							
	1	0.000			1152.041			
		0.000	0.000	0.000				
		1.911	0.000	0.000				
		1.911			1152.041			
	2	0.000			43.966			
		0.000	0.000	0.000				
		1.911	0.000	0.000				
		1.911			43.966			
	3	0.000			-87.296			
		0.000	0.000	0.000				
		1.911	0.000	0.000				
		1.911			-87.296			
28	----------							
	1	0.000			1561.506			
		0.000	0.000	0.000				
		2.553	0.000	0.000				
		2.553			1561.506			
	2	0.000			65.795			
		0.000	0.000	0.000				
		2.553	0.000	0.000				
		2.553			65.795			
	3	0.000			-130.245			
		0.000	0.000	0.000				
		2.553	0.000	0.000				
		2.553			-130.245			
29	----------							
	1	0.000			1974.198			
		0.000	0.000	0.000				
		3.194	0.000	0.000				
		3.194			1974.198			
	2	0.000			87.672			
		0.000	0.000	0.000				

A M A M E E L E M E N T F O R C E S

LT I LT ID	LOAD ID COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		3.194	0.000	0.000				
		3.194			87.672			
	3	0.000			-173.344			
		0.000	0.000	0.000				
33		3.194	0.000	0.000				
		3.194			-173.344			
30	----------							
	1	0.000			7622.726			
		0.000	0.000	0.000				
		3.835	0.000	0.000				
		3.835			7622.726			
	2	0.000			-38.313			
		0.000	0.000	0.000				
		3.835	0.000	0.000				
		3.835			-38.313			
	3	0.000			-149.189			
		0.000	0.000	0.000				
3		3.835	0.000	0.000				
		3.835			-149.189			
31	----------							
	1	0.000			1963.183			
		0.000	0.000	0.000				
		3.196	0.000	0.000				
		3.196			1963.183			
	2	0.000			-173.199			
		0.000	0.000	0.000				
		3.196	0.000	0.000				
		3.196			-173.199			
	3	0.000			173.195			
		0.000	0.000	0.000				
3		3.196	0.000	0.000				
		3.196			173.195			
32	----------							
	1	0.000			1545.762			
		0.000	0.000	0.000				
		2.557	0.000	0.000				
		2.557			1545.762			
	2	0.000			-129.902			
		0.000	0.000	0.000				
		2.557	0.000	0.000				
		2.557			-129.902			

A M E E L E M E N T F O R C E S

LT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
	3	0.000			129.897			
		0.000	0.000	0.000				
		2.557	0.000	0.000				
		2.557			129.897			
33	----------							
	1	0.000			1128.393			
		0.000	0.000	0.000				
		1.917	0.000	0.000				
		1.917			1128.393			
	2	0.000			-86.608			
		0.000	0.000	0.000				
		1.917	0.000	0.000				
		1.917			-86.608			
	3	0.000			86.601			
		0.000	0.000	0.000				
		1.917	0.000	0.000				
		1.917			86.601			
34	----------							
	1	0.000			711.155			
		0.000	0.000	0.000				
		1.278	0.000	0.000				
		1.278			711.155			
	2	0.000			-43.319			
		0.000	0.000	0.000				
		1.278	0.000	0.000				
		1.278			-43.319			
	3	0.000			43.308			
		0.000	0.000	0.000				
		1.278	0.000	0.000				
		1.278			43.308			
35	----------							
	1	0.000			293.000			
		0.000	0.000	0.000				
		0.639	0.000	0.000				
		0.639			293.000			
	2	0.000			0.000			
		0.000	0.000	0.000				
		0.639	0.000	0.000				
		0.639			0.000			
	3	0.000			0.000			
		0.000	0.000	0.000				

ISA KK 1

A M E E L E M E N T F O R C E S

LT LOAD ID COMB		DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		0.639	0.000	0.000				
		0.639			0.000			
36								
					-1320.311			
	1	0.000						
		0.000	0.000	0.000				
		1.815	0.000	0.000				
		1.815			-1320.311			
					-64.213			
	2	0.000						
		0.000	0.000	0.000				
		1.815	0.000	0.000				
		1.815			-64.213			
					129.009			
	3	0.000						
		0.000	0.000	0.000				
		1.815	0.000	0.000				
		1.815			129.009			
37								
					-1352.142			
	1	0.000						
		0.000	0.000	0.000				
		1.999	0.000	0.000				
		1.999			-1352.142			
					-69.203			
	2	0.000						
		0.000	0.000	0.000				
		1.999	0.000	0.000				
		1.999			-69.203			
					137.405			
	3	0.000						
		0.000	0.000	0.000				
		1.999	0.000	0.000				
		1.999			137.405			
38								
					-1559.843			
	1	0.000						
		0.000	0.000	0.000				
		2.350	0.000	0.000				
		2.350			-1559.843			
					-80.906			
	2	0.000						
		0.000	0.000	0.000				
		2.350	0.000	0.000				
		2.350			-80.906			
					160.159			
	3	0.000						
		0.000	0.000	0.000				
		2.350	0.000	0.000				
		2.350			160.159			

LISA KK 1

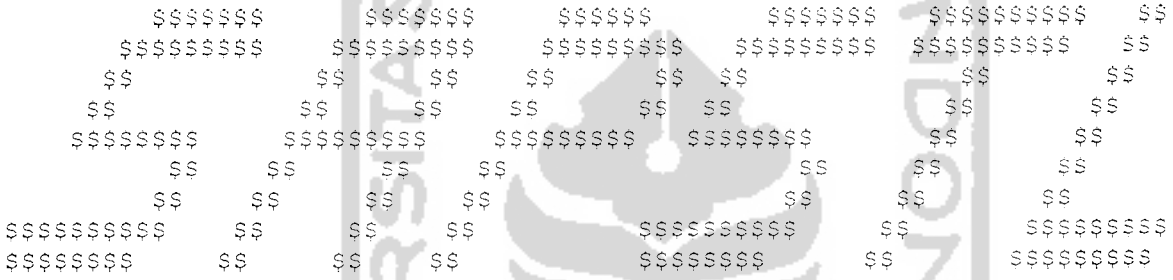
A M E E L E M E N T F O R C E S

LT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
39								
	1	0.000			-1848.099			
		0.000	0.000	0.000				
		2.806	0.000	0.000				
		2.806			-1848.099			
	2	0.000			-96.376			
		0.000	0.000	0.000				
		2.806	0.000	0.000				
		2.806			-96.376			
	3	0.000			190.553			
		0.000	0.000	0.000				
		2.806	0.000	0.000				
		2.806			190.553			
40								
	1	0.000			-2180.563			
		0.000	0.000	0.000				
		3.323	0.000	0.000				
		3.323			-2180.563			
	2	0.000			-114.022			
		0.000	0.000	0.000				
		3.323	0.000	0.000				
		3.323			-114.022			
	3	0.000			225.306			
		0.000	0.000	0.000				
		3.323	0.000	0.000				
		3.323			225.306			
41								
	1	0.000			-2172.116			
		0.000	0.000	0.000				
		3.325	0.000	0.000				
		3.325			-2172.116			
	2	0.000			225.259			
		0.000	0.000	0.000				
		3.325	0.000	0.000				
		3.325			225.259			
	3	0.000			-225.255			
		0.000	0.000	0.000				
		3.325	0.000	0.000				
		3.325			-225.255			
42								
	1	0.000			-1835.124			

ISA KK 1

A M E E L E M E N T F O R C E S

T LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		AXIAL
D COMB	ENDI	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	TORQ
	0.000	0.000	0.000				
	2.809	0.000	0.000				
	2.809			-1835.124			
2	0.000			190.304			
	0.000	0.000	0.000				
	2.809	0.000	0.000				
	2.809			190.304			
3	0.000			-190.299			
	0.000	0.000	0.000				
	2.809	0.000	0.000				
	2.809			-190.299			
43	----------						
1	0.000			-1538.186			
	0.000	0.000	0.000				
	2.354	0.000	0.000				
	2.354			-1538.186			
2	0.000			159.499			
	0.000	0.000	0.000				
	2.354	0.000	0.000				
	2.354			159.499			
3	0.000			-159.493			
	0.000	0.000	0.000				
	2.354	0.000	0.000				
	2.354			-159.493			
44	----------						
1	0.000			-1308.974			
	0.000	0.000	0.000				
	2.003	0.000	0.000				
	2.003			-1308.974			
2	0.000			135.705			
	0.000	0.000	0.000				
	2.003	0.000	0.000				
	2.003			135.705			
3	0.000			-135.695			
	0.000	0.000	0.000				
	2.003	0.000	0.000				
	2.003			-135.695			
45	----------						
1	0.000			-1188.238			
	0.000	0.000	0.000				
	1.816	0.000	0.000				
	1.816			-1188.238			



AISC STRESS CHECK FOR SAP90

VERSION 5.20

Copyright (C) 1986-1990
ASHRAF HABIBULLAH AND EDWARD L. WILSON
All rights reserved

```
PERIKSA DIMENSI PROFIL BAJA
C SATUAN : KG.M

C KONTROL INFORMATION
CONTROL
IT=1
C LOADING COMBINATION DATA
COMBO
1 C=1,0,0
2 C=0,1,0
3 C=0,0,1

SECTIONS
1  MN=S   SH=T T=0.07,0.15,0.007,0.024      E=2.1E10    FY=24E06
2  MN=S   SH=T T=0.06,0.013,0.006,0.022     E=2.1E10    FY=24E06

FRAME
1 24 1    T=2    M=1  K=1,1
25 45 1          M=2
```



PERIKSA DIMENSI PROFIL BAJA

C O N T R O L D A T A

EXECUTION MODE - - - - - - - - - - - - -	0
STRESS CHECK TYPE - - - - - - - - - - -	1
LIVE LOAD CONDITION NUMBER - - - - - -	0
PRINT SUPPRESSION FLAG - - - - - - - -	0
OVERRIDE FLAG FOR UNITY K-FACTORS - -	0
TYPE OF UNITS - - - - - - - - - - - - -	E
INTERACTION STRESS RATIO CUTOFF - - -	.0005
SHEAR STRESS RATIO CUTOFF - - - - - -	.0005

PERIKSA DIMENSI PROFIL BAJA

L O A D C O N D I T I O N C O M B I N A T I O N M U L T I P L I E R S

COMBINATION	CONDITION	FACTOR
1	1	1.000
2	2	1.000
3	3	1.000

PERIKSA DIMENSI PROFIL BAJA

S E C T I O N P R O P E R T Y D A T A

PROP ID	SECTION TYPE	DEPTH	FLANGE WIDTH TOP	FLANGE THICK TOP	WEB THICK	FLANGE WIDTH BOTTOM	FLANGE THICK BOTTOM
1	T	.070	.150	.007	.024		
2	T	.060	.013	.006	.022		

PERIKSA DIMENSI PROFIL BAJA

S E C T I O N P R O P E R T Y D A T A

PROP ID	SEC TYP	AREA	MOMENTS OF INERTIA I33	I22	SHEAR AREAS A2	A3
1	T	.2562E-02	.12635E-05	.20413E-05	.1680E-02	.8750E-03

2	T	.1266E-02	.35479E-06	.49014E-07	.1320E-02	.6500E-04

PERIKSA DIMENSI PROFIL BAJA

S E C T I O N P R O P E R T Y D A T A

PROP ID	SEC TYP	SECTION MODULI S33	SECTION MODULI S22	PLASTIC MODULI Z33	PLASTIC MODULI Z22	RADII OF GYRATION R33	RADII OF GYRATION R22
1	T	.2756E-04	.2722E-04	.4908E-04	.4845E-04	.022	.028
2	T	.1230E-04	.7541E-05	.1831E-04	.6787E-05	.017	.006

PERIKSA DIMENSI PROFIL BAJA

M A T E R I A L P R O P E R T Y D A T A

PROP ID	MAT TYP	MODULUS E	YIELD FY	BENDING FB33	BENDING FB22	AXIAL FA(C)	AXIAL FA(T)	SHEAR FV
1	S	.210E+11	.240E+08					
2	S	.210E+11	.240E+08					

PERIKSA DIMENSI PROFIL BAJA

F R A M E E L E M E N T D E S I G N D A T A

ELT ID	ELT TYPE	PROP ID	FACTOR R33	FACTOR K22	FACTOR FOR L33	FACTOR FOR L22	COEFF CM	COEFF CB	FACTOR LLRF
1	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
2	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
3	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
4	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
5	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
6	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
7	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
8	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
9	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
10	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
11	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
12	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
13	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
14	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
15	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
16	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
17	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
18	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
19	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
20	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
21	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
22	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
23	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
24	2	1	1.000	1.000	1.000	1.000	.850	1.000	1.000
25	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
26	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000

27	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
28	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
29	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
30	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
31	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
32	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
33	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
34	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
35	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
36	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
37	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
38	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
39	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
40	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
41	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
42	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
43	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
44	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000
45	1	2	1.000	1.000	1.000	1.000	.850	1.000	1.000

PERIKSA DIMENSI PROFIL BAJA

S A P 9 0 F R A M E E L E M E N T D A T A

ELT ID	JOINT END-I	JOINT END-J	ELEMENT LENGTH
1	1	2	1.844
2	2	3	1.844
3	3	4	1.844
4	4	5	1.844
5	5	6	1.844
6	6	7	1.844
7	7	8	1.844
8	8	9	1.844
9	9	10	1.844
10	10	11	1.844
11	11	12	1.844
12	12	13	1.844
13	1	14	2.073
14	14	15	2.079
15	15	16	2.079
16	16	17	2.079
17	17	18	2.079
18	18	19	2.079
19	19	20	2.078
20	20	21	2.078
21	21	22	2.078
22	22	23	2.078
23	23	24	2.078
24	24	13	2.078
25	2	14	.629
26	3	15	1.270
27	4	16	1.911
28	5	17	2.553
29	6	18	3.194

		(C)	.018	.018	.000	.000	1.64	2	(1.6-2)
		(T)	.360	.360	.000	.000	1.84	1	(1.6-1b)
12	T								
		(C)	.018	.018	.000	.000	.00	2	(1.6-2)
		(T)	.360	.360	.000	.000	.00	1	(1.6-1b)
13	T								
		(C)	.623	.623	.000	.000	2.07	1	(1.6-1a)
		(T)	.017	.017	.000	.000	2.07	3	(1.6-1b)
14	T								
		(C)	.564	.564	.000	.000	.00	1	(1.6-1a)
		(T)	.014	.014	.000	.000	.00	3	(1.6-1b)
15	T								
		(C)	.506	.506	.000	.000	.00	1	(1.6-1a)
		(T)	.011	.011	.000	.000	.00	3	(1.6-1b)
16	T								
		(C)	.449	.449	.000	.000	.00	1	(1.6-1a)
		(T)	.009	.009	.000	.000	.00	3	(1.6-1b)
17	T								
		(C)	.393	.393	.000	.000	.00	1	(1.6-1a)
		(T)	.006	.006	.000	.000	.00	3	(1.6-1b)

PERIKSA DIMENSI PROFIL BAJA

AISC SPECIFICATIONS, PART 1 (ELASTIC)
AXIAL LOAD & BIAXIAL MOMENT INTERACTION STRESS CHECK

ELEM ID	SECTION TYPE	CHK TYPE	STRESS = AXL + B33 + B22 RATIO				STATION LOCATION	COMBO NO	AISC EQUATION	COMPACT FLAGS
18	T									
		(C)	.337	.337	.000	.000	.00	1	(1.6-1a)	
		(T)	.003	.003	.000	.000	.00	3	(1.6-1b)	
19	T									
		(C)	.336	.336	.000	.000	2.08	1	(1.6-1a)	
		(T)	.005	.005	.000	.000	2.08	3	(1.6-1b)	
20	T									
		(C)	.392	.392	.000	.000	2.08	1	(1.6-1a)	
		(T)	.004	.004	.000	.000	2.08	2	(1.6-1b)	
21	T									
		(C)	.448	.448	.000	.000	2.08	1	(1.6-1a)	
		(T)	.006	.006	.000	.000	2.08	2	(1.6-1b)	
22	T									
		(C)	.504	.504	.000	.000	2.08	1	(1.6-1a)	
		(T)	.009	.009	.000	.000	2.08	2	(1.6-1b)	
23	T									
		(C)	.560	.560	.000	.000	2.08	1	(1.6-1a)	
		(T)	.012	.012	.000	.000	2.08	2	(1.6-1b)	
24	T									
		(C)	.616	.616	.000	.000	.00	1	(1.6-1a)	
		(T)	.014	.014	.000	.000	.00	2	(1.6-1b)	
25	T									
		(T)	.008	.008	.000	.000	.00	1	(1.6-1b)	
26	T									
		(C)	.001	.001	.000	.000	1.27	3	(1.6-2)	
		(T)	.020	.020	.000	.000	1.27	1	(1.6-1b)	
27	T									

		(C)	.003	.003	.000	.000	1.91	3	(1.6-2)
		(T)	.031	.031	.000	.000	1.91	1	(1.6-1b)
28	T								
		(C)	.007	.007	.000	.000	2.55	3	(1.6-2)
		(T)	.042	.042	.000	.000	2.55	1	(1.6-1b)
29	T								
		(C)	.013	.013	.000	.000	3.19	3	(1.6-2)
		(T)	.054	.054	.000	.000	3.19	1	(1.6-1b)
30	T								
		(C)	.016	.016	.000	.000	.00	3	(1.6-2)
		(T)	.207	.207	.000	.000	3.84	1	(1.6-1b)
31	T								
		(C)	.013	.013	.000	.000	3.20	2	(1.6-2)
		(T)	.053	.053	.000	.000	3.20	1	(1.6-1b)
32	T								
		(C)	.007	.007	.000	.000	2.56	2	(1.6-2)
		(T)	.042	.042	.000	.000	2.56	1	(1.6-1b)
33	T								
		(C)	.003	.003	.000	.000	1.92	2	(1.6-2)
		(T)	.031	.031	.000	.000	.00	1	(1.6-1b)
34	T								
		(C)	.001	.001	.000	.000	.00	2	(1.6-2)
		(T)	.019	.019	.000	.000	.00	1	(1.6-1b)
35	T								
		(T)	.008	.008	.000	.000	.00	1	(1.6-1b)

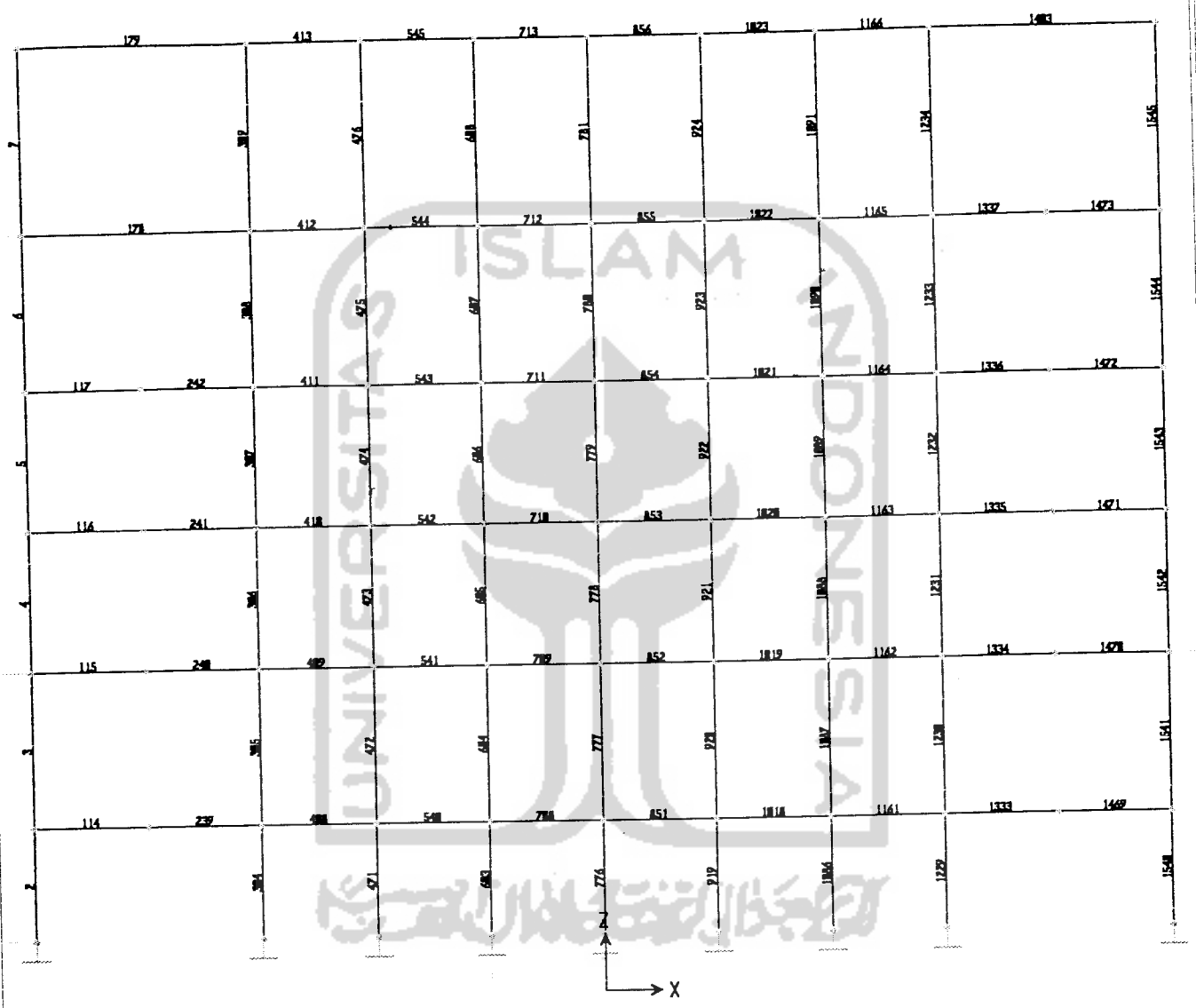
PERIKSA DIMENSI PROFIL BAJA

AISC SPECIFICATIONS, PART 1 (ELASTIC)
AXIAL LOAD & BIAXIAL MOMENT INTERACTION STRESS CHECK

ELEM ID	SECTION TYPE	CHK TYPE	STRESS = AXL + B33 + B22 RATIO				STATION LOCATION	COMBO NO	AISC EQUATION	COMPACT FLAGS
36	T									
		(C)	.050	.050	.000	.000	.00	1	(1.6-2)	
		(T)	.003	.003	.000	.000	.00	3	(1.6-1b)	
37	T									
		(C)	.054	.054	.000	.000	.00	1	(1.6-2)	
		(T)	.004	.004	.000	.000	.00	3	(1.6-1b)	
38	T									
		(C)	.071	.071	.000	.000	2.35	1	(1.6-2)	
		(T)	.004	.004	.000	.000	2.35	3	(1.6-1b)	
39	T									
		(C)	.107	.107	.000	.000	2.81	1	(1.6-2)	
		(T)	.005	.005	.000	.000	2.81	3	(1.6-1b)	
40	T									
		(C)	.176	.176	.000	.000	3.32	1	(1.6-1a)	
		(T)	.006	.006	.000	.000	3.32	3	(1.6-1b)	
41	T									
		(C)	.176	.176	.000	.000	.00	1	(1.6-1a)	
		(T)	.006	.006	.000	.000	.00	2	(1.6-1b)	
42	T									
		(C)	.107	.107	.000	.000	.00	1	(1.6-2)	
		(T)	.005	.005	.000	.000	.00	2	(1.6-1b)	
43	T									

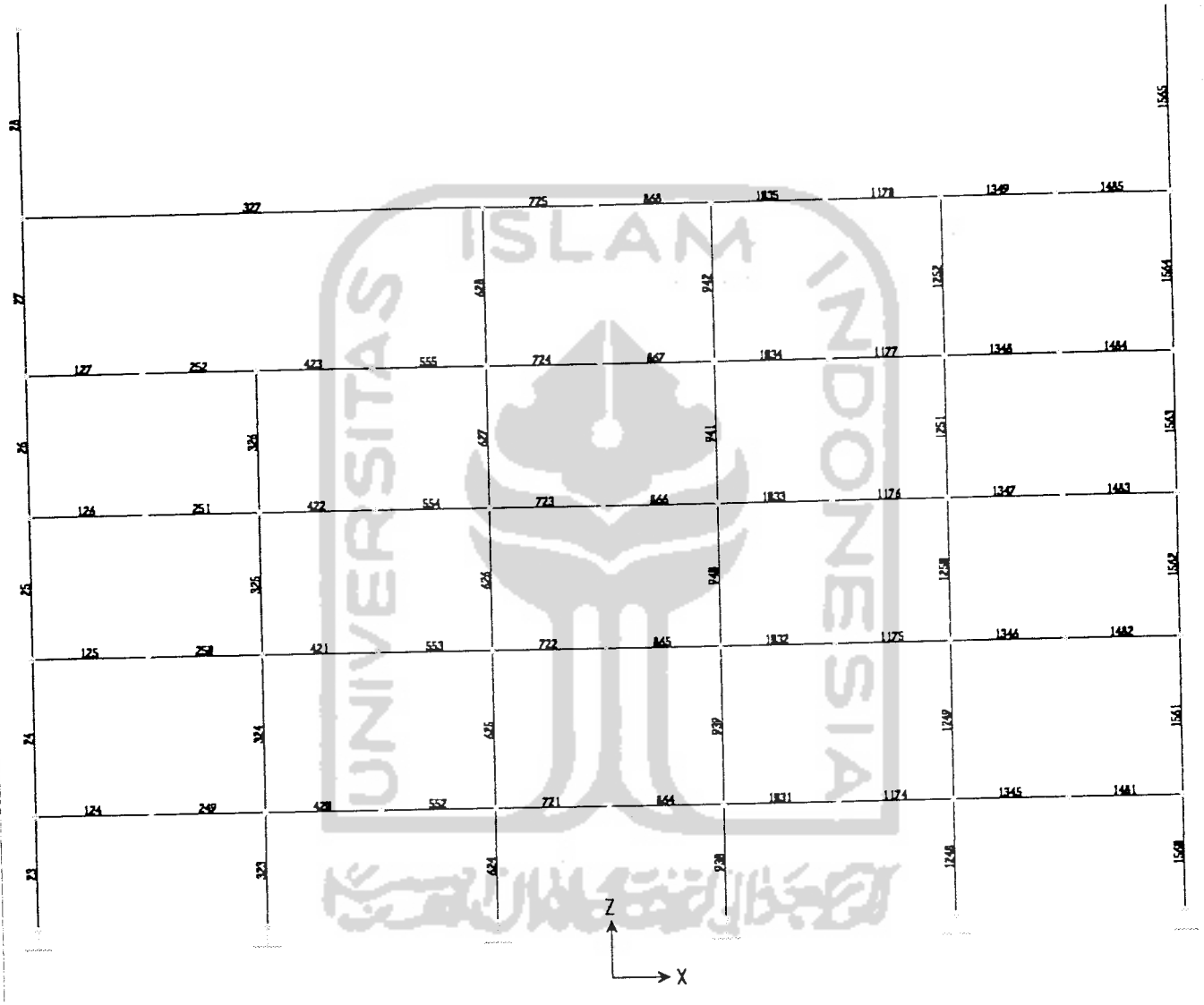
		(C)	.071	.071	.000	.000	.00	1 (1.6-2)
		(T)	.004	.004	.000	.000	.00	2 (1.6-1b)
44	T							
		(C)	.052	.052	.000	.000	2.00	1 (1.6-2)
		(T)	.004	.004	.000	.000	2.00	2 (1.6-1b)
45	T							
		(C)	.045	.045	.000	.000	1.82	1 (1.6-2)
		(T)	.003	.003	.000	.000	1.82	2 (1.6-1b)

LAMPIRAN 3



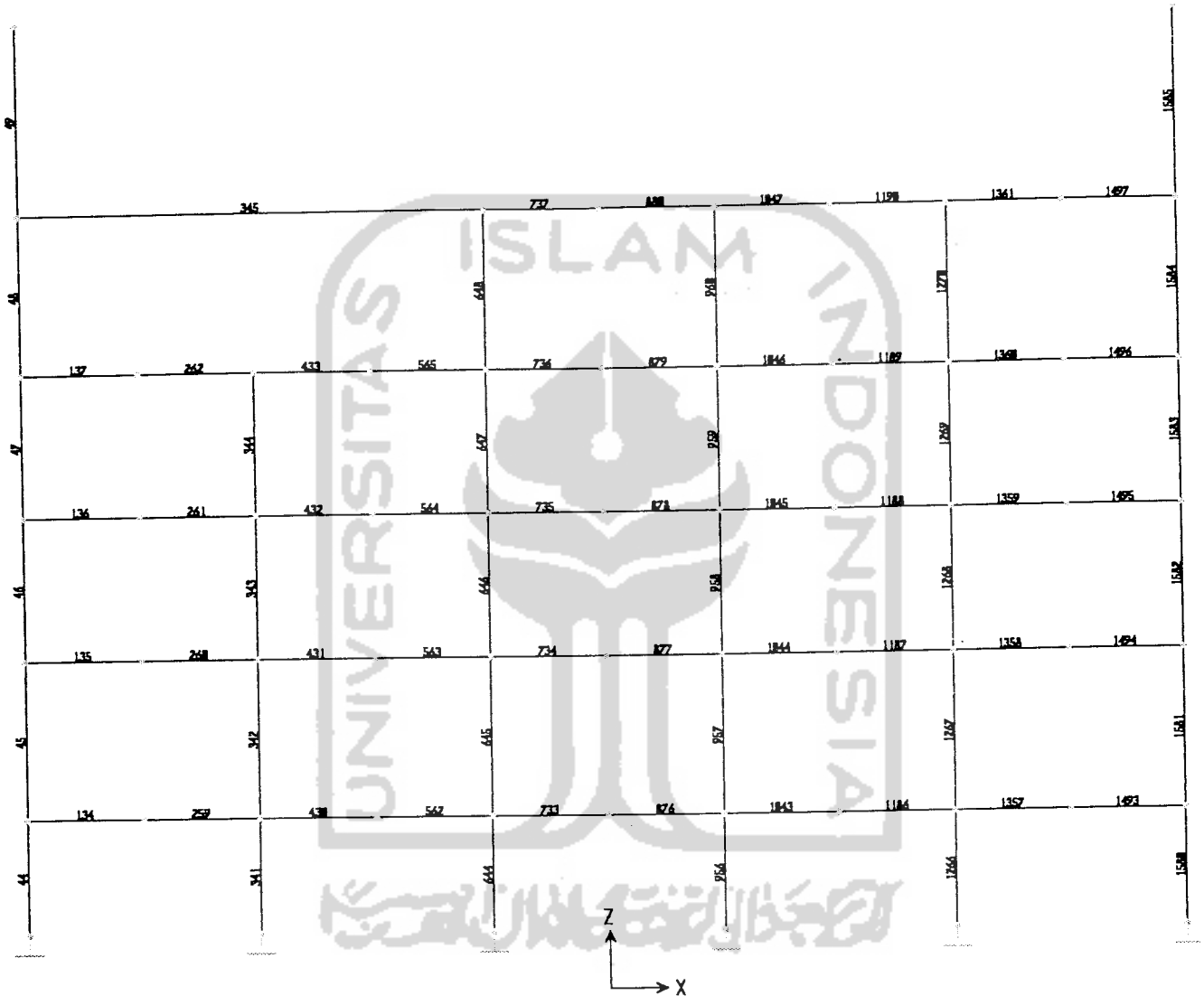
SAP2000 v7.40 - File:desain 650x650 - X-Z Plane @ Y=0 - KN-m Units

Lampiran 3.2



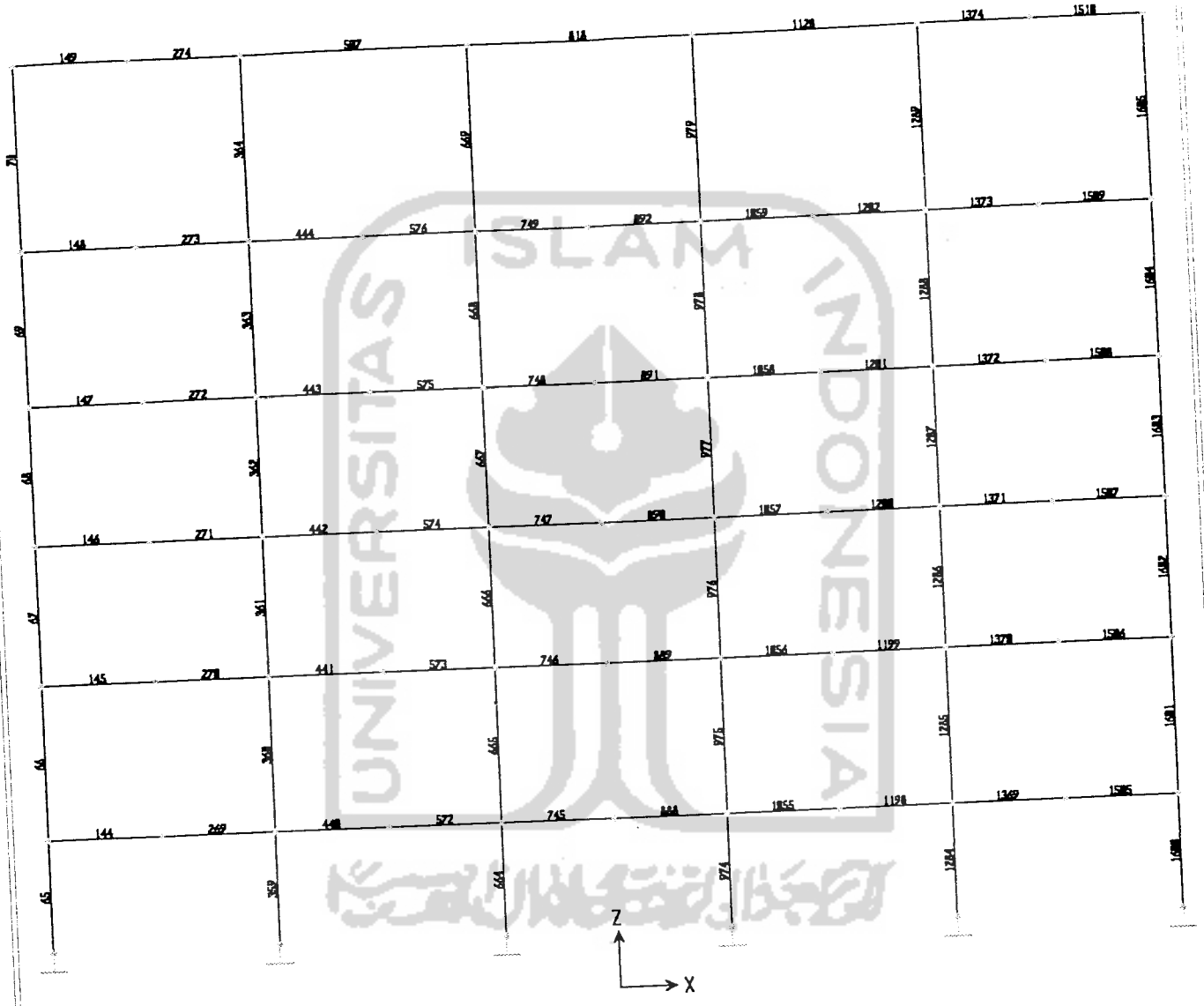
SAP2000 v7.40 - File:desain 650x650 - X-Z Plane @ Y=7.2 - KN-m Units

Lampiran 3.3



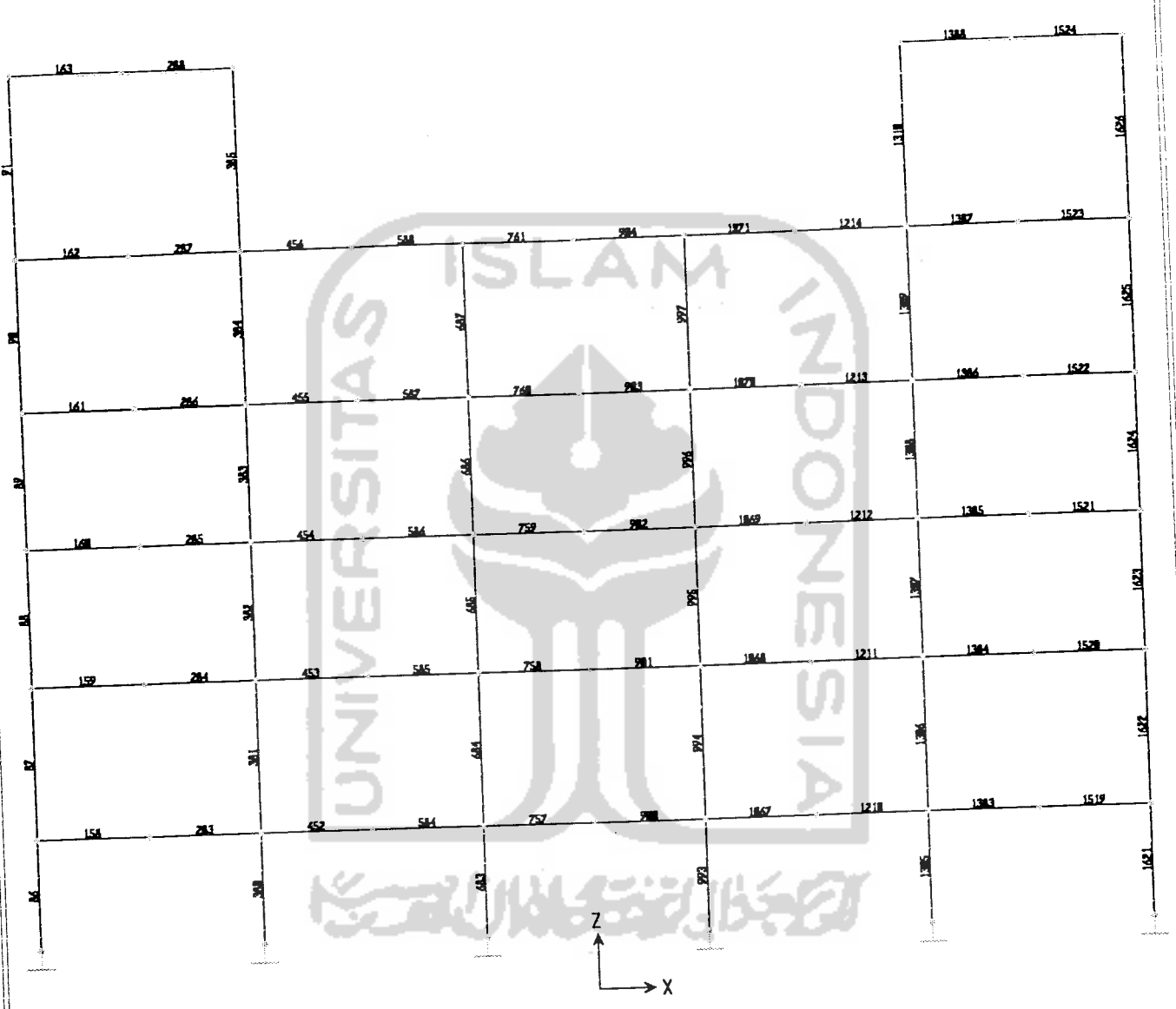
SAP2000 v7.40 - File:desain 650x650 - X-Z Plane @ Y=14.4 - KN-m Units

lampiran 3.4



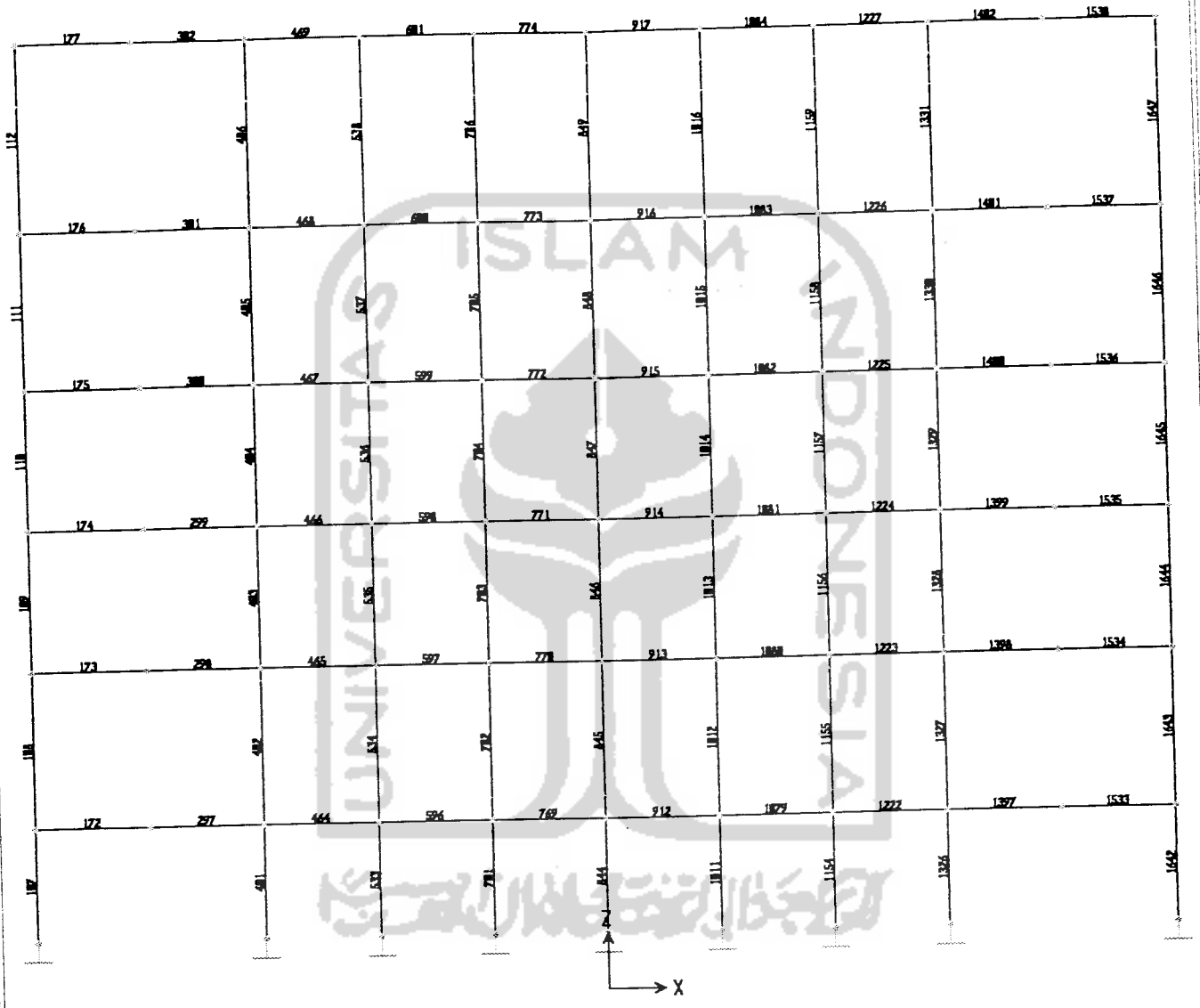
SAP2000 v7.40 - File:desain 650x650 - X-Z Plane @ Y=21.6 - KN-m Units

Lampiran 3.5

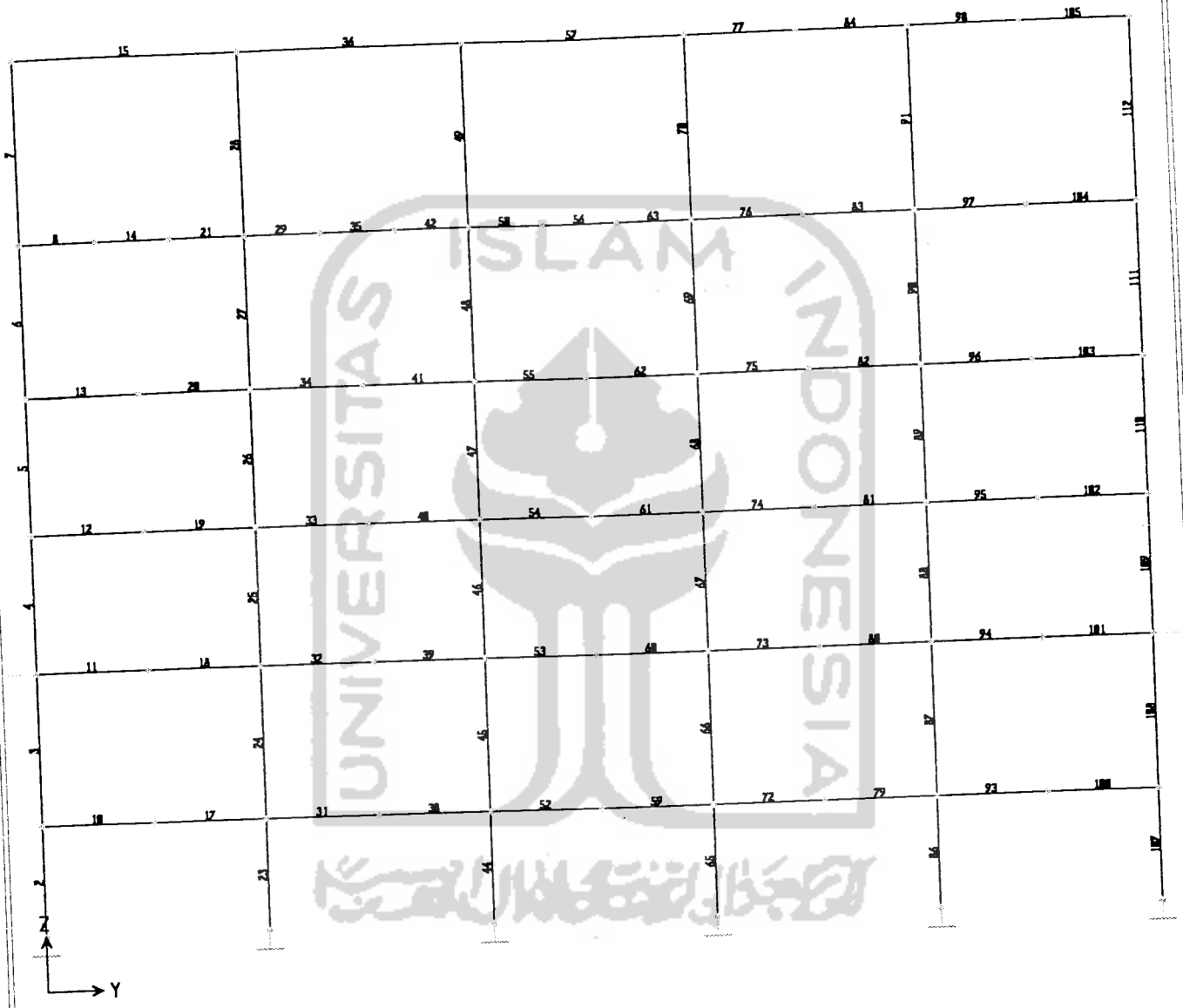


SAP2000 v7.40 - File:desain 650x650 - X-Z Plane @ Y=28.8 - KN-m Units

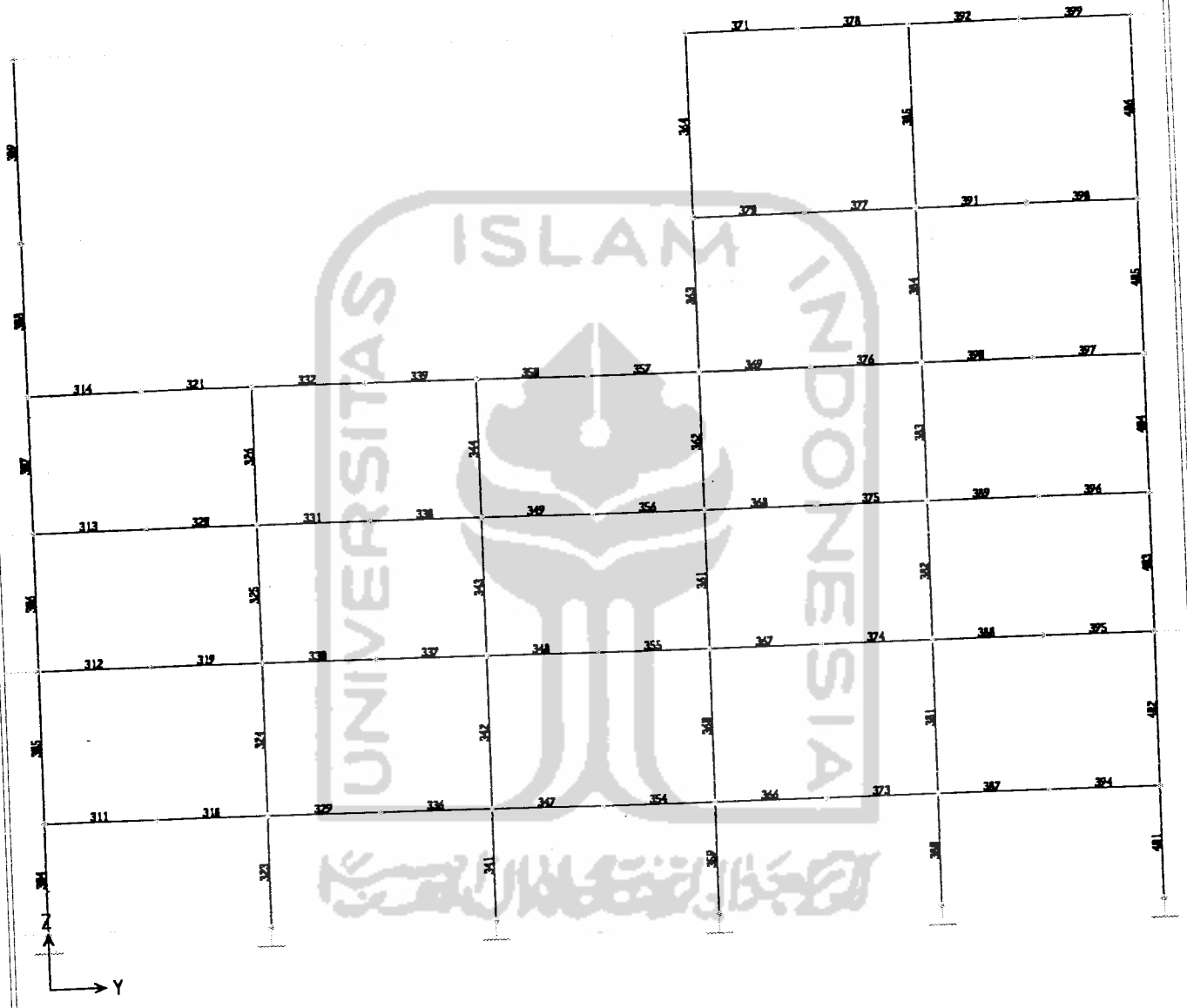
lampiran 3.6



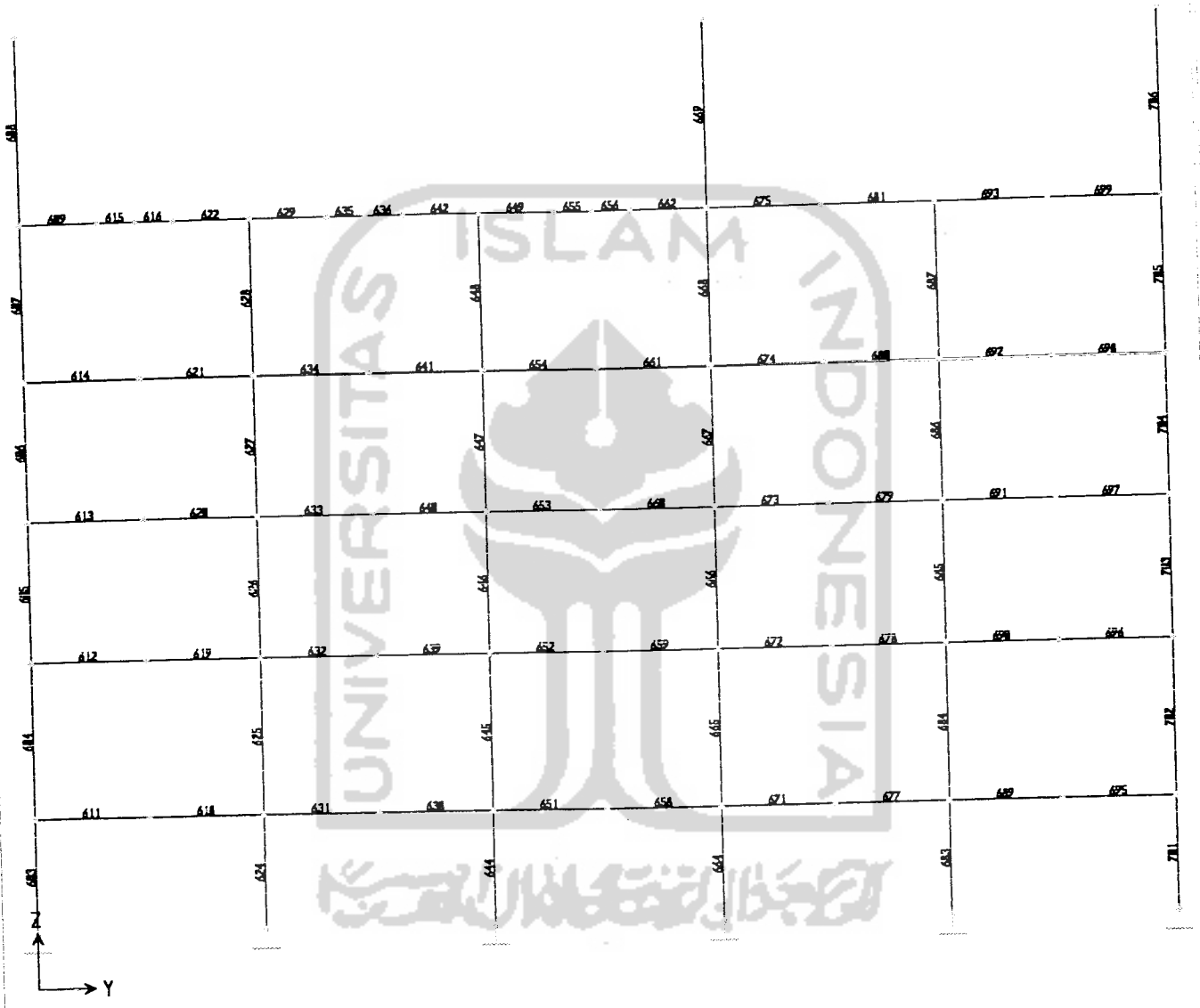
lampiran 3.7



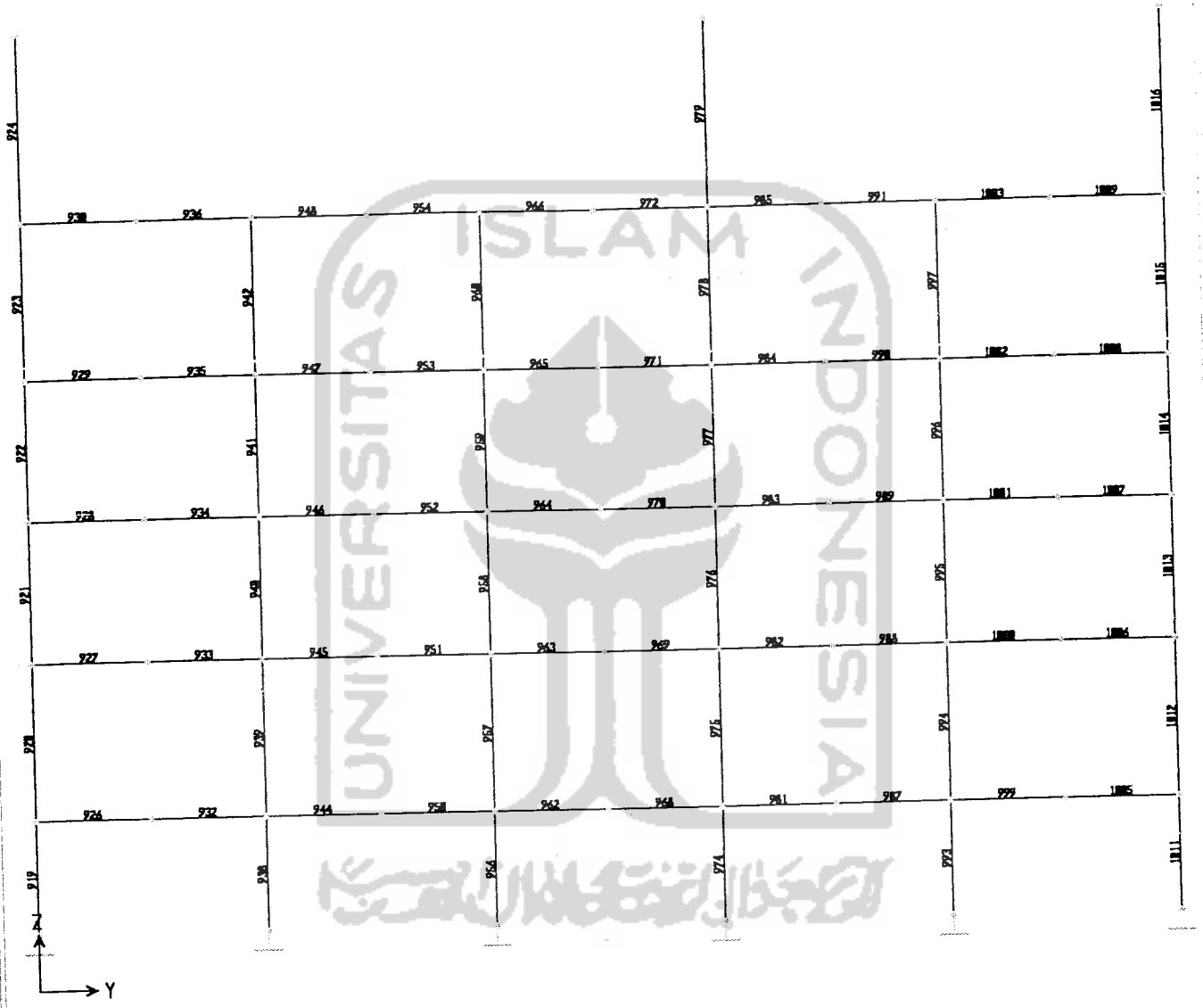
lampiran 3.8



lampiran 3.9

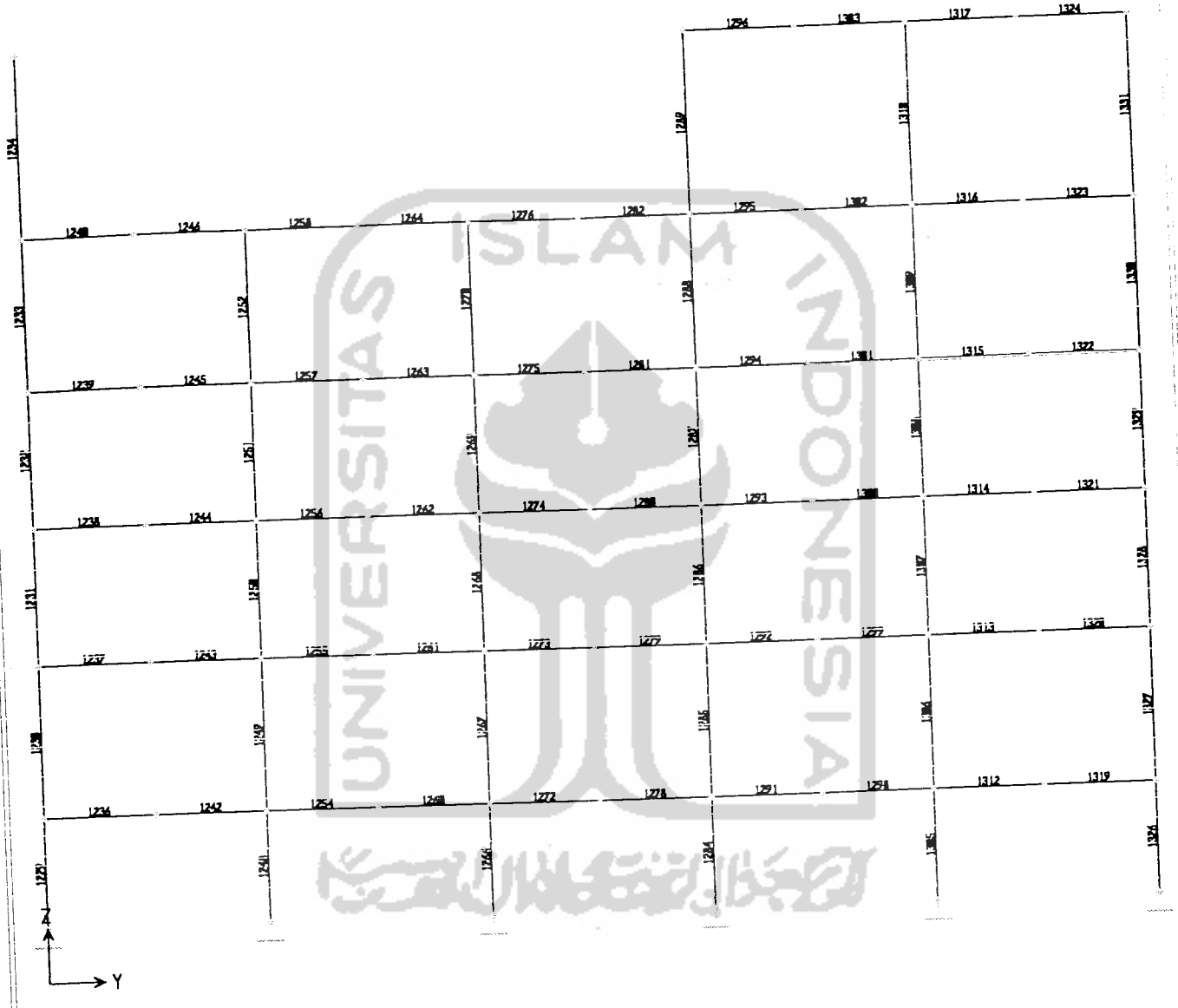


Lampiran 3.10



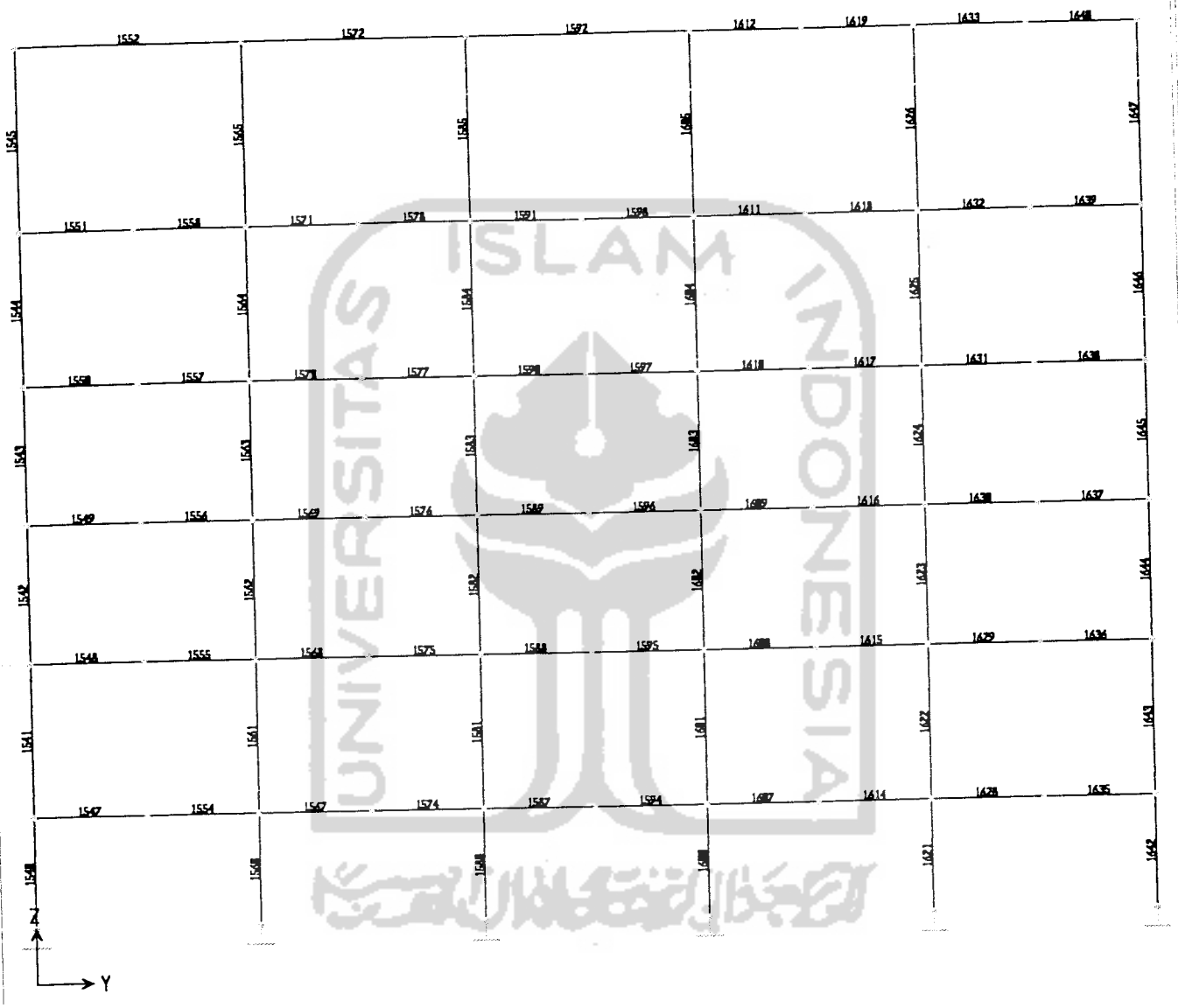
SAP2000 v7.40 - File:desain 650x650 - Y-Z Plane @ X=3.6 - KN-m Units

Lampiran 3.11

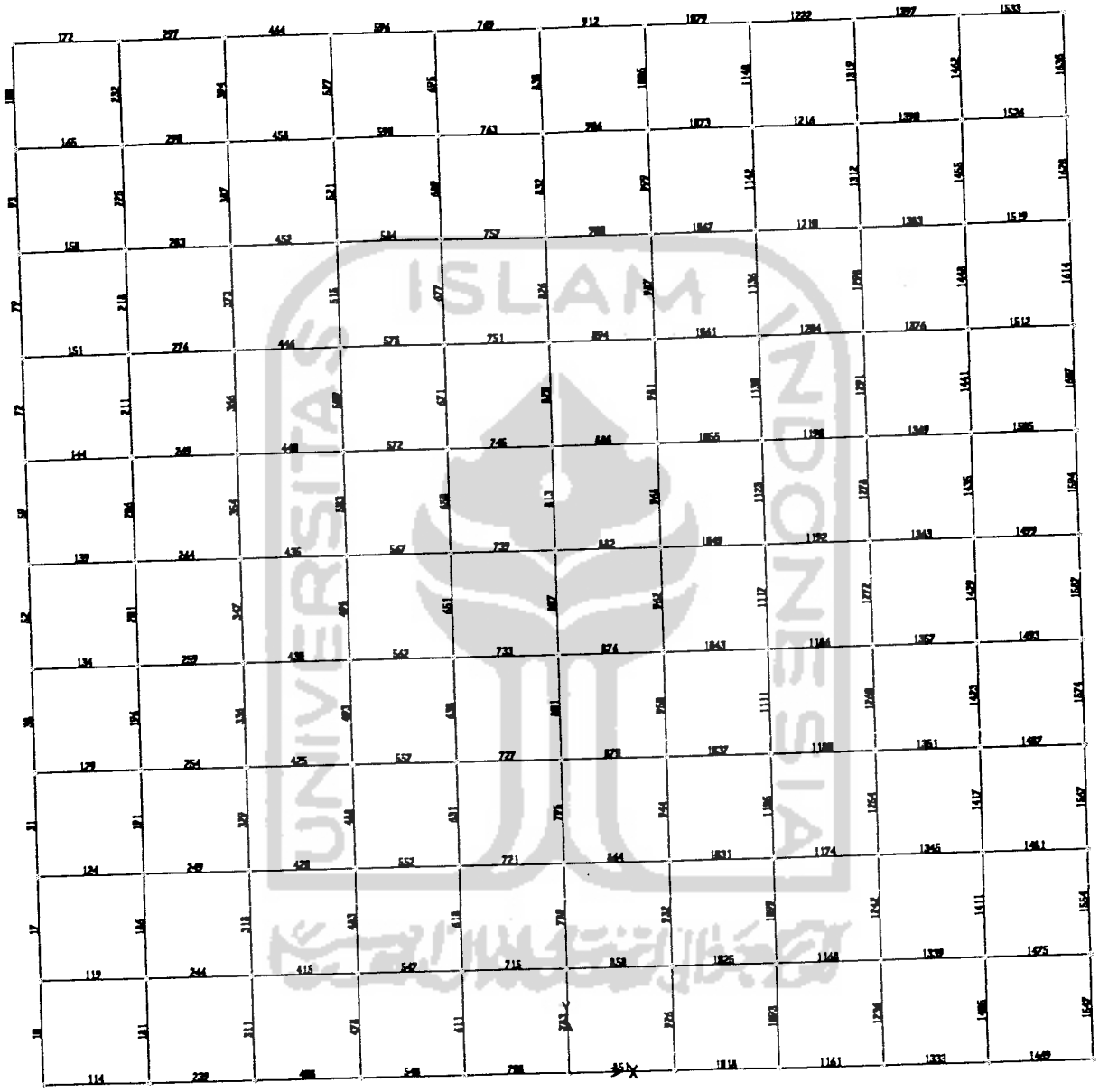


SAP2000 v7.40 - File:desain 650x650 - Y-Z Plane @ X=10.8 - KN-m Units

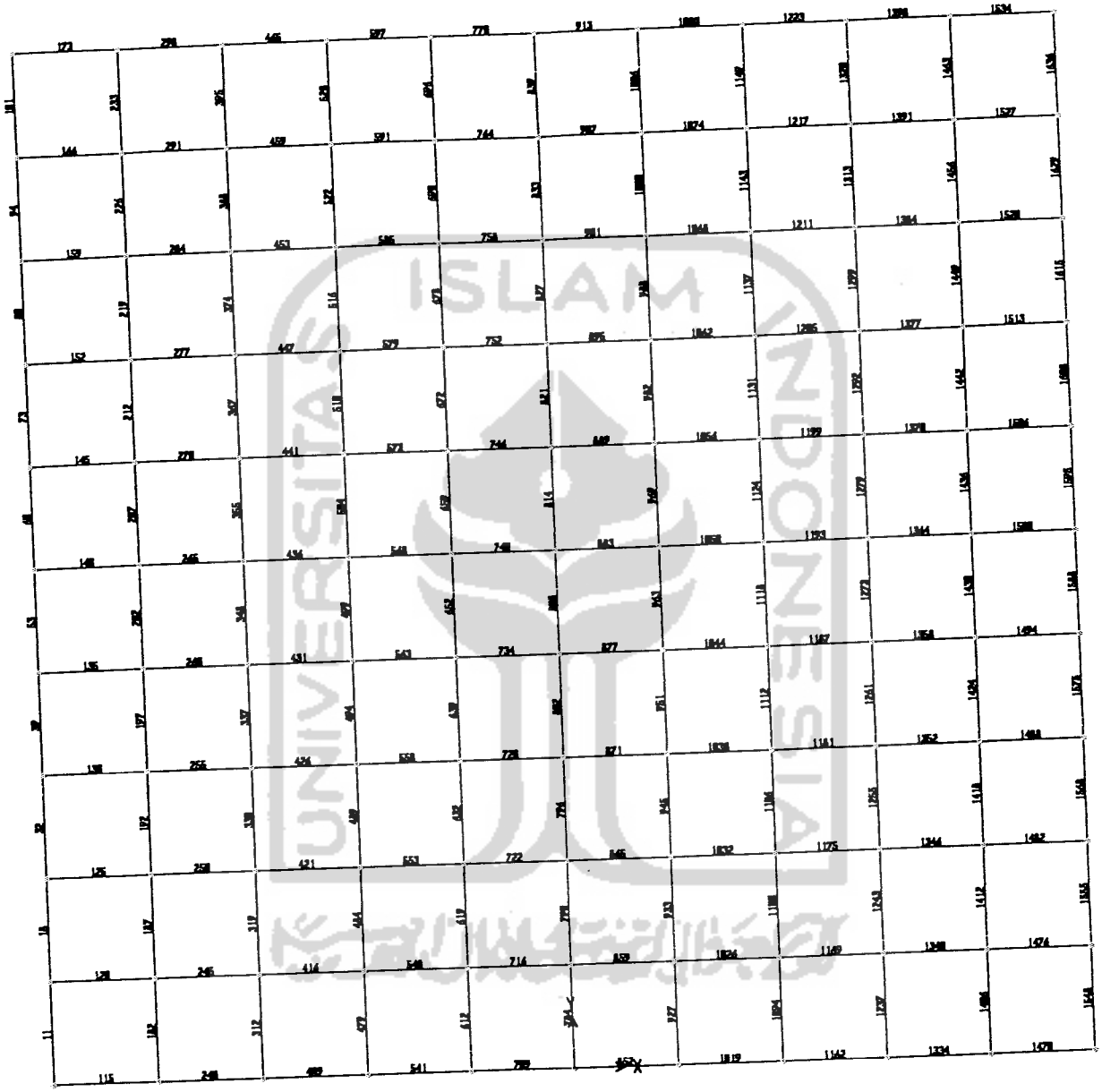
lampiran 3.12



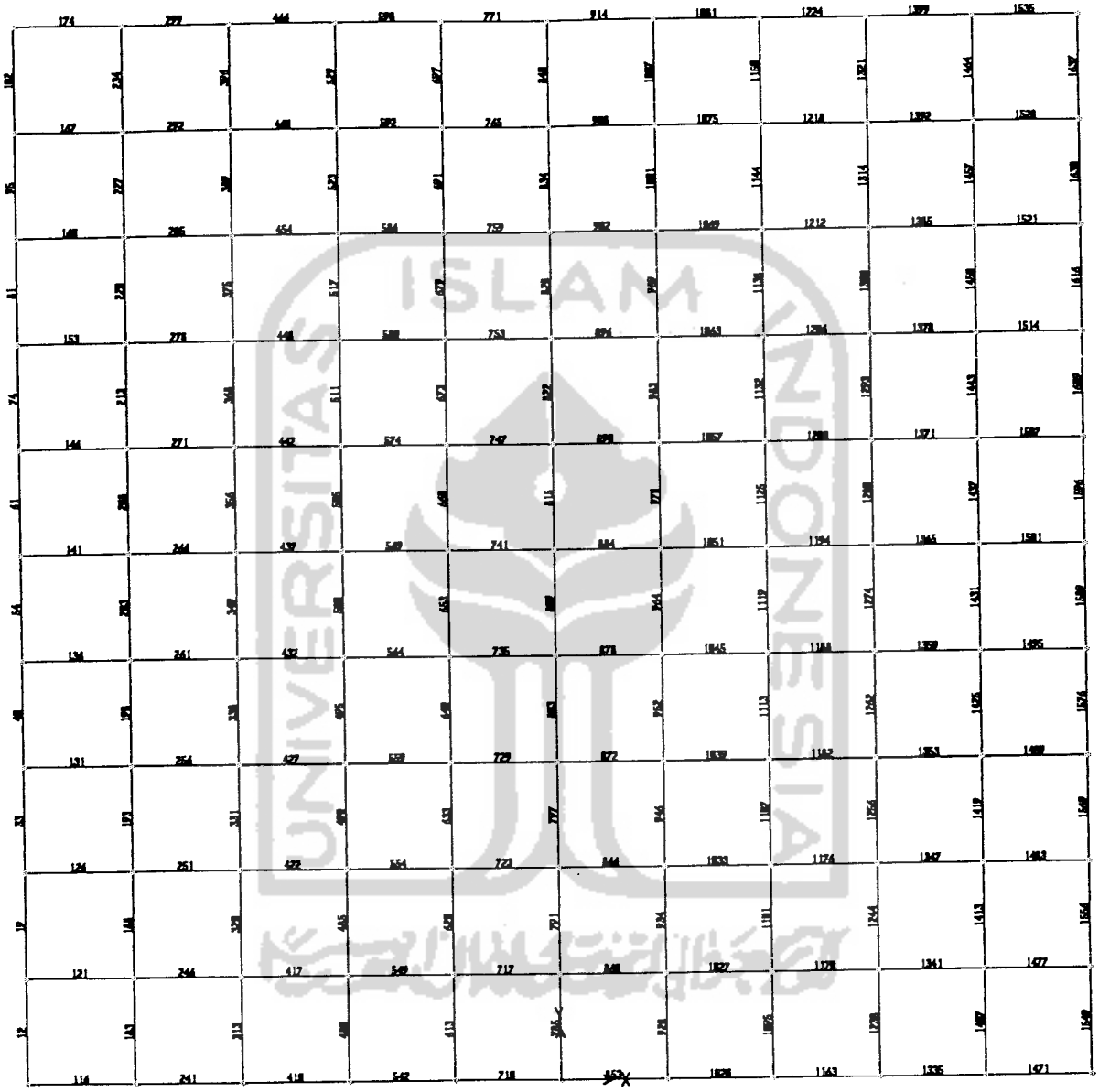
Lampiran 3.13



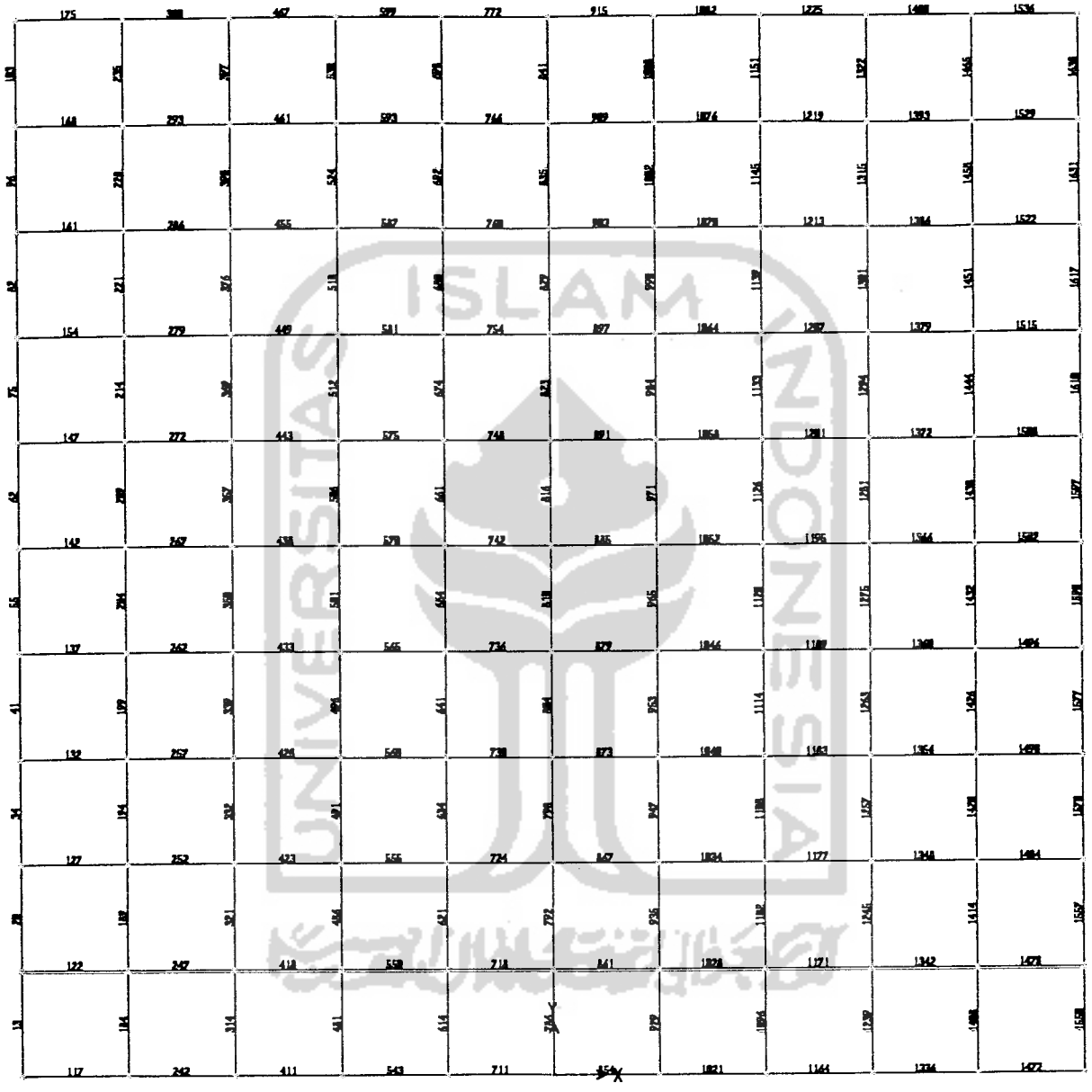
Lampiran 3.14



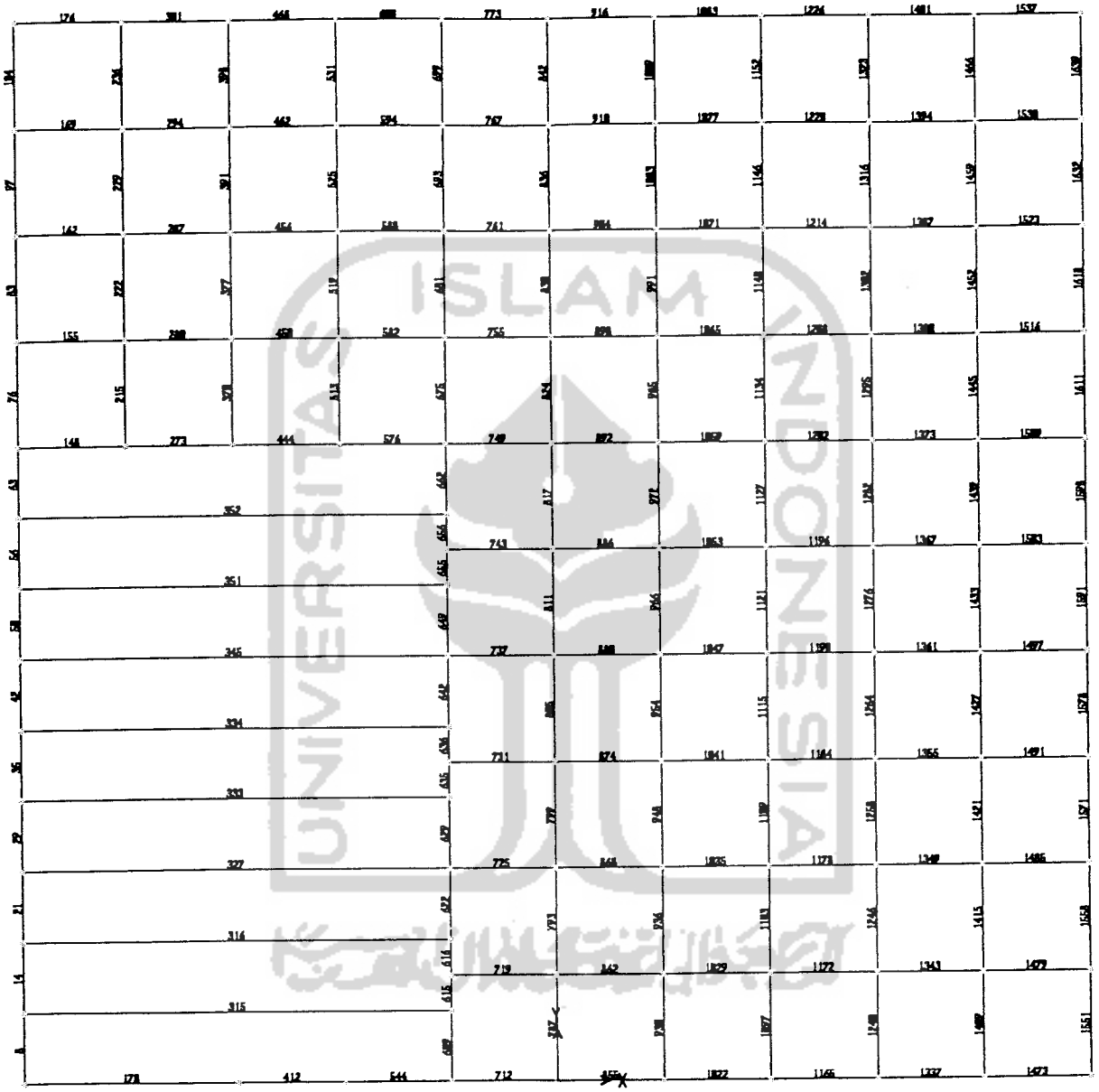
lampiran 3.15



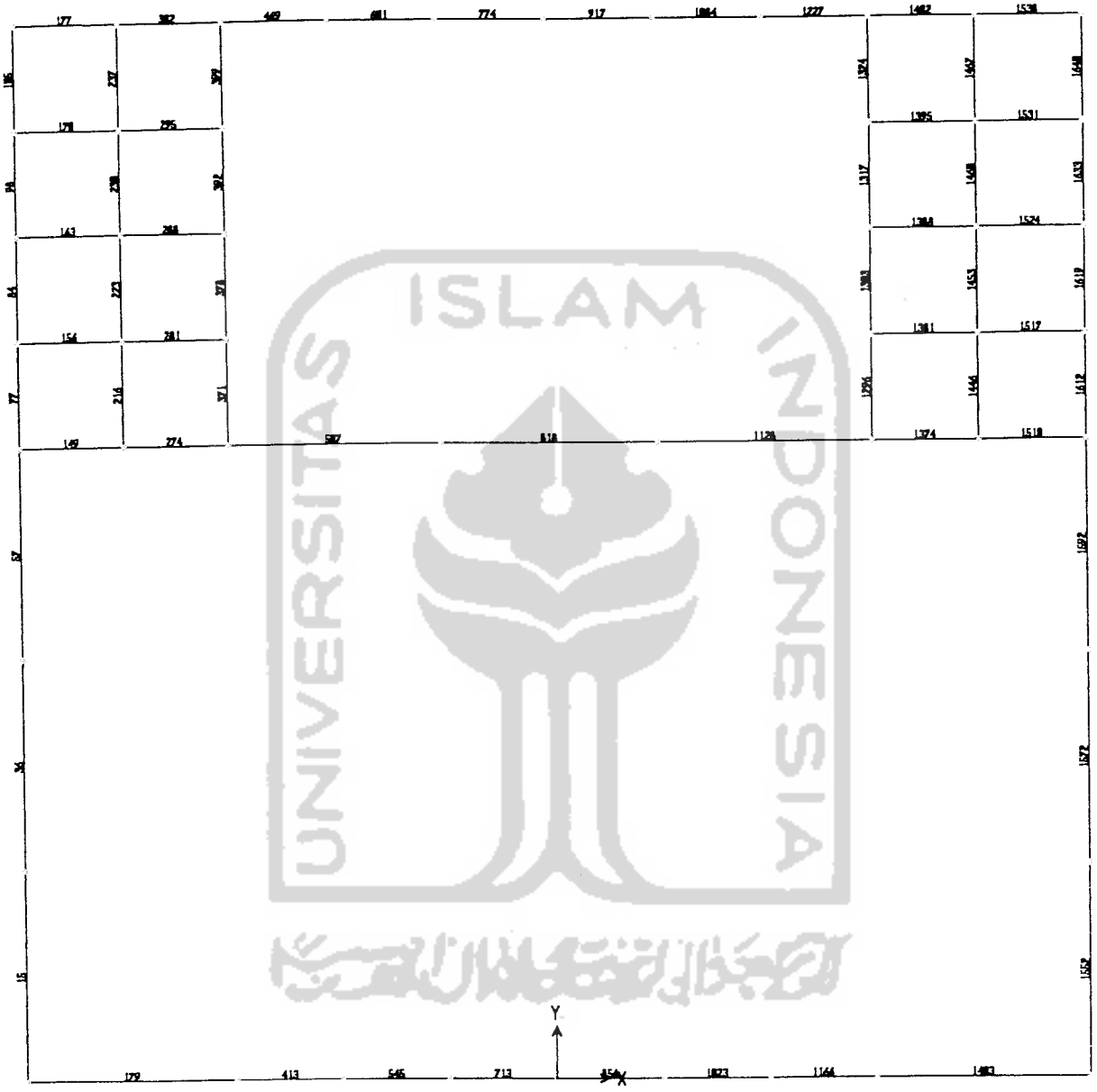
lampiran 3.16



Lampiran 3.17



lampiran 3.18



L

LAMPIRAN 4

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
1	110	DL	0	1.034	21.642	0.017	-0.057	0.028	83.964
2	110	DL	0.9	1.034	37.184	0.017	-0.057	0.013	57.493
3	110	DL	1.8	1.034	52.726	0.017	-0.057	-0.002	17.033
4	110	DL	2.7	1.034	68.268	0.017	-0.057	-0.017	-37.414
5	110	DL	3.6	1.034	83.811	0.017	-0.057	-0.032	-105.850
6	110	LL	0	0.362	5.125	0.003	-0.002	0.006	20.933
7	110	LL	0.9	0.362	9.175	0.003	-0.002	0.003	14.497
8	110	LL	1.8	0.362	13.225	0.003	-0.002	0.000	4.417
9	110	LL	2.7	0.362	17.275	0.003	-0.002	-0.003	-9.309
10	110	LL	3.6	0.362	21.325	0.003	-0.002	-0.006	-26.679
11	110	EX	0	-0.067	-0.054	1.458	-8.728	2.354	-0.006
12	110	EX	0.9	-0.067	-0.054	1.458	-8.728	1.042	0.042
13	110	EX	1.8	-0.067	-0.054	1.458	-8.728	-0.270	0.091
14	110	EX	2.7	-0.067	-0.054	1.458	-8.728	-1.582	0.139
15	110	EX	3.6	-0.067	-0.054	1.458	-8.728	-2.894	0.188
16	110	EY	0	-1.018	-33.602	0.036	0.020	0.055	-5.814
17	110	EY	0.9	-1.018	-33.602	0.036	0.020	0.023	24.428
18	110	EY	1.8	-1.018	-33.602	0.036	0.020	-0.009	54.669
19	110	EY	2.7	-1.018	-33.602	0.036	0.020	-0.041	84.911
20	110	EY	3.6	-1.018	-33.602	0.036	0.020	-0.074	115.152
21	110	COMB1	0	1.820	34.171	0.026	-0.071	0.043	134.249
22	110	COMB1	0.9	1.820	59.301	0.026	-0.071	0.020	92.187
23	110	COMB1	1.8	1.820	84.432	0.026	-0.071	-0.003	27.507
24	110	COMB1	2.7	1.820	109.563	0.026	-0.071	-0.026	-59.791
25	110	COMB1	3.6	1.820	134.693	0.026	-0.071	-0.049	-169.706
26	110	COMB2	0	0.923	15.312	1.562	-9.219	2.523	99.512
27	110	COMB2	0.9	0.923	34.183	1.562	-9.219	1.117	77.240
28	110	COMB2	1.8	0.923	53.053	1.562	-9.219	-0.289	37.983
29	110	COMB2	2.7	0.923	71.924	1.562	-9.219	-1.694	-18.257
30	110	COMB2	3.6	0.923	90.795	1.562	-9.219	-3.100	-91.480
31	110	COMB3	0	1.564	36.481	1.539	-9.232	2.488	103.175
32	110	COMB3	0.9	1.564	55.352	1.539	-9.232	1.103	61.850
33	110	COMB3	1.8	1.564	74.222	1.539	-9.232	-0.283	3.542
34	110	COMB3	2.7	1.564	93.093	1.539	-9.232	-1.668	-71.750
35	110	COMB3	3.6	1.564	111.964	1.539	-9.232	-3.053	-164.026
36	110	COMB4	0	1.063	15.425	-1.500	9.110	-2.422	99.525
37	110	COMB4	0.9	1.063	34.296	-1.500	9.110	-1.072	77.151
38	110	COMB4	1.8	1.063	53.167	-1.500	9.110	0.278	37.793
39	110	COMB4	2.7	1.063	72.037	-1.500	9.110	1.628	-18.549
40	110	COMB4	3.6	1.063	90.908	-1.500	9.110	2.977	-91.874
41	110	COMB5	0	1.704	36.594	-1.522	9.097	-2.457	103.188
42	110	COMB5	0.9	1.704	55.465	-1.522	9.097	-1.086	61.762
43	110	COMB5	1.8	1.704	74.336	-1.522	9.097	0.284	3.352
44	110	COMB5	2.7	1.704	93.206	-1.522	9.097	1.654	-72.042
45	110	COMB5	3.6	1.704	112.077	-1.522	9.097	3.024	-164.420
46	110	COMB6	0	0.224	-9.346	0.517	-2.789	0.833	95.244
47	110	COMB6	0.9	0.224	9.525	0.517	-2.789	0.368	95.163
48	110	COMB6	1.8	0.224	28.396	0.517	-2.789	-0.097	78.099
49	110	COMB6	2.7	0.224	47.267	0.517	-2.789	-0.562	44.051
50	110	COMB6	3.6	0.224	66.137	0.517	-2.789	-1.027	-6.981

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
51	110	COMB7	0	2.361	61.218	0.441	-2.831	0.717	107.453
52	110	COMB7	0.9	2.361	80.088	0.441	-2.831	0.320	43.865
53	110	COMB7	1.8	2.361	98.959	0.441	-2.831	-0.078	-36.707
54	110	COMB7	2.7	2.361	117.830	0.441	-2.831	-0.475	-134.262
55	110	COMB7	3.6	2.361	136.701	0.441	-2.831	-0.872	-248.801
56	110	COMB8	0	0.266	-9.312	-0.402	2.709	-0.651	95.248
57	110	COMB8	0.9	0.266	9.559	-0.402	2.709	-0.289	95.136
58	110	COMB8	1.8	0.266	28.430	-0.402	2.709	0.073	78.042
59	110	COMB8	2.7	0.266	47.301	-0.402	2.709	0.434	43.963
60	110	COMB8	3.6	0.266	66.171	-0.402	2.709	0.796	-7.099
61	110	COMB9	0	0.266	-9.312	-0.402	2.709	-0.651	95.248
62	110	COMB9	0.9	0.266	9.559	-0.402	2.709	-0.289	95.136
63	110	COMB9	1.8	0.266	28.430	-0.402	2.709	0.073	78.042
64	110	COMB9	2.7	0.266	47.301	-0.402	2.709	0.434	43.963
65	110	COMB9	3.6	0.266	66.171	-0.402	2.709	0.796	-7.099

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
1	115	DL	0	5.349	-85.528	0.030	-0.086	0.057	-116.566
2	115	DL	0.9	5.349	-70.436	0.030	-0.086	0.030	-46.382
3	115	DL	1.8	5.349	-55.344	0.030	-0.086	0.004	10.219
4	115	DL	2.7	5.349	-40.252	0.030	-0.086	-0.023	53.237
5	115	DL	3.6	5.349	-25.159	0.030	-0.086	-0.049	82.672
6	115	LL	0	1.465	-22.375	0.007	0.017	0.014	-30.086
7	115	LL	0.9	1.465	-18.325	0.007	0.017	0.007	-11.771
8	115	LL	1.8	1.465	-14.275	0.007	0.017	0.001	2.898
9	115	LL	2.7	1.465	-10.225	0.007	0.017	-0.005	13.923
10	115	LL	3.6	1.465	-6.175	0.007	0.017	-0.012	21.303
11	115	EX	0	-0.239	0.097	5.239	-11.051	10.382	0.336
12	115	EX	0.9	-0.239	0.097	5.239	-11.051	5.667	0.248
13	115	EX	1.8	-0.239	0.097	5.239	-11.051	0.952	0.161
14	115	EX	2.7	-0.239	0.097	5.239	-11.051	-3.763	0.073
15	115	EX	3.6	-0.239	0.097	5.239	-11.051	-8.478	-0.014
16	115	EY	0	-2.860	38.870	0.119	0.026	0.237	132.789
17	115	EY	0.9	-2.860	38.870	0.119	0.026	0.131	97.806
18	115	EY	1.8	-2.860	38.870	0.119	0.026	0.024	62.823
19	115	EY	2.7	-2.860	38.870	0.119	0.026	-0.083	27.841
20	115	EY	3.6	-2.860	38.870	0.119	0.026	-0.190	-7.142
21	115	COMB1	0	8.764	-138.433	0.047	-0.076	0.090	-188.016
22	115	COMB1	0.9	8.764	-113.842	0.047	-0.076	0.048	-74.492
23	115	COMB1	1.8	8.764	-89.252	0.047	-0.076	0.006	16.900
24	115	COMB1	2.7	8.764	-64.661	0.047	-0.076	-0.036	86.161
25	115	COMB1	3.6	8.764	-40.071	0.047	-0.076	-0.078	133.290
26	115	COMB2	0	5.388	-91.554	5.574	-11.675	11.044	-99.167
27	115	COMB2	0.9	5.388	-73.156	5.574	-11.675	6.028	-25.047
28	115	COMB2	1.8	5.388	-54.758	5.574	-11.675	1.012	32.514
29	115	COMB2	2.7	5.388	-36.360	5.574	-11.675	-4.005	73.517
30	115	COMB2	3.6	5.388	-17.961	5.574	-11.675	-9.021	97.961
31	115	COMB3	0	7.190	-116.042	5.499	-11.691	10.895	-182.824
32	115	COMB3	0.9	7.190	-97.644	5.499	-11.691	5.946	-86.665
33	115	COMB3	1.8	7.190	-79.246	5.499	-11.691	0.997	-7.064
34	115	COMB3	2.7	7.190	-60.847	5.499	-11.691	-3.952	55.977
35	115	COMB3	3.6	7.190	-42.449	5.499	-11.691	-8.901	102.461
36	115	COMB4	0	5.890	-91.759	-5.428	11.532	-10.758	-99.872
37	115	COMB4	0.9	5.890	-73.360	-5.428	11.532	-5.872	-25.569
38	115	COMB4	1.8	5.890	-54.962	-5.428	11.532	-0.987	32.176
39	115	COMB4	2.7	5.890	-36.564	-5.428	11.532	3.898	73.363
40	115	COMB4	3.6	5.890	-18.165	-5.428	11.532	8.783	97.991
41	115	COMB5	0	7.692	-116.247	-5.503	11.516	-10.907	-183.529
42	115	COMB5	0.9	7.692	-97.848	-5.503	11.516	-5.955	-87.186
43	115	COMB5	1.8	7.692	-79.450	-5.503	11.516	-1.003	-7.402
44	115	COMB5	2.7	7.692	-61.052	-5.503	11.516	3.950	55.824
45	115	COMB5	3.6	7.692	-42.653	-5.503	11.516	8.902	102.491
46	115	COMB6	0	3.461	-63.057	1.810	-3.533	3.588	-1.814
47	115	COMB6	0.9	3.461	-44.658	1.810	-3.533	1.959	46.658

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
48	115	COMB6	1.8	3.461	-26.260	1.810	-3.533	0.330	78.571
49	115	COMB6	2.7	3.461	-7.862	1.810	-3.533	-1.300	93.926
50	115	COMB6	3.6	3.461	10.536	1.810	-3.533	-2.929	92.722
51	115	COMB7	0	9.468	-144.683	1.561	-3.587	3.089	-280.670
52	115	COMB7	0.9	9.468	-126.285	1.561	-3.587	1.684	-158.735
53	115	COMB7	1.8	9.468	-107.886	1.561	-3.587	0.279	-53.358
54	115	COMB7	2.7	9.468	-89.488	1.561	-3.587	-1.126	35.461
55	115	COMB7	3.6	9.468	-71.090	1.561	-3.587	-2.531	107.721
56	115	COMB8	0	3.612	-63.118	-1.490	3.429	-2.952	-2.026
57	115	COMB8	0.9	3.612	-44.720	-1.490	3.429	-1.611	46.501
58	115	COMB8	1.8	3.612	-26.321	-1.490	3.429	-0.270	78.470
59	115	COMB8	2.7	3.612	-7.923	-1.490	3.429	1.071	93.880
60	115	COMB8	3.6	3.612	10.475	-1.490	3.429	2.412	92.731
61	115	COMB9	0	3.612	-63.118	-1.490	3.429	-2.952	-2.026
62	115	COMB9	0.9	3.612	-44.720	-1.490	3.429	-1.611	46.501
63	115	COMB9	1.8	3.612	-26.321	-1.490	3.429	-0.270	78.470
64	115	COMB9	2.7	3.612	-7.923	-1.490	3.429	1.071	93.880
65	115	COMB9	3.6	3.612	10.475	-1.490	3.429	2.412	92.731

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
1	120	DL	0	0.863	27.327	-0.007	-0.229	-0.011	83.237
2	120	DL	0.9	0.863	42.419	-0.007	-0.229	-0.005	51.851
3	120	DL	1.8	0.863	57.511	-0.007	-0.229	0.001	6.883
4	120	DL	2.7	0.863	72.603	-0.007	-0.229	0.007	-51.669
5	120	DL	3.6	0.863	87.696	-0.007	-0.229	0.013	-123.803
6	120	LL	0	0.156	6.661	0.007	-0.004	0.010	21.317
7	120	LL	0.9	0.156	10.711	0.007	-0.004	0.004	13.499
8	120	LL	1.8	0.156	14.761	0.007	-0.004	-0.002	2.037
9	120	LL	2.7	0.156	18.811	0.007	-0.004	-0.008	-13.070
10	120	LL	3.6	0.156	22.861	0.007	-0.004	-0.014	-31.822
11	120	EX	0	-0.260	-0.190	7.625	-9.509	12.336	0.019
12	120	EX	0.9	-0.260	-0.190	7.625	-9.509	5.473	0.190
13	120	EX	1.8	-0.260	-0.190	7.625	-9.509	-1.390	0.362
14	120	EX	2.7	-0.260	-0.190	7.625	-9.509	-8.253	0.533
15	120	EX	3.6	-0.260	-0.190	7.625	-9.509	-15.115	0.704
16	120	EY	0	-7.904	-32.999	0.061	0.052	0.095	-4.271
17	120	EY	0.9	-7.904	-32.999	0.061	0.052	0.040	25.429
18	120	EY	1.8	-7.904	-32.999	0.061	0.052	-0.014	55.128
19	120	EY	2.7	-7.904	-32.999	0.061	0.052	-0.069	84.827
20	120	EY	3.6	-7.904	-32.999	0.061	0.052	-0.124	114.527
21	120	COMB1	0	1.286	43.449	0.003	-0.281	0.003	133.991
22	120	COMB1	0.9	1.286	68.040	0.003	-0.281	0.000	83.821
23	120	COMB1	1.8	1.286	92.631	0.003	-0.281	-0.002	11.519
24	120	COMB1	2.7	1.286	117.221	0.003	-0.281	-0.004	-82.914
25	120	COMB1	3.6	1.286	141.812	0.003	-0.281	-0.007	-199.479
26	120	COMB2	0	-1.758	22.295	8.023	-10.211	12.977	99.503
27	120	COMB2	0.9	-1.758	40.693	8.023	-10.211	5.757	71.159
28	120	COMB2	1.8	-1.758	59.091	8.023	-10.211	-1.464	26.256
29	120	COMB2	2.7	-1.758	77.490	8.023	-10.211	-8.685	-35.206
30	120	COMB2	3.6	-1.758	95.888	8.023	-10.211	-15.905	-113.226
31	120	COMB3	0	3.221	43.084	7.985	-10.244	12.917	102.194
32	120	COMB3	0.9	3.221	61.483	7.985	-10.244	5.731	55.139
33	120	COMB3	1.8	3.221	79.881	7.985	-10.244	-1.455	-8.475
34	120	COMB3	2.7	3.221	98.279	7.985	-10.244	-8.641	-88.647
35	120	COMB3	3.6	3.221	116.678	7.985	-10.244	-15.827	-185.378
36	120	COMB4	0	-1.211	22.695	-7.990	9.758	-12.928	99.463
37	120	COMB4	0.9	-1.211	41.093	-7.990	9.758	-5.737	70.759
38	120	COMB4	1.8	-1.211	59.491	-7.990	9.758	1.455	25.496
39	120	COMB4	2.7	-1.211	77.889	-7.990	9.758	8.646	-36.325
40	120	COMB4	3.6	-1.211	96.288	-7.990	9.758	15.837	-114.705
41	120	COMB5	0	3.768	43.484	-8.029	9.725	-12.988	102.154
42	120	COMB5	0.9	3.768	61.882	-8.029	9.725	-5.762	54.739
43	120	COMB5	1.8	3.768	80.281	-8.029	9.725	1.464	-9.235
44	120	COMB5	2.7	3.768	98.679	-8.029	9.725	8.689	-89.766
45	120	COMB5	3.6	3.768	117.077	-8.029	9.725	15.915	-186.857
46	120	COMB6	0	-7.376	-1.820	2.463	-3.183	3.980	96.350
47	120	COMB6	0.9	-7.376	16.578	2.463	-3.183	1.764	89.709

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
48	120	COMB6	1.8	-7.376	34.977	2.463	-3.183	-0.453	66.509
49	120	COMB6	2.7	-7.376	53.375	2.463	-3.183	-2.670	26.750
50	120	COMB6	3.6	-7.376	71.773	2.463	-3.183	-4.886	-29.566
51	120	COMB7	0	9.222	67.479	2.335	-3.293	3.780	105.319
52	120	COMB7	0.9	9.222	85.877	2.335	-3.293	1.679	36.309
53	120	COMB7	1.8	9.222	104.275	2.335	-3.293	-0.423	-49.260
54	120	COMB7	2.7	9.222	122.674	2.335	-3.293	-2.525	-151.387
55	120	COMB7	3.6	9.222	141.072	2.335	-3.293	-4.626	-270.073
56	120	COMB8	0	-7.212	-1.700	-2.341	2.807	-3.791	96.338
57	120	COMB8	0.9	-7.212	16.698	-2.341	2.807	-1.684	89.589
58	120	COMB8	1.8	-7.212	35.097	-2.341	2.807	0.423	66.281
59	120	COMB8	2.7	-7.212	53.495	-2.341	2.807	2.529	26.415
60	120	COMB8	3.6	-7.212	71.893	-2.341	2.807	4.636	-30.010
61	120	COMB9	0	-7.212	-1.700	-2.341	2.807	-3.791	96.338
62	120	COMB9	0.9	-7.212	16.698	-2.341	2.807	-1.684	89.589
63	120	COMB9	1.8	-7.212	35.097	-2.341	2.807	0.423	66.281
64	120	COMB9	2.7	-7.212	53.495	-2.341	2.807	2.529	26.415
65	120	COMB9	3.6	-7.212	71.893	-2.341	2.807	4.636	-30.010

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
1	126	DL	0	3.574	-88.814	-0.147	-0.536	-0.271	-129.766
2	126	DL	0.9	3.574	-73.272	-0.147	-0.536	-0.138	-56.827
3	126	DL	1.8	3.574	-57.730	-0.147	-0.536	-0.005	2.123
4	126	DL	2.7	3.574	-42.187	-0.147	-0.536	0.127	47.086
5	126	DL	3.6	3.574	-26.645	-0.147	-0.536	0.260	78.061
6	126	LL	0	0.528	-22.682	0.003	-0.152	0.008	-32.879
7	126	LL	0.9	0.528	-18.632	0.003	-0.152	0.006	-14.287
8	126	LL	1.8	0.528	-14.582	0.003	-0.152	0.003	0.659
9	126	LL	2.7	0.528	-10.532	0.003	-0.152	0.001	11.961
10	126	LL	3.6	0.528	-6.482	0.003	-0.152	-0.002	19.618
11	126	EX	0	0.696	-0.299	10.065	-7.143	19.929	0.133
12	126	EX	0.9	0.696	-0.299	10.065	-7.143	10.871	0.402
13	126	EX	1.8	0.696	-0.299	10.065	-7.143	1.813	0.672
14	126	EX	2.7	0.696	-0.299	10.065	-7.143	-7.246	0.941
15	126	EX	3.6	0.696	-0.299	10.065	-7.143	-16.304	1.211
16	126	EY	0	17.590	21.197	-1.452	0.572	-2.913	71.081
17	126	EY	0.9	17.590	21.197	-1.452	0.572	-1.606	52.004
18	126	EY	1.8	17.590	21.197	-1.452	0.572	-0.299	32.926
19	126	EY	2.7	17.590	21.197	-1.452	0.572	1.009	13.849
20	126	EY	3.6	17.590	21.197	-1.452	0.572	2.316	-5.228
21	126	COMB1	0	5.133	-142.869	-0.172	-0.886	-0.312	-208.325
22	126	COMB1	0.9	5.133	-117.738	-0.172	-0.886	-0.157	-91.052
23	126	COMB1	1.8	5.133	-92.607	-0.172	-0.886	-0.001	3.603
24	126	COMB1	2.7	5.133	-67.477	-0.172	-0.886	0.154	75.641
25	126	COMB1	3.6	5.133	-42.346	-0.172	-0.886	0.309	125.061
26	126	COMB2	0	10.357	-101.182	9.958	-7.978	19.729	-134.438
27	126	COMB2	0.9	10.357	-82.311	9.958	-7.978	10.767	-51.866
28	126	COMB2	1.8	10.357	-63.440	9.958	-7.978	1.805	13.722
29	126	COMB2	2.7	10.357	-44.570	9.958	-7.978	-7.156	62.327
30	126	COMB2	3.6	10.357	-25.699	9.958	-7.978	-16.118	93.947
31	126	COMB3	0	-0.725	-114.536	10.873	-8.339	21.564	-179.219
32	126	COMB3	0.9	-0.725	-95.665	10.873	-8.339	11.779	-84.628
33	126	COMB3	1.8	-0.725	-76.795	10.873	-8.339	1.993	-7.021
34	126	COMB3	2.7	-0.725	-57.924	10.873	-8.339	-7.792	53.602
35	126	COMB3	3.6	-0.725	-39.053	10.873	-8.339	-17.577	97.241
36	126	COMB4	0	8.894	-100.553	-11.179	7.021	-22.123	-134.717
37	126	COMB4	0.9	8.894	-81.682	-11.179	7.021	-12.062	-52.711
38	126	COMB4	1.8	8.894	-62.811	-11.179	7.021	-2.001	12.311
39	126	COMB4	2.7	8.894	-43.941	-11.179	7.021	8.060	60.350
40	126	COMB4	3.6	8.894	-25.070	-11.179	7.021	18.121	91.404
41	126	COMB5	0	-2.187	-113.907	-10.264	6.661	-20.287	-179.498
42	126	COMB5	0.9	-2.187	-95.036	-10.264	6.661	-11.050	-85.473
43	126	COMB5	1.8	-2.187	-76.166	-10.264	6.661	-1.813	-8.432
44	126	COMB5	2.7	-2.187	-57.295	-10.264	6.661	7.424	51.625
45	126	COMB5	3.6	-2.187	-38.424	-10.264	6.661	16.662	94.698
46	126	COMB6	0	22.773	-85.382	1.492	-2.308	2.940	-82.291
47	126	COMB6	0.9	22.773	-66.511	1.492	-2.308	1.597	-13.939

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
48	126	COMB6	1.8	22.773	-47.640	1.492	-2.308	0.254	37.429
49	126	COMB6	2.7	22.773	-28.770	1.492	-2.308	-1.089	71.814
50	126	COMB6	3.6	22.773	-9.899	1.492	-2.308	-2.433	89.215
51	126	COMB7	0	-14.165	-129.896	4.543	-3.510	9.057	-231.561
52	126	COMB7	0.9	-14.165	-111.025	4.543	-3.510	4.969	-123.147
53	126	COMB7	1.8	-14.165	-92.154	4.543	-3.510	0.881	-31.716
54	126	COMB7	2.7	-14.165	-73.284	4.543	-3.510	-3.208	42.731
55	126	COMB7	3.6	-14.165	-54.413	4.543	-3.510	-7.296	100.194
56	126	COMB8	0	22.335	-85.193	-4.848	2.192	-9.615	-82.374
57	126	COMB8	0.9	22.335	-66.322	-4.848	2.192	-5.252	-14.192
58	126	COMB8	1.8	22.335	-47.452	-4.848	2.192	-0.888	37.006
59	126	COMB8	2.7	22.335	-28.581	-4.848	2.192	3.476	71.221
60	126	COMB8	3.6	22.335	-9.710	-4.848	2.192	7.839	88.452
61	126	COMB9	0	22.335	-85.193	-4.848	2.192	-9.615	-82.374
62	126	COMB9	0.9	22.335	-66.322	-4.848	2.192	-5.252	-14.192
63	126	COMB9	1.8	22.335	-47.452	-4.848	2.192	-0.888	37.006
64	126	COMB9	2.7	22.335	-28.581	-4.848	2.192	3.476	71.221
65	126	COMB9	3.6	22.335	-9.710	-4.848	2.192	7.839	88.452

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
1	128	DL	0	-30.801	23.853	0.142	-1.368	0.024	108.395
2	128	DL	0.9	-30.801	40.295	0.142	-1.368	-0.104	79.528
3	128	DL	1.8	-30.801	56.738	0.142	-1.368	-0.233	35.863
4	128	DL	2.7	-30.801	73.180	0.142	-1.368	-0.361	-22.600
5	128	DL	3.6	-30.801	89.622	0.142	-1.368	-0.489	-95.861
6	128	LL	0	-7.193	5.773	0.058	-0.041	0.038	25.056
7	128	LL	0.9	-7.193	9.823	0.058	-0.041	-0.014	18.038
8	128	LL	1.8	-7.193	13.873	0.058	-0.041	-0.067	7.375
9	128	LL	2.7	-7.193	17.923	0.058	-0.041	-0.119	-6.932
10	128	LL	3.6	-7.193	21.973	0.058	-0.041	-0.172	-24.885
11	128	EX	0	-0.469	-0.595	13.152	-4.452	21.213	-0.647
12	128	EX	0.9	-0.469	-0.595	13.152	-4.452	9.376	-0.111
13	128	EX	1.8	-0.469	-0.595	13.152	-4.452	-2.460	0.425
14	128	EX	2.7	-0.469	-0.595	13.152	-4.452	-14.297	0.961
15	128	EX	3.6	-0.469	-0.595	13.152	-4.452	-26.134	1.497
16	128	EY	0	-52.364	-50.176	-1.776	-1.220	-3.587	47.549
17	128	EY	0.9	-52.364	-50.176	-1.776	-1.220	-1.989	92.707
18	128	EY	1.8	-52.364	-50.176	-1.776	-1.220	-0.391	137.865
19	128	EY	2.7	-52.364	-50.176	-1.776	-1.220	1.207	183.023
20	128	EY	3.6	-52.364	-50.176	-1.776	-1.220	2.805	228.182
21	128	COMB1	0	-48.471	37.860	0.264	-1.708	0.090	170.163
22	128	COMB1	0.9	-48.471	64.071	0.264	-1.708	-0.148	124.294
23	128	COMB1	1.8	-48.471	90.281	0.264	-1.708	-0.386	54.836
24	128	COMB1	2.7	-48.471	116.492	0.264	-1.708	-0.624	-38.212
25	128	COMB1	3.6	-48.471	142.702	0.264	-1.708	-0.862	-154.850
26	128	COMB2	0	-53.860	12.252	13.437	-6.521	21.193	143.898
27	128	COMB2	0.9	-53.860	32.068	13.437	-6.521	9.100	123.955
28	128	COMB2	1.8	-53.860	51.884	13.437	-6.521	-2.993	86.176
29	128	COMB2	2.7	-53.860	71.699	13.437	-6.521	-15.086	30.564
30	128	COMB2	3.6	-53.860	91.515	13.437	-6.521	-27.179	-42.883
31	128	COMB3	0	-20.871	43.863	14.555	-5.753	23.453	113.942
32	128	COMB3	0.9	-20.871	63.678	14.555	-5.753	10.353	65.549
33	128	COMB3	1.8	-20.871	83.494	14.555	-5.753	-2.747	-0.679
34	128	COMB3	2.7	-20.871	103.310	14.555	-5.753	-15.846	-84.741
35	128	COMB3	3.6	-20.871	123.126	14.555	-5.753	-28.946	-186.637
36	128	COMB4	0	-52.875	13.503	-14.183	2.828	-23.355	145.256
37	128	COMB4	0.9	-52.875	33.318	-14.183	2.828	-10.591	124.187
38	128	COMB4	1.8	-52.875	53.134	-14.183	2.828	2.174	85.283
39	128	COMB4	2.7	-52.875	72.950	-14.183	2.828	14.938	28.545
40	128	COMB4	3.6	-52.875	92.766	-14.183	2.828	27.703	-46.027
41	128	COMB5	0	-19.886	45.113	-13.064	3.597	-21.095	115.300
42	128	COMB5	0.9	-19.886	64.929	-13.064	3.597	-9.337	65.781
43	128	COMB5	1.8	-19.886	84.745	-13.064	3.597	2.420	-1.572
44	128	COMB5	2.7	-19.886	104.561	-13.064	3.597	14.178	-86.759
45	128	COMB5	3.6	-19.886	124.376	-13.064	3.597	25.935	-189.781
46	128	COMB6	0	-92.003	-24.189	2.465	-4.146	2.965	179.322
47	128	COMB6	0.9	-92.003	-4.374	2.465	-4.146	0.746	192.176

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
48	128	COMB6	1.8	-92.003	15.442	2.465	-4.146	-1.472	187.195
49	128	COMB6	2.7	-92.003	35.258	2.465	-4.146	-3.690	164.380
50	128	COMB6	3.6	-92.003	55.074	2.465	-4.146	-5.908	123.730
51	128	COMB7	0	17.961	81.179	6.194	-1.584	10.498	79.469
52	128	COMB7	0.9	17.961	100.995	6.194	-1.584	4.923	-2.510
53	128	COMB7	1.8	17.961	120.811	6.194	-1.584	-0.651	-102.323
54	128	COMB7	2.7	17.961	140.627	6.194	-1.584	-6.225	-219.970
55	128	COMB7	3.6	17.961	160.443	6.194	-1.584	-11.800	-355.451
56	128	COMB8	0	-91.708	-23.814	-5.821	-1.341	-10.400	179.730
57	128	COMB8	0.9	-91.708	-3.998	-5.821	-1.341	-5.161	192.245
58	128	COMB8	1.8	-91.708	15.817	-5.821	-1.341	0.078	186.927
59	128	COMB8	2.7	-91.708	35.633	-5.821	-1.341	5.317	163.774
60	128	COMB8	3.6	-91.708	55.449	-5.821	-1.341	10.556	122.787
61	128	COMB9	0	-91.708	-23.814	-5.821	-1.341	-10.400	179.730
62	128	COMB9	0.9	-91.708	-3.998	-5.821	-1.341	-5.161	192.245
63	128	COMB9	1.8	-91.708	15.817	-5.821	-1.341	0.078	186.927
64	128	COMB9	2.7	-91.708	35.633	-5.821	-1.341	5.317	163.774
65	128	COMB9	3.6	-91.708	55.449	-5.821	-1.341	10.556	122.787

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
1	1135	DL	0	-3.882	-0.212	6.065	0.616	9.476	49.737
2	1135	DL	0.9	-3.882	8.951	6.065	0.616	4.017	45.804
3	1135	DL	1.8	-3.882	18.114	6.065	0.616	-1.442	33.625
4	1135	DL	2.7	-3.882	27.277	6.065	0.616	-6.901	13.200
5	1135	DL	3.6	-3.882	36.440	6.065	0.616	-12.360	-15.473
6	1135	LL	0	-0.851	0.004	1.477	0.277	2.297	9.009
7	1135	LL	0.9	-0.851	1.624	1.477	0.277	0.968	8.276
8	1135	LL	1.8	-0.851	3.244	1.477	0.277	-0.362	6.086
9	1135	LL	2.7	-0.851	4.864	1.477	0.277	-1.692	2.438
10	1135	LL	3.6	-0.851	6.484	1.477	0.277	-3.022	-2.669
11	1135	EX	0	-3.398	2.656	15.659	1.082	24.524	-1.283
12	1135	EX	0.9	-3.398	2.656	15.659	1.082	10.431	-3.674
13	1135	EX	1.8	-3.398	2.656	15.659	1.082	-3.662	-6.064
14	1135	EX	2.7	-3.398	2.656	15.659	1.082	-17.756	-8.455
15	1135	EX	3.6	-3.398	2.656	15.659	1.082	-31.849	-10.846
16	1135	EY	0	0.645	-0.050	9.282	0.971	15.073	-0.010
17	1135	EY	0.9	0.645	-0.050	9.282	0.971	6.720	0.035
18	1135	EY	1.8	0.645	-0.050	9.282	0.971	-1.634	0.081
19	1135	EY	2.7	0.645	-0.050	9.282	0.971	-9.988	0.126
20	1135	EY	3.6	0.645	-0.050	9.282	0.971	-18.342	0.171
21	1135	COMB1	0	-6.021	-0.249	9.642	1.183	15.047	74.098
22	1135	COMB1	0.9	-6.021	13.339	9.642	1.183	6.368	68.207
23	1135	COMB1	1.8	-6.021	26.927	9.642	1.183	-2.310	50.088
24	1135	COMB1	2.7	-6.021	40.514	9.642	1.183	-10.988	19.740
25	1135	COMB1	3.6	-6.021	54.102	9.642	1.183	-19.666	-22.838
26	1135	COMB2	0	-7.977	2.553	26.665	2.263	41.895	56.548
27	1135	COMB2	0.9	-7.977	13.194	26.665	2.263	17.897	49.462
28	1135	COMB2	1.8	-7.977	23.836	26.665	2.263	-6.102	32.798
29	1135	COMB2	2.7	-7.977	34.478	26.665	2.263	-30.101	6.557
30	1135	COMB2	3.6	-7.977	45.120	26.665	2.263	-54.100	-29.262
31	1135	COMB3	0	-8.384	2.584	20.818	1.652	32.399	56.555
32	1135	COMB3	0.9	-8.384	13.226	20.818	1.652	13.663	49.440
33	1135	COMB3	1.8	-8.384	23.868	20.818	1.652	-5.073	32.748
34	1135	COMB3	2.7	-8.384	34.510	20.818	1.652	-23.809	6.478
35	1135	COMB3	3.6	-8.384	45.151	20.818	1.652	-42.545	-29.370
36	1135	COMB4	0	-0.842	-3.025	-6.219	-0.008	-9.606	59.243
37	1135	COMB4	0.9	-0.842	7.616	-6.219	-0.008	-4.009	57.177
38	1135	COMB4	1.8	-0.842	18.258	-6.219	-0.008	1.588	45.534
39	1135	COMB4	2.7	-0.842	28.900	-6.219	-0.008	7.185	24.313
40	1135	COMB4	3.6	-0.842	39.542	-6.219	-0.008	12.782	-6.486
41	1135	COMB5	0	-1.248	-2.994	-12.067	-0.620	-19.102	59.250
42	1135	COMB5	0.9	-1.248	7.648	-12.067	-0.620	-8.242	57.155
43	1135	COMB5	1.8	-1.248	18.290	-12.067	-0.620	2.618	45.483
44	1135	COMB5	2.7	-1.248	28.932	-12.067	-0.620	13.478	24.233
45	1135	COMB5	3.6	-1.248	39.573	-12.067	-0.620	24.338	-6.594
46	1135	COMB6	0	-5.006	0.563	21.978	2.182	34.949	57.484
47	1135	COMB6	0.9	-5.006	11.205	21.978	2.182	15.169	52.188

PERHITUNGAN TULANGAN BALOK GRID

LT	TYPE	dimensi	d	momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	I	30/60	542	248.801	134.249	311.001	167.811	0.0102	18.824	3.688
2	II	30/60	542	280.670	133.290	350.838	166.613	0.0102	18.824	3.688
3	III	30/60	542	270.073	133.991	337.591	167.489	0.0102	18.824	3.688
4	IV	30/60	542	231.561	125.061	289.451	156.326	0.0102	18.824	3.688
5	V	30/60	542	254.541	128.182	318.176	160.228	0.0102	18.824	3.688
6	VI	25/45	392	29.370	74.098	36.713	92.623	0.0102	18.824	3.688

tulangan tumpuan

type	d perlu	analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
I	530.182	sebelah	3.52892	0.00976	1586.982	4.176269	5	1900	119.2157	366.618
II	563.115	rangkap	-	-	-	-	-	-	-	434.464
III	552.382	rangkap	-	-	-	-	-	-	-	434.464
IV	511.484	sebelah	3.2844	0.009084	1477.017	3.886886	4	1520	95.37255	300.5427
V	536.263	sebelah	3.61034	0.009985	1623.595	4.272619	5	1900	119.2157	366.618
VI	199.545	sebelah	0.95566	0.002643	259.0223	1.295111	2 (D16)	400	30.11765	60.31059

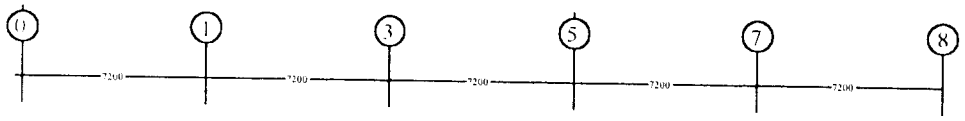
tulangan lapangan

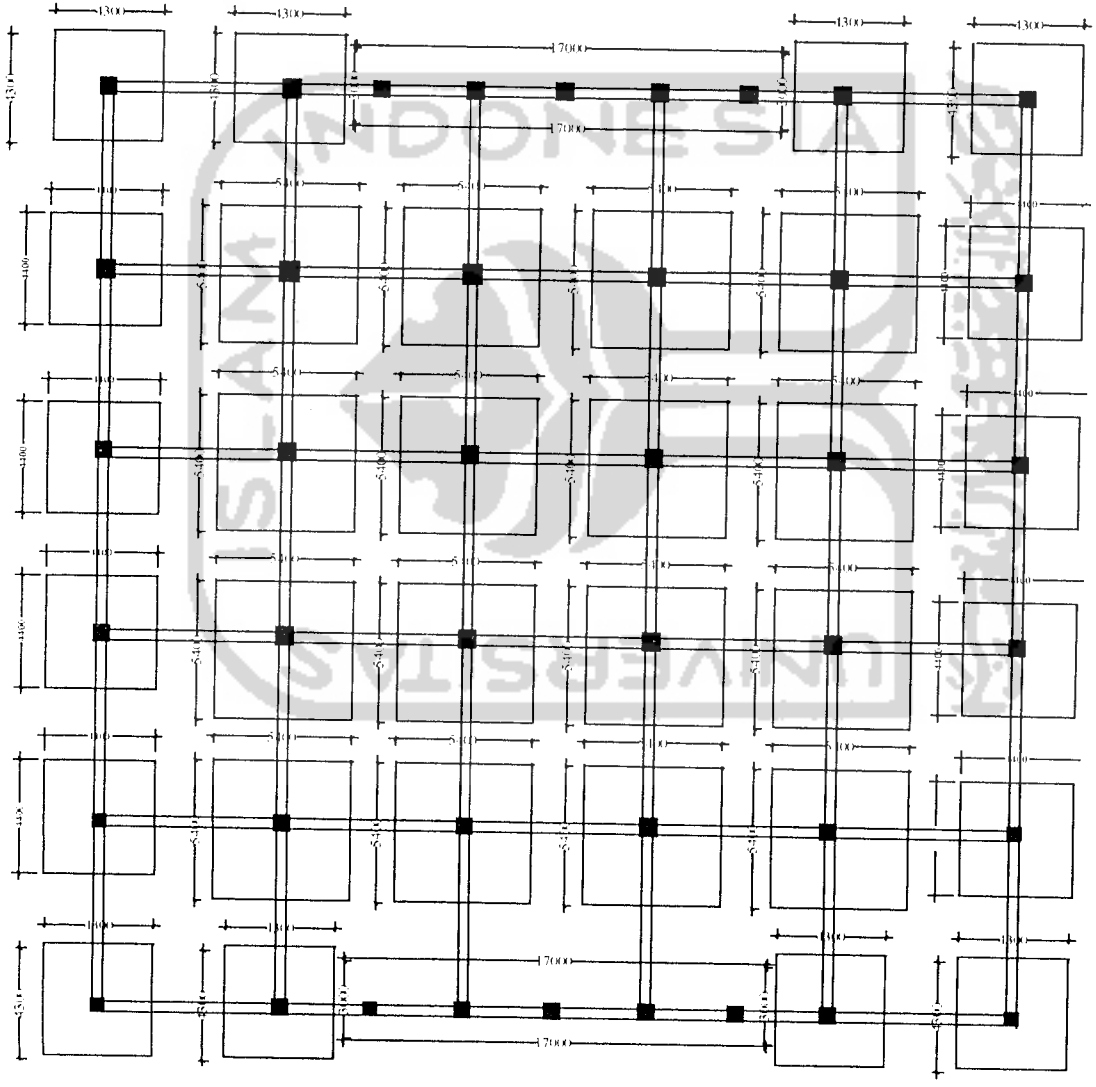
d perlu	d ada	analisis	Rn baru	p baru	As perlu	As pakai	n (D19)	As ada	a	Mn
389.45	423.5	sebelah	3.11884	0.008626	1095.915	3.872492	4	1132	71.02745	229.337
388.06	423.5	sebelah	3.09656	0.008564	1088.087	3.844829	4	1520	95.37255	317.5667
389.08	423.5	sebelah	3.11285	0.008609	1093.809	3.865049	4	1520	95.37255	317.5667
375.89	423.5	sebelah	2.90539	0.008036	1020.911	3.607458	4	1520	95.37255	317.5667
380.55	423.5	sebelah	2.97789	0.008236	1046.388	3.697485	4	1520	95.37255	317.5667
316.95	378	sebelah	2.16079	0.005976	564.7454	2.823727	3(D16)	600	37.64706	132.2824

As1	a										
1658.52	104.064	325.0487	12.54256	315.7516	[illegible]	0.021757	2	266	1924.52	5.064526	6	2280

kontrol tegangan

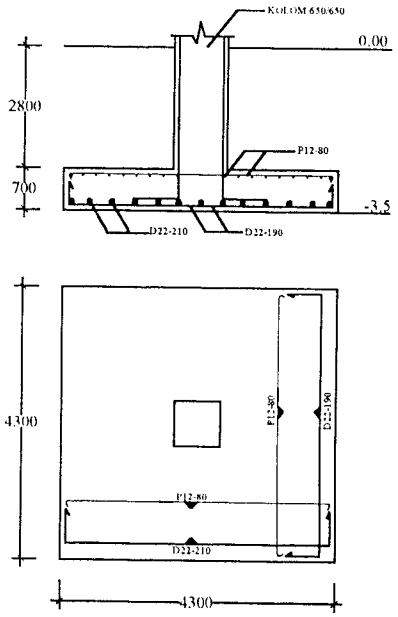
p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.014022	0.001636	0.012386	365.9229	127.7905	389.495	44.969	434.464



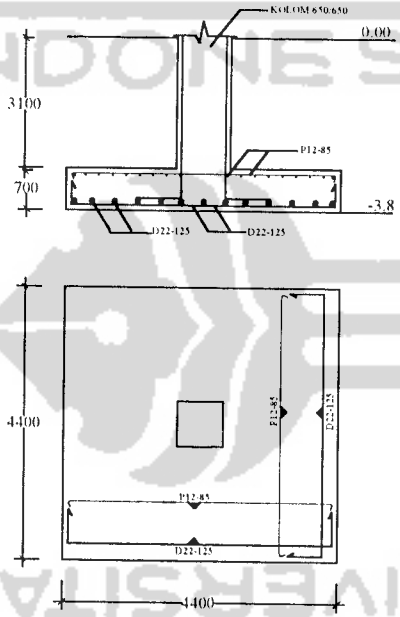




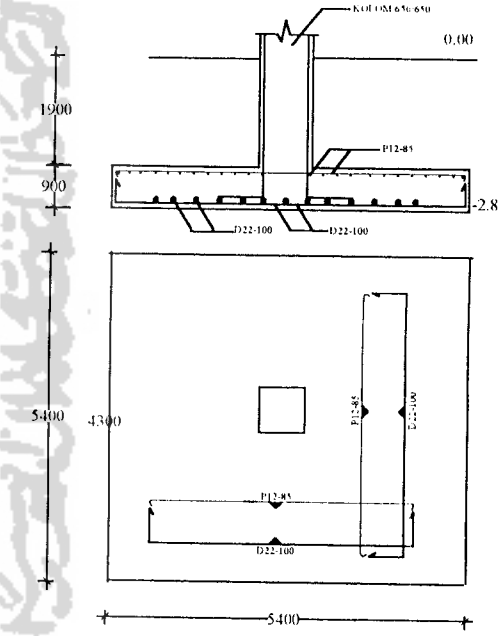
RENCANA PONDASI



DETAIL PONDASI P1

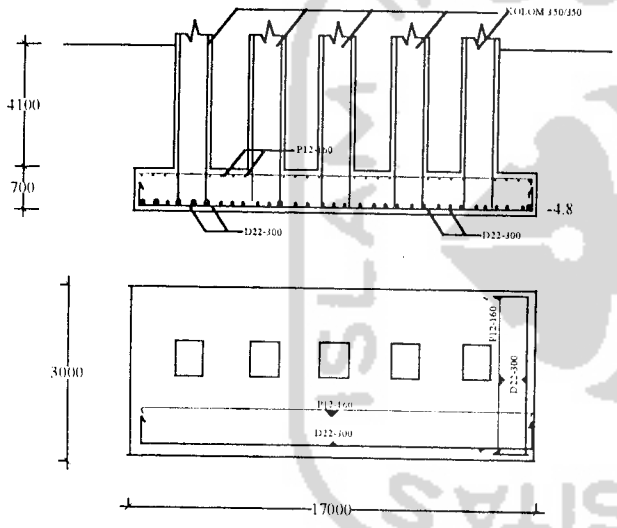


DETAIL PONDASI P2

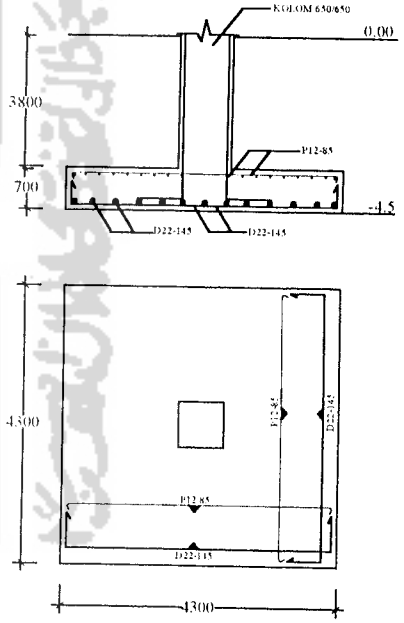


DETAIL PONDASI P3

DETAIL PONDASI



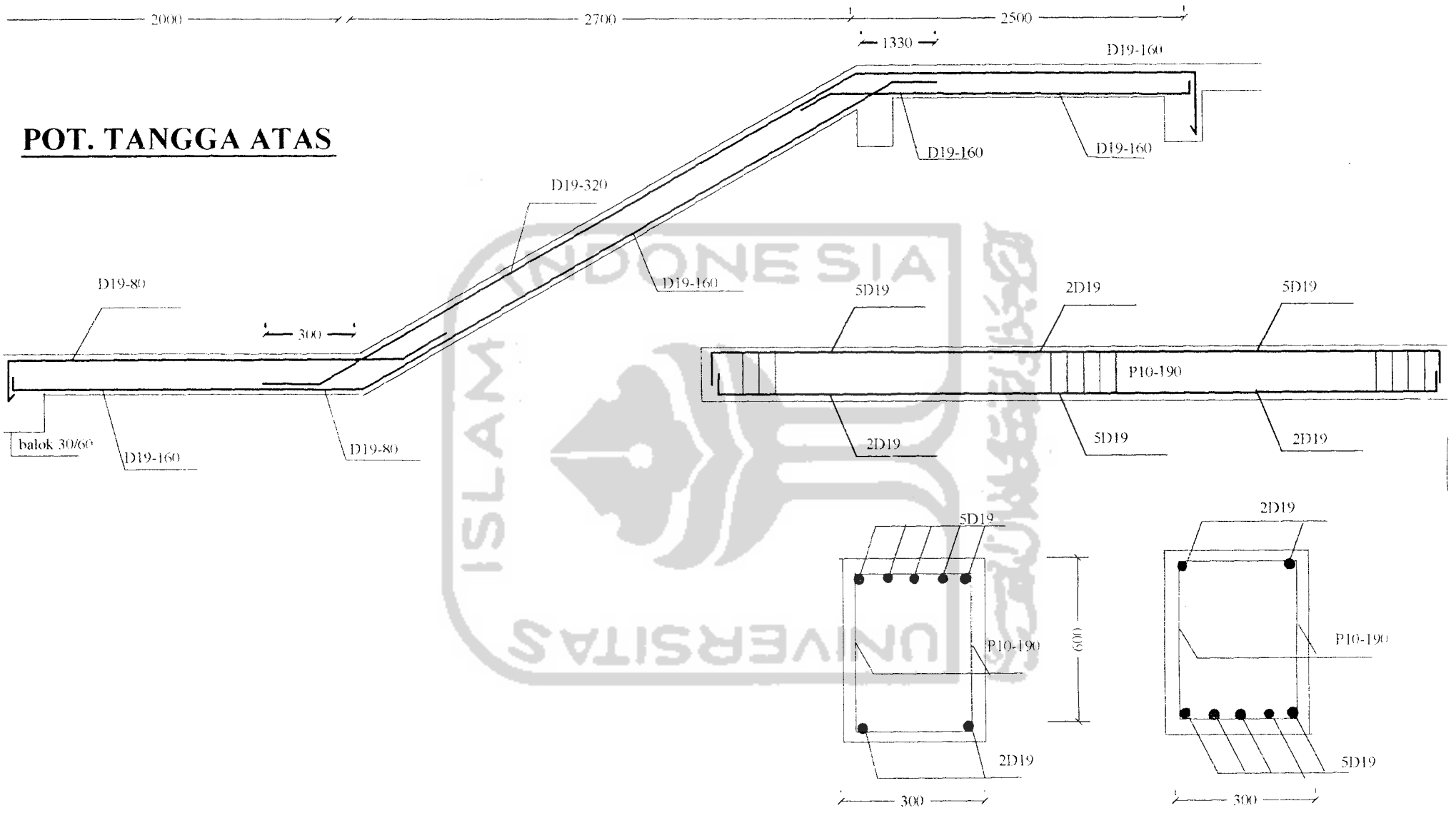
DETAIL PONDASI P4

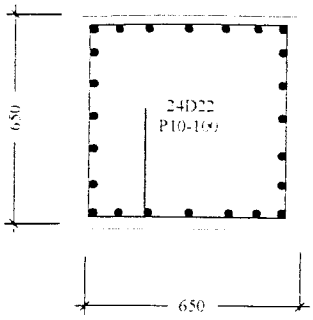


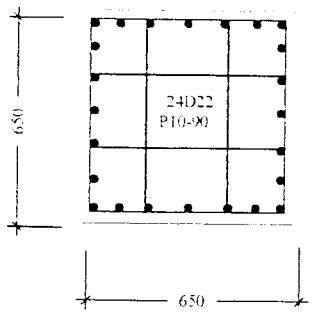
DETAIL PONDASI P5

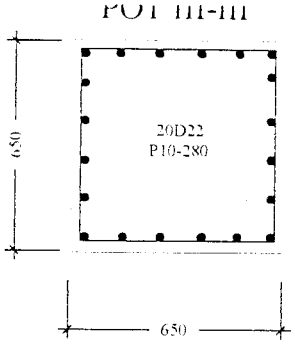
DETAIL PONDASI

POT. TANGGA ATAS

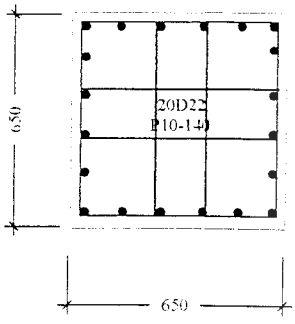




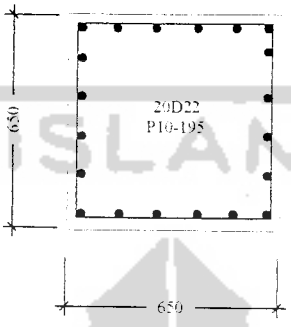




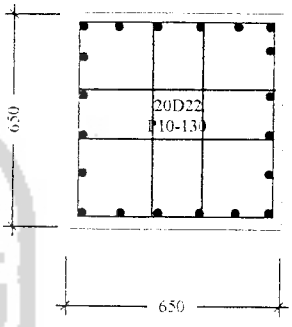
POT IV-IV



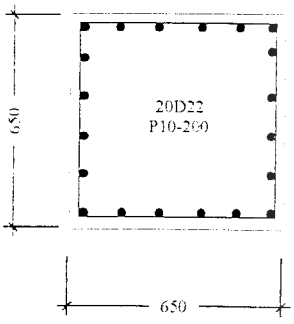
POT V-V



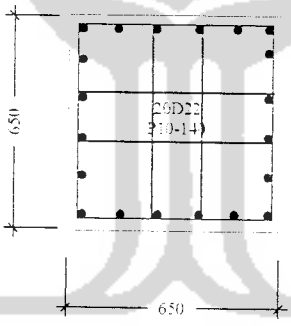
POT VI-VI



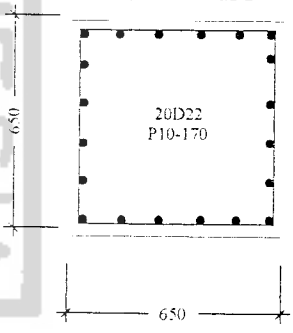
POT VII-VII



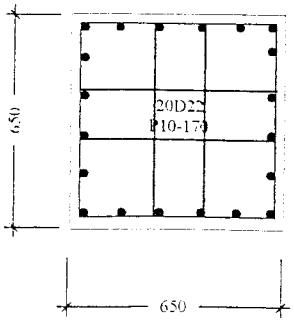
POT VIII-VIII



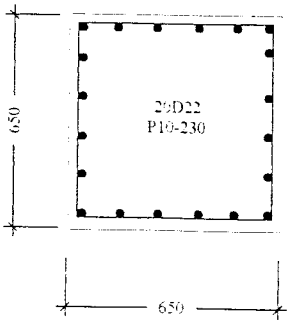
POT IX-IX



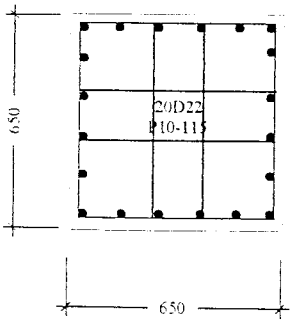
POT X-X



POT XI-XI



POT XII-XII



DETAIL KOLOM 42

P	
1.091	-3
1.091	2
1.091	6
-13.833	-6
-13.833	-3
-13.833	
-13.833	2
-13.833	6
12.017	-4
12.017	-
12.017	
12.017	
12.017	
12.017	
12.017	
12.017	
12.017	
12.017	

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
1	659	DL	0	-0.752	-63.361	-0.176	2.429	-1.262	-52.616
2	659	DL	3.6	-0.752	-32.825	-0.176	2.429	-0.630	120.519
3	659	DL	7.2	-0.752	-2.290	-0.176	2.429	0.002	183.726
4	659	DL	10.8	-0.752	28.246	-0.176	2.429	0.634	137.004
5	659	DL	14.4	-0.752	58.782	-0.176	2.429	1.267	-19.647
6	659	LL	0	-0.187	-0.270	-0.037	0.845	-0.267	-3.164
7	659	LL	3.6	-0.187	-0.270	-0.037	0.845	-0.135	-2.193
8	659	LL	7.2	-0.187	-0.270	-0.037	0.845	-0.002	-1.222
9	659	LL	10.8	-0.187	-0.270	-0.037	0.845	0.130	-0.251
10	659	LL	14.4	-0.187	-0.270	-0.037	0.845	0.263	0.719
11	659	EX	0	-17.344	-2.599	-0.485	0.312	-2.914	-14.173
12	659	EX	3.6	-17.344	-2.599	-0.485	0.312	-1.169	-4.818
13	659	EX	7.2	-17.344	-2.599	-0.485	0.312	0.576	4.538
14	659	EX	10.8	-17.344	-2.599	-0.485	0.312	2.321	13.894
15	659	EX	14.4	-17.344	-2.599	-0.485	0.312	4.067	23.249
16	659	EY	0	7.106	0.205	0.070	-0.241	0.290	1.293
17	659	EY	3.6	7.106	0.205	0.070	-0.241	0.039	0.554
18	659	EY	7.2	7.106	0.205	0.070	-0.241	-0.212	-0.186
19	659	EY	10.8	7.106	0.205	0.070	-0.241	-0.462	-0.925
20	659	EY	14.4	7.106	0.205	0.070	-0.241	-0.713	-1.664
21	659	COMB1	0	-1.202	-76.465	-0.270	4.268	-1.943	-68.202
22	659	COMB1	3.6	-1.202	-39.822	-0.270	4.268	-0.972	141.115
23	659	COMB1	7.2	-1.202	-3.179	-0.270	4.268	-0.001	218.516
24	659	COMB1	10.8	-1.202	33.464	-0.270	4.268	0.970	164.003
25	659	COMB1	14.4	-1.202	70.107	-0.270	4.268	1.941	-22.426
26	659	COMB2	0	-16.880	-69.363	-0.695	3.335	-4.462	-71.715
27	659	COMB2	3.6	-16.880	-37.301	-0.695	3.335	-1.961	120.280
28	659	COMB2	7.2	-16.880	-5.238	-0.695	3.335	0.540	196.849
29	659	COMB2	10.8	-16.880	26.825	-0.695	3.335	3.040	157.993
30	659	COMB2	14.4	-16.880	58.887	-0.695	3.335	5.541	3.711
31	659	COMB3	0	-21.357	-69.493	-0.739	3.487	-4.645	-72.530
32	659	COMB3	3.6	-21.357	-37.430	-0.739	3.487	-1.986	119.931
33	659	COMB3	7.2	-21.357	-5.367	-0.739	3.487	0.673	196.966
34	659	COMB3	10.8	-21.357	26.695	-0.739	3.487	3.332	158.576
35	659	COMB3	14.4	-21.357	58.758	-0.739	3.487	5.990	4.760
36	659	COMB4	0	19.542	-63.906	0.323	2.680	1.657	-41.951
37	659	COMB4	3.6	19.542	-31.843	0.323	2.680	0.493	130.397
38	659	COMB4	7.2	19.542	0.220	0.323	2.680	-0.671	187.319
39	659	COMB4	10.8	19.542	32.282	0.323	2.680	-1.835	128.816
40	659	COMB4	14.4	19.542	64.345	0.323	2.680	-2.999	-45.113
41	659	COMB5	0	15.065	-64.035	0.279	2.832	1.474	-42.766
42	659	COMB5	3.6	15.065	-31.972	0.279	2.832	0.468	130.048
43	659	COMB5	7.2	15.065	0.090	0.279	2.832	-0.538	187.436
44	659	COMB5	10.8	15.065	32.153	0.279	2.832	-1.544	129.399
45	659	COMB5	14.4	15.065	64.215	0.279	2.832	-2.549	-44.064
46	659	COMB6	0	1.091	-67.302	-0.287	2.929	-2.107	-60.347
47	659	COMB6	3.6	1.091	-35.239	-0.287	2.929	-1.073	124.228

LAMPIRAN 5

Lampiran 5.1

ID	Batang	Beban	Stasiun	P	V2	V3	T	M2	M3
1	1703	DL	0	-1.03461	-35.8969	-0.02269	3.656015	0.022766	-10.9825
2	1703	DL	0.9	-1.03461	-13.6354	-0.02269	3.656015	0.043186	11.30702
3	1703	DL	1.8	-1.03461	8.626146	-0.02269	3.656015	0.063606	13.56117
4	1703	DL	2.7	-1.03461	30.88766	-0.02269	3.656015	0.084027	-4.22004
5	1703	DL	3.6	-1.03461	53.14917	-0.02269	3.656015	0.104447	-42.0366
6	1703	LL	0	-0.21456	-5.10306	-0.01338	0.804304	-0.01122	-1.12048
7	1703	LL	0.9	-0.21456	-1.76136	-0.01338	0.804304	0.000825	1.968511
8	1703	LL	1.8	-0.21456	1.580341	-0.01338	0.804304	0.012867	2.049969
9	1703	LL	2.7	-0.21456	4.922041	-0.01338	0.804304	0.024908	-0.8761
10	1703	LL	3.6	-0.21456	8.263741	-0.01338	0.804304	0.03695	-6.80971
11	1703	EX	0	-74.8964	161.7217	-5.29366	0.083942	-11.4999	291.2403
12	1703	EX	0.9	-74.8964	161.7217	-5.29366	0.083942	-6.73556	145.6908
13	1703	EX	1.8	-74.8964	161.7217	-5.29366	0.083942	-1.97126	0.141244
14	1703	EX	2.7	-74.8964	161.7217	-5.29366	0.083942	2.793035	-145.408
15	1703	EX	3.6	-74.8964	161.7217	-5.29366	0.083942	7.557331	-290.958
16	1703	EY	0	-1.02149	-1.92671	4.20928	-4.67598	8.230458	-3.50076
17	1703	EY	0.9	-1.02149	-1.92671	4.20928	-4.67598	4.442107	-1.76672
18	1703	EY	1.8	-1.02149	-1.92671	4.20928	-4.67598	0.653755	-0.03268
19	1703	EY	2.7	-1.02149	-1.92671	4.20928	-4.67598	-3.1346	1.701354
20	1703	EY	3.6	-1.02149	-1.92671	4.20928	-4.67598	-6.92295	3.435393
21	1703	COMB1	0	-1.58483	-51.2412	-0.04863	5.674105	0.009372	-14.9718
22	1703	COMB1	0.9	-1.58483	-19.1806	-0.04863	5.674105	0.053143	16.71804
23	1703	COMB1	1.8	-1.58483	12.87992	-0.04863	5.674105	0.096914	19.55335
24	1703	COMB1	2.7	-1.58483	44.94046	-0.04863	5.674105	0.140685	-6.46582
25	1703	COMB1	3.6	-1.58483	77.00099	-0.04863	5.674105	0.184456	-61.3395
26	1703	COMB2	0	-80.1845	128.2942	-4.26468	2.960733	-9.46541	292.4621
27	1703	COMB2	0.9	-80.1845	153.7741	-4.26468	2.960733	-5.62721	165.5313
28	1703	COMB2	1.8	-80.1845	179.254	-4.26468	2.960733	-1.789	15.66872
29	1703	COMB2	2.7	-80.1845	204.7338	-4.26468	2.960733	2.049209	-157.126
30	1703	COMB2	3.6	-80.1845	230.2137	-4.26468	2.960733	5.887416	-352.852
31	1703	COMB3	0	-79.541	129.5081	-6.91652	5.906601	-14.6506	294.6676
32	1703	COMB3	0.9	-79.541	154.9879	-6.91652	5.906601	-8.42573	166.6444
33	1703	COMB3	1.8	-79.541	180.4678	-6.91652	5.906601	-2.20086	15.68931
34	1703	COMB3	2.7	-79.541	205.9476	-6.91652	5.906601	4.024005	-158.198
35	1703	COMB3	3.6	-79.541	231.4275	-6.91652	5.906601	10.24887	-355.016
36	1703	COMB4	0	77.09793	-211.321	6.852015	2.784455	14.68428	-319.143
37	1703	COMB4	0.9	77.09793	-185.842	6.852015	2.784455	8.517464	-140.419
38	1703	COMB4	1.8	77.09793	-160.362	6.852015	2.784455	2.350649	15.37211
39	1703	COMB4	2.7	77.09793	-134.882	6.852015	2.784455	-3.81616	148.2316
40	1703	COMB4	3.6	77.09793	-109.402	6.852015	2.784455	-9.98298	258.1593
41	1703	COMB5	0	77.74147	-210.108	4.20017	5.730322	9.499088	-316.937
42	1703	COMB5	0.9	77.74147	-184.628	4.20017	5.730322	5.718936	-139.306
43	1703	COMB5	1.8	77.74147	-159.148	4.20017	5.730322	1.938784	15.3927
44	1703	COMB5	2.7	77.74147	-133.668	4.20017	5.730322	-1.84137	147.1598
45	1703	COMB5	3.6	77.74147	-108.188	4.20017	5.730322	-5.62152	255.995
46	1703	COMB6	0	-25.8865	8.012641	2.719987	-0.53781	5.036366	75.82738
47	1703	COMB6	0.9	-25.8865	33.4925	2.719987	-0.53781	2.588377	57.15007
48	1703	COMB6	1.8	-25.8865	58.97236	2.719987	-0.53781	0.140388	15.54088
49	1703	COMB6	2.7	-25.8865	84.45222	2.719987	-0.53781	-2.3076	-49.0002
50	1703	COMB6	3.6	-25.8865	109.9321	2.719987	-0.53781	-4.75559	-136.473
51	1703	COMB7	0	-23.7413	12.05873	-6.1195	9.281749	-12.2476	83.17899
52	1703	COMB7	0.9	-23.7413	37.53859	-6.1195	9.281749	-6.74005	60.86019
53	1703	COMB7	1.8	-23.7413	63.01845	-6.1195	9.281749	-1.2325	15.60952
54	1703	COMB7	2.7	-23.7413	88.49831	-6.1195	9.281749	4.275053	-52.573

55	1703	COMB7	3.6	-23.7413	113.9782	-6.1195	9.281749	9.782602	-143.688
56	1703	COMB8	0	21.29828	-93.872	6.054994	-0.59069	12.28127	-107.654
57	1703	COMB8	0.9	21.29828	-68.3922	6.054994	-0.59069	6.831778	-34.6351
58	1703	COMB8	1.8	21.29828	-42.9123	6.054994	-0.59069	1.382283	15.4519
59	1703	COMB8	2.7	21.29828	-17.4325	6.054994	-0.59069	-4.06721	42.60704
60	1703	COMB8	3.6	21.29828	8.047405	6.054994	-0.59069	-9.51671	46.83033
61	1703	COMB9	0	21.29828	-93.872	6.054994	-0.59069	12.28127	-107.654
62	1703	COMB9	0.9	21.29828	-68.3922	6.054994	-0.59069	6.831778	-34.6351
63	1703	COMB9	1.8	21.29828	-42.9123	6.054994	-0.59069	1.382283	15.4519
64	1703	COMB9	2.7	21.29828	-17.4325	6.054994	-0.59069	-4.06721	42.60704
65	1703	COMB9	3.6	21.29828	8.047405	6.054994	-0.59069	-9.51671	46.83033

PERHITUNGAN TULANGAN BALOK PORTAL 0 - 0

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	A - B	40/65	570	328.92	266.34	411.150	332.925	0.0102	18.824	3.676
	B - C	40/65	570	312.23	232.58	390.288	290.725	0.0102	18.824	3.676
	C - D	40/65	570	312.95	234.93	391.188	293.663	0.0102	18.824	3.676
	D - E	40/65	570	312.05	234.99	390.063	293.738	0.0102	18.824	3.676
	E - F	40/65	570	314.19	244.11	392.738	305.138	0.0102	18.824	3.676
2	A - B	40/65	570	345.41	260.53	431.763	325.663	0.0102	18.824	3.676
	B - C	40/65	570	341.57	226.04	426.963	282.550	0.0102	18.824	3.676
	C - D	40/65	570	341.57	226.04	426.963	282.550	0.0102	18.824	3.676
	D - E	40/65	570	337.64	229.98	422.050	287.475	0.0102	18.824	3.676
	E - F	40/65	570	361.25	233.05	451.563	291.313	0.0102	18.824	3.676
3	A - B	40/65	570	304.03	255.04	380.038	318.800	0.0102	18.824	3.676
	B - C	40/65	570	314.14	226.34	392.675	282.925	0.0102	18.824	3.676
	C - D	40/65	570	313.02	227.20	391.275	284.000	0.0102	18.824	3.676
	D - E	40/65	570	308.27	230.71	385.338	288.388	0.0102	18.824	3.676
	E - F	40/65	570	334.60	236.05	418.250	295.063	0.0102	18.824	3.676
4	A - B	40/65	570	369.76	263.09	462.200	328.863	0.0102	18.824	3.676
	B - C	40/65	570	285.64	232.89	357.050	291.113	0.0102	18.824	3.676
	C - D	40/65	570	285.82	235.38	357.275	294.225	0.0102	18.824	3.676
	D - E	40/65	570	278.46	240.18	348.075	300.225	0.0102	18.824	3.676
	E - F	40/65	570	305.77	247.38	382.213	309.225	0.0102	18.824	3.676
5	A - B	40/65	570	278.75	277.22	348.438	346.525	0.0102	18.824	3.676
	B - C	40/65	570	293.91	240.96	367.388	301.200	0.0102	18.824	3.676
	C - D	40/65	570	286.01	241.99	357.513	302.488	0.0102	18.824	3.676
	D - E	40/65	570	348.01	259.30	435.013	324.125	0.0102	18.824	3.676
	E - F	40/65	570	364.24	267.71	455.300	334.638	0.0102	18.824	3.676
ATAP	A - B	30/55	470	53.54	6.10	66.925	7.625	0.0102	18.824	3.676
	B - C	30/55	470	79.82	35.19	99.775	43.988	0.0102	18.824	3.676
	C - D	30/55	470	101.75	32.99	127.188	41.238	0.0102	18.824	3.676
	D - E	30/55	470	152.49	147.74	190.613	184.675	0.0102	18.824	3.676
	E - F	30/55	470	158.64	140.46	198.300	175.575	0.0102	18.824	3.676

Tulangan Tumpuan Portal 0 - 0									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
528.789	sebelah	3.164	0.009	2001.475	5.267	6	2280	107.294	470.914
515.198	sebelah	3.003	0.008	1899.916	5.000	5	1900	89.412	399.224
515.792	sebelah	3.010	0.008	1904.297	5.011	6	2280	107.294	470.914
515.050	sebelah	3.001	0.008	1898.821	4.997	5	1900	89.412	399.224
516.813	sebelah	3.022	0.008	1911.843	5.031	6	2280	107.294	470.914
541.882	sebelah	3.322	0.009	2101.816	5.531	6	2280	107.294	470.914
538.861	sebelah	3.285	0.009	2078.450	5.470	6	2280	107.294	470.914
538.861	sebelah	3.285	0.009	2078.450	5.470	6	2280	107.294	470.914
535.752	sebelah	3.248	0.009	2054.536	5.407	6	2280	107.294	470.914
554.168	sebelah	3.475	0.010	2198.202	5.785	6	2280	107.294	470.914
508.388	sebelah	2.924	0.008	1850.019	4.868	5	1900	89.412	399.224
516.772	sebelah	3.022	0.008	1911.539	5.030	6	2280	107.294	470.914
515.850	sebelah	3.011	0.008	1904.723	5.012	6	2280	107.294	470.914
511.921	sebelah	2.965	0.008	1875.820	4.936	5	1900	89.412	399.224
533.335	sebelah	3.218	0.009	2036.037	5.358	6	2280	107.294	470.914
560.657	sebelah	3.556	0.010	2249.986	5.921	6	2280	107.294	470.914
492.773	sebelah	2.747	0.008	1738.116	4.574	5	1900	89.412	399.224
492.928	sebelah	2.749	0.008	1739.212	4.577	5	1900	89.412	399.224
486.540	sebelah	2.678	0.007	1694.426	4.459	5	1900	89.412	399.224
509.841	sebelah	2.941	0.008	1860.607	4.896	5	1900	89.412	399.224
486.793	sebelah	2.681	0.007	1696.191	4.464	5	1900	89.412	399.224
499.855	sebelah	2.827	0.008	1788.439	4.706	5	1900	89.412	399.224
493.092	sebelah	2.751	0.008	1740.368	4.580	5	1900	89.412	399.224
543.918	sebelah	3.347	0.009	2117.637	5.573	6	2280	107.294	470.914
556.456	sebelah	3.503	0.010	2216.397	5.833	6	2280	107.294	470.914
213.342	sebelah	0.757	0.002	395.107	1.040	2	760	35.765	137.444
260.491	sebelah	1.129	0.003	589.045	1.550	2	760	35.765	137.444
294.106	sebelah	1.439	0.004	750.881	1.976	2	760	35.765	137.444
360.046	sebelah	2.157	0.006	1125.326	2.961	3	1140	53.647	202.088
367.235	sebelah	2.244	0.006	1170.711	3.081	4	1520	71.529	264.015

Tulangan Lapangan Portal 0 - 0									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
475.834	sebelah	2.562	0.007	1620.676	4.265	5	1900	89.412	399.224
444.655	sebelah	2.237	0.006	1415.247	3.724	4	1520	71.529	324.815
446.896	sebelah	2.260	0.006	1429.547	3.762	4	1520	71.529	324.815
446.953	sebelah	2.260	0.006	1429.912	3.763	4	1520	71.529	324.815
455.544	sebelah	2.348	0.007	1485.407	3.909	4	1520	71.529	324.815
470.615	sebelah	2.506	0.007	1585.322	4.172	5	1900	89.412	399.224
438.359	sebelah	2.174	0.006	1375.451	3.620	4	1520	71.529	324.815
438.359	sebelah	2.174	0.006	1375.451	3.620	4	1520	71.529	324.815
442.163	sebelah	2.212	0.006	1399.426	3.683	4	1520	71.529	324.815
445.104	sebelah	2.242	0.006	1418.107	3.732	4	1520	71.529	324.815
465.630	sebelah	2.453	0.007	1551.916	4.084	5	1900	89.412	399.224
438.650	sebelah	2.177	0.006	1377.277	3.624	4	1520	71.529	324.815
439.482	sebelah	2.185	0.006	1382.510	3.638	4	1520	71.529	324.815
442.864	sebelah	2.219	0.006	1403.868	3.694	4	1520	71.529	324.815
447.960	sebelah	2.270	0.006	1436.362	3.780	4	1520	71.529	324.815
472.922	sebelah	2.530	0.007	1600.900	4.213	5	1900	89.412	399.224
444.952	sebelah	2.240	0.006	1417.133	3.729	4	1520	71.529	324.815
447.324	sebelah	2.264	0.006	1432.285	3.769	4	1520	71.529	324.815
451.862	sebelah	2.310	0.006	1461.493	3.846	4	1520	71.529	324.815
458.585	sebelah	2.379	0.007	1505.305	3.961	4	1520	71.529	324.815
485.456	sebelah	2.666	0.007	1686.881	4.439	5	1900	89.412	399.224
452.595	sebelah	2.318	0.006	1466.239	3.859	4	1520	71.529	324.815
453.561	sebelah	2.328	0.006	1472.507	3.875	4	1520	71.529	324.815
469.503	sebelah	2.494	0.007	1577.838	4.152	5	1900	89.412	399.224
477.056	sebelah	2.575	0.007	1629.013	4.287	5	1900	89.412	399.224
72.012	sebelah	0.086	0.000	45.016	0.118	2	760	35.765	137.444
172.960	sebelah	0.498	0.001	259.691	0.683	2	760	35.765	137.444
167.467	sebelah	0.467	0.001	243.455	0.641	2	760	35.765	137.444
354.394	sebelah	2.090	0.006	1090.272	2.869	3	1140	53.647	202.088
345.552	sebelah	1.987	0.006	1036.548	2.728	3	1140	53.647	202.088

PERHITUNGAN TULANGAN GESER BALOK PORTAL 0 - 0

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	A - B	118.95	21.25	70.15	470.914	399.224	6.55	147.210	263.450	441.840	243.219	0	405.364	52.983	142.5	2P10-100
	B - C	120.42	20.56	64.33	399.224	324.815	6.55	148.029	244.752	418.215	227.918	0	379.863	56.540	142.5	2P10-100
	C - D	120.36	20.60	64.37	470.914	324.815	6.55	148.008	254.308	418.362	235.807	0	393.011	54.649	142.5	2P10-100
	D - E	120.44	20.60	63.85	399.224	324.815	6.55	148.092	244.815	416.262	227.981	0	379.968	56.525	142.5	2P10-100
	E - F	124.48	21.27	69.13	470.914	324.815	6.55	153.038	259.337	443.384	240.836	0	401.394	53.508	142.5	2P10-100
2	A - B	116.89	20.92	83.82	470.914	399.224	6.55	144.701	260.940	496.745	240.709	0	401.182	53.536	142.5	2P10-100
	B - C	114.98	20.58	77.69	470.914	324.815	6.55	142.338	248.638	468.636	230.137	0	383.561	55.995	142.5	2P10-100
	C - D	115.15	20.70	77.71	470.914	324.815	6.55	142.643	248.942	469.025	230.441	0	384.069	55.921	142.5	2P10-100
	D - E	116.73	20.88	77.31	470.914	324.815	6.55	144.491	250.790	469.193	232.289	0	387.149	55.476	142.5	2P10-100
	E - F	116.88	20.98	83.19	470.914	324.815	6.55	144.753	251.053	494.151	232.552	0	387.586	55.414	142.5	2P10-100
3	A - B	118.17	21.21	71.31	399.224	399.224	6.55	146.349	253.012	445.851	234.448	0	390.746	54.966	142.5	2P10-100
	B - C	114 85	20.60	67.89	470.914	324.815	6.55	142.223	248.522	427.361	230.021	0	383.369	56.023	142.5	2P10-100
	C - D	115 28	20.80	67.49	470.914	324.815	6.55	142.884	249.184	426.342	230.683	0	384.471	55.863	142.5	2P10-100
	D - E	117 06	21.11	67.37	399.224	324.815	6.55	145.079	241.801	428.033	224.967	0	374.945	57.282	142.5	2P10-100
	E - F	118 78	21.39	70.9	470.914	324.815	6.55	147.179	253.478	444.959	234.977	0	391.629	54.842	142.5	2P10-100
4	A - B	125 36	21.31	38.16	470.914	399.224	6.55	154.004	270.243	314.276	250.012	0	416.687	51.544	142.5	2P10-100
	B - C	120.09	20.63	55.08	399.224	324.815	6.55	147.756	244.479	379.092	227.645	0	379.408	56.608	142.5	2P10-100
	C - D	120.21	21.03	54.95	399.224	324.815	6.55	148.302	245.025	379.092	228.191	0	380.318	56.473	142.5	2P10-100
	D - E	123.11	21.49	54.82	399.224	324.815	6.55	151.830	248.553	382.074	231.719	0	386.198	55.613	142.5	2P10-100
	E - F	124.62	21.53	57.07	399.224	324.815	6.55	153.458	250.180	393.152	233.346	0	388.910	55.225	142.5	2P10-100
5	A - B	155.98	10.70	42.61	399.224	399.224	6.55	175.014	281.677	353.976	263.113	0	438.521	48.977	142.5	2P10-100
	B - C	153.80	4.25	60.29	399.224	324.815	6.55	165.953	262.675	419.171	245.841	0	409.735	52.418	142.5	2P10-100
	C - D	155.05	9.11	39.39	399.224	324.815	6.55	172.368	269.091	337.806	252.257	0	420.428	51.085	142.5	2P10-100
	D - E	136.75	19.39	38.88	470.914	399.224	6.55	163.947	280.187	327.243	259.956	0	433.259	49.572	142.5	2P10-100
	E - F	137.84	19.46	40.05	470.914	399.224	6.55	165.165	281.405	333.375	261.174	0	435.289	49.341	142.5	2P10-100
ATAP	A - B	28.98	1.36	24.83	137.444	137.444	6.55	31.857	68.579	136.143	63.309	0	105.514	167.841	117.5	P10-100
	B - C	22.32	0.02	18.27	137.444	137.444	6.55	23.457	60.179	100.191	54.909	0	91.514	193.517	117.5	P10-100
	C - D	24.59	0.25	18.28	137.444	137.444	6.55	26.082	62.804	102.858	57.534	0	95.889	184.688	117.5	P10-100
	D - E	61.47	8.99	18.31	202.088	202.088	6.55	73.983	127.976	150.885	120.227	0	200.379	88.380	117.5	P10-100
	E - F	61.01	9.18	19.17	264.015	202.088	6.55	73.700	135.965	154.214	127.029	0	211.716	83.648	117.5	P10-100

PERHITUNGAN TULANGAN GESER BALOK PORTAL 0 - 0

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	A - B	118.95	21.25	70.15	470.914	399.224	6.55	147.210	263.450	441.840	243.219	213.528	190	165.880	129.477	285	P10-120
	B - C	120.42	20.56	64.33	399.224	324.815	6.55	148.029	244.752	418.215	227.918	200.095	190	143.491	149.679	285	P10-140
	C - D	120.36	20.60	64.37	470.914	324.815	6.55	148.008	254.308	418.362	235.807	207.021	190	155.035	138.534	285	P10-130
	D - E	120.44	20.60	63.85	399.224	324.815	6.55	148.092	244.815	416.262	227.981	200.150	190	143.584	149.583	285	P10-140
	E - F	124.48	21.27	69.13	470.914	324.815	6.55	153.038	259.337	443.384	240.836	211.436	190	162.394	132.256	285	P10-130
2	A - B	116.89	20.92	83.82	470.914	399.224	6.55	144.701	260.940	496.745	240.709	211.325	190	162.208	132.408	285	P10-130
	B - C	114.98	20.58	77.69	470.914	324.815	6.55	142.338	248.638	468.636	230.137	202.043	190	146.738	146.367	285	P10-140
	C - D	115.15	20.70	77.71	470.914	324.815	6.55	142.643	248.942	469.025	230.441	202.310	190	147.184	145.924	285	P10-140
	D - E	116.73	20.88	77.31	470.914	324.815	6.55	144.491	250.790	469.193	232.289	203.933	190	149.888	143.291	285	P10-140
	E - F	116.88	20.98	83.19	470.914	324.815	6.55	144.753	251.053	494.151	232.552	204.163	190	150.272	142.925	285	P10-140
3	A - B	118.17	21.21	71.31	399.224	399.224	6.55	146.349	253.012	445.851	234.448	205.828	190	153.046	140.334	285	P10-140
	B - C	114.85	20.60	67.89	470.914	324.815	6.55	142.223	248.522	427.361	230.021	201.942	190	146.569	146.535	285	P10-140
	C - D	115.28	20.80	67.49	470.914	324.815	6.55	142.884	249.184	426.342	230.683	202.522	190	147.537	145.574	285	P10-140
	D - E	117.06	21.11	67.37	399.224	324.815	6.55	145.079	241.801	428.033	224.967	197.504	190	139.174	154.322	285	P10-150
	E - F	118.78	21.39	70.90	470.914	324.815	6.55	147.179	253.478	444.959	234.977	206.293	190	153.821	139.627	285	P10-130
4	A - B	125.36	21.31	38.16	470.914	399.224	6.55	154.004	270.243	314.276	250.012	219.492	190	175.821	122.156	285	P10-120
	B - C	120.09	20.63	55.08	399.224	324.815	6.55	147.756	244.479	379.092	227.645	199.855	190	143.092	150.097	285	P10-150
	C - D	120.21	21.03	54.95	399.224	324.815	6.55	148.302	245.025	379.092	228.191	200.334	190	143.891	149.263	285	P10-140
	D - E	123.11	21.49	54.82	399.224	324.815	6.55	151.830	248.553	382.074	231.719	203.432	190	149.053	144.094	285	P10-140
	E - F	124.62	21.53	57.07	399.224	324.815	6.55	153.458	250.180	393.152	233.346	204.861	190	151.434	141.828	285	P10-140
5	A - B	155.98	10.70	42.61	399.224	399.224	6.55	175.014	281.677	353.976	263.113	230.993	190	194.989	110.148	285	P10-110
	B - C	153.80	4.25	60.29	399.224	324.815	6.55	165.953	262.675	419.171	245.841	215.830	190	169.717	126.549	285	P10-120
	C - D	155.05	9.11	39.39	399.224	324.815	6.55	172.368	269.091	337.806	252.257	221.463	190	179.104	119.917	285	P10-110
	D - E	136.75	19.39	38.88	470.914	399.224	6.55	163.947	280.187	327.243	259.956	228.222	190	190.370	112.820	285	P10-110
	E - F	137.84	19.46	40.05	470.914	399.224	6.55	165.165	281.405	333.375	261.174	229.291	190	192.152	111.774	285	P10-110
ATAP	A - B	28.98	1.36	24.83	137.444	137.444	6.55	31.857	68.579	136.143	63.309	54.666	156.7	-65.556	-270.14	235	P10-200
	B - C	22.32	0.02	18.27	137.444	137.444	6.55	23.457	60.179	100.191	54.909	47.413	156.7	-77.645	-228.08	235	P10-200
	C - D	24.59	0.25	18.28	137.444	137.444	6.55	26.082	62.804	102.858	57.534	49.680	156.7	-73.867	-239.75	235	P10-200
	D - E	61.47	8.99	18.31	202.088	202.088	6.55	73.983	127.976	150.885	120.227	103.815	156.7	16.358	1082.62	235	P10-200
	E - F	61.01	9.18	19.17	264.015	202.088	6.55	73.700	135.965	154.214	127.029	109.688	156.7	26.147	677.309	235	P10-200

PERHITUNGAN TULANGAN BALOK PORTAL 1 - 1

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	A - B	40/65	570	390.09	339.86	487.613	424.825	0.0102	18.824	3.676
	B - C	40/65	570	376.67	308.90	470.838	386.125	0.0102	18.824	3.676
	C - D	40/65	570	369.43	308.08	461.788	385.100	0.0102	18.824	3.676
	D - E	40/65	570	370.07	310.59	462.588	388.238	0.0102	18.824	3.676
	E - F	40/65	570	347.06	279.65	433.825	349.563	0.0102	18.824	3.676
2	A - B	40/65	570	386.90	309.68	483.625	387.100	0.0102	18.824	3.676
	B - C	40/65	570	401.93	299.67	502.413	374.588	0.0102	18.824	3.676
	C - D	40/65	570	382.99	293.94	478.738	367.425	0.0102	18.824	3.676
	D - E	40/65	570	384.08	298.98	480.100	373.725	0.0102	18.824	3.676
	E - F	40/65	570	398.71	256.28	498.388	320.350	0.0102	18.824	3.676
3	A - B	40/65	570	357.38	311.66	446.725	389.575	0.0102	18.824	3.676
	B - C	40/65	570	358.22	305.79	447.775	382.238	0.0102	18.824	3.676
	C - D	40/65	570	278.47	304.83	348.088	381.038	0.0102	18.824	3.676
	D - E	40/65	570	351.01	298.34	438.763	372.925	0.0102	18.824	3.676
	E - F	40/65	570	379.19	255.84	473.988	319.800	0.0102	18.824	3.676
4	A - B	40/65	570	398.70	365.84	498.375	457.300	0.0102	18.824	3.676
	B - C	40/65	570	365.84	304.03	457.300	380.038	0.0102	18.824	3.676
	C - D	40/65	570	323.00	310.59	403.750	388.238	0.0102	18.824	3.676
	D - E	40/65	570	370.07	304.38	462.588	380.475	0.0102	18.824	3.676
	E - F	40/65	570	336.53	271.75	420.663	339.688	0.0102	18.824	3.676
5	A - B	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-
	D - E	40/65	570	294.51	376.58	368.1375	470.725	0.0102	18.824	3.676
	E - F	40/65	570	280.34	311.13	350.425	388.9125	0.0102	18.824	3.676
ATAP	A - B	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-
	D - E	30/55	470	117.03	153.47	146.288	191.838	0.0102	18.824	3.676

	Tulangan Tumpuan Portal 1 - 1									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	575.864	rangkap	-	-	-	-	-	-	-	542.494
	565.871	sebelah	3.623	0.0101	2292.033	6.032	7	2660	125.176	539.886
	560.407	sebelah	3.553	0.0099	2247.978	5.916	6	2280	107.294	470.914
	560.892	sebelah	3.559	0.0099	2251.872	5.926	6	2280	107.294	470.914
	543.175	sebelah	3.338	0.0093	2111.856	5.558	6	2280	107.294	470.914
2	573.504	rangkap	-	-	-	-	-	-	-	542.494
	584.538	rangkap	-	-	-	-	-	-	-	542.494
	570.599	sebelah	3.684	0.0102	2330.490	6.133	7	2660	125.176	539.886
	571.410	rangkap	-	-	-	-	-	-	-	612.297
	582.191	rangkap	-	-	-	-	-	-	-	612.297
3	551.191	sebelah	3.437	0.0095	2174.654	5.723	6	2280	107.294	470.914
	551.839	sebelah	3.445	0.0096	2179.765	5.736	6	2280	107.294	470.914
	486.549	sebelah	2.678	0.0074	1694.487	4.459	5	1900	89.412	399.224
	546.257	sebelah	3.376	0.0094	2135.892	5.621	6	2280	107.294	470.914
	567.761	sebelah	3.647	0.0101	2307.367	6.072	7	2660	125.176	539.886
4	582.184	rangkap	-	-	-	-	-	-	-	612.297
	557.677	sebelah	3.519	0.0098	2226.133	5.858	6	2280	107.294	470.914
	524.009	sebelah	3.107	0.0086	1965.452	5.172	6	2280	107.294	470.914
	560.892	sebelah	3.559	0.0099	2251.872	5.926	6	2280	107.294	470.914
	534.871	sebelah	3.237	0.0090	2047.781	5.389	6	2280	107.294	470.914
5	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	500.365	sebelah	2.833	0.0079	1792.090	4.716	5	1900	89.412	399.224
	488.180	sebelah	2.696	0.0075	1705.866	4.489	5	1900	89.412	399.224
6	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	315.418	sebelah	1.656	0.0046	863.643	2.273	3	1140	53.647	202.088
	307.571	sebelah	1.574	0.0044	821.209	2.161	3	1140	53.647	202.088

Tulangan Lapangan Portal 1 - 1									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
537.511	sebelah	3.269	0.009	2068.044	5.442	6	2280	107.294	470.914
512.444	sebelah	2.971	0.008	1879.653	4.946	5	1900	89.412	399.224
511.763	sebelah	2.963	0.008	1874.664	4.933	5	1900	89.412	399.224
513.844	sebelah	2.987	0.008	1889.937	4.974	5	1900	89.412	399.224
487.579	sebelah	2.690	0.007	1701.667	4.478	5	1900	89.412	399.224
513.090	sebelah	2.979	0.008	1884.400	4.959	5	1900	89.412	399.224
504.730	sebelah	2.882	0.008	1823.489	4.799	5	1900	89.412	399.224
499.881	sebelah	2.827	0.008	1788.622	4.707	5	1900	89.412	399.224
504.148	sebelah	2.876	0.008	1819.290	4.788	5	1900	89.412	399.224
466.761	sebelah	2.465	0.007	1559.461	4.104	5	1900	89.412	399.224
514.728	sebelah	2.998	0.008	1896.448	4.991	5	1900	89.412	399.224
509.858	sebelah	2.941	0.008	1860.729	4.897	5	1900	89.412	399.224
509.057	sebelah	2.932	0.008	1854.887	4.881	5	1900	89.412	399.224
503.608	sebelah	2.870	0.008	1815.396	4.777	5	1900	89.412	399.224
466.360	sebelah	2.461	0.007	1556.784	4.097	5	1900	89.412	399.224
557.677	sebelah	3.519	0.010	2226.133	5.858	6	2280	107.294	470.914
508.388	sebelah	2.924	0.008	1850.019	4.868	5	1900	89.412	399.224
513.844	sebelah	2.987	0.008	1889.937	4.974	5	1900	89.412	399.224
508.681	sebelah	2.928	0.008	1852.149	4.874	5	1900	89.412	399.224
480.642	sebelah	2.614	0.007	1653.596	4.352	5	1900	89.412	399.224
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
565.804	sebelah	3.622	0.010	2291.485	6.030	7	2660	125.176	539.886
514.290	sebelah	2.993	0.008	1893.223	4.982	5	1900	89.412	399.224
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
361.201	sebelah	2.171	0.006	1132.558	2.980	3	1140	53.647	202.088
450.354	sebelah	3.375	0.009	1760.641	4.633	5	1900	89.412	323.224

PERHITUNGAN TULANGAN RANGKAP PORTAL 1 - 1

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
1	A - B	400	650	570	390.09	339.86	487.613	424.825	0.0102	18.824	3.676	575.864

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	8.278	227.19	74.363	0.563	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	A - B	400	650	570	386.90	309.68	483.625	387.1	0.0102	18.824	3.676	573.504

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	4.291	227.19	38.544	0.292	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	B - C	400	650	570	401.93	299.67	502.413	374.588	0.0102	18.824	3.676	584.538

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	23.078	227.19	207.308	1.571	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	D - E	400	650	570	384.08	298.98	480.100	373.725	0.0102	18.824	3.676	571.410

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	0.766	227.19	6.880	0.052	2	400	2725.6	7.173	8	3040

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.013	0.0018	0.012	271.591	130.278	559.065	53.232	612.296

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	E - F	400	650	570	398.71	256.28	498.388	320.350	0.0102	18.824	3.676	582.191

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	19.053	227.19	171.152	1.297	2	400	2725.6	7.173	8	3040

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.013	0.0018	0.012	271.591	130.278	559.065	53.232	612.296

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
4	A - B	400	650	570	398.70	365.84	498.375	457.3	0.0102	18.824	3.676	582.184

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	19.041	227.19	171.040	1.296	2	400	2725.6	7.17263	8	3040

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.013	0.0018	0.012	271.591	130.278	559.065	53.232	612.296

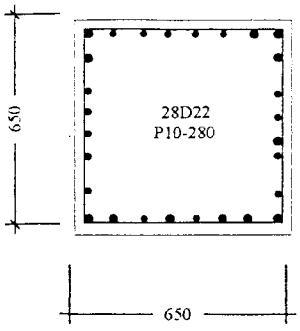
PERHITUNGAN TULANGAN GESER BALOK PORTAL 1 - 1

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	A - B	186.40	43.65	74.83	542.494	470.914	6.55	241.553	376.931	555.839	353.369	0	588.949	36.468	142.5	2P10-70
	B - C	186.18	43.88	64.31	539.886	399.224	6.55	241.563	367.017	511.665	345.182	0	575.303	37.333	142.5	2P10-70
	C - D	186.99	43.96	64.17	470.914	399.224	6.55	242.498	358.737	512.012	338.506	0	564.177	38.069	142.5	2P10-70
	D - E	185.82	43.87	62.98	470.914	399.224	6.55	241.175	357.414	505.691	337.183	0	561.972	38.218	142.5	2P10-70
	E - F	183.99	43.24	73.90	470.914	399.224	6.55	238.592	354.831	548.972	334.600	0	557.667	38.513	142.5	2P10-70
2	A - B	172.11	41.00	87.66	542.494	399.224	6.55	223.766	349.567	591.938	327.672	0	546.120	39.328	142.5	2P10-70
	B - C	180.75	44.01	73.45	542.494	399.224	6.55	235.998	361.800	544.488	339.905	0	566.508	37.912	142.5	2P10-70
	C - D	182.24	43.04	76.10	539.886	399.224	6.55	236.544	361.998	556.164	340.163	0	566.938	37.883	142.5	2P10-70
	D - E	180.17	43.13	74.98	612.297	399.224	6.55	234.465	369.592	549.381	346.074	0	576.789	37.236	142.5	2P10-70
	E - F	174.42	42.61	87.63	612.297	399.224	6.55	227.882	363.008	595.928	339.490	0	565.817	37.959	142.5	2P10-70
3	A - B	175.09	2.69	71.20	470.914	399.224	6.55	186.669	302.909	485.709	282.678	0	471.129	45.587	142.5	2P10-80
	B - C	182.07	44.16	68.95	470.914	399.224	6.55	237.542	353.781	527.132	333.550	0	555.917	38.635	142.5	2P10-70
	C - D	183.91	44.20	66.28	399.224	399.224	6.55	239.516	346.178	517.892	327.614	0	546.023	39.335	142.5	2P10-70
	D - E	180.28	44.03	64.82	470.914	399.224	6.55	235.526	351.765	507.770	331.534	0	552.557	38.869	142.5	2P10-70
	E - F	177.92	43.38	733.88	539.886	399.224	6.55	232.365	357.819	3314.661	335.984	0	559.973	38.355	142.5	2P10-70
4	A - B	187.14	43.30	89.25	612.297	470.914	6.55	241.962	386.666	616.812	361.481	0	602.468	35.649	142.5	2P10-70
	B - C	188.85	44.37	37.29	470.914	399.224	6.55	244.881	361.121	401.499	340.890	0	568.149	37.803	142.5	2P10-70
	C - D	193.17	44.90	44.92	470.914	399.224	6.55	249.974	366.213	438.638	345.982	0	576.637	37.246	142.5	2P10-70
	D - E	193.43	45.44	46.30	470.914	399.224	6.55	250.814	367.053	445.274	346.822	0	578.037	37.156	142.5	2P10-70
	E - F	182.76	43.26	54.04	470.914	399.224	6.55	237.321	353.561	464.289	333.330	0	555.549	38.660	142.5	2P10-70
5	A - B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D - E	199.46	43.96	32.17	399.224	539.886	6.55	255.591	381.045	390.705	359.210	0	598.683	35.875	142.5	2P10-100
	E - F	191.72	42.48	31.61	399.224	399.224	6.55	245.910	352.573	378.672	334.009	0	556.681	38.582	142.5	2P10-100
ATAP	A - B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D - E	64.84	10.32	15.51	202.088	202.088	6.55	78.918	132.911	144.060	125.162	0	208.604	84.896	117.5	P10-80
	E - F	67.39	11.10	14.10	202.088	323.224	6.55	82.415	152.590	141.635	142.519	0	237.531	74.557	117.5	P10-70

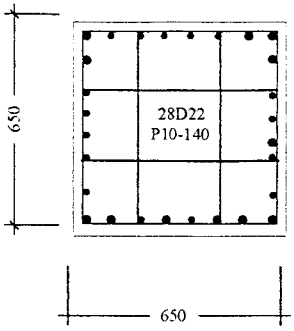
PERHITUNGAN TULANGAN GESER BALOK PORTAL 1 - 1

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pak	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	A - B	186.40	43.65	74.83	542.494	470.914	6.55	241.553	376.931	555.839	353.369	310.232	190	327.054	65.670	285	P10-60
	B - C	186.18	43.88	64.31	539.886	399.224	6.55	241.563	367.017	511.665	345.182	303.044	190	315.074	68.167	285	P10-60
	C - D	186.99	43.96	64.17	470.914	399.224	6.55	242.498	358.737	512.012	338.506	297.184	190	305.306	70.348	285	P10-70
	D - E	185.82	43.87	62.98	470.914	399.224	6.55	241.175	357.414	505.691	337.183	296.022	190	303.370	70.797	285	P10-70
	E - F	183.99	43.24	73.90	470.914	399.224	6.55	238.592	354.831	548.972	334.600	293.754	190	299.591	71.690	285	P10-70
2	A - B	172.11	41.00	87.66	542.494	399.224	6.55	223.766	349.567	591.938	327.672	287.672	190	289.453	74.201	285	P10-70
	B - C	180.75	44.01	73.45	542.494	399.224	6.55	235.998	361.800	544.488	339.905	298.411	190	307.352	69.879	285	P10-60
	C - D	182.24	43.04	76.10	539.886	399.224	6.55	236.544	361.998	556.164	340.163	298.638	190	307.730	69.794	285	P10-60
	D - E	180.17	43.13	74.98	612.297	399.224	6.55	234.465	369.592	549.381	346.074	303.827	190	316.379	67.886	285	P10-60
	E - F	174.42	42.61	87.63	612.297	399.224	6.55	227.882	363.008	595.928	339.490	298.047	190	306.745	70.018	285	P10-70
3	A - B	175.09	2.69	71.20	470.914	399.224	6.55	186.669	302.909	485.709	282.678	248.170	190	223.617	96.046	285	P10-90
	B - C	182.07	44.16	68.95	470.914	399.224	6.55	237.542	353.781	527.132	333.550	292.833	190	298.054	72.059	285	P10-70
	C - D	183.91	44.20	66.28	399.224	399.224	6.55	239.516	346.178	517.892	327.614	287.621	190	289.368	74.222	285	P10-70
	D - E	180.28	44.03	64.82	470.914	399.224	6.55	235.526	351.765	507.770	331.534	291.063	190	295.104	72.780	285	P10-70
	E - F	177.92	43.38	733.9	539.886	399.224	6.55	232.365	357.819	3314.66	335.984	294.969	190	301.615	71.209	285	P10-70
4	A - B	187.14	43.30	89.25	612.297	470.914	6.55	241.962	386.666	616.812	361.481	317.353	190	338.922	63.370	285	P10-60
	B - C	188.85	44.37	37.29	470.914	399.224	6.55	244.881	361.121	401.499	340.890	299.276	190	308.793	69.553	285	P10-60
	C - D	193.17	44.90	44.92	470.914	399.224	6.55	249.974	366.213	438.638	345.982	303.747	190	316.245	67.914	285	P10-60
	D - E	193.43	45.44	46.30	470.914	399.224	6.55	250.814	367.053	445.274	346.822	304.484	190	317.474	67.652	285	P10-60
	E - F	182.76	43.26	54.04	470.914	399.224	6.55	237.321	353.561	464.289	333.330	292.639	190	297.732	72.137	285	P10-70
5	A - B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D - E	199.46	43.96	32.17	399.224	539.886	6.55	255.591	381.045	390.705	359.210	315.360	190	335.600	63.998	285	P10-60
	E - F	191.72	42.48	31.61	399.224	399.224	6.55	245.910	352.573	378.672	334.009	293.235	190	298.725	71.898	285	P10-70
ATAP	A - B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D - E	64.84	10.32	15.51	202.088	202.088	6.55	78.918	132.911	144.060	125.162	108.076	156.7	23.460	754.877	235	P10-230
	E - F	67.39	11.10	14.10	202.088	323.224	6.55	82.415	152.590	141.635	142.519	123.063	156.7	48.439	365.610	235	P10-230

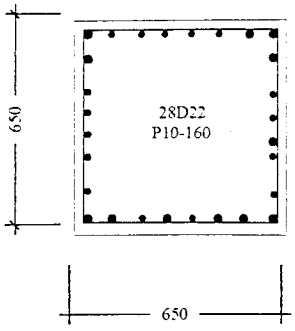
POT I-I



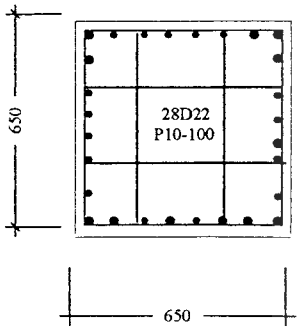
POT II-II



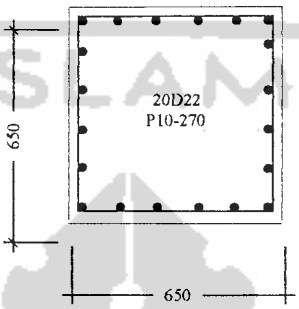
POT III-III



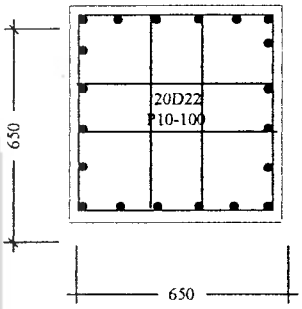
POT IV-IV



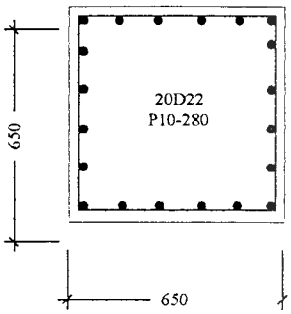
POT V-V



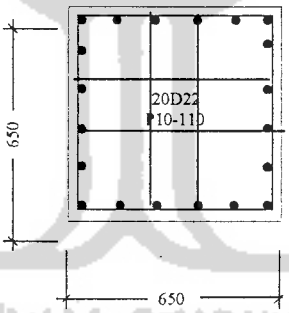
POT VI-VI



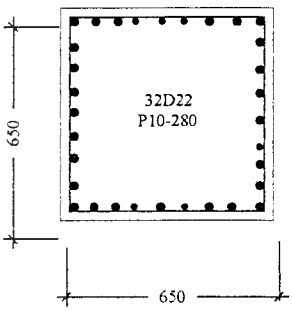
POT VII-VII



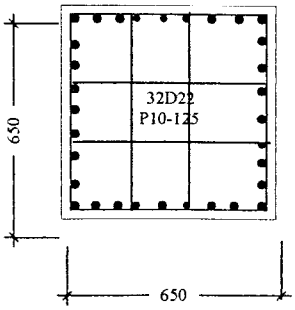
POT VIII-VIII



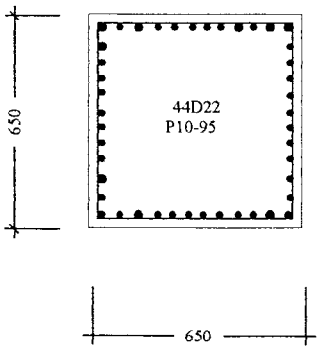
POT IX-IX



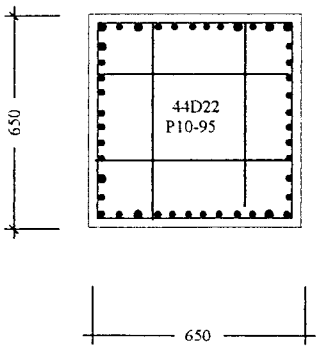
POT X-X



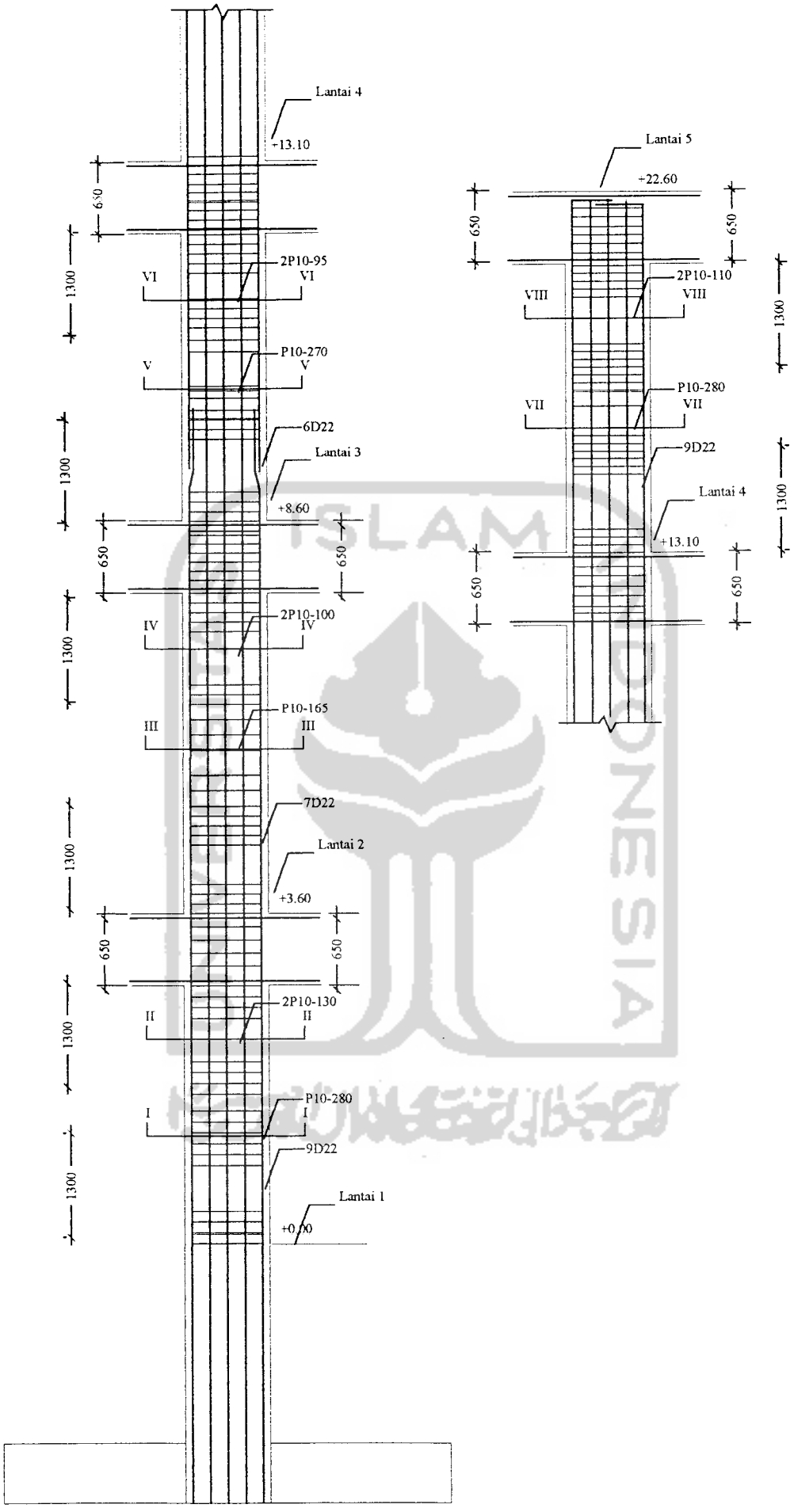
POT XI-XI



POT XII-XII

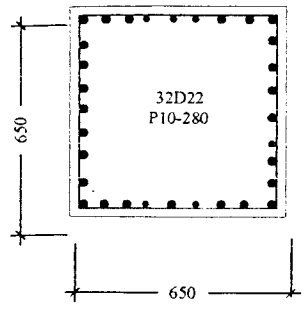


DETAIL KOLOM 16

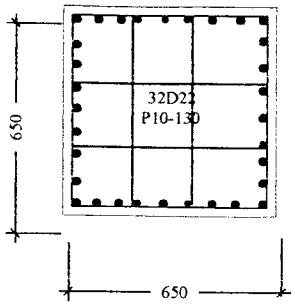


RENC. KOLOM 17

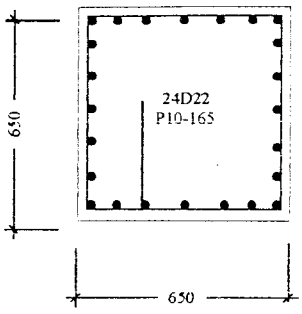
POT I-I



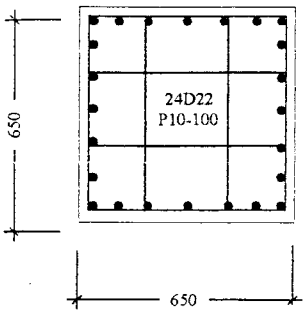
POT II-II



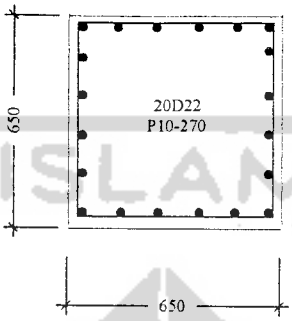
POT III-III



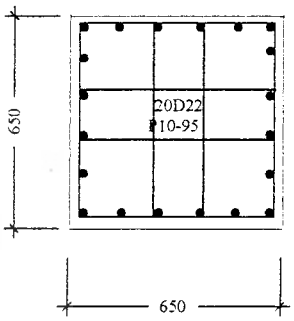
POT IV-IV



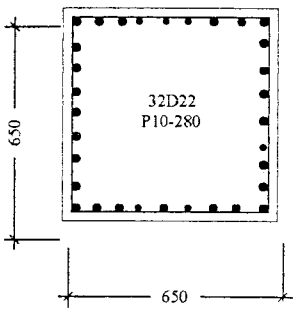
POT V-V



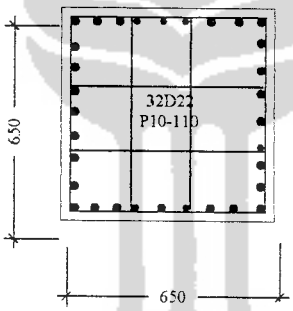
POT VI-VI



POT VII-VII

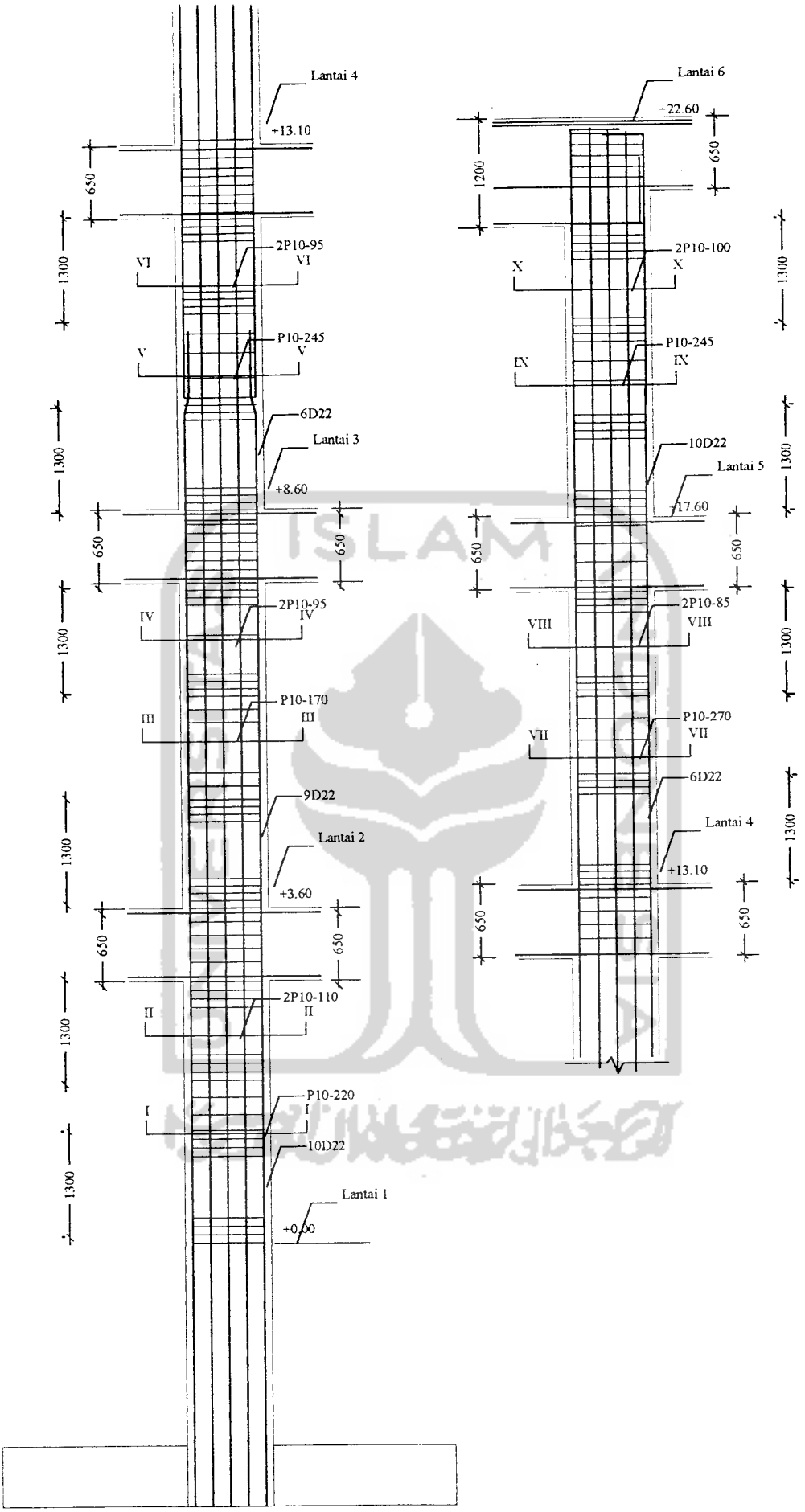


POT VIII-VIII



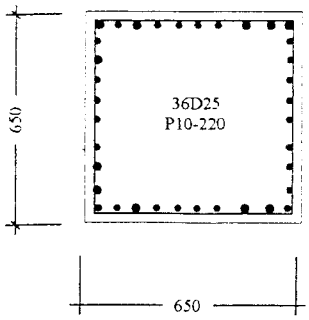
UNIVERSITAS ISLAM INDONESIA

DETAIL KOLOM 17

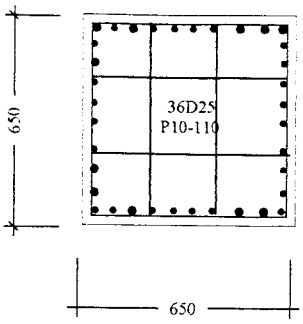


RENC. KOLOM 18

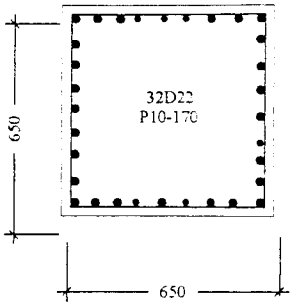
POT I-I



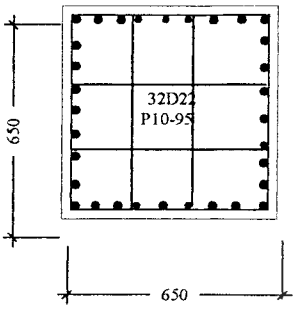
POT II-II



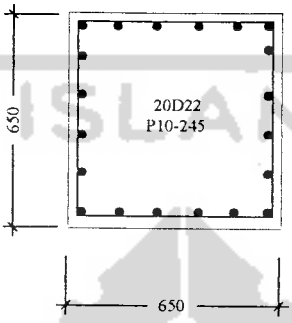
POT III-III



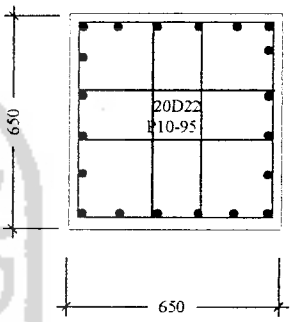
POT IV-IV



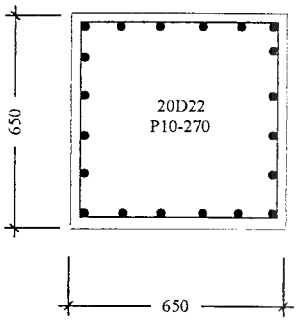
POT V-V



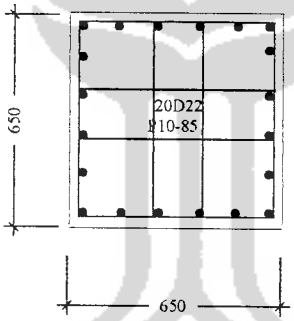
POT VI-VI



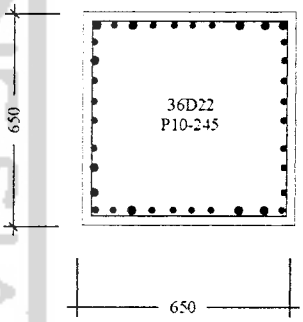
POT VII-VII



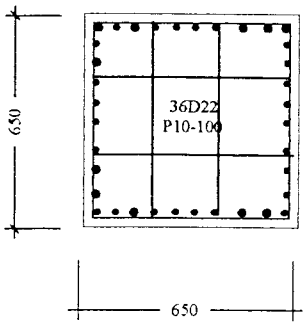
POT VIII-VIII



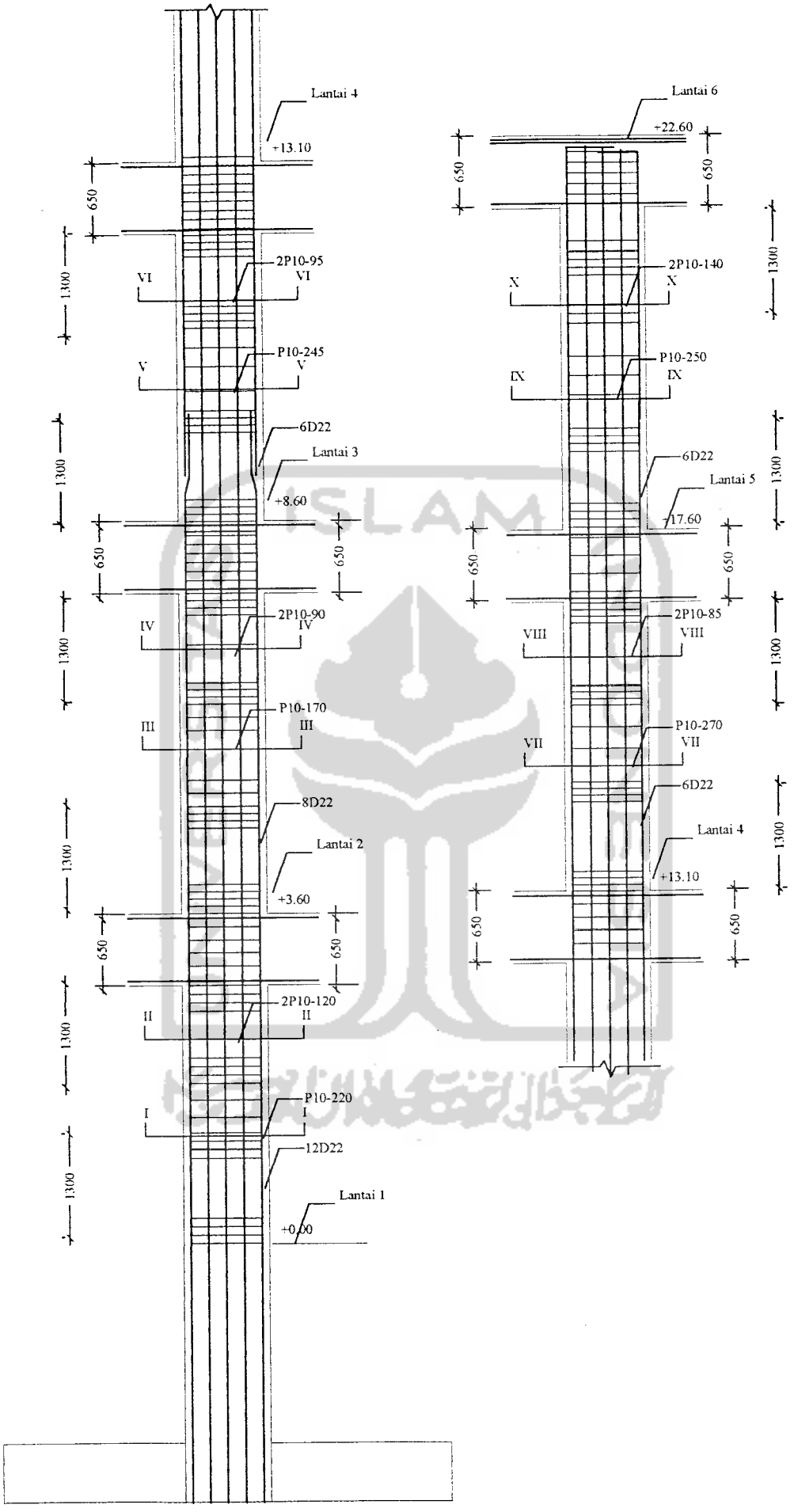
POT IX-IX



POT X-X

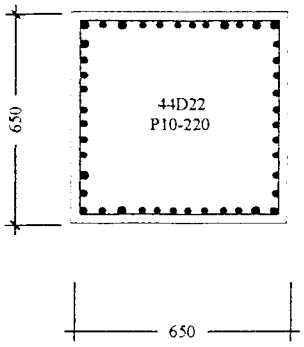


DETAIL KOLOM 18

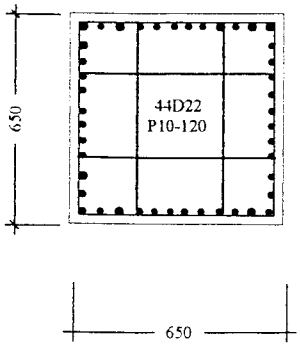


RENC. KOLOM 19

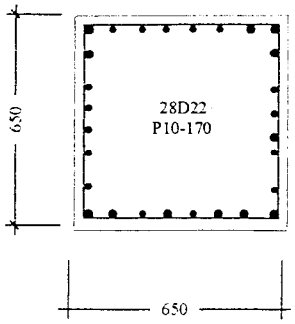
POT I-I



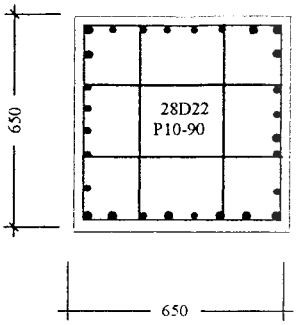
POT II-II



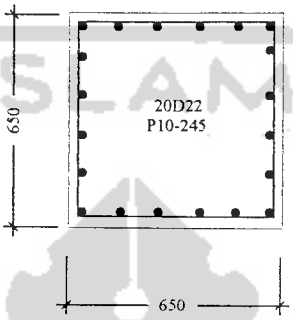
POT III-III



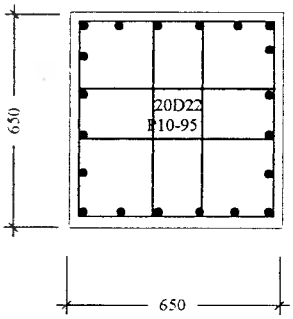
POT IV-IV



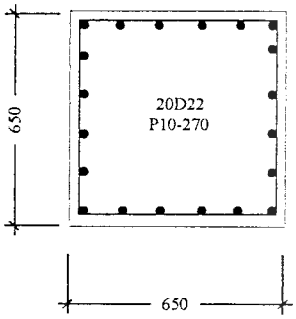
POT V-V



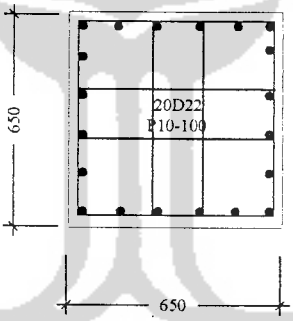
POT VI-VI



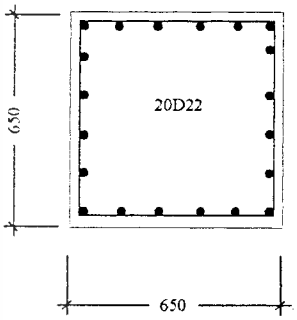
POT VII-VI



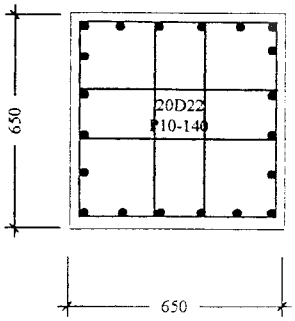
POT VIII-VIII



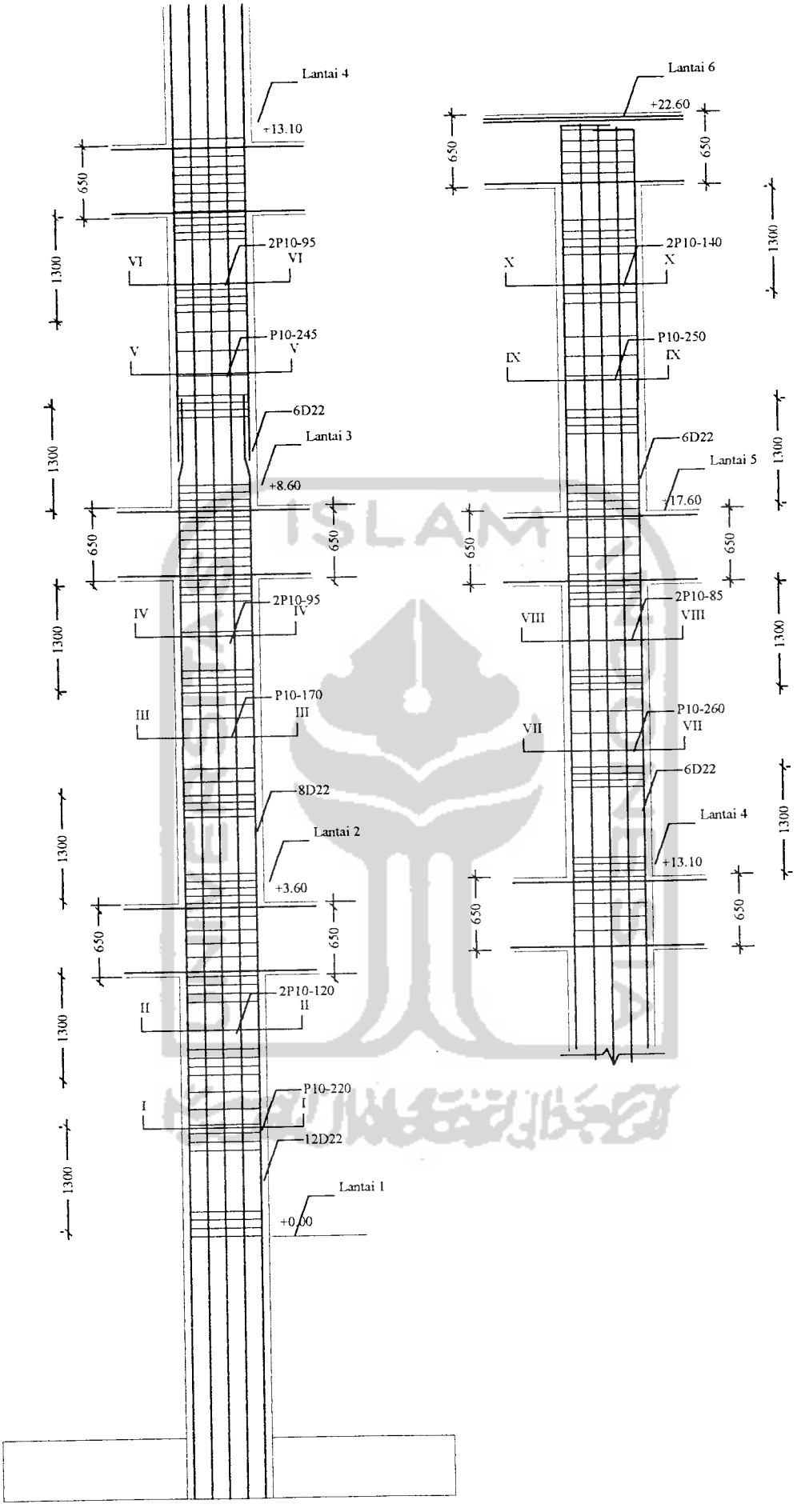
POT IX-IX



POT X-X

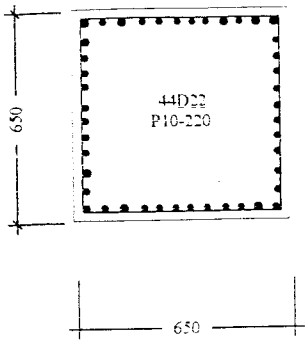


DETAIL KOLOM 19

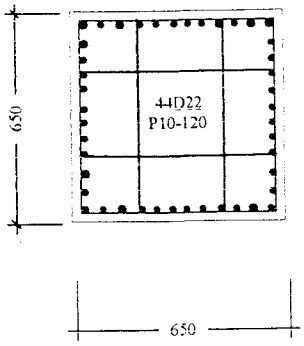


RENC. KOLOM 20

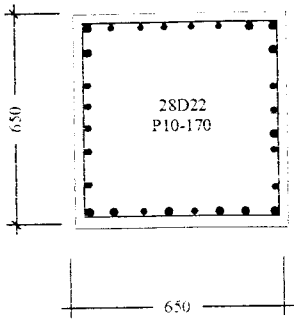
POT I-I



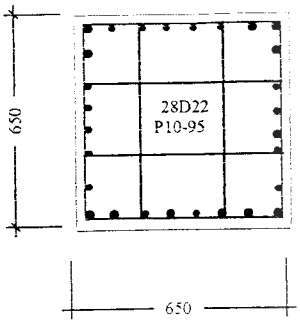
POT II-II



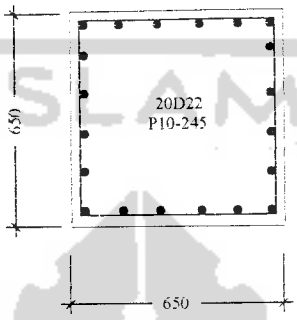
POT III-III



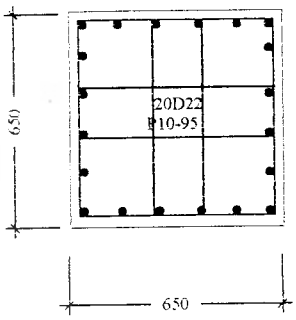
POT IV-IV



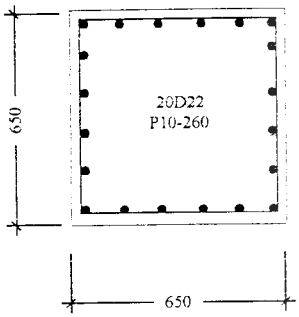
POT V-V



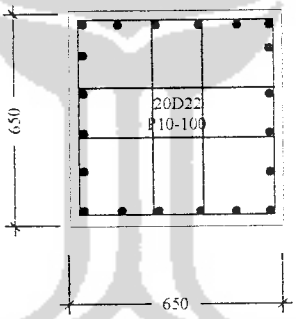
POT VI-VI



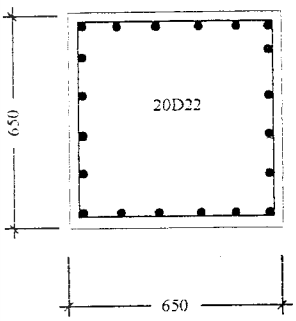
POT VII-VI



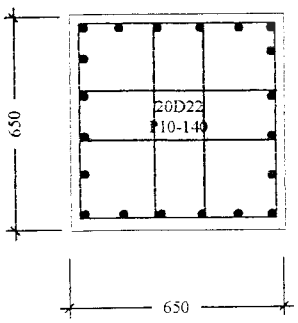
POT VIII-VIII



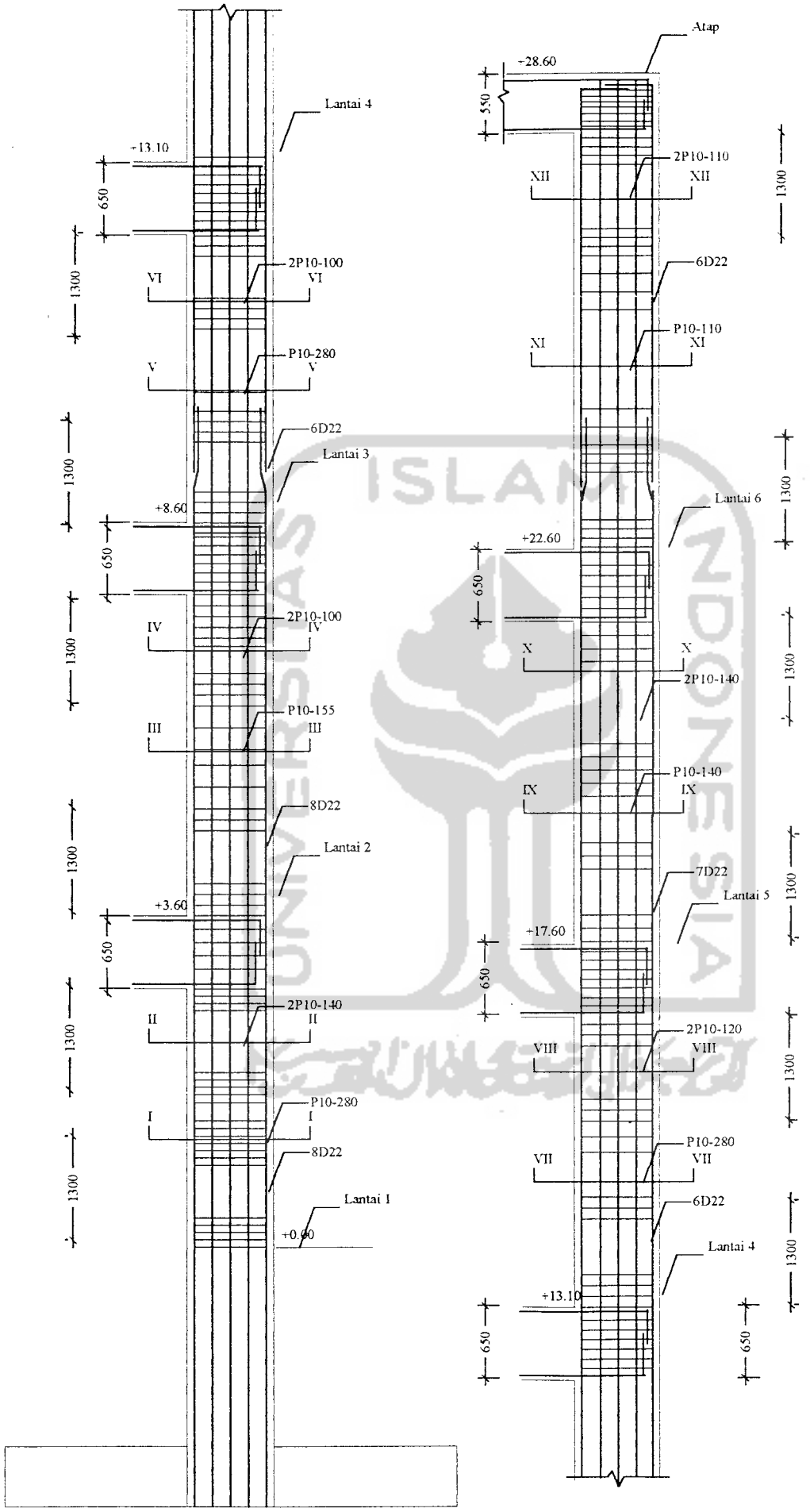
POT IX-IX



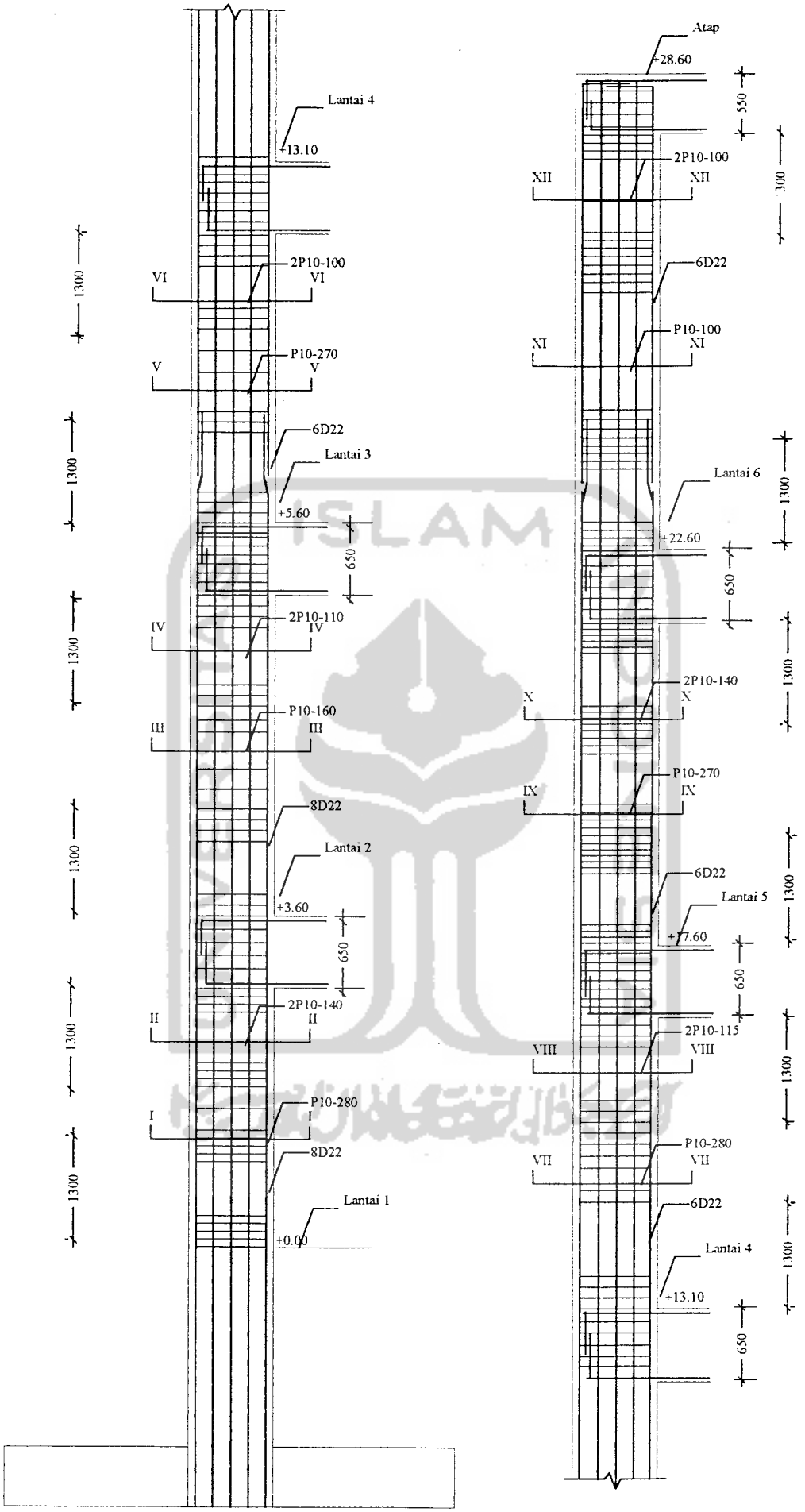
POT X-X



DETAIL KOLOM 20

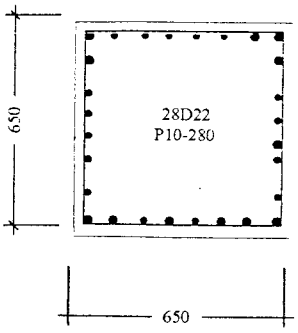


RENC. KOLOM 21

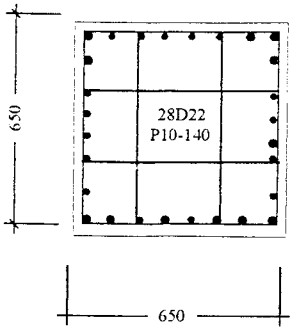


RENC. KOLOM 22

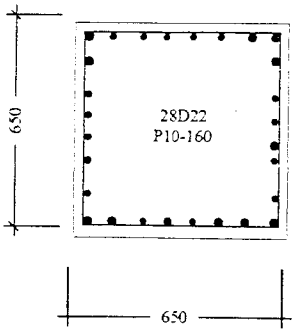
POT I-I



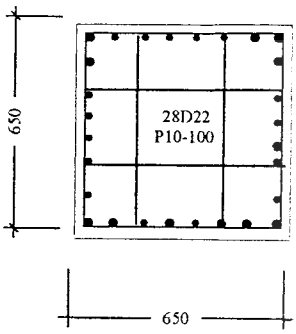
POT II-II



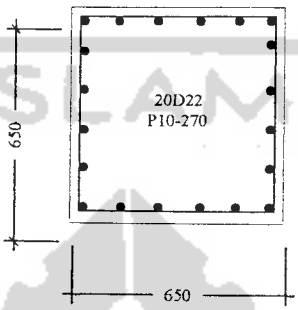
POT III-III



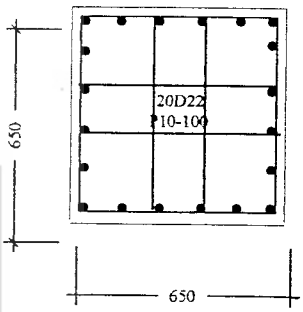
POT IV-IV



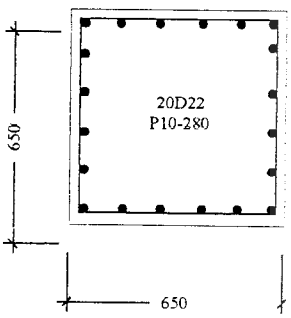
POT V-V



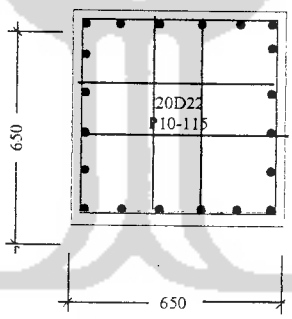
POT VI-VI



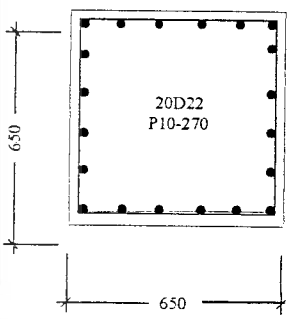
POT VII-VII



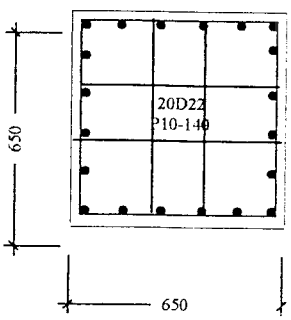
POT VIII-VIII



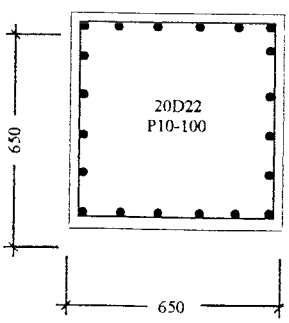
POT IX-IX



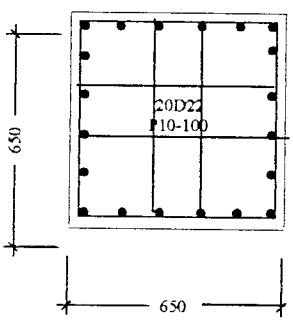
POT X-X



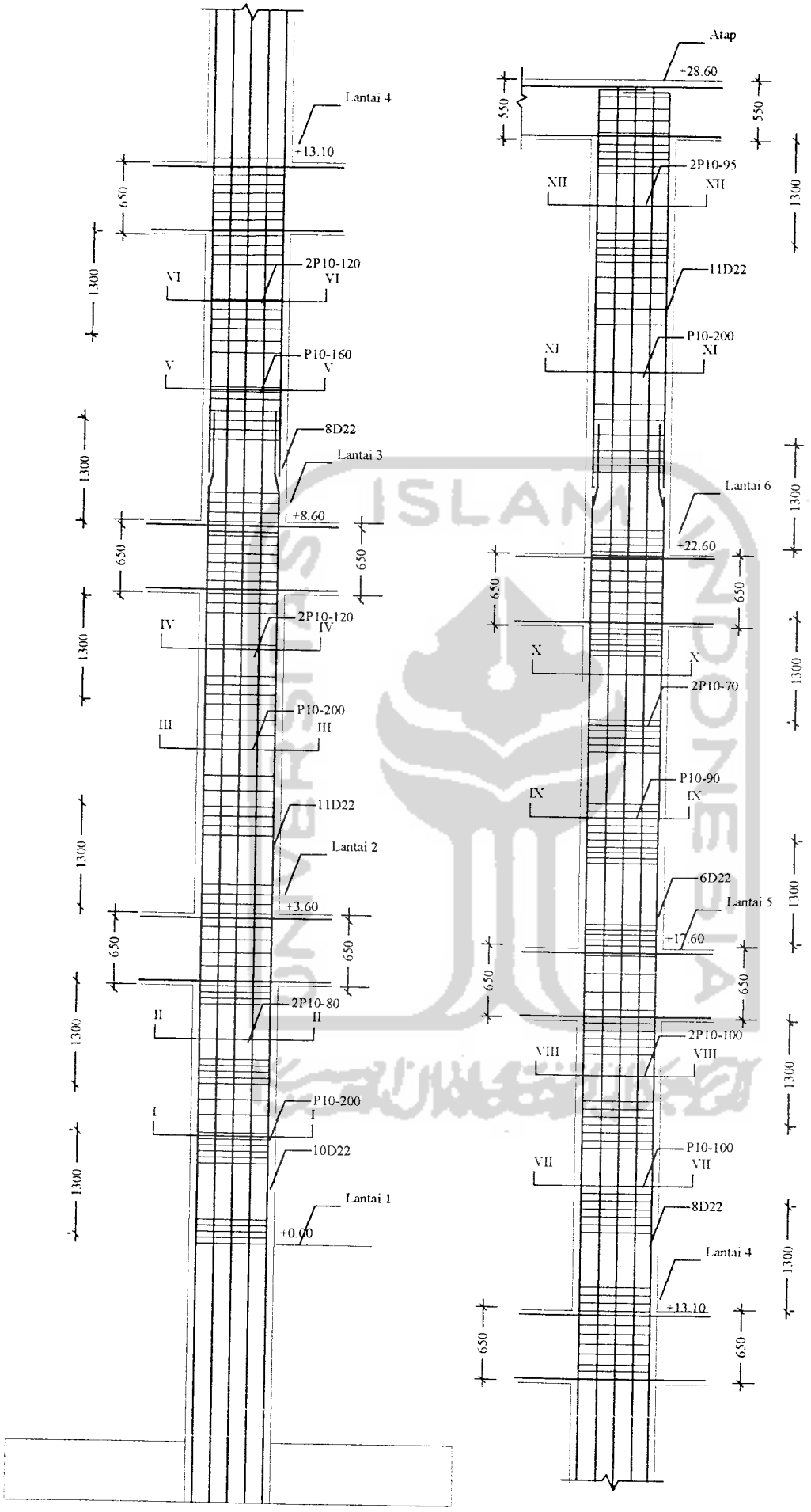
POT XI-XI



POT XII-XII

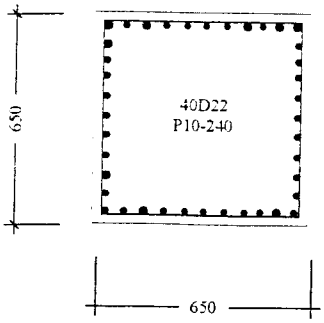


DETAIL KOLOM 22

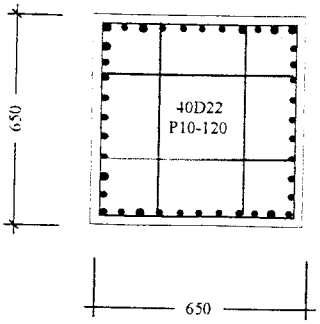


RENC. KOLOM 23

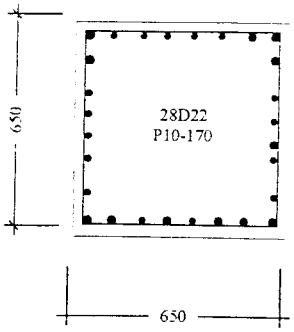
POT I-I



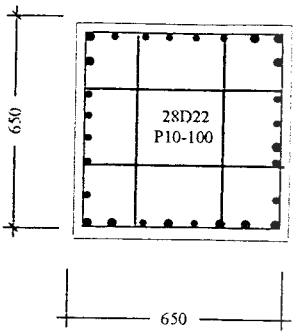
POT II-II



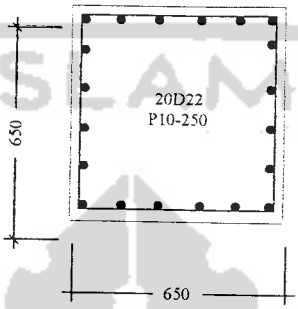
POT III-III



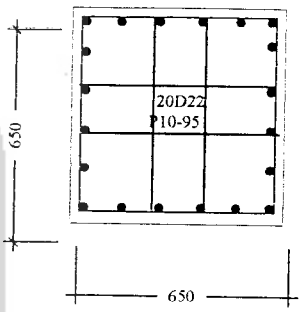
POT IV-IV



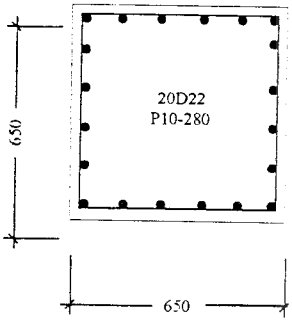
POT V-V



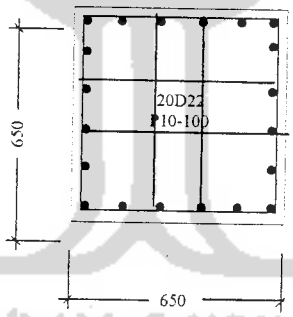
POT VI-VI



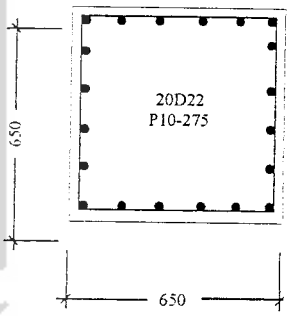
POT VII-VII



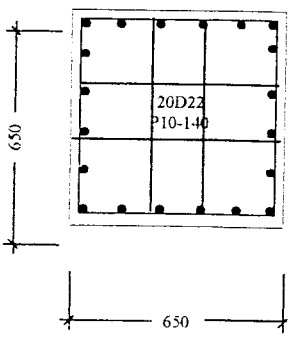
POT VIII-VIII



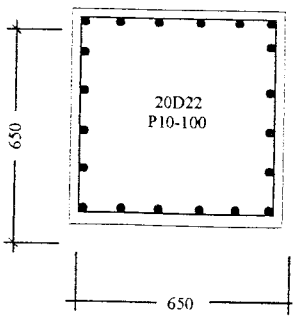
POT IX-IX



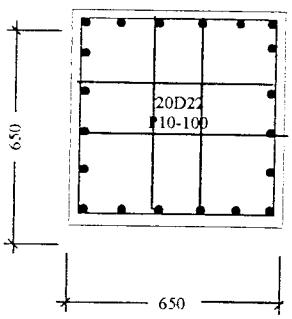
POT X-X



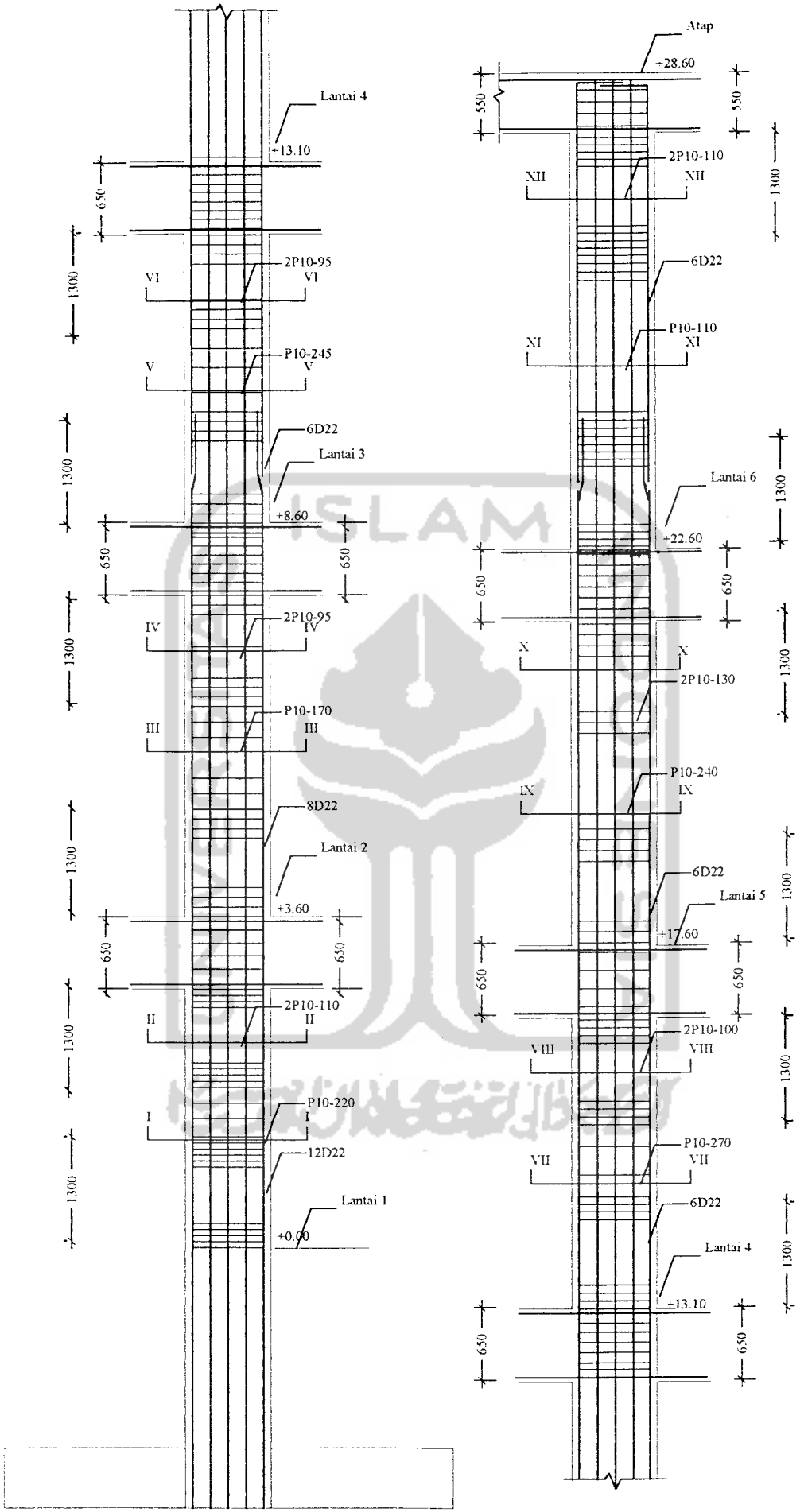
POT XI-XI



POT XII-XII

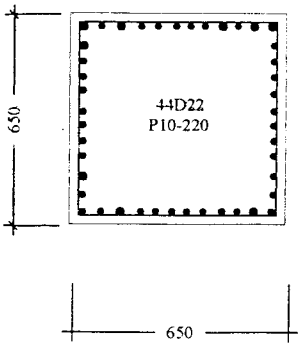


DETAIL KOLOM 23

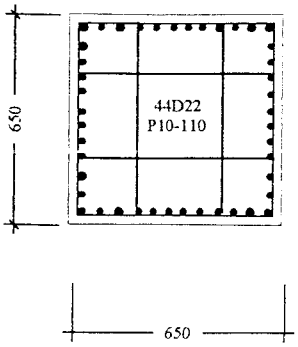


RENC. KOLOM 24

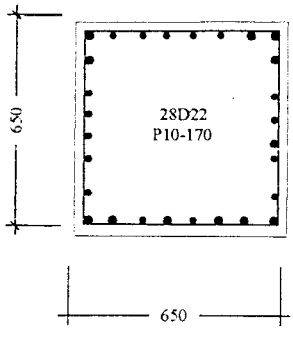
POT I-I



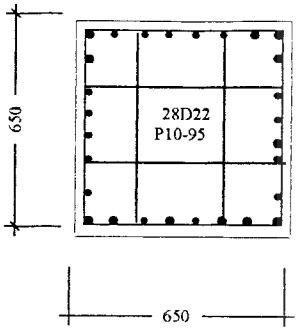
POT II-II



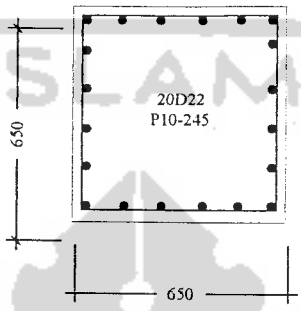
POT III-III



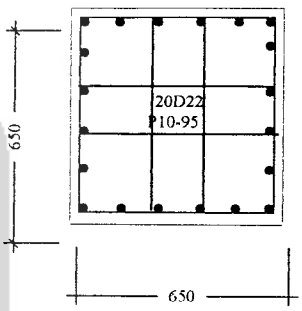
POT IV-IV



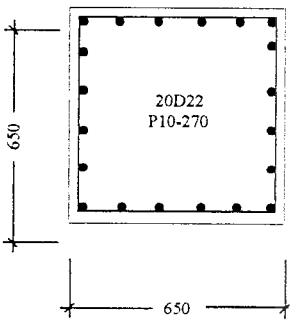
POT V-V



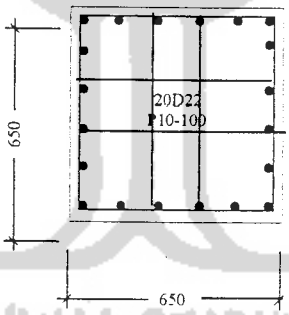
POT VI-VI



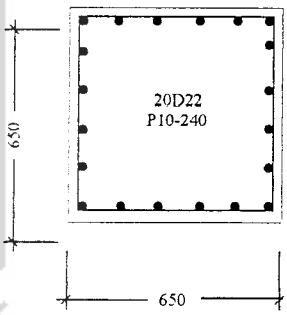
POT VII-VII



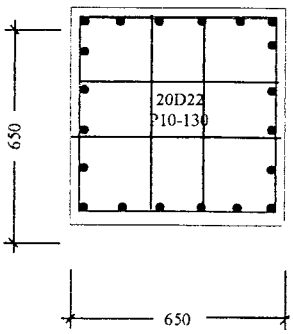
POT VIII-VIII



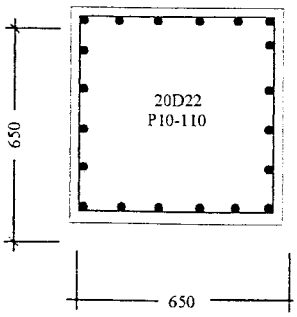
POT IX-IX



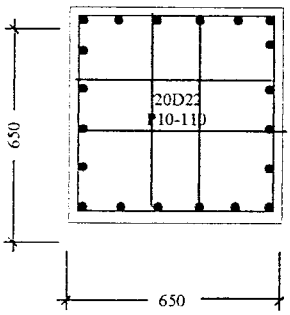
POT X-X



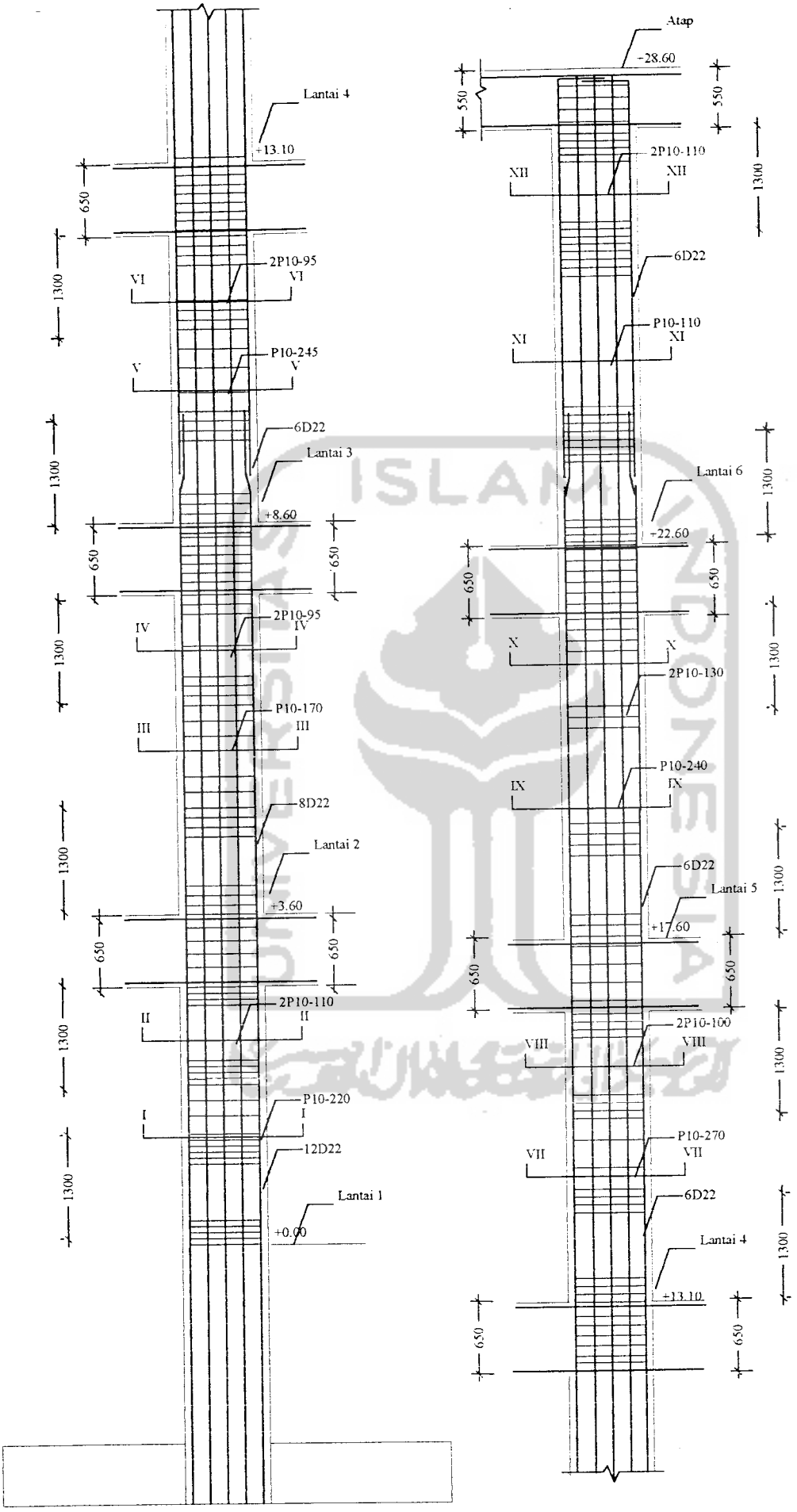
POT XI-XI



POT XII-XII

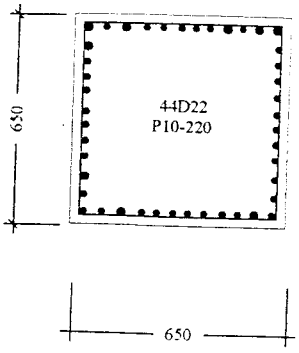


DETAIL KOLOM 24

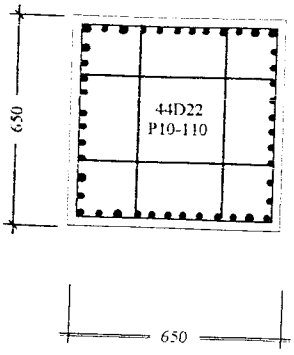


RENC. KOLOM 24

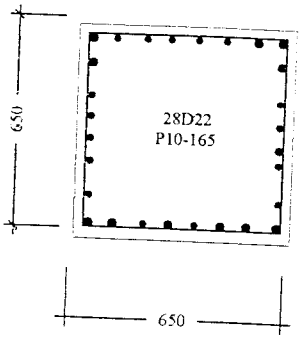
POT I-I



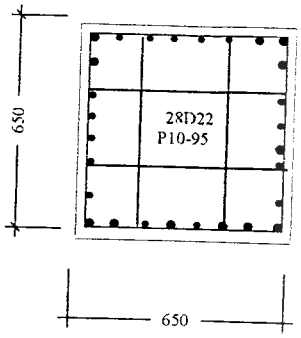
POT II-II



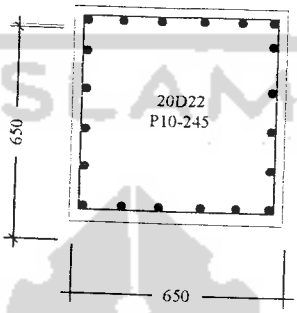
POT III-III



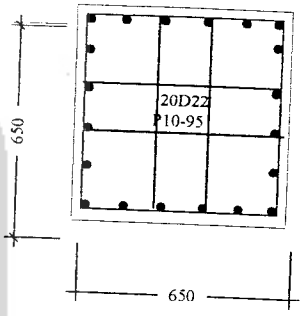
POT IV-IV



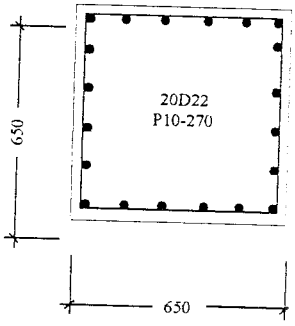
POT V-V



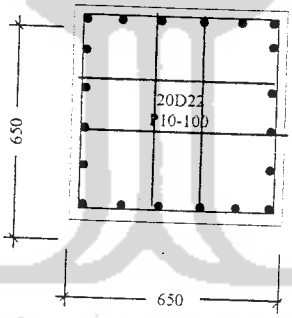
POT VI-VI



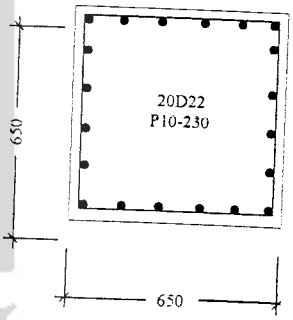
POT VII-VII



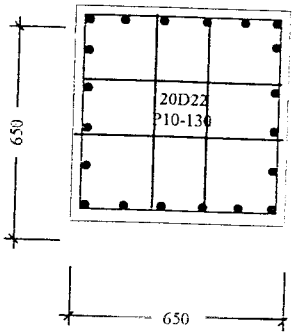
POT VIII-VIII



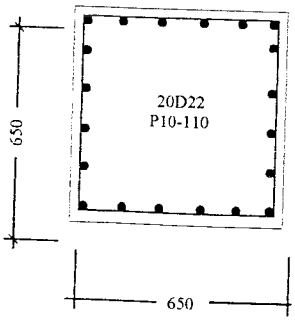
POT IX-IX



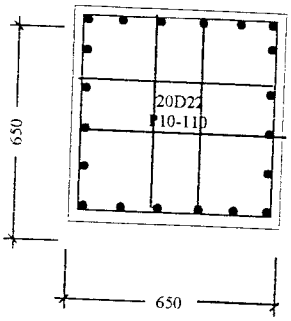
POT X-X



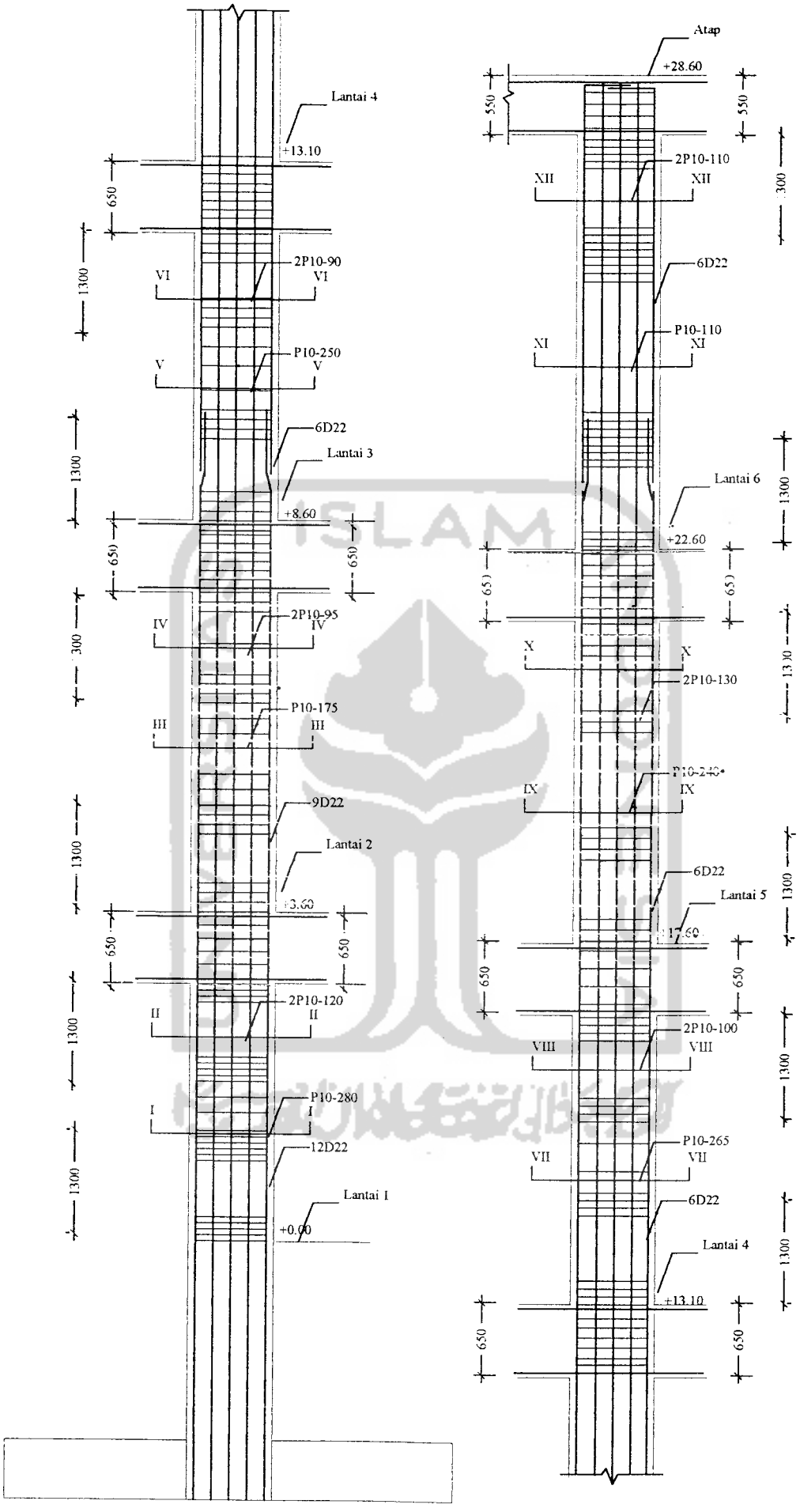
POT XI-XI



POT XII-XII

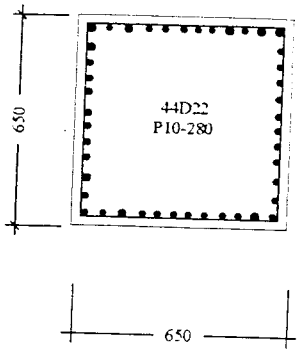


DETAIL KOLOM 25

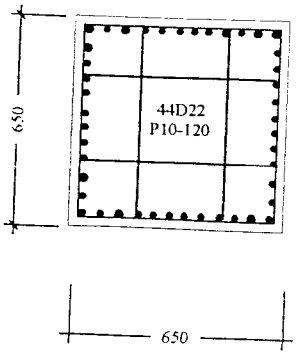


RENC. KOLOM 26

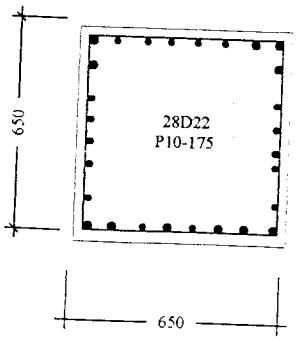
POT I-I



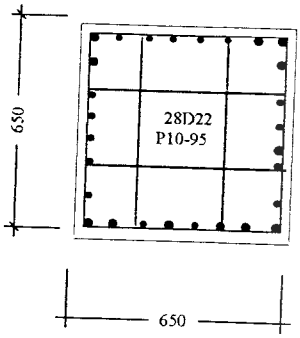
POT II-II



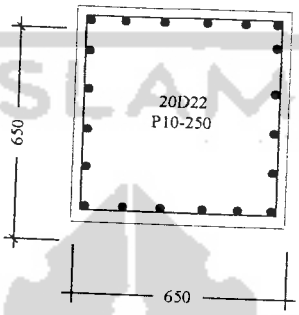
POT III-III



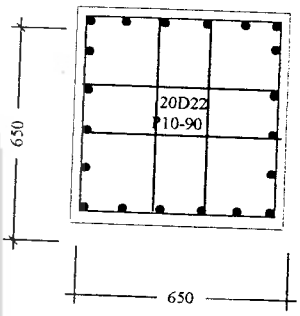
POT IV-IV



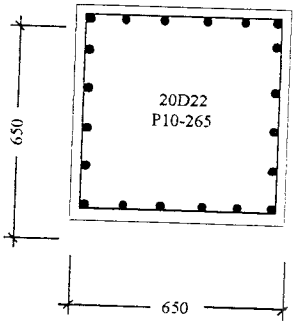
POT V-V



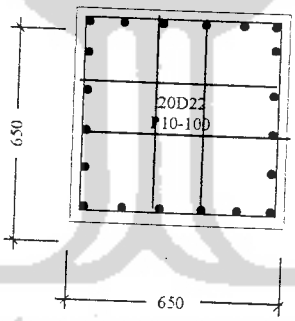
POT VI-VI



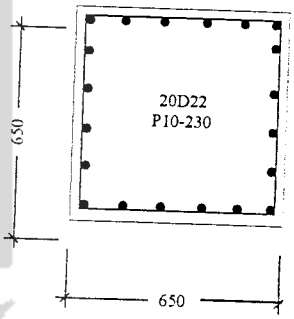
POT VII-VII



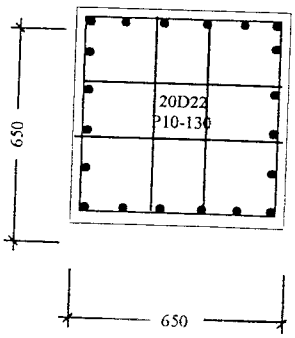
POT VIII-VIII



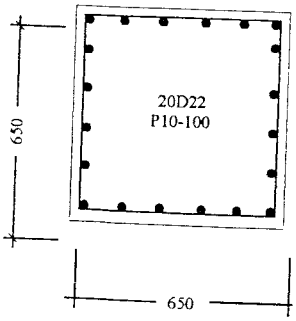
POT IX-IX



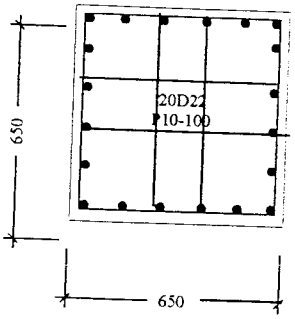
POT X-X



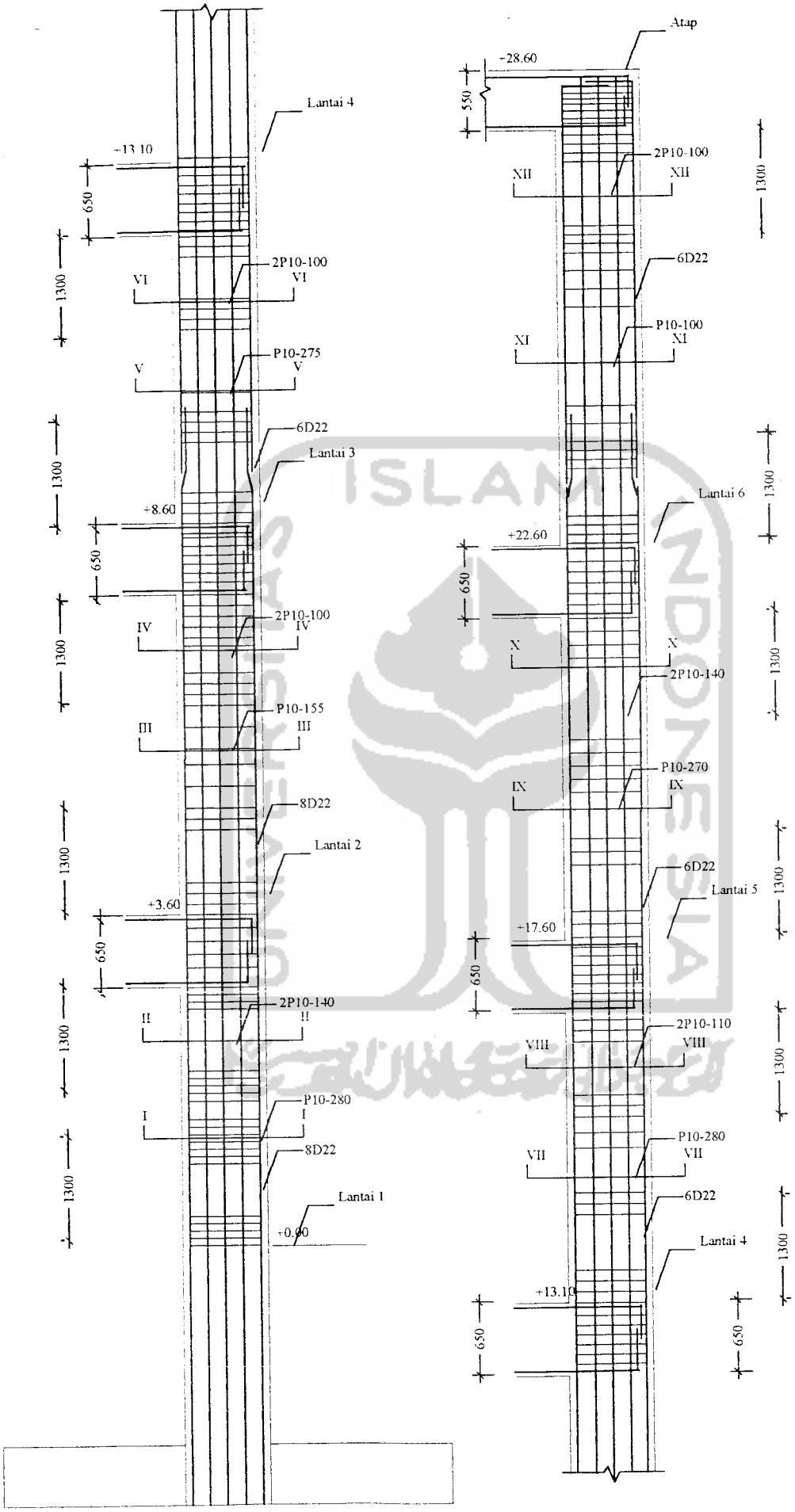
POT XI-XI



POT XII-XII

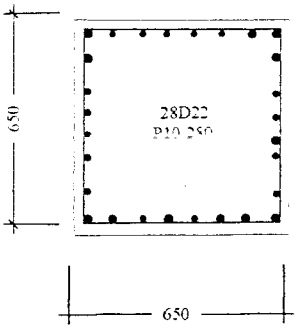


DETAIL KOLOM 26

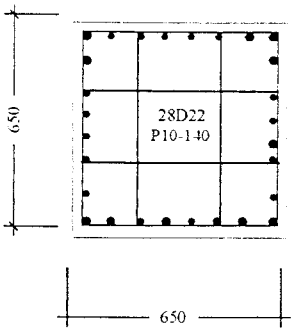


RENC. KOLOM 27

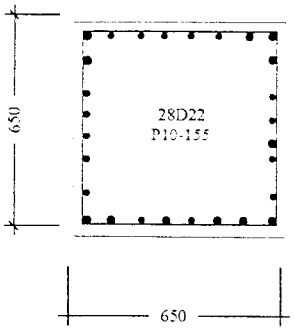
POT I-I



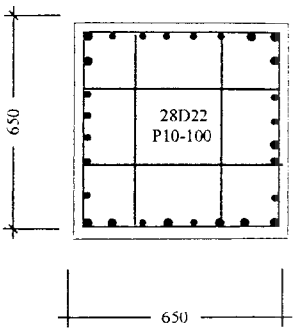
POT II-II



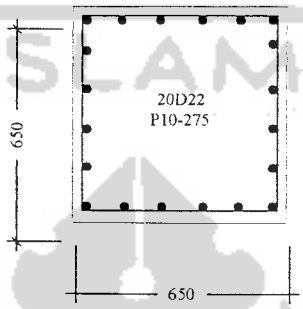
POT III-III



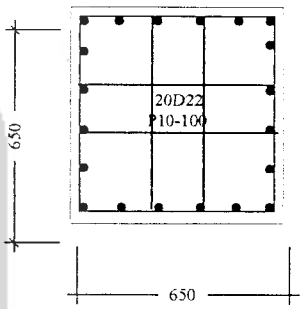
POT IV-IV



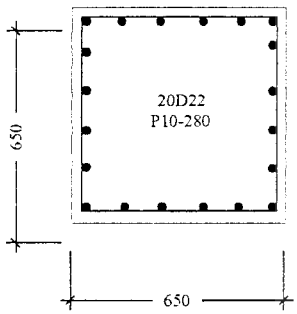
POT V-V



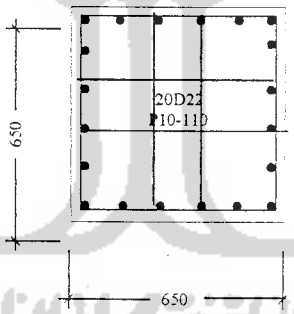
POT VI-VI



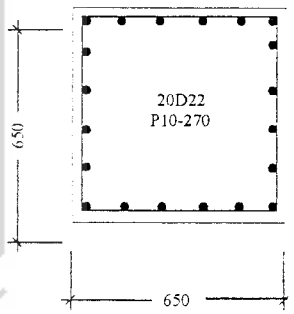
POT VII-VII



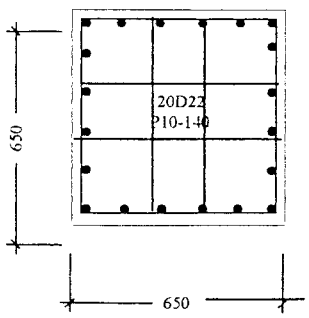
POT VIII-VIII



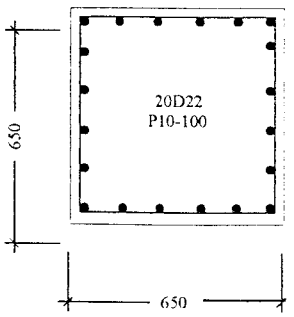
POT IX-IX



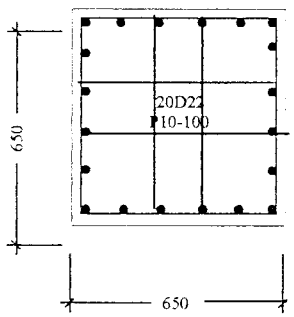
POT X-X



POT XI-XI

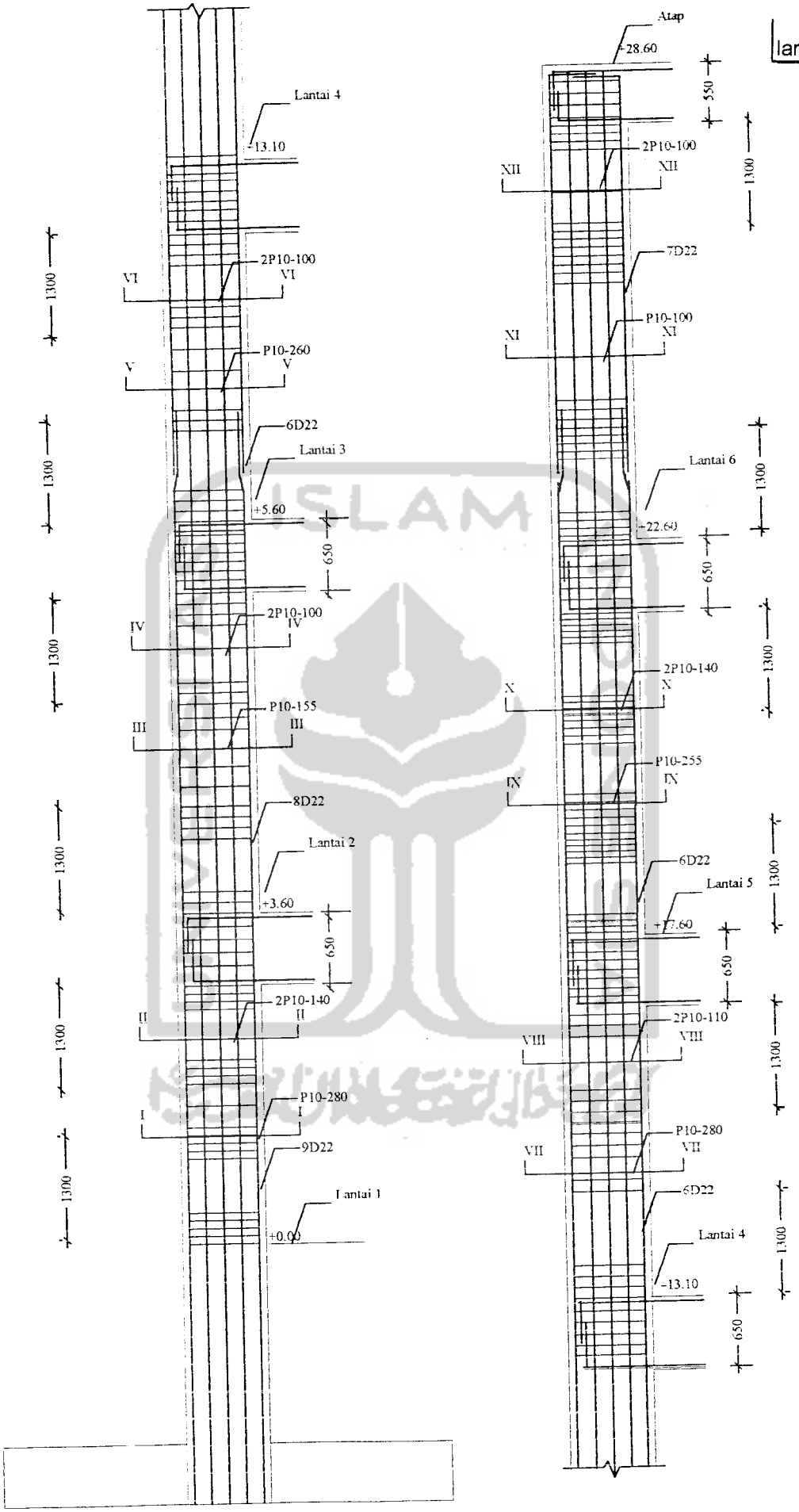


POT XII-XII



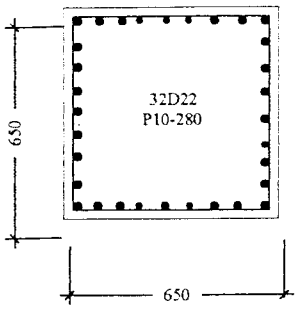
DETAIL KOLOM 27

lampiran 9.81

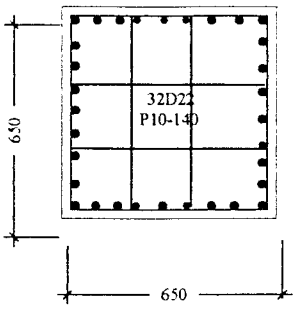


RENC. KOLOM 28

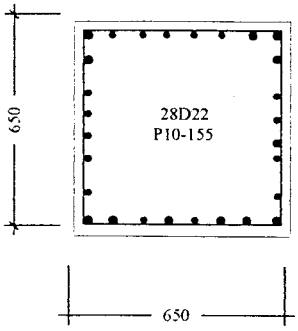
POT I-I



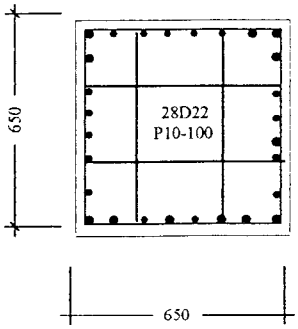
POT II-II



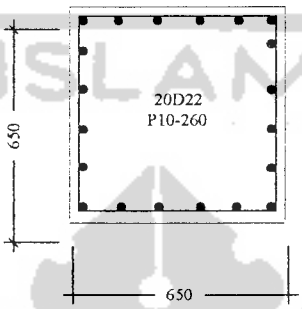
POT III-III



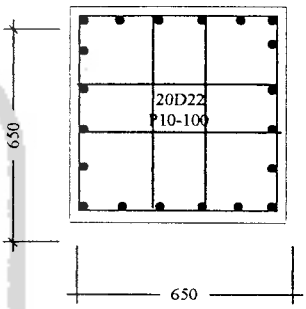
POT IV-IV



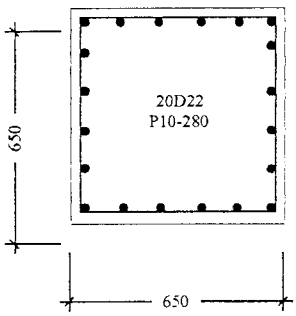
POT V-V



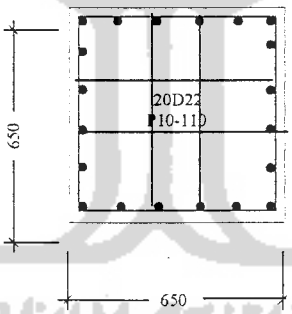
POT VI-VI



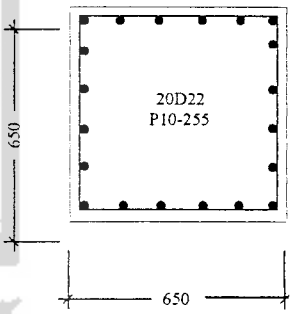
POT VII-VII



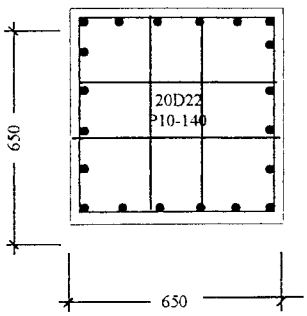
POT VIII-VIII



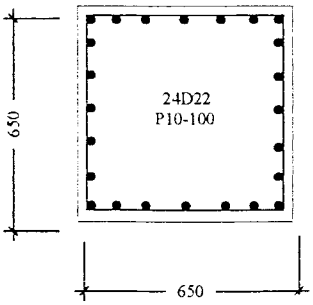
POT IX-IX



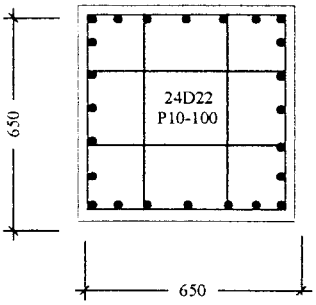
POT X-X



POT XI-XI

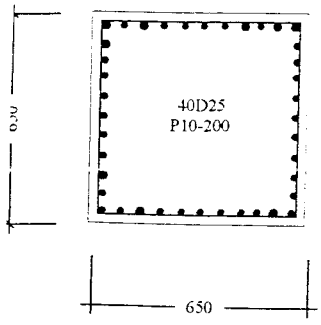


POT XII-XII

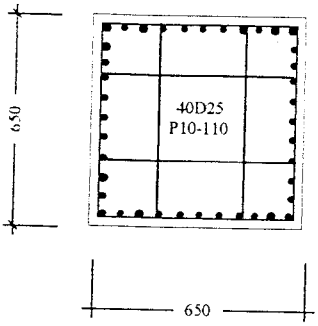


DETAIL KOLOM 28

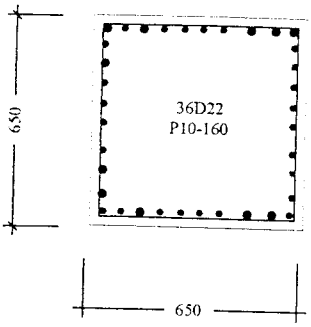
POT I-I



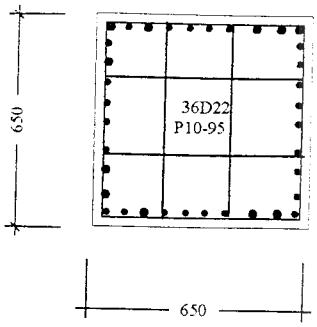
POT II-II



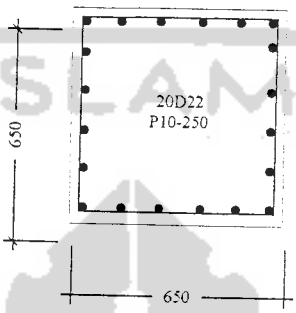
POT III-III



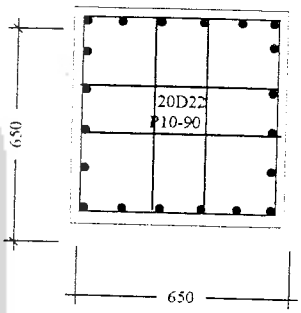
POT IV-IV



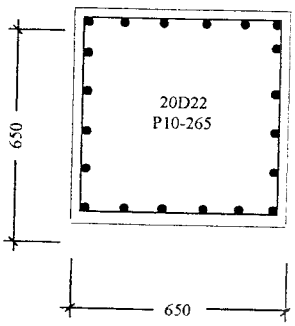
POT V-V



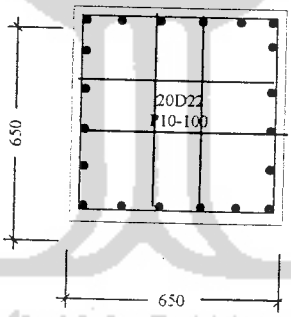
POT VI-VI



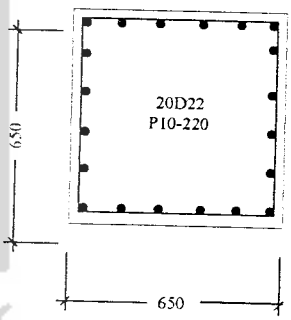
POT VII-VII



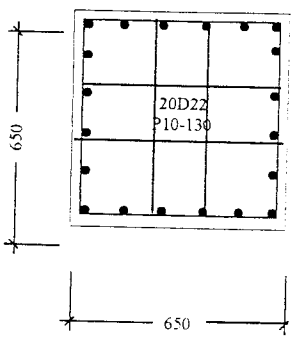
POT VIII-VIII



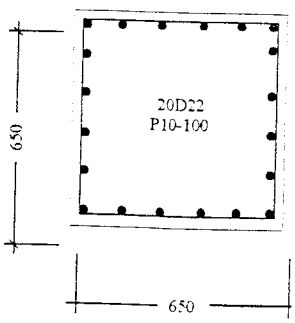
POT IX-IX



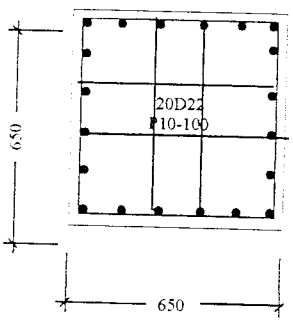
POT X-X



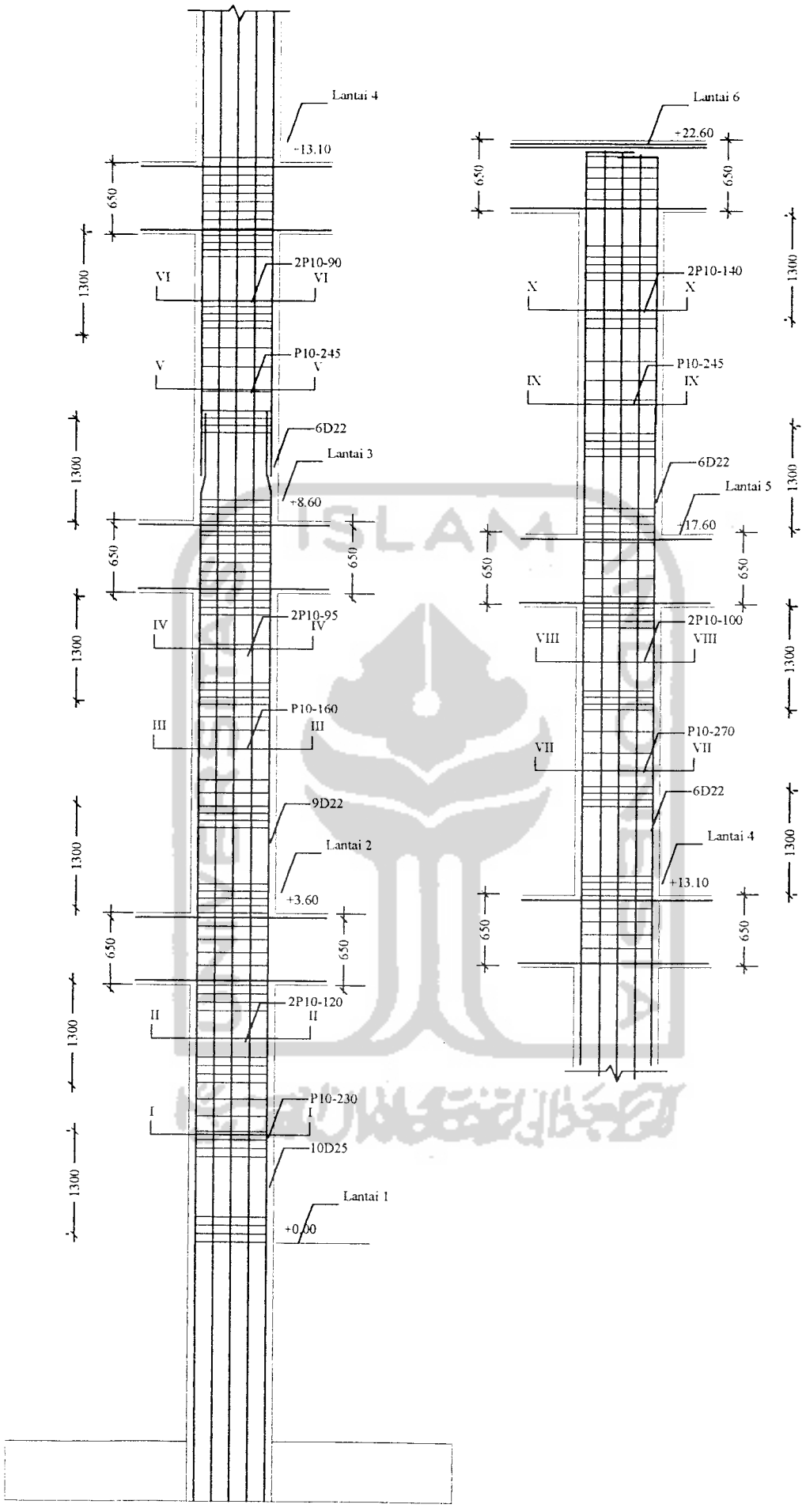
POT XI-XI



POT XII-XII

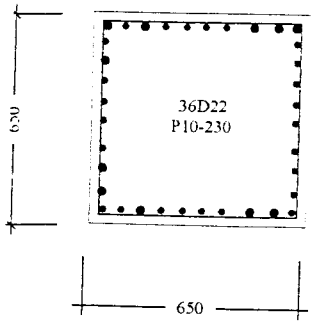


DETAIL KOLOM 29

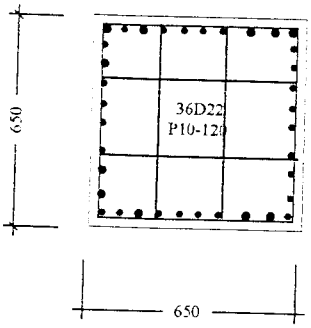


RENC. KOLOM 30

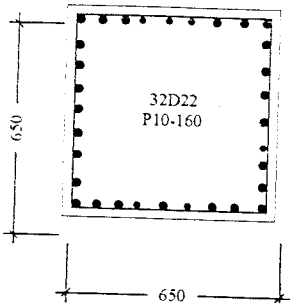
POT I-I



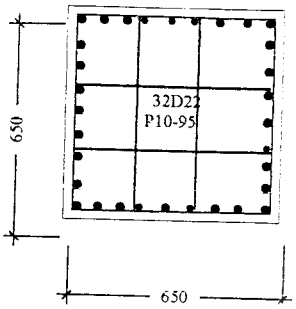
POT II-II



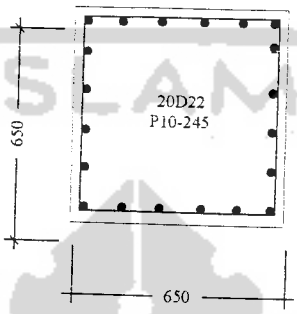
POT III-III



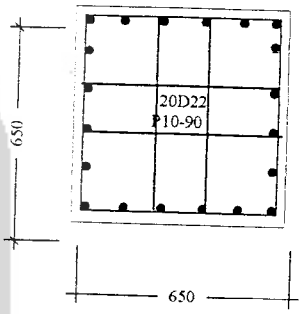
POT IV-IV



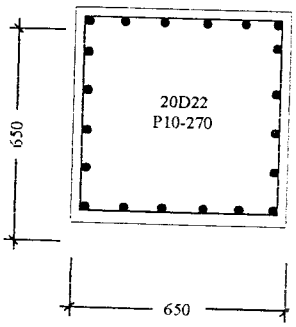
POT V-V



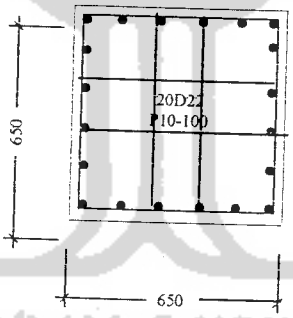
POT VI-VI



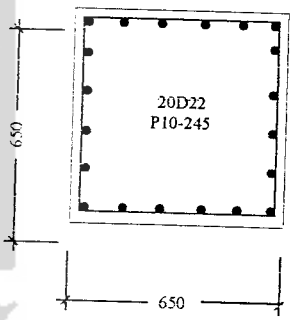
POT VII-VII



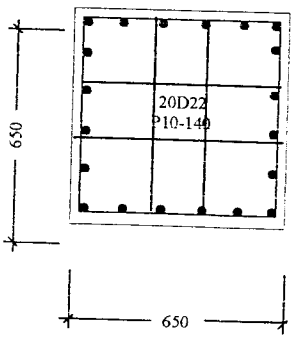
POT VIII-VIII



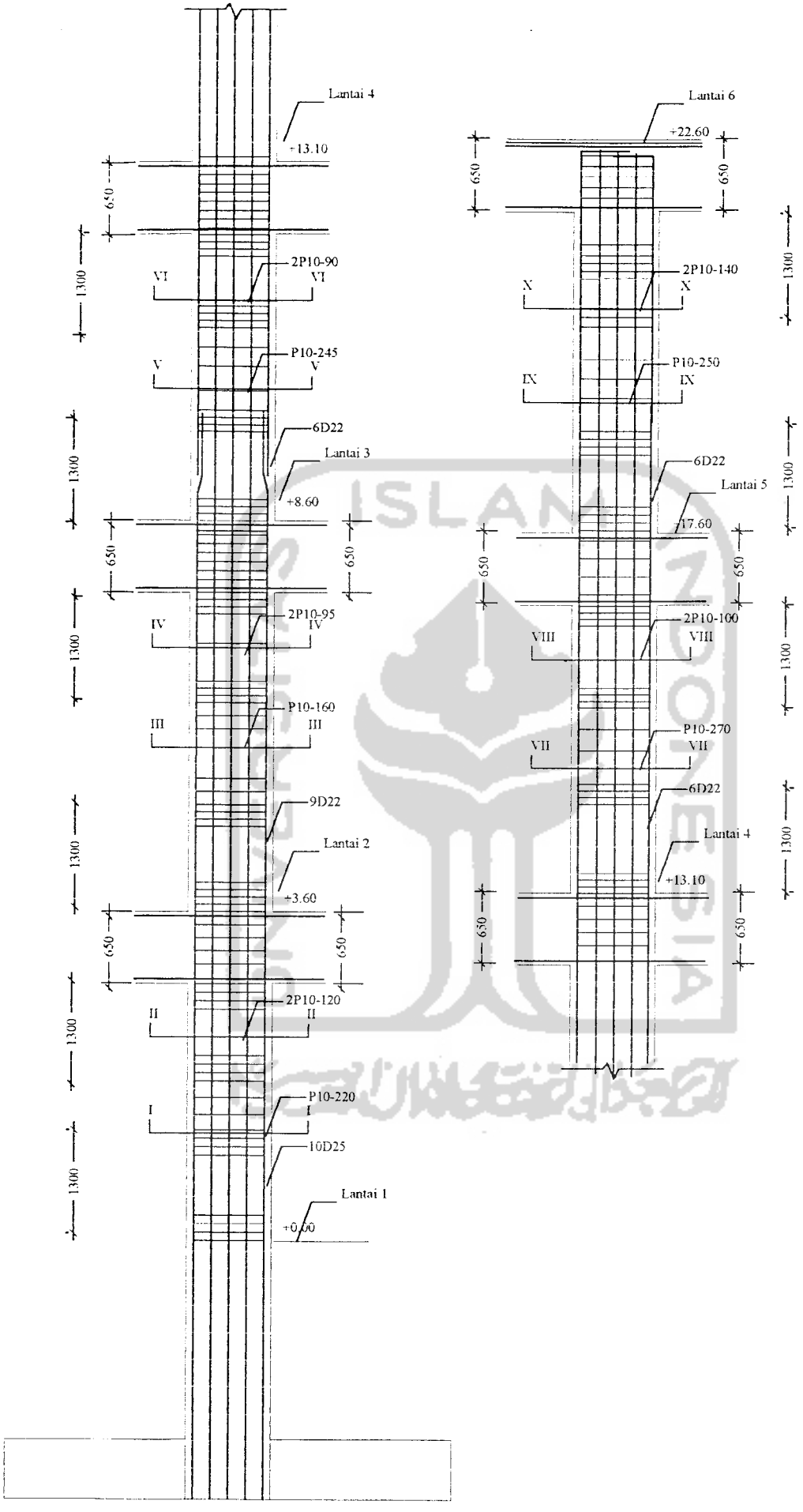
POT IX-IX



POT X-X

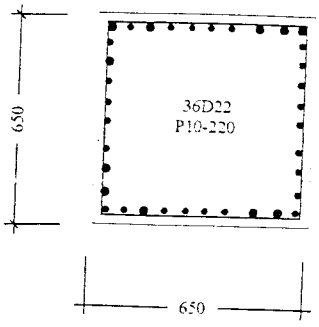


DETAIL KOLOM 30

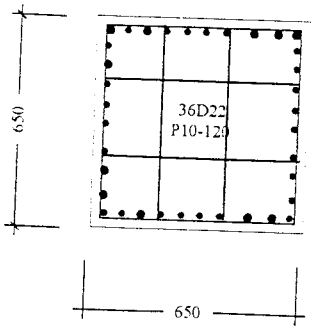


RENC. KOLOM 31

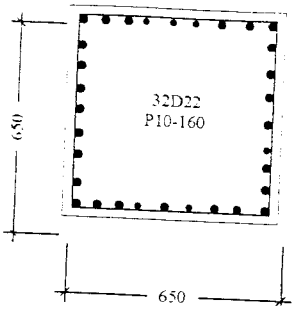
POT I-I



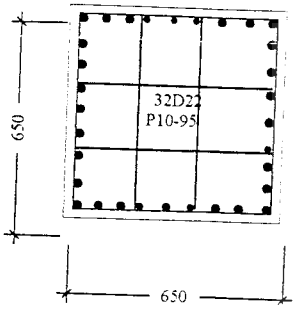
POT II-II



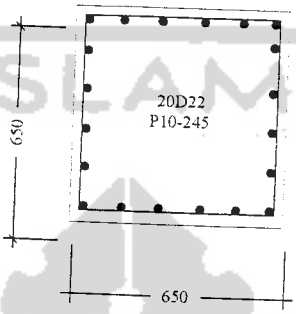
POT III-III



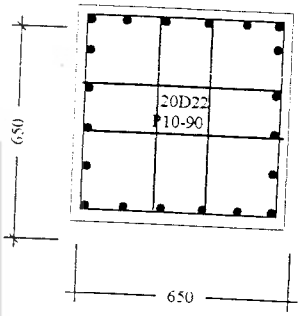
POT IV-IV



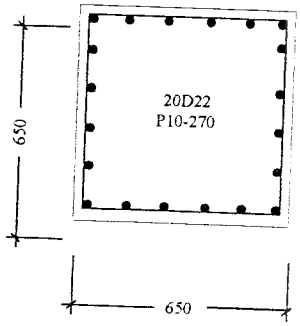
POT V-V



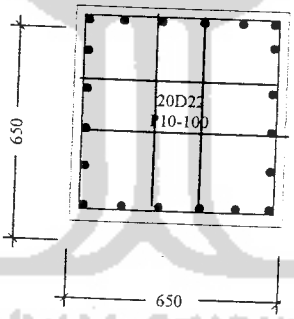
POT VI-VI



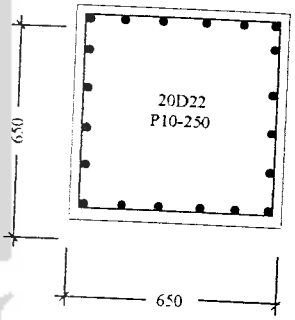
POT VII-VII



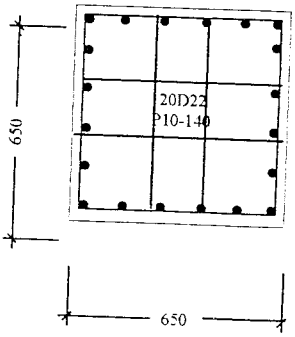
POT VIII-VIII



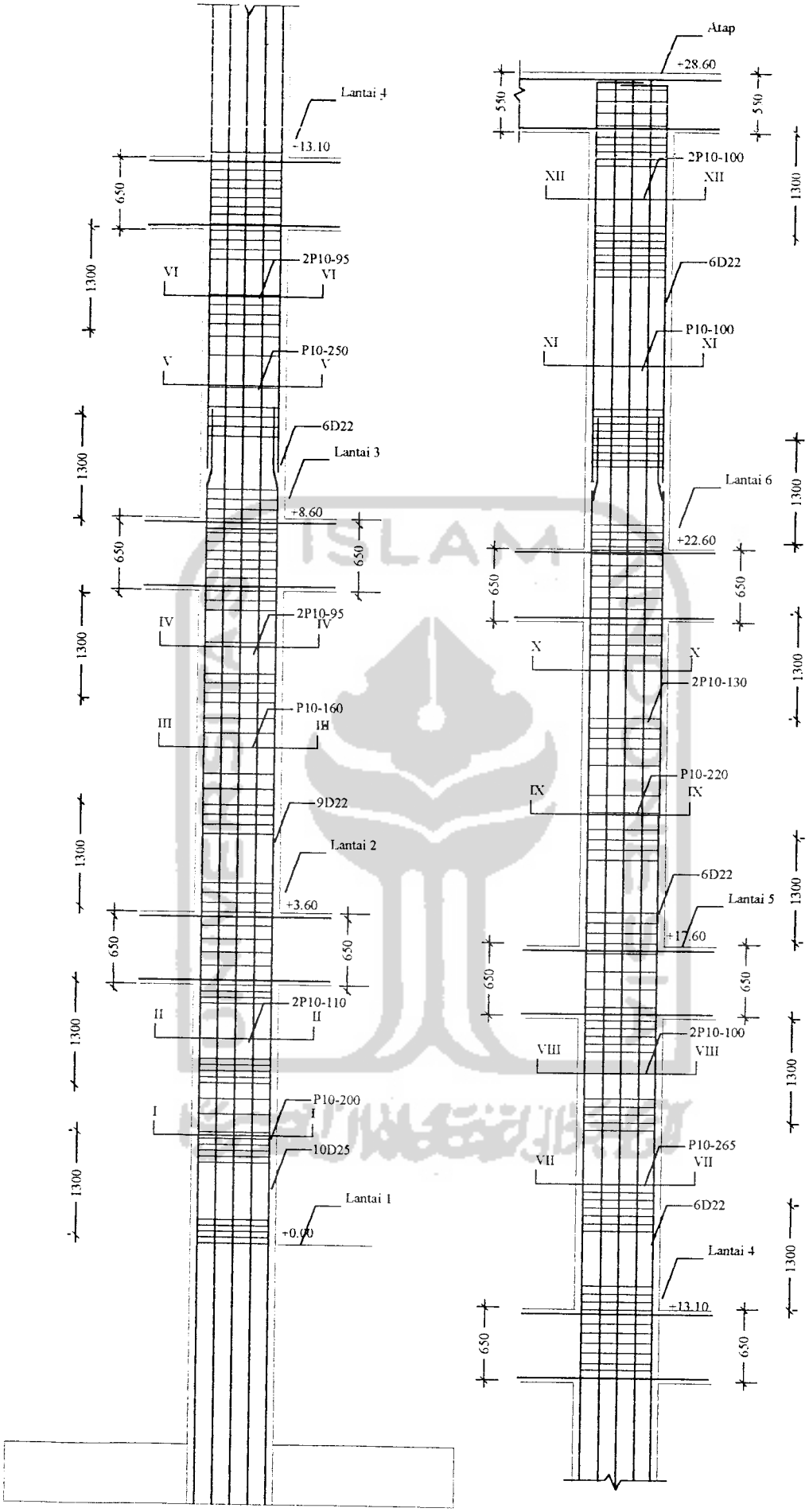
POT IX-IX



POT X-X

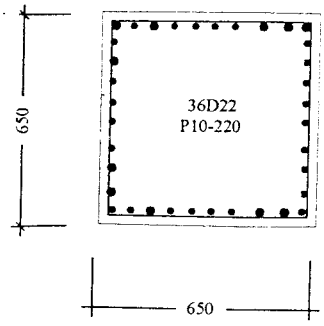


DETAIL KOLOM 31

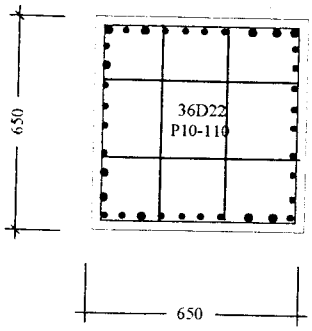


RENC. KOLOM 32

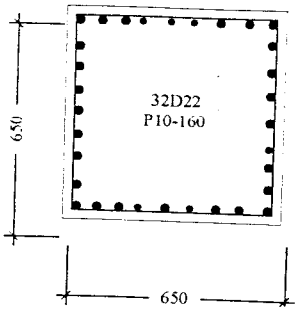
POT I-I



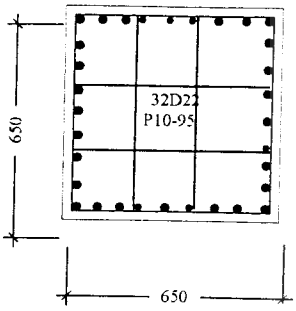
POT II-II



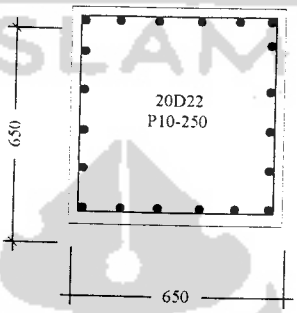
POT III-III



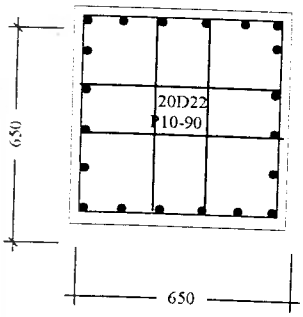
POT IV-IV



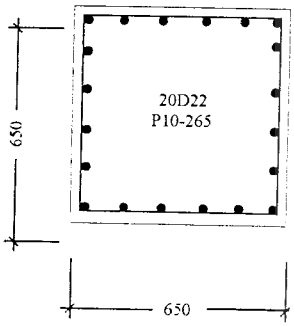
POT V-V



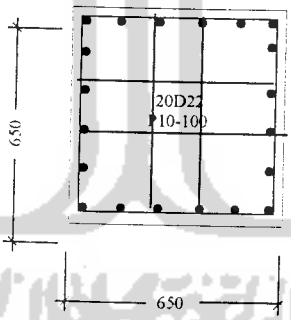
POT VI-VI



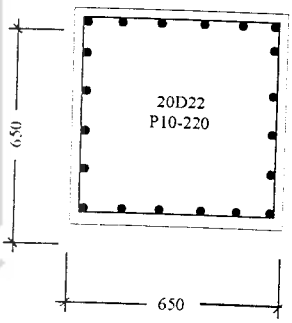
POT VII-VII



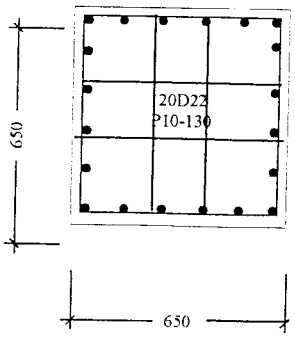
POT VIII-VIII



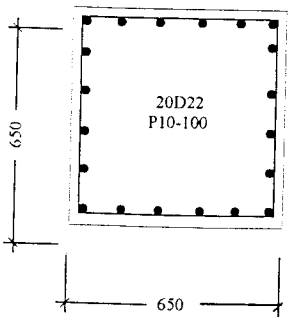
POT IX-IX



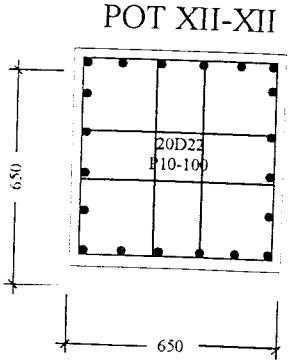
POT X-X



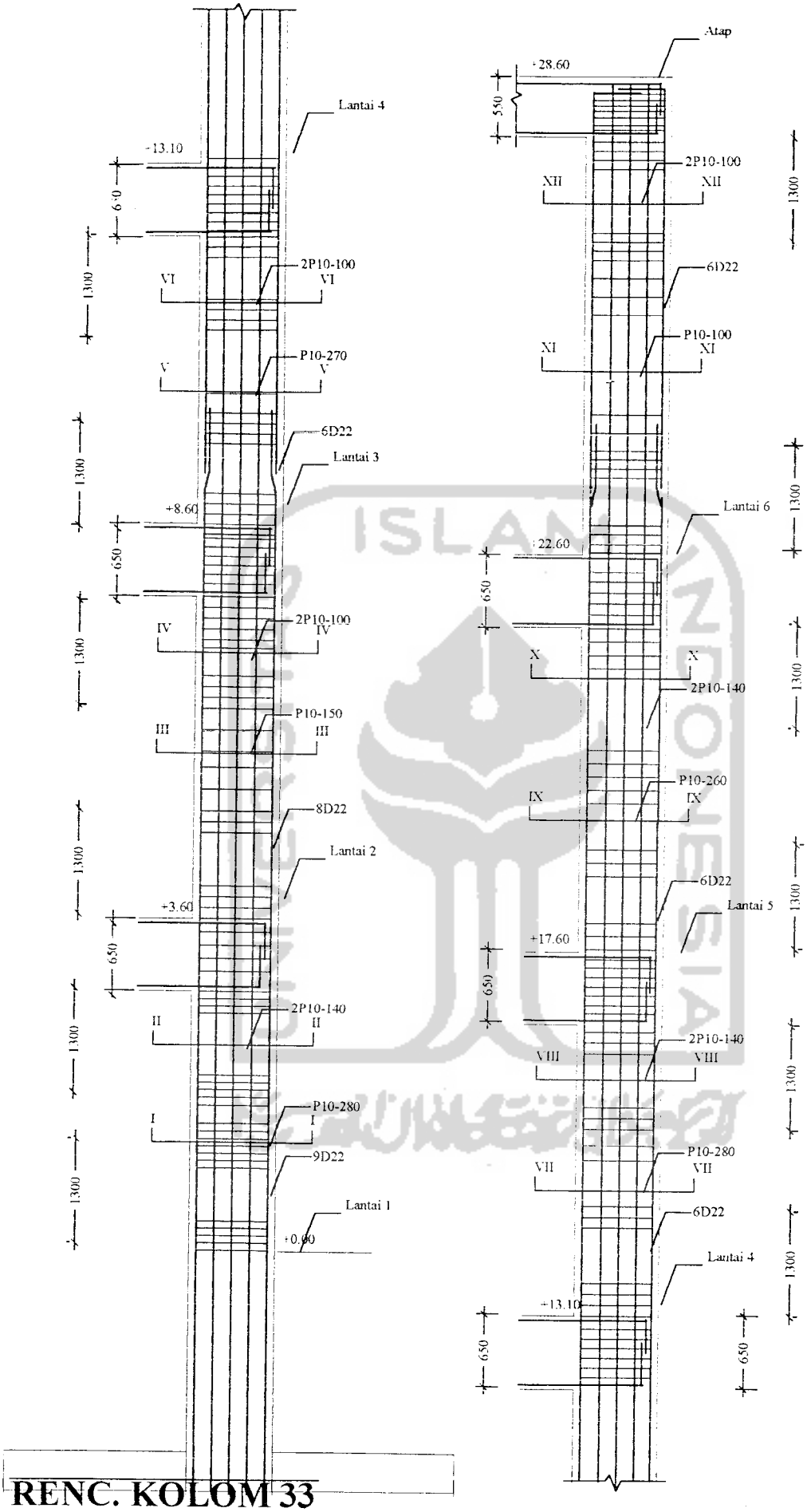
POT XI-XI



POT XII-XII

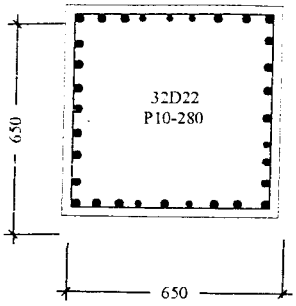


DETAIL KOLOM 32

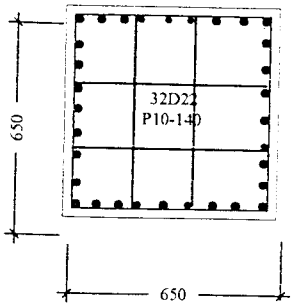


RENC. KOLOM 33

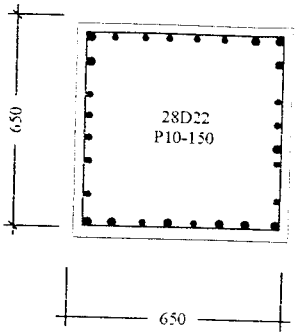
POT I-I



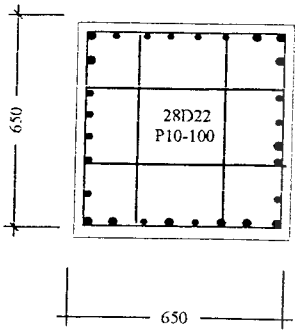
POT II-II



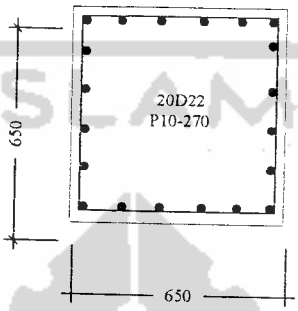
POT III-III



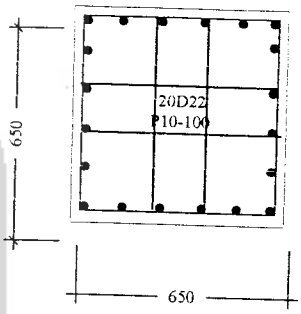
POT IV-IV



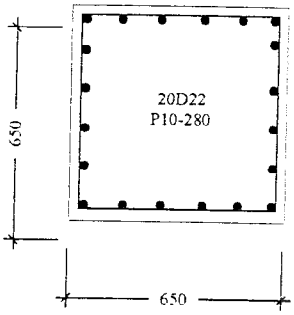
POT V-V



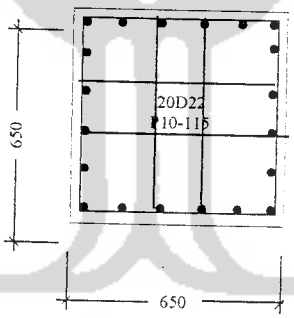
POT VI-VI



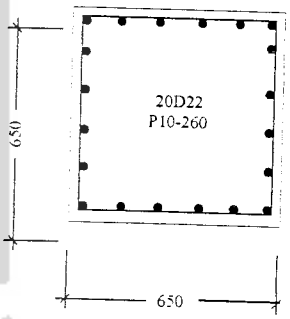
POT VII-VII



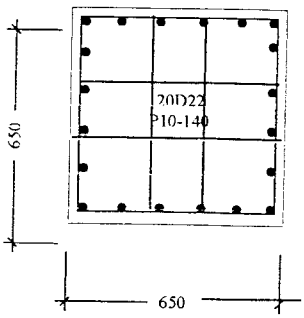
POT VIII-VIII



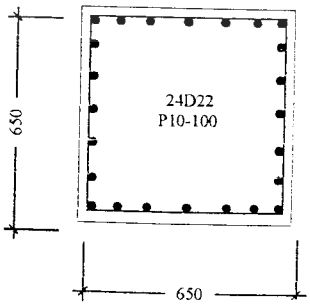
POT IX-IX



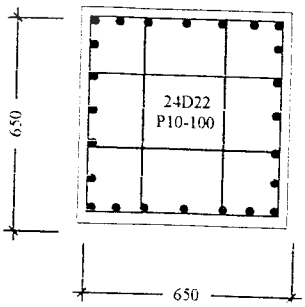
POT X-X



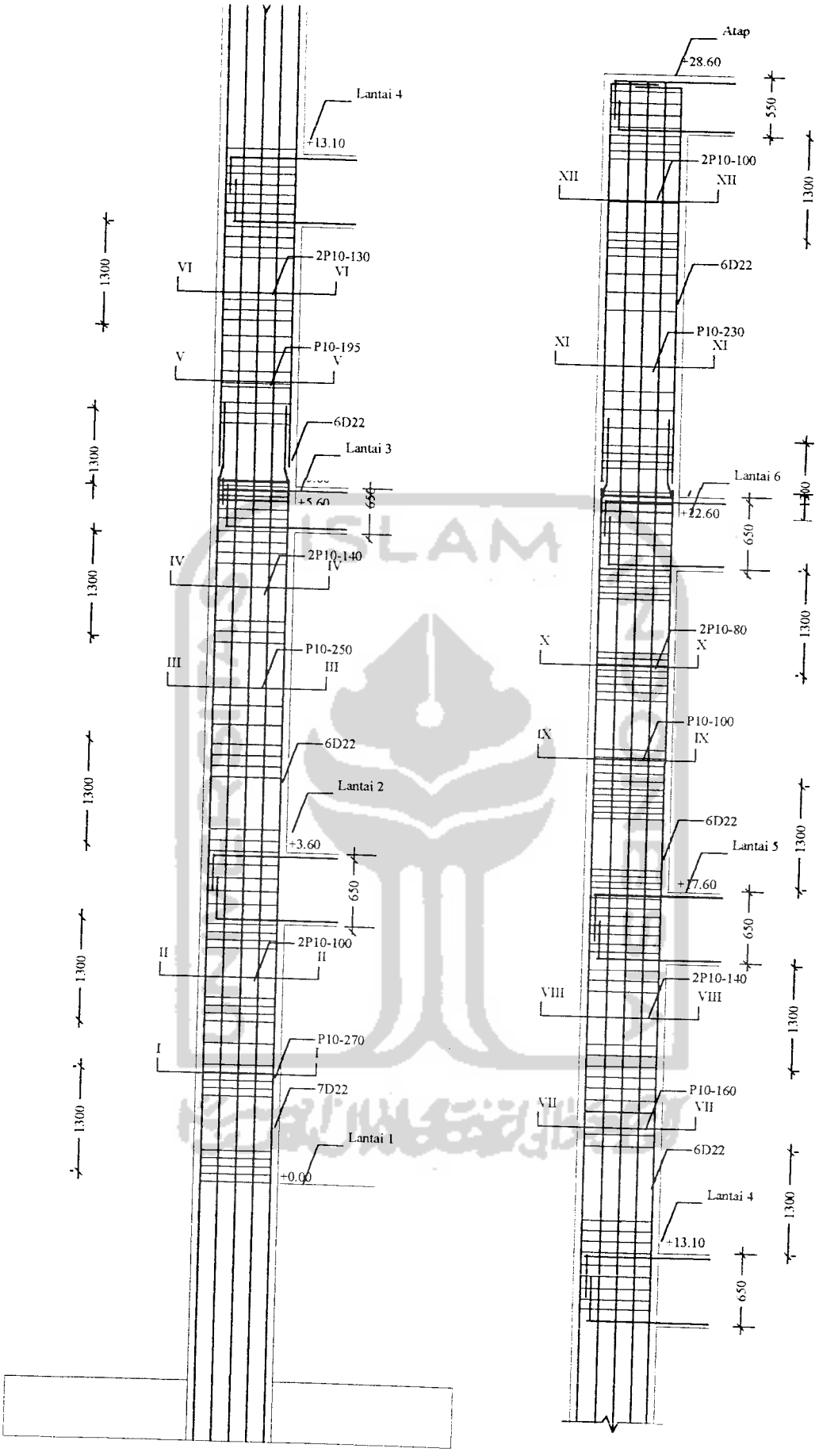
POT XI-XI



POT XII-XII

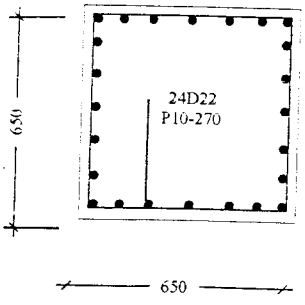


DETAIL KOLOM 33

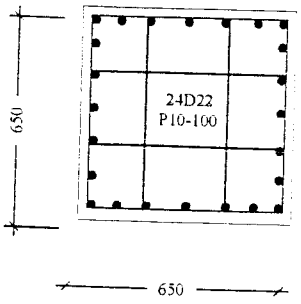


RENC. KOLOM 34

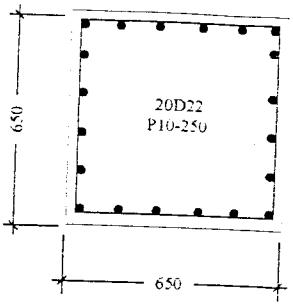
POT I-I



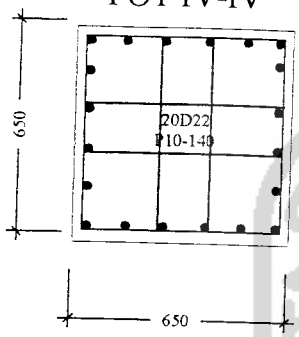
POT II-II



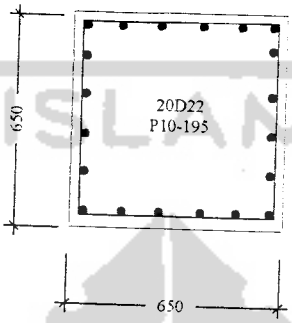
POT III-III



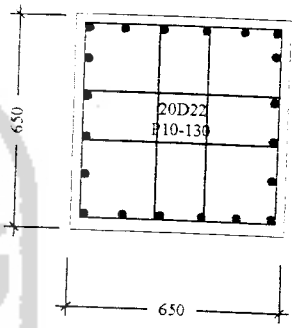
POT IV-IV



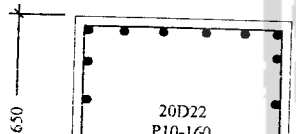
POT V-V



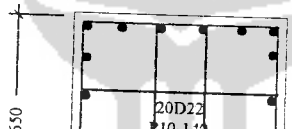
POT VI-VI



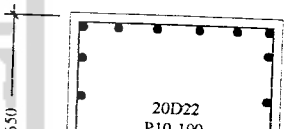
POT VII-VII



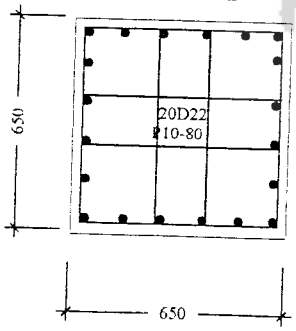
POT VIII-VIII



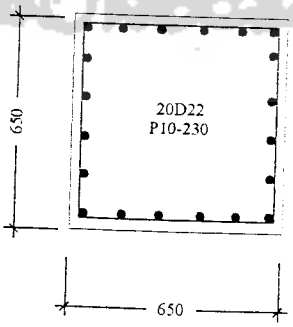
POT IX-IX



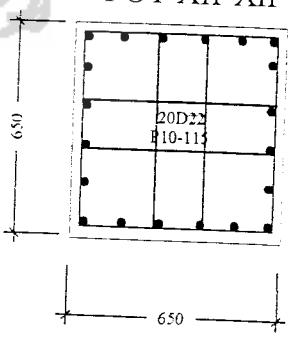
POT X-X



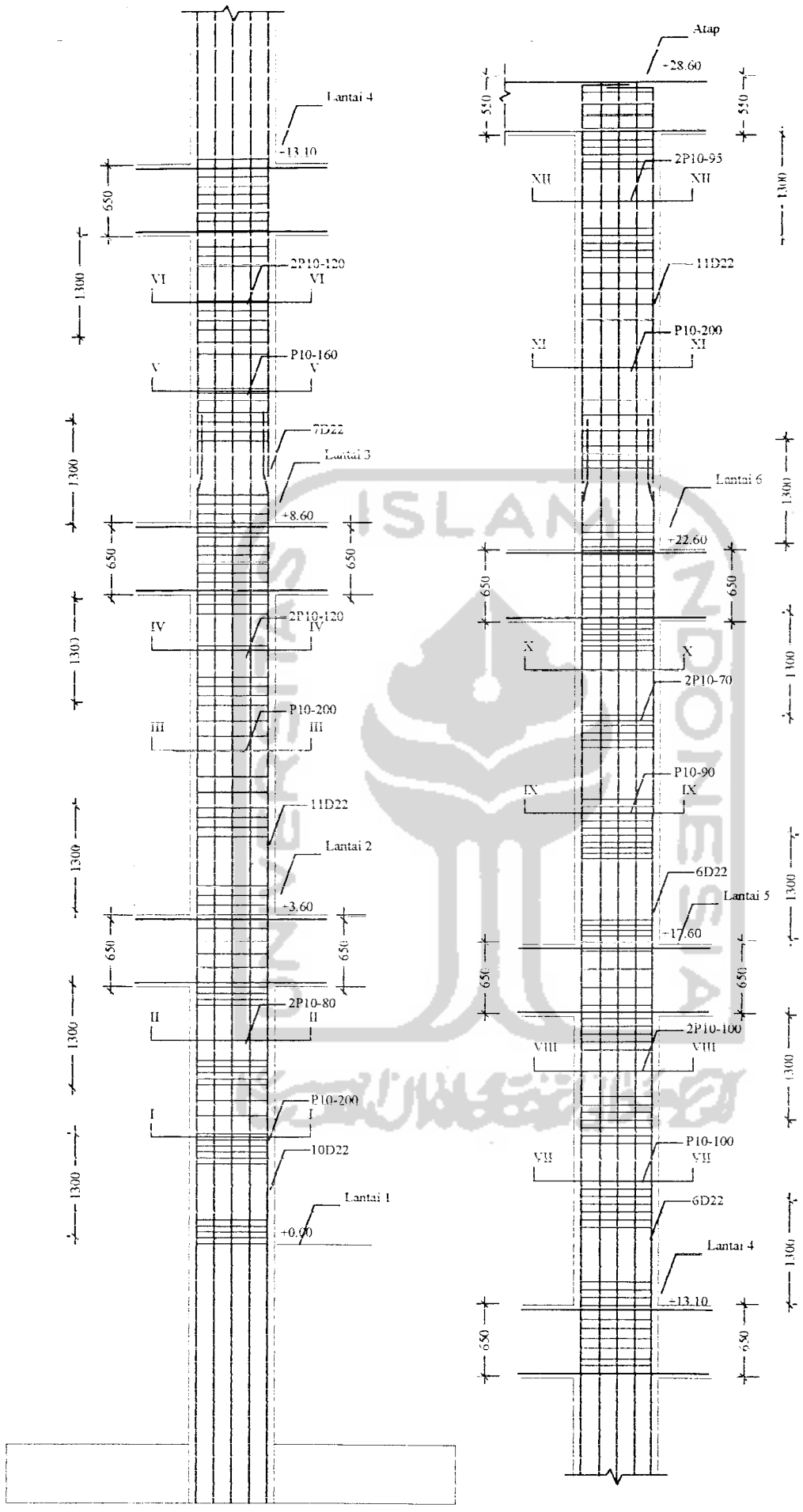
POT XI-XI



POT XII-XII

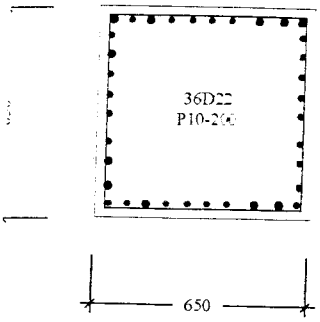


DETAIL KOLOM 34

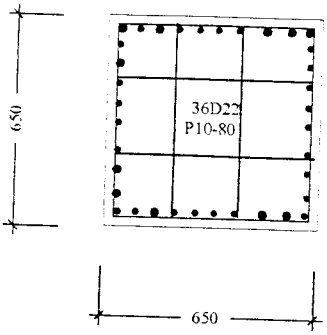


RENC. KOLOM 35

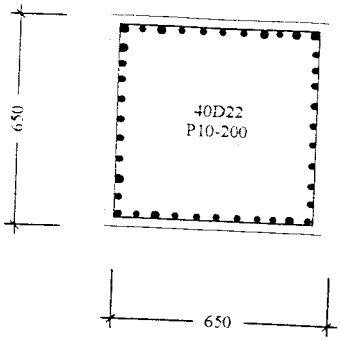
POT I-I



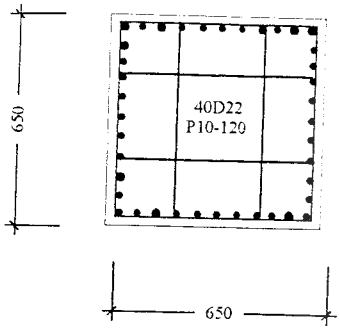
POT II-II



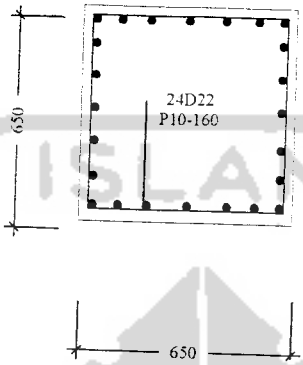
POT III-III



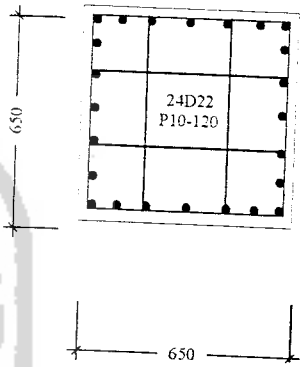
POT IV-IV



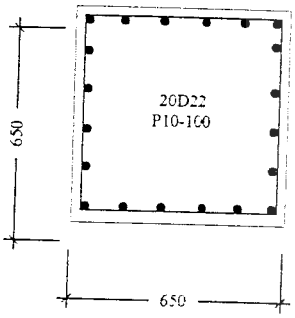
POT V-V



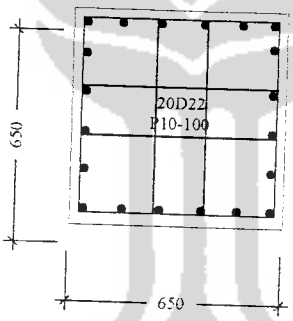
POT VI-VI



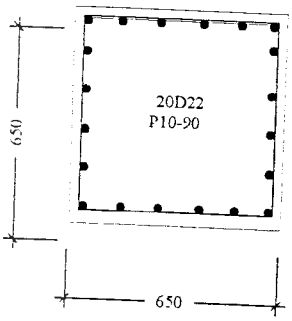
POT VII-VII



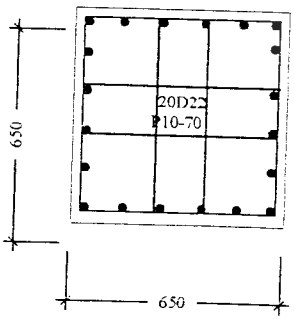
POT VIII-VIII



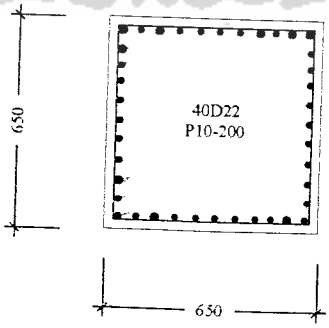
POT IX-IX



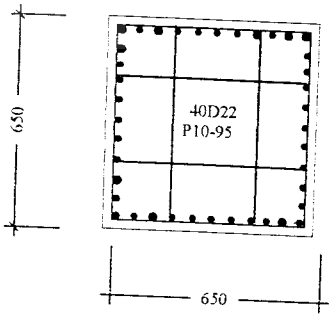
POT X-X



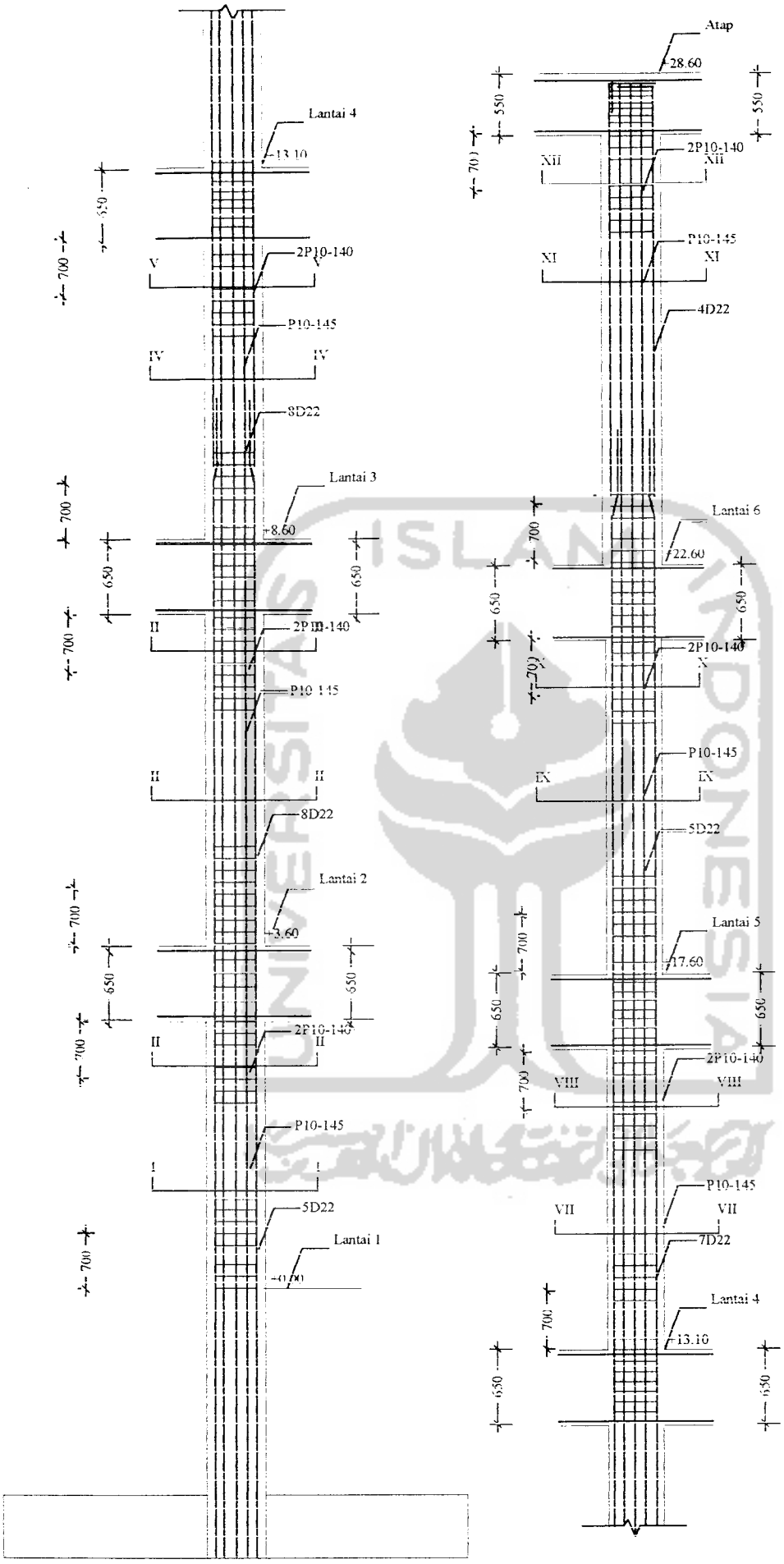
POT XI-XI



POT XII-XII

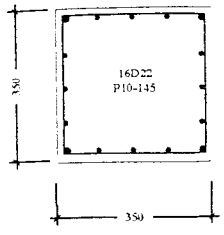


DETAIL KOLOM 35

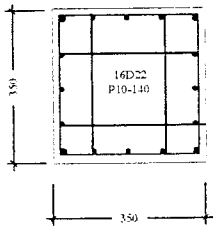


RENC. KOLOM 36

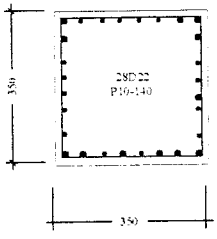
POT I-I



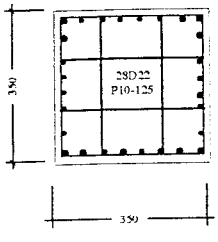
POT II-II



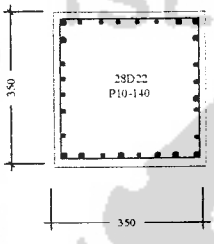
POT III-III



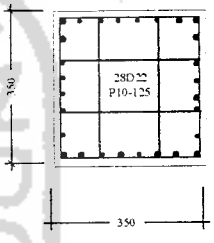
POT IV-IV



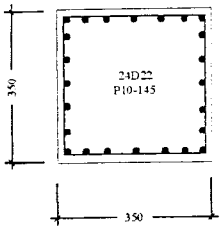
POT V-V



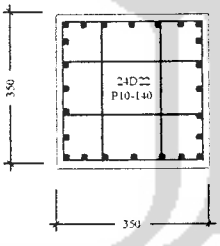
POT VI-VI



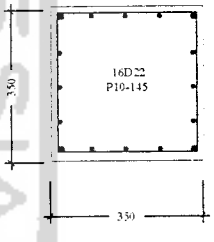
POT VII-VII



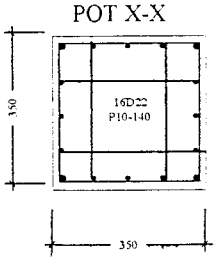
POT VIII-VIII



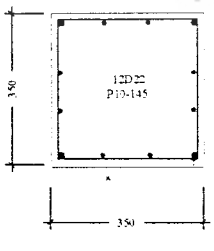
POT IX-IX



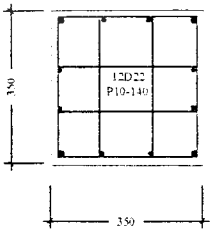
POT X-X



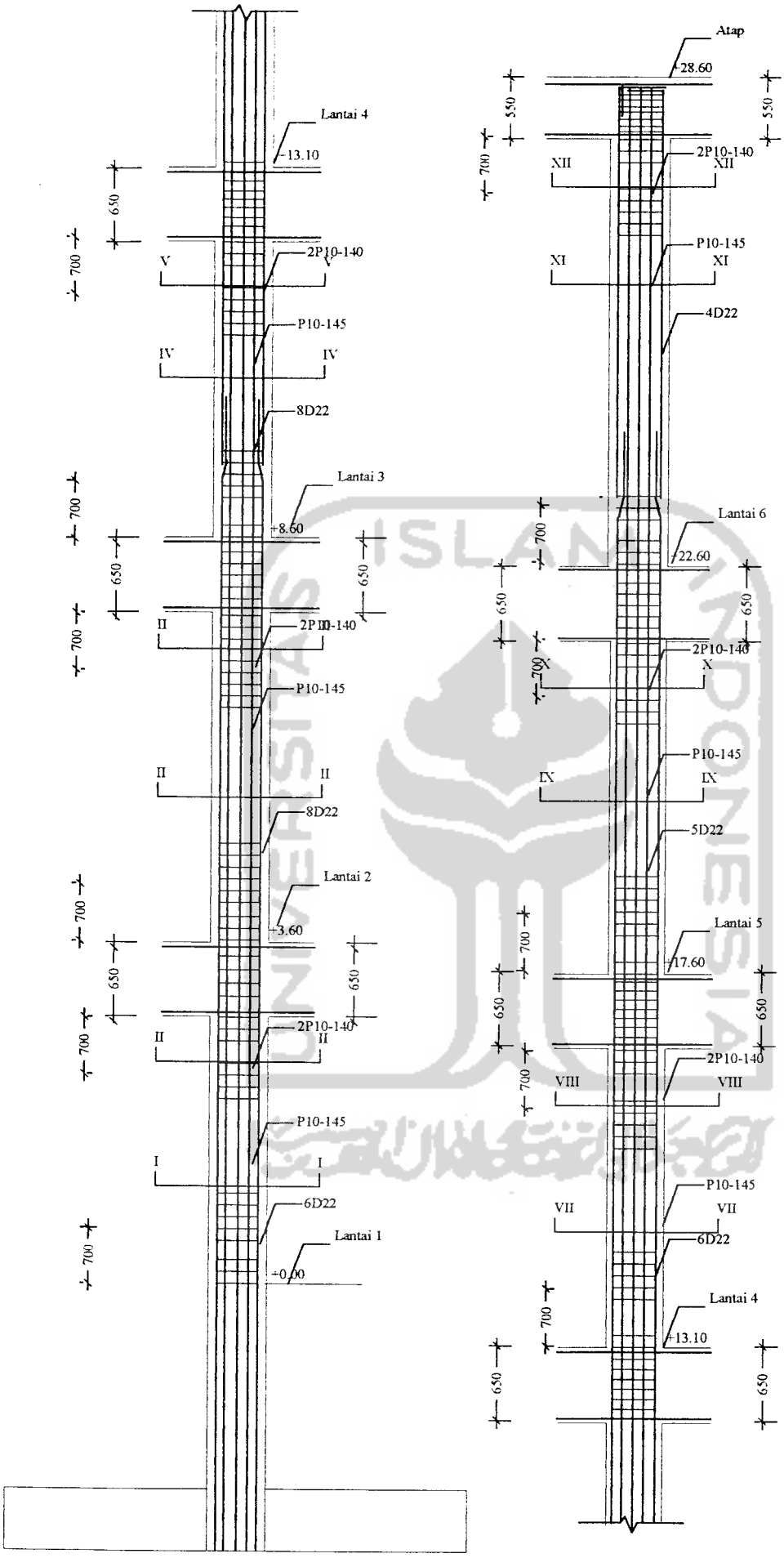
POT XI-XI



POT XII-XII

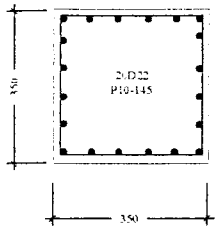


DETAIL KOLOM 36

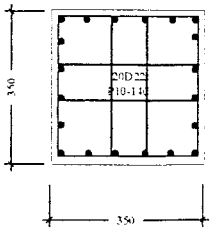


RENC. KOLOM 37

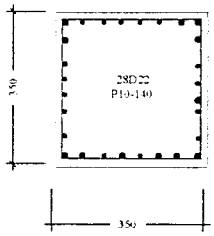
POT I-I



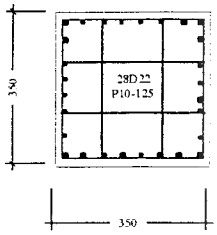
POT II-II



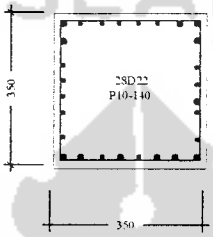
POT III-III



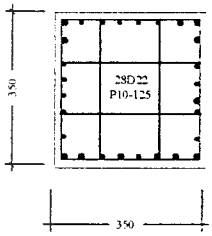
POT IV-IV



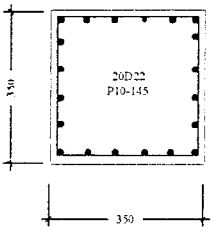
POT V-V



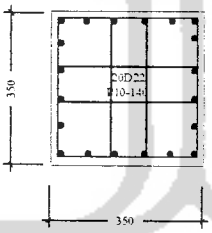
POT VI-VI



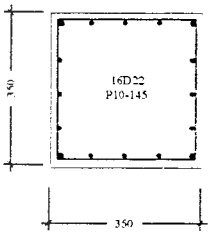
POT VII-VII



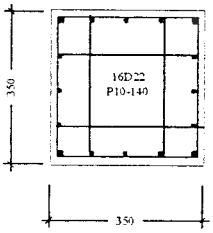
POT VIII-VIII



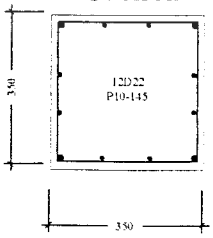
POT IX-IX



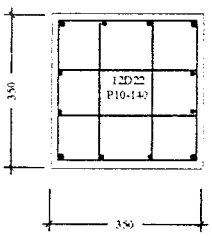
POT X-X



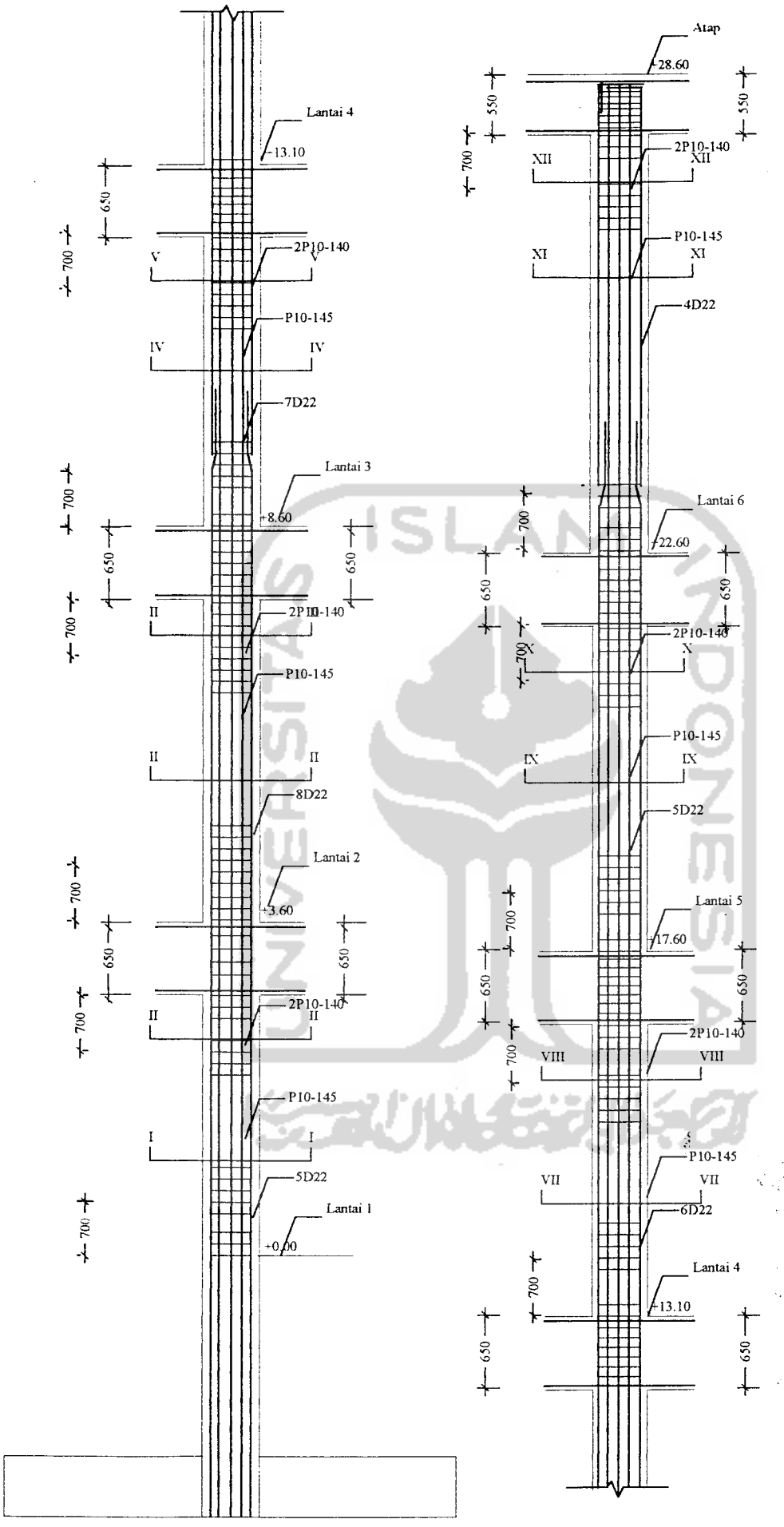
POT XI-XI



POT XII-XII

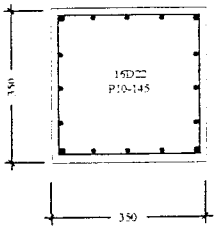


DETAIL KOLOM 37

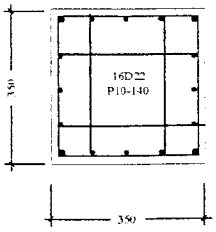


RENC. KOLOM 38

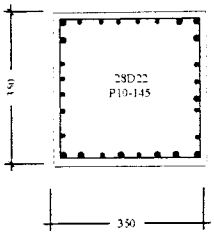
POT I-I



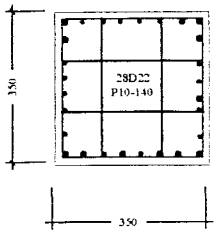
POT II-II



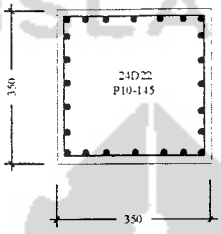
POT III-III



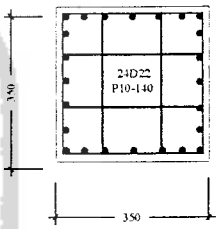
POT IV-IV



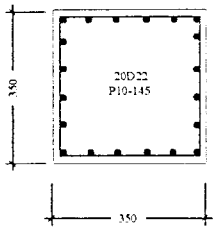
POT V-V



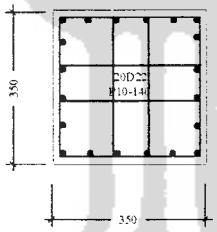
POT VI-VI



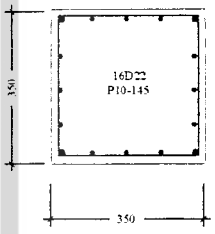
POT VII-VII



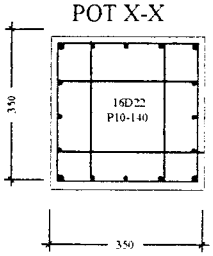
POT VIII-VIII



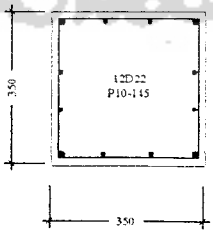
POT IX-IX



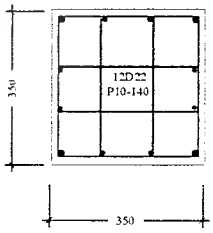
POT X-X



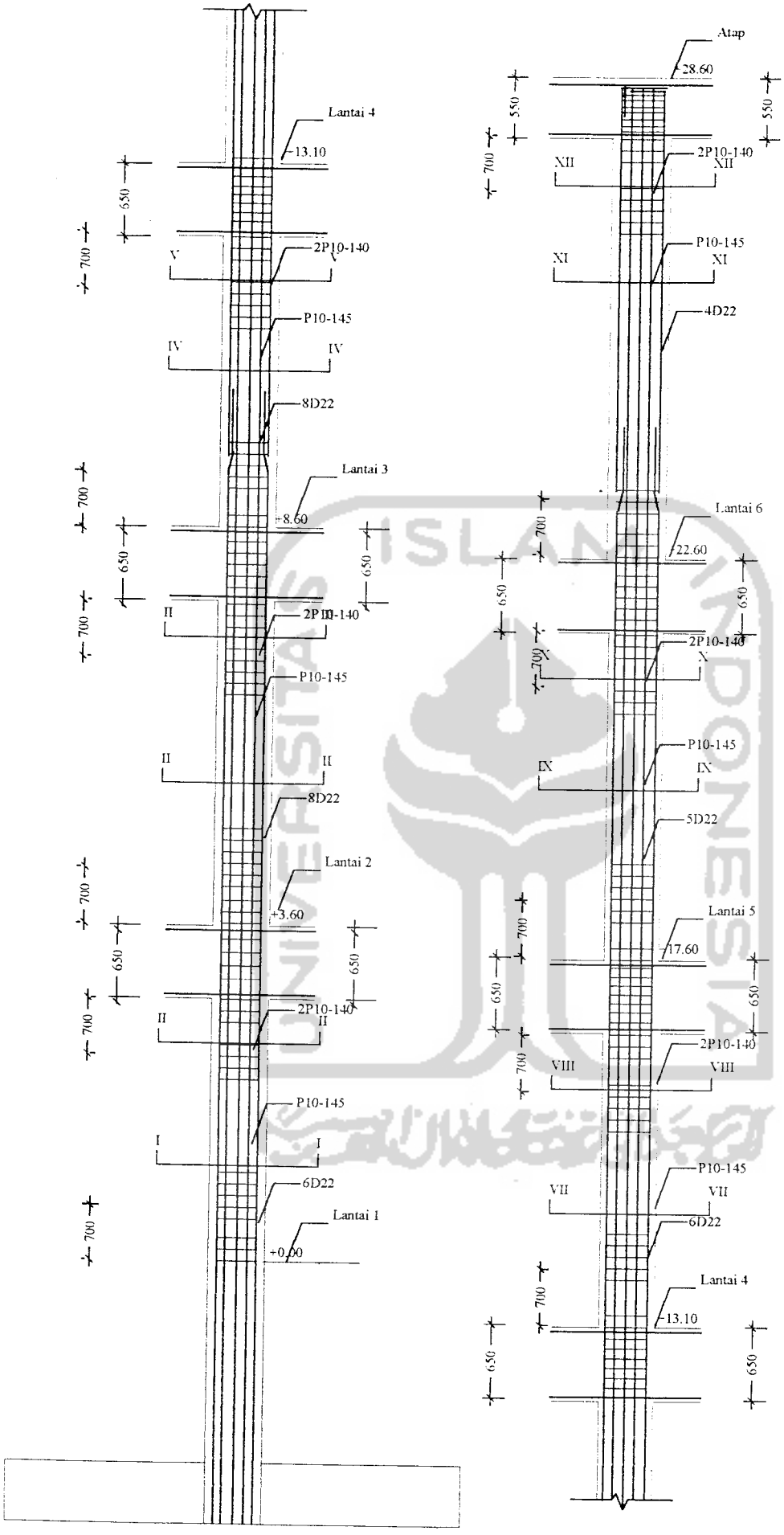
POT XI-XI



POT XII-XII

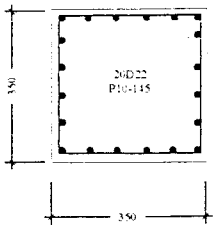


RENC. KOLOM 38

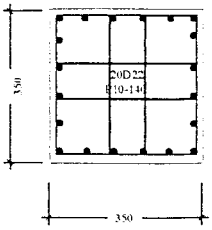


RENC. KOLOM 39

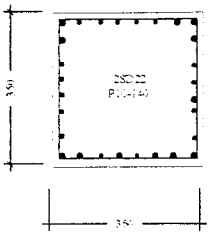
POT I-I



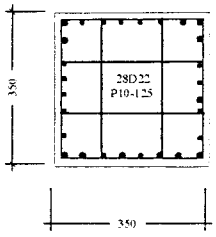
POT II-II



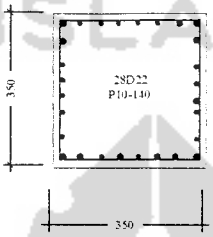
POT III-III



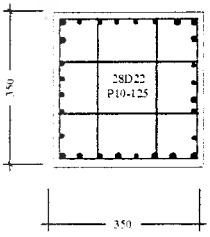
POT IV-IV



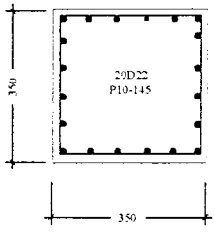
POT V-V



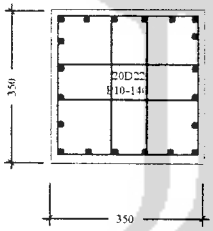
POT VI-VI



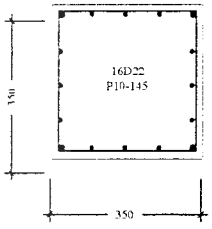
POT VII-VII



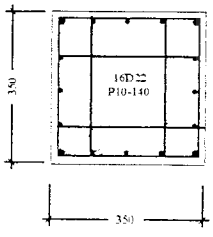
POT VIII-VIII



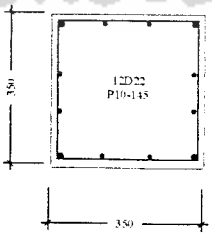
POT IX-IX



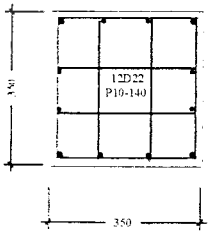
POT X-X



POT XI-XI

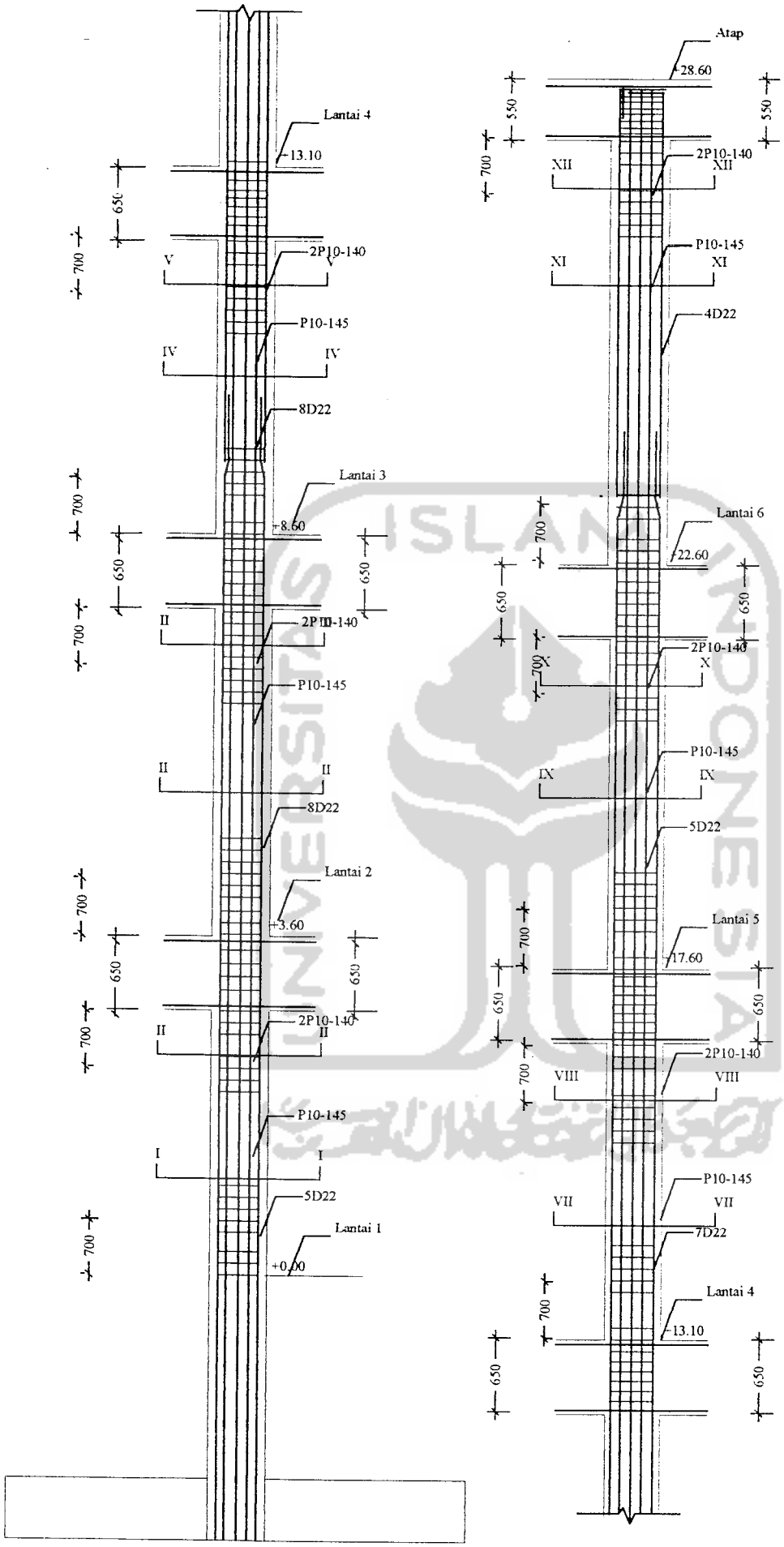


POT XII-XII



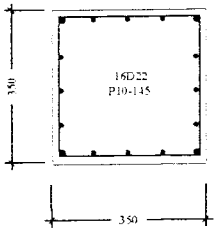
DETAIL KOLOM 39

lampiran 9.93

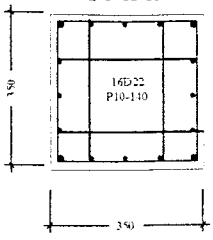


RENC. KOLOM 40

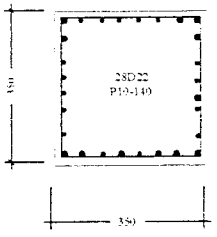
POT I-I



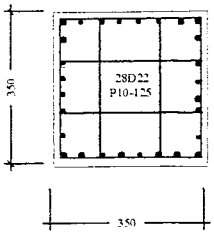
POT II-II



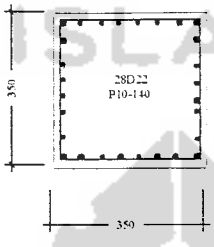
POT III-III



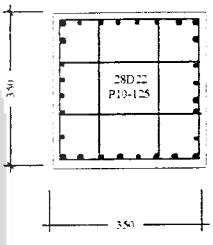
POT IV-IV



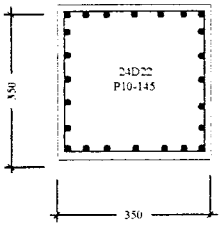
POT V-V



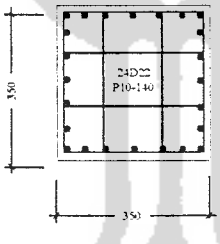
POT VI-VI



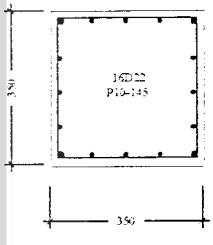
POT VII-VII



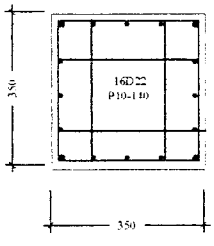
POT VIII-VIII



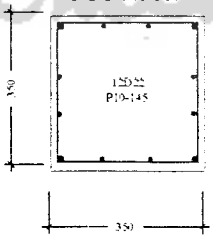
POT IX-IX



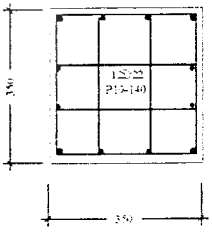
POT X-X



POT XI-XI

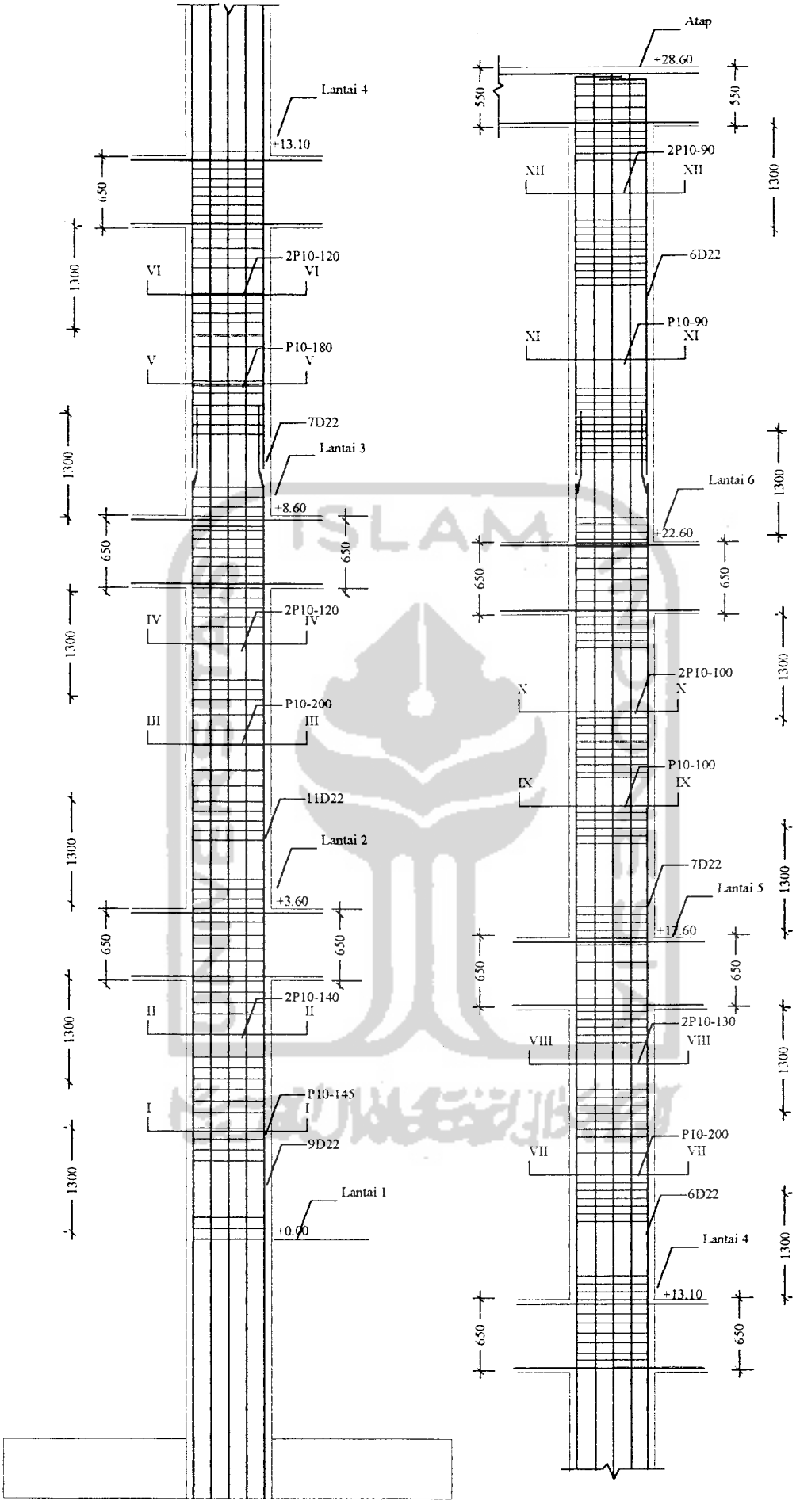


POT XII-XII



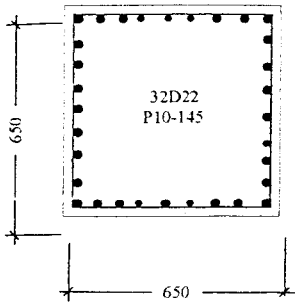
DETAIL KOLOM 40

lampiran 9.94

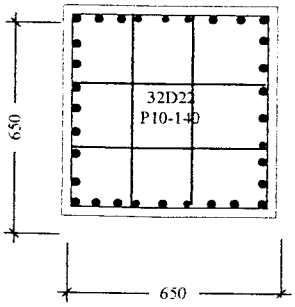


RENC. KOLOM 41

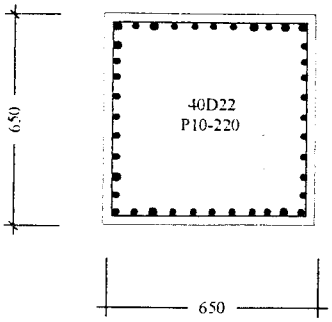
POT I-I



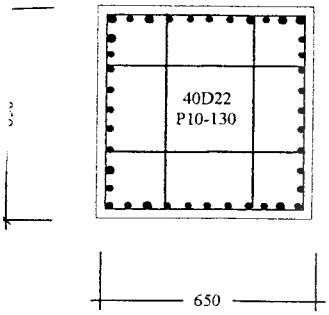
POT II-II



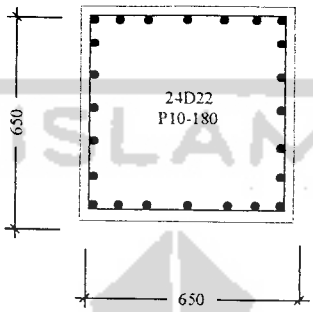
POT III-III



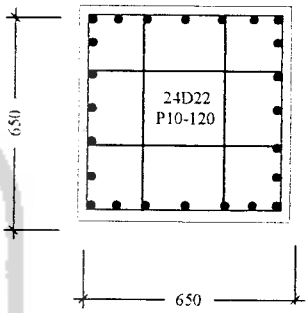
POT IV-IV



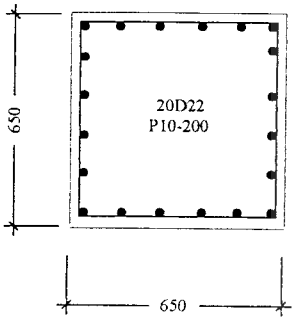
POT V-V



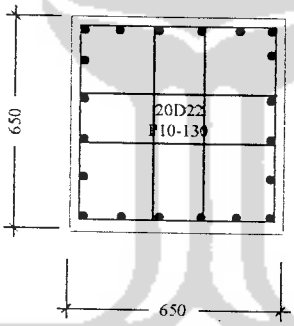
POT VI-VI



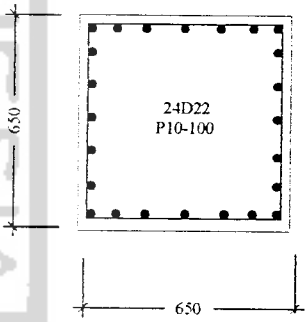
POT VII-VII



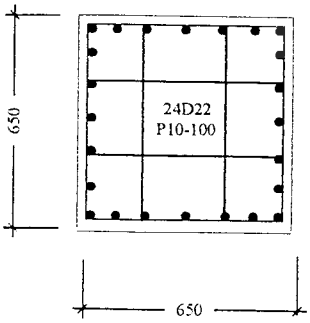
POT VIII-VIII



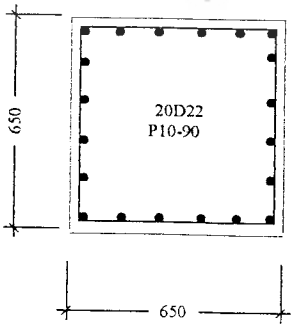
POT IX-IX



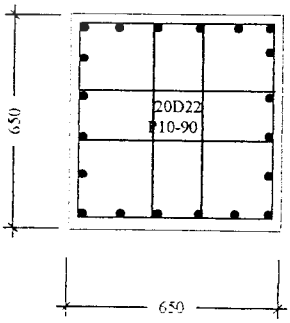
POT X-X



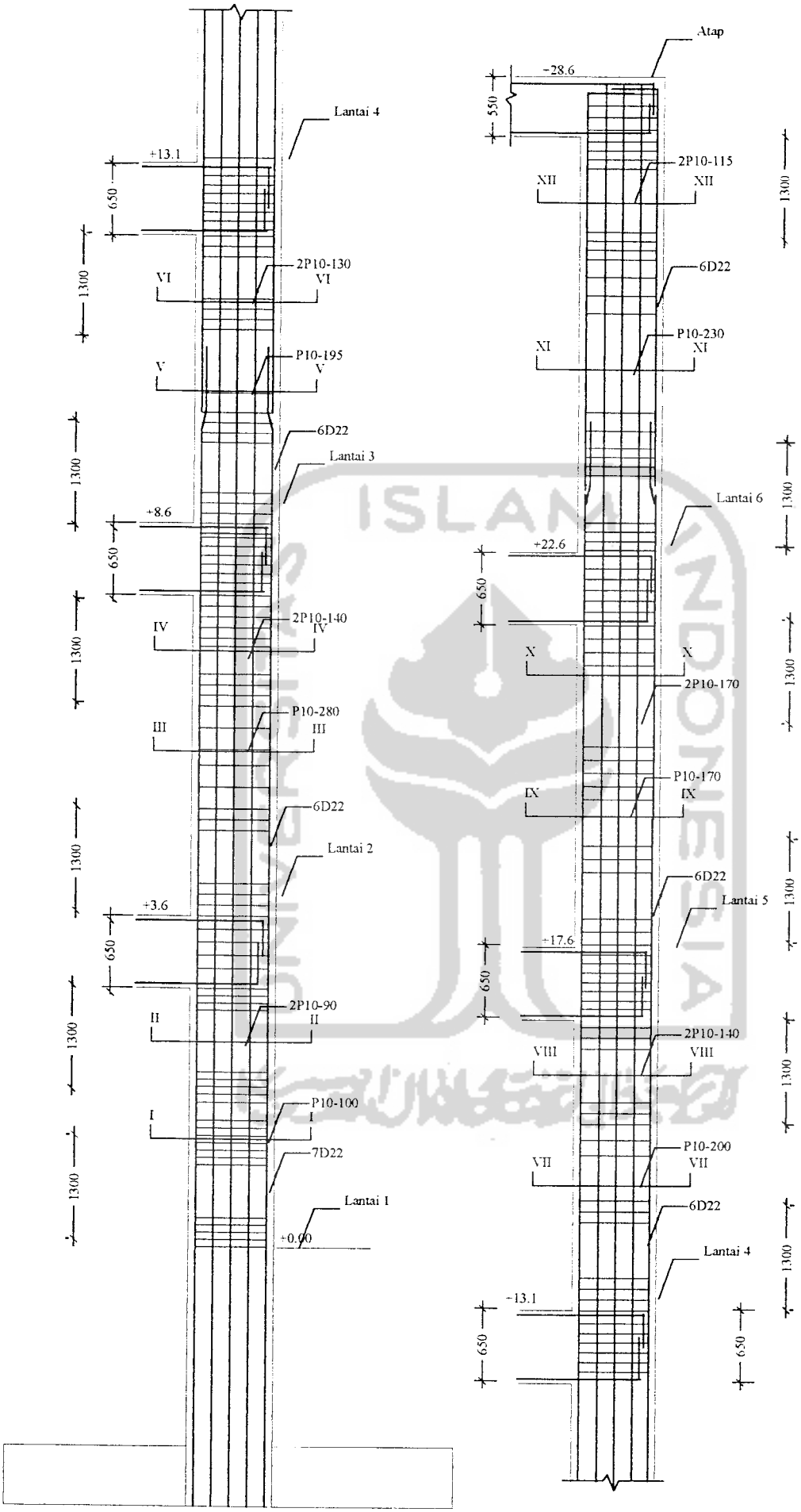
POT XI-XI



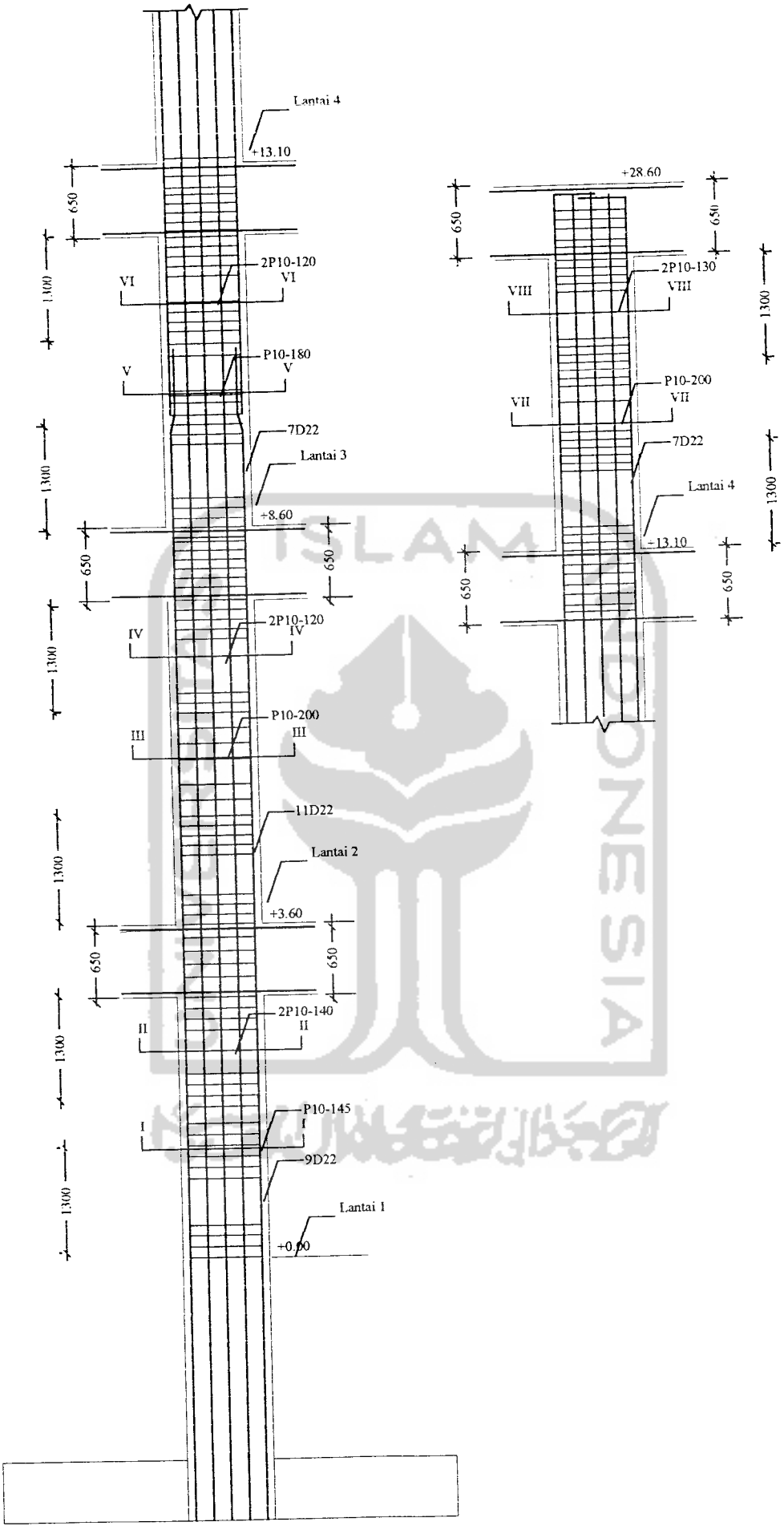
POT XII-XII



DETAIL KOLOM 41

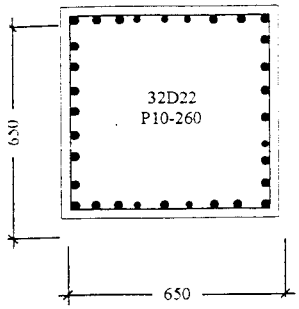


RENC. KOLOM 42

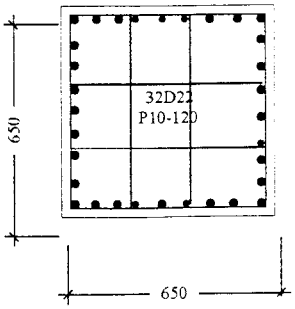


RENC. KOLOM 11

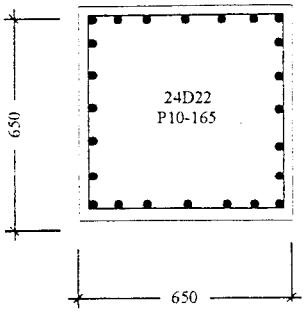
POT I-I



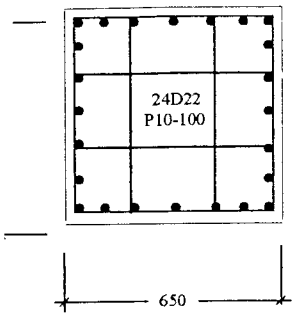
POT II-II



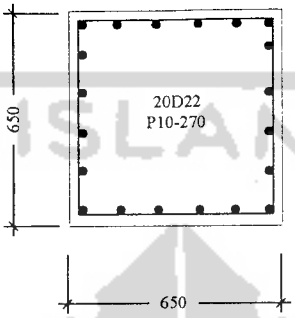
POT III-III



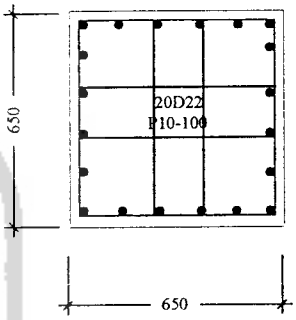
POT IV-IV



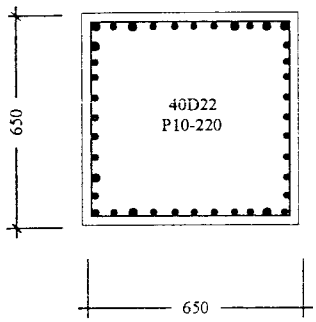
POT V-V



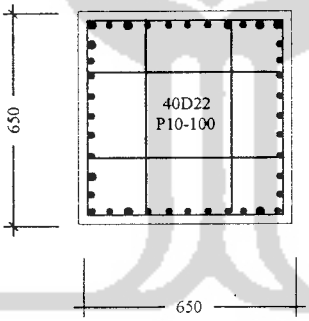
POT VI-VI



POT VII-VII

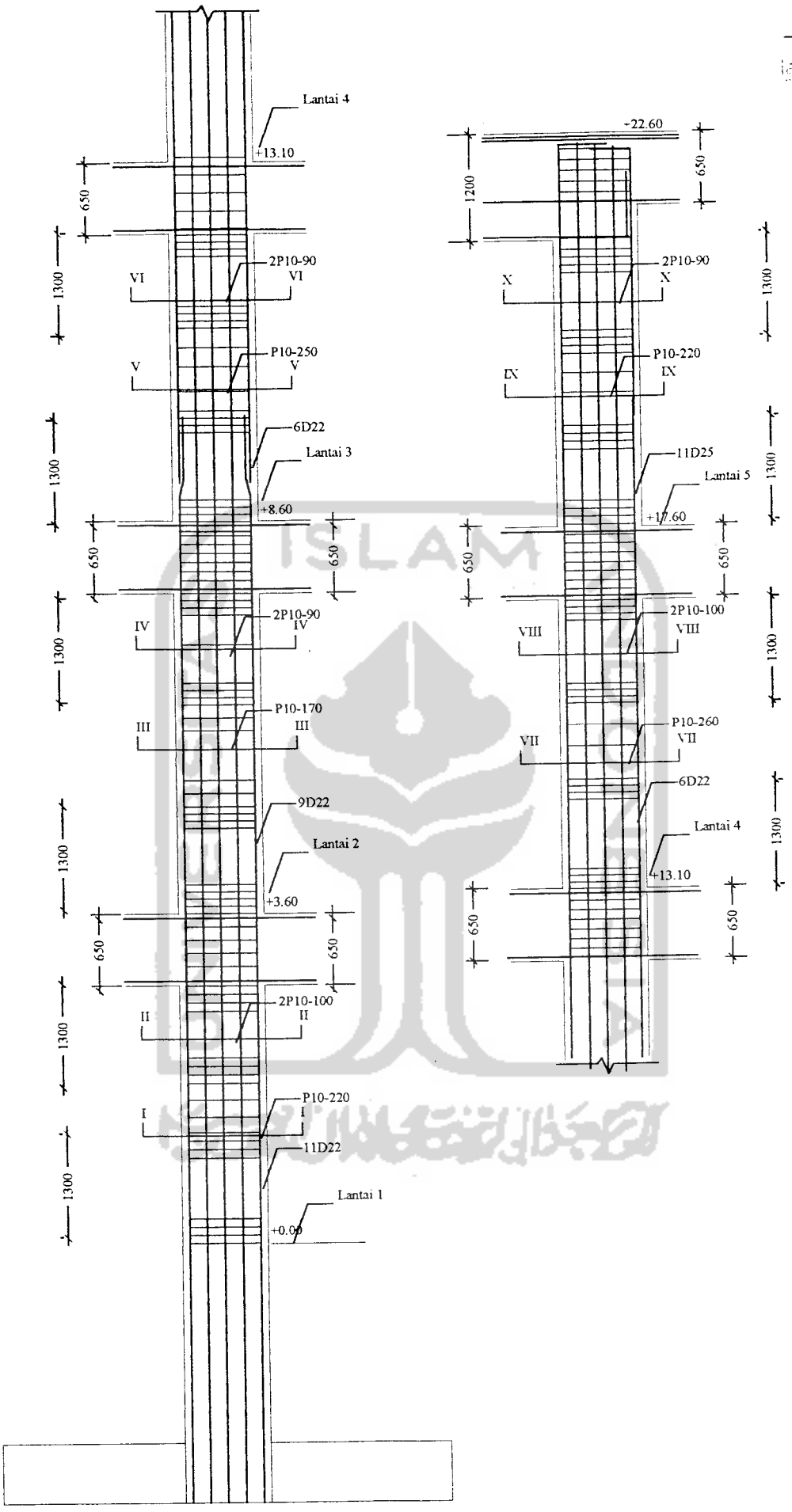


POT VIII-VIII



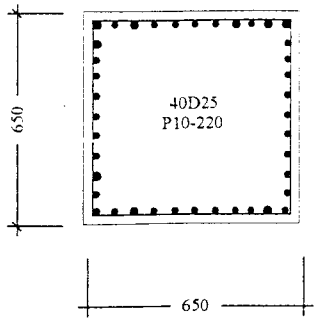
UNIVERSITAS ISLAM INDONESIA

DETAIL KOLOM 11

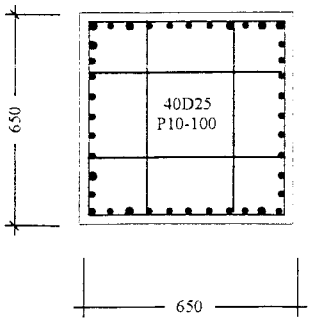


RENC. KOLOM 12

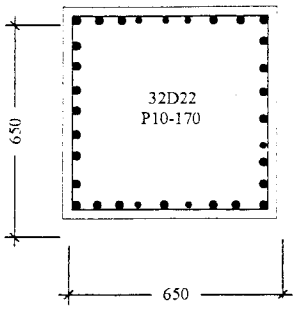
POT I-I



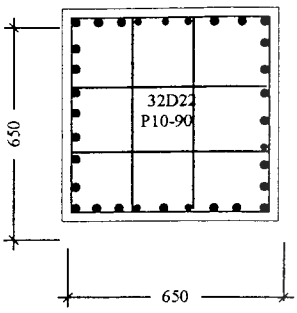
POT II-II



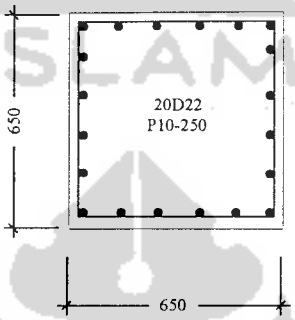
POT III-III



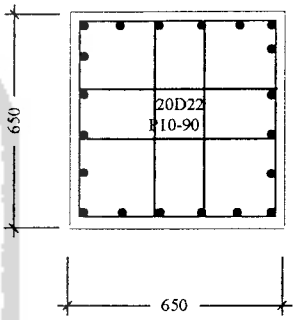
POT IV-IV



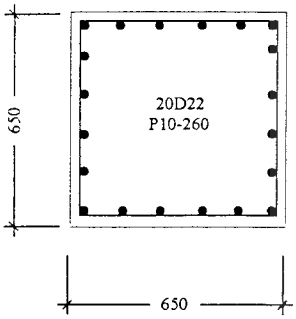
POT V-V



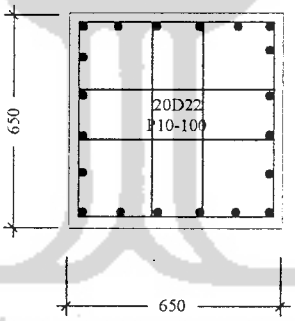
POT VI-VI



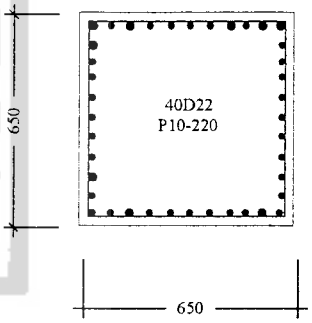
POT VII-VII



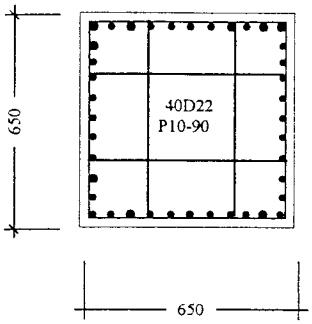
POT VIII-VIII



POT IX-IX

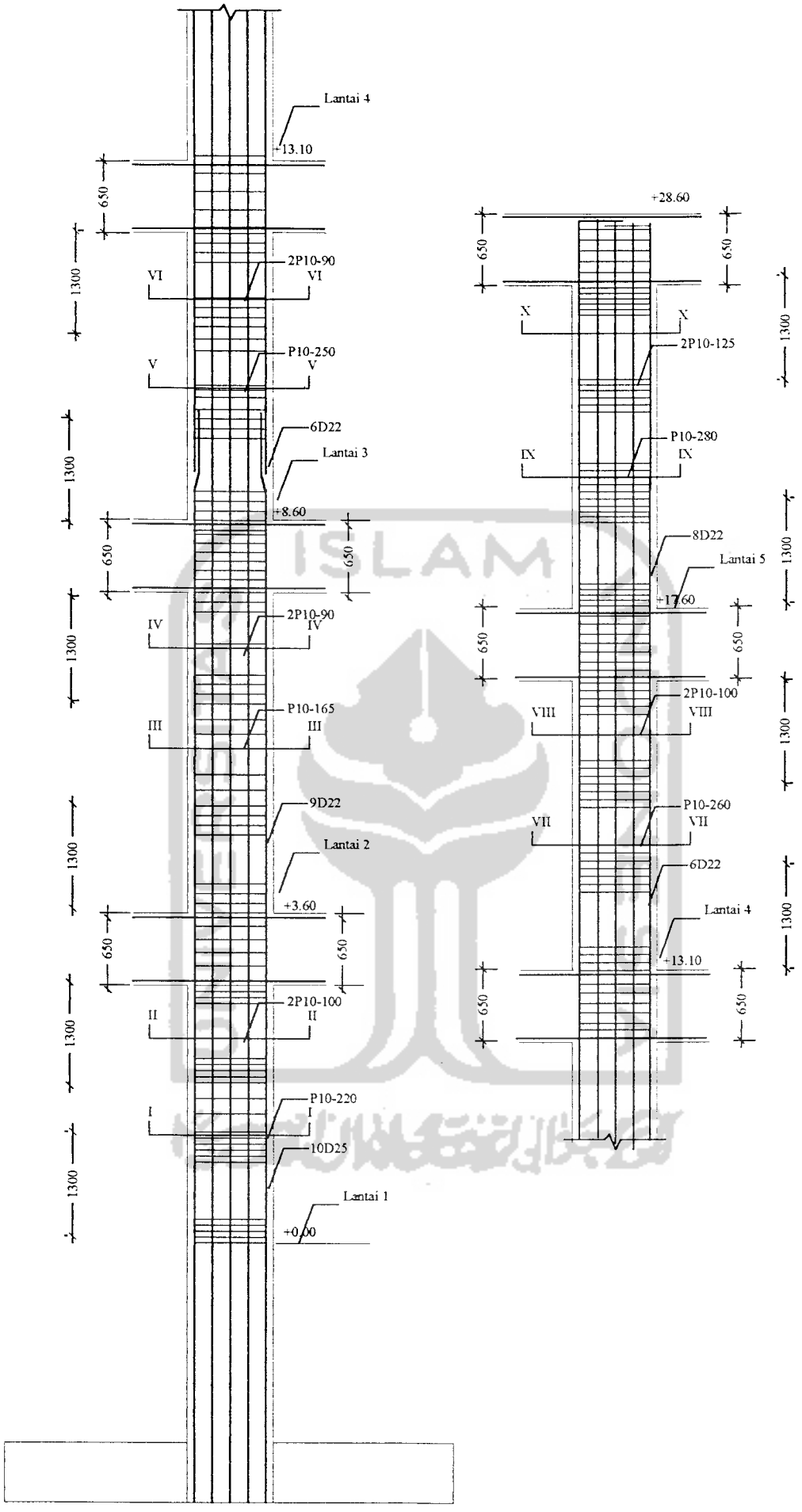


POT X-X



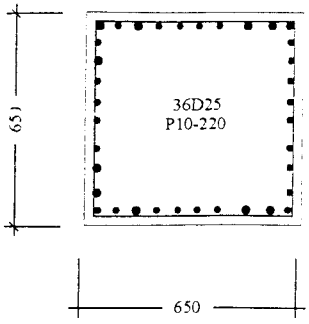
UNIVERSITAS ISLAM INDONESIA

DETAIL KOLOM 12

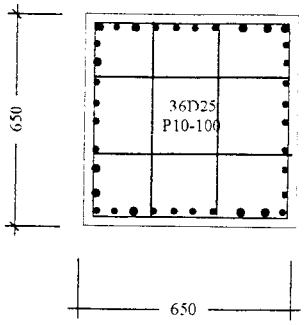


RENC. KOLOM 13

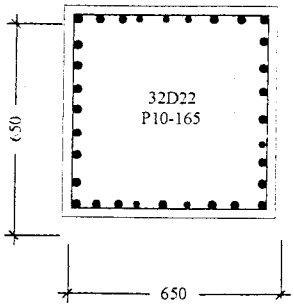
POT I-I



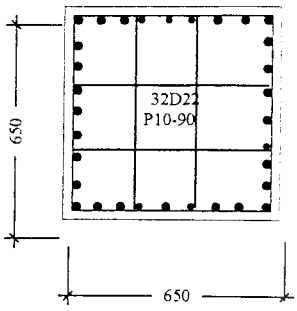
POT II-II



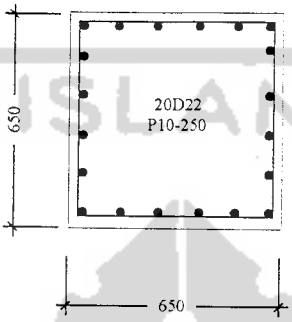
POT III-III



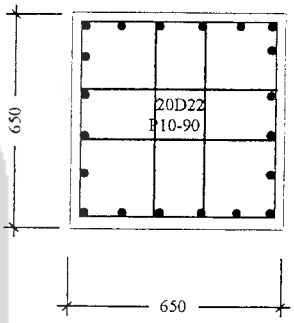
POT IV-IV



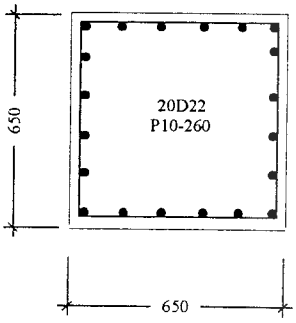
POT V-V



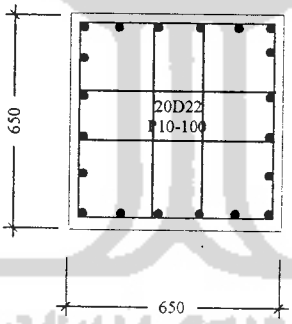
POT VI-VI



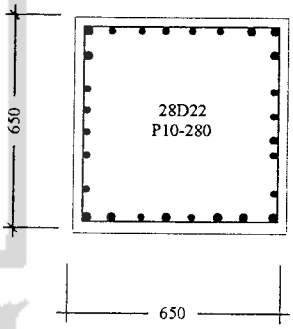
POT VII-VII



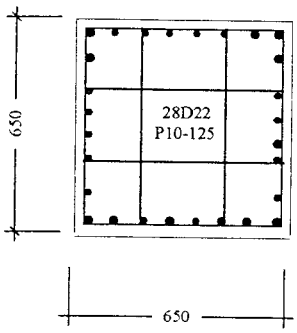
POT VIII-VIII



POT IX-IX

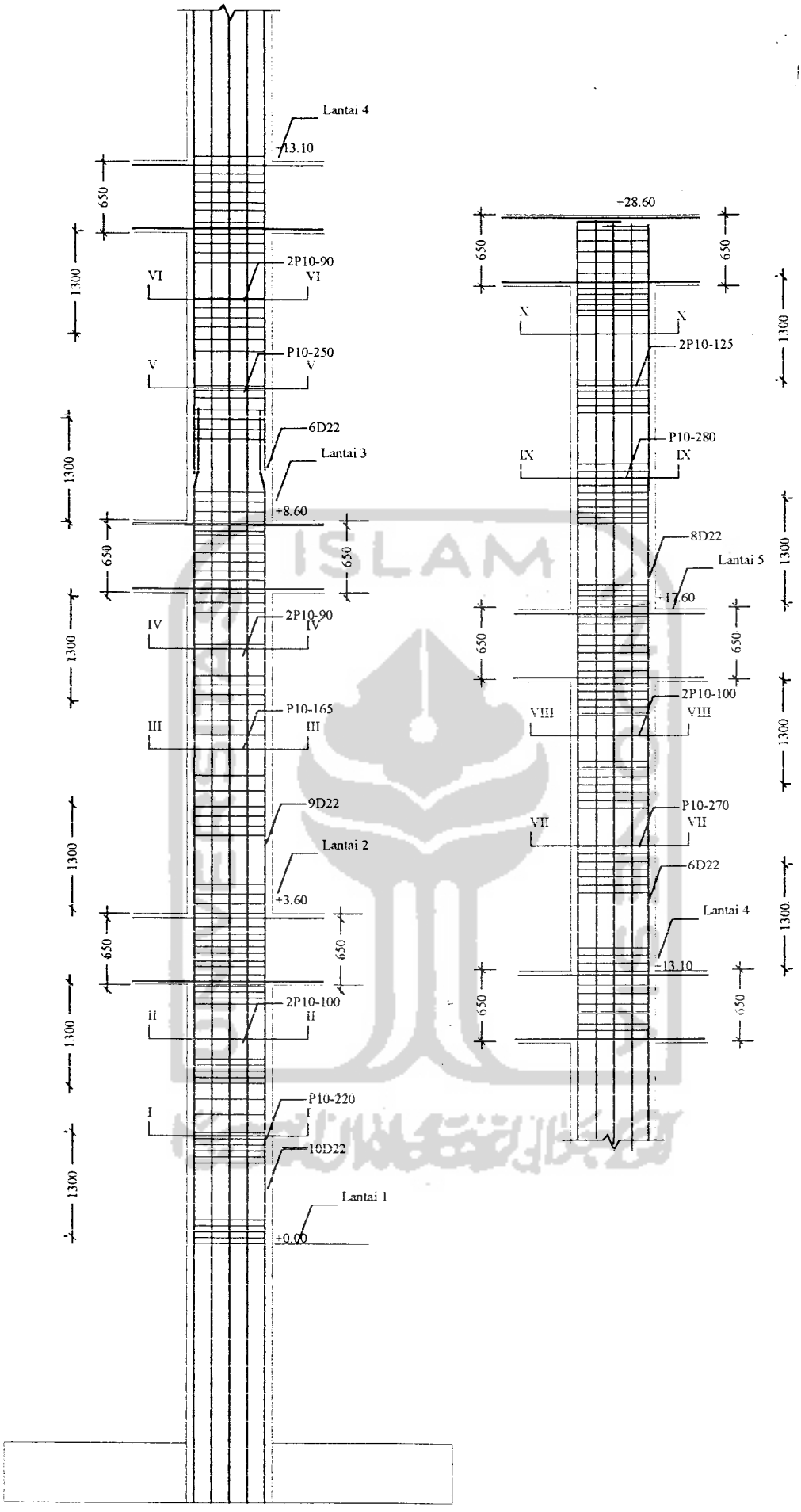


POT X-X



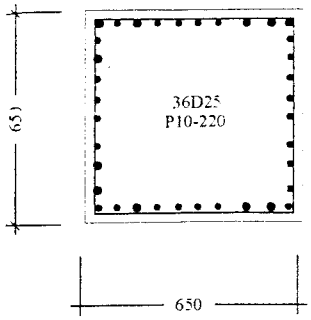
UNIVERSITAS ISLAM INDONESIA

DETAIL KOLOM 13

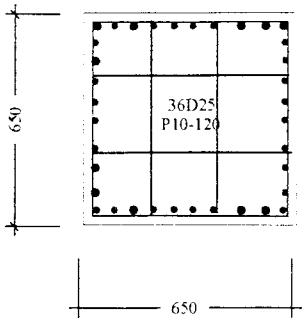


RENC. KOLOM 14

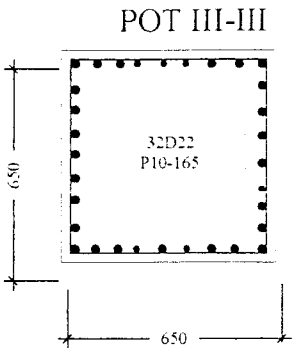
POT I-I



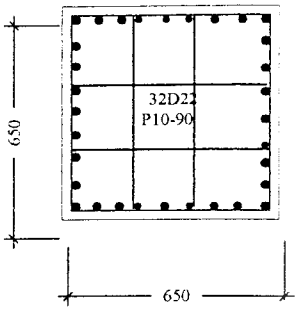
POT II-II



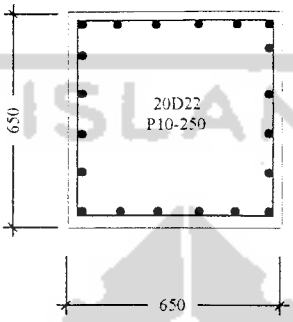
POT III-III



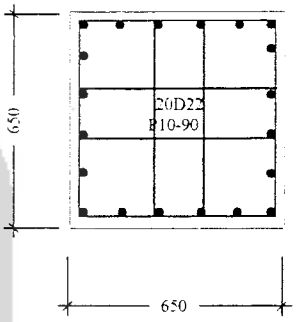
POT IV-IV



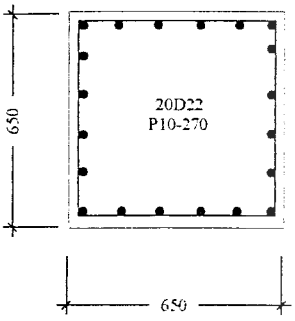
POT V-V



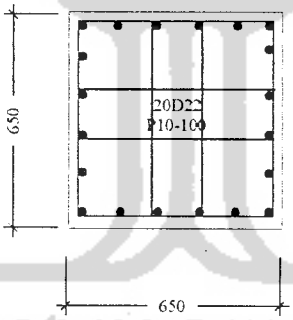
POT VI-VI



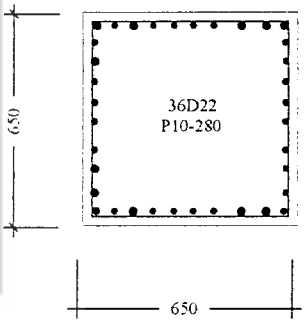
POT VII-VII



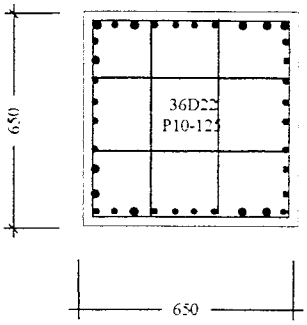
POT VIII-VIII



POT IX-IX

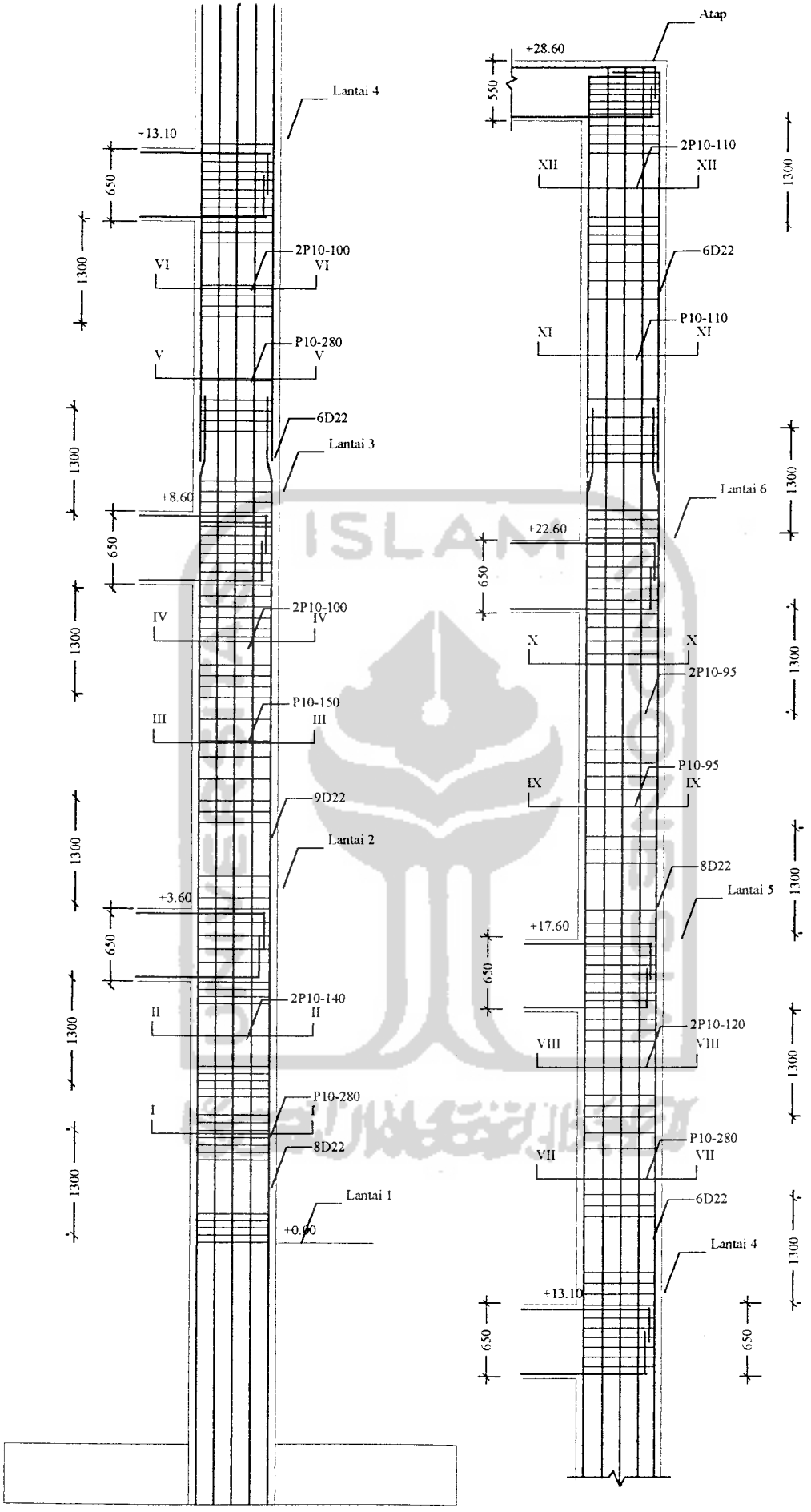


POT X-X



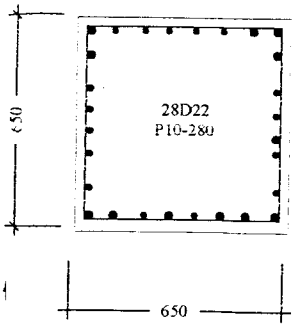
UNIVERSITAS ISLAM INDONESIA

DETAIL KOLOM 14

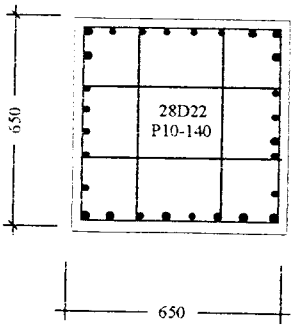


RENC. KOLOM 15

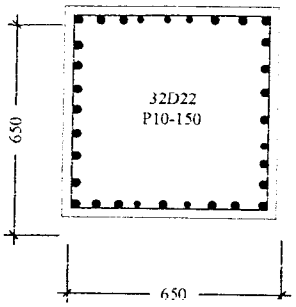
POT I-I



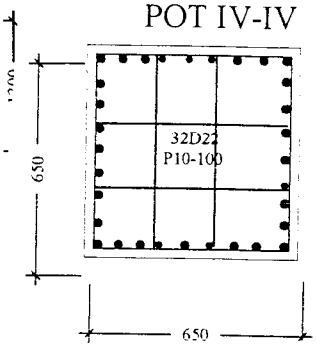
POT II-II



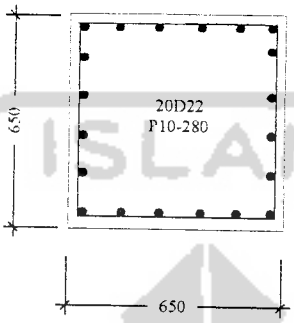
POT III-III



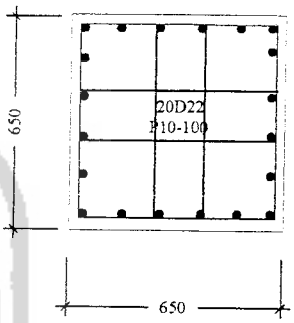
POT IV-IV



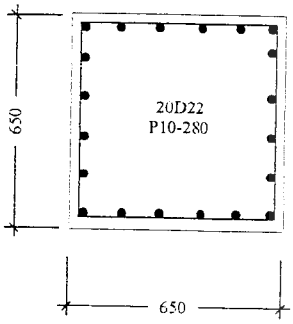
POT V-V



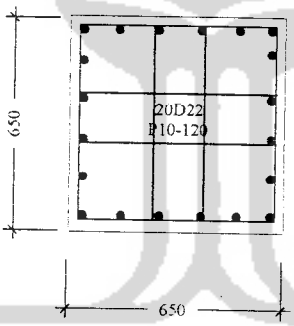
POT VI-VI



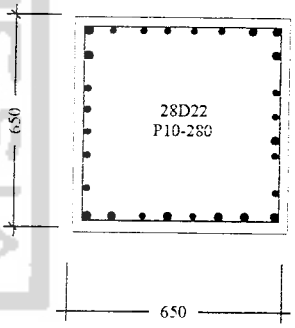
POT VII-VII



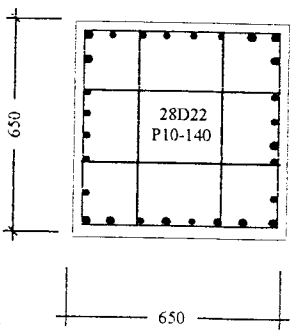
POT VIII-VIII



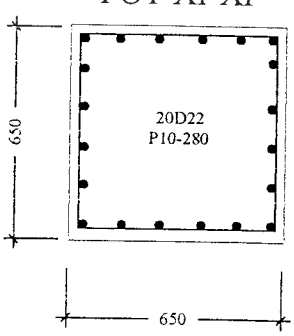
POT IX-IX



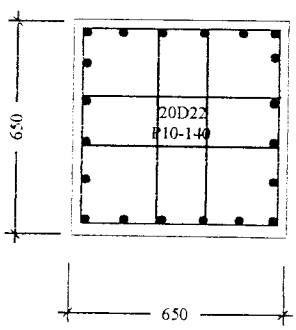
POT X-X



POT XI-XI

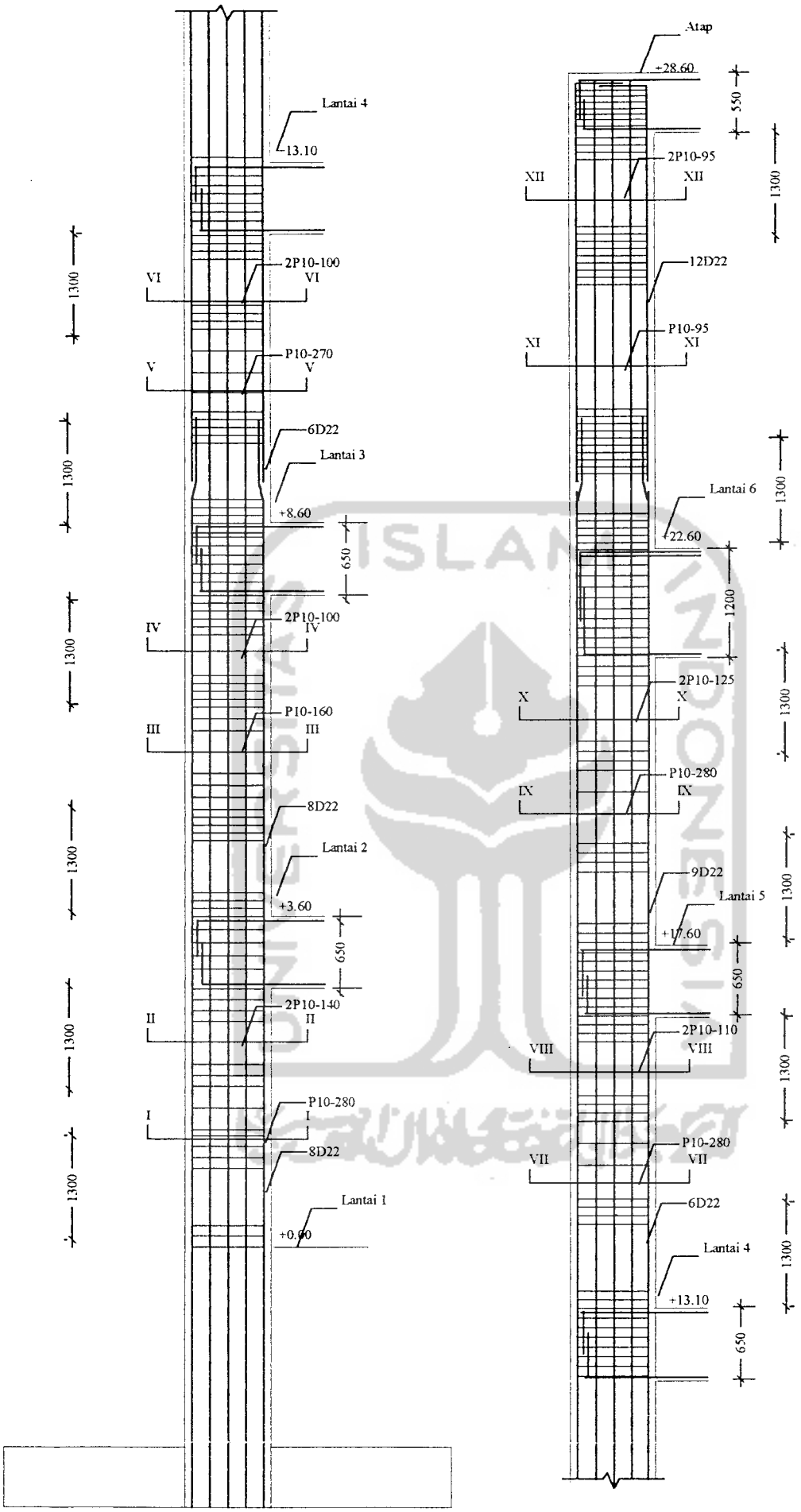


POT XII-XII



REN

DETAIL KOLOM 15



RENC. KOLOM 16

PERHITUNGAN TULANGAN BALOK PORTAL AS 3 - 3

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	A - B	40/65	570	359.33	306.23	449.163	382.788	0.0102	18.824	3.676
	B - C	40/65	570	366.17	293.33	457.713	366.663	0.0102	18.824	3.676
	C - D	40/65	570	366.80	293.15	458.500	366.438	0.0102	18.824	3.676
	D - E	40/65	570	364.98	302.20	456.225	377.750	0.0102	18.824	3.676
	E - F	40/65	570	323.28	222.58	404.100	278.225	0.0102	18.824	3.676
2	A - B	40/65	570	346.43	273.49	433.038	341.863	0.0102	18.824	3.676
	B - C	40/65	570	391.85	283.75	489.813	354.688	0.0102	18.824	3.676
	C - D	40/65	570	390.51	280.61	488.138	350.763	0.0102	18.824	3.676
	D - E	40/65	570	387.68	269.30	484.600	336.625	0.0102	18.824	3.676
	E - F	40/65	570	377.21	209.53	471.513	261.913	0.0102	18.824	3.676
3	A - B	40/65	570	296.39	283.06	370.488	353.825	0.0102	18.824	3.676
	B - C	40/65	570	361.96	280.73	452.450	350.913	0.0102	18.824	3.676
	C - D	40/65	570	362.27	278.29	452.838	347.863	0.0102	18.824	3.676
	D - E	40/65	570	363.54	297.19	454.425	371.488	0.0102	18.824	3.676
	E - F	40/65	570	361.17	207.25	451.463	259.063	0.0102	18.824	3.676
4	A - B	40/65	570	366.33	275.59	457.913	344.488	0.0102	18.824	3.676
	B - C	40/65	570	354.73	296.25	443.413	370.313	0.0102	18.824	3.676
	C - D	40/65	570	349.78	288.75	437.225	360.938	0.0102	18.824	3.676
	D - E	40/65	570	345.48	311.58	431.850	389.475	0.0102	18.824	3.676
	E - F	40/65	570	357.64	213.91	447.050	267.388	0.0102	18.824	3.676
5	A - B	40/65	570	338.41	267.13	423.013	333.913	0.0102	18.824	3.676
	B - C	40/65	570	382.35	287.61	477.938	359.513	0.0102	18.824	3.676
	C - D	40/65	570	371.12	309.16	463.900	386.450	0.0102	18.824	3.676
	D - E	40/65	570	372.86	340.68	466.075	425.850	0.0102	18.824	3.676
	E - F	40/65	570	316.62	277.16	395.775	346.450	0.0102	18.824	3.676

Tulangan Tumpuan Portal 3 - 3									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
552.693	sebelah	3.456	0.010	2186.519	5.754	6	2280	107.294	470.914
557.929	sebelah	3.522	0.010	2228.141	5.864	6	2280	107.294	470.914
558.408	sebelah	3.528	0.010	2231.974	5.874	6	2280	107.294	470.914
557.021	sebelah	3.511	0.010	2220.899	5.844	6	2280	107.294	470.914
524.236	sebelah	3.109	0.009	1967.155	5.177	6	2280	107.294	470.914
542.681	sebelah	3.332	0.009	2108.023	5.547	6	2280	107.294	470.914
577.161	rangkap	3.769	-	-	-	-	-	-	542.494
576.174	rangkap	3.756	-	-	-	-	-	-	542.494
574.082	rangkap	3.729	-	-	-	-	-	-	542.494
566.277	sebelah	3.628	0.010	2295.319	6.040	7	2660	125.176	539.886
501.960	sebelah	2.851	0.008	1803.530	4.746	5	1900	89.412	399.224
554.712	sebelah	3.481	0.010	2202.523	5.796	6	2280	107.294	470.914
554.949	sebelah	3.484	0.010	2204.409	5.801	6	2280	107.294	470.914
555.921	sebelah	3.497	0.010	2212.137	5.821	6	2280	107.294	470.914
554.106	sebelah	3.474	0.010	2197.716	5.783	6	2280	107.294	470.914
558.051	sebelah	3.523	0.010	2229.114	5.866	6	2280	107.294	470.914
549.144	sebelah	3.412	0.009	2158.528	5.680	6	2280	107.294	470.914
545.299	sebelah	3.364	0.009	2128.408	5.601	6	2280	107.294	470.914
541.937	sebelah	3.323	0.009	2102.242	5.532	6	2280	107.294	470.914
551.392	sebelah	3.440	0.010	2176.236	5.727	6	2280	107.294	470.914
536.363	sebelah	3.255	0.009	2059.221	5.419	6	2280	107.294	470.914
570.122	sebelah	3.678	0.010	2326.596	6.123	7	2660	125.176	539.886
561.687	sebelah	3.570	0.010	2258.261	5.943	6	2280	107.294	470.914
563.002	sebelah	3.586	0.010	2268.849	5.971	6	2280	107.294	470.914
518.808	sebelah	3.045	0.008	1926.629	5.070	6	2280	107.294	470.914

	Tulangan Lapangan Portal 3 - 3									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	510.224	sebelah	2.945	0.008	1863.406	4.904	5	1900	89.412	399.224
	499.362	sebelah	2.821	0.008	1784.910	4.697	5	1900	89.412	399.224
	499.209	sebelah	2.820	0.008	1783.815	4.694	5	1900	89.412	399.224
	506.856	sebelah	2.907	0.008	1838.884	4.839	5	1900	89.412	399.224
	434.991	sebelah	2.141	0.006	1354.397	3.564	4	1520	71.529	324.815
2	482.179	sebelah	2.631	0.007	1664.184	4.379	5	1900	89.412	399.224
	491.140	sebelah	2.729	0.008	1726.616	4.544	5	1900	89.412	399.224
	488.415	sebelah	2.699	0.007	1707.509	4.493	5	1900	89.412	399.224
	478.471	sebelah	2.590	0.007	1638.688	4.312	5	1900	89.412	399.224
	422.047	sebelah	2.015	0.006	1274.988	3.355	4	1520	71.529	324.815
3	490.542	sebelah	2.723	0.008	1722.417	4.533	5	1900	89.412	399.224
	488.519	sebelah	2.700	0.007	1708.239	4.495	5	1900	89.412	399.224
	486.392	sebelah	2.677	0.007	1693.392	4.456	6	2280	107.294	470.914
	502.637	sebelah	2.858	0.008	1808.398	4.759	5	1900	89.412	399.224
	419.744	sebelah	1.993	0.006	1261.114	3.319	4	1520	71.529	324.815
4	484.026	sebelah	2.651	0.007	1676.962	4.413	5	1900	89.412	399.224
	501.841	sebelah	2.849	0.008	1802.678	4.744	5	1900	89.412	399.224
	495.448	sebelah	2.777	0.008	1757.041	4.624	5	1900	89.412	399.224
	514.662	sebelah	2.997	0.008	1895.961	4.989	5	1900	89.412	399.224
	426.435	sebelah	2.057	0.006	1301.640	3.425	4	1520	71.529	324.815
5	476.539	sebelah	2.569	0.007	1625.483	4.278	5	1900	89.412	399.224
	494.469	sebelah	2.766	0.008	1750.104	4.606	5	1900	89.412	399.224
	512.659	sebelah	2.974	0.008	1881.235	4.951	5	1900	89.412	399.224
	538.159	sebelah	3.277	0.009	2073.034	5.455	6	2280	107.294	470.914
	485.403	sebelah	2.666	0.007	1686.516	4.438	5	1900	89.412	399.224

PERHITUNGAN TULANGAN RANGKAP PORTAL 3 - 3

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	B - C	400	650	570	391.85	283.75	489.813	354.688	0.0102	18.824	3.676	577.161

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	10.478	227.19	94.125	0.713	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	C - D	400	650	570	390.51	280.61	488.138	350.763	0.0102	18.824	3.676	576.174

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	8.803	227.193	79.079	0.599	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	D - E	400	650	570	387.68	269.30	484.600	336.625	0.0102	18.824	3.676	574.082

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	5.266	227.193	47.303	0.358	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.001	0.011	238.147	117.780	511.687	30.807	542.494

PERHITUNGAN TULANGAN GESER BALOK PORTAL 3 - 3

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	A - B	182.89	43.15	70.7	470.914	382.788	6.7	237.342	348.833	534.156	329.863	0	549.771	39.066	143	2P10-70
	B - C	182.22	43.02	66.5	470.914	366.663	6.6	236.502	348.392	515.592	328.918	0	548.197	39.179	143	2P10-70
	C - D	181.90	42.88	65.6	470.914	366.438	6.6	236.019	347.879	511.707	328.410	0	547.350	39.239	143	2P10-70
	D - E	183.16	43.09	64.9	470.914	377.750	6.6	237.563	350.934	510.269	331.202	0	552.003	38.908	143	2P10-70
	E - F	183.34	43.14	70.1	470.914	278.225	6.7	237.804	335.639	532.350	318.993	0	531.654	40.398	143	2P10-80
2	A - B	164.93	39.91	82	470.914	341.863	6.7	215.082	321.228	559.272	303.167	0	505.279	42.506	143	2P10-80
	B - C	176.05	43.14	78.1	542.494	354.688	6.6	230.150	350.002	558.296	329.142	0	548.570	39.152	143	2P10-70
	C - D	175.49	42.89	77	542.494	350.763	6.6	229.299	348.627	552.825	327.859	0	546.431	39.305	143	2P10-70
	D - E	177.04	43.03	76.4	542.494	336.625	6.6	231.074	348.513	552.038	328.073	0	546.789	39.280	143	2P10-70
	E - F	170.91	41.63	81.8	539.886	261.913	6.7	223.167	327.880	566.895	310.063	0	516.771	41.561	143	2P10-80
3	A - B	164.53	40.41	69.4	399.224	353.825	6.7	215.187	313.533	506.457	296.799	0	494.666	43.418	143	2P10-80
	B - C	175.62	43.10	66.5	470.914	350.913	6.6	229.656	339.442	508.914	320.334	0	533.890	40.228	143	2P10-80
	C - D	175.35	42.90	65.8	470.914	347.863	6.6	229.163	338.541	505.691	319.504	0	532.507	40.333	143	2P10-80
	D - E	177.54	43.58	65.4	470.914	371.488	6.6	232.176	344.711	506.814	325.124	0	541.874	39.636	143	2P10-70
	E - F	166.71	40.54	70.1	470.914	259.063	6.7	217.613	312.945	511.949	296.724	0	494.541	43.429	143	2P10-80
4	A - B	168.60	40.67	36	470.914	344.488	6.7	219.734	326.222	370.976	308.103	0	513.506	41.825	143	2P10-80
	B - C	181.71	43.13	39	470.914	370.313	6.6	236.082	348.460	399.714	328.901	0	548.168	39.181	143	2P10-70
	C - D	181.47	42.75	54.7	470.914	360.938	6.6	235.431	346.556	465.297	327.215	0	545.359	39.383	143	2P10-70
	D - E	183.40	43.81	34.4	470.914	389.475	6.6	238.571	353.508	383.135	333.504	0	555.839	38.640	143	2P10-70
	E - F	171.60	40.06	36.7	470.914	267.388	6.7	222.243	318.663	376.551	302.257	0	503.762	42.634	143	2P10-80
5	A - B	253.67	49.21	43.9	470.914	333.913	6.7	318.024	423.132	502.446	405.248	0	675.413	31.799	143	2P10-60
	B - C	239.34	43.08	26.7	539.886	359.513	6.6	296.541	416.690	408.681	395.778	0	659.630	32.560	143	2P10-60
	C - D	239.81	43.62	31.6	470.914	386.450	6.6	297.602	412.135	430.364	392.201	0	653.668	32.857	143	2P10-60
	D - E	201.18	43.90	29.3	470.914	425.850	6.6	257.334	377.131	380.478	356.281	0	593.801	36.170	143	2P10-70
	E - F	196.93	42.95	30.1	470.914	346.450	6.7	251.874	358.619	378.252	340.457	0	567.428	37.851	143	2P10-70

PERHITUNGAN TULANGAN GESER BALOK PORTAL 3 - 3

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	A - B	182.89	43.15	70.67	470.914	382.788	6.7	237.342	348.833	534.156	329.863	289.595	190	292.659	73.388	285	P10-70
	B - C	182.22	43.02	66.45	470.914	366.663	6.55	236.502	348.392	515.592	328.918	288.766	190	291.276	73.736	285	P10-70
	C - D	181.90	42.88	65.64	470.914	366.438	6.55	236.019	347.879	511.707	328.410	288.320	190	290.533	73.925	285	P10-70
	D - E	183.16	43.09	64.93	470.914	377.750	6.55	237.563	350.934	510.269	331.202	290.771	190	294.618	72.900	285	P10-70
	E - F	183.34	43.14	70.13	470.914	278.225	6.7	237.804	335.639	532.350	318.993	280.052	190	276.754	77.606	285	P10-70
2	A - B	164.93	39.91	81.95	470.914	341.863	6.7	215.082	321.228	559.272	303.167	266.159	190	253.598	84.692	285	P10-80
	B - C	176.05	43.14	78.13	542.494	354.688	6.55	230.150	350.002	558.296	329.142	288.963	190	291.604	73.653	285	P10-70
	C - D	175.49	42.89	77.03	542.494	350.763	6.55	229.299	348.627	552.825	327.859	287.836	190	289.726	74.131	285	P10-70
	D - E	177.04	43.03	76.42	542.494	336.625	6.55	231.074	348.513	552.038	328.073	288.024	190	290.040	74.050	285	P10-70
	E - F	170.91	41.63	81.84	539.886	261.913	6.7	223.167	327.880	566.895	310.063	272.212	190	263.687	81.451	285	P10-80
3	A - B	164.53	40.41	69.35	399.224	353.825	6.7	215.187	313.533	506.457	296.799	260.568	190	244.280	87.922	285	P10-80
	B - C	175.62	43.10	66.49	470.914	350.913	6.55	229.656	339.442	508.914	320.334	281.230	190	278.716	77.059	285	P10-70
	C - D	175.35	42.90	65.84	470.914	347.863	6.55	229.163	338.541	505.691	319.504	280.501	190	277.502	77.396	285	P10-70
	D - E	177.54	43.58	65.39	470.914	371.488	6.55	232.176	344.711	506.814	325.124	285.435	190	285.725	75.169	285	P10-70
	E - F	166.71	40.54	70.08	470.914	259.063	6.7	217.613	312.945	511.949	296.724	260.502	190	244.170	87.962	285	P10-80
4	A - B	168.60	40.67	36.01	470.914	344.488	6.7	219.734	326.222	370.976	308.103	270.492	190	260.820	82.346	285	P10-80
	B - C	181.71	43.13	38.96	470.914	370.313	6.55	236.082	348.460	399.714	328.901	288.751	190	291.251	73.743	285	P10-70
	C - D	181.47	42.75	54.73	470.914	360.938	6.55	235.431	346.556	465.297	327.215	287.271	190	288.785	74.372	285	P10-70
	D - E	183.40	43.81	34.42	470.914	389.475	6.55	238.571	353.508	383.135	333.504	292.792	190	297.986	72.076	285	P10-70
	E - F	171.60	40.06	36.74	470.914	267.388	6.7	222.243	318.663	376.551	302.257	265.360	190	252.266	85.139	285	P10-80
5	A - B	253.67	49.21	43.91	470.914	333.913	6.7	318.024	423.132	502.446	405.248	355.778	190	402.963	53.299	285	P10-50
	B - C	239.34	43.08	26.70	539.886	359.513	6.55	296.541	416.690	408.681	395.778	347.464	190	389.107	55.197	285	P10-50
	C - D	239.81	43.62	31.61	470.914	386.450	6.55	297.602	412.135	430.364	392.201	344.323	190	383.872	55.950	285	P10-50
	D - E	201.18	43.90	29.32	470.914	425.850	6.55	257.334	377.131	380.478	356.281	312.788	190	331.314	64.826	285	P10-60
	E - F	196.93	42.95	30.09	470.914	346.450	6.7	251.874	358.619	378.252	340.457	298.896	190	308.160	69.696	285	P10-60

PERHITUNGAN TULANGAN BALOK PORTAL 5 - 5

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	A - B	40/65	570	361.94	307.71	452.425	384.638	0.0102	18.824	3.676
	B - C	40/65	570	368.80	297.14	461.000	371.425	0.0102	18.824	3.676
	C - D	40/65	570	366.94	294.67	458.675	368.338	0.0102	18.824	3.676
	D - E	40/65	570	365.91	302.41	457.388	378.013	0.0102	18.824	3.676
	E - F	40/65	570	323.86	222.54	404.825	278.175	0.0102	18.824	3.676
2	A - B	40/65	570	362.74	299.94	453.425	374.925	0.0102	18.824	3.676
	B - C	40/65	570	396.88	290.73	496.100	363.413	0.0102	18.824	3.676
	C - D	40/65	570	390.14	284.31	487.675	355.388	0.0102	18.824	3.676
	D - E	40/65	570	389.14	296.84	486.425	371.050	0.0102	18.824	3.676
	E - F	40/65	570	377.85	209.36	472.313	261.700	0.0102	18.824	3.676
3	A - B	40/65	570	305.60	291.50	382.000	364.375	0.0102	18.824	3.676
	B - C	40/65	570	367.94	291.56	459.925	364.450	0.0102	18.824	3.676
	C - D	40/65	570	359.57	284.05	449.463	355.063	0.0102	18.824	3.676
	D - E	40/65	570	363.35	297.85	454.188	372.313	0.0102	18.824	3.676
	E - F	40/65	570	359.21	207.35	449.013	259.188	0.0102	18.824	3.676
4	A - B	40/65	570	365.02	274.41	456.275	343.013	0.0102	18.824	3.676
	B - C	40/65	570	359.42	314.46	449.275	393.075	0.0102	18.824	3.676
	C - D	40/65	570	340.08	296.24	425.100	370.300	0.0102	18.824	3.676
	D - E	40/65	570	342.18	312.10	427.725	390.125	0.0102	18.824	3.676
	E - F	40/65	570	352.16	211.86	440.200	264.825	0.0102	18.824	3.676
5	A - B	40/65	570	324.69	294.18	405.863	367.725	0.0102	18.824	3.676
	B - C	40/65	570	378.05	304.25	472.563	380.313	0.0102	18.824	3.676
	C - D	40/65	570	368.99	318.39	461.238	397.988	0.0102	18.824	3.676
	D - E	40/65	570	370.22	309.96	462.775	387.450	0.0102	18.824	3.676
	E - F	40/65	570	316.90	275.56	396.125	344.450	0.0102	18.824	3.676

	Tulangan Tumpuan Portal 5 - 5									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	554.697	sebelah	3.481	0.010	2202.401	5.796	6	2280	107.294	470.914
	559.929	sebelah	3.547	0.010	2244.144	5.906	6	2280	107.294	470.914
	558.515	sebelah	3.529	0.010	2232.826	5.876	6	2280	107.294	470.914
	557.731	sebelah	3.519	0.010	2226.558	5.859	6	2280	107.294	470.914
	524.706	sebelah	3.115	0.009	1970.685	5.186	6	2280	107.294	470.914
2	555.309	sebelah	3.489	0.010	2207.269	5.809	6	2280	107.294	470.914
	580.854	rangkap	-	-	-	-	-	-	-	542.494
	575.901	rangkap	-	-	-	-	-	-	-	542.494
	575.162	rangkap	-	-	-	-	-	-	-	542.494
	566.757	sebelah	3.634	0.010	2299.213	6.051	7	2660	125.176	539.886
3	509.699	sebelah	2.939	0.008	1859.573	4.894	5	1900	89.412	399.224
	559.275	sebelah	3.539	0.010	2238.911	5.892	6	2280	107.294	470.914
	552.878	sebelah	3.458	0.010	2187.980	5.758	6	2280	107.294	470.914
	555.776	sebelah	3.495	0.010	2210.981	5.818	6	2280	107.294	470.914
	552.601	sebelah	3.455	0.010	2185.789	5.752	6	2280	107.294	470.914
4	557.052	sebelah	3.511	0.010	2221.143	5.845	6	2280	107.294	470.914
	552.762	sebelah	3.457	0.010	2187.067	5.755	6	2280	107.294	470.914
	537.685	sebelah	3.271	0.009	2069.383	5.446	6	2280	107.294	470.914
	539.342	sebelah	3.291	0.009	2082.162	5.479	6	2280	107.294	470.914
	547.151	sebelah	3.387	0.009	2142.890	5.639	6	2280	107.294	470.914
5	525.378	sebelah	3.123	0.009	1975.735	5.199	6	2280	107.294	470.914
	566.907	sebelah	3.636	0.010	2300.430	6.054	7	2660	125.176	539.886
	560.073	sebelah	3.549	0.010	2245.300	5.909	6	2280	107.294	470.914
	561.006	sebelah	3.561	0.010	2252.785	5.928	6	2280	107.294	470.914
	519.037	sebelah	3.048	0.008	1928.333	5.075	6	2280	107.294	470.914

	Tulangan Lapangan Portal 5 - 5									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	511.456	sebelah	2.960	0.008	1872.412	4.927	5	1900	89.412	399.224
	502.595	sebelah	2.858	0.008	1808.094	4.758	5	1900	89.412	399.224
	500.501	sebelah	2.834	0.008	1793.064	4.719	5	1900	89.412	399.224
	507.032	sebelah	2.909	0.008	1840.162	4.843	5	1900	89.412	399.224
	434.952	sebelah	2.140	0.006	1354.154	3.564	4	1520	71.529	324.815
2	504.957	sebelah	2.885	0.008	1825.132	4.803	5	1900	89.412	399.224
	542.494	sebelah	2.796	0.008	1769.089	4.655	5	1900	89.412	399.224
	542.494	sebelah	2.735	0.008	1730.023	4.553	5	1900	89.412	399.224
	542.494	sebelah	2.855	0.008	1806.268	4.753	5	1900	89.412	399.224
	421.875	sebelah	2.014	0.006	1273.953	3.353	4	1520	71.529	324.815
3	497.802	sebelah	2.804	0.008	1773.774	4.668	5	1900	89.412	399.224
	497.853	sebelah	2.804	0.008	1774.140	4.669	5	1900	89.412	399.224
	491.399	sebelah	2.732	0.008	1728.441	4.549	5	1900	89.412	399.224
	503.195	sebelah	2.865	0.008	1812.414	4.770	5	1900	89.412	399.224
	419.845	sebelah	1.994	0.006	1261.723	3.320	4	1520	71.529	324.815
4	482.989	sebelah	2.639	0.007	1669.782	4.394	5	1900	89.412	399.224
	517.035	sebelah	3.025	0.008	1913.486	5.035	6	2280	107.294	470.914
	501.833	sebelah	2.849	0.008	1802.617	4.744	5	1900	89.412	399.224
	515.091	sebelah	3.002	0.008	1899.125	4.998	5	1900	89.412	399.224
	424.387	sebelah	2.038	0.006	1289.166	3.393	4	1520	71.529	324.815
5	500.085	sebelah	2.830	0.008	1790.082	4.711	5	1900	89.412	399.224
	508.572	sebelah	2.926	0.008	1851.358	4.872	5	1900	89.412	399.224
	520.256	sebelah	3.062	0.008	1937.400	5.098	6	2280	107.294	470.914
	513.322	sebelah	2.981	0.008	1886.103	4.963	5	1900	89.412	399.224
	484.000	sebelah	2.650	0.007	1676.780	4.413	5	1900	89.412	399.224

PERHITUNGAN TULANGAN RANGKAP PORTAL 5 - 5

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	B - C	400	650	570	396.88	290.73	496.1	363.413	0.0102	18.824	3.676	580.854

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	16.766	227.193	150.604	1.141	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	C - D	400	650	570	390.14	284.31	487.675	355.388	0.0102	18.824	3.676	575.901

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	8.341	227.193	74.924	0.568	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	D - E	400	650	570	389.14	296.84	486.425	371.050	0.0102	18.824	3.676	575.162

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	7.091	227.193	63.696	0.483	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

PERHITUNGAN TULANGAN GESER BALOK PORTAL 5 - 5

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	A - B	183.52	43.16	70.45	470.914	399.224	6.7	238.014	351.651	533.904	332.316	0	553.860	38.778	143	2P10-70
	B - C	182.91	43.08	66.72	470.914	399.224	6.55	237.290	353.529	517.514	333.298	0	555.497	38.664	143	2P10-70
	C - D	182.28	42.91	65.95	470.914	399.224	6.55	236.450	352.689	513.440	332.458	0	554.097	38.761	143	2P10-70
	D - E	183.21	43.21	65.20	470.914	399.224	6.55	237.741	353.981	511.581	333.750	0	556.249	38.611	143	2P10-70
	E - F	183.27	43.14	70.42	470.914	324.815	6.7	237.731	341.650	533.495	323.968	0	539.947	39.777	143	2P10-70
2	A - B	171.60	41.80	82.19	470.914	399.224	6.7	224.070	337.707	569.268	318.372	0	530.620	40.476	143	2P10-80
	B - C	177.74	43.34	98.50	542.494	399.224	6.55	232.134	357.936	645.834	336.041	0	560.068	38.348	143	2P10-70
	C - D	176.54	42.91	77.32	542.494	399.224	6.55	230.423	356.224	555.167	334.329	0	557.215	38.545	143	2P10-70
	D - E	176.83	43.25	76.74	542.494	399.224	6.55	231.084	356.886	553.392	334.991	0	558.318	38.468	143	2P10-70
	E - F	170.97	41.64	82.22	539.886	324.815	6.7	223.241	336.168	568.565	316.953	0	528.256	40.658	143	2P10-80
3	A - B	167.27	40.62	69.98	399.224	399.224	6.7	218.285	322.559	512.201	304.817	0	508.028	42.276	143	2P10-80
	B - C	178.37	43.48	65.57	470.914	399.224	6.55	232.943	349.182	508.337	328.951	0	548.252	39.175	143	2P10-70
	C - D	176.95	43.97	65.30	470.914	399.224	6.55	231.966	348.206	506.226	327.975	0	546.624	39.291	143	2P10-70
	D - E	177.63	43.42	64.98	470.914	399.224	6.55	232.103	348.342	505.019	328.111	0	546.852	39.275	143	2P10-70
	E - F	166.96	40.58	69.57	470.914	324.815	6.7	217.917	321.837	510.111	304.155	0	506.925	42.368	143	2P10-80
4	A - B	171.64	39.99	48.97	470.914	399.224	6.7	222.212	335.849	427.886	316.514	0	527.523	40.714	143	2P10-80
	B - C	186.43	43.76	55.85	470.914	470.914	6.55	241.700	367.516	476.270	345.618	0	576.031	37.286	143	2P10-70
	C - D	184.09	43.95	52.15	470.914	399.224	6.55	239.442	355.682	458.472	335.451	0	559.084	38.416	143	2P10-70
	D - E	184.00	43.55	52.13	470.914	399.224	6.55	238.928	355.167	457.874	334.936	0	558.227	38.475	143	2P10-70
	E - F	170.97	39.55	55.39	470.914	324.815	6.7	221.046	324.966	453.684	307.284	0	512.140	41.937	143	2P10-80
5	A - B	195.36	43.21	80.39	470.914	399.224	6.7	250.499	364.136	588.137	344.801	0	574.668	37.374	143	2P10-70
	B - C	193.92	43.59	24.80	539.886	399.224	6.55	249.386	374.839	353.546	353.004	0	588.341	36.505	143	2P10-70
	C - D	192.61	43.22	29.42	470.914	470.914	6.55	247.622	373.438	371.186	351.540	0	585.901	36.657	143	2P10-70
	D - E	196.34	43.05	28.75	470.914	399.224	6.55	251.360	367.599	372.110	347.368	0	578.947	37.098	143	2P10-70
	E - F	196.19	42.74	29.38	470.914	399.224	6.55	250.877	367.116	374.273	346.885	0	578.142	37.149	143	2P10-70

PERHITUNGAN TULANGAN GESER BALOK PORTAL 5 - 5

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	A - B	183.52	43.16	70.45	470.914	399.224	6.7	238.014	351.651	533.904	332.316	291.749	190	296.248	72.499	285	P10-70
	B - C	182.91	43.08	66.72	470.914	399.224	6.55	237.290	353.529	517.514	333.298	292.611	190	297.685	72.149	285	P10-70
	C - D	182.28	42.91	65.95	470.914	399.224	6.55	236.450	352.689	513.440	332.458	291.874	190	296.456	72.448	285	P10-70
	D - E	183.21	43.21	65.20	470.914	399.224	6.55	237.741	353.981	511.581	333.750	293.008	190	298.346	71.989	285	P10-70
	E - F	183.27	43.14	70.42	470.914	324.815	6.7	237.731	341.650	533.495	323.968	284.420	190	284.034	75.616	285	P10-70
2	A - B	171.60	41.80	82.19	470.914	399.224	6.7	224.070	337.707	569.268	318.372	279.507	190	275.845	77.861	285	P10-70
	B - C	177.74	43.34	98.50	542.494	399.224	6.55	232.134	357.936	645.834	336.041	295.019	190	301.698	71.189	285	P10-70
	C - D	176.54	42.91	77.32	542.494	399.224	6.55	230.423	356.224	555.167	334.329	293.516	190	299.194	71.785	285	P10-70
	D - E	176.83	43.25	76.74	542.494	399.224	6.55	231.084	356.886	553.392	334.991	294.097	190	300.162	71.553	285	P10-70
	E - F	170.97	41.64	82.22	539.886	324.815	6.7	223.241	336.168	568.565	316.953	278.262	190	273.770	78.451	285	P10-70
3	A - B	167.27	40.62	69.98	399.224	399.224	6.7	218.285	322.559	512.201	304.817	267.607	190	256.012	83.893	285	P10-80
	B - C	178.37	43.48	65.57	470.914	399.224	6.55	232.943	349.182	508.337	328.951	288.795	190	291.325	73.724	285	P10-70
	C - D	176.95	43.97	65.30	470.914	399.224	6.55	231.966	348.206	506.226	327.975	287.938	190	289.896	74.087	285	P10-70
	D - E	177.63	43.42	64.98	470.914	399.224	6.55	232.103	348.342	505.019	328.111	288.057	190	290.096	74.036	285	P10-70
	E - F	166.96	40.58	69.57	470.914	324.815	6.7	217.917	321.837	510.111	304.155	267.026	190	255.043	84.212	285	P10-80
4	A - B	171.64	39.99	48.97	470.914	399.224	6.7	222.212	335.849	427.886	316.514	277.876	190	273.126	78.636	285	P10-70
	B - C	186.43	43.76	55.85	470.914	470.914	6.55	241.700	367.516	476.270	345.618	303.427	190	315.712	68.029	285	P10-60
	C - D	184.09	43.95	52.15	470.914	399.224	6.55	239.442	355.682	458.472	335.451	294.501	190	300.835	71.393	285	P10-70
	D - E	184.00	43.55	52.13	470.914	399.224	6.55	238.928	355.167	457.874	334.936	294.049	190	300.082	71.572	285	P10-70
	E - F	170.97	39.55	55.39	470.914	324.815	6.7	221.046	324.966	453.684	307.284	269.773	190	259.621	82.727	285	P10-80
5	A - B	195.36	43.21	80.39	470.914	399.224	6.7	250.499	364.136	588.137	344.801	302.710	190	314.516	68.288	285	P10-60
	B - C	193.92	43.59	24.80	539.886	399.224	6.55	249.386	374.839	353.546	353.004	309.912	190	326.520	65.777	285	P10-60
	C - D	192.61	43.22	29.42	470.914	470.914	6.55	247.622	373.438	371.186	351.540	308.627	190	324.378	66.212	285	P10-60
	D - E	196.34	43.05	28.75	470.914	399.224	6.55	251.360	367.599	372.110	347.368	304.964	190	318.273	67.482	285	P10-60
	E - F	196.19	42.74	29.38	470.914	399.224	6.7	250.877	364.514	374.273	345.179	303.041	190	315.069	68.168	285	P10-60

PERHITUNGAN TULANGAN BALOK PORTAL 7 - 7

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	A - B	40/65	570	383.92	337.08	479.900	421.350	0.0102	18.824	3.676
	B - C	40/65	570	375.91	306.00	469.888	382.500	0.0102	18.824	3.676
	C - D	40/65	570	374.45	306.50	468.063	383.125	0.0102	18.824	3.676
	D - E	40/65	570	374.24	310.04	467.800	387.550	0.0102	18.824	3.676
	E - F	40/65	570	348.59	279.35	435.738	349.188	0.0102	18.824	3.676
2	A - B	40/65	570	383.72	321.89	479.650	402.363	0.0102	18.824	3.676
	B - C	40/65	570	400.13	293.30	500.163	366.625	0.0102	18.824	3.676
	C - D	40/65	570	393.93	290.35	492.413	362.938	0.0102	18.824	3.676
	D - E	40/65	570	391.85	297.84	489.813	372.300	0.0102	18.824	3.676
	E - F	40/65	570	399.95	255.43	499.938	319.288	0.0102	18.824	3.676
3	A - B	40/65	570	330.29	314.38	412.863	392.975	0.0102	18.824	3.676
	B - C	40/65	570	369.61	291.35	462.013	364.188	0.0102	18.824	3.676
	C - D	40/65	570	359.95	288.79	449.938	360.988	0.0102	18.824	3.676
	D - E	40/65	570	360.31	295.06	450.388	368.825	0.0102	18.824	3.676
	E - F	40/65	570	378.51	255.78	473.138	319.725	0.0102	18.824	3.676
4	A - B	40/65	570	289.63	180.29	362.038	225.363	0.0102	18.824	3.676
	B - C	40/65	570	351.38	292.81	439.225	366.013	0.0102	18.824	3.676
	C - D	40/65	570	337.03	295.14	421.288	368.925	0.0102	18.824	3.676
	D - E	40/65	570	334.70	307.35	418.375	384.188	0.0102	18.824	3.676
	E - F	40/65	570	361.43	268.15	451.788	335.188	0.0102	18.824	3.676
5	A - B	40/65	570	403.46	299.38	504.325	374.225	0.0102	18.824	3.676
	B - C	40/65	570	387.11	326.28	483.888	407.850	0.0102	18.824	3.676
	C - D	40/65	570	355.45	298.19	444.313	372.738	0.0102	18.824	3.676
	D - E	40/65	570	357.43	326.31	446.788	407.888	0.0102	18.824	3.676
	E - F	40/65	570	366.69	313.40	458.363	391.750	0.0102	18.824	3.676
ATAP	A - B	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-
	D - E	30/55	470	147.70	123.27	184.625	154.088	0.0102	18.824	3.676
	E - F	30/55	470	197.17	103.13	246.463	128.913	0.0102	18.824	3.676

Tulangan Tumpuan Portal 7 - 7									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
571.291	rangkap	-	-	-	-	-	-	-	542.494
565.300	sebelah	3.616	0.010	2287.408	6.019	7	2660	125.176	539.886
564.201	sebelah	3.602	0.010	2278.524	5.996	6	2280	107.294	470.914
564.043	sebelah	3.600	0.010	2277.246	5.993	6	2280	107.294	470.914
544.371	sebelah	3.353	0.009	2121.166	5.582	6	2280	107.294	470.914
571.142	rangkap	-	-	-	-	-	-	-	542.494
583.227	rangkap	-	-	-	-	-	-	-	542.494
578.691	rangkap	-	-	-	-	-	-	-	542.494
577.161	rangkap	-	-	-	-	-	-	-	542.494
583.096	rangkap	-	-	-	-	-	-	-	542.494
529.889	sebelah	3.177	0.009	2009.811	5.289	6	2280	107.294	470.914
560.543	sebelah	3.555	0.010	2249.073	5.919	6	2280	107.294	470.914
553.170	sebelah	3.462	0.010	2190.292	5.764	6	2280	107.294	470.914
553.446	sebelah	3.466	0.010	2192.483	5.770	6	2280	107.294	470.914
567.252	sebelah	3.641	0.010	2303.229	6.061	7	2660	125.176	539.886
496.203	sebelah	2.786	0.008	1762.395	4.638	5	1900	89.412	399.224
546.545	sebelah	3.380	0.009	2138.144	5.627	6	2280	107.294	470.914
535.268	sebelah	3.242	0.009	2050.824	5.397	6	2280	107.294	470.914
533.415	sebelah	3.219	0.009	2036.646	5.360	6	2280	107.294	470.914
554.306	sebelah	3.476	0.010	2199.298	5.788	6	2280	107.294	470.914
585.649	rangkap	-	-	-	-	-	-	-	542.494
573.660	rangkap	-	-	-	-	-	-	-	542.494
549.701	sebelah	3.419	0.009	2162.909	5.692	6	2280	107.294	470.914
551.230	sebelah	3.438	0.010	2174.958	5.724	6	2280	107.294	470.914
558.325	sebelah	3.527	0.010	2231.305	5.872	6	2280	107.294	470.914
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
354.346	sebelah	2.089	0.006	1089.977	2.868	3	1140	53.647	202.088
409.409	sebelah	2.789	0.008	1455.049	3.829	4	1520	71.529	264.015

lampiran 5.29

	Tulangan Lapangan Portal 7 - 7									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	535.308	sebelah	3.242	0.009	2051.128	5.398	6	2280	107.294	470.914
	510.033	sebelah	2.943	0.008	1862.007	4.900	5	1900	89.412	399.224
	510.449	sebelah	2.948	0.008	1865.049	4.908	5	1900	89.412	399.224
	513.388	sebelah	2.982	0.008	1886.590	4.965	5	1900	89.412	399.224
	487.317	sebelah	2.687	0.007	1699.842	4.473	5	1900	89.412	399.224
2	523.108	sebelah	3.096	0.009	1958.697	5.154	6	2280	107.294	470.914
	499.336	sebelah	2.821	0.008	1784.727	4.697	5	1900	89.412	399.224
	496.819	sebelah	2.793	0.008	1766.777	4.649	5	1900	89.412	399.224
	503.186	sebelah	2.865	0.008	1812.353	4.769	5	1900	89.412	399.224
	465.986	sebelah	2.457	0.007	1554.289	4.090	5	1900	89.412	399.224
3	516.969	sebelah	3.024	0.008	1912.999	5.034	6	2280	107.294	470.914
	497.674	sebelah	2.802	0.008	1772.862	4.665	5	1900	89.412	399.224
	495.483	sebelah	2.778	0.008	1757.284	4.624	5	1900	89.412	399.224
	500.832	sebelah	2.838	0.008	1795.437	4.725	5	1900	89.412	399.224
	466.306	sebelah	2.460	0.007	1556.419	4.096	5	1900	89.412	399.224
4	391.492	sebelah	1.734	0.005	1097.063	2.887	3	1140	53.647	247.688
	498.919	sebelah	2.816	0.008	1781.746	4.689	5	1900	89.412	399.224
	500.900	sebelah	2.839	0.008	1795.924	4.726	5	1900	89.412	399.224
	511.156	sebelah	2.956	0.008	1870.221	4.922	5	1900	89.412	399.224
	477.448	sebelah	2.579	0.007	1631.690	4.294	5	1900	89.412	399.224
5	504.485	sebelah	2.880	0.008	1821.724	4.794	5	1900	89.412	399.224
	526.663	sebelah	3.138	0.009	1985.410	5.225	6	2280	107.294	470.914
	503.482	sebelah	2.868	0.008	1814.483	4.775	5	1900	89.412	399.224
	526.687	sebelah	3.139	0.009	1985.593	5.225	6	2280	107.294	470.914
	516.163	sebelah	3.014	0.008	1907.036	5.019	6	2280	107.294	470.914
6	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	323.717	sebelah	1.744	0.005	909.692	2.394	3	1140	53.647	202.088
	296.094	sebelah	1.459	0.004	761.065	2.003	3	1140	53.647	202.088

PERHITUNGAN TULANGAN RANGKAP PORTAL 7 - 7

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
1	A - B	400	650	570	383.92	337.08	479.900	421.350	0.0102	18.824	3.676	571.291

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	0.566	227.19	5.084	0.039	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.0117	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	A - B	400	650	570	383.72	321.89	479.650	402.363	0.0102	18.824	3.676	571.142

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	0.316	227.19	2.838	0.021	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	B - C	400	650	570	400.13	293.30	500.163	366.625	0.0102	18.824	3.676	583.227

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	20.828	227.193	187.096	1.417	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	C - D	400	650	570	393.93	290.35	492.413	362.938	0.0102	18.824	3.676	578.691

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	13.078	227.193	117.480	0.890	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	D - E	400	650	570	391.85	297.84	489.813	372.300	0.0102	18.824	3.676	577.161

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	10.478	227.193	94.125	0.713	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	E - F	400	650	570	399.95	255.43	499.938	319.288	0.0102	18.824	3.676	583.096

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	20.603	227.193	185.075	1.402	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	A - B	400	650	570	403.46	299.38	504.325	374.225	0.0102	18.824	3.676	585.649

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	24.991	227.193	224.487	1.701	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.001	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	B - C	400	650	570	387.11	326.28	483.888	407.850	0.0102	18.824	3.676	573.660

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	4.553	227.193	40.902	0.310	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

PERHITUNGAN TULANGAN GESER BALOK PORTAL AS 7 - 7

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	A - B	184.43	43.28	75.39	542.494	470.914	6.55	239.096	374.474	555.734	350.912	0	584.854	36.723	142.5	2P10-70
	B - C	185.26	43.72	54.21	539.886	399.224	6.55	240.429	365.883	468.111	344.048	0	573.413	37.456	142.5	2P10-70
	C - D	184.60	43.69	54.71	470.914	399.224	6.55	239.705	355.944	469.487	335.713	0	559.522	38.386	142.5	2P10-70
	D - E	185.15	43.71	63.71	470.914	399.224	6.55	240.303	356.543	507.885	336.312	0	560.519	38.317	142.5	2P10-70
	E - F	183.99	43.25	74.60	470.914	399.224	6.55	238.602	354.842	551.922	334.611	0	557.684	38.512	142.5	2P10-70
2	A - B	173.62	42.50	89.07	542.494	470.914	6.55	226.926	362.305	601.020	338.743	0	564.571	38.042	142.5	2P10-70
	B - C	178.54	43.64	77.65	542.494	399.224	6.55	233.289	359.091	559.419	337.196	0	561.993	38.217	142.5	2P10-70
	C - D	178.32	43.42	77.20	542.494	399.224	6.55	232.827	358.629	557.067	336.734	0	561.223	38.269	142.5	2P10-70
	D - E	178.68	43.68	76.26	542.494	399.224	6.55	233.478	359.280	553.770	337.385	0	562.308	38.195	142.5	2P10-70
	E - F	174.12	42.53	88.66	542.494	399.224	6.55	227.483	353.284	599.855	331.389	0	552.315	38.886	142.5	2P10-70
3	A - B	176.04	43.20	74.28	470.914	470.914	6.55	230.202	356.019	542.178	334.121	0	556.868	38.569	142.5	2P10-70
	B - C	178.35	43.57	65.46	470.914	399.224	6.55	233.016	349.256	507.948	329.025	0	548.374	39.166	142.5	2P10-70
	C - D	178.16	43.27	65.39	470.914	399.224	6.55	232.502	348.741	507.140	328.510	0	547.517	39.227	142.5	2P10-70
	D - E	178.59	43.64	64.99	470.914	399.224	6.55	233.342	349.581	506.300	329.350	0	548.917	39.127	142.5	2P10-70
	E - F	176.85	43.25	74.25	539.886	399.224	6.55	231.105	356.559	542.955	334.724	0	557.873	38.499	142.5	2P10-70
4	A - B	184.19	43.79	54.79	399.224	247.688	6.55	239.379	325.799	469.497	310.758	0	517.929	41.468	142.5	2P10-80
	B - C	189.18	43.62	55.86	470.914	399.224	6.55	244.440	360.680	479.052	340.449	0	567.414	37.852	142.5	2P10-70
	C - D	183.96	43.08	53.14	470.914	399.224	6.55	238.392	354.632	461.580	334.401	0	557.334	38.536	142.5	2P10-70
	D - E	184.46	43.52	52.66	470.914	399.224	6.55	239.379	355.619	460.551	335.388	0	558.979	38.423	142.5	2P10-70
	E - F	184.80	43.75	59.48	470.914	399.224	6.55	239.978	356.217	489.794	335.986	0	559.977	38.354	142.5	2P10-70
5	A - B	196.80	42.59	70.75	542.494	399.224	6.55	251.360	377.161	548.510	355.266	0	592.11	36.273	142.5	2P10-70
	B - C	200.29	44.10	28.31	542.494	470.914	6.55	256.610	391.988	375.512	368.426	0	614.044	34.977	142.5	2P10-70
	C - D	200.44	42.52	31.32	470.914	399.224	6.55	255.108	371.348	386.652	351.117	0	585.194	36.702	142.5	2P10-70
	D - E	202.05	44.58	30.84	470.914	470.914	6.55	258.962	384.778	388.490	362.880	0	604.801	35.512	142.5	2P10-70
	E - F	193.29	42.87	34.41	470.914	470.914	6.55	247.968	373.785	392.490	351.887	0	586.478	36.621	142.5	2P10-70
ATAP	A - B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D - E	61.81	9.68	11.65	202.088	202.088	6.55	75.065	129.058	123.995	119.660	0	199.434	107.69	142.5	2P10-100
	E - F			2.94	264.015	202.088	6.55	75.233	137.408	112.781						

PERHITUNGAN TULANGAN GESER BALOK PORTAL AS 7 - 7

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	A - B	184.43	43.28	75.39	542.494	470.914	6.55	239.096	374.474	555.734	350.912	308.075	190	323.459	66.400	285	P10-60
	B - C	185.26	43.72	54.21	539.886	399.224	6.55	240.429	365.883	468.111	344.048	302.049	190	313.415	68.528	285	P10-60
	C - D	184.6	43.69	54.71	470.914	399.224	6.55	239.705	355.944	469.487	335.713	294.731	190	301.219	71.302	285	P10-70
	D - E	185.15	43.71	63.71	470.914	399.224	6.55	240.303	356.543	507.885	336.312	295.257	190	302.095	71.096	285	P10-70
	E - F	183.99	43.25	74.6	470.914	399.224	6.55	238.602	354.842	551.922	334.611	293.764	190	299.606	71.686	285	P10-70
2	A - B	173.62	42.5	89.07	542.494	470.914	6.55	226.926	362.305	601.020	338.743	297.391	190	305.652	70.268	285	P10-70
	B - C	178.54	43.64	77.65	542.494	399.224	6.55	233.289	359.091	559.419	337.196	296.033	190	303.388	70.792	285	P10-70
	C - D	178.32	43.42	77.2	542.494	399.224	6.55	232.827	358.629	557.067	336.734	295.627	190	302.712	70.951	285	P10-70
	D - E	178.68	43.68	76.26	542.494	399.224	6.55	233.478	359.280	553.770	337.385	296.199	190	303.665	70.728	285	P10-70
	E - F	174.12	42.53	88.66	542.494	399.224	6.55	227.483	353.284	599.855	331.389	290.935	190	294.892	72.832	285	P10-70
3	A - B	176.04	43.2	74.28	470.914	470.914	6.55	230.202	356.019	542.178	334.121	293.333	190	298.889	71.858	285	P10-70
	B - C	178.35	43.57	65.46	470.914	399.224	6.55	233.016	349.256	507.948	329.025	288.859	190	291.432	73.697	285	P10-70
	C - D	178.16	43.27	65.39	470.914	399.224	6.55	232.502	348.741	507.140	328.510	288.408	190	290.680	73.888	285	P10-70
	D - E	178.59	43.64	64.99	470.914	399.224	6.55	233.342	349.581	506.300	329.350	289.145	190	291.909	73.576	285	P10-70
	E - F	176.85	43.25	74.25	539.886	399.224	6.55	231.105	356.559	542.955	334.724	293.863	190	299.772	71.647	285	P10-70
4	A - B	184.19	43.79	54.79	399.224	247.688	6.55	239.379	325.799	469.497	310.758	272.822	190	264.704	81.138	285	P10-80
	B - C	189.18	43.62	55.86	470.914	399.224	6.55	244.440	360.680	479.052	340.449	298.889	190	308.148	69.699	285	P10-60
	C - D	183.96	43.08	53.14	470.914	399.224	6.55	238.392	354.632	461.580	334.401	293.579	190	299.299	71.760	285	P10-70
	D - E	184.46	43.52	52.66	470.914	399.224	6.55	239.379	355.619	460.551	335.388	294.446	190	300.743	71.415	285	P10-70
	E - F	184.8	43.75	59.48	470.914	399.224	6.55	239.978	356.217	489.794	335.986	294.971	190	301.619	71.208	285	P10-70
5	A - B	196.8	42.59	70.75	542.494	399.224	6.55	251.360	377.161	548.510	355.266	311.898	190	329.829	65.117	285	P10-60
	B - C	200.29	44.1	28.31	542.494	470.914	6.55	256.610	391.988	375.512	368.426	323.451	190	349.085	61.525	285	P10-60
	C - D	200.44	42.52	31.32	470.914	399.224	6.55	255.108	371.348	386.652	351.117	308.255	190	323.758	66.338	285	P10-60
	D - E	202.05	44.58	30.84	470.914	470.914	6.55	258.962	384.778	388.490	362.880	318.582	190	340.970	62.990	285	P10-60
	E - F	193.29	42.87	34.41	470.914	470.914	6.55	247.968	373.785	392.490	351.887	308.931	190	324.885	66.108	285	P10-60
ATAP	A - B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B - C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C - D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D - E	61.81	9.68	11.65	202.088	202.088	6.55	75.065	129.058	123.995	119.660	105.053	190	-14.912	-1440.3	285	P10-280
	E - F	[illegible]	[illegible]	8.94	264.015	202.088	6.55	75.233	137.498	112.781	126.661	111.199	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PERHITUNGAN TULANGAN BALOK PORTAL 8 - 8

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	A - B	40/65	570	306.27	267.28	382.838	334.100	0.0102	18.824	3.676
	B - C	40/65	570	288.78	233.49	360.975	291.863	0.0102	18.824	3.676
	C - D	40/65	570	288.24	236.20	360.300	295.250	0.0102	18.824	3.676
	D - E	40/65	570	288.50	235.00	360.625	293.750	0.0102	18.824	3.676
	E - F	40/65	570	290.23	244.03	362.788	305.038	0.0102	18.824	3.676
2	A - B	40/65	570	311.66	261.14	389.575	326.425	0.0102	18.824	3.676
	B - C	40/65	570	318.65	228.06	398.313	285.075	0.0102	18.824	3.676
	C - D	40/65	570	315.53	228.36	394.413	285.450	0.0102	18.824	3.676
	D - E	40/65	570	314.41	230.00	393.013	287.500	0.0102	18.824	3.676
	E - F	40/65	570	336.88	232.84	421.100	291.050	0.0102	18.824	3.676
3	A - B	40/65	570	283.09	258.52	353.863	323.150	0.0102	18.824	3.676
	B - C	40/65	570	290.08	229.23	362.600	286.538	0.0102	18.824	3.676
	C - D	40/65	570	284.18	228.73	355.225	285.913	0.0102	18.824	3.676
	D - E	40/65	570	283.65	230.00	354.563	287.500	0.0102	18.824	3.676
	E - F	40/65	570	307.67	235.93	384.588	294.913	0.0102	18.824	3.676
4	A - B	40/65	570	345.08	265.00	431.350	331.250	0.0102	18.824	3.676
	B - C	40/65	570	258.61	237.95	323.263	297.438	0.0102	18.824	3.676
	C - D	40/65	570	251.83	236.14	314.788	295.175	0.0102	18.824	3.676
	D - E	40/65	570	250.74	240.00	313.425	300.000	0.0102	18.824	3.676
	E - F	40/65	570	275.57	246.64	344.463	308.300	0.0102	18.824	3.676
5	A - B	40/65	570	309.98	285.79	387.475	357.238	0.0102	18.824	3.676
	B - C	40/65	570	328.88	251.44	411.100	314.300	0.0102	18.824	3.676
	C - D	40/65	570	311.72	253.88	389.650	317.350	0.0102	18.824	3.676
	D - E	40/65	570	315.55	251.96	394.438	314.950	0.0102	18.824	3.676
	E - F	40/65	570	320.28	270.27	400.350	337.838	0.0102	18.824	3.676
ATAP	A - B	30/55	470	52.44	5.79	65.550	7.234	0.0102	18.824	3.676
	B - C	30/55	470	74.43	23.29	93.038	29.109	0.0102	18.824	3.676
	C - D	30/55	470	89.85	14.25	112.313	17.813	0.0102	18.824	3.676
	D - E	30/55	470	194.38	118.75	242.975	148.438	0.0102	18.824	3.676
	E - F	30/55	470	195.12	103.75	243.900	129.688	0.0102	18.824	3.676

lampiran 5.36

Tulangan Tumpuan Portal 8 - 8									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
510.258	sebelah	2.946	0.008	1863.650	4.904	5	1900	89.412	399.224
495.474	sebelah	2.778	0.008	1757.223	4.624	5	1900	89.412	399.224
495.010	sebelah	2.772	0.008	1753.937	4.616	5	1900	89.412	399.224
495.234	sebelah	2.775	0.008	1755.519	4.620	5	1900	89.412	399.224
496.716	sebelah	2.792	0.008	1766.046	4.647	5	1900	89.412	399.224
514.728	sebelah	2.998	0.008	1896.448	4.991	5	1900	89.412	399.224
520.468	sebelah	3.065	0.009	1938.982	5.103	6	2280	107.294	470.914
517.914	sebelah	3.035	0.008	1919.997	5.053	6	2280	107.294	470.914
516.994	sebelah	3.024	0.008	1913.182	5.035	6	2280	107.294	470.914
535.149	sebelah	3.240	0.009	2049.911	5.395	6	2280	107.294	470.914
490.568	sebelah	2.723	0.008	1722.600	4.533	5	1900	89.412	399.224
496.588	sebelah	2.790	0.008	1765.134	4.645	5	1900	89.412	399.224
491.512	sebelah	2.733	0.008	1729.232	4.551	5	1900	89.412	399.224
491.053	sebelah	2.728	0.008	1726.007	4.542	5	1900	89.412	399.224
511.423	sebelah	2.959	0.008	1872.169	4.927	5	1900	89.412	399.224
541.623	sebelah	3.319	0.009	2099.808	5.526	6	2280	107.294	470.914
468.878	sebelah	2.487	0.007	1573.639	4.141	5	1900	89.412	399.224
462.691	sebelah	2.422	0.007	1532.383	4.033	5	1900	89.412	399.224
461.689	sebelah	2.412	0.007	1525.750	4.015	5	1900	89.412	399.224
484.009	sebelah	2.651	0.007	1676.841	4.413	5	1900	89.412	399.224
513.339	sebelah	2.981	0.008	1886.225	4.964	5	1900	89.412	399.224
528.757	sebelah	3.163	0.009	2001.231	5.266	6	2280	107.294	470.914
514.778	sebelah	2.998	0.008	1896.813	4.992	5	1900	89.412	399.224
517.930	sebelah	3.035	0.008	1920.118	5.053	6	2280	107.294	470.914
521.798	sebelah	3.081	0.009	1948.900	5.129	6	2280	107.294	470.914
211.139	sebelah	0.742	0.002	386.990	1.018	2	760	35.765	137.444
251.542	sebelah	1.053	0.003	549.269	1.445	2	760	35.765	137.444
276.373	sebelah	1.271	0.004	663.063	1.745	2	760	35.765	137.444
406.502	sebelah	2.750	0.008	1434.460	3.775	4	1520	71.529	264.015
407.275	sebelah	2.760	0.008	1439.921	3.789	4	1520	71.529	264.015

lampiran 5.37

	Tulangan Lapangan Portal 8 - 8									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	476.673	sebelah	2.571	0.007	1626.396	4.280	5	1900	89.412	399.224
	445.524	sebelah	2.246	0.006	1420.784	3.739	4	1520	71.529	324.815
	448.102	sebelah	2.272	0.006	1437.274	3.782	4	1520	71.529	324.815
	446.963	sebelah	2.260	0.006	1429.973	3.763	4	1520	71.529	324.815
	455.469	sebelah	2.347	0.007	1484.920	3.908	4	1520	71.529	324.815
2	471.166	sebelah	2.512	0.007	1589.034	4.182	5	1900	89.412	399.224
	440.313	sebelah	2.194	0.006	1387.743	3.652	4	1520	71.529	324.815
	440.603	sebelah	2.196	0.006	1389.568	3.657	4	1520	71.529	324.815
	442.182	sebelah	2.212	0.006	1399.548	3.683	4	1520	71.529	324.815
	444.904	sebelah	2.240	0.006	1416.829	3.728	4	1520	71.529	324.815
3	468.796	sebelah	2.487	0.007	1573.091	4.140	5	1900	89.412	399.224
	441.441	sebelah	2.205	0.006	1394.862	3.671	4	1520	71.529	324.815
	440.960	sebelah	2.200	0.006	1391.820	3.663	4	1520	71.529	324.815
	442.182	sebelah	2.212	0.006	1399.548	3.683	4	1520	71.529	324.815
	447.846	sebelah	2.269	0.006	1435.632	3.778	4	1520	71.529	324.815
4	474.635	sebelah	2.549	0.007	1612.522	4.243	5	1900	89.412	399.224
	449.759	sebelah	2.289	0.006	1447.923	3.810	4	1520	71.529	324.815
	448.045	sebelah	2.271	0.006	1436.909	3.781	4	1520	71.529	324.815
	451.693	sebelah	2.308	0.006	1460.397	3.843	4	1520	71.529	324.815
	457.898	sebelah	2.372	0.007	1500.802	3.949	4	1520	71.529	324.815
5	492.902	sebelah	2.749	0.008	1739.029	4.576	5	1900	89.412	399.224
	462.333	sebelah	2.418	0.007	1530.010	4.026	5	1900	89.412	399.224
	464.570	sebelah	2.442	0.007	1544.857	4.065	5	1900	89.412	399.224
	462.810	sebelah	2.423	0.007	1533.174	4.035	5	1900	89.412	399.224
	479.332	sebelah	2.600	0.007	1644.590	4.328	5	1900	89.412	399.224
6	70.143	sebelah	0.082	0.000	42.710	0.112	2	760	35.765	137.444
	140.701	sebelah	0.329	0.001	171.854	0.452	2	760	35.765	137.444
	110.064	sebelah	0.202	0.001	105.160	0.277	2	760	35.765	137.444
	317.727	sebelah	1.680	0.005	876.336	2.306	3	1140	53.647	202.088
	296.983	sebelah	1.468	0.004	765.641	2.015	3	1140	53.647	202.088

PERHITUNGAN TULANGAN GESER BALOK PORTAL AS 8 - 8

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b paka	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	A - B	124.63	21.29	70.52	399.224	399.224	6.55	153.216	259.879	449.400	241.315	0	402.191	53.402	142.500	2P10-100
	B - C	120.64	20.6	64.74	399.224	324.815	6.55	148.302	245.025	420.210	228.191	0	380.318	56.473	142.500	2P10-100
	C - D	120.71	20.61	64.69	399.224	324.815	6.55	148.386	245.109	420.084	228.275	0	380.458	56.452	142.500	2P10-100
	D - E	120.51	20.57	64.14	399.224	324.815	6.55	148.134	244.857	417.522	228.023	0	380.038	56.514	142.500	2P10-100
	E - F	124.44	51.52	69.47	399.224	324.815	6.55	184.758	281.481	476.532	264.647	0	441.078	48.693	142.500	2P10-80
2	A - B	117.18	20.98	84.02	399.224	399.224	6.55	145.068	251.731	497.952	233.167	0	388.611	55.268	142.500	2P10-100
	B - C	115.38	20.69	77.79	470.914	324.815	6.55	142.874	249.173	469.592	230.672	0	384.454	55.865	142.500	2P10-100
	C - D	116.01	20.74	77.85	470.914	324.815	6.55	143.588	249.887	470.558	231.386	0	385.644	55.693	142.500	2P10-100
	D - E	115.99	20.75	77.41	470.914	324.815	6.55	143.577	249.877	468.699	231.376	0	385.626	55.695	142.500	2P10-100
	E - F	116.88	20.98	83.35	470.914	324.815	6.55	144.753	251.053	494.823	232.552	0	387.586	55.414	142.500	2P10-100
3	A - B	118.02	21.28	70.82	399.224	399.224	6.55	146.265	252.928	443.709	234.364	0	390.606	54.985	142.500	2P10-100
	B - C	115.94	20.78	67.03	399.224	324.815	6.55	143.556	240.279	425.082	223.445	0	372.408	57.672	142.500	2P10-100
	C - D	116.52	20.86	66.69	399.224	324.815	6.55	144.249	240.972	424.347	224.138	0	373.563	57.494	142.500	2P10-100
	D - E	116.52	20.9	64.48	399.224	324.815	6.55	144.291	241.014	415.107	224.18	0	373.633	57.483	142.500	2P10-100
	E - F	118.84	21.41	69.97	399.224	324.815	6.55	147.263	243.985	441.137	227.151	0	378.585	56.731	142.500	2P10-100
4	A - B	124.18	21.52	54.76	470.914	399.224	6.55	152.985	269.225	382.977	248.994	0	414.989	51.755	142.500	2P10-100
	B - C	121.3	20.81	52.36	399.224	324.815	6.55	149.216	245.938	369.128	229.104	0	381.840	56.248	142.500	2P10-100
	C - D	125.15	20.95	52.15	399.224	324.815	6.55	153.405	250.128	372.435	233.294	0	388.823	55.238	142.500	2P10-100
	D - E	122.36	21.02	52.05	399.224	324.815	6.55	150.549	247.272	369.159	230.438	0	384.063	55.922	142.500	2P10-100
	E - F	124.97	21.62	34.22	399.224	324.815	6.55	153.92	250.642	297.644	233.808	0	389.680	55.116	142.500	2P10-100
5	A - B	133.18	21.31	34.47	399.224	399.224	6.55	162.215	268.877	306.989	250.313	0	417.188	51.482	142.500	2P10-100
	B - C	131.7	20.82	35.27	470.914	399.224	6.55	160.146	276.386	308.280	256.155	0	426.924	50.308	142.500	2P10-100
	C - D	133.92	21.24	34.6	399.224	399.224	6.55	162.918	269.581	308.238	251.017	0	418.361	51.337	142.500	2P10-100
	D - E	133.91	21.25	34.8	470.914	399.224	6.55	162.918	279.158	309.078	258.927	0	431.544	49.769	142.500	2P10-80
	E - F	134.3	21.43	35.35	470.914	399.224	6.55	163.517	279.756	311.987	259.525	0	432.542	49.654	142.500	2P10-80
ATAP	A - B	27.55	1.59	21.52	137.444	137.444	6.55	30.597	67.319	120.981	60.9274	0	101.546	211.51	142.500	2P10-100
	B - C	22.41	0.08	15.31	137.444	137.444	6.55	23.6145	60.336	87.917	53.9449	0	89.908	238.88	142.500	P10-100
	C - D	23.48	0.31	15.4	137.444	137.444	6.55	24.9795	61.701	89.660	55.3099	0	92.183	232.99	142.500	P10-100
	D - E	39.53	8.92	15.35	264.015	202.088	6.55	50.8725	113.138	115.343	102.301	0	170.502	125.97	142.500	P10-100
	E - F	59.24	3.66	15.58	264.015	202.088	6.55	71.295	133.561	136.731	122.724	0				

PERHITUNGAN TULANGAN GESER BALOK PORTAL AS 8 - 8

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	A - B	124.63	21.29	70.52	399.224	399.224	6.55	153.216	259.879	449.400	241.315	211.856	190	163.094	131.688	285	P10-130
	B - C	120.64	20.60	64.74	399.224	324.815	6.55	148.302	245.025	420.210	228.191	200.334	190	143.891	149.263	285	P10-140
	C - D	120.71	20.61	64.69	399.224	324.815	6.55	148.386	245.109	420.084	228.275	200.408	190	144.014	149.136	285	P10-140
	D - E	120.51	20.57	64.14	399.224	324.815	6.55	148.134	244.857	417.522	228.023	200.187	190	143.645	149.519	285	P10-140
	E - F	124.44	51.52	69.47	399.224	324.815	6.55	184.758	281.481	476.532	264.647	232.340	190	197.234	108.894	285	P10-100
2	A - B	117.18	20.98	84.02	399.224	399.224	6.55	145.068	251.731	497.952	233.167	204.703	190	151.172	142.074	285	P10-140
	B - C	115.38	20.69	77.79	470.914	324.815	6.55	142.874	249.173	469.592	230.672	202.513	190	147.522	145.589	285	P10-140
	C - D	116.01	20.74	77.85	470.914	324.815	6.55	143.588	249.887	470.558	231.386	203.140	190	148.567	144.565	285	P10-140
	D - E	115.99	20.75	77.41	470.914	324.815	6.55	143.577	249.877	468.699	231.376	203.131	190	148.551	144.580	285	P10-140
	E - F	116.88	20.98	83.35	470.914	324.815	6.55	144.753	251.053	494.823	232.552	204.163	190	150.272	142.925	285	P10-140
3	A - B	118.02	21.28	70.82	399.224	399.224	6.55	146.265	252.928	443.709	234.364	205.754	190	152.923	140.447	285	P10-140
	B - C	115.94	20.78	67.03	399.224	324.815	6.55	143.556	240.279	425.082	223.445	196.168	190	136.946	156.832	285	P10-150
	C - D	116.52	20.86	66.69	399.224	324.815	6.55	144.249	240.972	424.347	224.138	196.776	190	137.960	155.679	285	P10-150
	D - E	116.52	20.90	64.48	399.224	324.815	6.55	144.291	241.014	415.107	224.180	196.813	190	138.022	155.610	285	P10-150
	E - F	118.84	21.41	69.97	399.224	324.815	6.55	147.263	243.985	441.137	227.151	199.422	190	142.370	150.858	285	P10-150
4	A - B	124.18	21.52	54.76	470.914	399.224	6.55	152.985	269.225	382.977	248.994	218.598	190	174.330	123.201	285	P10-120
	B - C	121.30	20.81	52.36	399.224	324.815	6.55	149.216	245.938	369.128	229.104	201.136	190	145.227	147.889	285	P10-140
	C - D	125.15	20.95	52.15	399.224	324.815	6.55	153.405	250.128	372.435	233.294	204.815	190	151.358	141.900	285	P10-140
	D - E	122.36	21.02	52.05	399.224	324.815	6.55	150.549	247.272	369.159	230.438	202.307	190	147.179	145.929	285	P10-140
	E - F	124.97	21.62	34.22	399.224	324.815	6.55	153.920	250.642	297.644	233.808	205.266	190	152.110	141.197	285	P10-140
5	A - B	133.18	21.31	34.47	399.224	399.224	6.55	162.215	268.877	306.989	250.313	219.756	190	176.261	121.851	285	P10-120
	B - C	131.70	20.82	35.27	470.914	399.224	6.55	160.146	276.386	308.280	256.155	224.885	190	184.808	116.216	285	P10-110
	C - D	133.92	21.24	34.60	399.224	399.224	6.55	162.918	269.581	308.238	251.017	220.374	190	177.290	121.144	285	P10-120
	D - E	133.91	21.25	34.80	470.914	399.224	6.55	162.918	279.158	309.078	258.927	227.319	190	188.864	113.720	285	P10-110
	E - F	134.30	21.43	35.35	470.914	399.224	6.55	163.517	279.756	311.987	259.525	227.844	190	189.740	113.195	285	P10-110
ATAP	A - B	27.55	1.59	21.52	137.444	137.444	6.55	30.597	67.319	120.981	60.927	53.490	190	-100.85	-212.96	285	P10-200
	B - C	22.41	0.08	15.31	137.444	137.444	6.55	23.615	60.336	87.917	53.945	47.360	190	-111.07	-193.37	285	P10-200
	C - D	23.48	0.31	15.40	137.444	137.444	6.55	24.980	61.701	89.660	55.310	48.558	190	-109.07	-196.92	285	P10-200
	D - E	39.53	8.92	15.35	264.015	202.088	6.55	50.873	113.138	115.343	102.301	89.813	190	-40.312	-532.79	285	P10-200
	E - F	59.24	8.66	15.58	264.015	202.088	6.55	71.295	133.561	136.731	122.724	107.742	190	-10.429			

Lampiran 5.40

PERHITUNGAN TULANGAN BALOK PORTAL A - A

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	0 - 1	40/65	570	323.700	132.890	404.625	166.113	0.0102	18.824	3.676
	1 - 2	40/65	570	290.271	178.326	362.839	222.908	0.0102	18.824	3.676
	2 - 3	40/65	570	323.182	257.533	403.978	321.916	0.0102	18.824	3.676
	3 - 4	40/65	570	319.854	256.216	399.818	320.270	0.0102	18.824	3.676
	4 - 5	40/65	570	318.848	254.440	398.560	318.050	0.0102	18.824	3.676
	5 - 6	40/65	570	316.616	251.491	395.770	314.364	0.0102	18.824	3.676
	6 - 7	40/65	570	289.661	177.572	362.076	221.965	0.0102	18.824	3.676
	7 - 8	40/65	570	321.396	133.704	401.745	167.130	0.0102	18.824	3.676
2	0 - 1	40/65	570	358.256	127.713	447.820	159.641	0.0102	18.824	3.676
	1 - 2	40/65	570	366.572	247.126	458.215	308.908	0.0102	18.824	3.676
	2 - 3	40/65	570	405.932	341.491	507.415	426.864	0.0102	18.824	3.676
	3 - 4	40/65	570	400.784	340.432	500.980	425.540	0.0102	18.824	3.676
	4 - 5	40/65	570	398.177	336.614	497.721	420.768	0.0102	18.824	3.676
	5 - 6	40/65	570	396.058	371.906	495.073	464.883	0.0102	18.824	3.676
	6 - 7	40/65	570	370.525	251.943	463.156	314.929	0.0102	18.824	3.676
	7 - 8	40/65	570	360.032	128.054	450.040	160.068	0.0102	18.824	3.676
3	0 - 1	40/65	570	336.153	128.661	420.191	160.826	0.0102	18.824	3.676
	1 - 2	40/65	570	329.449	219.597	411.811	274.496	0.0102	18.824	3.676
	2 - 3	40/65	570	361.089	297.103	451.361	371.379	0.0102	18.824	3.676
	3 - 4	40/65	570	355.016	294.668	443.770	368.335	0.0102	18.824	3.676
	4 - 5	40/65	570	350.793	289.289	438.491	361.611	0.0102	18.824	3.676
	5 - 6	40/65	570	346.896	282.941	433.620	353.676	0.0102	18.824	3.676
	6 - 7	40/65	570	335.847	225.893	419.809	282.366	0.0102	18.824	3.676
	7 - 8	40/65	570	340.649	130.159	425.811	162.699	0.0102	18.824	3.676
4	0 - 1	40/65	570	302.849	134.331	378.561	167.914	0.0102	18.824	3.676
	1 - 2	40/65	570	185.790	90.607	232.238	113.259	0.0102	18.824	3.676
	2 - 3	40/65	570	293.896	227.308	367.370	284.135	0.0102	18.824	3.676
	3 - 4	40/65	570	287.825	224.872	359.781	281.090	0.0102	18.824	3.676
	4 - 5	40/65	570	281.830	217.853	352.288	272.316	0.0102	18.824	3.676
	5 - 6	40/65	570	277.617	210.157	347.021	262.696	0.0102	18.824	3.676
	6 - 7	40/65	570	276.879	168.640	346.099	210.800	0.0102	18.824	3.676
	7 - 8	40/65	570	313.856	135.753	392.320	169.691	0.0102	18.824	3.676
5	0 - 1	40/65	570	193.254	96.050	241.568	120.063	0.0102	18.824	3.676
	1 - 2	40/65	570	185.790	90.607	232.238	113.259	0.0102	18.824	3.676
	2 - 3	40/65	570	212.669	148.158	265.836	185.198	0.0102	18.824	3.676
	3 - 4	40/65	570	205.101	134.921	256.376	168.651	0.0102	18.824	3.676
	4 - 5	40/65	570	198.772	129.004	248.465	161.255	0.0102	18.824	3.676
	5 - 6	40/65	570	192.088	120.484	240.110	150.605	0.0102	18.824	3.676
	6 - 7	40/65	570	197.208	81.409	246.510	101.761	0.0102	18.824	3.676
	7 - 8	40/65	570	271.916	151.407	339.895	189.259	0.0102	18.824	3.676
ATAP	0 - 1	30/55	470	90.734	22.683	113.418	28.354	0.0102	18.824	3.676
	1 - 2	30/55	470	89.838	48.578	112.298	60.723	0.0102	18.824	3.676
	2 - 3	30/55	470	108.648	89.853	135.810	112.316	0.0102	18.824	3.676
	3 - 4	30/55	470	98.228	87.589	122.785	109.486	0.0102	18.824	3.676
	4 - 5	30/55	470	90.982	77.415	113.728	96.769	0.0102	18.824	3.676
	5 - 6	30/55	470	93.632	72.756	117.040	90.945	0.0102	18.824	3.676
	6 - 7	30/55	470	105.230	74.228	131.538	92.785	0.0102	18.824	3.676
	7 - 8	30/55	470	84.934	14.421	106.168	18.026	0.0102	18.824	3.676

	Tulangan Tumpuan Portal A - A									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	524.576	sebelah	3.113	0.009	1969.711	5.183	6	2280	107.294	470.914
	496.751	sebelah	2.792	0.008	1766.296	4.648	5	1900	89.412	399.224
	524.156	sebelah	3.108	0.009	1966.559	5.175	6	2280	107.294	470.914
	521.451	sebelah	3.076	0.009	1946.308	5.122	6	2280	107.294	470.914
	520.630	sebelah	3.067	0.009	1940.187	5.106	6	2280	107.294	470.914
	518.804	sebelah	3.045	0.008	1926.605	5.070	6	2280	107.294	470.914
	496.229	sebelah	2.786	0.008	1762.584	4.638	5	1900	89.412	399.224
	522.706	sebelah	3.091	0.009	1955.691	5.147	6	2280	107.294	470.914
2	551.866	sebelah	3.446	0.010	2179.984	5.737	6	2280	107.294	470.914
	558.235	sebelah	3.526	0.010	2230.587	5.870	6	2280	107.294	470.914
	587.441	rangkap	-	-	-	-	-	-	-	542.494
	583.704	rangkap	-	-	-	-	-	-	-	542.494
	581.802	rangkap	-	-	-	-	-	-	-	542.494
	580.252	rangkap	-	-	-	-	-	-	-	542.494
	561.237	sebelah	3.564	0.010	2254.641	5.933	6	2280	107.294	470.914
	553.233	sebelah	3.463	0.010	2190.791	5.765	6	2280	107.294	470.914
3	534.571	sebelah	3.233	0.009	2045.487	5.383	6	2280	107.294	470.914
	529.214	sebelah	3.169	0.009	2004.694	5.276	6	2280	107.294	470.914
	554.044	sebelah	3.473	0.010	2197.223	5.782	6	2280	107.294	470.914
	549.365	sebelah	3.415	0.009	2160.269	5.685	6	2280	107.294	470.914
	546.088	sebelah	3.374	0.009	2134.572	5.617	6	2280	107.294	470.914
	543.046	sebelah	3.337	0.009	2110.858	5.555	6	2280	107.294	470.914
	534.328	sebelah	3.230	0.009	2043.625	5.378	6	2280	107.294	470.914
	538.134	sebelah	3.276	0.009	2072.846	5.455	6	2280	107.294	470.914
4	507.400	sebelah	2.913	0.008	1842.833	4.850	5	1900	89.412	399.224
	397.419	sebelah	1.787	0.005	1130.530	2.975	3	1140	53.647	247.688
	499.844	sebelah	2.827	0.008	1788.354	4.706	5	1900	89.412	399.224
	494.654	sebelah	2.768	0.008	1751.412	4.609	5	1900	89.412	399.224
	489.475	sebelah	2.711	0.008	1714.933	4.513	5	1900	89.412	399.224
	485.803	sebelah	2.670	0.007	1689.297	4.446	5	1900	89.412	399.224
	485.157	sebelah	2.663	0.007	1684.806	4.434	5	1900	89.412	399.224
	516.538	sebelah	3.019	0.008	1909.810	5.026	6	2280	107.294	470.914
5	405.323	sebelah	1.859	0.005	1175.949	3.095	4	1520	71.529	324.815
	397.419	sebelah	1.787	0.005	1130.530	2.975	3	1140	53.647	247.688
	425.196	sebelah	2.046	0.006	1294.089	3.405	4	1520	71.529	324.815
	417.562	sebelah	1.973	0.005	1248.037	3.284	4	1520	71.529	324.815
	411.069	sebelah	1.912	0.005	1209.526	3.183	4	1520	71.529	324.815
	404.099	sebelah	1.848	0.005	1168.853	3.076	4	1520	71.529	324.815
	409.449	sebelah	1.897	0.005	1200.009	3.158	4	1520	71.529	324.815
	480.789	sebelah	2.615	0.007	1654.606	4.354	5	1900	89.412	399.224
6	277.730	sebelah	1.284	0.004	669.587	1.762	2 4	760	35.765	137.444
	276.355	sebelah	1.271	0.004	662.975	1.745	2 4	760	35.765	137.444
	303.912	sebelah	1.537	0.004	801.786	2.110	3 5	1140	53.647	202.088
	288.971	sebelah	1.390	0.004	724.890	1.908	2 4	760	35.765	137.444
	278.109	sebelah	1.287	0.004	671.417	1.767	2 4	760	35.765	137.444
	282.130	sebelah	1.325	0.004	690.973	1.818	2 4	760	35.765	137.444
	299.094	sebelah	1.489	0.004	776.562	2.044	2 4	760	35.765	137.444
	268.706	sebelah	1.202	0.003	626.785	1.649	2 4	760	35.765	137.444

Tulangan Lapangan Portal A - A									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
336.112	sebelah	1.278	0.004	808.634	2.128	3	1140	53.647	247.688
389.354	sebelah	1.715	0.005	1085.112	2.856	4	1520	71.529	324.815
467.901	sebelah	2.477	0.007	1567.086	4.124	5	1900	89.412	399.224
466.703	sebelah	2.464	0.007	1559.072	4.103	5	1900	89.412	399.224
465.082	sebelah	2.447	0.007	1548.265	4.074	5	1900	89.412	399.224
462.379	sebelah	2.419	0.007	1530.320	4.027	5	1900	89.412	399.224
388.530	sebelah	1.708	0.005	1080.524	2.843	3	1140	53.647	247.688
337.139	sebelah	1.286	0.004	813.587	2.141	3	1140	53.647	247.688
329.500	sebelah	1.228	0.003	777.132	2.045	3	1140	53.647	247.688
458.349	sebelah	2.377	0.007	1503.759	3.957	4	1520	71.529	324.815
538.799	sebelah	3.285	0.009	2077.969	5.468	6	2280	107.294	470.914
537.963	sebelah	3.274	0.009	2071.525	5.451	6	2280	107.294	470.914
534.938	sebelah	3.238	0.009	2048.293	5.390	6	2280	107.294	470.914
562.282	sebelah	3.577	0.010	2263.044	5.955	6	2280	107.294	470.914
462.795	sebelah	2.423	0.007	1533.070	4.034	5	1900	89.412	399.224
329.939	sebelah	1.232	0.003	779.207	2.051	3	1140	53.647	247.688
330.720	sebelah	1.238	0.003	782.901	2.060	3	1140	53.647	247.688
432.066	sebelah	2.112	0.006	1336.245	3.516	3	1140	53.647	247.688
502.563	sebelah	2.858	0.008	1807.869	4.758	5	1900	89.412	399.224
500.500	sebelah	2.834	0.008	1793.052	4.719	5	1900	89.412	399.224
495.910	sebelah	2.782	0.008	1760.320	4.632	5	1900	89.412	399.224
490.439	sebelah	2.721	0.008	1721.693	4.531	5	1900	89.412	399.224
438.216	sebelah	2.173	0.006	1374.557	3.617	4	1520	71.529	324.815
332.640	sebelah	1.252	0.003	792.016	2.084	3	1140	53.647	247.688
337.929	sebelah	1.292	0.004	817.403	2.151	3	1140	53.647	247.688
277.535	sebelah	0.871	0.002	551.343	1.451	2	760	35.765	167.844
439.587	sebelah	2.186	0.006	1383.167	3.640	4	1520	71.529	324.815
437.225	sebelah	2.163	0.006	1368.344	3.601	4	1520	71.529	324.815
430.347	sebelah	2.095	0.006	1325.633	3.489	4	1520	71.529	324.815
422.678	sebelah	2.021	0.006	1278.803	3.365	4	1520	71.529	324.815
378.632	sebelah	1.622	0.005	1026.173	2.700	3	1140	53.647	247.688
339.713	sebelah	1.306	0.004	826.056	2.174	3	1140	53.647	247.688
285.750	sebelah	0.924	0.003	584.463	1.538	2	760	35.765	167.844
277.535	sebelah	0.871	0.002	551.343	1.451	2	760	35.765	167.844
354.895	sebelah	1.425	0.004	901.540	2.372	3	1140	53.647	247.688
338.670	sebelah	1.298	0.004	820.993	2.161	3	1140	53.647	247.688
331.161	sebelah	1.241	0.003	784.988	2.066	3	1140	53.647	247.688
320.038	sebelah	1.159	0.003	733.144	1.929	2	760	35.765	167.844
263.071	sebelah	0.783	0.002	495.373	1.304	2	760	35.765	167.844
358.765	sebelah	1.456	0.004	921.310	2.424	3	1140	53.647	247.688
138.863	sebelah	0.321	0.001	167.393	0.441	2	760	35.765	137.444
203.216	sebelah	0.687	0.002	358.490	0.943	2	760	35.765	137.444
276.378	sebelah	1.271	0.004	663.085	1.745	3	1140	53.647	202.088
272.874	sebelah	1.239	0.003	646.378	1.701	3	1140	53.647	202.088
256.537	sebelah	1.095	0.003	571.297	1.503	2	760	35.765	137.444
248.698	sebelah	1.029	0.003	536.915	1.413	2	760	35.765	137.444
251.201	sebelah	1.050	0.003	547.778	1.442	2	760	35.765	137.444
110.722	sebelah	0.204	0.001	106.422	0.280	2	760	35.765	137.444

PERHITUNGAN TULANGAN RANGKAP PORTAL A - A

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	2 - 3	400	650	570	405.932	341.491	507.415	426.864	0.0102	18.824	3.676	587.441

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	28.081	227.193	252.244	1.911	2	264	2589.600	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	3 - 4	400	650	570	400.784	340.432	500.980	425.540	0.0102	18.824	3.676	583.704

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	21.646	227.193	194.440	1.473	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	4 - 5	400	650	570	398.177	336.619	497.721	420.774	0.0102	18.824	3.676	581.802

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	18.387	227.193	165.167	1.251	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	5 - 6	400	650	570	396.058	371.906	495.073	464.883	0.0102	18.824	3.676	580.252

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	15.738	227.193	141.374	1.071	2	264	2589.600	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

A - A

PERHITUNGAN TULANGAN GESER BALOK PORTAL A - A

lampiran 5.45

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	0 - 1	122.58	20.90	37.99	470.914	247.688	6.55	150.654	246.650	310.212	229.943	0	383.238	56.042	142.5	2P10-100
	1 - 2	51.02	7.36	128.27	399.224	324.815	3.1	61.299	265.665	600.033	190.511	0	317.518	67.642	142.5	P10-60
	2 - 3	51.24	7.60	148.39	470.914	399.224	3.25	61.782	296.050	685.020	213.876	0	356.460	60.253	142.5	P10-60
	3 - 4	49.96	7.30	148.58	470.914	399.224	3.25	60.123	294.391	684.159	212.217	0	353.695	60.724	142.5	P10-60
	4 - 5	49.93	7.34	148.10	470.914	399.224	3.25	60.134	294.401	682.154	212.227	0	353.712	60.721	142.5	P10-60
	5 - 6	49.47	7.31	146.98	470.914	399.224	3.25	59.619	293.887	676.935	211.713	0	352.855	60.868	142.5	P10-60
	6 - 7	49.44	7.09	126.27	399.224	247.688	3.1	59.357	241.953	589.691	174.804	0	291.341	73.720	142.5	P10-70
	7 - 8	120.46	20.83	36.96	470.914	247.688	6.55	148.355	244.351	303.587	227.643	0	379.405	56.609	142.5	2P10-100
2	0 - 1	116.13	20.92	46.96	470.914	247.688	6.55	143.903	239.899	341.135	223.191	0	371.985	57.738	142.5	2P10-100
	1 - 2	48.45	7.48	157.09	470.914	324.815	3.1	58.727	283.327	718.505	200.732	0	334.554	64.198	142.5	P10-60
	2 - 3	53.93	8.57	186.65	542.494	470.914	3.25	65.625	338.466	849.555	242.761	0	404.602	53.083	142.5	2P10-100
	3 - 4	51.09	7.95	188.27	542.494	470.914	3.25	61.992	334.833	852.726	239.128	0	398.547	53.890	142.5	2P10-100
	4 - 5	50.30	7.90	187.82	542.494	470.914	3.25	61.110	333.951	849.954	238.246	0	397.077	54.089	142.5	2P10-100
	5 - 6	50.44	8.02	185.44	542.494	470.914	3.25	61.383	334.224	840.231	238.519	0	397.532	54.027	142.5	2P10-100
	6 - 7	52.13	8.20	155.44	470.914	399.224	3.1	63.347	308.950	716.195	218.631	0	364.385	58.942	142.5	2P10-100
	7 - 8	117.18	21.38	46.04	470.914	247.688	6.55	145.488	241.484	338.856	224.777	0	374.628	57.330	142.5	2P10-100
3	0 - 1	116.19	20.98	41.70	470.914	247.688	6.55	144.029	240.025	319.169	223.317	0	372.195	57.705	142.5	2P10-100
	1 - 2	53.37	8.50	134.20	470.914	247.688	3.1	64.964	267.795	628.604	193.205	0	322.009	66.699	142.5	P10-60
	2 - 3	57.44	9.26	158.75	470.914	399.224	3.25	70.035	304.303	736.785	222.129	0	370.215	58.014	142.5	2P10-100
	3 - 4	53.15	8.26	161.72	470.914	399.224	3.25	64.481	298.748	743.705	216.574	0	360.957	59.502	142.5	2P10-100
	4 - 5	51.61	8.19	161.27	470.914	399.224	3.25	62.790	297.058	740.124	214.884	0	358.140	59.970	142.5	2P10-100
	5 - 6	52.09	8.37	157.52	470.914	399.224	3.25	63.483	297.751	725.067	215.577	0	359.295	59.777	142.5	2P10-100
	6 - 7	58.15	9.38	132.29	470.914	324.815	3.1	70.907	295.507	626.525	212.912	0	354.854	60.525	142.5	P10-60
	7 - 8	118.27	21.38	40.48	470.914	247.688	6.55	146.633	242.629	316.649	225.921	0	376.535	57.040	142.5	2P10-100
4	0 - 1	122.12	20.85	21.81	399.224	247.688	6.55	150.119	236.538	241.721	221.497	0	369.162	58.179	142.5	2P10-100
	1 - 2	55.55	8.30	97.78	247.688	167.844	3.1	67.043	184.330	477.719	141.198	0	235.331	91.266	142.5	P10-90
	2 - 3	62.11	9.78	119.48	399.224	324.815	3.25	75.485	270.418	577.301	202.041	0	336.736	63.782	142.5	P10-60
	3 - 4	57.01	8.36	123.50	399.224	324.815	3.25	68.639	263.572	587.339	195.195	0	325.326	66.019	142.5	P10-60
	4 - 5	54.66	8.37	123.23	399.224	324.815	3.25	66.182	261.115	583.748	192.738	0	321.231	66.860	142.5	P10-60
	5 - 6	54.91	8.45	119.24	399.224	324.815	3.25	66.528	261.461	567.336	193.085	0	321.808	66.740	142.5	P10-60
	6 - 7	63.58	10.05	97.82	399.224	247.688	3.1	77.312	259.908	488.156	192.759	0	321.266	66.853	142.5	P10-60
	7 - 8	123.61	21.53	31.49	470.914	247.688	6.55	152.397	248.393	284.655	231.686	0	386.143	55.621	142.5	2P10-100
5	0 - 1	96.84	10.01	19.21	324.815	167.844	6.55	112.193	178.006	192.875	166.551	0	277.585	77.373	142.5	P10-70
	1 - 2	59.51	7.81	58.46	247.688	167.844	3.1	70.686	187.973	316.218	144.842	0	241.403	88.970	142.5	P10-80
	2 - 3	65.84	8.17	72.96	324.815	247.688	3.25	77.711	231.846	384.143	177.780	0	296.300	72.486	142.5	P10-70
	3 - 4	61.88	8.59	77.90	324.815	247.688	3.25	73.994	228.129	401.174	174.063	0	290.105	74.034	142.5	P10-70
	4 - 5	58.46	8.27	78.15	324.815	247.688	3.25	70.067	224.202	398.297	170.136	0	283.560	75.743	142.5	P10-70
	5 - 6	59.29	8.36	73.49	324.815	167.844	3.25	71.033	203.671	379.691	157.146	0	261.910	82.004	142.5	P10-80
	6 - 7	64.39	9.44	57.33	324.815	167.844	3.1	77.522	216.578	318.308	165.441	0	275.736	77.892	142.5	P10-70
	7 - 8	133.20	21.26	20.66	399.224	247.688	6.55	162.183	248.603	248.955	233.562	0	389.269	55.174	142.5	2P10-100
ATAP	0 - 1	22.68	0.49	13.93	137.444	137.444	6.55	24.329	61.050	82.835	55.780	0	92.967	190.494	117.5	P10-110
	1 - 2	25.45	3.15	19.68	137.444	137.444	3.1	30.030	107.619	112.686	84.092	0	140.154	126.358	117.5	P10-110
	2 - 3	25.97	3.02	33.84	202.088	202.088	3.25	30.440	139.256	172.568	107.783	0	179.639	98.585	117.5	P10-90
	3 - 4	22.00	1.68	37.22	137.444	202.088	3.25	24.864	116.277	181.188	89.837	0	149.729	118.278	117.5	P10-110
	4 - 5	17.12	1.30	36.88	137.444	137.444	3.25	19.341	93.349	174.237	71.944	0	119.906	147.695	117.5	P10-110
	5 - 6	20.38	1.96	33.29	137.444	137.444	3.25	23.457	97.465	163.275	76.060	0	126.766	139.703	117.5	P10-110
	6 - 7	33.14	4.95	20.71	137.444	137.444	3.1	39.995	117.584	126.977	94.057	0	156.761	112.979	117.5	

PORTAL A - A

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	0 - 1	122.58	20.90	37.99	470.914	247.688	6.55	150.654	246.650	310.212	229.943	201.873	190	146.455	146.650	285	P10-140
	1 - 2	51.02	7.36	128.27	399.224	324.815	3.1	61.299	265.665	600.033	190.511	167.255	190	88.758	241.981	285	P10-240
	2 - 3	51.24	7.60	148.39	470.914	399.224	3.25	61.782	296.050	685.020	213.876	187.767	190	122.945	174.692	285	P10-170
	3 - 4	49.96	7.30	148.58	470.914	399.224	3.25	60.123	294.391	684.159	212.217	186.311	190	120.518	178.211	285	P10-170
	4 - 5	49.93	7.34	148.10	470.914	399.224	3.25	60.134	294.401	682.154	212.227	186.320	190	120.533	178.188	285	P10-170
	5 - 6	49.47	7.31	146.98	470.914	399.224	3.25	59.619	293.887	676.935	211.713	185.868	190	119.780	179.308	285	P10-170
	6 - 7	49.44	7.09	126.27	399.224	247.688	3.1	59.357	241.953	589.691	174.804	153.465	190	65.776	326.53	285	P10-280
	7 - 8	120.46	20.83	36.96	470.914	247.688	6.55	148.355	244.351	303.587	227.643	199.854	190	143.090	150.099	285	P10-150
2	0 - 1	116.13	20.92	46.96	470.914	247.688	6.55	143.903	239.899	341.135	223.191	195.945	190	136.576	157.258	285	P10-150
	1 - 2	48.45	7.48	157.09	470.914	324.815	3.1	58.727	283.327	718.505	200.732	176.228	190	103.714	207.086	285	P10-200
	2 - 3	53.93	8.57	186.65	542.494	470.914	3.25	65.625	338.466	849.555	242.761	213.127	190	165.211	130.001	285	P10-130
	3 - 4	51.09	7.95	188.27	542.494	470.914	3.25	61.992	334.833	852.726	239.128	209.937	190	159.895	134.323	285	P10-130
	4 - 5	50.30	7.90	187.82	542.494	470.914	3.25	61.110	333.951	849.954	238.246	209.163	190	158.605	135.416	285	P10-130
	5 - 6	50.44	8.02	185.44	542.494	470.914	3.25	61.383	334.224	840.231	238.519	209.403	190	159.004	135.076	285	P10-130
	6 - 7	52.13	8.20	155.44	470.914	399.224	3.1	63.347	308.950	716.195	218.631	191.942	190	129.903	165.335	285	P10-160
	7 - 8	117.18	21.38	46.04	470.914	247.688	6.55	145.488	241.484	338.856	224.777	197.337	190	138.896	154.631	285	P10-150
3	0 - 1	116.19	20.98	41.70	470.914	247.688	6.55	144.029	240.025	319.169	223.317	196.056	190	136.760	157.046	285	P10-150
	1 - 2	53.37	8.50	134.20	470.914	247.688	3.1	64.964	267.795	628.604	193.205	169.620	190	92.700	231.689	285	P10-230
	2 - 3	57.44	9.26	158.75	470.914	399.224	3.25	70.035	304.303	736.785	222.129	195.013	190	135.021	159.068	285	P10-150
	3 - 4	53.15	8.26	161.72	470.914	399.224	3.25	64.481	298.748	743.705	216.574	190.136	190	126.894	169.256	285	P10-160
	4 - 5	51.61	8.19	161.27	470.914	399.224	3.25	62.790	297.058	740.124	214.884	188.652	190	124.420	172.621	285	P10-170
	5 - 6	52.09	8.37	157.52	470.914	399.224	3.25	63.483	297.751	725.067	215.577	189.261	190	125.434	171.226	285	P10-170
	6 - 7	58.15	9.38	132.29	470.914	324.815	3.1	70.907	295.507	626.525	212.912	186.921	190	121.535	176.719	285	P10-170
	7 - 8	118.27	21.38	40.48	470.914	247.688	6.55	146.633	242.629	316.649	225.921	198.342	190	140.570	152.789	285	P10-150
4	0 - 1	122.12	20.85	21.81	399.224	247.688	6.55	150.119	236.538	241.721	221.497	194.458	190	134.097	160.165	285	P10-160
	1 - 2	55.55	8.30	97.78	247.688	167.844	3.1	67.043	184.330	477.719	141.198	123.962	190	16.603	1293.602	285	P10-280
	2 - 3	62.11	9.78	119.48	399.224	324.815	3.25	75.485	270.418	577.301	202.041	177.377	190	105.629	203.331	285	P10-200
	3 - 4	57.01	8.36	123.50	399.224	324.815	3.25	68.639	263.572	587.339	195.195	171.367	190	95.612	224.633	285	P10-220
	4 - 5	54.66	8.37	123.23	399.224	324.815	3.25	66.182	261.115	583.748	192.738	169.210	190	92.017	233.410	285	P10-230
	5 - 6	54.91	8.45	119.24	399.224	324.815	3.25	66.528	261.461	567.336	193.085	169.514	190	92.524	232.131	285	P10-230
	6 - 7	63.58	10.05	97.82	399.224	247.688	3.1	77.312	259.908	488.156	192.759	169.229	190	92.048	233.331	285	P10-230
	7 - 8	123.61	21.53	31.49	470.914	247.688	6.55	152.397	248.393	284.655	231.686	203.403	190	149.005	144.140	285	P10-140
5	0 - 1	96.84	10.01	19.21	324.815	167.844	6.55	112.193	178.006	192.875	166.551	146.220	190	53.699	399.959	285	P10-280
	1 - 2	59.51	7.81	58.46	247.688	167.844	3.1	70.686	187.973	316.218	144.842	127.160	190	21.934	979.185	285	P10-280
	2 - 3	65.84	8.17	72.96	324.815	247.688	3.25	77.711	231.846	384.143	177.780	156.078	190	70.130	306.256	285	P10-280
	3 - 4	61.88	8.59	77.90	324.815	247.688	3.25	73.994	228.129	401.174	174.063	152.815	190	64.691	332.003	285	P10-280
	4 - 5	58.46	8.27	78.15	324.815	247.688	3.25	70.067	224.202	398.297	170.136	149.367	190	58.945	364.367	285	P10-280
	5 - 6	59.29	8.36	73.49	324.815	167.844	3.25	71.033	203.671	379.691	157.146	137.962	190	39.937	537.782	285	P10-280
	6 - 7	64.39	9.44	57.33	324.815	167.844	3.1	77.522	216.578	318.308	165.441	145.245	190	52.076	412.431	285	P10-280
	7 - 8	133.20	21.26	20.66	399.224	247.688	6.55	162.183	248.603	248.955	233.562	205.050	190	151.750	141.533	285	P10-140
A~AP	0 - 1	22.68	0.49	13.93	137.444	137.444	6.55	24.329	61.050	82.835	55.780	48.971	190	-108.38	-198.166	285	P10-190
	1 - 2	25.45	3.15	19.68	137.444	137.444	3.1	30.030	107.619	112.686	84.092	73.827	190	-66.96	-320.775	285	P10-280
	2 - 3	25.97	3.02	33.84	202.088	202.088	3.25	30.440	139.256	172.568	107.783	94.626	190	-32.290	-665.137	285	P10-280
	3 - 4	22.00	1.68	37.22	137.444	202.088	3.25	24.864	116.277	181.188	89.837	78.870	190	-58.549	-366.830	285	P10-280
	4 - 5	17.12	1.30	36.88	137.444	137.444	3.25	19.341	93.349	174.237	71.944	63.161	190	-84.73	-253.479	285	P10-250
	5 - 6	20.38	1.96	33.29	137.444	137.444	3.25	23.457	97.465	163.275	76.060	66.775	190	-78.71	-272.875	285	P10-270
	6 - 7	33.14	4.95	20.71	137.444	137.444	3.1	39.995	117.584	126.977	94.057	82.575	190				

PERHITUNGAN TULANGAN BALOK PORTAL B - B

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	0 - 1	40/65	570	376.843	319.695	471.054	399.619	0.0102	18.824	3.676
	1 - 3	40/65	570	363.952	291.013	454.940	363.766	0.0102	18.824	3.676
	3 - 5	40/65	570	358.936	294.864	448.670	368.580	0.0102	18.824	3.676
	5 - 7	40/65	570	318.158	159.079	397.698	198.849	0.0102	18.824	3.676
	7 - 8	40/65	570	367.488	319.623	459.360	399.529	0.0102	18.824	3.676
2	0 - 1	40/65	570	382.077	311.490	477.596	389.363	0.0102	18.824	3.676
	1 - 3	40/65	570	364.730	239.826	455.913	299.783	0.0102	18.824	3.676
	3 - 5	40/65	570	377.410	286.563	471.763	358.204	0.0102	18.824	3.676
	5 - 7	40/65	570	370.376	233.149	462.970	291.436	0.0102	18.824	3.676
	7 - 8	40/65	570	378.826	289.556	473.533	361.945	0.0102	18.824	3.676
3	0 - 1	40/65	570	367.944	261.503	459.930	326.879	0.0102	18.824	3.676
	1 - 3	40/65	570	344.849	298.766	431.061	373.458	0.0102	18.824	3.676
	3 - 5	40/65	570	350.475	297.115	438.094	371.394	0.0102	18.824	3.676
	5 - 7	40/65	570	339.278	278.145	424.098	347.681	0.0102	18.824	3.676
	7 - 8	40/65	570	352.411	296.060	440.514	370.075	0.0102	18.824	3.676
4	0 - 1	40/65	570	323.012	313.119	403.765	391.399	0.0102	18.824	3.676
	1 - 3	40/65	570	344.849	298.766	431.061	373.458	0.0102	18.824	3.676
	3 - 5	40/65	570	350.475	297.115	438.094	371.394	0.0102	18.824	3.676
	5 - 7	40/65	570	339.278	281.361	424.098	351.701	0.0102	18.824	3.676
	7 - 8	40/65	570	352.411	296.060	440.514	370.075	0.0102	18.824	3.676
5	0 - 3	30/120	1120	889.821	612.639	1112.276	765.799	0.0102	18.824	3.676
	3 - 5	40/65	570	412.035	393.673	515.044	492.091	0.0102	18.824	3.676
	5 - 7	40/65	570	435.275	318.318	544.094	397.898	0.0102	18.824	3.676
	7 - 8	40/65	570	432.881	351.402	541.101	439.253	0.0102	18.824	3.676

	Tulangan Tumpuan Portal B - B									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	566.001	sebelah	3.625	0.010	2293.086	6.034	7	2660	125.176	539.886
	556.236	sebelah	3.501	0.010	2214.644	5.828	6	2280	107.294	470.914
	552.390	sebelah	3.452	0.010	2184.122	5.748	6	2280	107.294	470.914
	520.066	sebelah	3.060	0.008	1935.988	5.095	6	2280	107.294	470.914
	558.932	sebelah	3.535	0.010	2236.161	5.885	6	2280	107.294	470.914
2	569.918	sebelah	3.675	0.010	2324.934	6.118	7	2660	125.176	539.886
	556.830	sebelah	3.508	0.010	2219.378	5.840	6	2280	107.294	470.914
	566.427	sebelah	3.630	0.010	2296.536	6.044	7	2660	125.176	539.886
	561.124	sebelah	3.562	0.010	2253.734	5.931	6	2280	107.294	470.914
	567.489	sebelah	3.644	0.010	2305.152	6.066	7	2660	125.176	539.886
3	559.278	sebelah	3.539	0.010	2238.935	5.892	6	2280	107.294	470.914
	541.442	sebelah	3.317	0.009	2098.403	5.522	6	2280	107.294	470.914
	545.841	sebelah	3.371	0.009	2132.637	5.612	6	2280	107.294	470.914
	537.050	sebelah	3.263	0.009	2064.503	5.433	6	2280	107.294	470.914
	547.346	sebelah	3.390	0.009	2144.417	5.643	6	2280	107.294	470.914
4	524.018	sebelah	3.107	0.009	1965.525	5.172	6	2280	107.294	470.914
	541.442	sebelah	3.317	0.009	2098.403	5.522	6	2280	107.294	470.914
	545.841	sebelah	3.371	0.009	2132.637	5.612	6	2280	107.294	470.914
	537.050	sebelah	3.263	0.009	2064.503	5.433	6	2280	107.294	470.914
5	547.346	sebelah	3.390	0.009	2144.417	5.643	6	2280	107.294	470.914
	869.738	sebelah	2.217	0.006	2755.620	7.252	8	3040	143.059	1274.940
	591.840	rangkap	-	-	-	-	-	-	-	683.983
	608.302	rangkap	-	-	-	-	-	-	-	614.130
	606.627	rangkap	-	-	-	-	-	-	-	686.261

Tulangan Lapangan Portal B - B									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
521.321	sebelah	3.075	0.009	1945.341	5.119	6	2280	107.294	470.914
497.386	sebelah	2.799	0.008	1770.811	4.660	5	1900	89.412	399.224
500.666	sebelah	2.836	0.008	1794.244	4.722	5	1900	89.412	399.224
367.742	sebelah	1.530	0.004	967.994	2.547	3	1140	53.647	247.688
521.262	sebelah	3.074	0.009	1944.903	5.118	6	2280	107.294	470.914
514.588	sebelah	2.996	0.008	1895.413	4.988	5	1900	89.412	399.224
451.529	sebelah	2.307	0.006	1459.339	3.840	4	1520	71.529	324.815
493.568	sebelah	2.756	0.008	1743.733	4.589	5	1900	89.412	399.224
445.199	sebelah	2.243	0.006	1418.709	3.733	4	1520	71.529	324.815
496.139	sebelah	2.785	0.008	1761.945	4.637	5	1900	89.412	399.224
471.493	sebelah	2.515	0.007	1591.243	4.187	5	1900	89.412	399.224
503.968	sebelah	2.874	0.008	1817.988	4.784	5	1900	89.412	399.224
502.573	sebelah	2.858	0.008	1807.942	4.758	5	1900	89.412	399.224
486.265	sebelah	2.675	0.007	1692.509	4.454	5	1900	89.412	399.224
501.680	sebelah	2.848	0.008	1801.522	4.741	5	1900	89.412	399.224
515.931	sebelah	3.012	0.008	1905.326	5.014	6	2280	107.294	470.914
503.968	sebelah	2.874	0.008	1817.988	4.784	5	1900	89.412	399.224
502.573	sebelah	2.858	0.008	1807.942	4.758	5	1900	89.412	399.224
489.068	sebelah	2.706	0.008	1712.079	4.505	5	1900	89.412	399.224
501.680	sebelah	2.848	0.008	1801.522	4.741	5	1900	89.412	399.224
721.672	sebelah	1.526	0.004	1897.236	4.993	5	1900	89.412	817.224
578.502	rangkap	-	-	-	-	-	-	-	683.983
520.197	sebelah	3.062	0.008	1936.962	5.09727	6	2280	107.294	470.914
546.562	sebelah	3.380	0.009	2138.277	5.62705	6	2280	107.294	470.914

lampiran 5.50

PERHITUNGAN TULANGAN RANGKAP PORTAL B - B

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	3 - 5	400	650	570	412.035	-393.673	515.044	-492.091	0.0102	18.824	3.676	591.84

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D16)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	35.710	227.193	320.771	1.604	2	760	3085.6	8.120	9	3420

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.015	0.0033	0.012	274.060	136.437	581.923	102.060	683.983

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	3 - 5	400	650	570	393.673	412.035	492.091	515.044	0.0102	18.824	3.676	578.502

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	12.757	227.193	114.595	0.868	2	760	3085.6	8.120	9	3420

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.015	0.0033	0.012	274.06	136.437	581.923	102.060	683.983

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	5 - 7	400	650	570	435.275	318.318	544.094	397.898	0.0102	18.824	3.676	608.302

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D16)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	64.760	227.193	581.72	2.909	3	600	2925.6	7.699	8	3040

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.0133	0.0026	0.011	244.672	125.788	542.196	71.934	614.130

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	7 - 8	400	650	570	432.881	351.402	541.101	439.253	0.0102	18.824	3.676	606.627

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D16)	As' ada	As tarik	As pakai	n D22)	As ada
2325.6	109.44	479.334	61.767	227.193	554.839	2.774	3	1140	3465.6	9.12	9	3420

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.015	0.005	0.01	219.737	131.471	563.516	122.745	686.261

B - B

PERHITUNGAN TULANGAN GESER BALOK PORTAL B - B

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	0 - 1	193.66	20.90	37.99	539.886	470.914	6.55	225.288	360.319	384.846	336.817	0	561.362	38.260	142.5	2P10-60
	1 - 3	187.41	7.36	128.27	470.914	399.224	6.55	204.509	320.748	743.243	300.517	0	500.862	42.881	142.5	2P10-80
	3 - 5	187.40	7.60	148.39	470.914	399.224	6.55	204.750	320.990	827.988	300.759	0	501.264	42.847	142.5	2P10-80
	5 - 7	191.43	7.30	148.58	470.914	247.688	6.55	208.667	304.663	832.703	287.955	0	479.925	44.752	142.5	2P10-80
	7 - 8	180.34	7.34	148.10	470.914	470.914	6.55	197.064	322.881	819.084	300.983	0	501.638	42.815	142.5	2P10-80
2	0 - 1	184.21	7.31	146.98	539.886	399.224	6.55	201.096	326.550	818.412	304.715	0	507.858	42.291	142.5	2P10-80
	1 - 3	168.70	7.09	126.27	470.914	324.815	6.55	184.580	290.879	714.914	272.378	0	453.964	47.311	142.5	2P10-80
	3 - 5	181.14	20.83	36.96	539.886	399.224	6.55	212.069	337.522	367.301	315.687	0	526.146	40.821	142.5	2P10-80
	5 - 7	177.79	20.92	46.96	470.914	324.815	6.55	208.646	314.945	405.878	296.444	0	494.074	43.470	142.5	2P10-80
	7 - 8	180.34	7.48	157.09	539.886	399.224	6.55	197.211	322.665	856.989	300.830	0	501.383	42.837	142.5	2P10-80
3	0 - 1	184.77	8.57	186.65	470.914	399.224	6.55	203.007	319.247	986.937	299.016	0	498.359	43.097	142.5	2P10-80
	1 - 3	184.58	7.95	188.27	470.914	399.224	6.55	202.157	318.396	992.891	298.165	0	496.942	43.220	142.5	2P10-80
	3 - 5	179.84	7.90	187.82	470.914	399.224	6.55	197.127	313.367	985.971	293.136	0	488.559	43.961	142.5	2P10-80
	5 - 7	176.93	8.02	185.44	470.914	399.224	6.55	194.198	310.437	973.046	290.206	0	483.677	44.405	142.5	2P10-80
	7 - 8	181.34	8.20	155.44	470.914	399.224	6.55	199.017	315.257	851.865	295.026	0	491.709	43.679	142.5	2P10-80
4	0 - 1	189.91	21.38	46.04	470.914	470.914	6.55	221.855	347.671	415.223	325.773	0	542.956	39.557	142.5	2P10-60
	1 - 3	191.62	20.98	41.70	470.914	399.224	6.55	223.230	339.470	398.370	319.239	0	532.064	40.367	142.5	2P10-60
	3 - 5	187.79	8.50	134.20	470.914	399.224	6.55	206.105	322.344	769.745	302.113	0	503.522	42.655	142.5	2P10-80
	5 - 7	184.18	9.26	158.75	470.914	399.224	6.55	203.112	319.352	869.862	299.121	0	498.534	43.081	142.5	2P10-80
	7 - 8	188.94	8.26	161.72	470.914	399.224	6.55	207.060	323.300	886.284	303.069	0	505.114	42.520	142.5	2P10-80
5	0 - 3	253.71	39.74	41.92	1274.940	817.224	7.90	308.119	539.846	484.179	506.407	0	844.012	25.447	142.5	3P10-60
	3 - 5	220.53	9.38	132.29	683.983	683.983	6.55	241.406	424.149	797.024	392.343	0	653.906	32.845	142.5	2P10-60
	5 - 7	198.22	21.38	40.48	614.130	470.914	6.55	230.580	375.529	400.596	350.301	0	583.835	36.787	142.5	2P10-60
	7 - 8	204.86	20.85	21.81	686.261	470.914	6.55	236.996	391.580	328.598	364.675	0	607.792	35.337	142.5	2P10-60

PORTAL B - B

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	0 - 1	193.66	20.90	37.99	539.886	470.914	6.55	225.288	360.319	384.846	336.817	295.701	190	302.834	70.922	285	P10-70
	1 - 3	187.41	7.36	128.27	470.914	399.224	6.55	204.509	320.748	743.243	300.517	263.832	190	249.720	86.007	285	P10-80
	3 - 5	187.40	7.60	148.39	470.914	399.224	6.55	204.750	320.990	827.988	300.759	264.044	190	250.073	85.885	285	P10-80
	5 - 7	191.43	7.30	148.58	470.914	247.688	6.55	208.667	304.663	832.703	287.955	252.803	190	231.339	92.840	285	P10-90
	7 - 8	180.34	7.34	148.10	470.914	470.914	6.55	197.064	322.881	819.084	300.983	264.241	190	250.401	85.773	285	P10-80
2	0 - 1	184.21	7.31	146.98	539.886	399.224	6.55	201.096	326.550	818.412	304.715	267.517	190	255.862	83.942	285	P10-80
	1 - 3	168.70	7.09	126.27	470.914	324.815	6.55	184.580	290.879	714.914	272.378	239.128	190	208.547	102.987	285	P10-90
	3 - 5	181.14	20.83	36.96	539.886	399.224	6.55	212.069	337.522	367.301	315.687	277.150	190	271.917	78.986	285	P10-70
	5 - 7	177.79	20.92	46.96	470.914	324.815	6.55	208.646	314.945	405.878	296.444	260.256	190	243.760	88.110	285	P10-80
	7 - 8	180.34	7.48	157.09	539.886	399.224	6.55	197.211	322.665	856.989	300.830	264.107	190	250.178	85.849	285	P10-80
3	0 - 1	184.77	8.57	186.65	470.914	399.224	6.55	203.007	319.247	986.937	299.016	262.514	190	247.523	86.770	285	P10-80
	1 - 3	184.58	7.95	188.27	470.914	399.224	6.55	202.157	318.396	992.891	298.165	261.767	190	246.279	87.209	285	P10-80
	3 - 5	179.84	7.90	187.82	470.914	399.224	6.55	197.127	313.367	985.971	293.136	257.352	190	238.919	89.895	285	P10-80
	5 - 7	176.93	8.02	185.44	470.914	399.224	6.55	194.198	310.437	973.046	290.206	254.780	190	234.633	91.537	285	P10-90
	7 - 8	181.34	8.20	155.44	470.914	399.224	6.55	199.017	315.257	851.865	295.026	259.011	190	241.685	88.866	285	P10-80
4	0 - 1	189.91	21.38	46.04	470.914	470.914	6.55	221.855	347.671	415.223	325.773	286.005	190	286.675	74.920	285	P10-70
	1 - 3	191.62	20.98	41.70	470.914	399.224	6.55	223.230	339.470	398.370	319.239	280.268	190	277.113	77.505	285	P10-70
	3 - 5	187.79	8.50	134.20	470.914	399.224	6.55	206.105	322.344	769.745	302.113	265.233	190	252.055	85.210	285	P10-80
	5 - 7	184.18	9.26	158.75	470.914	399.224	6.55	203.112	319.352	869.862	299.121	262.606	190	247.677	86.716	285	P10-80
	7 - 8	188.94	8.26	161.72	470.914	399.224	6.55	207.060	323.300	886.284	303.069	266.072	190	253.453	84.740	285	P10-80
5	0 - 3	253.71	8.26	161.72	1274.94	817.224	7.90	275.069	506.795	954.293	473.356	415.572	190	502.620	42.731	285	2P10-80
	3 - 5	220.53	9.38	132.29	683.983	683.983	6.55	241.406	424.149	797.024	392.343	344.449	190	384.081	55.919	285	P10-50
	5 - 7	198.22	21.38	40.48	614.130	470.914	6.55	230.580	375.529	400.596	350.301	307.538	190	322.564	66.584	285	P10-60
	7 - 8	204.86	20.85	21.81	686.261	470.914	6.55	236.996	391.580	328.598	364.675	320.158	190	343.597	62.508	285	P10-60

PERHITUNGAN TULANGAN BALOK PORTAL C - C

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	0 - 1	40/65	570	381.521	311.430	476.901	389.288	0.0102	18.824	3.676
	1 - 3	40/65	570	368.162	280.780	460.203	350.975	0.0102	18.824	3.676
	3 - 5	40/65	570	361.932	281.649	452.415	352.061	0.0102	18.824	3.676
	5 - 7	40/65	570	360.947	281.195	451.184	351.494	0.0102	18.824	3.676
	7 - 8	40/65	570	372.595	311.098	465.744	388.873	0.0102	18.824	3.676
2	0 - 1	40/65	570	397.352	305.050	496.690	381.313	0.0102	18.824	3.676
	1 - 3	40/65	570	394.356	277.599	492.945	346.999	0.0102	18.824	3.676
	3 - 5	40/65	570	383.628	276.439	479.535	345.549	0.0102	18.824	3.676
	5 - 7	40/65	570	380.410	274.846	475.513	343.558	0.0102	18.824	3.676
	7 - 8	40/65	570	388.766	218.816	485.958	273.520	0.0102	18.824	3.676
3	0 - 1	40/65	570	375.522	300.821	469.403	376.026	0.0102	18.824	3.676
	1 - 3	40/65	570	345.957	292.980	432.446	366.225	0.0102	18.824	3.676
	3 - 5	40/65	570	356.195	292.629	445.244	365.786	0.0102	18.824	3.676
	5 - 7	40/65	570	351.967	284.843	439.959	356.054	0.0102	18.824	3.676
	7 - 8	40/65	570	359.490	292.083	449.363	365.104	0.0102	18.824	3.676
4	0 - 1	40/65	570	327.023	308.590	408.779	385.738	0.0102	18.824	3.676
	1 - 3	40/65	570	345.957	292.980	432.446	366.225	0.0102	18.824	3.676
	3 - 5	40/65	570	356.195	292.629	445.244	365.786	0.0102	18.824	3.676
	5 - 7	40/65	570	351.967	284.843	439.959	356.054	0.0102	18.824	3.676
	7 - 8	40/65	570	359.490	292.083	449.363	365.104	0.0102	18.824	3.676
5	0 - 3	30/120	1120	889.801	611.184	1112.25	763.980	0.0102	18.824	3.676
	3 - 5	40/65	570	403.918	376.438	504.898	470.548	0.0102	18.824	3.676
	5 - 7	40/65	570	429.099	312.237	536.374	390.296	0.0102	18.824	3.676
	7 - 8	40/65	570	428.856	346.922	536.070	433.653	0.0102	18.824	3.676

Tulangan Tumpuan Portal C - C									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
569.504	sebelah	3.670	0.010	2321.551	6.109	7	2660	125.176	539.886
559.444	sebelah	3.541	0.010	2240.262	5.895	6	2280	107.294	470.914
554.691	sebelah	3.481	0.010	2202.352	5.796	6	2280	107.294	470.914
553.935	sebelah	3.472	0.010	2196.359	5.780	6	2280	107.294	470.914
562.802	sebelah	3.584	0.010	2267.237	5.966	6	2280	107.294	470.914
581.199	rangkap	-	-	-	-	-	-	-	542.498
579.004	rangkap	-	-	-	-	-	-	-	542.498
571.074	rangkap	-	-	-	-	-	-	-	542.498
568.674	sebelah	3.659	0.010	2314.791	6.092	7	2660	125.176	539.886
574.886	rangkap	-	-	-	-	-	-	-	542.498
565.008	sebelah	3.612	0.010	2285.047	6.013	7	2660	125.176	539.886
542.311	sebelah	3.328	0.009	2105.145	5.540	6	2280	107.294	470.914
550.277	sebelah	3.426	0.010	2167.443	5.704	6	2280	107.294	470.914
547.001	sebelah	3.385	0.009	2141.715	5.636	6	2280	107.294	470.914
552.816	sebelah	3.458	0.010	2187.493	5.757	6	2280	107.294	470.914
527.262	sebelah	3.145	0.009	1989.931	5.237	6	2280	107.294	470.914
542.311	sebelah	3.328	0.009	2105.145	5.540	6	2280	107.294	470.914
550.277	sebelah	3.426	0.010	2167.443	5.704	6	2280	107.294	470.914
547.001	sebelah	3.385	0.009	2141.715	5.636	6	2280	107.294	470.914
552.816	sebelah	3.458	0.010	2187.493	5.757	6	2280	107.294	470.914
869.729	sebelah	2.217	0.006	2755.558	7.251	8	3040	143.059	1274.940
585.981	rangkap	-	-	-	-	-	-	-	542.498
603.971	rangkap	-	-	-	-	-	-	-	614.130
603.800	rangkap	-	-	-	-	-	-	-	614.130

Tulangan Lapangan Portal C - C									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
514.538	sebelah	2.995	0.008	1895.048	4.987	5	1900	89.412	399.224
488.563	sebelah	2.701	0.007	1708.543	4.496	5	1900	89.412	399.224
489.318	sebelah	2.709	0.008	1713.831	4.510	5	1900	89.412	399.224
488.924	sebelah	2.705	0.008	1711.069	4.503	5	1900	89.412	399.224
514.264	sebelah	2.992	0.008	1893.028	4.982	5	1900	89.412	399.224
509.240	sebelah	2.934	0.008	1856.226	4.885	5	1900	89.412	399.224
485.787	sebelah	2.670	0.007	1689.187	4.445	5	1900	89.412	399.224
484.771	sebelah	2.659	0.007	1682.128	4.427	5	1900	89.412	399.224
483.373	sebelah	2.644	0.007	1672.435	4.401	5	1900	89.412	399.224
431.297	sebelah	2.105	0.006	1331.493	3.504	4	1520	71.529	324.815
505.698	sebelah	2.893	0.008	1830.493	4.817	5	1900	89.412	399.224
499.064	sebelah	2.818	0.008	1782.780	4.692	5	1900	89.412	399.224
498.765	sebelah	2.815	0.008	1780.644	4.686	5	1900	89.412	399.224
492.085	sebelah	2.740	0.008	1733.267	4.561	5	1900	89.412	399.224
498.299	sebelah	2.809	0.008	1777.322	4.677	5	1900	89.412	399.224
512.187	sebelah	2.968	0.008	1877.767	4.941	5	1900	89.412	399.224
499.064	sebelah	2.818	0.008	1782.780	4.692	5	1900	89.412	399.224
498.765	sebelah	2.815	0.008	1780.644	4.686	5	1900	89.412	399.224
492.085	sebelah	2.740	0.008	1733.267	4.561	5	1900	89.412	399.224
498.299	sebelah	2.809	0.008	1777.322	4.677	5	1900	89.412	399.224
720.814	sebelah	1.523	0.004	1892.730	4.981	5	1900	89.412	399.224
565.697	sebelah	3.621	0.010	2290.621	6.028	7	2660	125.176	539.886
515.204	sebelah	3.003	0.008	1899.959	5.000	5	1900	89.412	399.224
543.067	sebelah	3.337	0.009	2111.017	5.555	6	2280	107.294	470.914

PERHITUNGAN TULANGAN RANGKAP PORTAL C - C

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	0 - 1	400	650	570	397.352	305.050	496.690	381.313	0.0102	18.824	3.676	581.199

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	17.356	227.193	155.904	1.181	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	1 - 3	400	650	570	394.356	277.579	492.945	346.974	0.0102	18.824	3.676	579.004

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	13.611	227.193	122.264	0.926	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	3 - 5	400	650	570	383.628	276.429	479.535	345.536	0.0102	18.824	3.676	571.074

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	0.201	227.193	1.805	0.014	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.001	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	7 - 8	400	650	570	388.766	218.816	485.958	273.520	0.0102	18.824	3.676	574.886

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	6.623	227.193	59.497	0.451	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	3 - 5	400	650	570	403.918	376.438	504.898	470.548	0.0102	18.824	3.676	585.981

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	25.563	227.193	229.630	1.740	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	5 - 7	400	650	570	429.099	312.237	536.374	390.296	0.0102	18.824	3.676	603.971

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D16)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	57.040	227.193	512.373	2.562	3	600	2925.6	7.699	8	3040

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.013	0.0026	0.011	244.672	125.788	542.196	71.934	614.130

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	7 - 8	400	650	570	428.856	346.922	536.07	433.653	0.0102	18.824	3.676	603.800

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D16)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.44	479.334	56.736	227.193	509.644	2.548	3	600	2925.6	7.699	8	3040

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.013	0.0026	0.011	244.672	125.788	542.196	71.934	614.130

lampiran 5.60

PERHITUNGAN TULANGAN GESER BALOK PORTAL C - C

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	0 - 1	190.26	44.40	51.55	539.886	399.224	6.55	246.393	371.847	462.903	350.012	0	583.353	36.817	142.5	2P10-60
	1 - 3	184.26	43.32	46.57	470.914	399.224	6.55	238.959	355.199	434.553	334.968	0	558.279	38.471	142.5	2P10-60
	3 - 5	182.73	42.95	46.77	470.914	399.224	6.55	236.964	353.204	433.398	332.973	0	554.954	38.702	142.5	2P10-60
	5 - 7	182.56	43.03	46.28	470.914	399.224	6.55	236.870	353.109	431.246	332.878	0	554.797	38.713	142.5	2P10-60
	7 - 8	188.24	44.06	46.40	470.914	399.224	6.55	243.915	360.155	438.795	339.924	0	566.539	37.910	142.5	2P10-60
2	0 - 1	183.00	43.89	59.77	542.498	399.224	6.55	238.235	364.037	489.269	342.142	0	570.236	37.664	142.5	2P10-60
	1 - 3	181.39	43.90	55.82	542.498	399.224	6.55	236.555	362.357	470.999	340.462	0	567.436	37.850	142.5	2P10-60
	3 - 5	177.48	43.08	56.27	542.498	399.224	6.55	231.588	357.390	467.922	335.495	0	559.158	38.411	142.5	2P10-60
	5 - 7	177.66	43.08	55.60	539.886	399.224	6.55	231.777	357.231	465.297	335.396	0	558.993	38.422	142.5	2P10-60
	7 - 8	178.45	43.43	60.42	542.498	324.815	6.55	232.974	348.836	486.738	328.671	0	547.785	39.208	142.5	2P10-60
3	0 - 1	183.25	43.56	50.90	539.886	399.224	6.55	238.151	363.604	451.931	341.769	0	569.616	37.705	142.5	2P10-60
	1 - 3	184.69	44.48	48.19	470.914	399.224	6.55	240.629	356.868	443.027	336.637	0	561.062	38.280	142.5	2P10-60
	3 - 5	184.49	43.21	47.91	470.914	399.224	6.55	239.085	355.325	440.307	335.094	0	558.489	38.457	142.5	2P10-60
	5 - 7	177.64	43.53	48.17	470.914	399.224	6.55	232.229	348.468	434.543	328.237	0	547.062	39.260	142.5	2P10-60
	7 - 8	180.04	44.25	51.29	470.914	399.224	6.55	235.505	351.744	450.923	331.513	0	552.522	38.872	142.5	2P10-60
4	0 - 1	188.65	43.57	34.10	470.914	399.224	6.55	243.831	360.071	387.051	339.840	0	566.399	37.920	142.5	2P10-60
	1 - 3	190.99	44.48	37.94	470.914	399.224	6.55	247.244	363.483	406.592	343.252	0	572.087	37.543	142.5	2P10-60
	3 - 5	186.67	43.21	42.86	470.914	399.224	6.55	241.374	357.614	421.386	337.383	0	562.304	38.196	142.5	2P10-60
	5 - 7	185.29	43.53	40.65	470.914	399.224	6.55	240.261	356.501	410.991	336.270	0	560.449	38.322	142.5	2P10-60
	7 - 8	187.95	44.76	43.06	470.914	399.224	6.55	244.346	360.585	425.198	340.354	0	567.257	37.862	142.5	2P10-60
5	0 - 3	253.35	39.67	43.61	1274.94	817.224	7.90	307.677	539.404	490.835	505.965	0	843.275	25.469	142.5	2P10-50
	3 - 5	215.98	45.55	18.96	542.498	539.886	6.55	274.607	419.200	354.239	394.034	0	656.723	32.704	142.5	2P10-60
	5 - 7	195.96	43.49	24.85	614.130	399.224	6.55	251.423	386.794	355.793	363.233	0	605.389	35.477	142.5	2P10-60
	7 - 8	203.31	43.96	25.91	614.130	470.914	6.55	259.634	404.582	368.456	379.354	0	632.257	33.970	142.5	2P10-60

lampiran 5.61

PORTAL C - C

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	0 - 1	190.26	20.90	37.99	539.886	470.914	6.55	221.718	356.749	381.276	333.247	292.566	190	297.611	72.167	285	P10-70
	1 - 3	184.26	7.36	128.27	470.914	399.224	6.55	201.201	317.441	739.935	297.210	260.928	190	244.880	87.706	285	P10-80
	3 - 5	182.73	7.60	148.39	470.914	399.224	6.55	199.847	316.086	823.085	295.855	259.739	190	242.898	88.422	285	P10-80
	5 - 7	182.56	7.30	148.58	470.914	247.688	6.55	199.353	295.349	823.389	278.642	244.627	190	217.712	98.652	285	P10-90
	7 - 8	188.24	7.34	148.10	470.914	470.914	6.55	205.359	331.176	827.379	309.278	271.523	190	262.539	81.807	285	P10-80
2	0 - 1	183.00	7.31	146.98	539.886	399.224	6.55	199.826	325.279	817.142	303.444	266.402	190	254.003	84.556	285	P10-80
	1 - 3	181.39	7.09	126.27	470.914	324.815	6.55	197.904	304.204	728.238	285.703	250.826	190	228.043	94.182	285	P10-80
	3 - 5	177.48	20.83	36.96	539.886	399.224	6.55	208.226	333.679	363.458	311.844	273.776	190	266.294	80.654	285	P10-80
	5 - 7	177.66	20.92	46.96	470.914	324.815	6.55	208.509	314.809	405.741	296.308	260.136	190	243.561	88.182	285	P10-80
	7 - 8	178.45	7.48	157.09	539.886	399.224	6.55	195.227	320.680	855.005	298.845	262.364	190	247.274	86.858	285	P10-80
3	0 - 1	183.25	8.57	186.65	470.914	399.224	6.55	201.411	317.651	985.341	297.420	261.113	190	245.188	87.597	285	P10-80
	1 - 3	184.69	7.95	188.27	470.914	399.224	6.55	202.272	318.512	993.006	298.281	261.869	190	246.448	87.149	285	P10-80
	3 - 5	184.49	7.90	187.82	470.914	399.224	6.55	202.010	318.249	990.854	298.018	261.638	190	246.063	87.285	285	P10-80
	5 - 7	177.64	8.02	185.44	470.914	399.224	6.55	194.943	311.183	973.791	290.952	255.434	190	235.724	91.113	285	P10-90
	7 - 8	180.04	8.20	155.44	470.914	399.224	6.55	197.652	313.892	850.500	293.661	257.812	190	239.687	89.607	285	P10-80
4	0 - 1	188.65	21.38	46.04	470.914	470.914	6.55	220.532	346.348	413.900	324.450	284.844	190	284.739	75.429	285	P10-70
	1 - 3	190.99	20.98	41.70	470.914	399.224	6.55	222.569	338.808	397.709	318.577	279.687	190	276.146	77.776	285	P10-70
	3 - 5	186.67	8.50	134.20	470.914	399.224	6.55	204.929	321.168	768.569	300.937	264.201	190	250.335	85.796	285	P10-80
	5 - 7	185.29	9.26	158.75	470.914	399.224	6.55	204.278	320.517	871.028	300.286	263.629	190	249.382	86.123	285	P10-80
	7 - 8	187.95	8.26	161.72	470.914	399.224	6.55	206.021	322.260	885.245	302.029	265.159	190	251.932	85.251	285	P10-80
5	0 - 3	253.35	39.67	43.61	1274.94	817.224	7.90	307.677	539.404	490.835	505.965	444.200	190	550.334	39.027	285	2P10-60
	3 - 5	215.98	9.38	132.29	683.983	683.983	6.55	236.628	419.372	792.246	387.566	340.254	190	377.090	56.956	285	P10-50
	5 - 7	195.96	21.38	40.48	614.130	470.914	6.55	228.207	373.156	398.223	347.928	305.455	190	319.092	67.309	285	P10-60
	7 - 8	203.31	20.85	21.81	686.261	470.914	6.55	235.368	389.952	326.970	363.048	318.729	190	341.215	62.944	285	P10-60

lampiran 5.62

PERHITUNGAN TULANGAN BALOK PORTAL D - D

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	0 - 1	40/65	570	376.583	311.331	470.729	389.164	0.0102	18.824	3.676
	1 - 3	40/65	570	363.446	280.581	454.308	350.726	0.0102	18.824	3.676
	3 - 5	40/65	570	360.547	281.081	450.684	351.351	0.0102	18.824	3.676
	5 - 7	40/65	570	360.330	281.010	450.413	351.263	0.0102	18.824	3.676
	7 - 8	40/65	570	376.606	311.264	470.758	389.080	0.0102	18.824	3.676
2	0 - 1	40/65	570	381.752	279.973	477.190	349.966	0.0102	18.824	3.676
	1 - 3	40/65	570	381.552	275.160	476.940	343.950	0.0102	18.824	3.676
	3 - 5	40/65	570	380.366	274.265	475.458	342.831	0.0102	18.824	3.676
	5 - 7	40/65	570	381.623	274.711	477.029	343.389	0.0102	18.824	3.676
	7 - 8	40/65	570	389.516	281.195	486.895	351.494	0.0102	18.824	3.676
3	0 - 1	40/65	570	368.430	281.415	460.538	351.769	0.0102	18.824	3.676
	1 - 3	40/65	570	363.600	274.500	454.500	343.125	0.0102	18.824	3.676
	3 - 5	40/65	570	359.645	274.098	449.556	342.623	0.0102	18.824	3.676
	5 - 7	40/65	570	363.139	264.320	453.924	330.400	0.0102	18.824	3.676
	7 - 8	40/65	570	371.937	283.114	464.921	353.893	0.0102	18.824	3.676
4	0 - 1	40/65	570	346.465	290.886	433.081	363.608	0.0102	18.824	3.676
	1 - 3	40/65	570	347.162	283.071	433.953	353.839	0.0102	18.824	3.676
	3 - 5	40/65	570	343.360	280.700	429.200	350.875	0.0102	18.824	3.676
	5 - 7	40/65	570	346.112	283.099	432.640	353.874	0.0102	18.824	3.676
	7 - 8	40/65	570	354.465	292.539	443.081	365.674	0.0102	18.824	3.676
5	0 - 1	40/65	570	254.897	197.675	318.621	247.094	0.0102	18.824	3.676
	1 - 3	40/65	570	257.440	181.250	321.800	226.563	0.0102	18.824	3.676
	3 - 5	40/65	570	329.101	297.050	411.376	371.313	0.0102	18.824	3.676
	5 - 7	40/65	570	332.808	297.954	416.010	372.443	0.0102	18.824	3.676
	7 - 8	40/65	570	326.442	314.555	408.053	393.194	0.0102	18.824	3.676
ATAP	0 - 1	30/55	470	138.003	86.478	172.504	108.098	0.0102	18.824	3.676
	1 - 3	30/55	470	78.587	14.341	98.234	17.926	0.0102	18.824	3.676
	3 - 5	30/55	470	64.837	18.128	81.046	22.660	0.0102	18.824	3.676
	5 - 7	30/55	470	67.202	13.976	84.003	17.470	0.0102	18.824	3.676
	7 - 8	30/55	470	136.678	95.320	170.848	119.150	0.0102	18.824	3.676

	Tulangan Tumpuan Portal D - D									
	d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
1	565.806	sebelah	3.622	0.010	2291.504	6.030	7	2660	125.176	539.886
	555.849	sebelah	3.496	0.010	2211.565	5.820	6	2280	107.294	470.914
	553.628	sebelah	3.468	0.010	2193.925	5.773	6	2280	107.294	470.914
	553.462	sebelah	3.466	0.010	2192.604	5.770	6	2280	107.294	470.914
	565.823	sebelah	3.622	0.010	2291.644	6.031	7	2660	125.176	539.886
2	569.676	sebelah	3.672	0.010	2322.957	6.113	7	2660	125.176	539.886
	569.527	sebelah	3.670	0.010	2321.740	6.110	7	2660	125.176	539.886
	568.641	sebelah	3.658	0.010	2314.523	6.091	7	2660	125.176	539.886
	569.580	sebelah	3.671	0.010	2322.172	6.111	7	2660	125.176	539.886
	575.440	rangkap	-	-	-	-	-	-	-	542.494
3	559.648	sebelah	3.544	0.010	2241.893	5.900	6	2280	107.294	470.914
	555.967	sebelah	3.497	0.010	2212.502	5.822	6	2280	107.294	470.914
	552.935	sebelah	3.459	0.010	2188.436	5.759	6	2280	107.294	470.914
	555.615	sebelah	3.493	0.010	2209.697	5.815	6	2280	107.294	470.914
	562.305	sebelah	3.577	0.010	2263.233	5.956	6	2280	107.294	470.914
4	542.709	sebelah	3.332	0.009	2108.236	5.548	6	2280	107.294	470.914
	543.255	sebelah	3.339	0.009	2112.477	5.559	6	2280	107.294	470.914
	540.272	sebelah	3.303	0.009	2089.342	5.498	6	2280	107.294	470.914
	542.432	sebelah	3.329	0.009	2106.088	5.542	6	2280	107.294	470.914
	548.939	sebelah	3.409	0.009	2156.916	5.676	6	2280	107.294	470.914
5	465.500	sebelah	2.452	0.007	1551.046	4.082	5	1900	89.412	399.224
	467.816	sebelah	2.476	0.007	1566.520	4.122	5	1900	89.412	399.224
	528.934	sebelah	3.165	0.009	2002.576	5.270	6	2280	107.294	470.914
	531.905	sebelah	3.201	0.009	2025.133	5.329	6	2280	107.294	470.914
	526.793	sebelah	3.140	0.009	1986.396	5.227	6	2280	107.294	470.914
6	342.517	sebelah	1.952	0.005	1018.416	2.680	3 6	1140	53.647	202.088
	258.471	sebelah	1.112	0.003	579.946	1.526	2 3	760	35.765	137.444
	234.773	sebelah	0.917	0.003	478.476	1.259	2 3	760	35.765	137.444
	239.017	sebelah	0.951	0.003	495.928	1.305	2 3	760	35.765	137.444
	340.868	sebelah	1.934	0.005	1008.638	2.654	3 6	1140	53.647	202.088

lampiran 5.64

Tulangan Lapangan Portal D - D									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
514.456	sebelah	2.994	0.008	1894.446	4.985	5	1900	89.412	399.224
488.390	sebelah	2.699	0.007	1707.332	4.493	6	2280	107.294	470.914
488.825	sebelah	2.704	0.008	1710.375	4.501	5	1900	89.412	399.224
488.763	sebelah	2.703	0.007	1709.943	4.500	5	1900	89.412	399.224
514.401	sebelah	2.994	0.008	1894.038	4.984	5	1900	89.412	399.224
487.860	sebelah	2.693	0.007	1703.633	4.483	5	1900	89.412	399.224
483.649	sebelah	2.647	0.007	1674.346	4.406	5	1900	89.412	399.224
482.861	sebelah	2.638	0.007	1668.900	4.392	5	1900	89.412	399.224
483.254	sebelah	2.642	0.007	1671.614	4.399	5	1900	89.412	399.224
488.924	sebelah	2.705	0.008	1711.069	4.503	5	1900	89.412	399.224
489.115	sebelah	2.707	0.008	1712.407	4.506	5	1900	89.412	399.224
483.068	sebelah	2.640	0.007	1670.330	4.396	5	1900	89.412	399.224
482.714	sebelah	2.636	0.007	1667.883	4.389	5	1900	89.412	399.224
474.026	sebelah	2.542	0.007	1608.384	4.233	5	1900	89.412	399.224
490.589	sebelah	2.723	0.008	1722.746	4.534	5	1900	89.412	399.224
497.277	sebelah	2.798	0.008	1770.038	4.658	5	1900	89.412	399.224
490.552	sebelah	2.723	0.008	1722.484	4.533	5	1900	89.412	399.224
488.493	sebelah	2.700	0.007	1708.057	4.495	5	1900	89.412	399.224
490.576	sebelah	2.723	0.008	1722.654	4.533	5	1900	89.412	399.224
498.688	sebelah	2.814	0.008	1780.097	4.684	5	1900	89.412	399.224
409.933	sebelah	1.901	0.005	1202.850	3.165	4	1520	71.529	324.815
392.533	sebelah	1.743	0.005	1102.904	2.902	3	1140	53.647	247.688
502.518	sebelah	2.857	0.008	1807.546	4.757	5	1900	89.412	399.224
503.283	sebelah	2.866	0.008	1813.047	4.771	5	1900	89.412	399.224
517.113	sebelah	3.025	0.008	1914.064	5.037	6	2280	107.294	470.914
271.138	sebelah	1.223	0.003	638.179	1.679	2	760	35.765	137.444
110.415	sebelah	0.203	0.001	105.832	0.279	2	760	35.765	137.444
124.140	sebelah	0.256	0.001	133.779	0.352	2	760	35.765	137.444
109.001	sebelah	0.198	0.001	103.138	0.271	2	760	35.765	137.444
284.662	sebelah	1.348	0.004	703.430	1.851	2	760	35.765	137.444

PERHITUNGAN TULANGAN RANGKAP PORTAL D - D

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	7 - 8	400	650	570	389.516	281.495	486.895	351.869	0.0102	18.824	3.676	575.440

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	7.561	227.193	67.918	0.515	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

lampiran 5.66

PERHITUNGAN TULANGAN GESER BALOK PORTAL D - D

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	0 - 1	188.54	44.18	51.64	539.886	399.224	6.55	244.356	369.810	461.244	347.975	0	579.958	37.033	142.5	2P10-60
	1 - 3	182.68	43.06	46.76	470.914	470.914	6.55	237.027	362.844	433.419	340.946	0	568.243	37.797	142.5	2P10-60
	3 - 5	182.11	42.93	46.83	470.914	399.224	6.55	236.292	352.532	432.978	332.301	0	553.834	38.780	142.5	2P10-60
	5 - 7	182.24	42.99	46.50	470.914	399.224	6.55	236.492	352.731	431.792	332.500	0	554.167	38.757	142.5	2P10-60
	7 - 8	188.08	44.08	50.71	539.886	399.224	6.55	243.768	369.222	456.750	347.387	0	578.978	37.096	142.5	2P10-60
2	0 - 1	178.90	43.32	61.27	539.886	399.224	6.55	233.331	358.785	490.665	336.950	0	561.583	38.245	142.5	2P10-60
	1 - 3	176.61	43.12	56.18	539.886	399.224	6.55	230.717	356.170	466.673	334.335	0	557.226	38.544	142.5	2P10-60
	3 - 5	175.99	43.01	56.23	539.886	399.224	6.55	229.950	355.404	466.116	333.569	0	555.948	38.632	142.5	2P10-60
	5 - 7	176.67	43.15	55.96	539.886	399.224	6.55	230.811	356.265	465.843	334.430	0	557.383	38.533	142.5	2P10-60
	7 - 8	177.97	43.15	59.20	542.494	399.224	6.55	232.176	357.978	480.816	336.083	0	560.138	38.343	142.5	2P10-60
3	0 - 1	178.05	43.73	52.48	470.914	399.224	6.55	232.869	349.109	453.285	328.878	0	548.129	39.183	142.5	2P10-60
	1 - 3	176.93	43.98	49.13	470.914	399.224	6.55	231.956	348.195	438.302	327.964	0	546.607	39.293	142.5	2P10-60
	3 - 5	176.05	43.06	48.81	470.914	399.224	6.55	230.066	346.305	435.068	326.074	0	543.457	39.520	142.5	2P10-60
	5 - 7	177.34	43.33	48.68	470.914	399.224	6.55	231.704	347.943	436.160	327.712	0	546.187	39.323	142.5	2P10-60
	7 - 8	180.20	44.12	50.16	470.914	399.224	6.55	235.536	351.776	446.208	331.545	0	552.574	38.868	142.5	2P10-60
4	0 - 1	184.37	43.82	41.07	470.914	399.224	6.55	239.600	355.839	412.094	335.608	0	559.347	38.398	142.5	2P10-60
	1 - 3	184.31	43.51	39.79	470.914	399.224	6.55	239.211	355.451	406.329	335.220	0	558.699	38.442	142.5	2P10-60
	3 - 5	182.73	43.31	39.88	470.914	399.224	6.55	237.342	353.582	404.838	333.351	0	555.584	38.658	142.5	2P10-60
	5 - 7	184.14	43.47	39.71	470.914	399.224	6.55	238.991	355.230	405.773	334.999	0	558.332	38.467	142.5	2P10-60
	7 - 8	187.73	44.50	40.41	470.914	399.224	6.55	243.842	360.081	413.564	339.850	0	566.417	37.918	142.5	2P10-60
5	0 - 1	150.98	31.26	29.38	399.224	324.815	6.55	191.352	288.075	314.748	271.241	0	452.068	47.510	142.5	2P10-80
	1 - 3	149.84	30.36	29.21	399.224	247.688	6.55	189.210	275.630	311.892	260.589	0	434.314	49.452	142.5	2P10-80
	3 - 5	196.47	43.78	28.62	470.914	399.224	6.55	252.263	368.502	372.467	348.271	0	580.452	37.002	142.5	2P10-60
	5 - 7	193.08	43.67	29.42	470.914	399.224	6.55	248.588	364.827	372.152	344.596	0	574.327	37.396	142.5	2P10-60
	7 - 8	198.21	44.05	29.35	470.914	470.914	6.55	254.373	380.190	377.643	358.292	0	597.153	35.967	142.5	2P10-60
ATAP	0 - 1	63.36	10.45	19.02	202.088	137.444	6.55	77.501	122.858	157.385	116.349	0	193.914	91.327	117.5	P10-90
	1 - 3	26.10	0.81	14.08	137.444	137.444	6.55	28.256	64.977	87.392	59.707	0	99.512	177.965	117.5	P10-110
	3 - 5	22.31	0.20	15.32	137.444	137.444	6.55	23.636	60.357	87.980	55.087	0	91.812	192.890	117.5	P10-110
	5 - 7	22.54	0.01	14.97	137.444	137.444	6.55	23.678	60.399	86.552	55.129	0	91.882	192.743	117.5	P10-110
	7 - 8	67.72	5.93	15.46	202.088	137.444	6.55	77.333	122.690	142.265	116.181	0	193.634	91.459	117.5	P10-90

PORTAL D - D

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	0 - 1	188.54	44.18	51.64	539.886	399.224	6.55	244.356	369.810	461.244	347.975	305.496	190	319.161	67.294	285	P10-60
	1 - 3	182.68	43.06	46.76	470.914	470.914	6.55	237.027	362.844	433.419	340.946	299.325	190	308.876	69.535	285	P10-60
	3 - 5	182.11	42.93	46.83	470.914	399.224	6.55	236.292	352.532	432.978	332.301	291.736	190	296.226	72.504	285	P10-70
	5 - 7	182.24	42.99	46.50	470.914	399.224	6.55	236.492	352.731	431.792	332.500	291.911	190	296.518	72.433	285	P10-70
	7 - 8	188.08	44.08	50.71	539.886	399.224	6.55	243.768	369.222	456.750	347.387	304.980	190	318.300	67.476	285	P10-60
2	0 - 1	178.90	43.32	61.27	539.886	399.224	6.55	233.331	358.785	490.665	336.950	295.817	190	303.029	70.876	285	P10-70
	1 - 3	176.61	43.12	56.18	539.886	399.224	6.55	230.717	356.170	466.673	334.335	293.522	190	299.203	71.783	285	P10-70
	3 - 5	175.99	43.01	56.23	539.886	399.224	6.55	229.950	355.404	466.116	333.569	292.849	190	298.082	72.053	285	P10-70
	5 - 7	176.67	43.15	55.96	539.886	399.224	6.55	230.811	356.265	465.843	334.430	293.605	190	299.341	71.750	285	P10-70
	7 - 8	177.97	43.15	59.20	542.494	399.224	6.55	232.176	357.978	480.816	336.083	295.056	190	301.760	71.175	285	P10-70
3	0 - 1	178.05	43.73	52.48	470.914	399.224	6.55	232.869	349.109	453.285	328.878	288.730	190	291.217	73.751	285	P10-70
	1 - 3	176.93	43.98	49.13	470.914	399.224	6.55	231.956	348.195	438.302	327.964	287.928	190	289.881	74.091	285	P10-70
	3 - 5	176.05	43.06	48.81	470.914	399.224	6.55	230.066	346.305	435.068	326.074	286.269	190	287.115	74.805	285	P10-70
	5 - 7	177.34	43.33	48.68	470.914	399.224	6.55	231.704	347.943	436.160	327.712	287.707	190	289.512	74.186	285	P10-70
	7 - 8	180.20	44.12	50.16	470.914	399.224	6.55	235.536	351.776	446.208	331.545	291.072	190	295.120	72.776	285	P10-70
4	0 - 1	184.37	43.82	41.07	470.914	399.224	6.55	239.600	355.839	412.094	335.608	294.639	190	301.066	71.339	285	P10-70
	1 - 3	184.31	43.51	39.79	470.914	399.224	6.55	239.211	355.451	406.329	335.220	294.298	190	300.497	71.474	285	P10-70
	3 - 5	182.73	43.31	39.88	470.914	399.224	6.55	237.342	353.582	404.838	333.351	292.657	190	297.762	72.130	285	P10-70
	5 - 7	184.14	43.47	39.71	470.914	399.224	6.55	238.991	355.230	405.773	334.999	294.105	190	300.174	71.550	285	P10-70
	7 - 8	187.73	44.50	40.41	470.914	399.224	6.55	243.842	360.081	413.564	339.850	298.363	190	307.272	69.898	285	P10-60
5	0 - 1	150.98	31.26	29.38	399.224	324.815	6.55	191.352	288.075	314.748	271.241	238.129	190	206.882	103.816	285	P10-100
	1 - 3	149.84	30.36	29.21	399.224	247.688	6.55	189.210	275.630	311.892	260.589	228.778	190	191.296	112.274	285	P10-110
	3 - 5	196.47	43.78	28.62	470.914	399.224	6.55	252.263	368.502	372.467	348.271	305.756	190	319.594	67.203	285	P10-60
	5 - 7	193.08	43.67	29.42	470.914	399.224	6.55	248.588	364.827	372.152	344.596	302.530	190	314.217	68.353	285	P10-60
	7 - 8	198.21	44.05	29.35	470.914	470.914	6.55	254.373	380.190	377.643	358.292	314.554	190	334.256	64.255	285	P10-60
ATAP	0 - 1	63.36	10.45	19.02	202.088	137.444	6.55	77.501	122.858	157.385	116.349	100.465	156.7	10.776	1993.14	235	P10-230
	1 - 3	25.10	0.81	14.08	137.444	137.444	6.55	28.256	64.977	87.392	59.707	51.556	156.7	-70.739	-303.62	235	P10-230
	3 - 5	22.31	0.20	15.32	137.444	137.444	6.55	23.636	60.357	87.980	55.087	47.567	156.7	-77.388	-277.53	235	P10-230
	5 - 7	22.54	0.01	14.97	137.444	137.444	6.55	23.678	60.399	86.552	55.129	47.603	156.7	-77.328	-277.75	235	P10-230
	7 - 8	67.72	5.93	15.46	202.088	137.444	6.55	77.333	122.690	142.265	116.181	100.320	156.7	10.534	2038.89	235	P10-230

PERHITUNGAN TULANGAN BALOK PORTAL E - E

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	0 - 1	40/65	570	369.816	319.948	462.270	399.935	0.0102	18.824	3.676
	1 - 3	40/65	570	357.299	290.129	446.624	362.661	0.0102	18.824	3.676
	3 - 5	40/65	570	358.875	294.254	448.594	367.818	0.0102	18.824	3.676
	5 - 7	40/65	570	356.398	288.518	445.498	360.648	0.0102	18.824	3.676
	7 - 8	40/65	570	368.003	319.614	460.004	399.518	0.0102	18.824	3.676
2	0 - 1	40/65	570	381.614	288.728	477.018	360.910	0.0102	18.824	3.676
	1 - 3	40/65	570	375.294	167.253	469.118	209.066	0.0102	18.824	3.676
	3 - 5	40/65	570	373.827	282.669	467.284	353.336	0.0102	18.824	3.676
	5 - 7	40/65	570	374.676	278.929	468.345	348.661	0.0102	18.824	3.676
	7 - 8	40/65	570	380.128	289.500	475.160	361.875	0.0102	18.824	3.676
3	0 - 1	40/65	570	364.635	288.399	455.794	360.499	0.0102	18.824	3.676
	1 - 3	40/65	570	356.453	276.488	445.566	345.610	0.0102	18.824	3.676
	3 - 5	40/65	570	353.351	279.156	441.689	348.945	0.0102	18.824	3.676
	5 - 7	40/65	570	344.550	278.764	430.688	348.455	0.0102	18.824	3.676
	7 - 8	40/65	570	363.109	289.425	453.886	361.781	0.0102	18.824	3.676
4	0 - 1	40/65	570	341.488	297.366	426.860	371.708	0.0102	18.824	3.676
	1 - 3	40/65	570	338.551	280.626	423.189	350.783	0.0102	18.824	3.676
	3 - 5	40/65	570	332.457	285.044	415.571	356.305	0.0102	18.824	3.676
	5 - 7	40/65	570	337.794	281.974	422.243	352.468	0.0102	18.824	3.676
	7 - 8	40/65	570	343.483	293.924	429.354	367.405	0.0102	18.824	3.676
5	0 - 1	40/65	570	438.038	267.812	547.548	334.765	0.0102	18.824	3.676
	1 - 3	40/65	570	459.836	327.221	574.795	409.026	0.0102	18.824	3.676
	3 - 5	40/65	570	440.487	318.426	550.609	398.033	0.0102	18.824	3.676
	5 - 7	40/65	570	453.772	319.292	567.215	399.115	0.0102	18.824	3.676
	7 - 8	40/65	570	423.229	335.140	529.036	418.925	0.0102	18.824	3.676
ATAP	0 - 1	30/55	470	245.642	157.038	307.053	196.298	0.0102	18.824	3.676
	1 - 3	-	-	-	-	-	-	-	-	-
	3 - 5	-	-	-	-	-	-	-	-	-
	5 - 7	-	-	-	-	-	-	-	-	-
	7 - 8	30/55	470	186.096	173.435	232.620	216.794	0.0102	18.824	3.676

lampiran 5.69

Tulangan Tumpuan Portal E - E									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
560.699	sebelah	3.557	0.010	2250.326	5.922	6	2280	107.294	470.914
551.129	sebelah	3.437	0.010	2174.161	5.721	6	2280	107.294	470.914
552.343	sebelah	3.452	0.010	2183.751	5.747	6	2280	107.294	470.914
550.434	sebelah	3.428	0.010	2168.678	5.707	6	2280	107.294	470.914
559.323	sebelah	3.540	0.010	2239.294	5.893	6	2280	107.294	470.914
569.573	sebelah	3.670	0.010	2322.117	6.111	7	2660	125.176	539.886
564.837	sebelah	3.610	0.010	2283.660	6.010	7	2660	125.176	539.886
563.732	sebelah	3.596	0.010	2274.733	5.986	6	2280	107.294	470.914
564.372	sebelah	3.604	0.010	2279.899	6.000	6	2280	107.294	470.914
568.463	sebelah	3.656	0.010	2313.075	6.087	7	2660	125.176	539.886
556.758	sebelah	3.507	0.010	2218.800	5.839	6	2280	107.294	470.914
550.476	sebelah	3.428	0.010	2169.013	5.708	6	2280	107.294	470.914
548.076	sebelah	3.399	0.009	2150.137	5.658	6	2280	107.294	470.914
541.207	sebelah	3.314	0.009	2096.583	5.517	6	2280	107.294	470.914
555.592	sebelah	3.493	0.010	2209.514	5.815	6	2280	107.294	470.914
538.797	sebelah	3.285	0.009	2077.951	5.468	6	2280	107.294	470.914
536.475	sebelah	3.256	0.009	2060.079	5.421	6	2280	107.294	470.914
531.625	sebelah	3.198	0.009	2022.997	5.324	6	2280	107.294	470.914
535.875	sebelah	3.249	0.009	2055.473	5.409	6	2280	107.294	470.914
540.368	sebelah	3.304	0.009	2090.090	5.500	6	2280	107.294	470.914
610.229	rangkap	-	-	-	-	-	-	-	684.370
625.228	rangkap	-	-	-	-	-	-	-	755.630
611.933	rangkap	-	-	-	-	-	-	-	684.370
621.092	rangkap	-	-	-	-	-	-	-	684.370
599.826	rangkap	-	-	-	-	-	-	-	614.130
456.971	sebelah	3.475	0.010	1812.756	4.770	5	1900	89.412	323.224
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
397.746	sebelah	2.633	0.007	1373.327	3.614	4	1520	71.529	264.015

Tulangan Lapangan Portal E - E									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
521.527	sebelah	3.077	0.009	1946.880	5.123	6	2280	107.294	470.914
496.630	sebelah	2.791	0.008	1765.432	4.646	6	2280	107.294	470.914
500.148	sebelah	2.830	0.008	1790.532	4.712	5	1900	89.412	399.224
495.249	sebelah	2.775	0.008	1755.629	4.620	5	1900	89.412	399.224
521.255	sebelah	3.074	0.009	1944.848	5.118	6	2280	107.294	470.914
495.429	sebelah	2.777	0.008	1756.907	4.623	5	1900	89.412	399.224
377.072	sebelah	1.609	0.004	1017.733	2.678	3	1140	53.647	247.688
490.203	sebelah	2.719	0.008	1720.038	4.526	5	1900	89.412	399.224
486.950	sebelah	2.683	0.007	1697.280	4.467	5	1900	89.412	399.224
496.091	sebelah	2.785	0.008	1761.604	4.636	5	1900	89.412	399.224
495.147	sebelah	2.774	0.008	1754.905	4.618	5	1900	89.412	399.224
484.814	sebelah	2.659	0.007	1682.427	4.427	5	1900	89.412	399.224
487.148	sebelah	2.685	0.007	1698.661	4.470	5	1900	89.412	399.224
486.806	sebelah	2.681	0.007	1696.276	4.464	5	1900	89.412	399.224
496.027	sebelah	2.784	0.008	1761.148	4.635	5	1900	89.412	399.224
502.786	sebelah	2.860	0.008	1809.469	4.762	5	1900	89.412	399.224
488.429	sebelah	2.699	0.007	1707.606	4.494	5	1900	89.412	399.224
492.258	sebelah	2.742	0.008	1734.490	4.564	5	1900	89.412	399.224
489.600	sebelah	2.712	0.008	1715.809	4.515	5	1900	89.412	399.224
499.867	sebelah	2.827	0.008	1788.524	4.707	5	1900	89.412	399.224
477.147	sebelah	2.576	0.007	1629.633	4.289	5	1900	89.412	399.224
527.422	sebelah	3.147	0.009	1991.136	5.240	6	2280	107.294	470.914
520.285	sebelah	3.063	0.008	1937.619	5.099	6	2280	107.294	470.914
520.992	sebelah	3.071	0.009	1942.888	5.113	6	2280	107.294	470.914
533.765	sebelah	3.223	0.009	2039.323	5.367	6	2280	107.294	470.914
365.376	sebelah	2.222	0.006	1158.888	3.050	4	1520	71.529	264.015
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
383.977	sebelah	2.454	0.007	1279.893	3.368	5	1900	89.412	323.224

PERHITUNGAN TULANGAN RANGKAP PORTAL E - E

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	0 - 1	400	650	570	438.038	267.812	547.548	334.765	0.010	18.824	3.676	610.229

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D16)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	68.213	227.193	612.744	3.064	4	800	3125.6	8.225	9	3420

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.015	0.0035	0.011	269.084	135.616	578.893	105.481	684.374

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	1 - 3	400	650	570	459.836	327.221	574.795	409.026	0.0102	18.8235	3.676	625.228

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D22)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	95.461	227.193	857.501	2.257	3	1140	3465.6	9.120	10	3800

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.0167	0.0050	0.012	274.06	142.067	602.538	153.090	755.628

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
5	3 - 5	400	650	570	440.487	318.426	550.609	398.033	0.0102	18.824	3.676	611.933

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D16)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	71.275	227.193	640.242	3.201	4	800	3125.6	8.225	9	3420

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.015	0.0035	0.011	269.084	135.616	578.893	105.481	684.374

PERHITUNGAN TULANGAN GESER BALOK PORTAL E - E

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	0 - 1	191.26	44.86	46.80	470.914	470.914	6.55	247.926	373.743	444.486	351.845	0	586.408	36.626	142.5	2P10-60
	1 - 3	185.31	43.63	43.07	470.914	470.914	6.55	240.387	366.204	421.281	344.306	0	573.843	37.428	142.5	2P10-60
	3 - 5	186.93	44.05	43.36	470.914	399.224	6.55	242.529	358.769	424.641	338.538	0	564.229	38.065	142.5	2P10-60
	5 - 7	185.37	43.65	42.68	470.914	399.224	6.55	240.471	356.711	419.727	336.480	0	560.799	38.298	142.5	2P10-60
	7 - 8	191.10	44.88	46.75	470.914	470.914	6.55	247.779	373.596	444.129	351.698	0	586.163	36.641	142.5	2P10-60
2	0 - 1	179.81	43.78	56.35	539.886	399.224	6.55	234.770	360.223	471.440	338.388	0	563.981	38.082	142.5	2P10-60
	1 - 3	178.72	43.48	52.88	539.886	247.688	6.55	233.310	338.520	455.406	320.209	0	533.682	40.244	142.5	2P10-80
	3 - 5	179.05	43.68	52.21	470.914	399.224	6.55	233.867	350.106	453.149	329.875	0	549.792	39.065	142.5	2P10-60
	5 - 7	178.84	43.51	52.41	470.914	399.224	6.55	233.468	349.707	453.590	329.476	0	549.127	39.112	142.5	2P10-60
	7 - 8	180.07	43.66	55.92	539.886	399.224	6.55	234.917	360.370	469.781	338.535	0	564.226	38.066	142.5	2P10-60
3	0 - 1	181.44	44.40	47.04	470.914	399.224	6.55	237.132	353.372	434.700	333.141	0	555.234	38.682	142.5	2P10-60
	1 - 3	177.40	43.37	46.04	470.914	399.224	6.55	231.809	348.048	425.177	327.817	0	546.362	39.310	142.5	2P10-60
	3 - 5	178.17	44.43	44.98	470.914	399.224	6.55	233.730	349.970	422.646	329.739	0	549.564	39.081	142.5	2P10-60
	5 - 7	178.88	43.41	44.45	470.914	399.224	6.55	233.405	349.644	420.095	329.413	0	549.022	39.120	142.5	2P10-60
	7 - 8	181.56	44.44	47.36	470.914	399.224	6.55	237.300	353.540	436.212	333.309	0	555.514	38.663	142.5	2P10-60
4	0 - 1	188.84	44.74	35.92	470.914	399.224	6.55	245.259	361.499	396.123	341.268	0	568.779	37.761	142.5	2P10-60
	1 - 3	185.20	43.28	35.32	470.914	399.224	6.55	239.904	356.144	388.248	335.913	0	559.854	38.363	142.5	2P10-60
	3 - 5	183.97	43.25	35.70	470.914	399.224	6.55	238.581	354.821	388.521	334.590	0	557.649	38.515	142.5	2P10-60
	5 - 7	185.46	43.37	35.94	470.914	399.224	6.55	240.272	356.511	391.220	336.280	0	560.467	38.321	142.5	2P10-60
	7 - 8	189.08	44.80	36.65	470.914	399.224	6.55	245.574	361.814	399.504	341.583	0	569.304	37.726	142.5	2P10-60
5	0 - 1	202.90	44.25	29.81	684.370	399.224	6.55	259.508	404.262	384.710	379.068	0	631.781	33.995	142.5	2P10-60
	1 - 3	204.69	44.88	22.47	755.630	470.914	6.55	262.049	425.900	356.423	397.382	0	662.304	32.429	142.5	2P10-60
	3 - 5	200.03	43.99	18.85	684.370	470.914	6.55	256.221	410.553	335.391	383.692	0	639.487	33.586	142.5	2P10-60
	5 - 7	202.36	44.20	20.52	684.370	470.914	6.55	258.888	413.220	345.072	386.359	0	643.932	33.354	142.5	2P10-60
	7 - 8	200.02	43.62	20.52	614.130	470.914	6.55	255.822	400.771	342.006	375.543	0	625.905	34.314	142.5	2P10-60
ATAP	0 - 1	104.71	18.65	25.00	323.224	264.015	6.55	129.528	207.976	234.528	196.718	0	327.863	54.015	142.5	2P10-100
	1 - 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3 - 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5 - 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7 - 8	98.60	16.79	7.78	264.015	323.224	6.55	121.160	199.607	153.836	188.349	0	313.915	56.415	142.5	2P10-100

PORTAL E - E

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	0 - 1	191.26	44.86	46.80	470.914	470.914	6.55	247.926	373.743	444.486	351.845	308.894	190	324.823	66.121	285	P10-60
	1 - 3	185.31	43.63	43.07	470.914	470.914	6.55	240.387	366.204	421.281	344.306	302.275	190	313.792	68.445	285	P10-60
	3 - 5	186.93	44.05	43.36	470.914	399.224	6.55	242.529	358.769	424.641	338.538	297.211	190	305.352	70.337	285	P10-70
	5 - 7	185.37	43.65	42.68	470.914	399.224	6.55	240.471	356.711	419.727	336.480	295.404	190	302.341	71.038	285	P10-70
	7 - 8	191.10	44.88	46.75	470.914	470.914	6.55	247.779	373.596	444.129	351.698	308.765	190	324.608	66.165	285	P10-60
2	0 - 1	179.81	43.78	56.35	539.886	399.224	6.55	234.770	360.223	471.440	338.388	297.080	190	305.134	70.388	285	P10-70
	1 - 3	178.72	43.48	52.88	539.886	247.688	6.55	233.310	338.520	455.406	320.209	281.120	190	278.533	77.110	285	P10-70
	3 - 5	179.05	43.68	52.21	470.914	399.224	6.55	233.867	350.106	453.149	329.875	289.606	190	292.677	73.383	285	P10-70
	5 - 7	178.84	43.51	52.41	470.914	399.224	6.55	233.468	349.707	453.590	329.476	289.256	190	292.093	73.530	285	P10-70
	7 - 8	180.07	43.66	55.92	539.886	399.224	6.55	234.917	360.370	469.781	338.535	297.209	190	305.349	70.338	285	P10-70
3	0 - 1	181.44	44.40	47.04	470.914	399.224	6.55	237.132	353.372	434.700	333.141	292.473	190	297.455	72.205	285	P10-70
	1 - 3	177.40	43.37	46.04	470.914	399.224	6.55	231.809	348.048	425.177	327.817	287.799	190	289.666	74.146	285	P10-70
	3 - 5	178.17	44.43	44.98	470.914	399.224	6.55	233.730	349.970	422.646	329.739	289.486	190	292.477	73.433	285	P10-70
	5 - 7	178.88	43.41	44.45	470.914	399.224	6.55	233.405	349.644	420.095	329.413	289.201	190	292.001	73.553	285	P10-70
	7 - 8	181.56	44.44	47.36	470.914	399.224	6.55	237.300	353.540	436.212	333.309	292.621	190	297.701	72.145	285	P10-70
4	0 - 1	188.84	44.74	35.92	470.914	399.224	6.55	245.259	361.499	396.123	341.268	299.608	190	309.347	69.429	285	P10-60
	1 - 3	185.20	43.28	35.32	470.914	399.224	6.55	239.904	356.144	388.248	335.913	294.907	190	301.511	71.233	285	P10-70
	3 - 5	183.97	43.25	35.70	470.914	399.224	6.55	238.581	354.821	388.521	334.590	293.745	190	299.575	71.694	285	P10-70
	5 - 7	185.46	43.37	35.94	470.914	399.224	6.55	240.272	356.511	391.220	336.280	295.229	190	302.049	71.106	285	P10-70
	7 - 8	189.08	44.80	36.65	470.914	399.224	6.55	245.574	361.814	399.504	341.583	299.884	190	309.807	69.326	285	P10-60
5	0 - 1	202.90	44.25	29.81	684.370	399.224	6.55	259.508	404.262	384.710	379.068	332.794	190	364.657	58.898	285	P10-50
	1 - 3	204.69	44.88	22.47	755.630	470.914	6.55	262.049	425.900	356.423	397.382	348.872	190	391.454	54.866	285	P10-50
	3 - 5	200.03	43.99	18.85	684.370	470.914	6.55	256.221	410.553	335.391	383.692	336.853	190	371.422	57.825	285	P10-50
	5 - 7	202.36	44.20	20.52	684.370	470.914	6.55	258.888	413.220	345.072	386.359	339.195	190	375.325	57.224	285	P10-50
	7 - 8	200.02	43.62	20.52	614.130	470.914	6.55	255.822	400.771	342.006	375.543	329.699	190	359.498	59.743	285	P10-50
ATAP	0 - 1	104.71	18.65	25.00	323.224	264.015	6.55	129.528	207.976	234.528	196.718	169.863	190	93.105	230.68	235	P10-230
	1 - 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3 - 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5 - 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7 - 8	98.60	16.79	7.78	264.015	323.224	6.55	121.160	199.607	153.836	188.349	162.637	190	81.062	264.95	235	P10-230

lampiran 5.74

PERHITUNGAN TULANGAN BALOK PORTAL F - F

LT	BALOK	Dimensi	d	Momen KN.m		Mn KN.m		p	m	Rn
				M-	M+	M-	M+			
1	0 - 1	40/65	570	326.797	133.326	408.496	166.658	0.0102	18.824	3.676
	1 - 2	40/65	570	299.751	185.488	374.689	231.860	0.0102	18.824	3.676
	2 - 3	40/65	570	321.070	255.225	401.338	319.031	0.0102	18.824	3.676
	3 - 4	40/65	570	322.128	258.346	402.660	322.933	0.0102	18.824	3.676
	4 - 5	40/65	570	321.606	257.185	402.008	321.481	0.0102	18.824	3.676
	5 - 6	40/65	570	318.097	252.903	397.621	316.129	0.0102	18.824	3.676
	6 - 7	40/65	570	293.846	181.470	367.308	226.838	0.0102	18.824	3.676
	7 - 8	40/65	570	322.539	138.817	403.174	173.521	0.0102	18.824	3.676
2	0 - 1	40/65	570	364.605	128.182	455.756	160.228	0.0102	18.824	3.676
	1 - 2	40/65	570	381.752	263.494	477.190	329.368	0.0102	18.824	3.676
	2 - 3	40/65	570	400.311	335.506	500.389	419.383	0.0102	18.824	3.676
	3 - 4	40/65	570	403.908	335.506	504.885	419.383	0.0102	18.824	3.676
	4 - 5	40/65	570	403.291	341.643	504.114	427.054	0.0102	18.824	3.676
	5 - 6	40/65	570	398.059	333.307	497.574	416.634	0.0102	18.824	3.676
	6 - 7	40/65	570	379.317	260.027	474.146	325.034	0.0102	18.824	3.676
	7 - 8	40/65	570	361.919	128.387	452.399	160.484	0.0102	18.824	3.676
3	0 - 1	40/65	570	346.620	130.367	433.275	162.959	0.0102	18.824	3.676
	1 - 2	40/65	570	353.377	242.611	441.721	303.264	0.0102	18.824	3.676
	2 - 3	40/65	570	351.870	287.110	439.838	358.888	0.0102	18.824	3.676
	3 - 4	40/65	570	359.140	298.093	448.925	372.616	0.0102	18.824	3.676
	4 - 5	40/65	570	358.425	296.822	448.031	371.028	0.0102	18.824	3.676
	5 - 6	40/65	570	349.530	285.248	436.913	356.560	0.0102	18.824	3.676
	6 - 7	40/65	570	349.436	238.627	436.795	298.284	0.0102	18.824	3.676
	7 - 8	40/65	570	343.437	130.576	429.296	163.220	0.0102	18.824	3.676
4	0 - 1	40/65	570	318.217	136.638	397.771	170.798	0.0102	18.824	3.676
	1 - 2	40/65	570	298.386	187.884	372.983	234.855	0.0102	18.824	3.676
	2 - 3	40/65	570	283.500	215.553	354.375	269.441	0.0102	18.824	3.676
	3 - 4	40/65	570	292.759	228.957	365.949	286.196	0.0102	18.824	3.676
	4 - 5	40/65	570	292.250	228.022	365.313	285.028	0.0102	18.824	3.676
	5 - 6	40/65	570	281.522	213.872	351.903	267.340	0.0102	18.824	3.676
	6 - 7	40/65	570	294.583	184.146	368.229	230.183	0.0102	18.824	3.676
	7 - 8	40/65	570	316.437	136.980	395.546	171.225	0.0102	18.824	3.676
5	0 - 1	40/65	570	278.931	145.925	348.664	182.406	0.0102	18.824	3.676
	1 - 2	40/65	570	225.507	111.831	281.884	139.789	0.0102	18.824	3.676
	2 - 3	40/65	570	196.938	124.333	246.173	155.416	0.0102	18.824	3.676
	3 - 4	40/65	570	210.699	140.971	263.374	176.214	0.0102	18.824	3.676
	4 - 5	40/65	570	210.380	140.673	262.975	175.841	0.0102	18.824	3.676
	5 - 6	40/65	570	196.843	124.171	246.054	155.214	0.0102	18.824	3.676
	6 - 7	40/65	570	223.061	109.235	278.826	136.544	0.0102	18.824	3.676
	7 - 8	40/65	570	280.553	149.107	350.691	186.384	0.0102	18.824	3.676
ATAP	0 - 1	30/55	470	126.356	105.517	157.945	131.896	0.0102	18.824	3.676
	1 - 2	30/55	470	116.547	59.863	145.684	74.829	0.0102	18.824	3.676
	2 - 3	30/55	470	93.273	72.471	116.591	90.589	0.0102	18.824	3.676
	3 - 4	30/55	470	99.061	85.613	123.826	107.016	0.0102	18.824	3.676
	4 - 5	30/55	470	98.525	85.235	123.156	106.544	0.0102	18.824	3.676
	5 - 6	30/55	470	95.002	73.498	118.753	91.873	0.0102	18.824	3.676
	6 - 7	30/55	470	116.003	60.592	145.004	75.740	0.0102	18.824	3.676
	7 - 8	30/55	470	125.658	100.962	157.073	126.203	0.0102	18.824	3.676

Tulangan Tumpuan Portal F - F									
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a	Mn
527.080	sebelah	3.143	0.009	1988.556	5.233	6	2280	107.294	470.914
504.798	sebelah	2.883	0.008	1823.982	4.800	5	1900	89.412	399.224
522.441	sebelah	3.088	0.009	1953.708	5.141	6	2280	107.294	470.914
523.301	sebelah	3.098	0.009	1960.145	5.158	6	2280	107.294	470.914
522.877	sebelah	3.093	0.009	1956.969	5.150	6	2280	107.294	470.914
520.016	sebelah	3.060	0.008	1935.617	5.094	6	2280	107.294	470.914
499.801	sebelah	2.826	0.008	1788.050	4.705	5	1900	89.412	399.224
523.635	sebelah	3.102	0.009	1962.646	5.165	6	2280	107.294	470.914
556.735	sebelah	3.507	0.010	2218.618	5.838	6	2280	107.294	470.914
569.676	sebelah	3.672	0.010	2322.957	6.113	7	2660	125.176	539.886
583.359	rangkap	-	-	-	-	-	-	-	542.494
585.974	rangkap	-	-	-	-	-	-	-	542.494
585.526	rangkap	-	-	-	-	-	-	-	542.494
581.716	rangkap	-	-	-	-	-	-	-	542.494
567.856	sebelah	3.648	0.010	2308.140	6.074	7	2660	125.176	539.886
554.681	sebelah	3.481	0.010	2202.273	5.795	6	2280	107.294	470.914
542.830	sebelah	3.334	0.009	2109.179	5.550	6	2280	107.294	470.914
548.096	sebelah	3.399	0.009	2150.295	5.659	6	2280	107.294	470.914
546.926	sebelah	3.384	0.009	2141.125	5.635	6	2280	107.294	470.914
552.547	sebelah	3.454	0.010	2185.363	5.751	6	2280	107.294	470.914
551.997	sebelah	3.447	0.010	2181.012	5.740	6	2280	107.294	470.914
545.104	sebelah	3.362	0.009	2126.886	5.597	6	2280	107.294	470.914
545.031	sebelah	3.361	0.009	2126.314	5.596	6	2280	107.294	470.914
540.332	sebelah	3.303	0.009	2089.811	5.500	6	2280	107.294	470.914
520.114	sebelah	3.061	0.008	1936.347	5.096	6	2280	107.294	470.914
503.647	sebelah	2.870	0.008	1815.676	4.778	5	1900	89.412	399.224
490.923	sebelah	2.727	0.008	1725.094	4.540	5	1900	89.412	399.224
498.876	sebelah	2.816	0.008	1781.435	4.688	5	1900	89.412	399.224
498.442	sebelah	2.811	0.008	1778.338	4.680	5	1900	89.412	399.224
489.208	sebelah	2.708	0.008	1713.058	4.508	5	1900	89.412	399.224
500.427	sebelah	2.833	0.008	1792.534	4.717	5	1900	89.412	399.224
518.658	sebelah	3.044	0.008	1925.516	5.067	6	2280	107.294	470.914
486.951	sebelah	2.683	0.007	1697.292	4.467	5	1900	89.412	399.224
437.842	sebelah	2.169	0.006	1372.208	3.611	4	1520	71.529	324.815
409.168	sebelah	1.894	0.005	1198.366	3.154	4	1520	71.529	324.815
423.222	sebelah	2.027	0.006	1282.101	3.374	4	1520	71.529	324.815
422.902	sebelah	2.024	0.006	1280.160	3.369	4	1520	71.529	324.815
409.070	sebelah	1.893	0.005	1197.788	3.152	4	1520	71.529	324.815
435.461	sebelah	2.145	0.006	1357.324	3.572	4	1520	71.529	324.815
488.365	sebelah	2.698	0.007	1707.162	4.493	5	1900	89.412	399.224
327.744	sebelah	1.788	0.005	932.465	2.454	3	1140	53.647	202.088
314.766	sebelah	1.649	0.005	860.078	2.263	3	1140	53.647	202.088
281.589	sebelah	1.320	0.004	688.324	1.811	2	760	35.765	137.444
290.194	sebelah	1.401	0.004	731.037	1.924	2	760	35.765	137.444
289.408	sebelah	1.394	0.004	727.082	1.913	2	760	35.765	137.444
284.187	sebelah	1.344	0.004	701.083	1.845	2	760	35.765	137.444
314.031	sebelah	1.641	0.005	856.064	2.253	3	1140	53.647	202.088
326.838	sebelah	1.778	0.005	927.314	2.440	3	1140	53.647	202.088

Tulangan Lapangan Portal F - F								
d perlu	Analisis	Rn baru	p baru	As perlu	As pakai	n (D22)	As ada	a
336.662	sebelah	1.282	0.004	811.287	2.135	3	1140	53.647
397.096	sebelah	1.784	0.005	1128.693	2.970	4	1520	71.529
465.799	sebelah	2.455	0.007	1553.041	4.087	5	1900	89.412
468.639	sebelah	2.485	0.007	1572.033	4.137	5	1900	89.412
467.584	sebelah	2.474	0.007	1564.968	4.118	5	1900	89.412
463.676	sebelah	2.433	0.007	1538.912	4.050	5	1900	89.412
392.771	sebelah	1.745	0.005	1104.243	2.906	3	1140	53.647
343.525	sebelah	1.335	0.004	844.700	2.223	3	1140	53.647
330.104	sebelah	1.233	0.003	779.986	2.053	3	1140	53.647
473.285	sebelah	2.534	0.007	1603.358	4.219	5	1900	89.412
534.057	sebelah	3.227	0.009	2041.550	5.373	6	2280	107.294
534.057	sebelah	3.227	0.009	2041.550	5.373	6	2280	107.294
538.919	sebelah	3.286	0.009	2078.894	5.471	6	2280	107.294
532.304	sebelah	3.206	0.009	2028.170	5.337	6	2280	107.294
470.161	sebelah	2.501	0.007	1582.262	4.164	5	1900	89.412
330.368	sebelah	1.235	0.003	781.234	2.056	3	1140	53.647
332.906	sebelah	1.254	0.003	793.282	2.088	3	1140	53.647
454.143	sebelah	2.334	0.006	1476.285	3.885	4	1520	71.529
494.039	sebelah	2.762	0.008	1747.061	4.598	5	1900	89.412
503.400	sebelah	2.867	0.008	1813.893	4.773	5	1900	89.412
502.326	sebelah	2.855	0.008	1806.159	4.753	5	1900	89.412
492.435	sebelah	2.744	0.008	1735.731	4.568	5	1900	89.412
450.399	sebelah	2.295	0.006	1452.043	3.821	4	1520	71.529
333.172	sebelah	1.256	0.003	794.554	2.091	3	1140	53.647
340.818	sebelah	1.314	0.004	831.441	2.188	3	1140	53.647
399.652	sebelah	1.807	0.005	1143.272	3.009	4	1520	71.529
428.070	sebelah	2.073	0.006	1311.638	3.452	4	1520	71.529
441.178	sebelah	2.202	0.006	1393.201	3.666	4	1520	71.529
440.277	sebelah	2.193	0.006	1387.511	3.651	4	1520	71.529
426.397	sebelah	2.057	0.006	1301.409	3.425	4	1520	71.529
395.657	sebelah	1.771	0.005	1120.526	2.949	3	1140	53.647
341.245	sebelah	1.318	0.004	833.522	2.193	3	1140	53.647
352.210	sebelah	1.404	0.004	887.952	2.337	3	1140	53.647
308.332	sebelah	1.076	0.003	680.490	1.791	2	760	35.765
325.110	sebelah	1.196	0.003	756.565	1.991	2	760	35.765
346.180	sebelah	1.356	0.004	857.807	2.257	3	1140	53.647
345.814	sebelah	1.353	0.004	855.994	2.253	3	1140	53.647
324.898	sebelah	1.194	0.003	755.579	1.988	3	1140	53.647
304.732	sebelah	1.051	0.003	664.694	1.749	2	760	35.765
356.030	sebelah	1.434	0.004	907.315	2.388	3	1140	53.647
299.501	sebelah	1.493	0.004	778.680	2.049	3	1140	53.647
225.588	sebelah	0.847	0.002	441.769	1.163	2	760	35.765
248.210	sebelah	1.025	0.003	534.812	1.407	2	760	35.765
269.778	sebelah	1.211	0.003	631.796	1.663	2	760	35.765
269.182	sebelah	1.206	0.003	629.006	1.655	2	760	35.765
249.963	sebelah	1.040	0.003	542.391	1.427	2	760	35.765
226.958	sebelah	0.857	0.002	447.149	1.177	2	760	35.765
292.965	sebelah	1.428	0.004	745.066	1.961	2	760	35.765

PERHITUNGAN TULANGAN RANGKAP PORTAL F - F

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	2 - 3	400	650	570	400.311	315.506	500.389	394.383	0.010	18.824	3.676	583.359

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	21.055	227.193	189.129	1.433	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	Momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	3 - 4	400	650	570	403.908	335.506	504.885	419.383	0.010	18.824	3.676	585.974

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	25.551	227.193	229.517	1.739	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	4 - 5	400	650	570	403.391	341.643	504.239	427.054	0.0102	18.824	3.676	585.599

anggap baja cesak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	24.905	227.193	223.712	1.695	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

LT	BALOK	b	h	d	momen KN.m		Mn KN.m		p	m	Rn	d perlu
					M-	M+	M-	M+				
2	5 - 6	400	650	570	398.659	332.707	498.324	415.884	0.010	18.824	3.676	582.154

anggap baja desak leleh

As1	a	Mn1	Mn2	fs'	As'	As pakai	n (D13)	As' ada	As tarik	As pakai	n (D22)	As ada
2325.6	109.440	479.334	18.990	227.193	170.579	1.292	2	264	2589.6	6.815	7	2660

kontrol tegangan

p	p'	p-p'	fs'	a	Mn1	Mn2	Mn
0.012	0.0012	0.011	238.147	117.780	511.687	30.807	542.494

PERHITUNGAN TULANGAN GESER BALOK PORTAL F - F

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
1	0 - 1	122.22	20.83	38.15	470.914	247.688	6.55	150.203	246.199	310.433	229.491	0	382.485	56.153	142.5	2P10-100
	1 - 2	48.46	6.50	129.16	399.224	324.815	3.1	57.708	262.074	600.180	186.920	0	311.533	68.942	142.5	P10-60
	2 - 3	49.36	7.25	149.45	470.914	399.224	3.25	59.441	293.708	687.131	211.534	0	352.557	60.919	142.5	P10-60
	3 - 4	49.93	7.37	149.66	470.914	399.224	3.25	60.165	294.433	688.737	212.259	0	353.765	60.712	142.5	P10-60
	4 - 5	50.18	7.39	149.20	470.914	399.224	3.25	60.449	294.716	687.089	212.542	0	354.237	60.631	142.5	P10-60
	5 - 6	49.11	7.22	148.08	470.914	399.224	3.25	59.147	293.414	681.083	211.240	0	352.067	61.004	142.5	P10-60
	6 - 7	48.30	6.85	127.24	399.224	247.688	3.1	57.908	240.504	592.316	173.355	0	288.926	74.336	142.5	P10-70
	7 - 8	122.28	20.84	37.17	470.914	247.688	6.55	150.276	246.272	306.390	229.565	0	382.608	56.135	142.5	2P10-100
2	0 - 1	117.47	21.12	24.17	470.914	247.688	6.55	145.520	241.516	247.034	224.808	0	374.680	57.322	142.5	2P10-100
	1 - 2	54.62	8.75	158.57	539.886	399.224	3.1	66.539	331.610	732.533	234.132	0	390.220	55.040	142.5	2P10-100
	2 - 3	49.97	7.85	188.42	542.494	470.914	3.25	60.711	333.552	852.075	237.847	0	396.412	54.180	142.5	2P10-100
	3 - 4	50.60	8.00	190.10	542.494	470.914	3.25	61.530	334.371	859.950	238.666	0	397.777	53.994	142.5	2P10-100
	4 - 5	50.98	7.39	189.70	542.494	470.914	3.25	61.289	334.129	858.029	238.425	0	397.375	54.049	142.5	2P10-100
	5 - 6	49.60	7.22	187.11	542.494	470.914	3.25	59.661	332.502	845.523	236.797	0	394.662	54.420	142.5	2P10-100
	6 - 7	54.82	6.85	157.07	539.886	399.224	3.1	64.754	329.825	724.448	232.347	0	387.245	55.463	142.5	2P10-100
	7 - 8	117.34	20.84	46.53	470.914	247.688	6.55	145.089	241.085	340.515	224.378	0	373.963	57.432	142.5	2P10-100
3	0 - 1	118.69	21.42	42.01	470.914	247.688	6.55	147.116	243.112	323.558	226.404	0	377.340	56.918	142.5	2P10-100
	1 - 2	62.32	10.25	136.23	470.914	324.815	3.1	76.199	300.799	648.365	218.204	0	363.674	59.057	142.5	2P10-100
	2 - 3	51.23	8.12	161.31	470.914	399.224	3.25	62.318	296.585	739.820	214.411	0	357.352	60.102	142.5	P10-60
	3 - 4	52.29	8.35	164.38	470.914	399.224	3.25	63.672	297.940	754.068	215.766	0	359.610	59.725	142.5	2P10-100
	4 - 5	52.71	8.41	163.96	470.914	399.224	3.25	64.176	298.444	752.808	216.270	0	360.450	59.586	142.5	2P10-100
	5 - 6	50.83	8.06	160.17	470.914	399.224	3.25	61.835	296.102	734.549	213.928	0	356.547	60.238	142.5	P10-60
	6 - 7	62.49	10.25	134.63	470.914	324.815	3.1	76.377	300.978	641.823	218.383	0	363.971	59.009	142.5	2P10-100
	7 - 8	118.53	21.38	41.04	470.914	247.688	6.55	146.906	242.902	319.274	226.194	0	376.990	56.971	142.5	2P10-100
4	0 - 1	124.51	21.57	32.81	470.914	247.688	6.55	153.384	249.380	291.186	232.673	0	387.788	55.385	142.5	2P10-100
	1 - 2	68.93	11.11	102.05	399.224	324.815	3.1	84.042	288.408	512.652	213.254	0	355.423	60.428	142.5	P10-60
	2 - 3	53.91	8.20	123.69	399.224	324.815	3.25	65.216	260.149	584.714	191.772	0	319.621	67.197	142.5	P10-60
	3 - 4	55.46	8.52	127.38	399.224	324.815	3.25	67.179	262.112	602.175	193.736	0	322.893	66.516	142.5	P10-60
	4 - 5	55.94	8.60	127.03	399.224	324.815	3.25	67.767	262.700	601.293	194.324	0	323.873	66.315	142.5	P10-60
	5 - 6	53.46	8.13	122.29	399.224	324.815	3.25	64.670	259.603	578.288	191.226	0	318.711	67.389	142.5	P10-60
	6 - 7	69.03	11.11	100.83	399.224	247.688	3.1	84.147	266.743	507.633	199.595	0	332.658	64.564	142.5	P10-60
	7 - 8	124.45	21.54	32.30	470.914	247.688	6.55	153.290	249.286	288.950	232.578	0	387.630	55.407	142.5	2P10-100

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	sendi plastis				
												Vc	Vs	s1	s2	s pakai
5	0 - 1	134.22	21.38	21.26	399.224	247.688	6.55	163.380	249.800	252.672	234.759	0	391.264	54.893	142.5	2P10-100
	1 - 2	74.83	11.52	60.74	324.815	167.844	3.1	90.668	229.724	345.776	178.587	0	297.646	72.158	142.5	P10-70
	2 - 3	57.72	8.03	77.24	324.815	167.844	3.25	69.038	201.676	393.446	155.151	0	258.585	83.058	142.5	P10-80
	3 - 4	60.18	8.54	82.07	324.815	247.688	3.25	72.156	226.292	416.850	172.226	0	287.043	74.824	142.5	P10-70
	4 - 5	60.54	8.60	82.05	324.815	247.688	3.25	72.597	226.733	417.207	172.667	0	287.778	74.633	142.5	P10-70
	5 - 6	57.37	7.49	77.33	324.815	247.688	3.25	68.103	222.239	392.889	168.173	0	280.288	76.627	142.5	P10-70
	6 - 7	74.53	11.41	60.83	324.815	167.844	3.1	90.237	229.294	345.723	178.157	0	296.928	72.333	142.5	P10-70
	7 - 8	134.28	21.42	21.33	399.224	247.688	6.55	163.485	249.905	253.071	234.864	0	391.439	54.868	142.5	2P10-100
ATAP	0 - 1	61.88	9.32	9.75	202.088	202.088	6.55	74.760	128.753	115.710	121.004	0	201.674	87.813	117.5	P10-80
	1 - 2	30.78	4.29	22.75	202.088	137.444	3.1	36.824	132.659	132.374	103.599	0	172.666	102.57	117.5	P10-100
	2 - 3	18.24	1.49	35.44	137.444	137.444	3.25	20.717	94.725	169.565	73.319	0	122.199	144.92	117.5	P10-110
	3 - 4	18.90	1.64	39.24	137.444	137.444	3.25	21.567	95.575	186.375	74.170	0	123.616	143.26	117.5	P10-110
	4 - 5	19.03	1.65	39.34	137.444	137.444	3.25	21.714	95.722	186.942	74.317	0	123.861	142.98	117.5	P10-110
	5 - 6	18.12	1.49	35.99	137.444	137.444	3.25	20.591	94.599	171.749	73.193	0	121.989	145.17	117.5	P10-110
	6 - 7	31.15	4.39	23.05	202.088	137.444	3.1	37.317	133.153	134.127	104.093	0	173.488	102.08	117.5	P10-100
	7 - 8	55.24	7.36	10.09	202.088	137.444	6.55	65.730	111.087	108.108	104.578	0	174.297	101.61	117.5	P10-100

	6 - 7	69.03	11.11	100.05	330.224	247.688	3.1	84.147	266.743	307.633	199.595	175.230	190	102.049	210.463	285	P10-230
	7 - 8	124.45	21.54	32.30	470.914	247.688	6.55	153.290	249.286	288.950	232.578	204.187	190	150.311	142.888	285	P10-140

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
5	0 - 1	134.22	21.38	21.26	399.224	247.688	6.55	163.380	249.800	252.672	234.759	206.101	190	153.501	139.918	285	P10-130
	1 - 2	74.83	11.52	60.74	324.815	167.844	3.1	90.668	229.724	345.776	178.587	156.787	190	71.311	301.182	285	P10-280
	2 - 3	57.72	8.03	77.24	324.815	167.844	3.25	69.038	201.676	393.446	155.151	136.211	190	37.018	580.19	285	P10-280
	3 - 4	60.18	8.54	82.07	324.815	247.688	3.25	72.156	226.292	416.850	172.226	151.201	190	62.002	346.400	285	P10-280
	4 - 5	60.54	8.60	82.05	324.815	247.688	3.25	72.597	226.733	417.207	172.667	151.589	190	62.648	342.832	285	P10-280
	5 - 6	57.37	7.49	77.33	324.815	247.688	3.25	68.103	222.239	392.889	168.173	147.643	190	56.072	383.04	285	P10-280
	6 - 7	74.53	11.41	60.83	324.815	167.844	3.1	90.237	229.294	345.723	178.157	156.409	190	70.681	303.867	285	P10-280
	7 - 8	134.28	21.42	21.33	399.224	247.688	6.55	163.485	249.905	253.071	234.864	206.193	190	153.655	139.778	285	P10-130
ATAP	0 - 1	61.88	9.32	9.75	202.088	202.088	6.55	74.760	128.753	115.710	121.004	104.486	190	-15.857	-1354.45	285	P10-280
	1 - 2	30.78	4.29	22.75	202.088	137.444	3.1	36.824	132.659	132.374	103.599	89.457	190	-40.906	-525.054	285	P10-280
	2 - 3	18.24	1.49	35.44	137.444	137.444	3.25	20.717	94.725	169.565	73.319	63.310	190	-84.48	-254.224	285	P10-250
	3 - 4	18.90	1.64	39.24	137.444	137.444	3.25	21.567	95.575	186.375	74.170	64.045	190	-83.26	-257.961	285	P10-250
	4 - 5	19.03	1.65	39.34	137.444	137.444	3.25	21.714	95.722	186.942	74.317	64.172	190	-83.05	-258.618	285	P10-250
	5 - 6	18.12	1.49	35.99	137.444	137.444	3.25	20.591	94.599	171.749	73.193	63.201	190	-84.66	-253.679	285	P10-250
	6 - 7	31.15	4.39	23.05	202.088	137.444	3.1	37.317	133.153	134.127	104.093	89.883	190	-40.195	-534.331	285	P10-280
	7 - 8	55.24	7.36	10.09	202.088	137.444	6.55	65.730	111.087	108.108	104.578	90.302	190	-39.497	-543.778	285	P10-280

Tabel Pembebanan Kolom 15

ID	Batang	Beban	Stasiun	P	T	V2	V3	M2	M3
1	15	DL	0	-1538.694	-32.443	-32.317	0.078	-37.411	-37.070
2	15	DL	1.8	-1520.776	-32.443	-32.317	0.078	20.760	21.328
3	15	DL	3.6	-1502.857	-32.443	-32.317	0.078	78.930	79.725
4	15	LL	0	-189.530	-6.187	-6.149	0.017	-7.157	-7.068
5	15	LL	1.8	-189.530	-6.187	-6.149	0.017	3.910	4.069
6	15	LL	3.6	-189.530	-6.187	-6.149	0.017	14.978	15.206
7	15	EX	0	313.378	87.215	0.733	-2.844	-0.915	288.747
8	15	EX	1.8	313.378	87.215	0.733	-2.844	-2.235	131.759
9	15	EX	3.6	313.378	87.215	0.733	-2.844	-3.555	-25.228
10	15	EY	0	597.418	1.920	154.009	-0.580	509.013	1.683
11	15	EY	1.8	597.418	1.920	154.009	-0.580	231.797	-1.773
12	15	EY	3.6	597.418	1.920	154.009	-0.580	-45.418	-5.229
13	15	COMB1	0	-2149.681	-48.832	-48.618	0.121	-56.344	-55.793
14	15	COMB1	1.8	-2128.179	-48.832	-48.618	0.121	31.168	32.104
15	15	COMB1	3.6	-2106.677	-48.832	-48.618	0.121	118.680	120.001
16	15	COMB2	0	-1217.800	54.217	11.477	-3.076	115.589	260.338
17	15	COMB2	1.8	-1198.985	54.217	11.477	-3.076	94.931	162.747
18	15	COMB2	3.6	-1180.171	54.217	11.477	-3.076	74.272	65.155
19	15	COMB3	0	-1594.173	53.008	-85.549	-2.711	-205.090	259.277
20	15	COMB3	1.8	-1575.358	53.008	-85.549	-2.711	-51.102	163.863
21	15	COMB3	3.6	-1556.544	53.008	-85.549	-2.711	102.886	68.449
22	15	COMB4	0	-1875.893	-128.934	9.936	2.896	117.510	-346.030
23	15	COMB4	1.8	-1857.079	-128.934	9.936	2.896	99.624	-113.948
24	15	COMB4	3.6	-1838.264	-128.934	9.936	2.896	81.738	118.134
25	15	COMB5	0	-2252.266	-130.144	-87.089	3.262	-203.169	-347.090
26	15	COMB5	1.8	-2233.452	-130.144	-87.089	3.262	-46.408	-112.831
27	15	COMB5	3.6	-2214.637	-130.144	-87.089	3.262	110.352	121.428
28	15	COMB6	0	-1009.031	-8.474	124.134	-1.412	490.386	49.346
29	15	COMB6	1.8	-990.216	-8.474	124.134	-1.412	266.944	64.600
30	15	COMB6	3.6	-971.402	-8.474	124.134	-1.412	43.503	79.854
31	15	COMB7	0	-2263.608	-12.507	-199.284	-0.194	-578.542	45.812
32	15	COMB7	1.8	-2244.793	-12.507	-199.284	-0.194	-219.830	68.323
33	15	COMB7	3.6	-2225.979	-12.507	-199.284	-0.194	138.882	90.835
34	15	COMB8	0	-1206.458	-63.420	123.672	0.379	490.962	-132.564
35	15	COMB8	1.8	-1187.644	-63.420	123.672	0.379	268.352	-18.408
36	15	COMB8	3.6	-1168.830	-63.420	123.672	0.379	45.743	95.748
37	15	COMB9	0	-1206.458	-63.420	123.672	0.379	490.962	-132.564
38	15	COMB9	1.8	-1187.644	-63.420	123.672	0.379	268.352	-18.408
39	15	COMB9	3.6	-1168.830	-63.420	123.672	0.379	45.743	95.748

TABEL PENULANGAN KOLOM PORTAL AS A - A

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
1	A - 0	650/650	5492	2746	7.2263	8	8 D22	3040	2P10-100	P10-270
	A - 1	650/650	7030	3515	9.2500	10	10 D22	3800	2P10-80	P10-200
	A - 2	350/350	3189	1594.5	4.1961	5	5 D22	1900	2P10-140	P10-145
	A - 3	350/350	4655	2327.5	6.1250	7	7 D22	2660	2P10-140	P10-145
	A - 4	350/350	3900	1950	5.1316	6	6 D22	2280	2P10-140	P10-145
	A - 5	350/350	4696	2348	6.1789	7	7 D22	2660	2P10-140	P10-145
	A - 6	350/350	3377	1688.5	4.4434	5	5 D22	1900	2P10-140	P10-145
	A - 7	650/650	6792	3396	8.9368	9	9 D22	3420	2P10-140	P10-145
	A - 8	650/650	4985	2492.5	6.5592	7	7 D22	2660	2P10-90	P10-100
2	A - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-250
	A - 1	650/650	7945	3972.5	10.4539	11	11 D22	4180	2P10-120	P10-200
	A - 2	350/350	5247	2623.5	6.9039	7	7 D22	2660	2P10-140	P10-145
	A - 3	350/350	5849	2924.5	7.6961	8	8 D22	3040	2P10-140	P10-145
	A - 4	350/350	5556	2778	7.3105	8	8 D22	3040	2P10-140	P10-145
	A - 5	350/350	5964	2982	7.8474	8	8 D22	3040	2P10-140	P10-145
	A - 6	350/350	5345	2672.5	7.0329	8	8 D22	3040	2P10-140	P10-145
	A - 7	650/650	7793	3896.5	10.2539	11	11 D22	4180	2P10-130	P10-220
	A - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-280
3	A - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-130	P10-195
	A - 1	650/650	5912	2956	7.7789	8	8 D22	3040	2P10-120	P10-160
	A - 2	350/350	5546	2773	7.2974	8	8 D22	3040	2P10-140	P10-145
	A - 3	350/350	5670	2835	7.4605	8	8 D22	3040	2P10-140	P10-145
	A - 4	350/350	5094	2547	6.7026	7	7 D22	2660	2P10-140	P10-145
	A - 5	350/350	5589	2794.5	7.3539	8	8 D22	3040	2P10-140	P10-145
	A - 6	350/350	5543	2771.5	7.2934	8	8 D22	3040	2P10-140	P10-145
	A - 7	650/650	4830	2415	6.3553	7	7 D22	2660	2P10-120	P10-180
	A - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-130	P10-195

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
4	A - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-160
	A - 1	650/650	5912	2956	7.7789	8	8 D22	3040	2P10-100	P10-100
	A - 2	350/350	4768	2384	6.2737	7	7 D22	2660	P10-60	P10-130
	A - 3	350/350	4738	2369	6.2342	7	7 D22	2660	P10-60	P10-130
	A - 4	350/350	4110	2055	5.4079	6	6 D22	2280	P10-60	P10-130
	A - 5	350/350	4627	2313.5	6.0882	7	7 D22	2660	P10-60	P10-130
	A - 6	350/350	4755	2377.5	6.2566	7	7 D22	2660	P10-60	P10-130
	A - 7	650/650	4574	2287	6.0184	7	7 D22	2660	2P10-130	P10-200
	A - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-200
5	A - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-80	P10-100
	A - 1	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-70	P10-90
	A - 2	350/350	3798	1899	4.9974	5	5 D22	1900	P10-60	P10-130
	A - 3	350/350	4627	2313.5	6.0882	7	7 D22	2660	P10-60	P10-130
	A - 4	350/350	4344	2172	5.7158	6	6 D22	2280	P10-60	P10-130
	A - 5	350/350	3605	1802.5	4.7434	5	5 D22	1900	P10-60	P10-130
	A - 6	350/350	3840	1920	5.0526	6	6 D22	2280	P10-60	P10-130
	A - 7	650/650	5245	2622.5	6.9013	7	7 D22	3430	2P10-100	P10-100
	A - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-170	P10-170
6	A - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-115	P10-230
	A - 1	650/650	8156	4078	10.7316	11	11 D22	4180	2P10-95	P10-200
	A - 2	350/350	1451	725.5	3.6275	4	4 D16	800	P10-60	P10-130
	A - 3	350/350	1442	721	3.6050	4	4 D16	800	P10-60	P10-130
	A - 4	350/350	1225	612.5	3.0625	4	4 D16	800	P10-60	P10-130
	A - 5	350/350	1443	721.5	3.6075	4	4 D16	800	P10-60	P10-130
	A - 6	350/350	1491	745.5	3.7275	4	4 D16	800	P10-60	P10-130
	A - 7	650/650	5245	2622.5	6.9013	7	7 D22	2660	2P10-90	P10-90
	A - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-115	P10-230

lampiran 6.5

TABEL PENULANGAN KOLOM PORTAL AS B - B

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
1	B - 0	650/650	6151	3075.5	8.0934	9	9 D22	3420	2P10-140	P10-280
	B - 1	650/650	6694	3347	8.8079	9	9 D22	3420	2P10-120	P10-260
	B - 3	650/650	10019	5009.5	10.2235	11	11D25	5390	2P10-100	P10-220
	B - 5	650/650	9766	4883	9.9653	10	10D25	4900	2P10-100	P10-220
	B - 7	650/650	9315	4657.5	9.5051	10	10D25	4900	2P10-120	P10-220
	B - 8	650/650	5893	2946.5	7.7539	8	8 D22	3040	2P10-140	P10-280
2	B - 0	650/650	6047	3023.5	7.9566	8	8 D22	3040	2P10-100	P10-155
	B - 1	650/650	4995	2497.5	6.5724	7	7 D22	2660	2P10-100	P10-165
	B - 3	650/650	6587	3293.5	8.6671	9	9 D22	3420	2P10-90	P10-170
	B - 5	650/650	6427	3213.5	8.4566	9	9 D22	3420	2P10-90	P10-165
	B - 7	650/650	6362	3181	8.3711	9	9 D22	3420	2P10-90	P10-165
	B - 8	650/650	6092	3046	8.0158	9	9 D22	3420	2P10-100	P10-150
3	B - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-270
	B - 1	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-270
	B - 3	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-90	P10-250
	B - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-90	P10-250
	B - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-90	P10-250
	B - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-280
4	B - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-110	P10-280
	B - 1	650/650	8084	4042	10.6368	11	11 D22	4180	2P10-100	P10-220
	B - 3	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-260
	B - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-260
	B - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-270
	B - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-120	P10-280
5	B - 0	650/650	7591	3795.5	9.9882	10	10 D22	3800	2P10-120	P10-280
	B - 1	-	-	-	-	-	-	-	-	-
	B - 3	650/650	10192	5096	10.4000	11	11D25	5390	2P10-90	P10-220

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
	B - 5	650/650	5950	2975	7.8289	8	8 D22	3040	2P10-125	P10-280
	B - 7	650/650	6984	3492	9.1895	10	10 D22	3800	2P10-125	P10-280
	B - 8	650/650	5566	2783	7.3237	8	8 D22	3040	2P10-140	P10-280
6	B - 0	650/650	9639.5	4819.75	9.8362	10	10 D25	4900	2P10-95	P10-95
	B - 1	-	-	-	-	-	-	-	-	-
	B - 3	-	-	-	-	-	-	-	-	-
	B - 5	-	-	-	-	-	-	-	-	-
	B - 7	-	-	-	-	-	-	-	-	-
	B - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-110	P10-110

TABEL PENULANGAN KOLOM PORTAL AS C - C

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
1	C - 0	650/650	5852	2926	7.7000	8	8 D22	3040	2P10-140	P10-280
	C - 1	650/650	6491	3245.5	8.5408	9	9 D22	3420	2P10-130	P10-280
	C - 3	650/650	9247	4623.5	9.4357	10	10 D25	4900	2P10-110	P10-220
	C - 5	650/650	8903	4451.5	11.7145	12	12 D22	4560	2P10-120	P10-220
	C - 7	650/650	8572	4286	11.2789	12	12 D22	4560	2P10-120	P10-220
	C - 8	650/650	5607	2803.5	7.3776	8	8 D22	3040	2P10-140	P10-280
2	C - 0	650/650	5664	2832	7.4526	8	8 D22	3040	2P10-100	P10-160
	C - 1	650/650	4738	2369	6.2342	7	7 D22	2660	2P10-100	P10-165
	C - 3	650/650	6145	3072.5	8.0855	9	9 D22	3420	2P10-95	P10-170
	C - 5	650/650	6008	3004	7.9053	8	8 D22	3040	2P10-90	P10-170
	C - 7	650/650	5957	2978.5	7.8382	8	8 D22	3040	2P10-95	P10-170
	C - 8	650/650	5811	2905.5	7.6461	8	8 D22	3040	2P10-100	P10-155
3	C - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-270
	C - 1	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-95	P10-270
	C - 3	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-95	P10-245
	C - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-95	P10-245
	C - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-95	P10-245
	C - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-280
4	C - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-110	P10-280
	C - 1	650/650	6192	3096	8.1474	9	9 D22	3420	2P10-110	P10-280
	C - 3	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-85	P10-270
	C - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-270
	C - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-260
	C - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-120	P10-280
5	C - 0	650/650	6219	3109.5	8.1829	9	9 D22	3420	2P10-125	P10-280
	C - 1	-	-	-	-	-	-	-	-	-
	C - 3	650/650	9770	4885	9.9694	10	10 D25	4900	2P10-100	P10-245
	C - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-250

lampiran 6.9

TABEL PENULANGAN KOLOM PORTAL AS D - D

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
1	D - 0	650/650	5998	2999	7.8921	8	8 D22	3040	2P10-140	P10-280
	D - 1	650/650	8434	4217	11.0974	11	11 D22	4180	2P10-120	P10-240
	D - 3	650/650	9001	4500.5	11.8434	12	12 D22	4560	2P10-110	P10-220
	D - 5	650/650	9132	4566	12.0158	12	12 D22	4560	2P10-110	P10-220
	D - 7	650/650	9147	4573.5	12.0355	12	12 D22	4560	2P10-120	P10-280
	D - 8	650/650	5800	2900	7.6316	8	8 D22	3040	2P10-140	P10-280
2	D - 0	650/650	5689	2844.5	7.4855	8	8 D22	3040	2P10-100	P10-160
	D - 1	650/650	5917	2958.5	7.7855	8	8 D22	3040	2P10-100	P10-170
	D - 3	650/650	6016	3008	7.9158	8	8 D22	3040	2P10-95	P10-170
	D - 5	650/650	6114	3057	8.0447	9	9 D22	3420	2P10-95	P10-165
	D - 7	650/650	6351	3175.5	8.3566	9	9 D22	3420	2P10-95	P10-175
	D - 8	650/650	5767	2883.5	7.5882	8	8 D22	3040	2P10-100	P10-155
3	D - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-270
	D - 1	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-95	P10-250
	D - 3	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-95	P10-245
	D - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-95	P10-245
	D - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-90	P10-250
	D - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-275
4	D - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-115	P10-280
	D - 1	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-280
	D - 3	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-270
	D - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-270
	D - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-265
	D - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-110	P10-280
5	D - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-270
	D - 1	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-275
	D - 3	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-130	P10-240
	D - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-130	P10-230

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
	D - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-130	P10-230
	D - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-270
6	D - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-100
	D - 1	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-100
	D - 3	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-110	P10-110
	D - 5	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-110	P10-110
	D - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-100
	D - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-100	P10-100

lampiran 6.11

TABEL PENULANGAN KOLOM PORTAL AS E - E

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
1	E - 0	650/650	6544	3272	8.6105	9	9 D22	4410	2P10-140	P10-280
	E - 1	650/650	9999	4999.5	10.2031	11	11 D25	5390	2P10-110	P10-200
	E - 3	650/650	9222	4611	9.4102	10	10 D25	4900	2P10-120	P10-230
	E - 5	650/650	9293	4646.5	9.4827	10	10 D25	4900	2P10-120	P10-220
	E - 7	650/650	9737	4868.5	9.9357	10	10 D25	4900	2P10-110	P10-200
	E - 8	650/650	6151	3075.5	8.0934	9	9 D22	4410	2P10-140	P10-280
2	E - 0	650/650	5867	2933.5	7.7197	8	8 D22	3920	2P10-100	P10-155
	E - 1	650/650	6884	3442	9.0579	10	10 D22	4900	2P10-95	P10-160
	E - 3	650/650	6263	3131.5	8.2408	9	9 D22	4410	2P10-95	P10-160
	E - 5	650/650	6266	3133	8.2447	9	9 D22	4410	2P10-95	P10-160
	E - 7	650/650	6756	3378	8.8895	9	9 D22	4410	2P10-95	P10-160
	E - 8	650/650	6053	3026.5	7.9645	8	8 D22	3920	2P10-100	P10-150
3	E - 0	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-100	P10-260
	E - 1	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-90	P10-250
	E - 3	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-90	P10-245
	E - 5	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-95	P10-245
	E - 7	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-90	P10-250
	E - 8	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-100	P10-270
4	E - 0	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-110	P10-280
	E - 1	650/650	4225	2112.5	5.5592	6	6 D22	4818	2P10-100	P10-265
	E - 3	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-100	P10-270
	E - 5	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-100	P10-270
	E - 7	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-100	P10-265
	E - 8	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-115	P10-280
5	E - 0	650/650	4225	2112.5	5.5592	6	6 D22	4818	2P10-140	P10-255
	E - 1	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-130	P10-220
	E - 3	650/650	4225	2112.5	5.5592	6	6 D22	4818	2P10-140	P10-245
	E - 5	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-140	P10-250
	E - 7	650/650	4225	2112.5	5.5592	6	6 D22	2940	2P10-130	P10-220

lampiran 6.13

TABEL PENULANGAN KOLOM PORTAL AS F - F

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
1	F - 0	650/650	5189	2594.5	6.8276	7	7 D22	2660	2P10-100	P10-270
	F - 1	650/650	6977	3488.5	9.1803	10	10 D22	3800	2P10-80	P10-200
	F - 2	350/350	3438	1719	4.5237	5	5 D22	1900	2P10-140	P10-145
	F - 3	350/350	4500	2250	5.9211	6	7 D22	2280	2P10-140	P10-145
	F - 4	350/350	3527	1763.5	4.6408	5	6 D22	1900	2P10-140	P10-145
	F - 5	350/350	4502	2251	5.9237	6	7 D22	2280	2P10-140	P10-145
	F - 6	350/350	3371	1685.5	4.4355	5	5 D22	1900	2P10-140	P10-145
	F - 7	650/650	6811	3405.5	8.9618	9	9 D22	3420	2P10-140	P10-145
	F - 8	650/650	4945	2472.5	6.5066	7	7 D22	2660	2P10-90	P10-100
2	F - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-250
	F - 1	650/650	7855	3927.5	10.3355	11	11 D22	4180	2P10-120	P10-200
	F - 2	350/350	5413	2706.5	7.1224	8	8 D22	3040	2P10-140	P10-145
	F - 3	350/350	5849	2924.5	7.6961	8	8 D22	3040	2P10-140	P10-145
	F - 4	350/350	5489	2744.5	7.2224	8	8 D22	3040	2P10-140	P10-145
	F - 5	350/350	5818	2909	7.6553	8	8 D22	3040	2P10-140	P10-145
	F - 6	350/350	5357	2678.5	7.0487	8	8 D22	3040	2P10-140	P10-145
	F - 7	650/650	7775	3887.5	10.2303	11	11 D22	4180	2P10-130	P10-220
	F - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-280
3	F - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-130	P10-195
	F - 1	650/650	4856	2428	6.3895	7	7 D22	2660	2P10-120	P10-160
	F - 2	350/350	5517	2758.5	7.2592	8	8 D22	3040	2P10-140	P10-145
	F - 3	350/350	5525	2762.5	7.2697	8	8 D22	3040	2P10-140	P10-145
	F - 4	350/350	5023	2511.5	6.6092	7	7 D22	2660	2P10-140	P10-145
	F - 5	350/350	5525	2762.5	7.2697	8	8 D22	3040	2P10-140	P10-145
	F - 6	350/350	5529	2764.5	7.2750	8	8 D22	3040	2P10-140	P10-145
	F - 7	650/650	4793	2396.5	6.3066	7	7 D22	2660	2P10-120	P10-180
	F - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-130	P10-195

LANTAI	AS	DIMENSI	Ast	As=As'	jumlah tulangan	dipakai n	tulangan	AS pakai	tulangan geser	
									sendi plastis	luar sendi plastis
4	F - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-160
	F - 1	650/650	4293	2146.5	5.6487	6	6 D22	2280	2P10-100	P10-100
	F - 2	350/350	4652	2326	6.1211	7	7 D22	2660	2P10-140	P10-145
	F - 3	350/350	4464	2232	5.8737	6	6 D22	2280	2P10-140	P10-145
	F - 4	350/350	3866	1933	5.0868	6	6 D22	2280	2P10-140	P10-145
	F - 5	350/350	4435	2217.5	5.8355	6	6 D22	2280	2P10-140	P10-145
	F - 6	350/350	4597	2298.5	6.0487	7	7 D22	2660	2P10-140	P10-145
	F - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-130	P10-200
	F - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-140	P10-200
5	F - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-80	P10-100
	F - 1	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-70	P10-90
	F - 2	350/350	3535	1767.5	4.6513	5	5 D22	1900	2P10-140	P10-145
	F - 3	350/350	3624	1812	4.7684	5	5 D22	1900	2P10-140	P10-145
	F - 4	350/350	3169	1584.5	4.1697	5	5 D22	1900	2P10-140	P10-145
	F - 5	350/350	3591	1795.5	4.7250	5	5 D22	1900	2P10-140	P10-145
	F - 6	350/350	3713	1856.5	4.8855	5	5 D22	1900	2P10-140	P10-145
	F - 7	650/650	5245	2622.5	6.9013	7	7 D22	2660	2P10-100	P10-100
	F - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-170	P10-170
6	F - 0	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-115	P10-230
	F - 1	650/650	8156	4078	10.7316	11	11 D22	4180	2P10-95	P10-200
	F - 2	350/350	1451	725.5	3.6275	4	4 D16	800	2P10-140	P10-145
	F - 3	350/350	1442	721	3.6050	4	4 D16	800	2P10-140	P10-145
	F - 4	350/350	1225	612.5	3.0625	4	4 D16	800	2P10-140	P10-145
	F - 5	350/350	1443	721.5	3.6075	4	4 D16	800	2P10-140	P10-145
	F - 6	350/350	1491	745.5	3.7275	4	4 D16	800	2P10-140	P10-145
	F - 7	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-90	P10-90
	F - 8	650/650	4225	2112.5	5.5592	6	6 D22	2280	2P10-115	P10-230

lampiran 6.15

h = 650 b = 650

y = 325

Perhitungan Grafik Mn-Pn

No.	Rumus	Ast			
		1% Ag	2% Ag	3% Ag	4% Ag
1	fc'	25	25	25	25
2	fy	400	400	400	400
3	d'	60	60	60	60
4	Ag	422500	422500	422500	422500
5	Ast	4225	8450	12675	16900
6	Pno	10578.344	12178.563	13778.781	15379.000
7	Pmaks = 0,85 Pno	8991.592	10351.778	11711.964	13072.150
8	d=h-d' (dalam keadaan seimbang)	590	590	590	590
9	xb	354	354	354	354
10	fs'	498.305	498.305	498.305	498.305
11	fs' pakai	400	400	400	400
12	a	300.9	300.9	300.9	300.9
13	Cc	4156.181	4156.181	4156.1813	4156.1813
14	As'=As	2112.5	4225	6337.5	8450
15	Cs	800.1094	1600.219	2400.3281	3200.4375
16	Ts	845	1690	2535	3380
17	Pnb	4111.291	4066.400	4021.509	3976.619
18	Mnb	1161.415	1597.369	2033.323	2469.277
19	eb	0.282	0.393	0.506	0.621
20	Patah desak (syarat x> xb)				
21	x diambil	400	400	400	400
22	fs'	510	510	510	510
23	fs' pakai	400	400	400	400
24	fs	285	285	285	285
25	a	340	340	340	340
26	Cc	4696.25	4696.25	4696.25	4696.25
27	Cs	800.109	1600.219	2400.3281	3200.4375
28	Ts	602.063	1204.125	1806.1875	2408.25
29	Pn	4894.297	5092.344	5290.3906	5488.4375
30	Mn	1099.494	1471.070	1842.645	2214.2209
31	e	0.225	0.289	0.348	0.403
32	Patah tarik (syarat x< xb)				
33	x diambil	200	200	200	200
34	a	170	170	170	170
35	fs'	420	420	420	420
36	fs' pakai	400	400	400	400
37	Cc	2348.125	2348.125	2348.125	2348.125
38	Cs	800.109	1600.219	2400.3281	3200.4375
39	fs	1170	1170	1170	1170
40	fs=fy	400	400	400	400
41	Ts	845	1690	2535	3380
42	Pn	2303.234	2258.344	2213.453	2168.563
43	Mn	999.504	1435.458	1871.412	2307.366
44	e	0.434	0.636	0.845	1.064
45	Pada Pn=0				
46	a	61.176	122.353	183.529	244.706
47	Mno	472.703	893.712	1263.026	1580.647

h = 350 b = 350

y = 175

Perhitungan Grafik Mn-Pn

No.	Rumus	Ast			
		1% Ag	2% Ag	3% Ag	4% Ag
1	fc'	25	25	25	25
2	fy	400	400	400	400
3	d'	60	60	60	60
4	Ag	122500	122500	122500	122500
5	Ast	1225	2450	3675	4900
6	Pno	3067.094	3531.063	3995.031	4459
7	Pmaks = 0,85 Pno	2607.03	3001.403	3395.777	3790.15
8	d=h-d' (dalam keadaan seimbang)	290	290	290	290
9	xb	174	174	174	174
10	fs'	393.103	393.103	393.103	393.103
11	fs' pakai	393.103	393.103	393.103	393.103
12	a	147.9	147.9	147.9	147.9
13	Cc	1100.006	1100.006	1100.006	1100.00625
14	As'=As	612.5	1225	1837.5	2450
15	Cs	227.760	455.520	683.281	911.041
16	Ts	240.776	481.552	722.328	963.103
17	Pnb	1086.991	1073.975	1060.959	1047.944
18	Mnb	165.037	218.919	272.801	326.682
19	eb	0.152	0.204	0.257	0.312
20	Patah desak (syarat x> xb)				
21	x diambil	250	250	250	250
22	fs'	456	456	456	456
23	fs' pakai	400	400	400	400
24	fs	96	96	96	96
25	a	212.5	212.5	212.5	212.5
26	Cc	1580.469	1580.469	1580.469	1580.46875
27	Cs	231.984	463.969	695.953	927.938
28	Ts	58.8	117.6	176.4	235.2
29	Pn	1753.653	1926.838	2100.022	2273.20625
30	Mn	142.097	175.538	208.978	242.418
31	e	0.081	0.091	0.100	0.107
32	Patah tarik (syarat x< xb)				
33	x diambil	100	100	100	100
34	a	85	85	85	85
35	fs'	240	240	240	240
36	fs' pakai	240	240	240	240
37	Cc	632.188	632.188	632.188	632.188
38	Cs	133.984	267.969	401.953	535.938
39	fs	1140	1140	1140	1140
40	fs=fy	400	400	400	400
41	Ts	245	490	735	980
42	Pn	521.172	410.156	299.141	188.125
43	Mn	127.348	170.931	214.514	258.098
44	e	0.244	0.417	0.717	1.372
45	Pada Pn=0				
46	a	32.941	65.882	98.824	131.765
47	Mno	67.015	125.959	176.832	219.635

TABEL PERENCANAAN PONDASI P2

Perencanaan Pondasi Persegi Panjang P2	
σ tanah (KN/m2)	300
f'c (MPa)	25
fy (MPa)	400
γb beton (KN/m3)	24
γb tanah (KN/m3)	21.4
P (KN)	3906.873
My (KNm)	641.703
Mx (KNm)	616.197
h kolom (mm)	650
t kolom (mm)	650
tebal pelat (h) (mm)	700
σ netto tanah (KN/m2)	**283.2**
Dicoba nilai B (m)	4.5
A perlu (m2)	19.49777658
P pakai arah x (m)	4.4
L pakai arah y (m)	4.4
A ada (m2)	19.36
Aada(m2)>Aperlu(m2)	**Aman**
σ kontak (KN/m2)	**290.4024371**
Kontrol tegangan	**Aman**
Pb (mm)	70
θ tul.pokok (mm)	22
d (mm)	619

Tinjauan Beban Sementara	
P (KN)	3906.873
Mx (KNm)	616.197
My (KNm)	641.703
ex (m)	0.157721277
ey (m)	0.164249772
P (m)	4.4
L (m)	4.4
σ netto tanah (KN/m2)	283.2
1,5.σnetto tanah(KN/m2)	**424.8**
σ kontak (KN/m2)	**108.8670155**
Kontrol	**Aman**

Perencanaan Geser 1 Arah (x)	
m (m)	1.256
L (m)	4.4
qux terjadi (KN/m2)	232.81421
Vu (KN)	1286.62446
Vu/ϕ (KN)	2144.3741
Vc (KN)	2269.66667
Vc > Vu/ϕ	**Aman**
Perencanaan Geser 1 Arah (y)	
n (m)	1.256
P (m)	4.4
quy terjadi (KN/m2)	238.78072
Vu (KN)	1319.59778
Vu/ϕ (KN)	2199.32963
Vc (KN)	2269.66667
Vc > Vu/ϕ	**Aman**

Perencanaan Geser Dua (2) arah	
x (m)	1.269
y (m)	1.269
P (m)	4.4
L (m)	4.4
qu.pakai (KN/m2)	201.801291
Vu (KN)	3905.26264
Vu/ϕ (KN)	6508.77107
βc	1
bo (mm)	5076
Vc1 (KN)	94261.32
Vc2 (KN)	62840.88
Vc2 (KN) > Vu/ϕ (KN)	**Aman**

Kuat Tumpuan Pondasi	
Luas pondasi (A2) (m2)	19.36
Luas kolom (A1) (m2)	0.4225
(A2/A1)^0,5	6.76923077
jika lebih besar dari 2, dipakai nilai 2	
ϕPn (KN)	12569.375
Kuat Tumpuan Kolom	
ϕPn (KN)	6284.6875
ϕPn pondasi > ϕPn kolom	
Aman	

Perencanaan Tulangan Lentur Pondasi P2 (Arah X dan Y)

Tul. Lentur Arah Sisi Panjang (X)	
P (m)	4.4
h kolom (m)	0.65
l1 (m)	1.875
qux (KN/m2)	232.8142115
Mu1 (KNm)	409.2437312
Mu1/ϕ (KNm)	511.5546639
Digunakan tul. pokok ∅22mm	
A1∅22 (mm2)	380
tebal pelat (mm)	700
Pb (mm)	70
d (mm)	619
fy (Mpa)	400
f'c (Mpa)	25
β1	0.85
m	18.82352941
Rn (Mpa)	1.335090638
ρmin	0.0035
ρb	0.02709375
ρmaks	0.020320313
ρ aktual	0.003449733
1,33.ρ aktual	0.004588145
ρ pakai	0.004588145
As perlu (mm2)	2840.061498
jrk tul.pokok/s (mm)	133.7999196
jrk tul.pakai/s (mm)	125
Dipakai Tul. Pokok	**D22- 125**
As aktual (mm)	3040
a (mm)	57.22352941
Mn (KNm)	717.9120941
1,33 Mu1/ϕ (KNm)	680.3677031
Mn >1,33 Mu1/ϕ	**Aman**

Tul. Lentur Arah Sisi Lebar (Y)	
L (m)	4.4
t kolom (m)	0.65
l1 (m)	1.875
quy (KN/m2)	238.780721
Mu1 (KNm)	419.731736
Mu2/ϕ (KNm)	524.66467
Digunakan tul. pokok ∅22mm	
A1∅22 (mm2)	380
tebal pelat (mm)	700
Pb (mm)	70
d (mm)	619
fy (Mpa)	400
f'c (Mpa)	25
β1	0.85
m	18.8235294
Rn (Mpa)	1.36930604
ρmin	0.0035
ρb	0.02709375
ρmaks	0.02032031
ρ aktual	0.0035413
1,33.ρ aktual	0.00470992
ρ pakai	0.00470992
As perlu (mm2)	2915.4427
jrk tul.pokok/s (mm)	130.340411
jrk tul.pakai/s (mm)	125
Dipakai Tul. Pokok	**D22- 125**
As aktual (mm)	3040
a (mm)	57.2235294
Mn (KNm)	717.912094
1,33 Mu2/ϕ (KNm)	697.804012
Mn >1,33 Mu2/ϕ	**Aman**

Tul. Susut Pondasi Arah - X	
As susut (mm2)	1300
Digunakan tul.susut ∅12 mm	
A1∅12 (mm2)	113
jrk tul. Susut/s (mm)	86.92307692
jrk tul.pakai (mm)	85
Dipakai Tul. Susut	**P12 - 85**

Tul. Susut Pondasi Arah - Y	
As susut (mm2)	1300
Digunakan tul.susut ∅12 mm	
A1∅12 (mm2)	113
jrk tul. Susut/s (mm)	86.9230769
jrk tul.pakai (mm)	85
Dipakai Tul. Susut	**P12 - 85**

PORTAL F - F

LT	BALOK	VD	VL	VE	Mnak b-	Mnak b+	ln	1.05 VG	Vu,b 1	Vu,b 2	Vu,b pakai	luar sendi plastis					
												Vu,b	Vc	Vs	s1	s2	s pakai
1	0 - 1	122.22	20.83	38.15	470.914	247.688	6.55	150.203	246.199	310.433	229.491	201.476	190	145.794	147.315	285	P10-140
	1 - 2	48.46	6.50	129.16	399.224	324.815	3.1	57.708	262.074	600.180	186.920	164.102	190	83.503	257.207	285	P10-250
	2 - 3	49.36	7.25	149.45	470.914	399.224	3.25	59.441	293.708	687.131	211.534	185.712	190	119.519	179.700	285	P10-170
	3 - 4	49.93	7.37	149.66	470.914	399.224	3.25	60.165	294.433	688.737	212.259	186.348	190	120.579	178.120	285	P10-170
	4 - 5	50.18	7.39	149.20	470.914	399.224	3.25	60.449	294.716	687.089	212.542	186.597	190	120.994	177.509	285	P10-170
	5 - 6	49.11	7.22	148.08	470.914	399.224	3.25	59.147	293.414	681.083	211.240	185.453	190	119.089	180.349	285	P10-180
	6 - 7	48.30	6.85	127.24	399.224	247.688	3.1	57.908	240.504	592.316	173.355	152.193	190	63.655	337.4	285	P10-280
	7 - 8	122.28	20.84	37.17	470.914	247.688	6.55	150.276	246.272	306.390	229.565	201.541	190	145.902	147.206	285	P10-140
2	0 - 1	117.47	21.12	24.17	470.914	247.688	6.55	145.520	241.516	247.034	224.808	197.365	190	138.942	154.580	285	P10-150
	1 - 2	54.62	8.75	158.57	539.886	399.224	3.1	66.539	331.610	732.533	234.132	205.551	190	152.584	140.759	285	P10-140
	2 - 3	49.97	7.85	188.42	542.494	470.914	3.25	60.711	333.552	852.075	237.847	208.813	190	158.021	135.916	285	P10-130
	3 - 4	50.60	8.00	190.10	542.494	470.914	3.25	61.530	334.371	859.950	238.666	209.532	190	159.219	134.893	285	P10-130
	4 - 5	50.98	7.39	189.70	542.494	470.914	3.25	61.289	334.129	858.029	238.425	209.320	190	158.866	135.193	285	P10-130
	5 - 6	49.60	7.22	187.11	542.494	470.914	3.25	59.661	332.502	845.523	236.797	207.891	190	156.485	137.251	285	P10-130
	6 - 7	54.82	6.85	157.07	539.886	399.224	3.1	64.754	329.825	724.448	232.347	203.984	190	149.973	143.210	285	P10-140
	7 - 8	117.34	20.84	46.53	470.914	247.688	6.55	145.089	241.085	340.515	224.378	196.987	190	138.312	155.284	285	P10-150
3	0 - 1	118.69	21.42	42.01	470.914	247.688	6.55	147.116	243.112	323.558	226.404	198.766	190	141.277	152.025	285	P10-150
	1 - 2	62.32	10.25	136.23	470.914	324.815	3.1	76.199	300.799	648.365	218.204	191.567	190	129.279	166.134	285	P10-160
	2 - 3	51.23	8.12	161.31	470.914	399.224	3.25	62.318	296.585	739.820	214.411	188.237	190	123.729	173.586	285	P10-170
	3 - 4	52.29	8.35	164.38	470.914	399.224	3.25	63.672	297.940	754.068	215.766	189.427	190	125.711	170.849	285	P10-170
	4 - 5	52.71	8.41	163.96	470.914	399.224	3.25	64.176	298.444	752.808	216.270	189.869	190	126.448	169.853	285	P10-160
	5 - 6	50.83	8.06	160.17	470.914	399.224	3.25	61.835	296.102	734.549	213.928	187.813	190	123.022	174.583	285	P10-170
	6 - 7	62.49	10.25	134.63	470.914	324.815	3.1	76.377	300.978	641.823	218.383	191.724	190	129.540	165.799	285	P10-160
	7 - 8	118.53	21.38	41.04	470.914	247.688	6.55	146.906	242.902	319.274	226.194	198.582	190	140.970	152.356	285	P10-150
4	0 - 1	124.51	21.57	32.81	470.914	247.688	6.55	153.384	249.380	291.186	232.673	204.270	190	150.449	142.756	285	P10-140
	1 - 2	68.93	11.11	102.05	399.224	324.815	3.1	84.042	288.408	512.652	213.254	187.221	190	122.035	175.995	285	P10-170
	2 - 3	53.91	8.20	123.69	399.224	324.815	3.25	65.216	260.149	584.714	191.772	168.362	190	90.603	237.051	285	P10-230
	3 - 4	55.46	8.52	127.38	399.224	324.815	3.25	67.179	262.112	602.175	193.736	170.086	190	93.476	229.765	285	P10-220
	4 - 5	55.94	8.60	127.03	399.224	324.815	3.25	67.767	262.700	601.293	194.324	170.602	190	94.337	227.670	285	P10-220
	5 - 6	53.46	8.13	122.29	399.224	324.815	3.25	64.670	259.603	578.288	191.226	167.883	190	89.804	239.160	285	P10-230
	6 - 7	69.03	11.11	100.83	399.224	247.688	3.1	84.147	266.743	507.633	199.595	175.230	190	102.049	210.463	285	P10-210
	7 - 8	124.45	21.54	32.30	470.914	247.688	6.55	153.290	249.286	288.950	232.578	204.187	190	150.311	142.888	285	P10-140

TABEL PERENCANAAN PONDASI P3

Perencanaan Pondasi Persegi Panjang P3	
σ tanah (KN/m2)	300
f'c (MPa)	25
fy (MPa)	400
γb beton (KN/m3)	24
γb tanah (KN/m3)	19.5
P (KN)	6400.098
My (KNm)	644.933
Mx (KNm)	664.41
h kolom (mm)	650
t kolom (mm)	650
tebal pelat (h) (mm)	900
σ netto tanah (KN/m2)	**278.4**
Dicoba nilai B (m)	5.4
A perlu (m2)	28.0080953
P pakai arah x (m)	5.4
L pakai arah y (m)	5.4
A ada (m2)	29.16
Aada(m2)>Aperlu(m2)	**Aman**
σ kontak (KN/m2)	**269.373236**
Kontrol tegangan	**Aman**
Pb (mm)	70
θ tul.pokok (mm)	22
d (mm)	819

Tinjauan Beban Sementara	
P (KN)	6400.098
Mx (KNm)	664.41
My (KNm)	644.933
ex (m)	0.10381247
ey (m)	0.10076924
P (m)	5.4
L (m)	5.4
σ netto tanah (KN/m2)	278.4
1,5.σnetto tanah(KN/m2)	**417.6**
σ kontak (KN/m2)	**114.062359**
Kontrol	**Aman**

Perencanaan Geser 1 Arah (x)	
m (m)	1.556
L (m)	5.4
qux terjadi (KN/m2)	237.5037985
Vu (KN)	1995.601917
Vu/ϕ (KN)	3326.003195
Vc (KN)	3685.5
Vc > Vu/ϕ	**Aman**
Perencanaan Geser 1 Arah (y)	
n (m)	1.556
P (m)	5.4
quy terjadi (KN/m2)	239.4650323
Vu (KN)	2012.080988
Vu/ϕ (KN)	3353.468313
Vc (KN)	3685.5
Vc > Vu/ϕ	**Aman**

Perencanaan Geser Dua (2) arah	
x (m)	1.469
y (m)	1.469
P (m)	5.4
L (m)	5.4
qu.pakai (KN/m2)	219.4820988
Vu (KN)	6397.940039
Vu/ϕ (KN)	10663.2334
βc	1
bo (mm)	5876
Vc1 (KN)	144373.32
Vc2 (KN)	96248.88
Vc2 (KN) > Vu/ϕ (KN)	**Aman**

Kuat Tumpuan Pondasi	
Luas pondasi (A2) (m2)	29.16
Luas kolom (A1) (m2)	0.4225
(A2/A1)^0,5	8.307692308
jika lebih besar dari 2, dipakai nilai 2	
ϕPn (KN)	12569.375
Kuat Tumpuan Kolom	
ϕPn (KN)	6284.6875
ϕPn pondasi > ϕPn kolom	
Aman	

Perencanaan Tulangan Lentur Pondasi P3 (Arah X dan Y)

Tul. Lentur Arah Sisi Panjang (X)	
P (m)	5.4
h kolom (m)	0.65
l1 (m)	2.375
qux (KN/m2)	237.503799
Mu1 (KNm)	669.834932
Mu1/ϕ (KNm)	837.293665
Digunakan tul. pokok ∅22mm	
A1∅22 (mm2)	380
tebal pelat (mm)	900
Pb (mm)	70
d (mm)	819
fy (Mpa)	400
f'c (Mpa)	25
β1	0.85
m	18.8235294
Rn (Mpa)	1.24827422
ρmin	0.0035
ρb	0.02709375
ρmaks	0.02032031
ρ aktual	0.00321816
1.33ρ aktual	0.00428015
ρ pakai	0.00428015
As perlu (mm2)	3505.44398
jrk tul.pokok/s (mm)	108.402816
jrk tul.pakai/s (mm)	100
Dipakai Tul. Pokok	**D22- 100**
As aktual (mm)	3800
a (mm)	71.5294118
Mn (KNm)	1190.51765
Mn > Mu1/ϕ	**Aman**

Tul. Lentur Arah Sisi Lebar (Y)	
L (m)	5.4
t kolom (m)	0.65
l1 (m)	2.375
quy (KN/m2)	239.4650323
Mu1 (KNm)	675.366224
Mu2/ϕ (KNm)	844.20778
Digunakan tul. pokok ∅22mm	
A1∅22 (mm2)	380
tebal pelat (mm)	900
Pb (mm)	70
d (mm)	819
fy (Mpa)	400
f'c (Mpa)	25
β1	0.85
m	18.82352941
Rn (Mpa)	1.258582088
ρmin	0.0035
ρb	0.02709375
ρmaks	0.020320313
ρ aktual	0.003245598
1.33ρ aktual	0.004316645
ρ pakai	0.004316645
As perlu (mm2)	3535.332381
jrk tul.pokok/s (mm)	107.4863575
jrk tul.pakai/s (mm)	100
Dipakai Tul. Pokok	**D22- 100**
As aktual (mm)	3800
a (mm)	71.52941176
Mn (KNm)	1190.517647
Mn > Mu2/ϕ	**Aman**

Tul. Susut Pondasi Arah - X	
As susut (mm2)	1300
Digunakan tul.susut ∅12 mm	
A1∅12 (mm2)	113
jrk tul. Susut/s (mm)	86.9230769
jrk tul.pakai (mm)	85
Dipakai Tul. Susut	**P12 - 85**

Tul. Susut Pondasi Arah - Y	
As susut (mm2)	1300
Digunakan tul.susut ∅12 mm	
A1∅12 (mm2)	113
jrk tul. Susut/s (mm)	86.92307692
jrk tul.pakai (mm)	85
Dipakai Tul. Susut	**P12 - 85**

TABEL PERENCANAAN PONDASI P4

Perencanaan Pondasi Persegi Panjang P4	
σ tanah (KN/m2)	300
f'c (MPa)	25
fy (MPa)	400
γb beton (KN/m3)	24
γb tanah (KN/m3)	18.1
P (KN)	8418.93
My (KNm)	548.175
Mx (KNm)	605
h kolom (mm)	350
t kolom (mm)	350
tebal pelat (h) (mm)	700
σ netto tanah (KN/m2)	**283.2**
Dicoba nilai B (m)	17
A perlu (m2)	29.87643156
P pakai arah x (m)	17
L pakai arah y (m)	3
A ada (m2)	51
Aada(m2)>Aperlu(m2)	**Aman**
σ kontak (KN/m2)	**192.5961476**
Kontrol tegangan	**Aman**
Pb (mm)	70
θ tul.pokok (mm)	22
d (mm)	619

Tinjauan Beban Sementara	
P (KN)	8418.93
Mx (KNm)	605
My (KNm)	548.175
ex (m)	0.071861864
ey (m)	0.065112194
P (m)	17
L (m)	3
σ netto tanah (KN/m2)	283.2
1,5.σnetto tanah(KN/m2	**424.8**
σ kontak (KN/m2)	**84.73583407**
Kontrol	**Aman**

Perencanaan Geser 1 Arah (x)	
m (m)	0.506
L (m)	3
qux terjadi (KN/m2)	188.0963668
Vu (KN)	285.5302848
Vu/ϕ (KN)	475.883808
Vc (KN)	1547.5
Vc > Vu/ϕ	**Aman**
Perencanaan Geser 1 Arah (y)	
n (m)	0.706
P (m)	17
quy terjadi (KN/m2)	168.3411832
Vu (KN)	2020.430881
Vu/ϕ (KN)	3367.384802
Vc (KN)	8769.166667
Vc > Vu/ϕ	**Aman**

Perencanaan Geser Dua (2) arah	
x (m)	15.369
y (m)	0.969
P (m)	17
L (m)	3
qu.pakai (KN/m2)	165.0770588
Vu (KN)	8404.037439
Vu/ϕ (KN)	14006.72907
βc	5.666666667
bo (mm)	32676
Vc1 (KN)	273651.8894
Vc2 (KN)	404528.88
Vc2 (KN) > Vu/ϕ (KN)	**Aman**

Kuat Tumpuan Pondasi	
Luas pondasi (A2) (m2)	51
Luas kolom (A1) (m2)	0.6125
(A2/A1)^0.5	9.124982527
jika lebih besar dari 2, dipakai nilai 2	
ϕPn (KN)	18221.875
Kuat Tumpuan Kolom	
ϕPn (KN)	9110.9375
ϕPn pondasi > ϕPn kolom	
Aman	

Perencanaan Tulangan Lentur Pondasi P4 (Arah X dan Y)

Tul. Lentur Arah Sisi Panjang (X)	
P (m)	17
h kolom (m)	0.35
l1 (m)	1.125
qux (KN/m2)	188.0963668
Mu1 (KNm)	119.0297321
Mu1/ϕ (KNm)	148.7871651
Digunakan tul. pokok ∅22mm	
A1∅22 (mm2)	380
tebal pelat (mm)	700
Pb (mm)	70
d (mm)	619
fy (Mpa)	400
f'c (Mpa)	25
β1	0.85
m	18.82352941
Rn (Mpa)	0.388315004
ρmin	0.0035
ρb	0.02709375
ρmaks	0.020320313
ρ aktual	0.001219195
1,33.ρ aktual	0.001621529
ρ pakai	0.002
As perlu (mm2)	1238
jrk tul.pokok/s (mm)	306.9466882
jrk tul.pakai/s (mm)	300
Dipakai Tul. Pokok	**D22- 300**
As aktual (mm)	1266.666667
a (mm)	23.84313725
Mn (KNm)	307.5864052
1,33 Mu1/ϕ	197.8869296
Mn > Mu1/ϕ	**Aman**

Tul. Lentur Arah Sisi Lebar (Y)	
L (m)	3
t kolom (m)	0.35
l1 (m)	1.325
quy (KN/m2)	168.3411832
Mu1 (KNm)	147.7719949
Mu2/ϕ (KNm)	184.7149936
Digunakan tul. pokok ∅22mm	
A1∅22 (mm2)	380
tebal pelat (mm)	700
Pb (mm)	70
d (mm)	619
fy (Mpa)	400
f'c (Mpa)	25
β1	0.85
m	18.82352941
Rn (Mpa)	0.482081928
ρmin	0.0035
ρb	0.02709375
ρmaks	0.020320313
ρ aktual	0.001219195
1.33.ρ aktual	0.001621529
ρ pakai	0.002
As perlu (mm2)	1238
jrk tul.pokok/s (mm)	306.9466882
jrk tul.pakai/s (mm)	300
Dipakai Tul. Pokok	**D22- 300**
As aktual (mm)	1266.666667
a (mm)	23.84313725
Mn (KNm)	307.5864052
1,33 Mu2/ϕ	245.6709415
Mn > Mu2/ϕ	**Aman**

Tul. Susut Pondasi Arah - X	
As susut (mm2)	700
Digunakan tul.susut ∅12 mm	
A1∅12 (mm2)	113
jrk tul. Susut/s (mm)	161.4285714
jrk tul.pakai (mm)	160
Dipakai Tul. Susut	**P12 - 160**

Tul. Susut Pondasi Arah - Y	
As susut (mm2)	700
Digunakan tul.susut ∅12 mm	
A1∅12 (mm2)	113
jrk tul. Susut/s (mm)	161.4285714
jrk tul.pakai (mm)	160
Dipakai Tul. Susut	**P12 - 160**

TABEL PERENCANAAN PONDASI P5

Perencanaan Pondasi Persegi Panjang P5	
σ tanah (KN/m2)	300
f'c (MPa)	25
fy (MPa)	400
γb beton (KN/m3)	24
γb tanah (KN/m3)	21.4
P (KN)	3365.577
My (KNm)	679.954
Mx (KNm)	623.643
h kolom (mm)	650
t kolom (mm)	650
tebal pelat (h) (mm)	700
σ netto tanah (KN/m2)	**283.2**
Dicoba nilai B (m)	4.3
A perlu (m2)	18.2096336
P pakai arah x (m)	4.3
L pakai arah y (m)	4.3
A ada (m2)	18.49
Aada(m2)>Aperlu(m2)	**Aman**
σ kontak (KN/m2)	**280.397488**
Kontrol tegangan	**Aman**
Pb (mm)	70
θ tul.pokok (mm)	22
d (mm)	619

Tinjauan Beban Sementara	
P (KN)	3365.577
Mx (KNm)	623.643
My (KNm)	679.954
ex (m)	0.18530047
ey (m)	0.20203192
P (m)	4.3
L (m)	4.3
σ netto tanah (KN/m2)	283.2
1,5.σnetto tanah(KN/m2	**424.8**
σ kontak (KN/m2)	**100.020294**
Kontrol	**Aman**

Perencanaan Geser 1 Arah (x)	
m (m)	1.206
L (m)	4.3
qux terjadi (KN/m2)	215.88512
Vu (KN)	1119.53707
Vu/ϕ (KN)	1865.89512
Vc (KN)	2218.08333
Vc > Vu/ϕ	**Aman**
Perencanaan Geser 1 Arah (y)	
n (m)	1.206
P (m)	4.3
quy terjadi (KN/m2)	224.2875
Vu (KN)	1163.11013
Vu/ϕ (KN)	1938.51688
Vc (KN)	2218.08333
Vc > Vu/ϕ	**Aman**

Perencanaan Geser Dua (2) arah	
x (m)	1.269
y (m)	1.269
P (m)	4.3
L (m)	4.3
qu.pakai (KN/m2)	182.021471
Vu (KN)	3363.96664
Vu/ϕ (KN)	5606.61107
βc	1
bo (mm)	5076
Vc1 (KN)	94261.32
Vc2 (KN)	62840.88
Vc2 (KN) > Vu/ϕ (KN)	**Aman**

Kuat Tumpuan Pondasi	
Luas pondasi (A2) (m2)	18.49
Luas kolom (A1) (m2)	0.4225
(A2/A1)^0,5	6.61538462
jika lebih besar dari 2, dipakai nilai 2	
ϕPn (KN)	12569.375
Kuat Tumpuan Kolom	
ϕPn (KN)	6284.6875
ϕPn pondasi > ϕPn kolom	
Aman	

Perencanaan Tulangan Lentur Pondasi P5 (Arah X dan Y)

Tul. Lentur Arah Sisi Panjang (X)	
P (m)	4.3
h kolom (m)	0.65
l1 (m)	1.825
qux (KN/m2)	215.885123
Mu1 (KNm)	359.516194
Mu1/ϕ (KNm)	449.395242
Digunakan tul. pokok ∅22mm	
A1∅22 (mm2)	380
tebal pelat (mm)	700
Pb (mm)	70
d (mm)	619
fy (Mpa)	400
f'c (Mpa)	25
β1	0.85
m	18.8235294
Rn (Mpa)	1.17286269
ρmin	0.0035
ρb	0.02709375
ρmaks	0.02032031
ρ aktual	0.00301788
1,33.ρ aktual	0.00401377
ρ pakai	0.00401377
As perlu (mm2)	2484.52598
jrk tul.pokok/s (mm)	152.94668
jrk tul.pakai/s (mm)	145
Dipakai Tul. Pokok	**D22- 145**
As aktual (mm)	2620.68966
a (mm)	49.3306288
Mn (KNm)	623.026705
1,33 Mu1/ϕ	597.695672
Mn > Mu1/ϕ	**Aman**

Tul. Lentur Arah Sisi Lebar (Y)	
L (m)	4.3
t kolom (m)	0.65
l1 (m)	1.825
quy (KN/m2)	224.287502
Mu1 (KNm)	373.508781
Mu2/ϕ (KNm)	466.885976
Digunakan tul. pokok ∅22mm	
A1∅22 (mm2)	380
tebal pelat (mm)	700
Pb (mm)	70
d (mm)	619
fy (Mpa)	400
f'c (Mpa)	25
β1	0.85
m	18.8235294
Rn (Mpa)	1.21851122
ρmin	0.0035
ρb	0.02709375
ρmaks	0.02032031
ρ aktual	0.00313902
1,33.ρ aktual	0.00417489
ρ pakai	0.00417489
As perlu (mm2)	2584.25781
jrk tul.pokok/s (mm)	147.044153
jrk tul.pakai/s (mm)	145
Dipakai Tul. Pokok	**D22- 145**
As aktual (mm)	2620.68966
a (mm)	49.3306288
Mn (KNm)	623.026705
1,33 Mu2/ϕ	620.958348
Mn > Mu2/ϕ	**Aman**

Tul. Susut Pondasi Arah - X	
As susut (mm2)	1300
Digunakan tul.susut ∅12 mm	
A1∅12 (mm2)	113
jrk tul. Susut/s (mm)	86.9230769
jrk tul.pakai (mm)	85
Dipakai Tul. Susut	**P12 - 85**

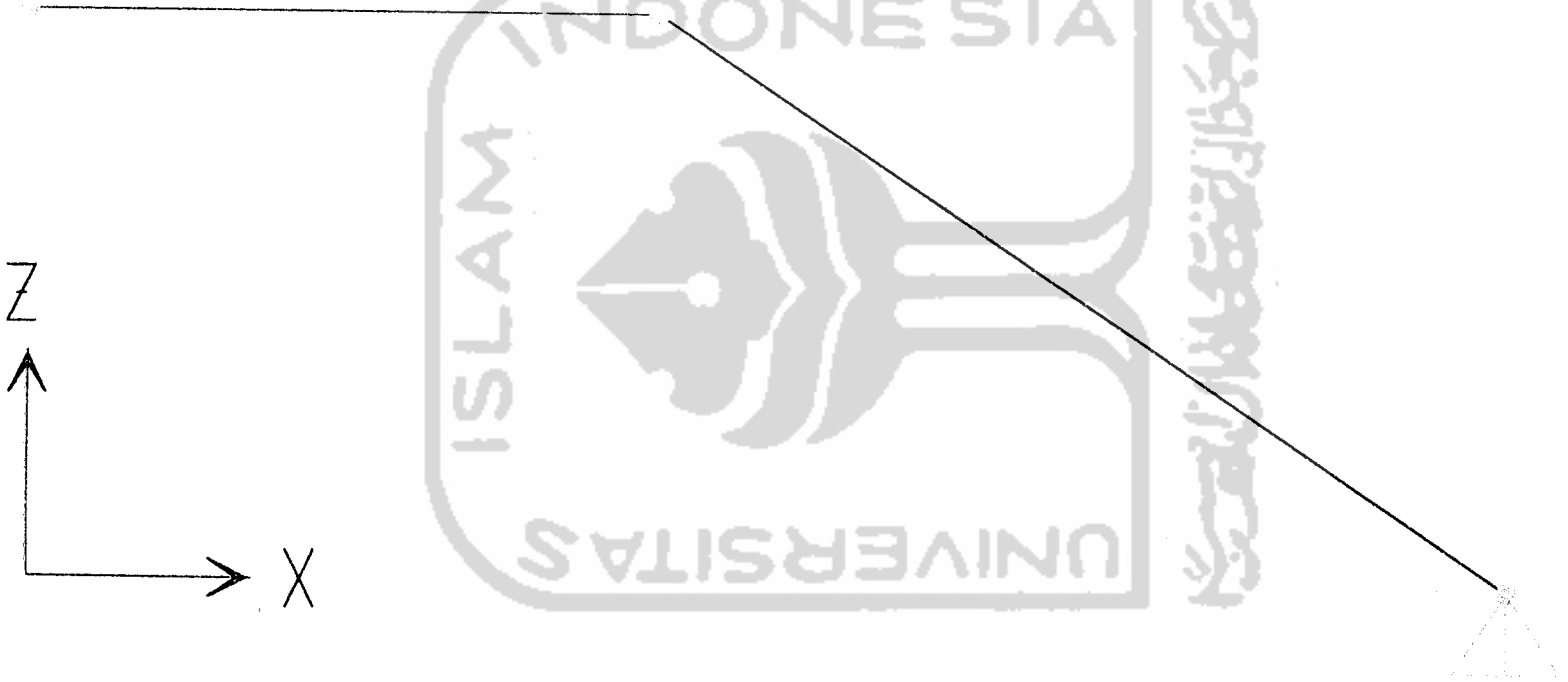
Tul. Susut Pondasi Arah - Y	
As susut (mm2)	1300
Digunakan tul.susut ∅12 mm	
A1∅12 (mm2)	113
jrk tul. Susut/s (mm)	86.9230769
jrk tul.pakai (mm)	85
Dipakai Tul. Susut	**P12 - 85**

LAMPIRAN 8

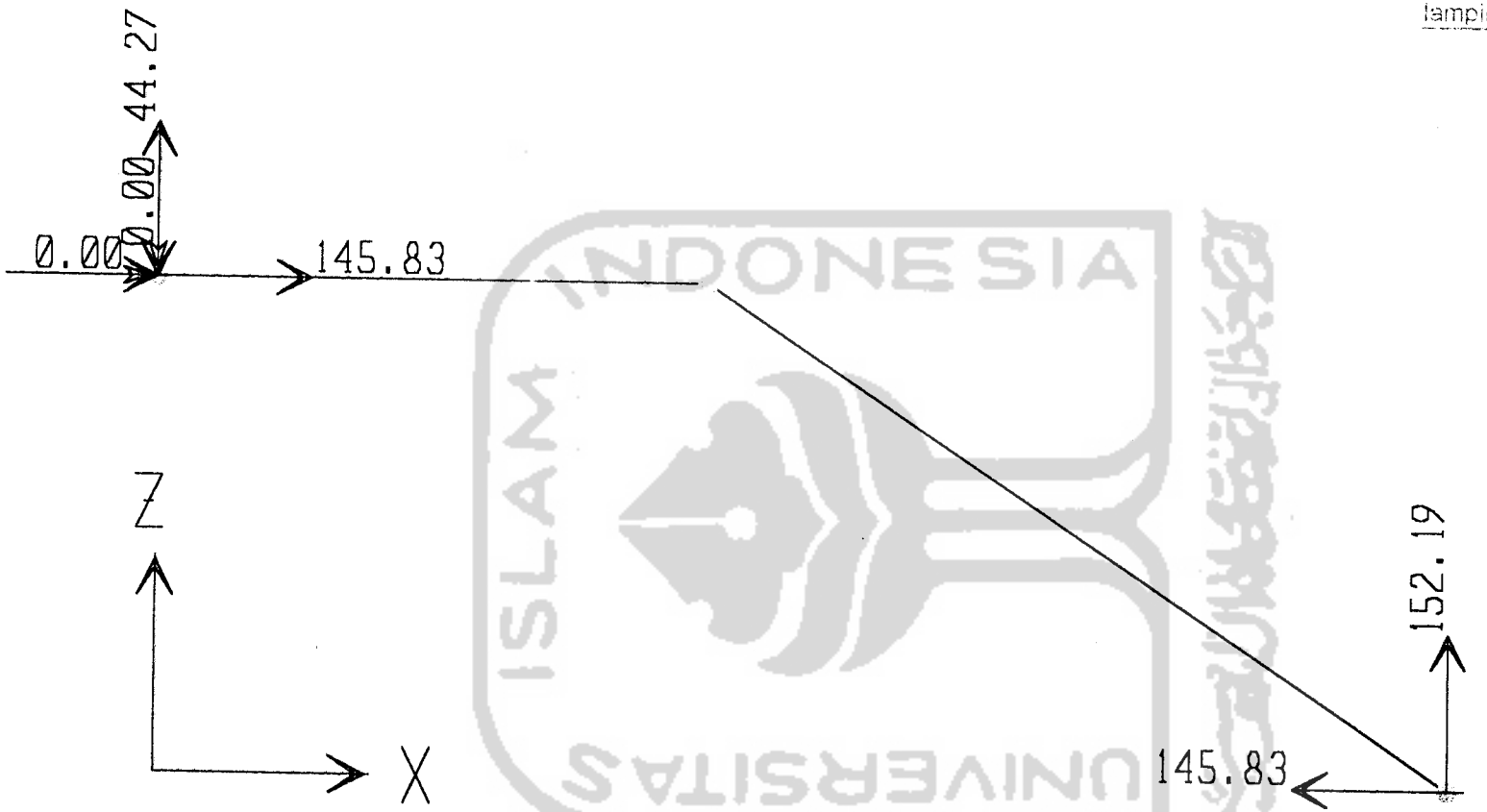
SAP2000

9/2/02 15:08:05

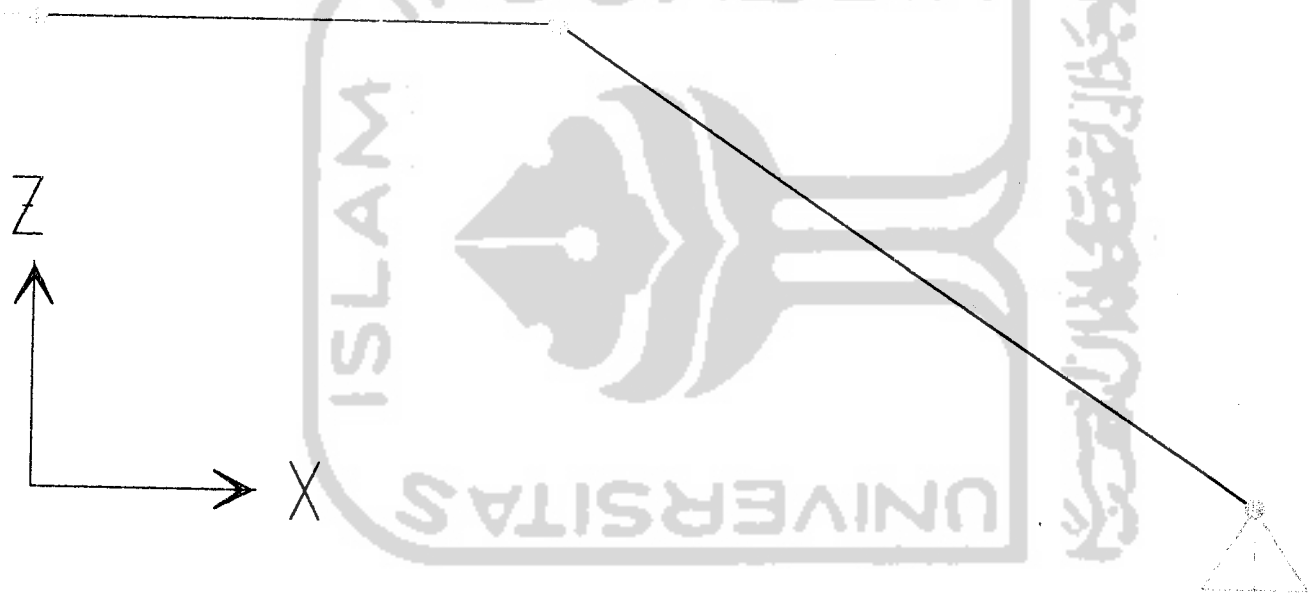
lampiran 8.1

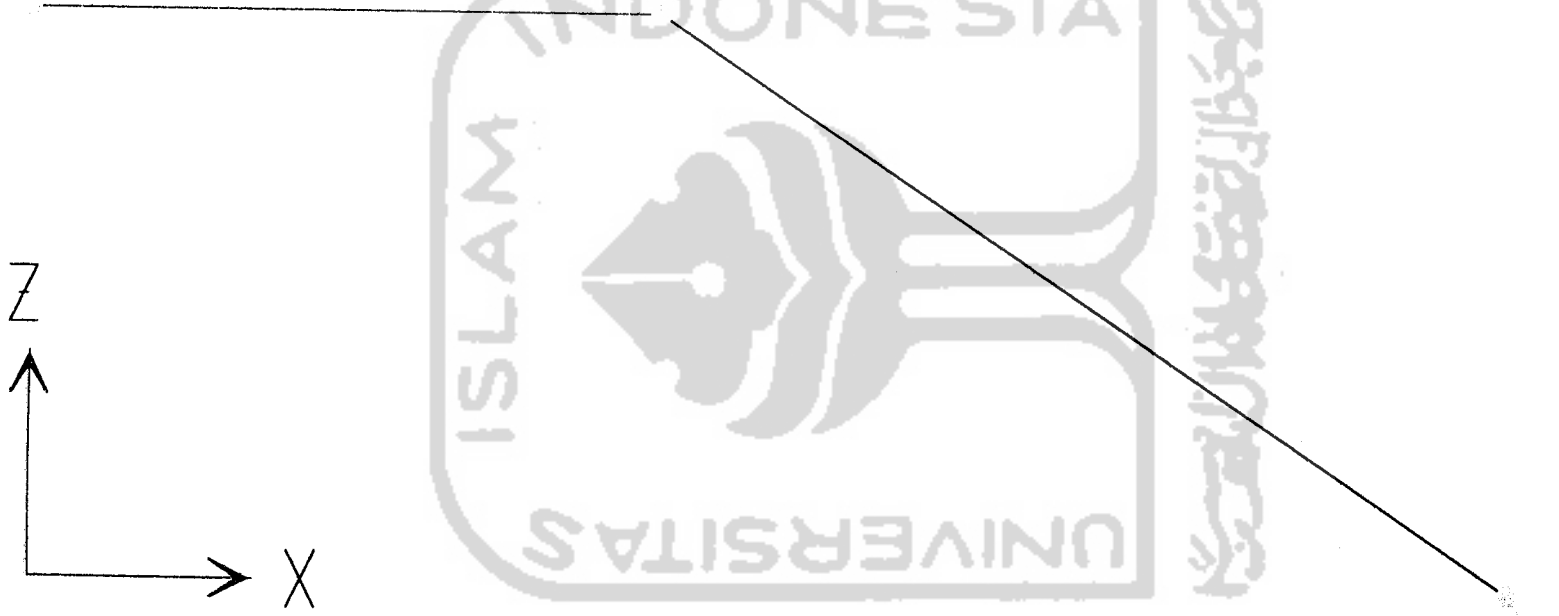


lampiran 8.2

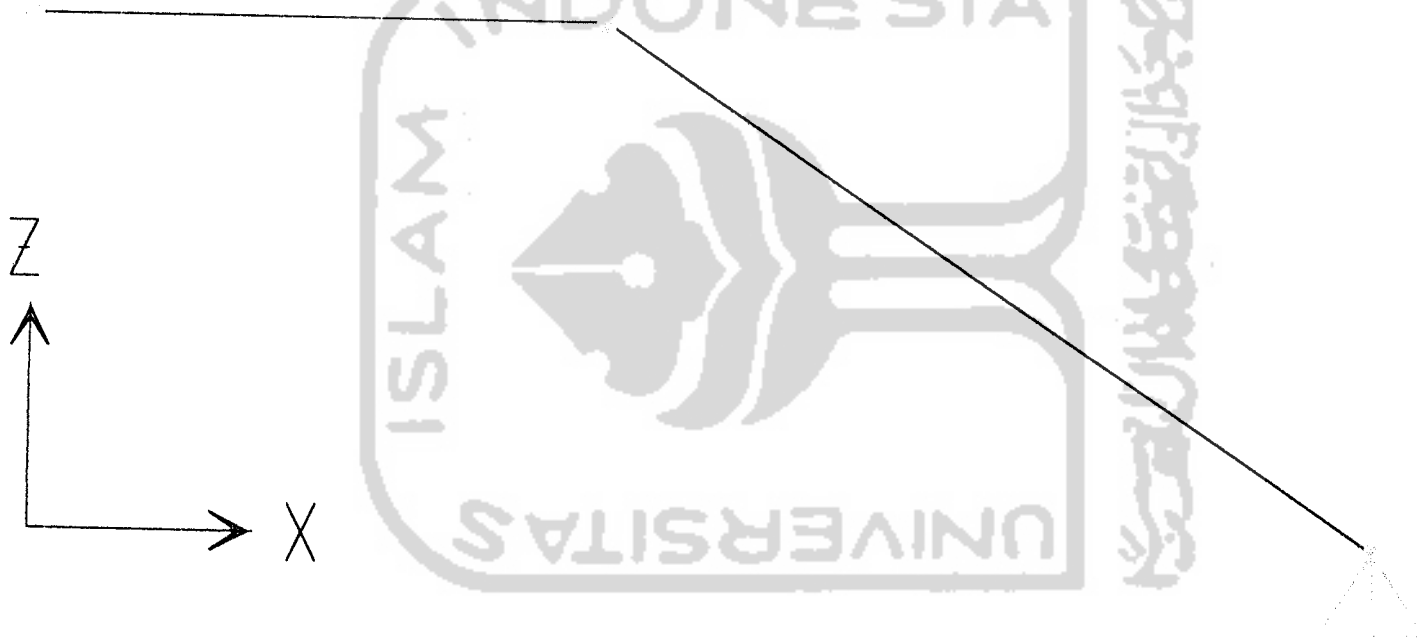


lampiran 8.3




Z
X

lampiran 8.5

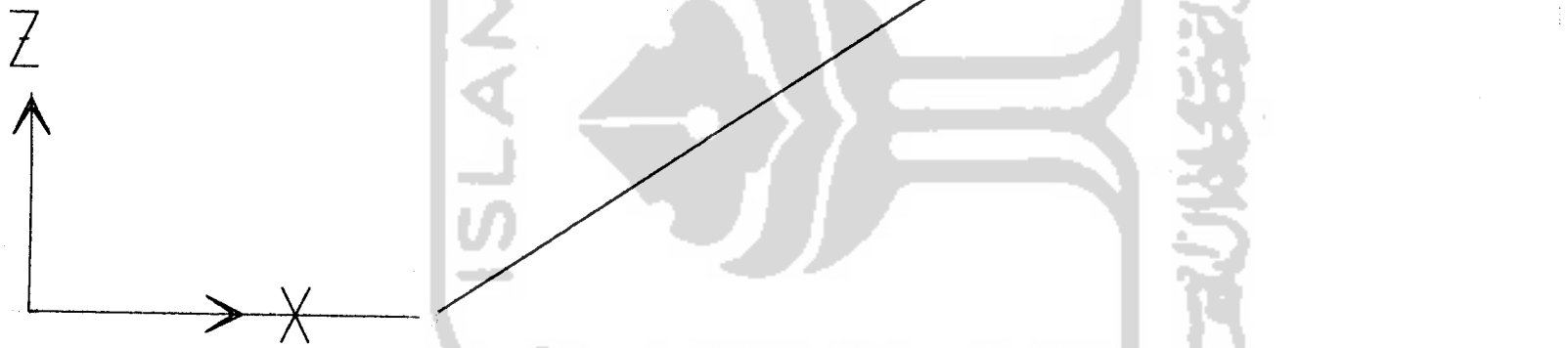


lampiran 8.6




123.83
56.32
0.00
0.00
166.31
0.00
0.00
56.32

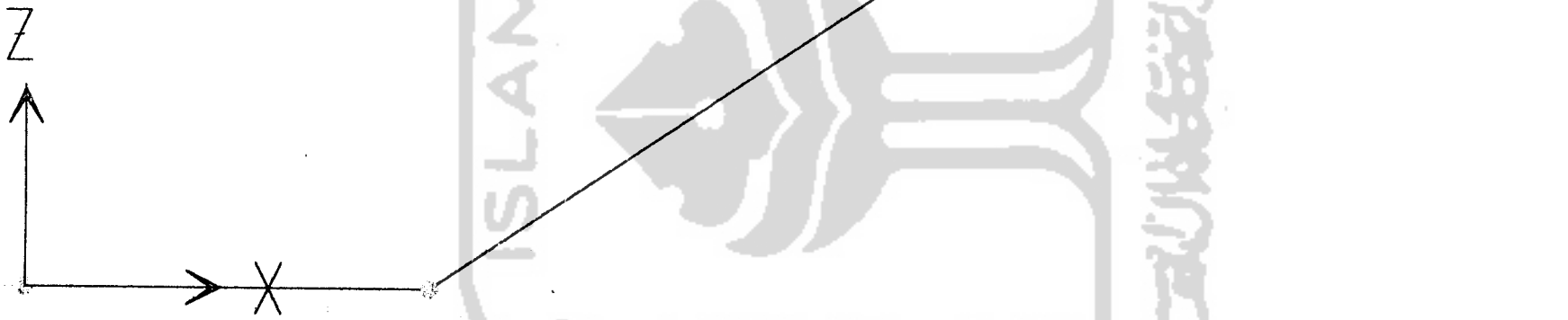
lampiran 8.8




Z
X

9/2/02 14:59:45

lampiran 8.10

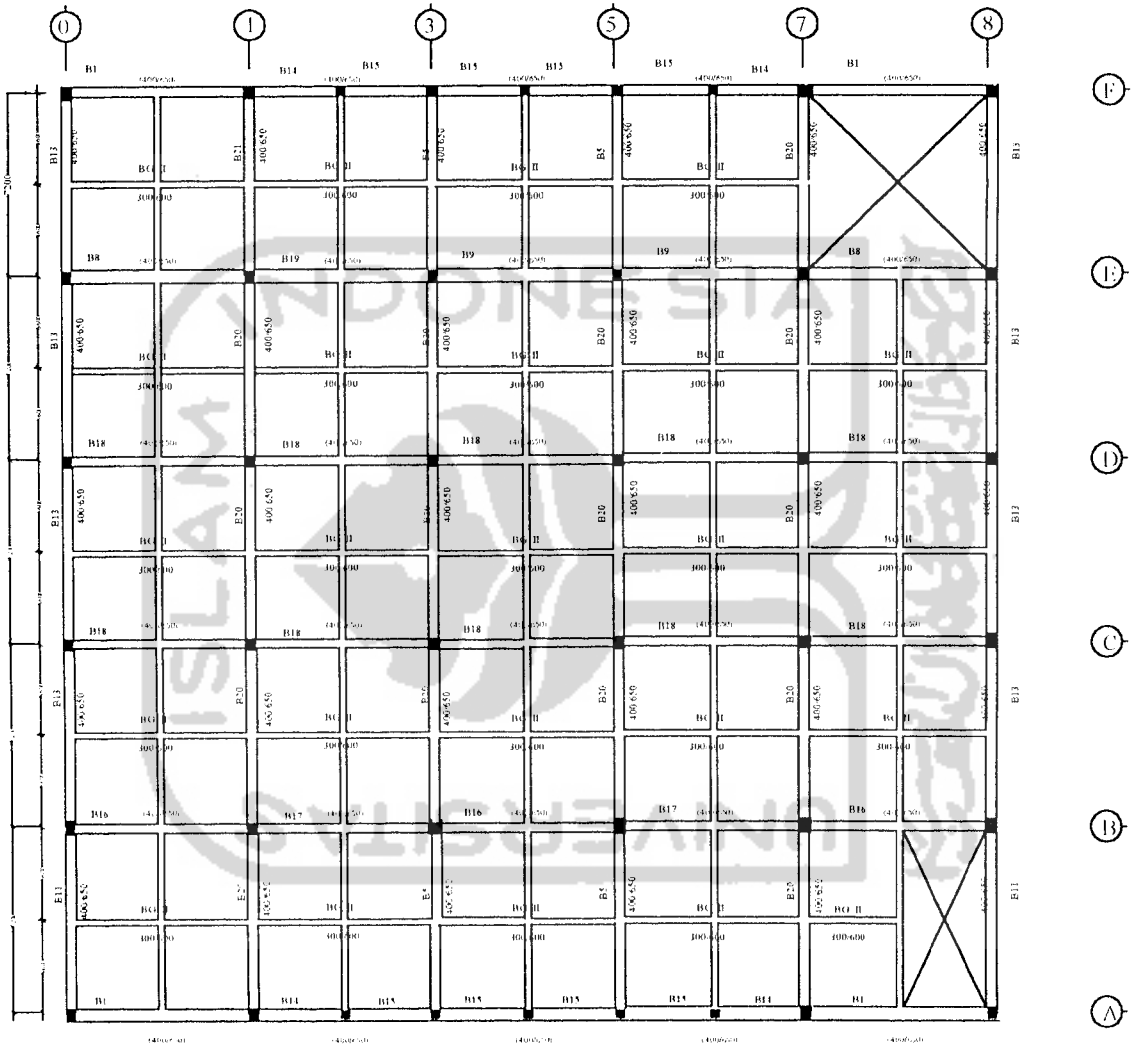


ISLAM INDONESIA UNIVERSITAS

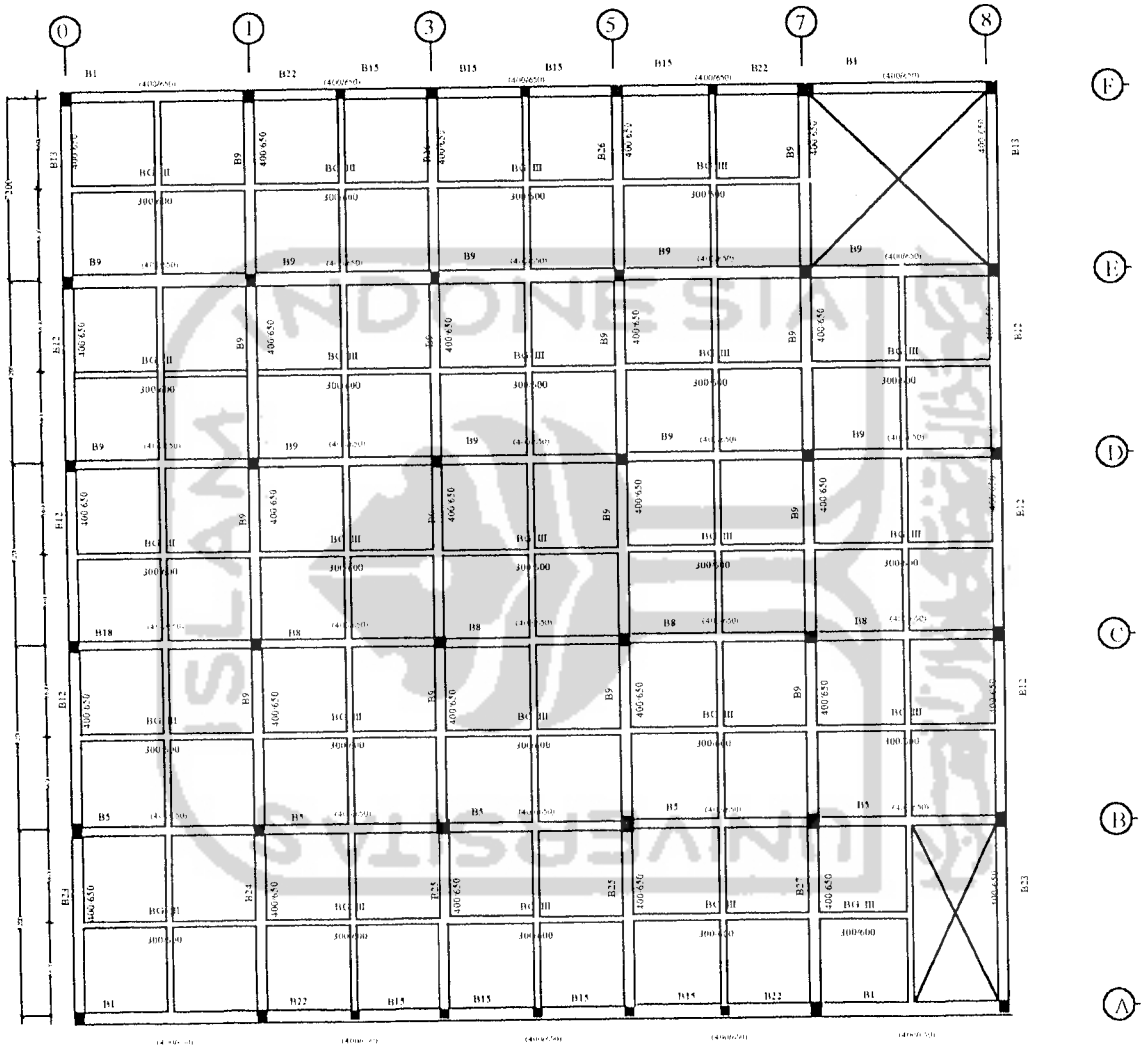
SAP2000 v7.42 - File:ANA MANING 2 - Shear Force 2-2 Diagram (LOAD1) - KN-m Units

LAMPIRAN 9

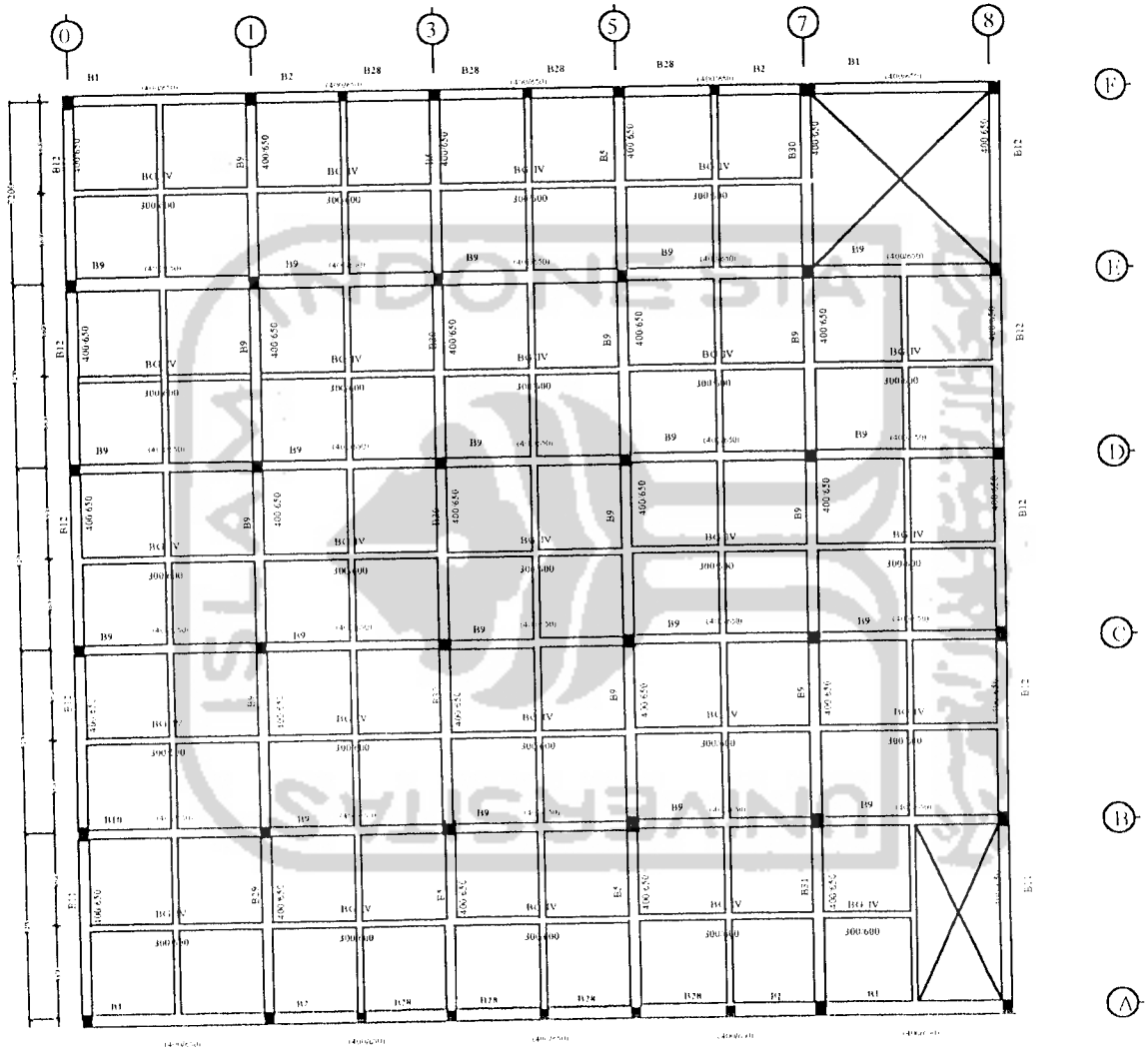
DENAH BALOK LANTAI 1



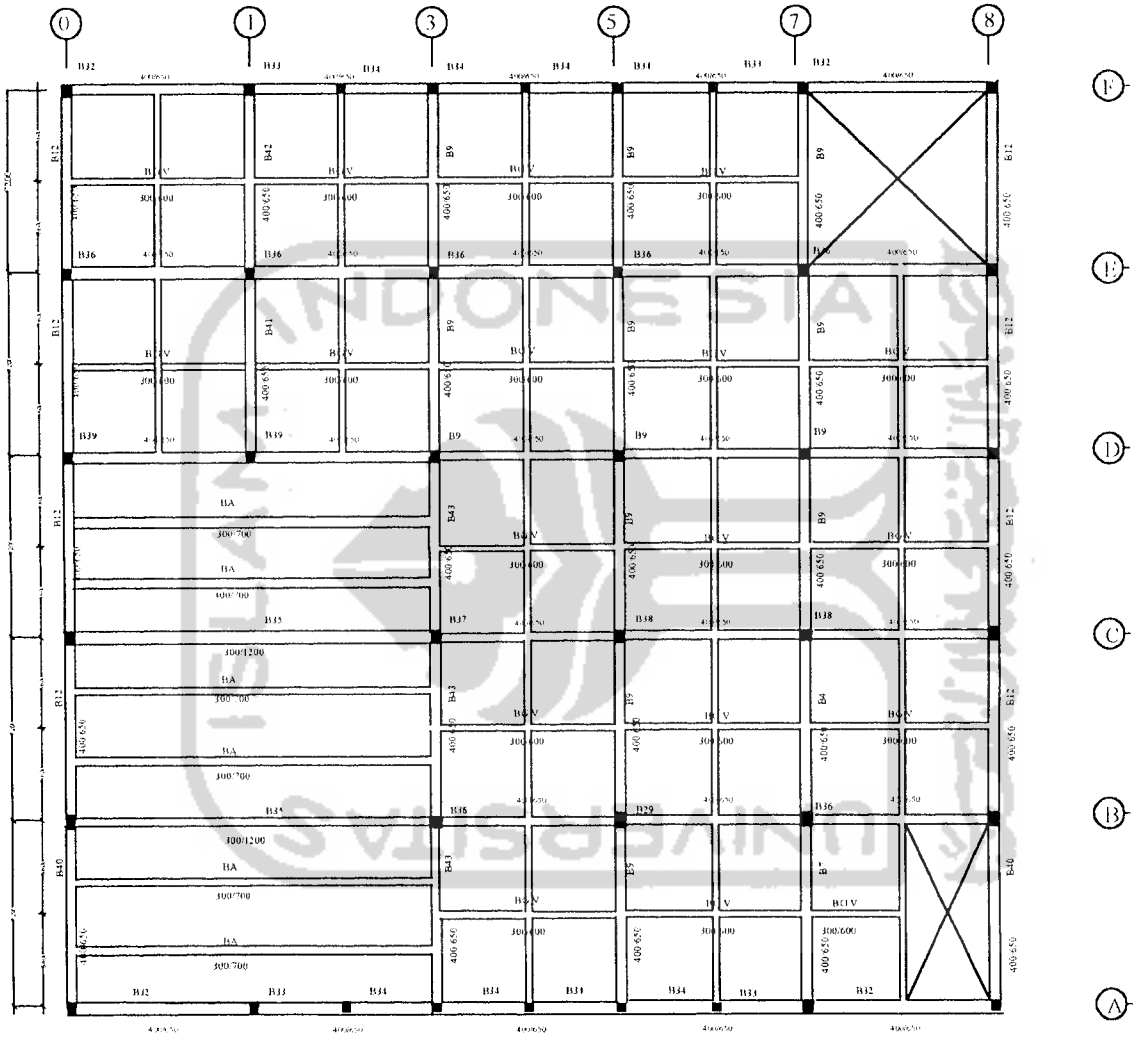
DENAH BALOK LANTAI 2



DENAH BALOK LANTAI 3

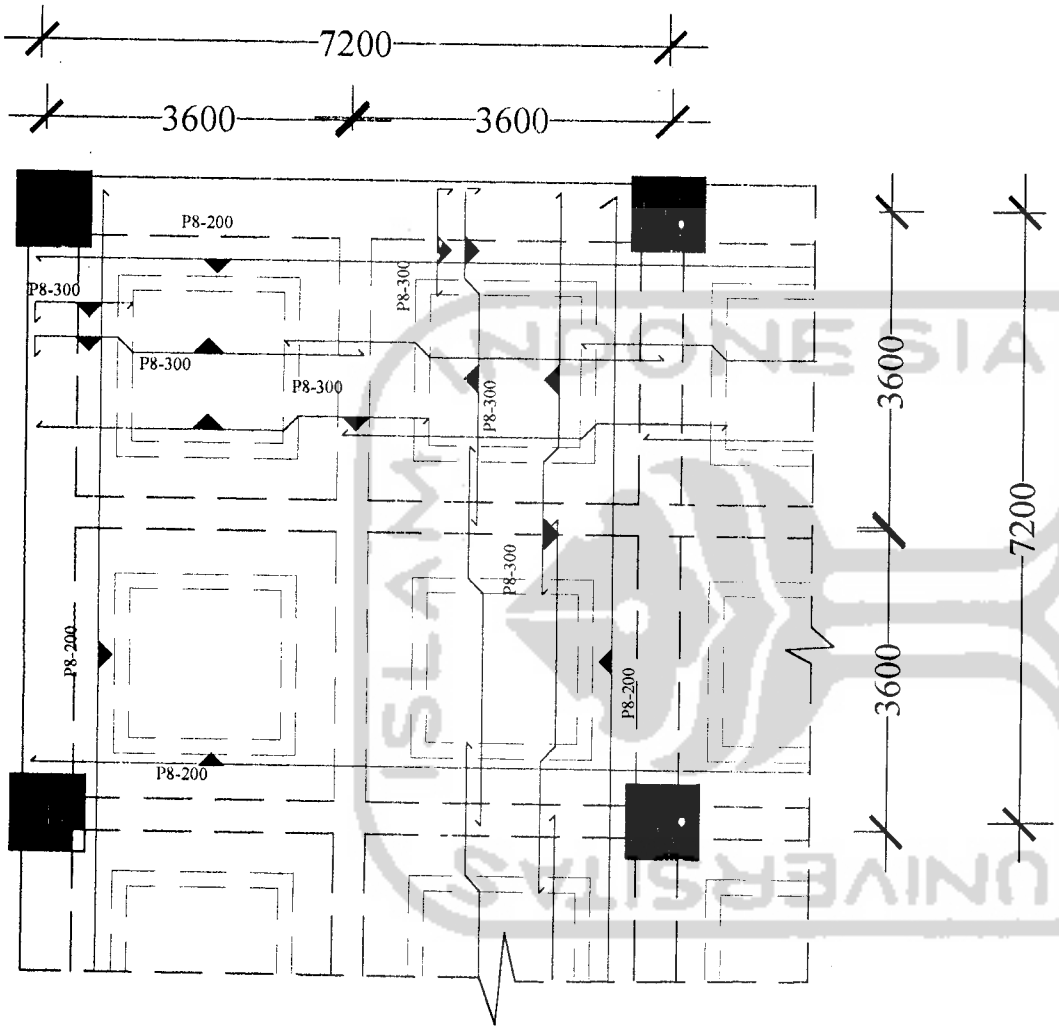


DENAH BALOK LANTAI 4



DENAH BALOK LANTAI 5

DENAH BALOK ATAP



DETAIL PELAT LANTAI
TYPE A (KANTOR)

Keterangan :

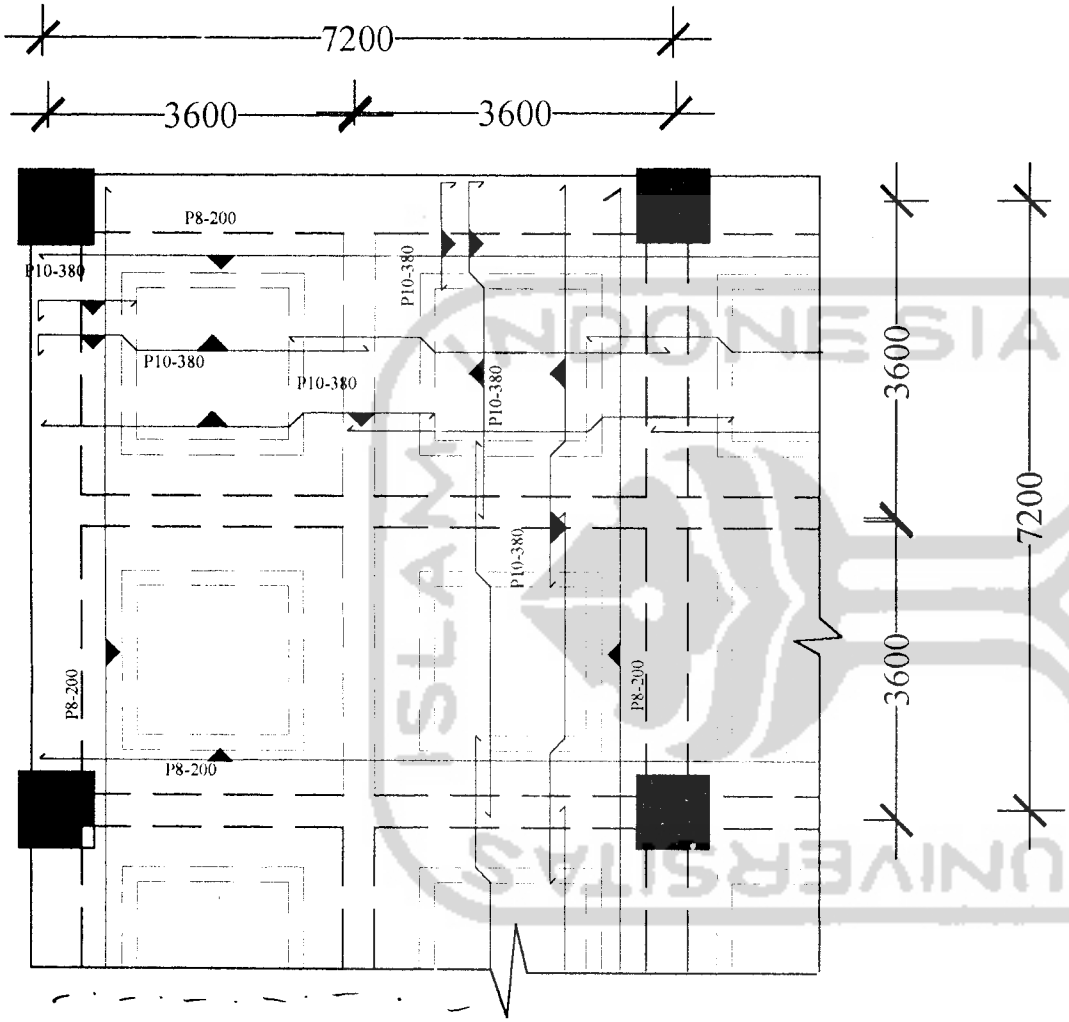
lx = P8-150

tx = P8-150

ly = P8-150

ty = P8-150

Tul. bagi = P8-200



Keterangan :

lx = P10-190

tx = P10-190

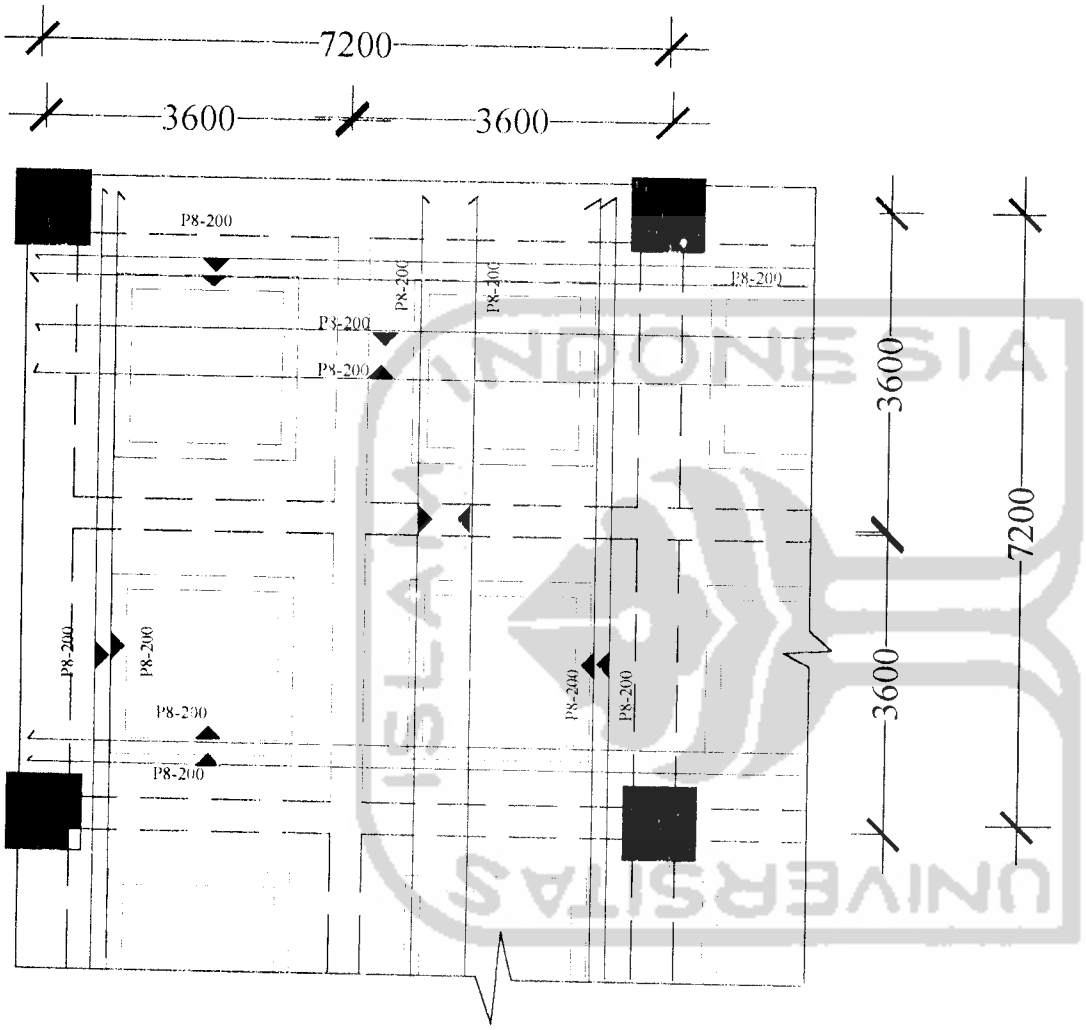
ly = P10-190

ty = P10-190

Tul. bagi = P8-200

DETAIL PELAT LANTAI
TYPE A (PERPUSTAKAAN)

lampiran 9.28



DETAIL PELAT ATAP

Keterangan :

lx = P8-200

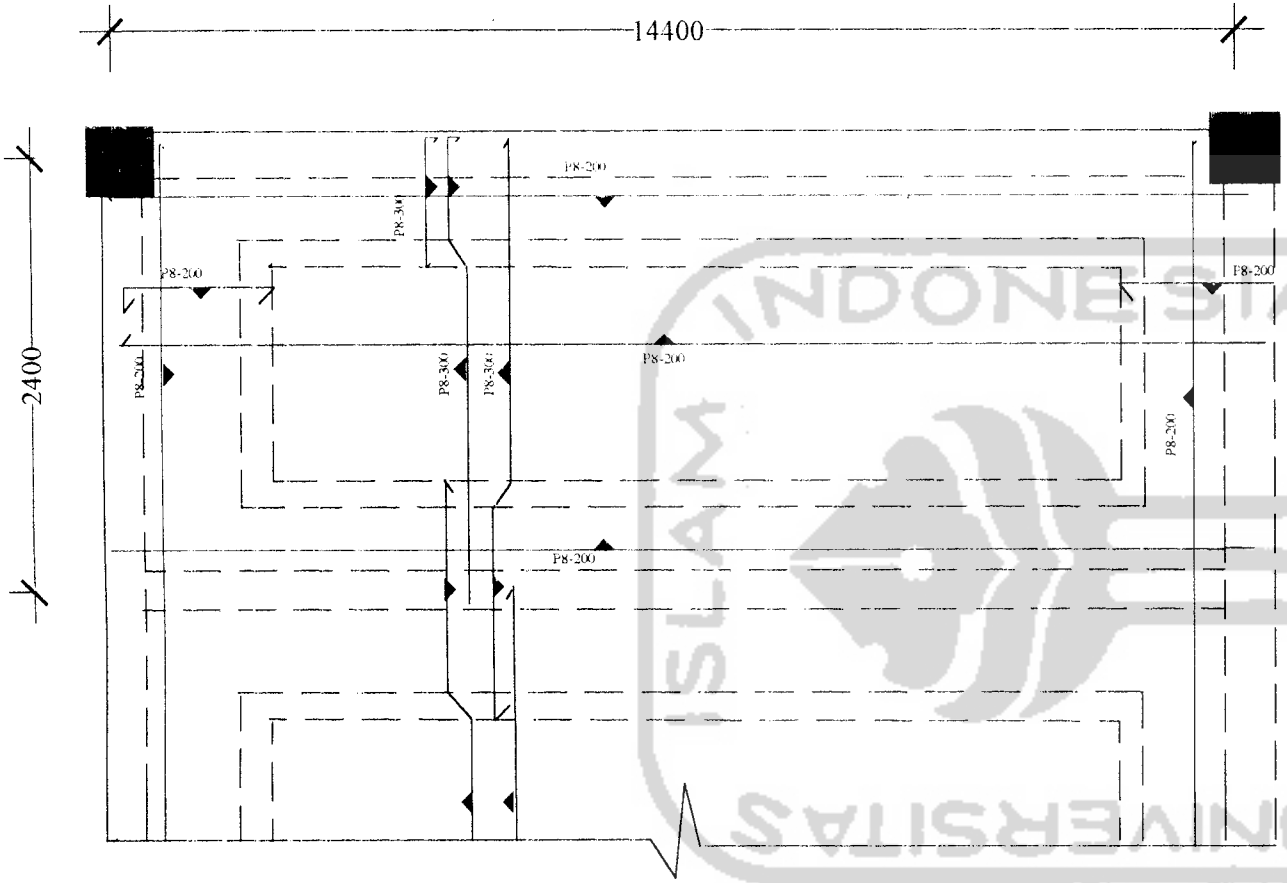
tx = P8-200

ly = P8-200

ty = P8-200

Tul. bagi = P8-200

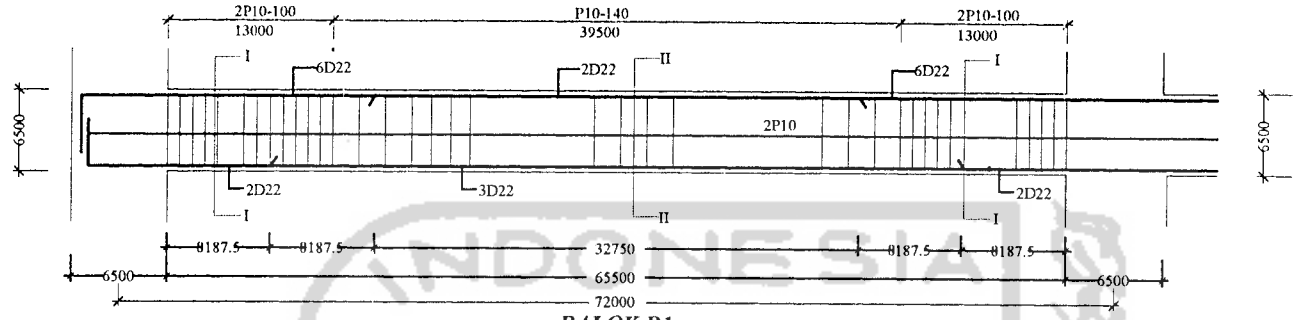
Tul.susut = P8-200



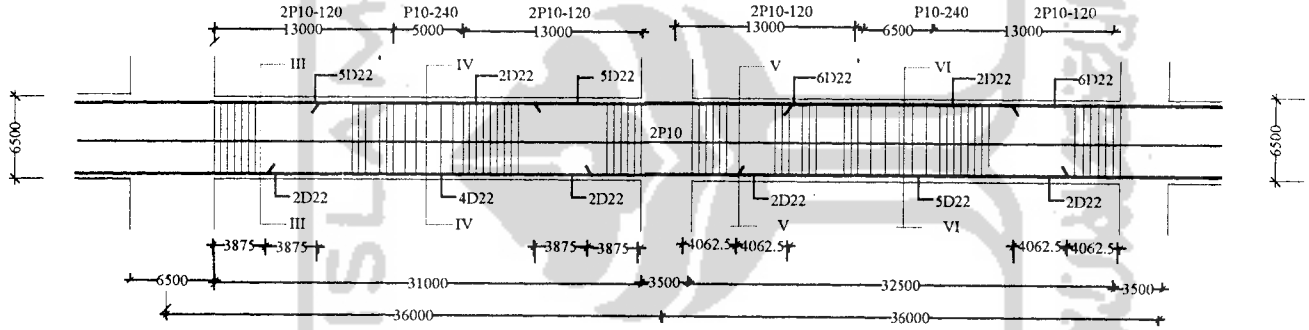
Keterangan :

Tx	=	P8-150
Lx	=	P8-150
Ty	=	P8-200
Ly	=	P8-200
Tul. bagi	=	P8-200

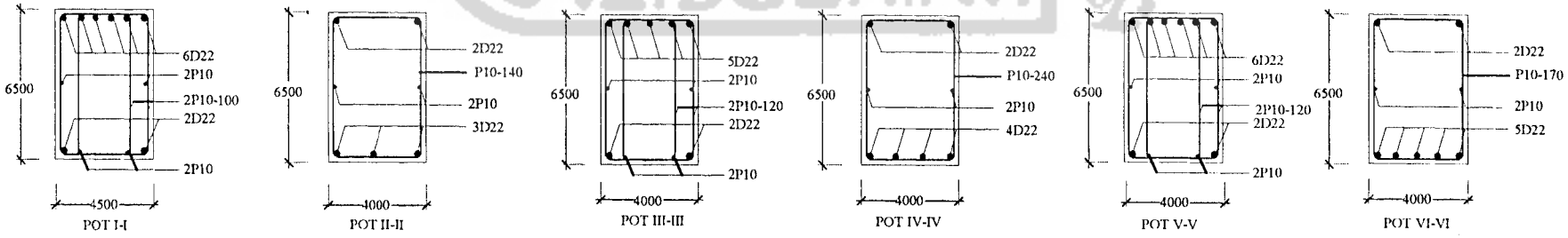
DETAIL PELAT TYPE B



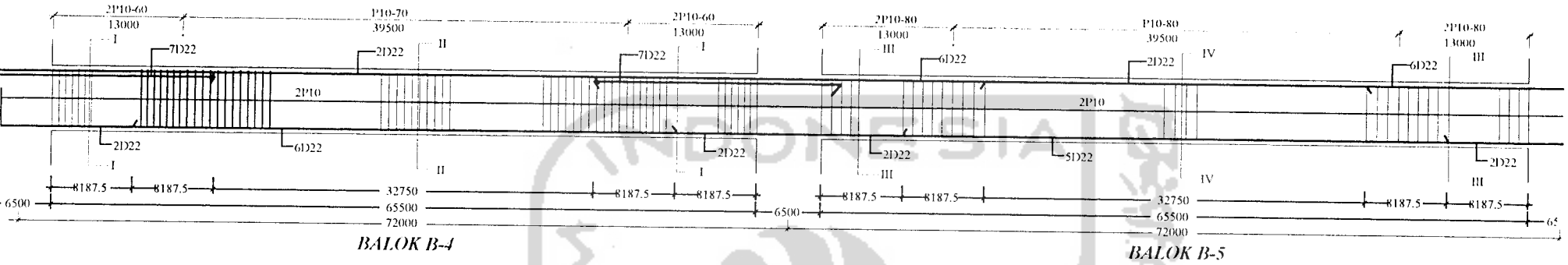
BALOK B1



BALOK B2,B3

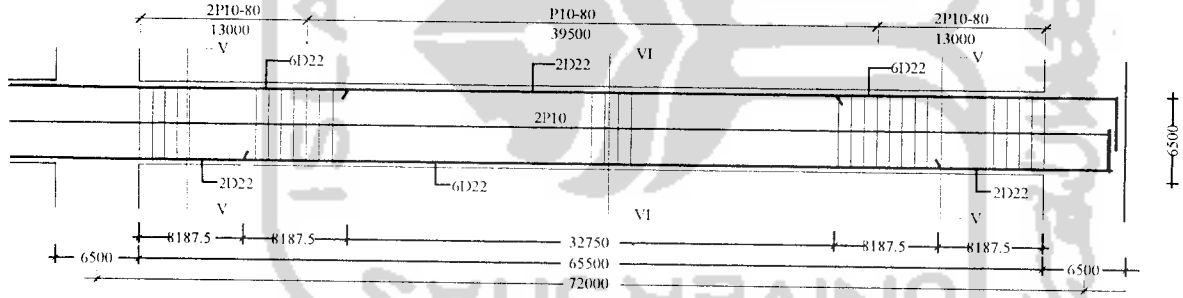


DETAIL BALOK B-1 , B-2 &B-3

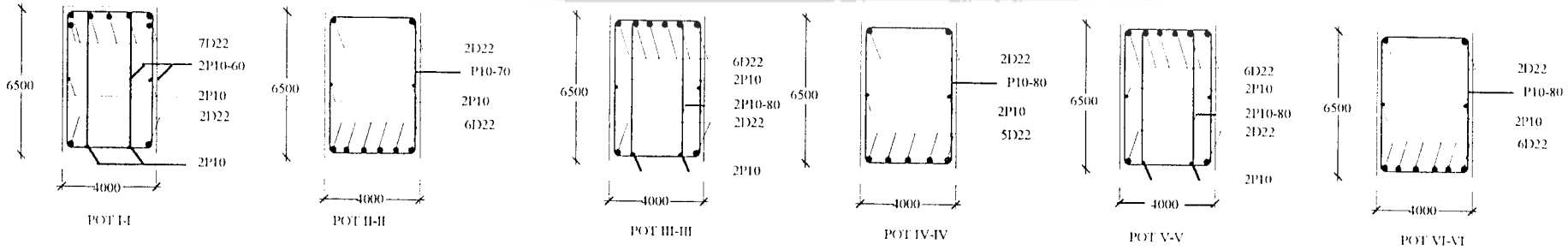


BALOK B-4

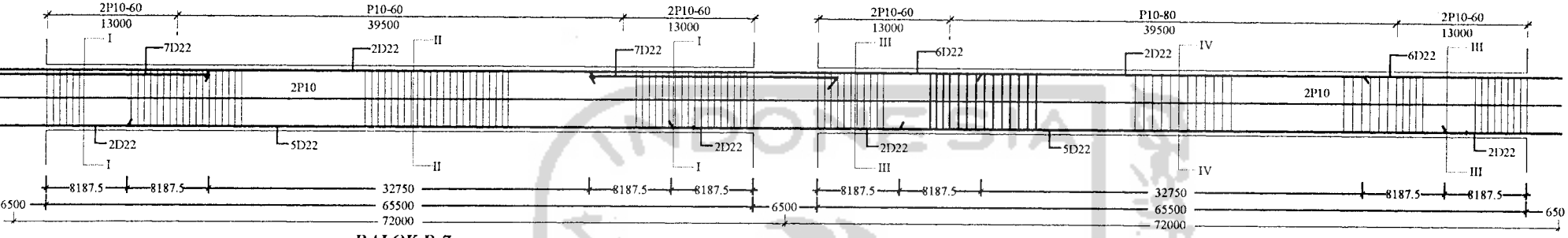
BALOK B-5



BALOK B-6

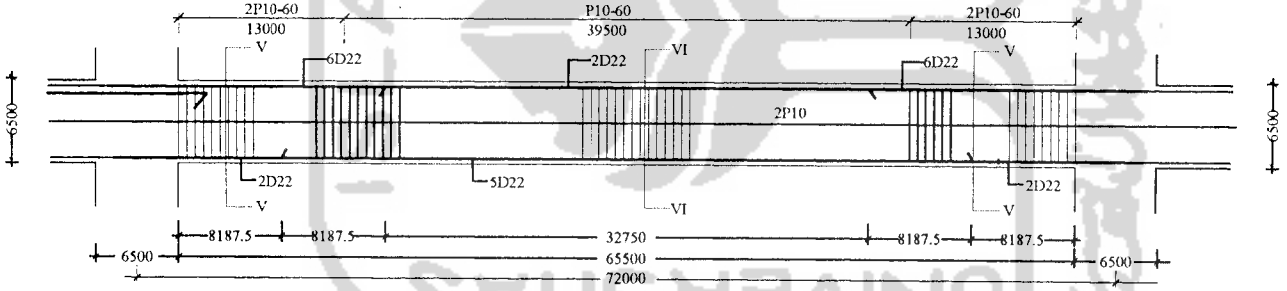


DETAIL BALOK B-4,B-5 &B6

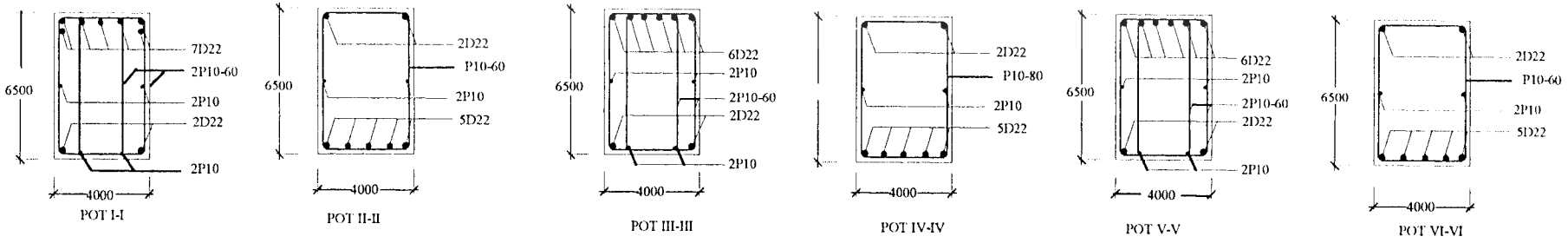


BALOK B-7

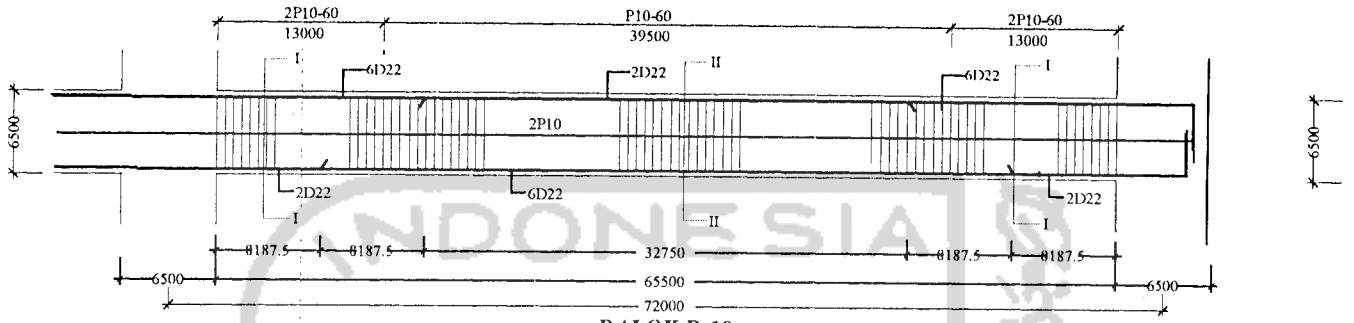
BALOK B-8



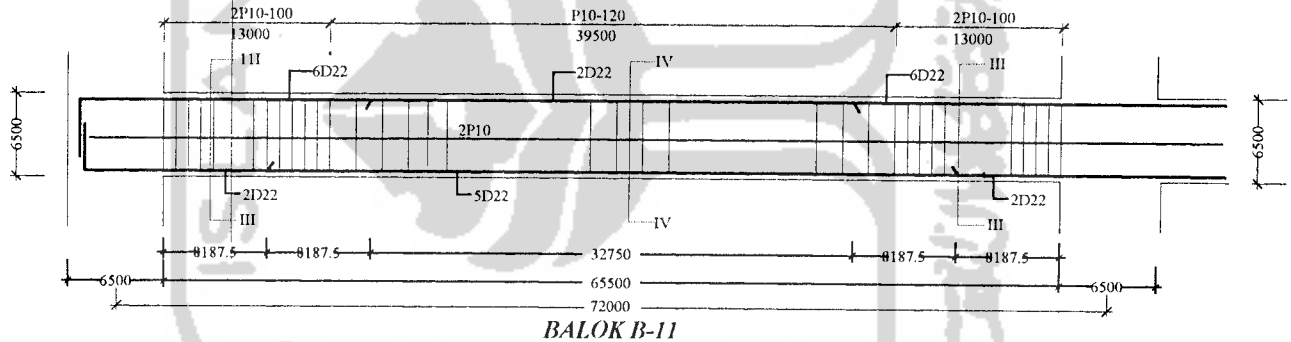
BALOK B-9



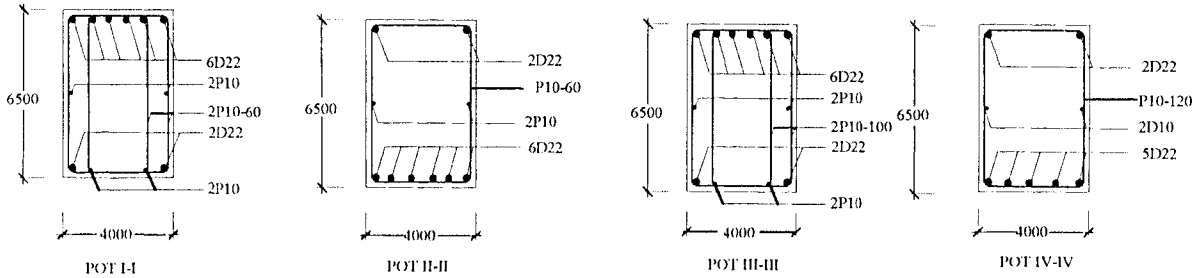
DETAIL BALOK B-7,B-8 & B-9



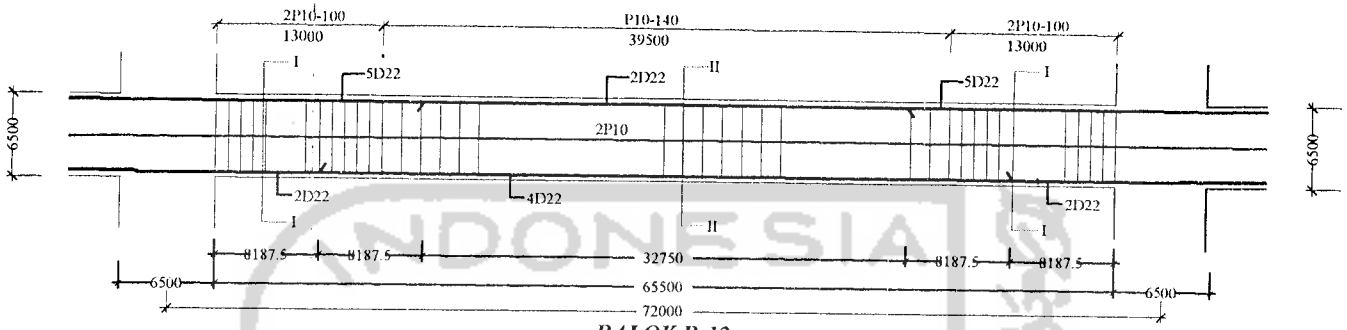
BALOK B-10



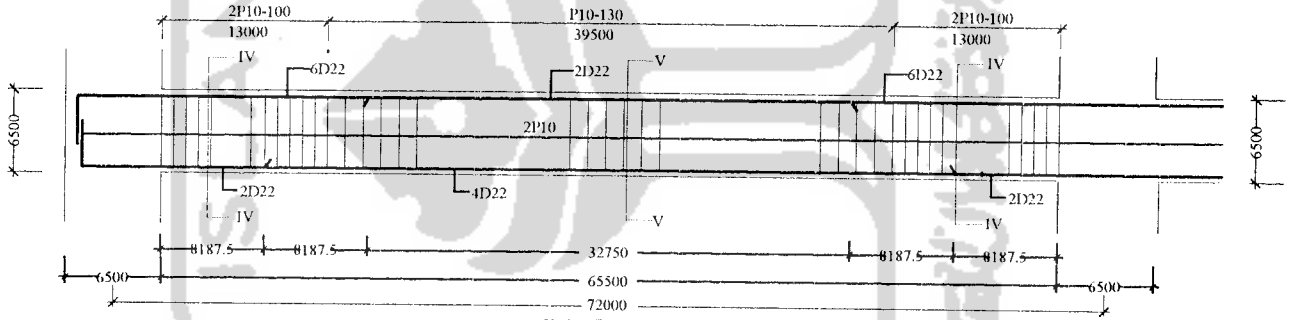
BALOK B-11



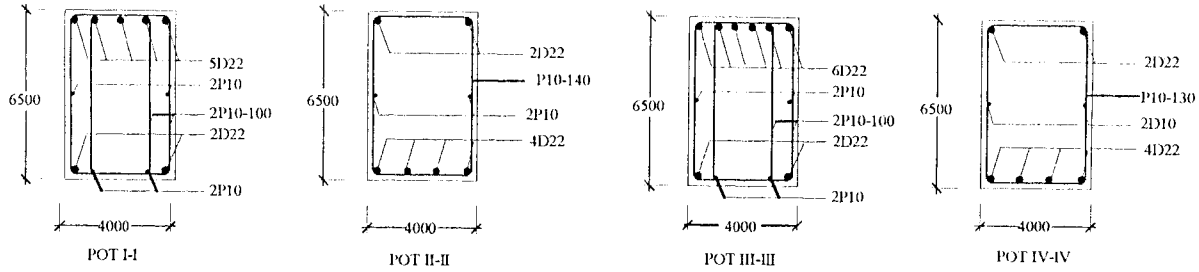
DETAIL BALOK B-10 & B-11



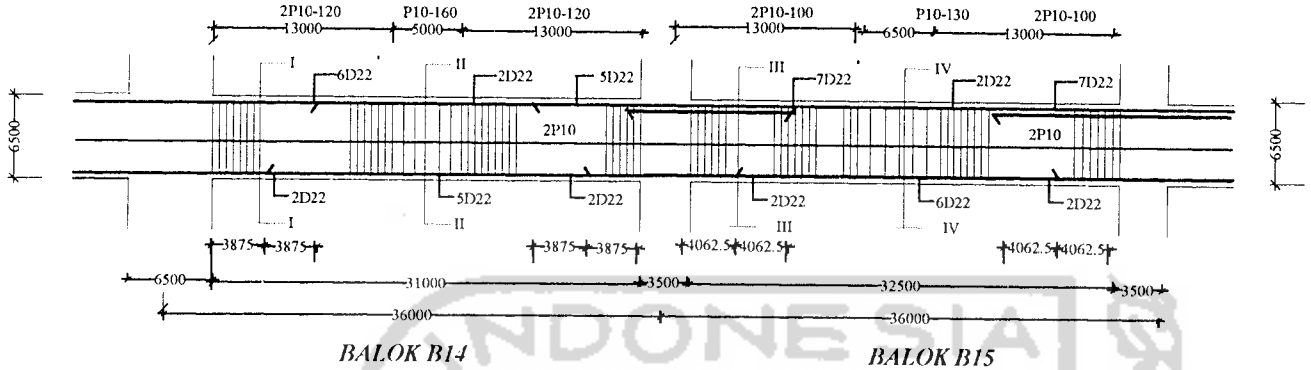
BALOK B-12



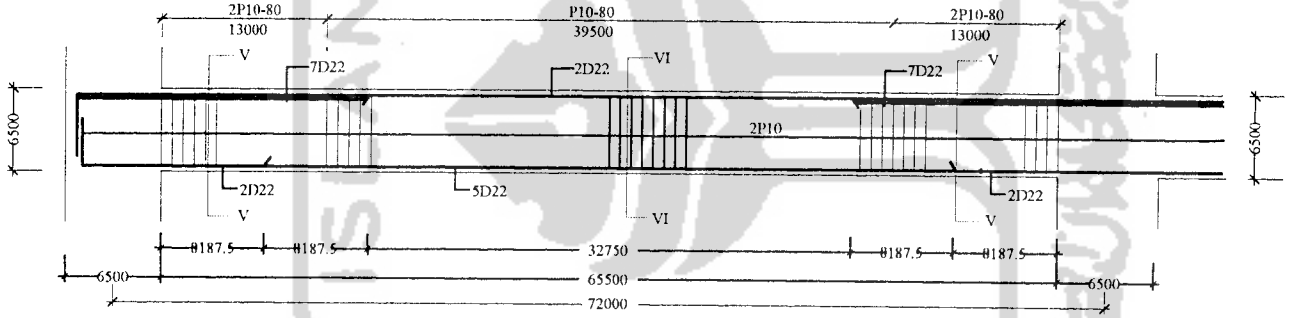
BALOK B-13



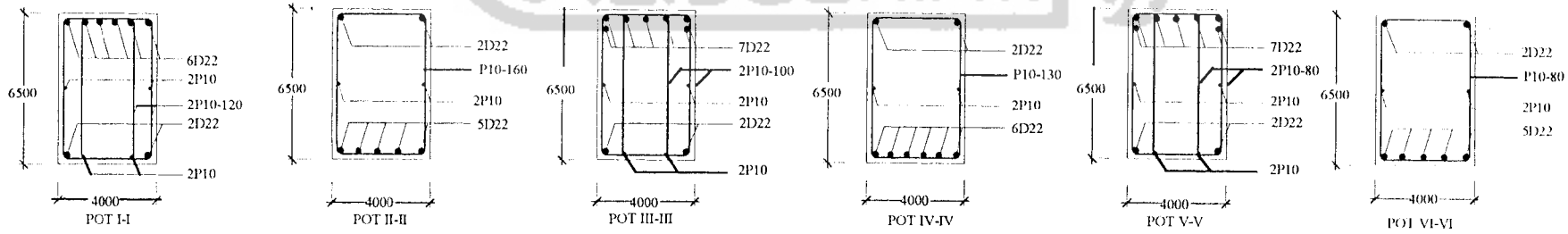
DETAIL BALOK B-12 & B-13



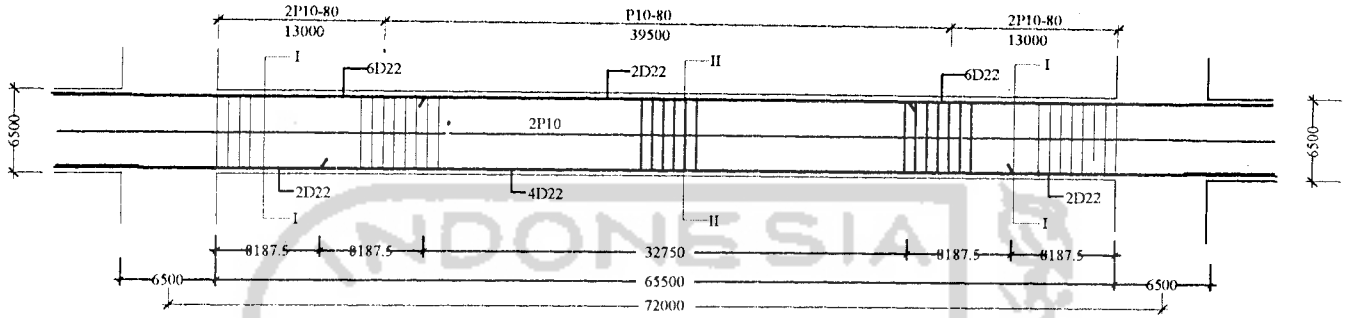
BALOK B14 *BALOK B15*



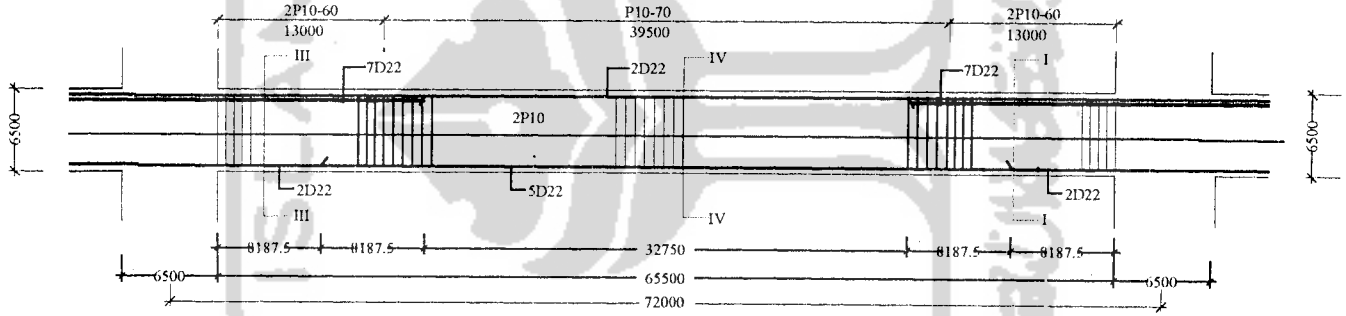
BALOK B16



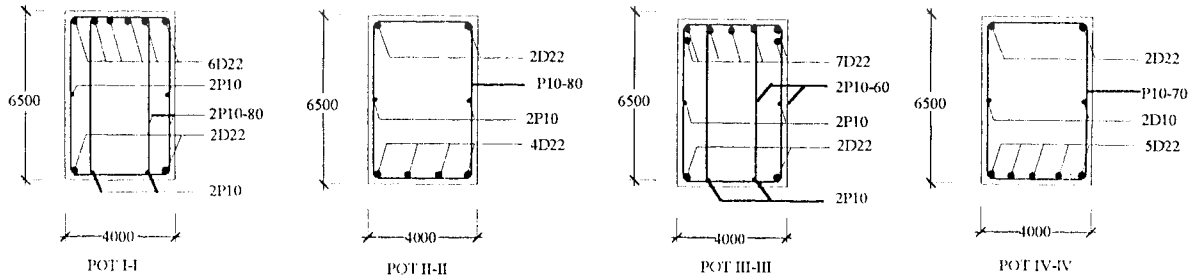
DETAIL BALOK B-14 , B-15 &B-16



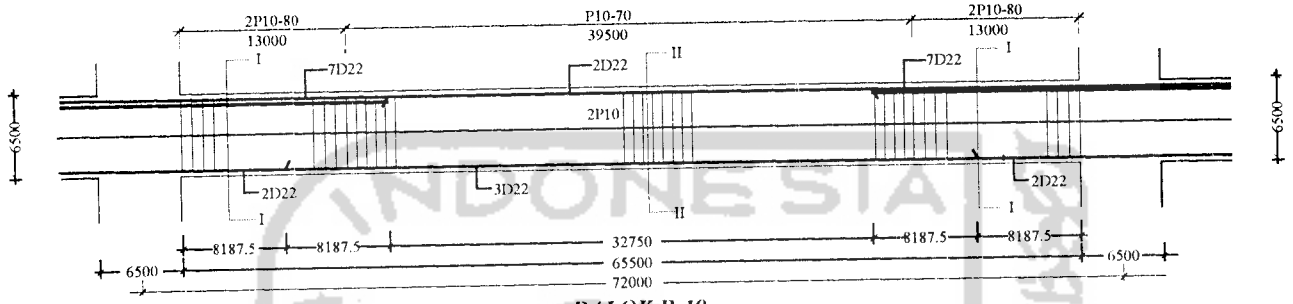
BALOK B-17



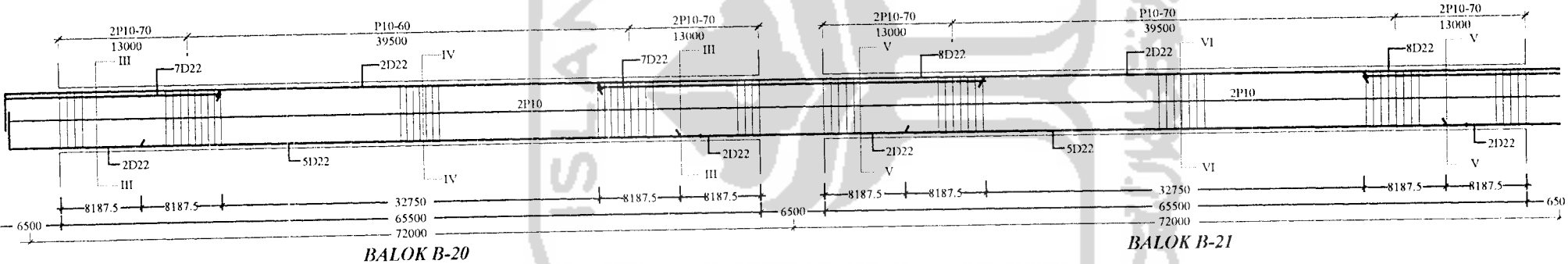
BALOK B-18



DETAIL BALOK B-17 & B-18

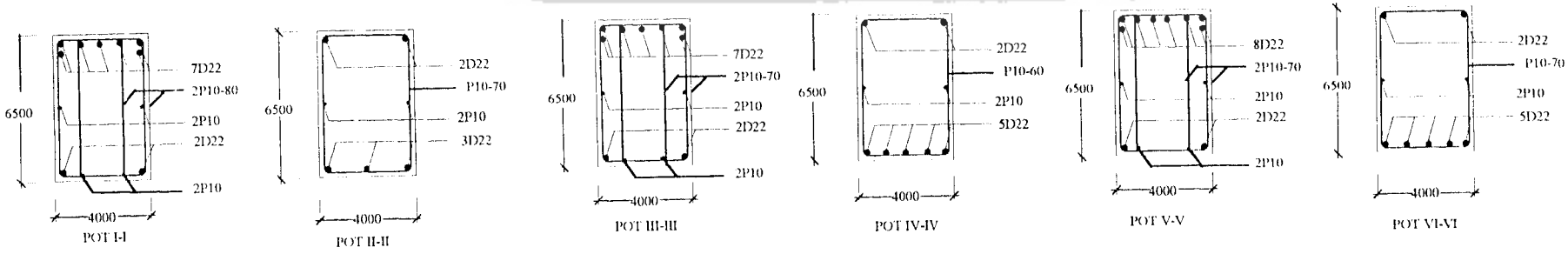


BALOK B-19

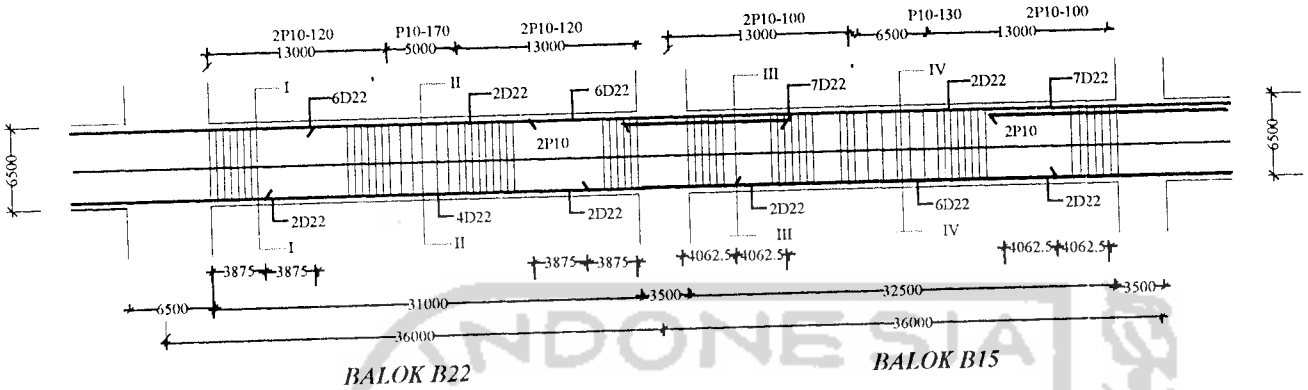


BALOK B-20

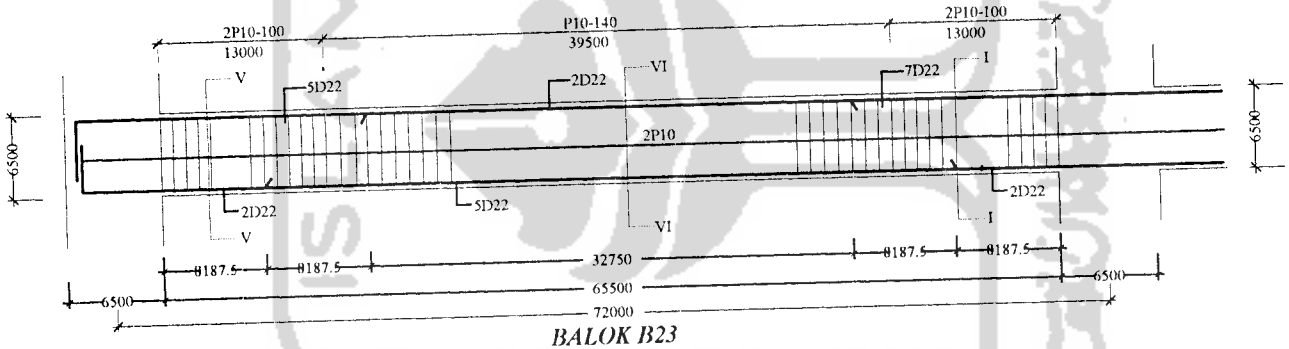
BALOK B-21



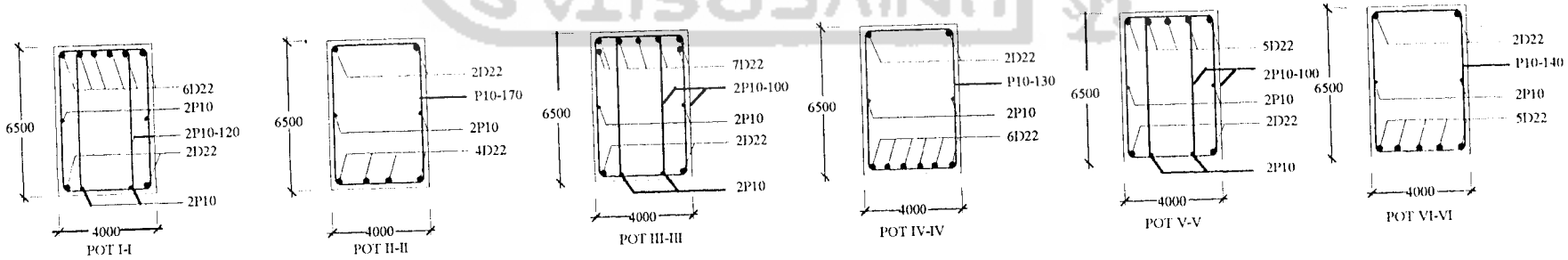
DETAIL BALOK B-19,B-20 & B-21



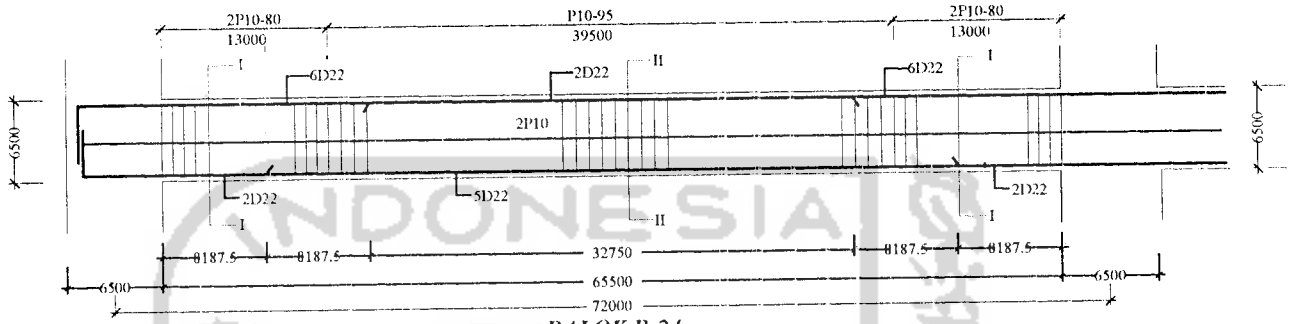
BALOK B22 *BALOK B15*



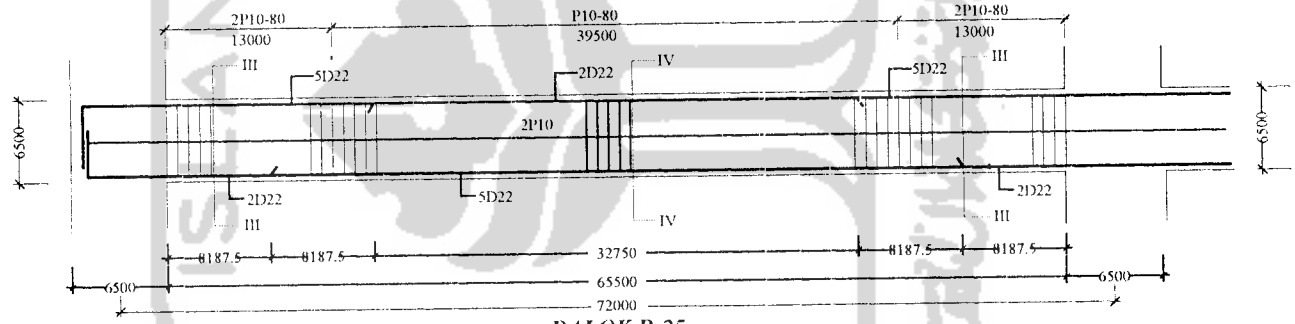
BALOK B23



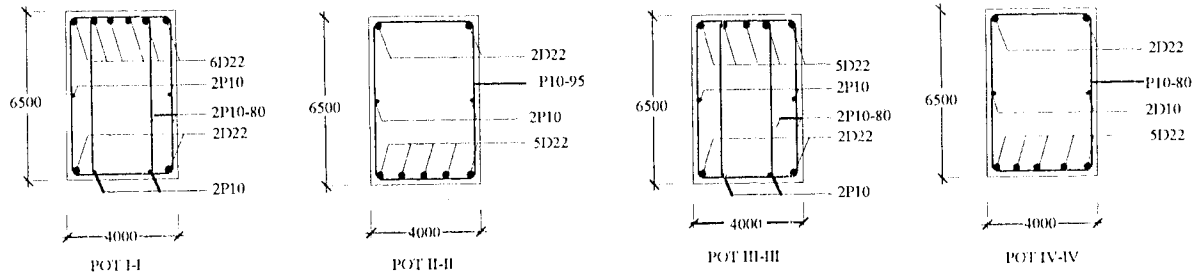
DETAIL BALOK B-15 , B-22 &B-23



BALOK B-24

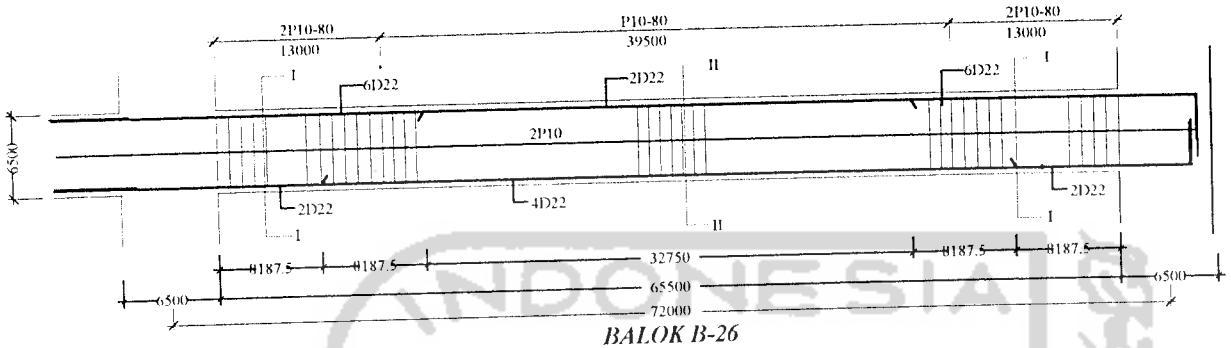


BALOK B-25

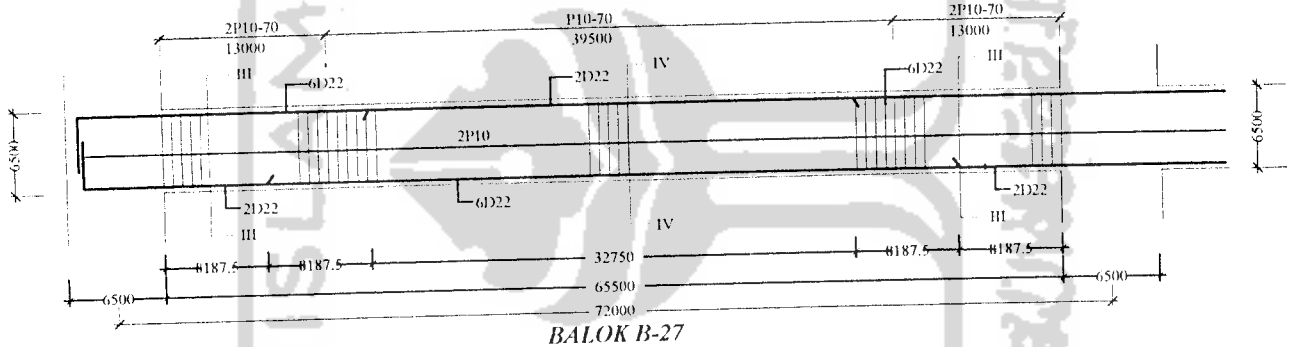


DETAIL BALOK B-24 & B-25

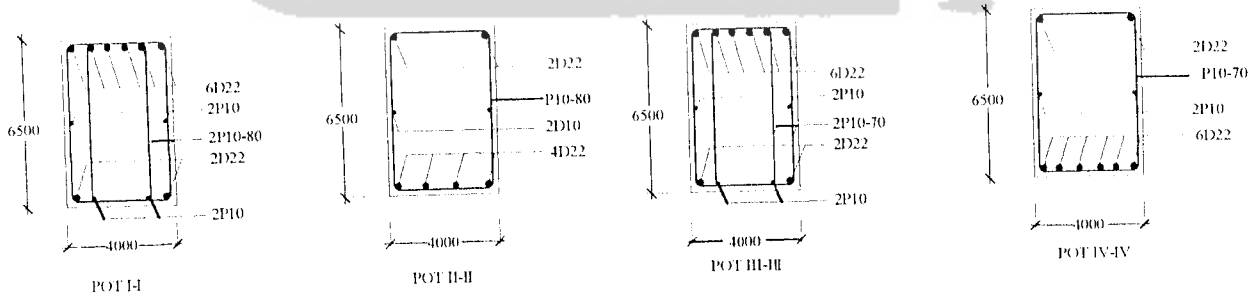
lampiran 9.40



BALOK B-26

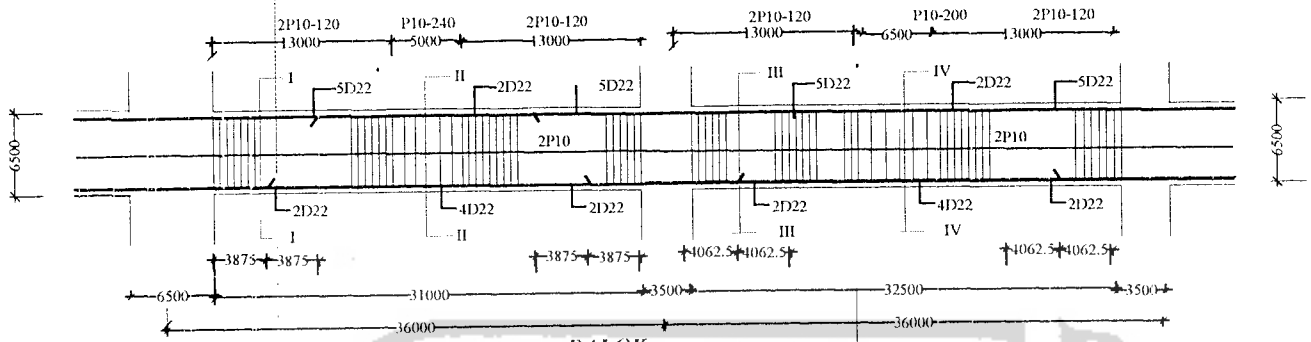


BALOK B-27

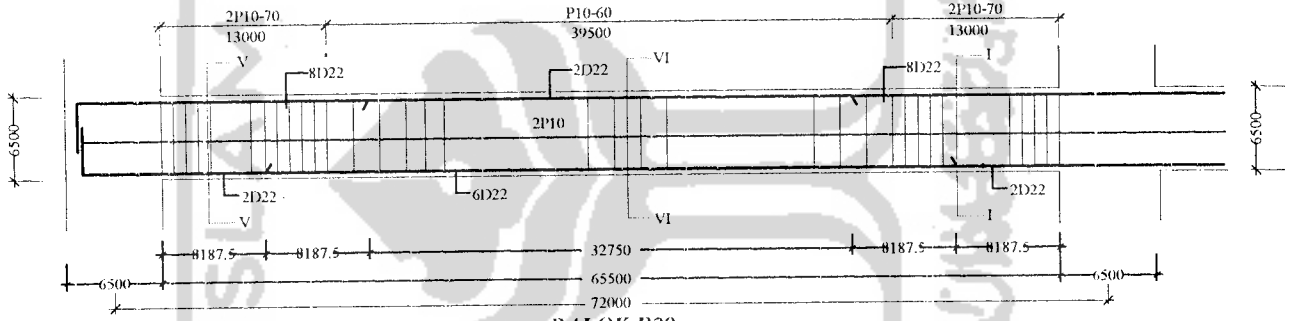


DETAIL BALOK B-26 & B-27

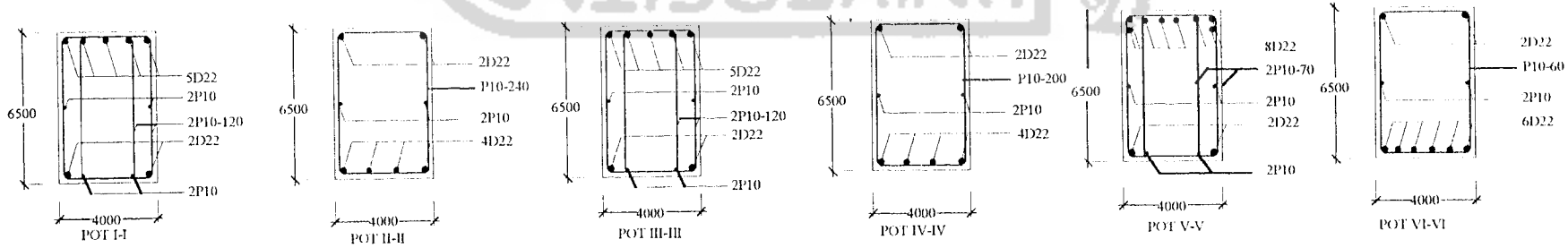
lampiran 9.41



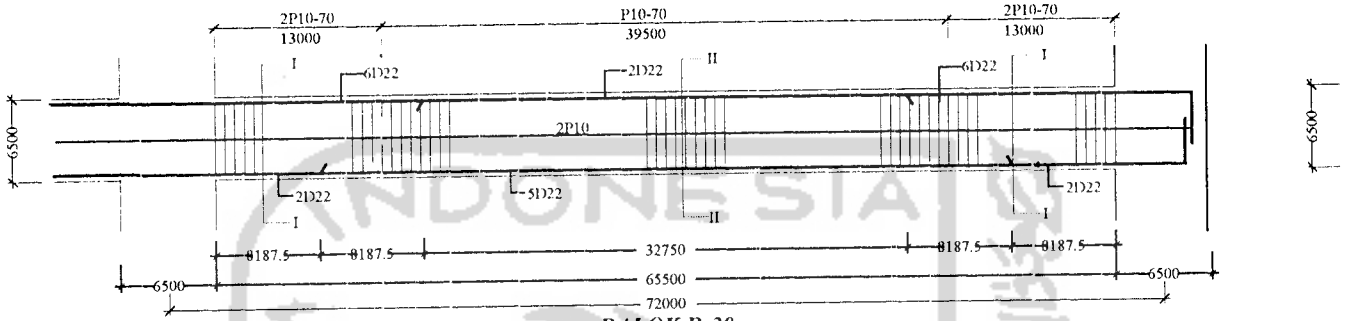
BALOK B2,B28



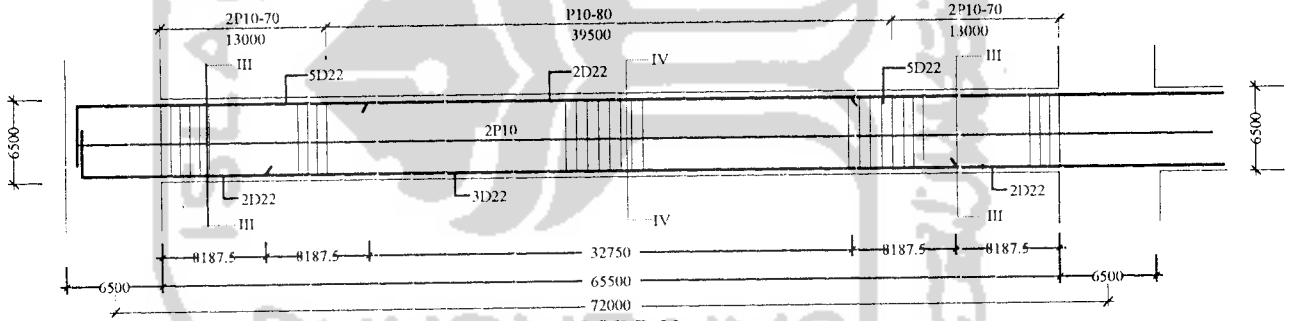
BALOK B29



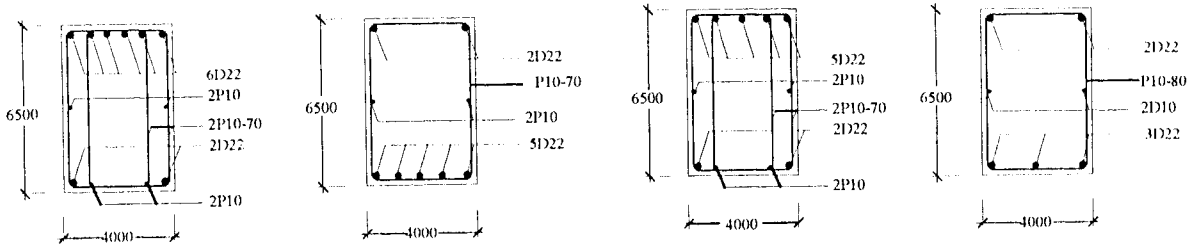
DETAIL BALOK B-2 , B-28 &B-29



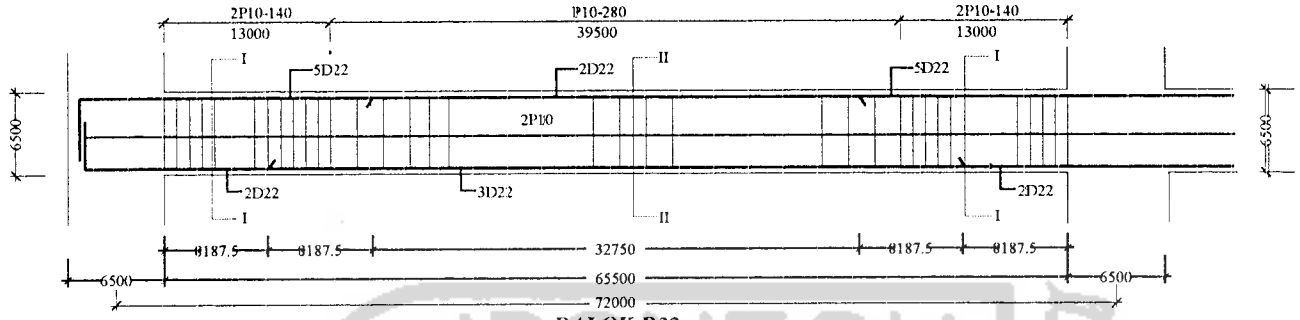
BALOK B-30



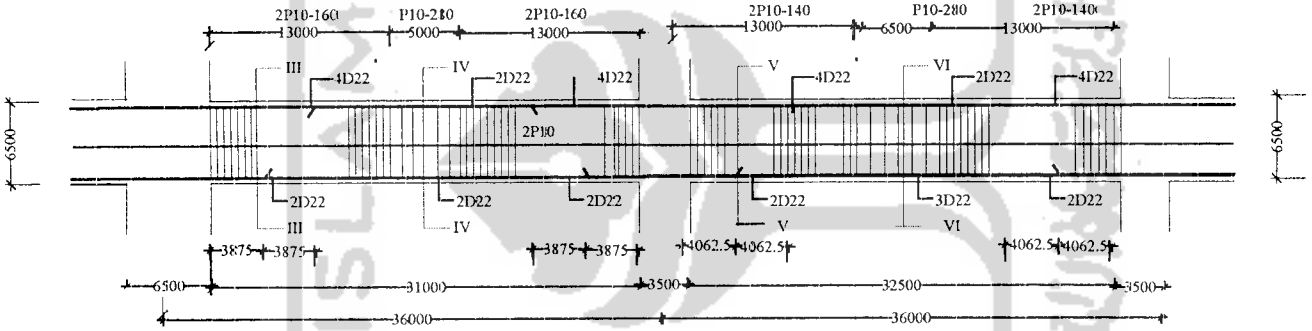
BALOK B-31



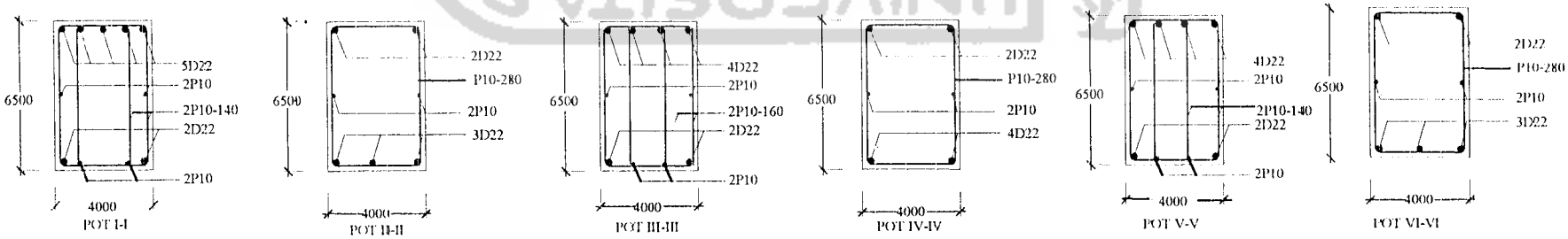
lampiran 9.43



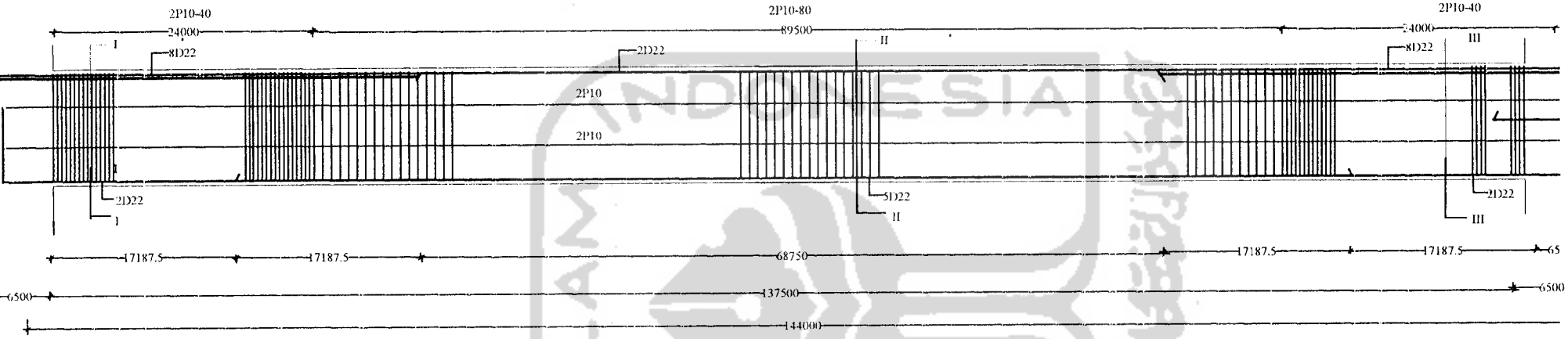
BALOK B32



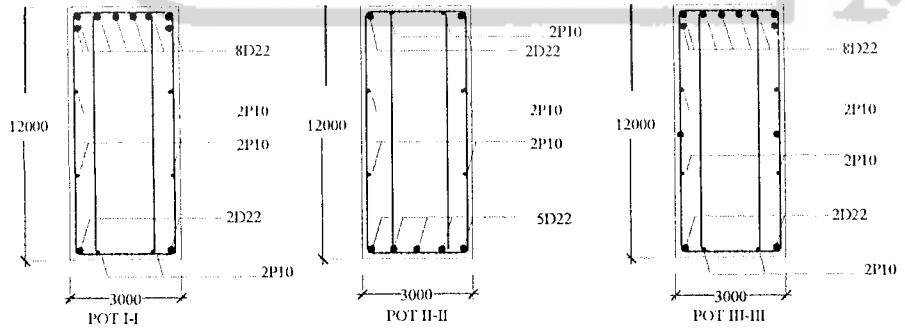
BALOK B33,B34

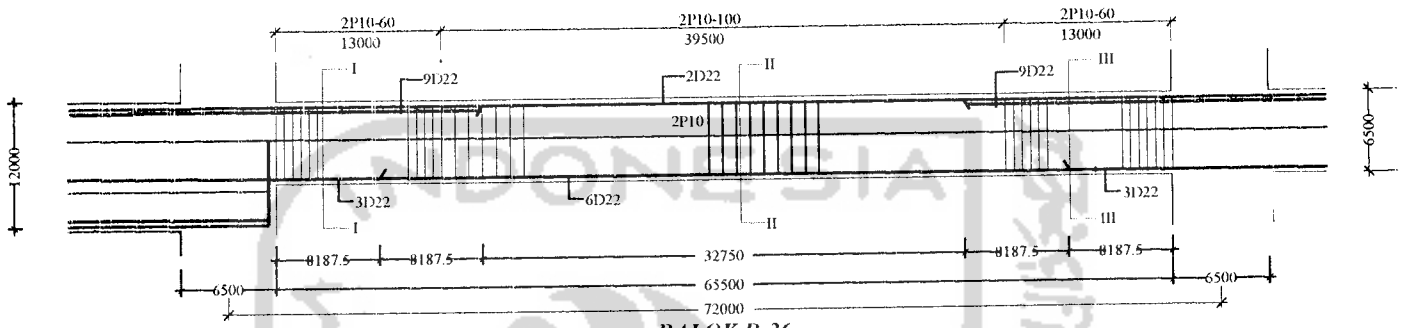


DETAIL BALOK B-32 , B-33 &B-34

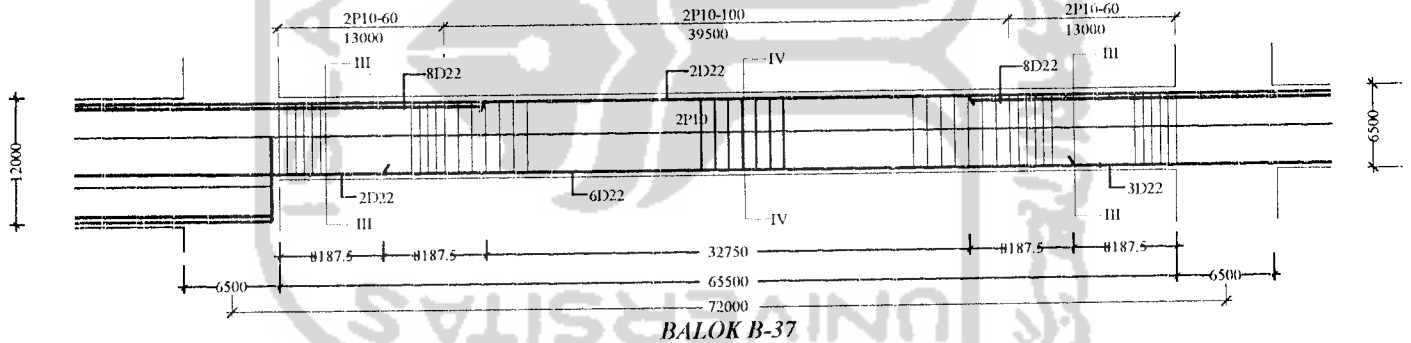

2P10-40
24000
2P10-80
89500
2P10-40
24000
I
II
III
8D22
2D22
2P10
2P10
5D22
17187.5
17187.5
68750
17187.5
17187.5
65
6500
137500
6500
144000

BALOK B-35

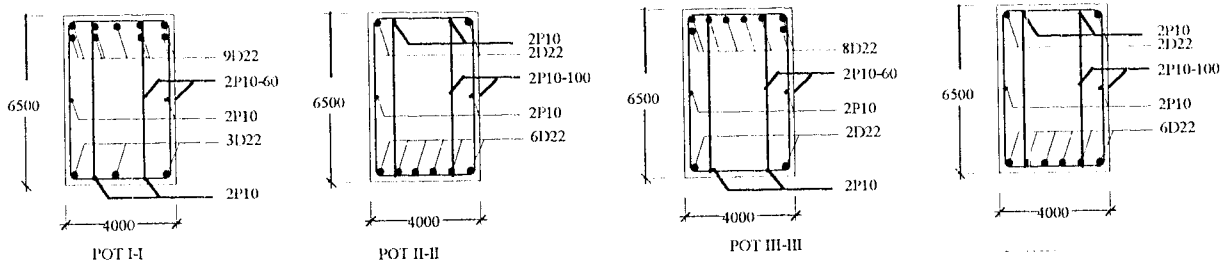

12000
8D22
2P10
2P10
2D22
2P10
3000
POT I-I
12000
2P10
2D22
2P10
2P10
5D22
3000
POT II-II
12000
8D22
2P10
2P10
2D22
2P10
3000
POT III-III

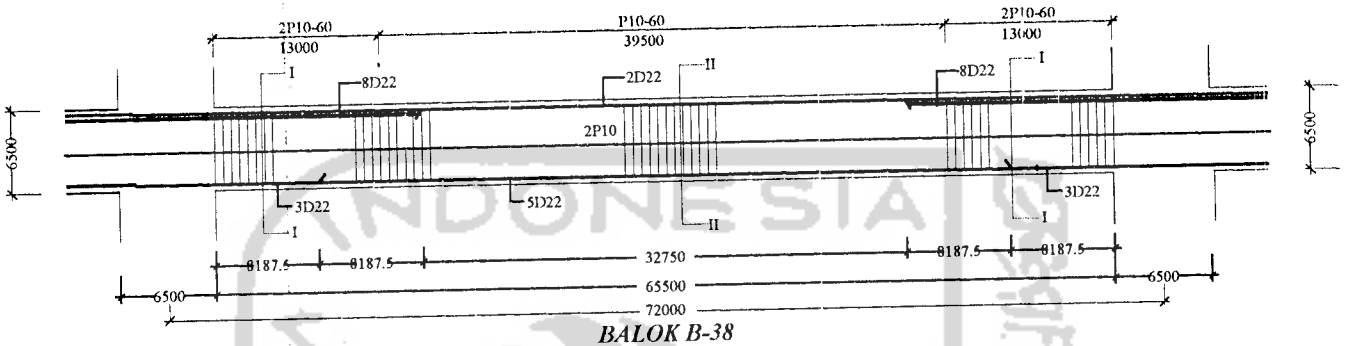


BALOK B-36

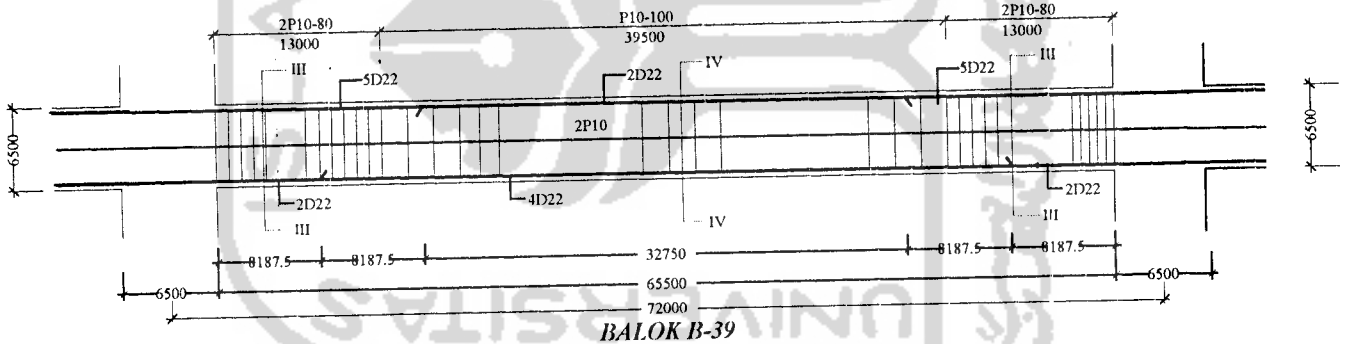


BALOK B-37

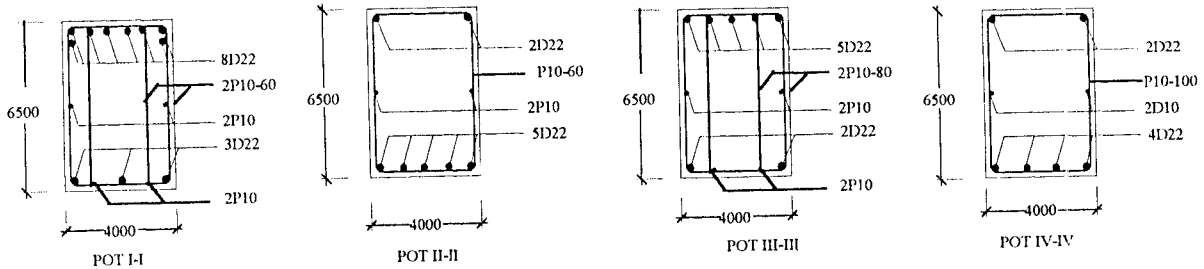


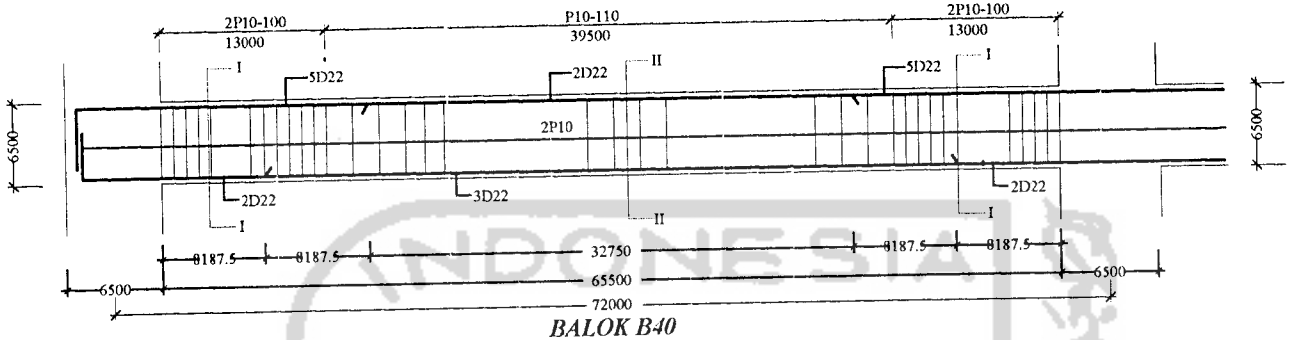


BALOK B-38

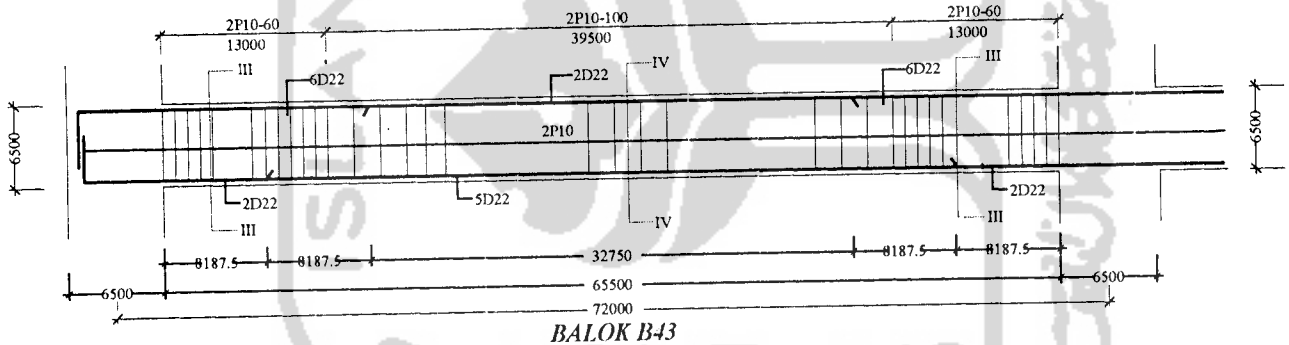


BALOK B-39

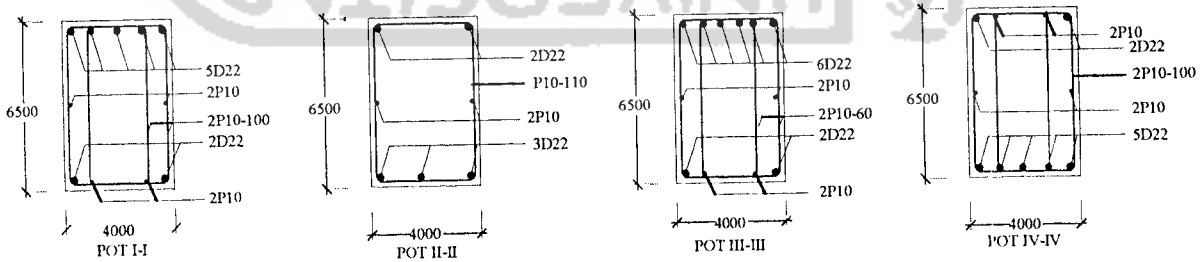




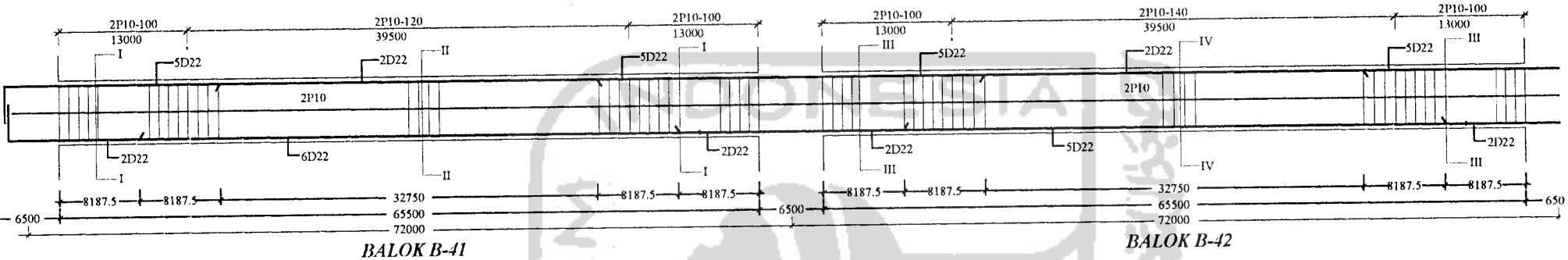
BALOK B40



BALOK B43

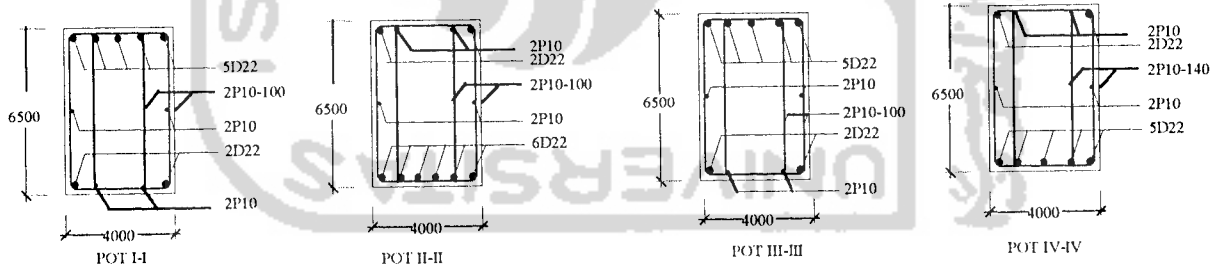


DETAIL BALOK B-40 , B-43

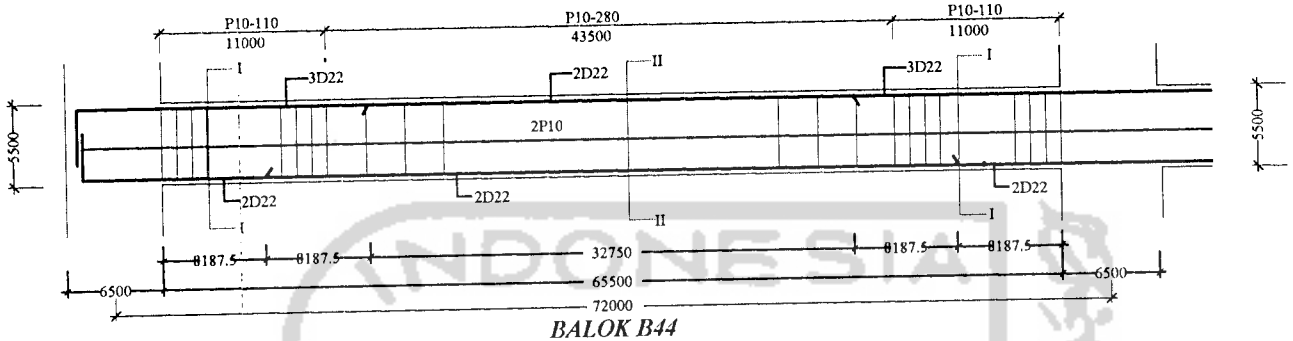


BALOK B-41

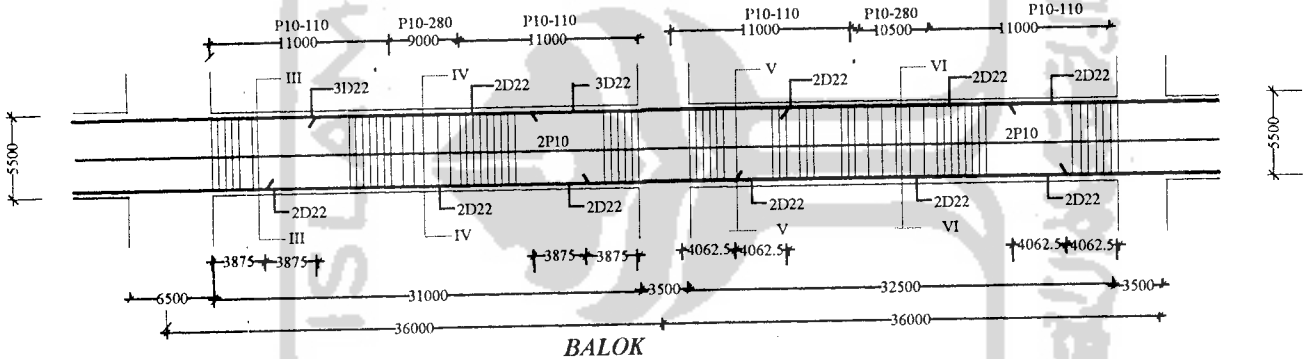
BALOK B-42



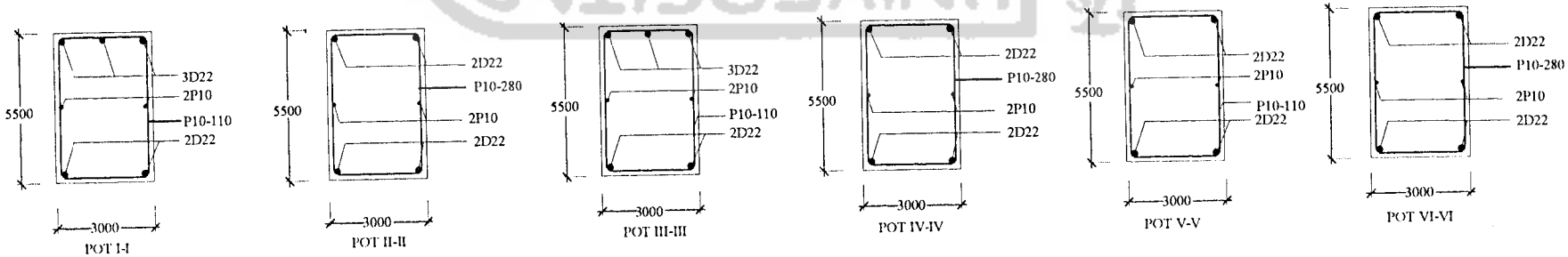
DETAIL BALOK B-41 & B-42



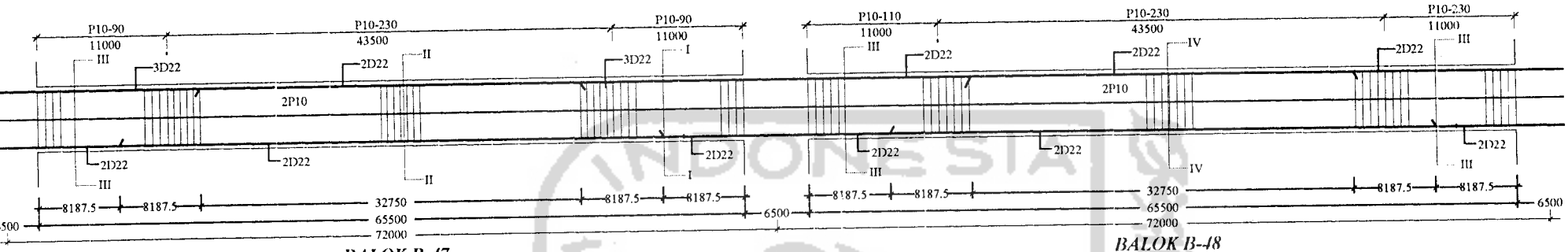
BALOK B44



BALOK B45,B46

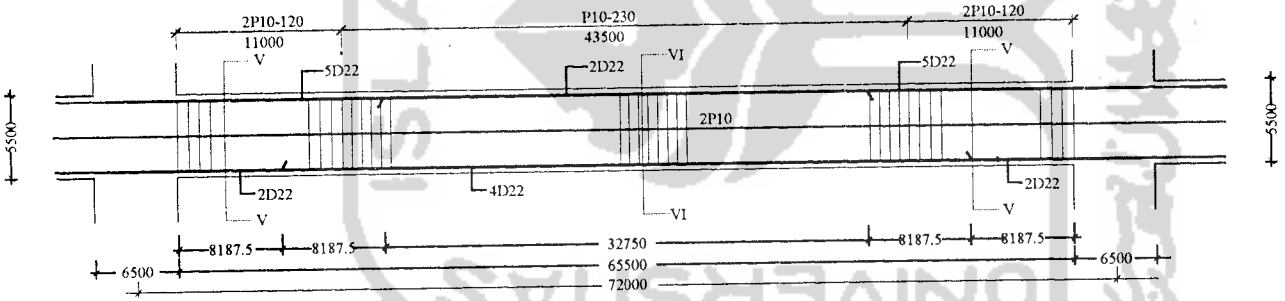


DETAIL BALOK B-44 , B-45 &B-46

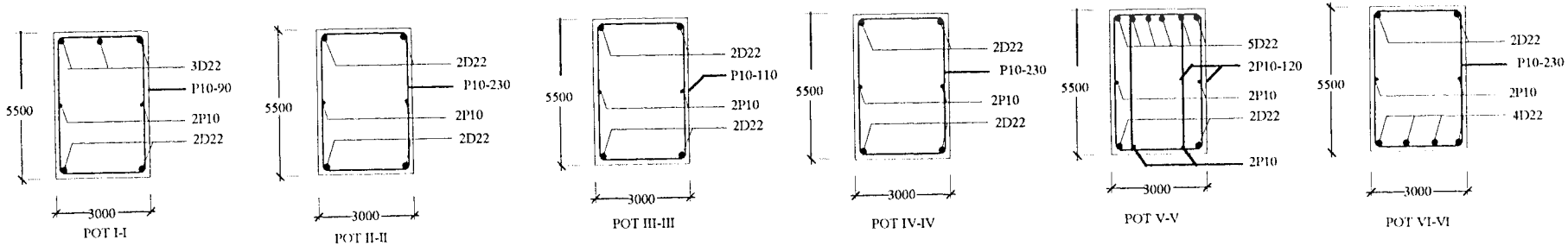


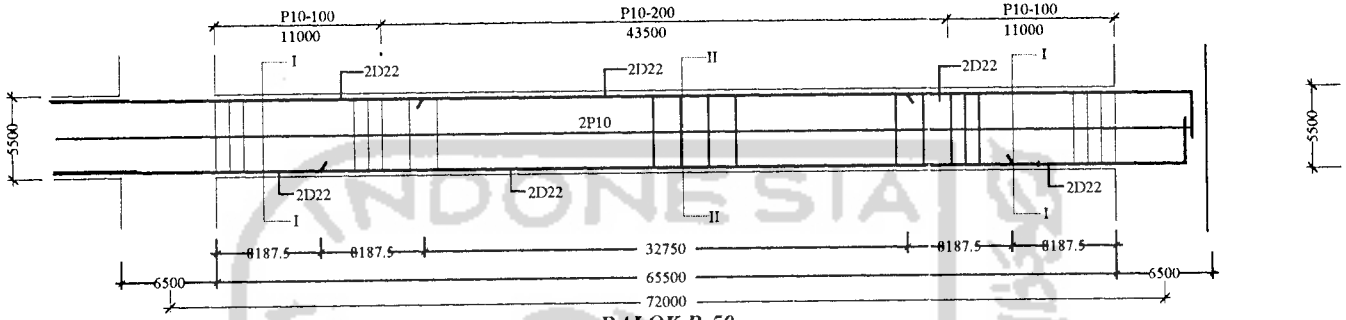
BALOK B-47

BALOK B-48

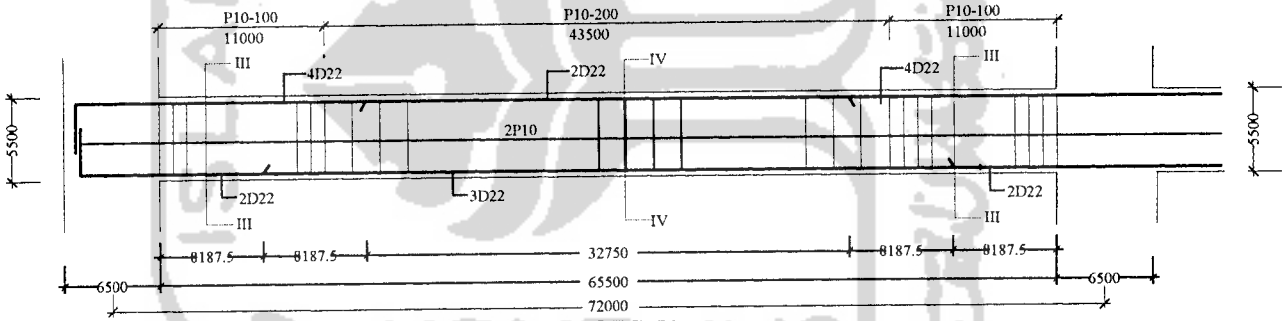


BALOK B-49

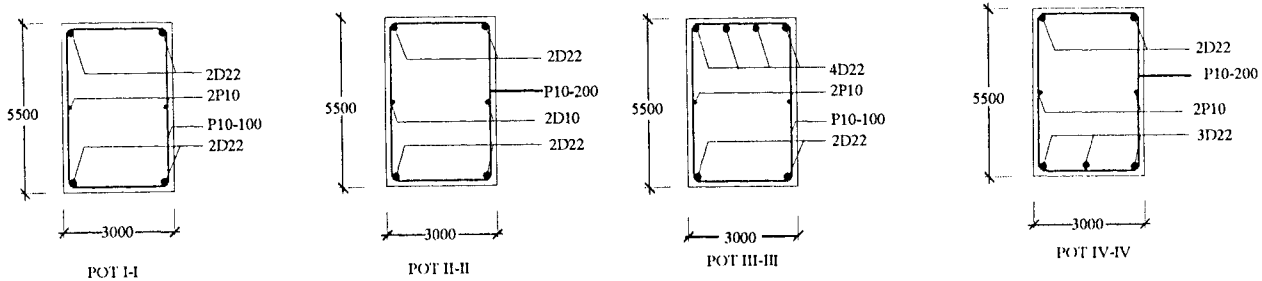


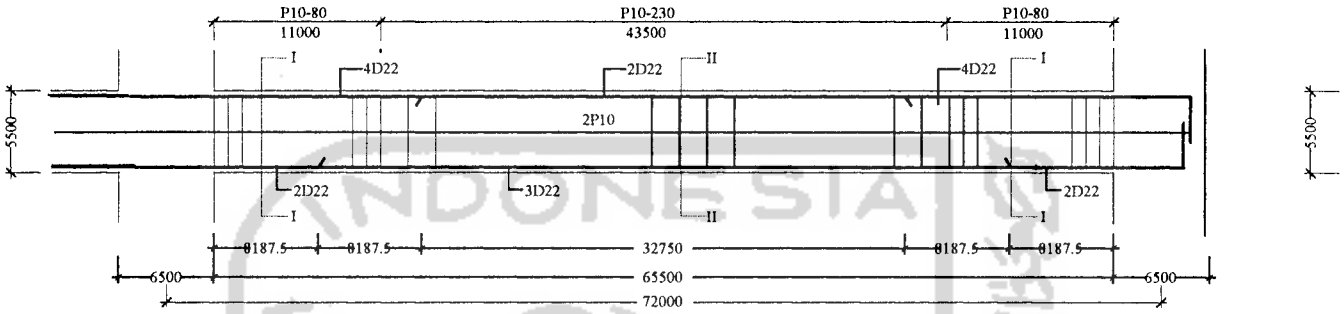


BALOK B-50

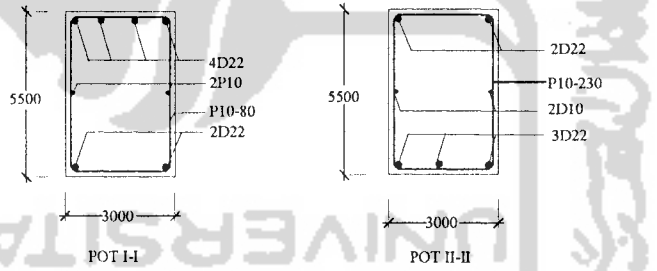


BALOK B-51

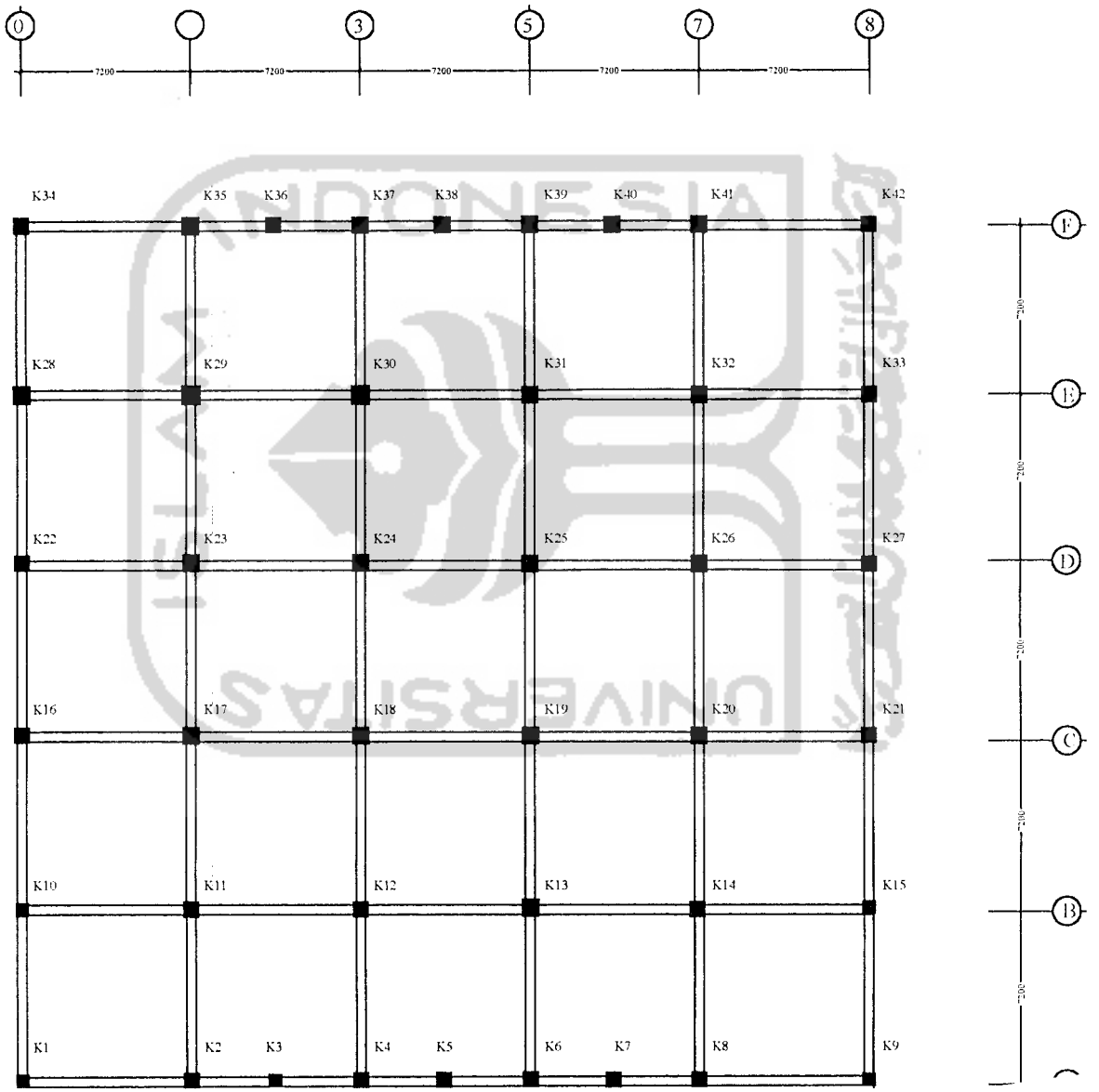




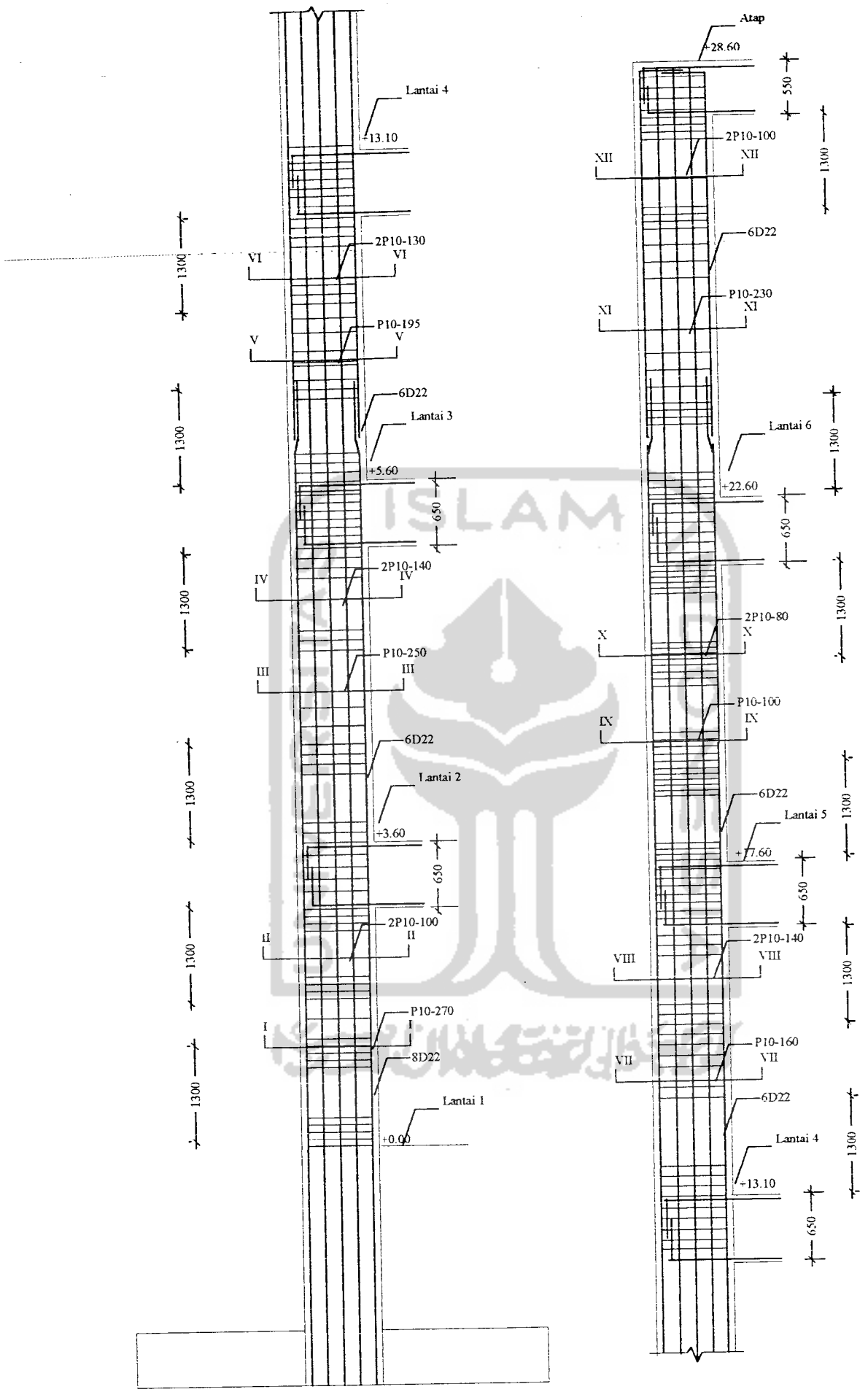
BALOK B-52



DETAIL BALOK B-52

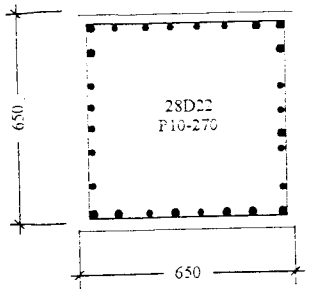


RENCANA KOLOM

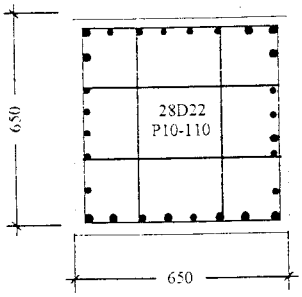

Atap
+28.60
550
2P10-100
XII
XII
1300
6D22
P10-230
XI
XI
Lantai 6
+22.60
650
2P10-80
X
X
P10-100
IX
IX
6D22
Lantai 5
+17.60
650
2P10-140
VIII
VIII
P10-160
VII
VII
6D22
Lantai 4
+13.10
650
Lantai 4
+13.10
2P10-130
VI
VI
P10-195
V
V
6D22
Lantai 3
+5.60
650
2P10-140
IV
IV
P10-250
III
III
6D22
Lantai 2
+3.60
650
2P10-100
II
II
P10-270
I
I
8D22
Lantai 1
+0.00
1300

RENC. KOLOM 1

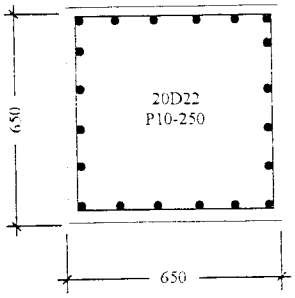
POT I-I



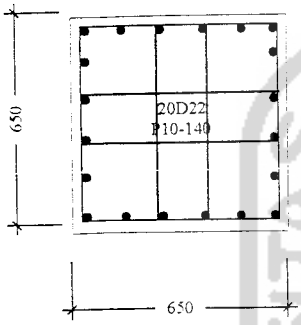
POT II-II



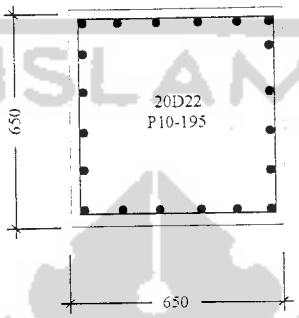
POT III-III



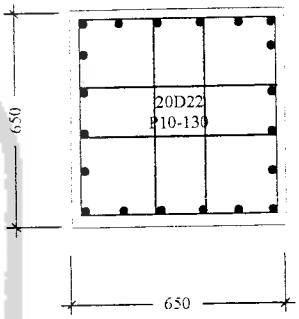
POT IV-IV



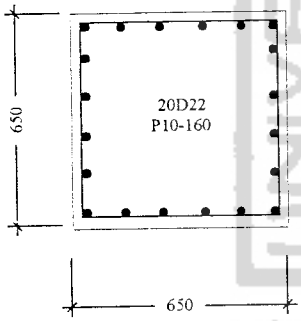
POT V-V



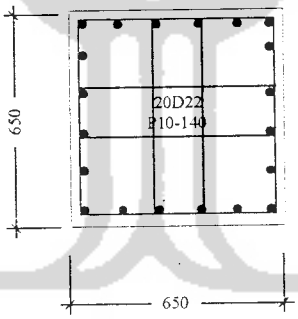
POT VI-VI



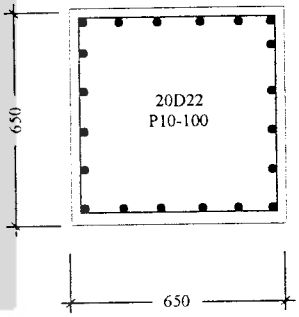
POT VII-VII



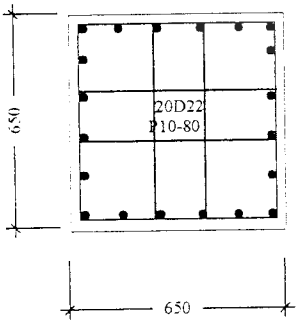
POT VIII-VIII



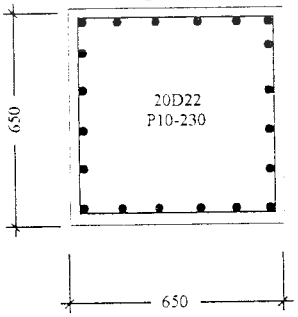
POT IX-IX



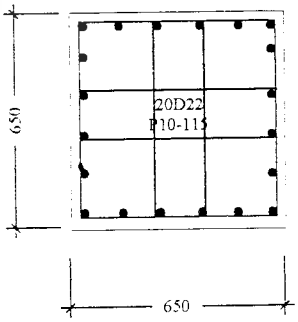
POT X-X



POT XI-XI

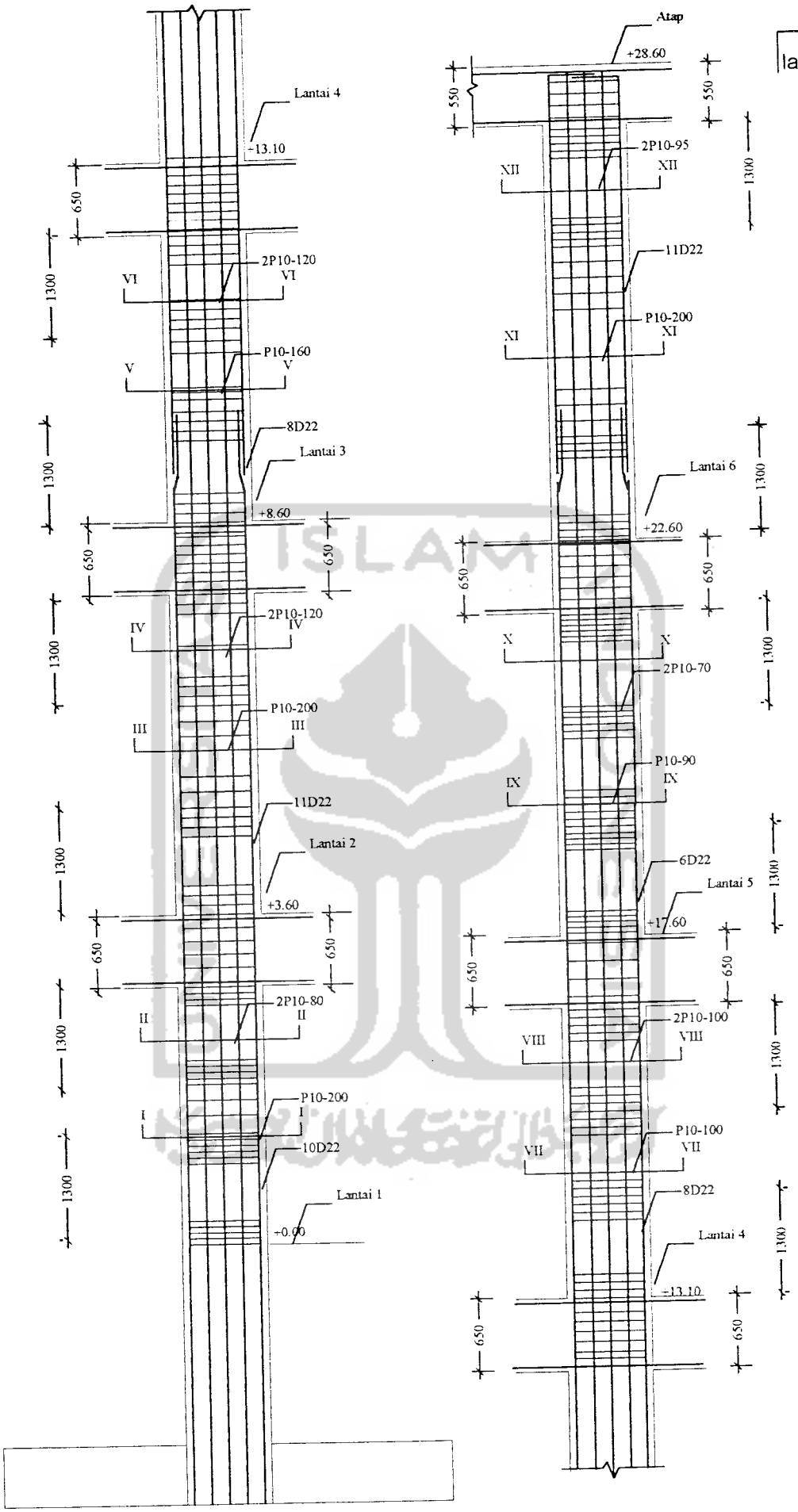


POT XII-XII



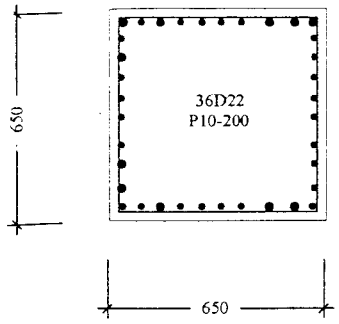
DETAIL KOLOM 1

lampiran 9.55

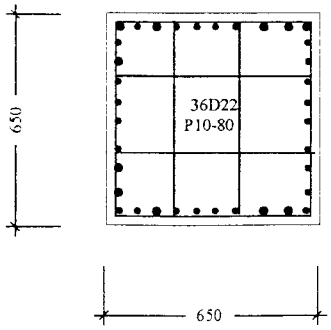


RENC. KOLOM 2

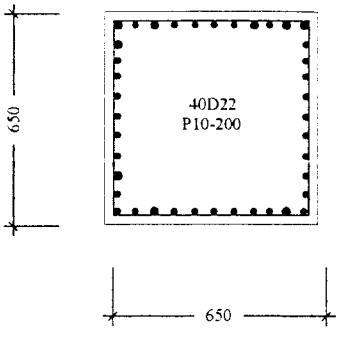
POT I-I



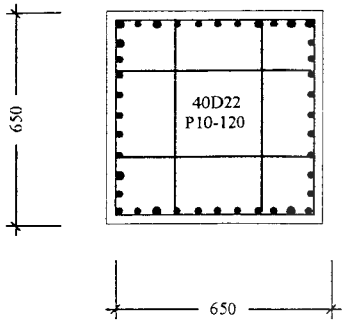
POT II-II



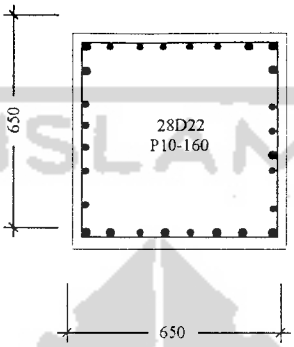
POT III-III



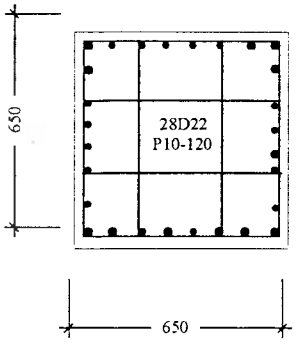
POT IV-IV



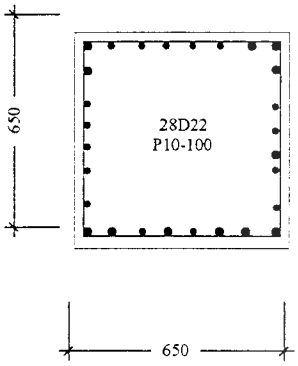
POT V-V



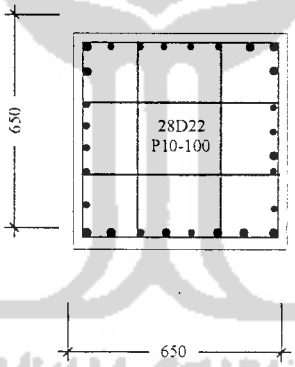
POT VI-VI



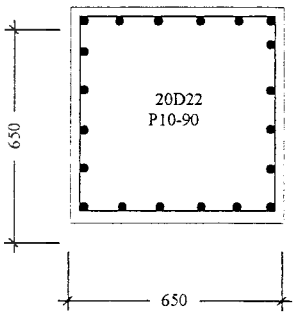
POT VII-VII



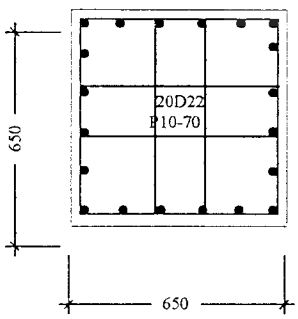
POT VIII-VIII



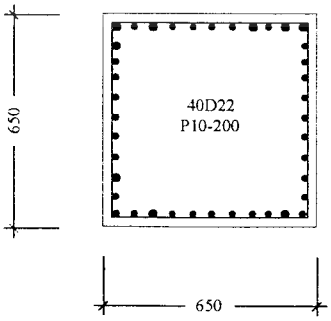
POT IX-IX



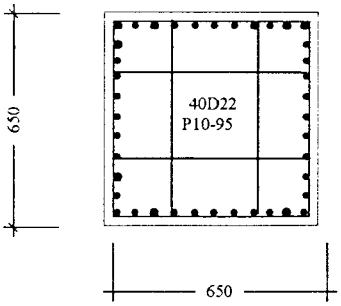
POT X-X



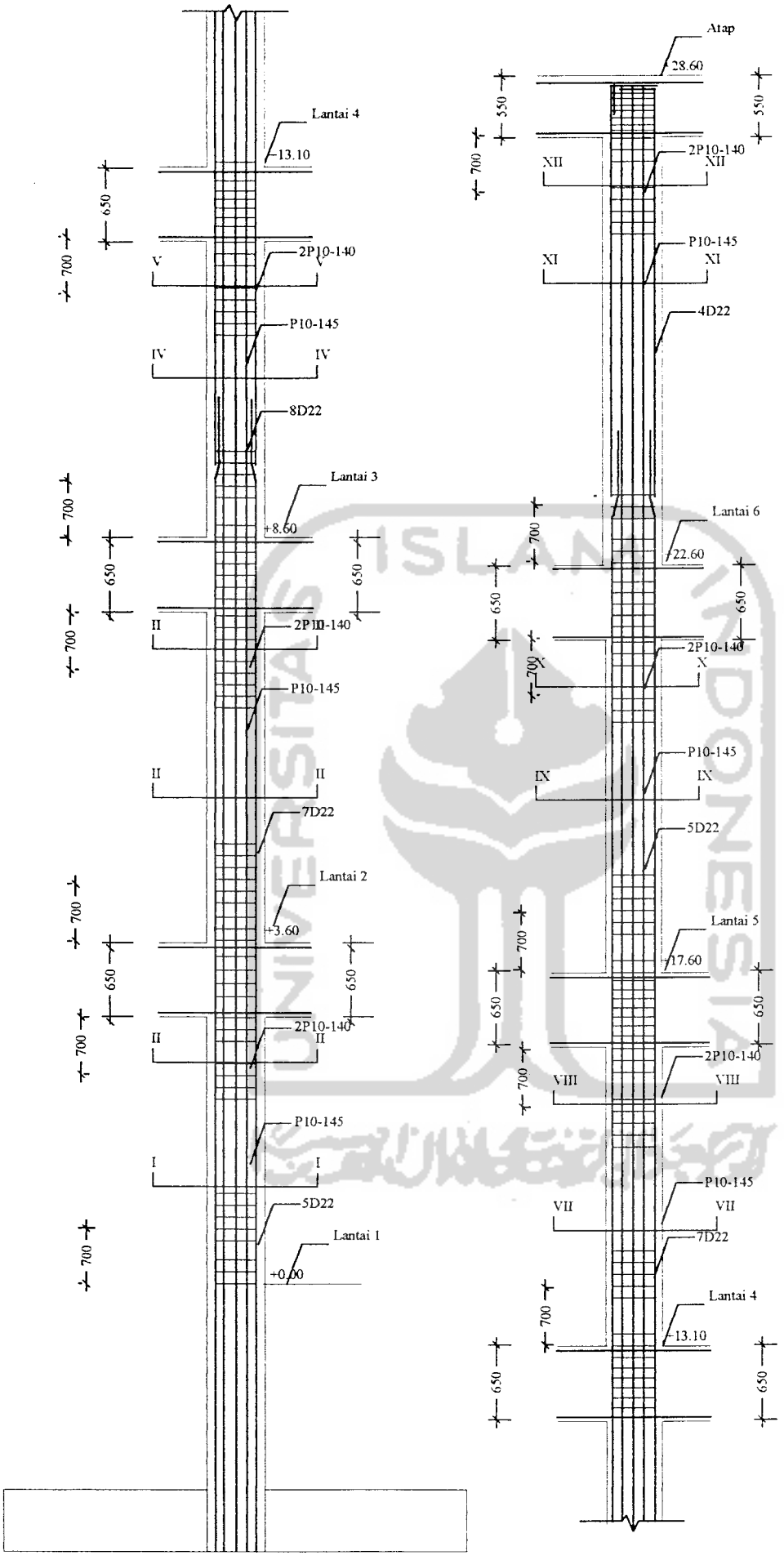
POT XI-XI



POT XII-XII

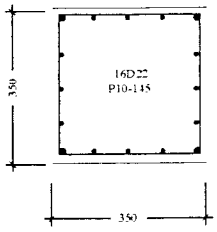


DETAIL KOLOM 2

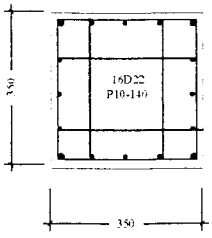

Atap
+28.60
550
550
700
XII
2P10-140
XII
P10-145
XI
XI
4D22
Lantai 4
+13.10
650
700
V
2P10-140
V
P10-145
IV
IV
8D22
Lantai 3
700
+8.60
650
650
700
II
2P10-140
P10-145
II
II
7D22
Lantai 2
700
+3.60
650
650
700
II
2P10-140
II
P10-145
I
I
5D22
Lantai 1
700
+0.00
Lantai 6
700
+22.60
650
650
700
X
2P10-140
X
P10-145
IX
IX
5D22
Lantai 5
700
+17.60
650
650
700
VIII
2P10-140
VIII
P10-145
VII
VII
7D22
Lantai 4
700
+13.10
650
650

RENC. KOLOM 3

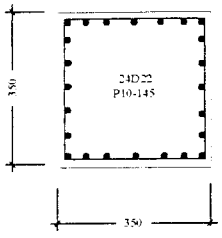
POT I-I



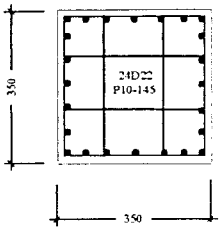
POT II-II



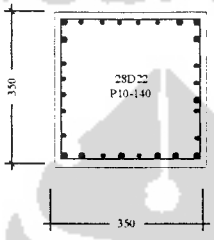
POT III-III



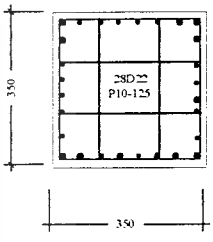
POT IV-IV



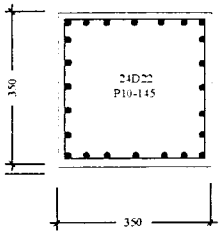
POT V-V



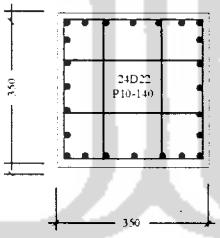
POT VI-VI



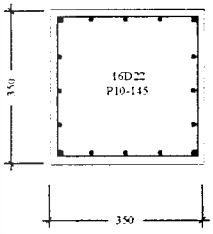
POT VII-VII



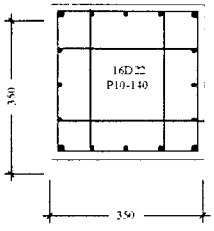
POT VIII-VIII



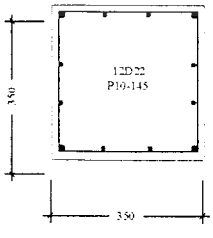
POT IX-IX



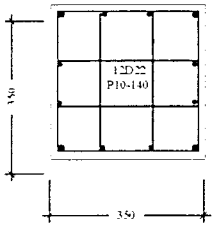
POT X-X



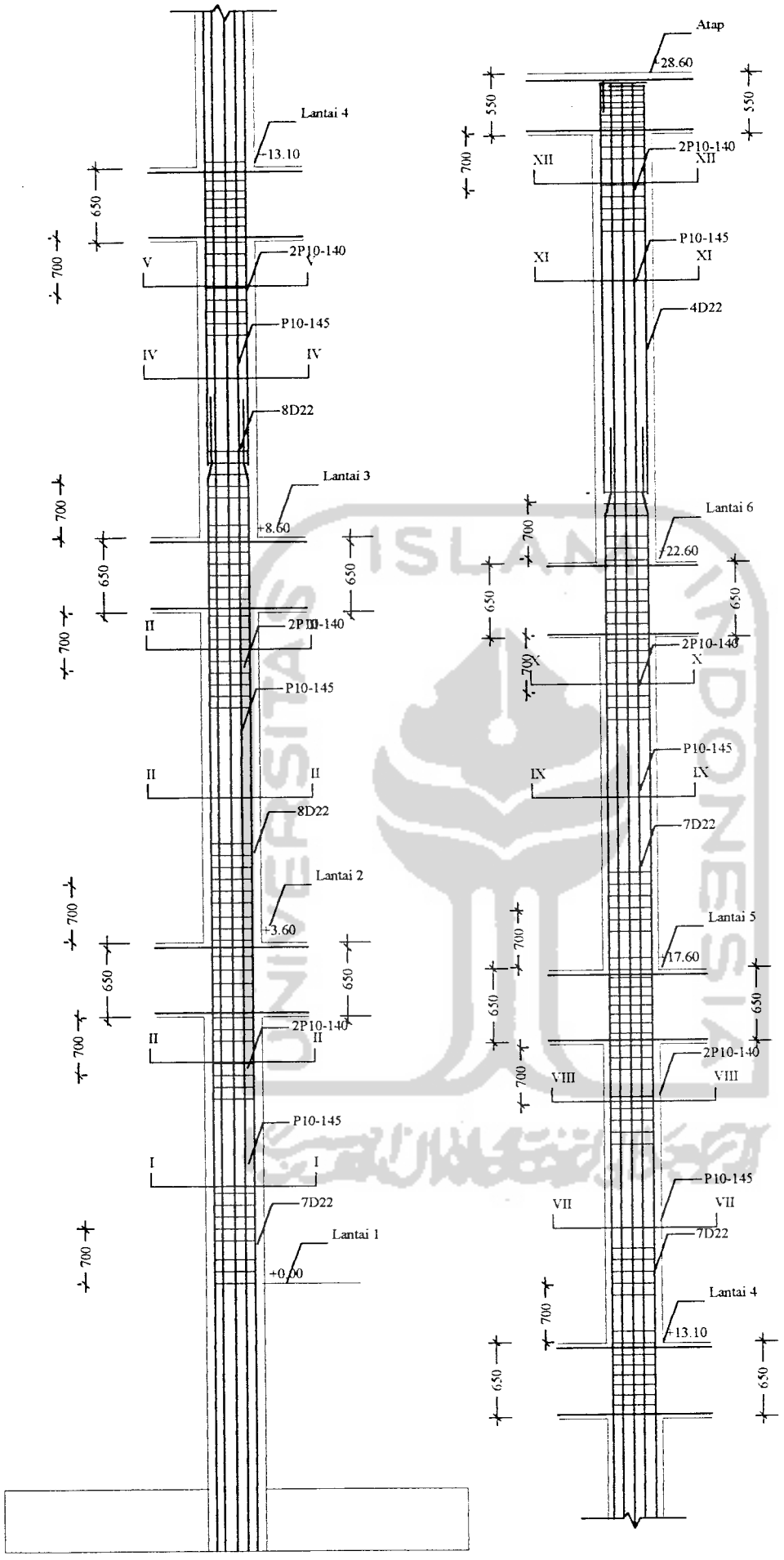
POT XI-XI



POT XII-XII

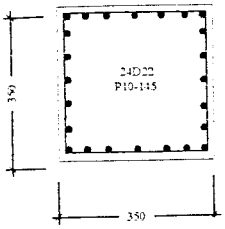


DETAIL KOLOM 3

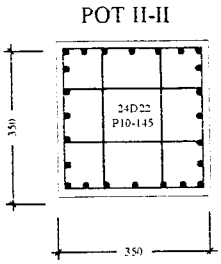

Atap
+28.60
550
550
700
2P10-140
XII
XII
P10-145
XI
XI
4D22
Lantai 4
+13.10
650
700
V
2P10-140
P10-145
IV
IV
8D22
Lantai 3
+8.60
700
650
650
700
II
2P10-140
P10-145
II
II
8D22
Lantai 2
+3.60
700
650
650
700
II
2P10-140
II
P10-145
I
I
7D22
Lantai 1
+0.00
700
Lantai 6
22.60
700
650
650
2P10-140
X
X
P10-145
IX
IX
7D22
Lantai 5
17.60
700
650
650
700
2P10-140
VIII
VIII
P10-145
VII
VII
7D22
Lantai 4
+13.10
700
650
650

RENC. KOLOM 4

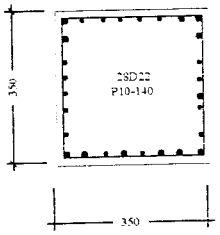
POT I-I



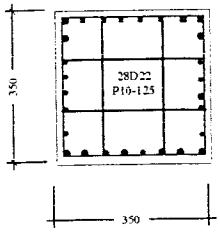
POT II-II



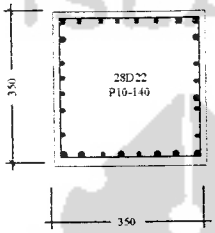
POT III-III



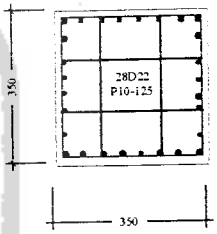
POT IV-IV



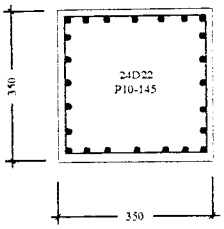
POT V-V



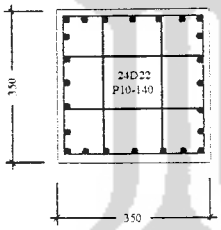
POT VI-VI



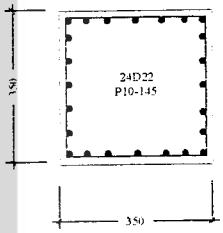
POT VII-VII



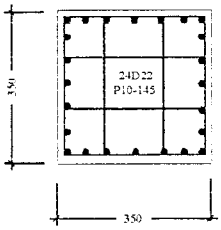
POT VIII-VIII



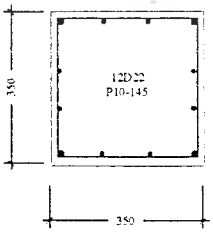
POT IX-IX



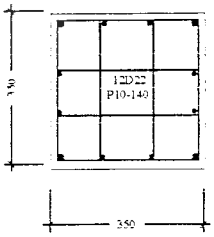
POT X-X



POT XI-XI

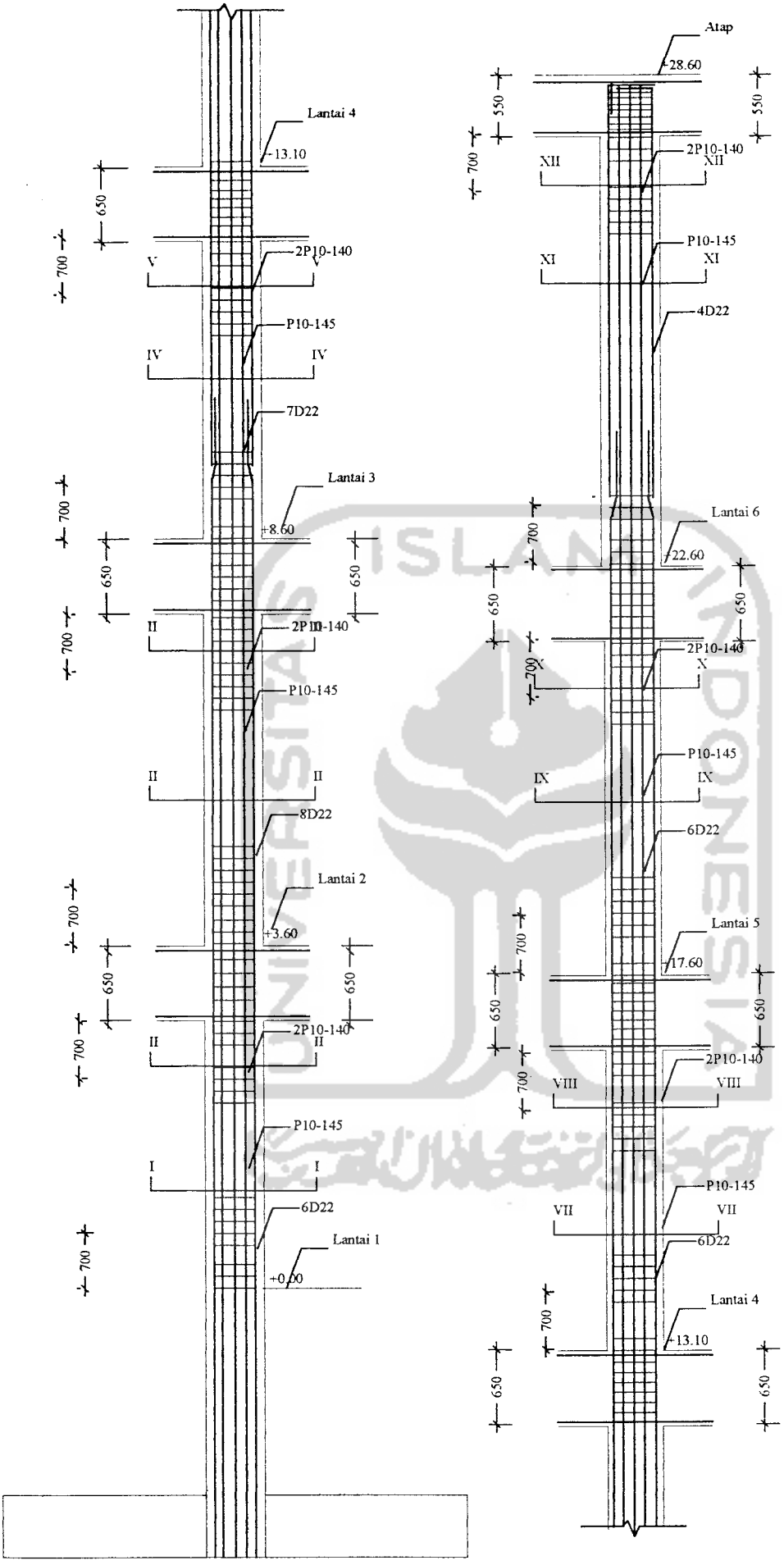


POT XII-XII



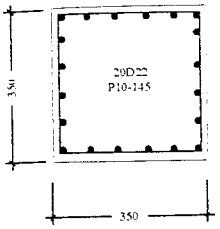
DETAIL KOLOM 4

lampiran 9.58

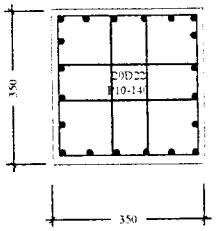


RENC. KOLOM 5

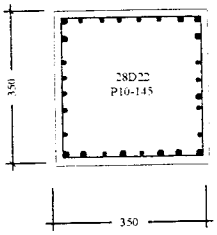
POT I-I



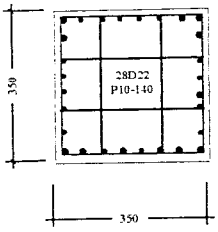
POT II-II



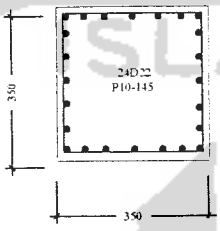
POT III-III



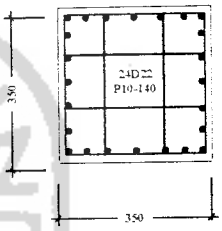
POT IV-IV



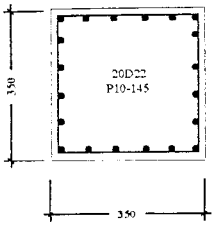
POT V-V



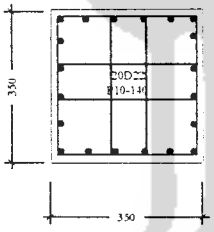
POT VI-VI



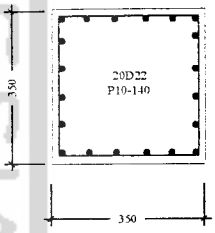
POT VII-VII



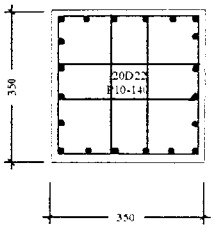
POT VIII-VIII



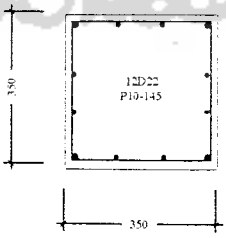
POT IX-IX



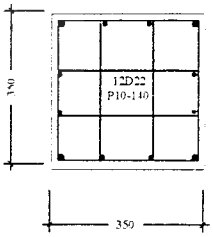
POT X-X



POT XI-XI

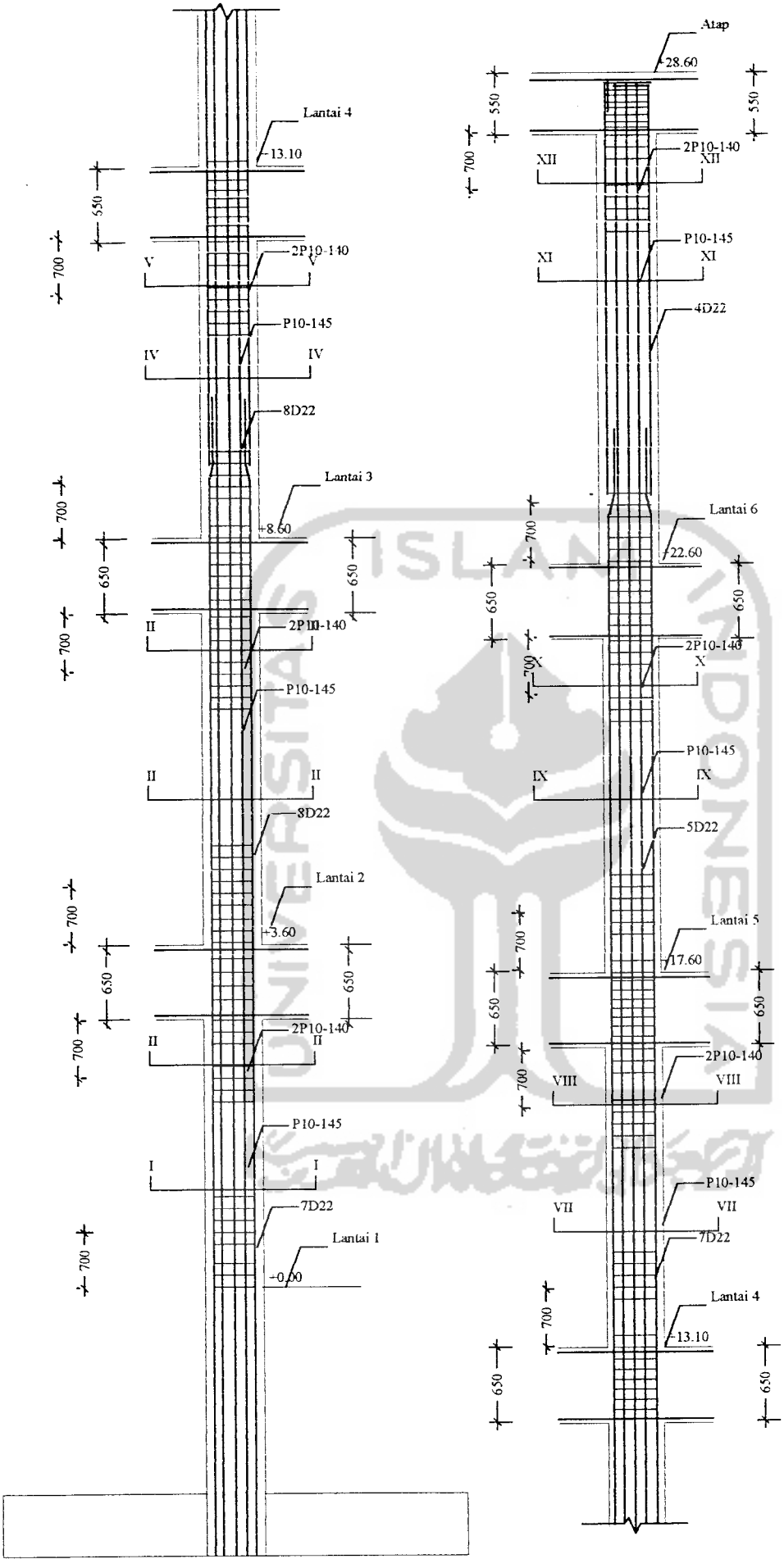


POT XII-XII



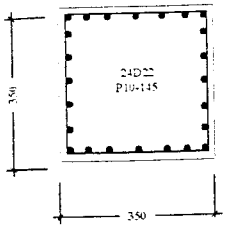
DETAIL KOLOM 5

lampiran 9.59

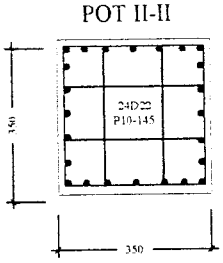


RENC. KOLOM 6

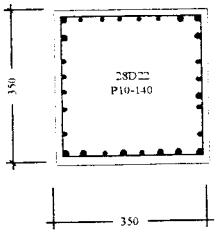
POT I-I



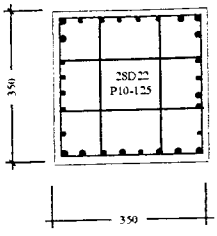
POT II-II



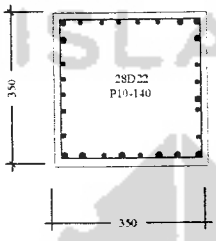
POT III-III



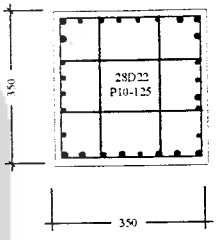
POT IV-IV



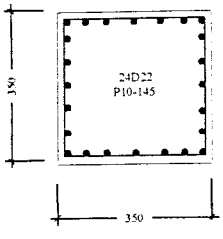
POT V-V



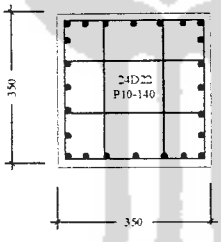
POT VI-VI



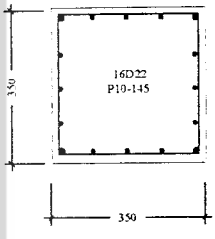
POT VII-VII



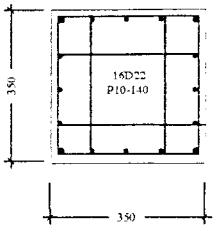
POT VIII-VIII



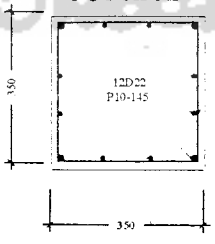
POT IX-IX



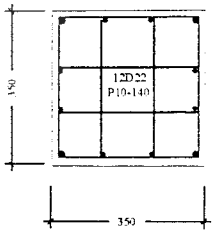
POT X-X



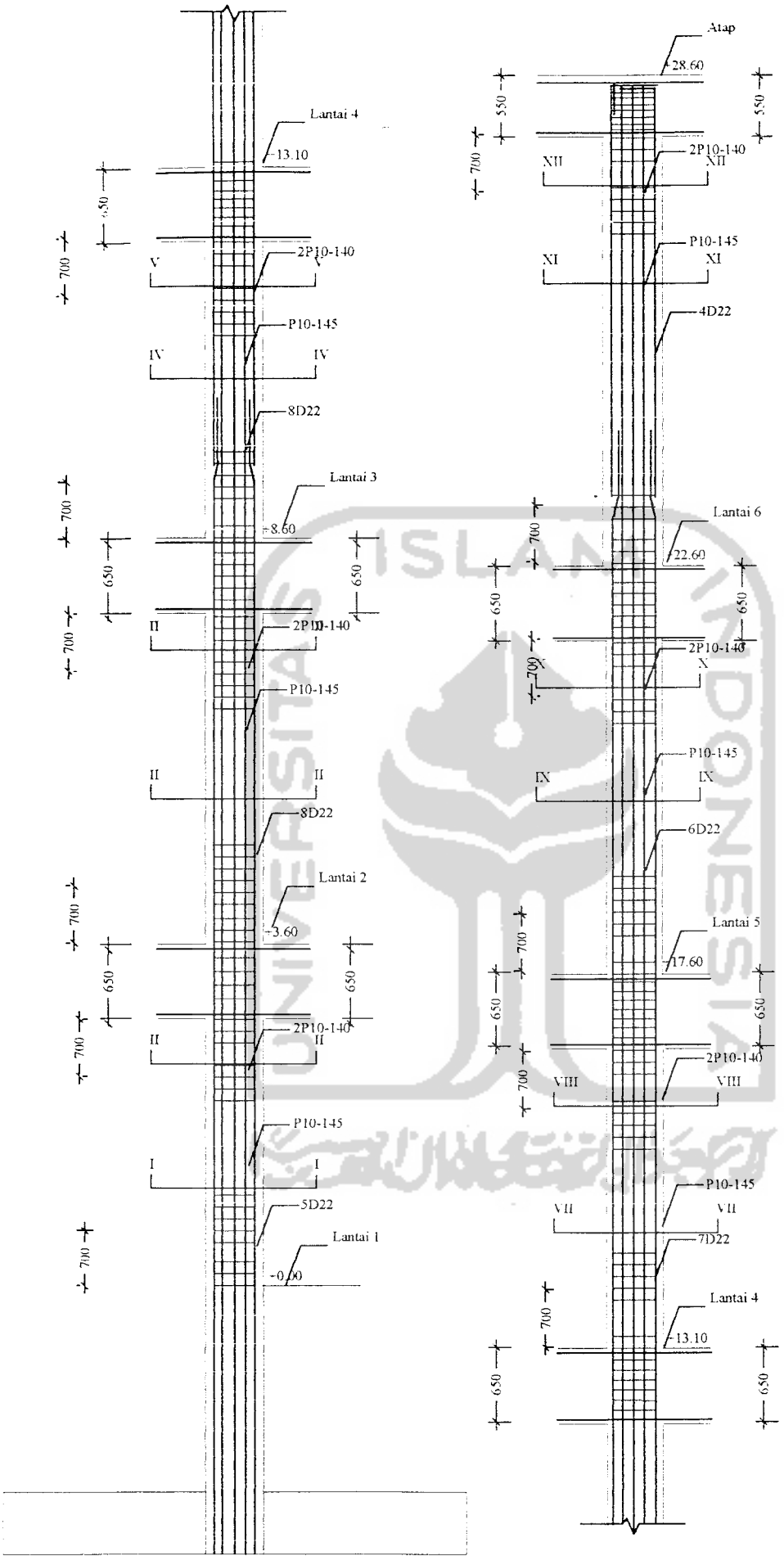
POT XI-XI



POT XII-XII

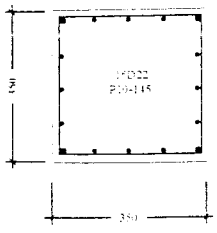


DETAIL KOLOM 6

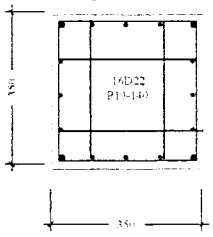

Atap
+28.60
Lantai 4
+13.10
Lantai 3
+8.60
Lantai 2
+3.60
Lantai 1
-0.00
Lantai 6
+22.60
Lantai 5
+17.60
2P10-140
P10-145
4D22
8D22
6D22
5D22
7D22
550
650
700
I
II
IV
V
VII
VIII
IX
X
XI
XII

RENC. KOLOM 7

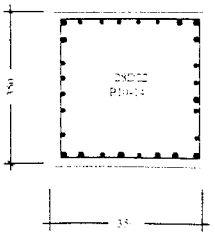
POT I-I



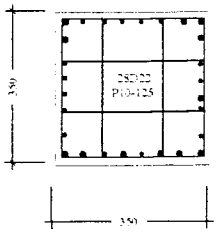
POT II-II



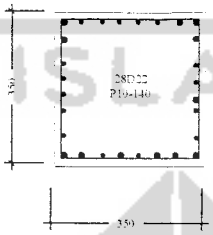
POT III-III



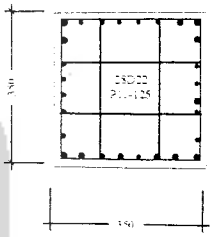
POT IV-IV



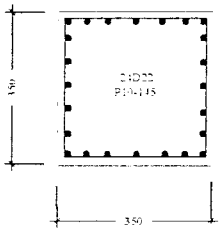
POT V-V



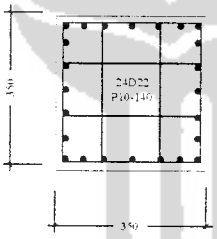
POT VI-VI



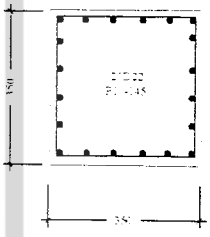
POT VII-VII



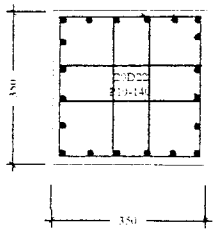
POT VIII-VIII



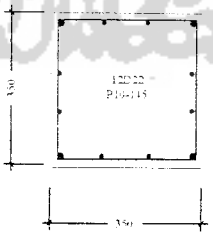
POT IX-IX



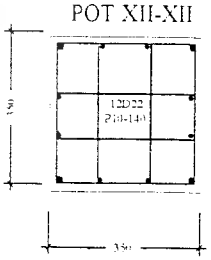
POT X-X



POT XI-XI

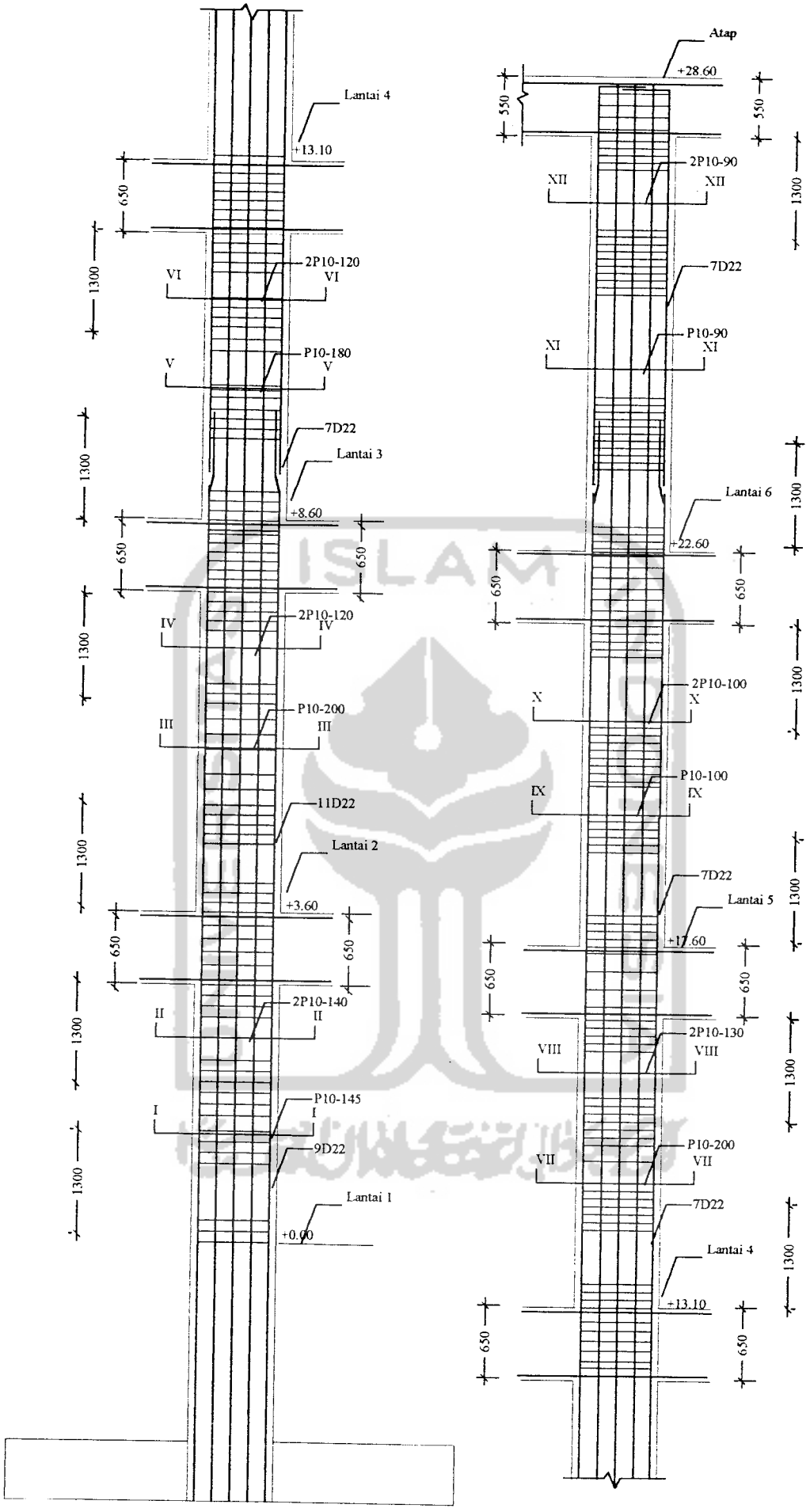


POT XII-XII



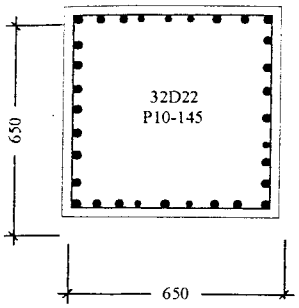
UNIVERSITAS ISLAM INDONESIA

DETAIL KOLOM 7

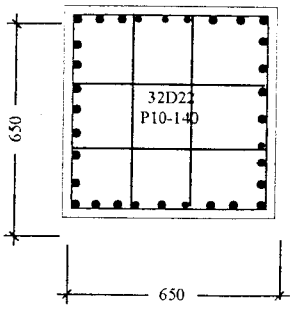

Atap
+28.60
550
550
2P10-90
XII
XII
1300
7D22
P10-90
XI
XI
Lantai 6
+22.60
650
650
2P10-100
X
X
P10-100
IX
IX
7D22
Lantai 5
+17.60
650
650
2P10-130
VIII
VIII
P10-200
VII
VII
7D22
Lantai 4
+13.10
650
650
Lantai 4
+13.10
650
1300
2P10-120
VI
VI
P10-180
V
V
7D22
Lantai 3
+8.60
650
650
2P10-120
IV
IV
P10-200
III
III
11D22
Lantai 2
+3.60
650
650
2P10-140
II
II
P10-145
I
I
9D22
Lantai 1
+0.00

RENC. KOLOM 8

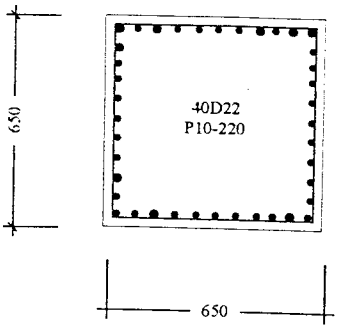
POT I-I



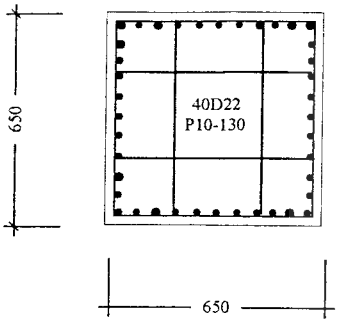
POT II-II



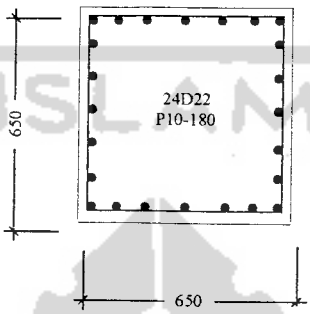
POT III-III



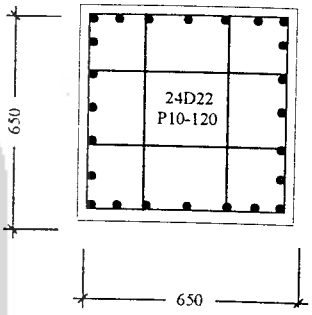
POT IV-IV



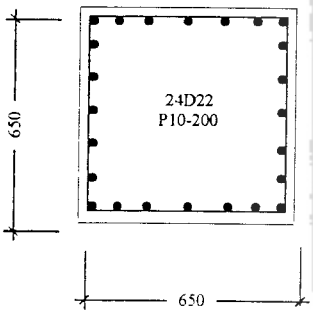
POT V-V



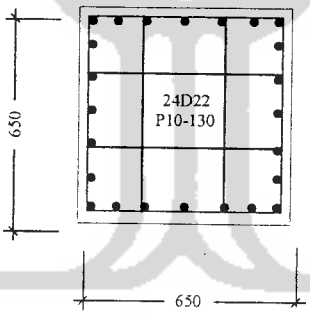
POT VI-VI



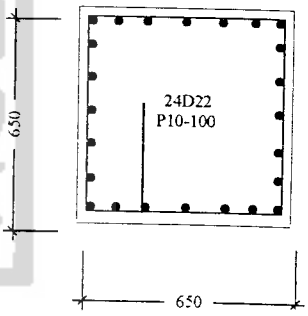
POT VII-VII



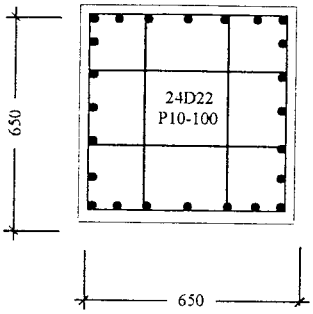
POT VIII-VIII



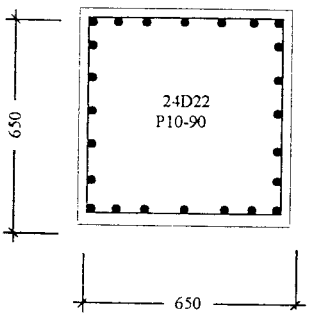
POT IX-IX



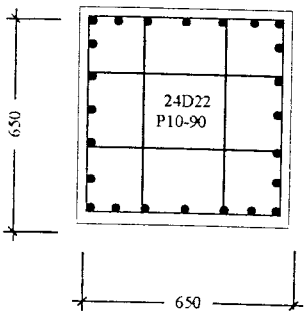
POT X-X



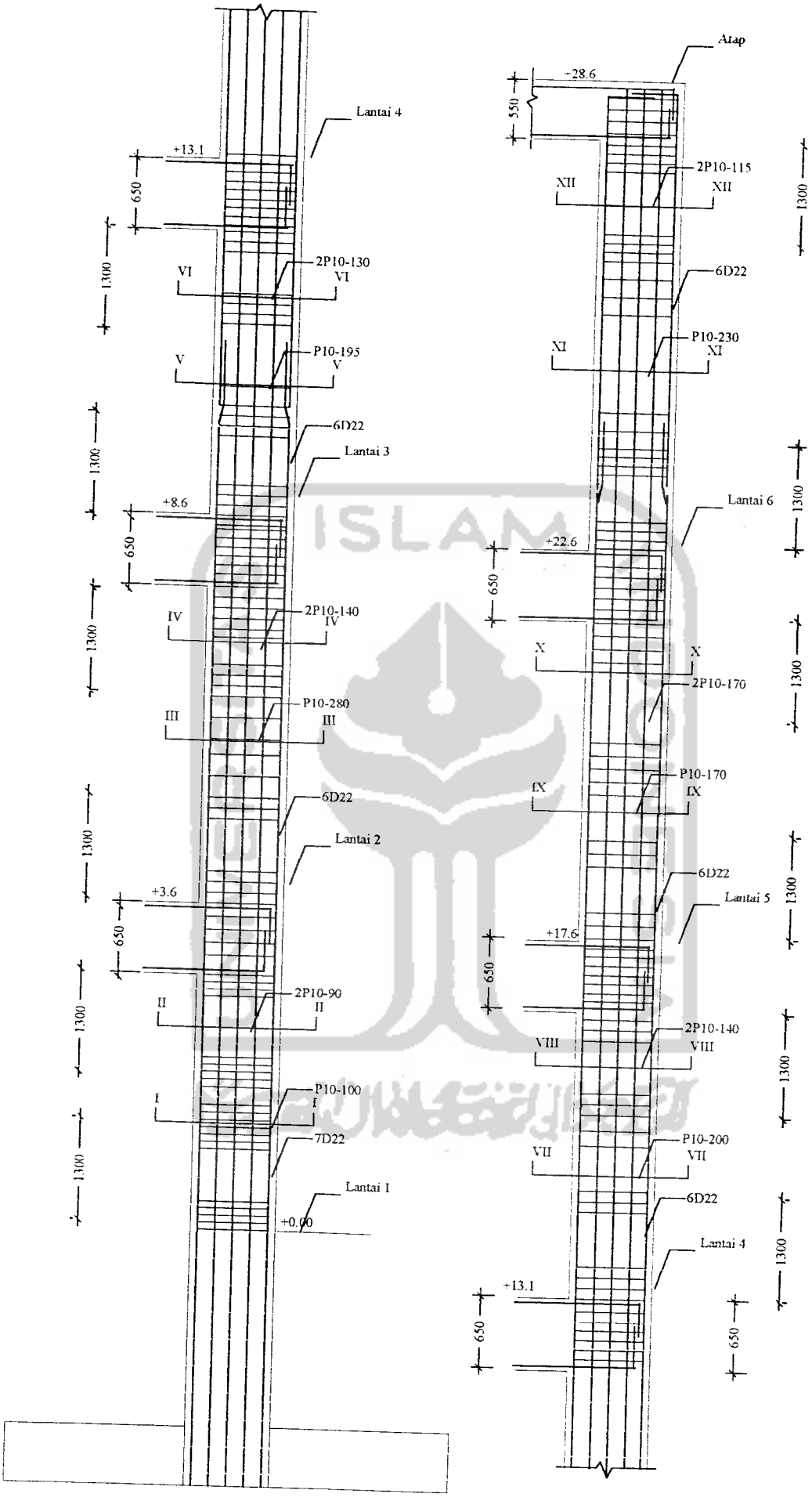
POT XI-XI



POT XII-XII

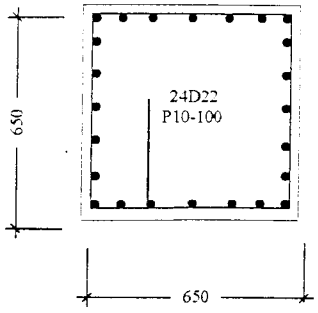


DETAIL KOLOM 8

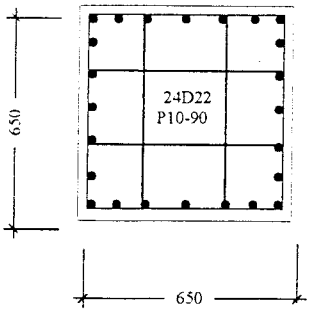

Atap
+28.6
550
2P10-115
XII
XII
1300
6D22
P10-230
XI
XI
Lantai 6
+22.6
650
X
X
2P10-170
P10-170
IX
IX
6D22
Lantai 5
+17.6
650
2P10-140
VIII
VIII
P10-200
VII
VII
6D22
Lantai 4
+13.1
650
650
Lantai 4
+13.1
650
2P10-130
VI
VI
P10-195
V
V
6D22
Lantai 3
+8.6
650
2P10-140
IV
IV
P10-280
III
III
6D22
Lantai 2
+3.6
650
2P10-90
II
II
P10-100
I
I
7D22
Lantai 1
+0.00
1300
1300
1300
1300
1300
1300
1300
1300
1300

RENC. KOLOM 9

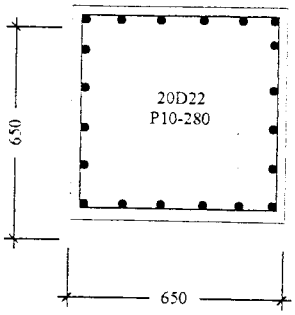
POT I-I



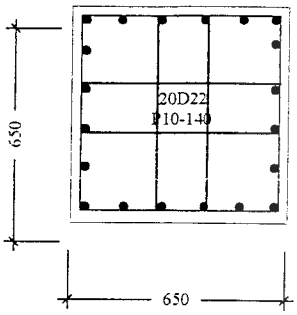
POT II-II



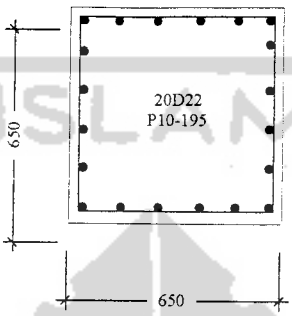
POT III-III



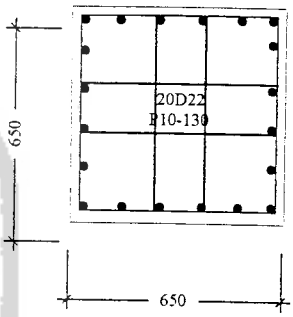
POT IV-IV



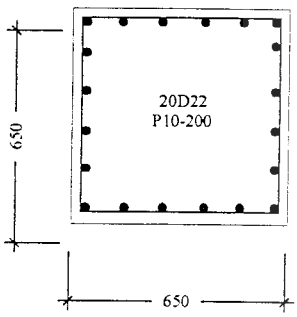
POT V-V



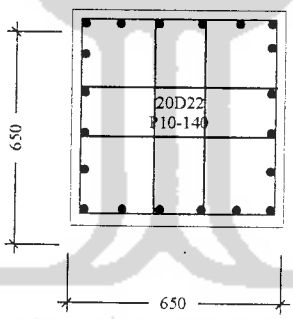
POT VI-VI



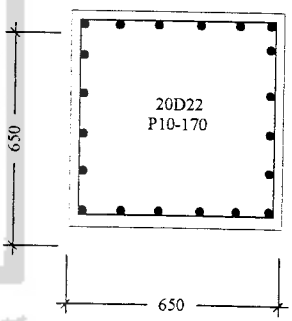
POT VII-VII



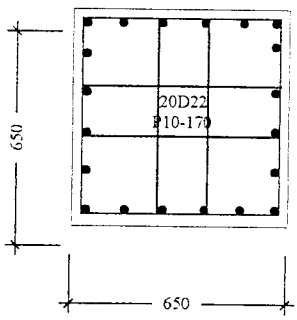
POT VIII-VIII



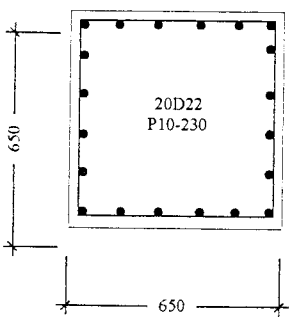
POT IX-IX



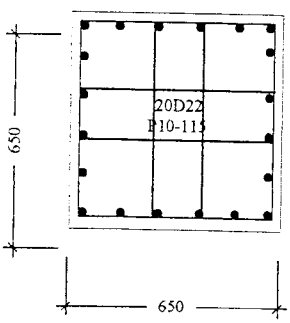
POT X-X



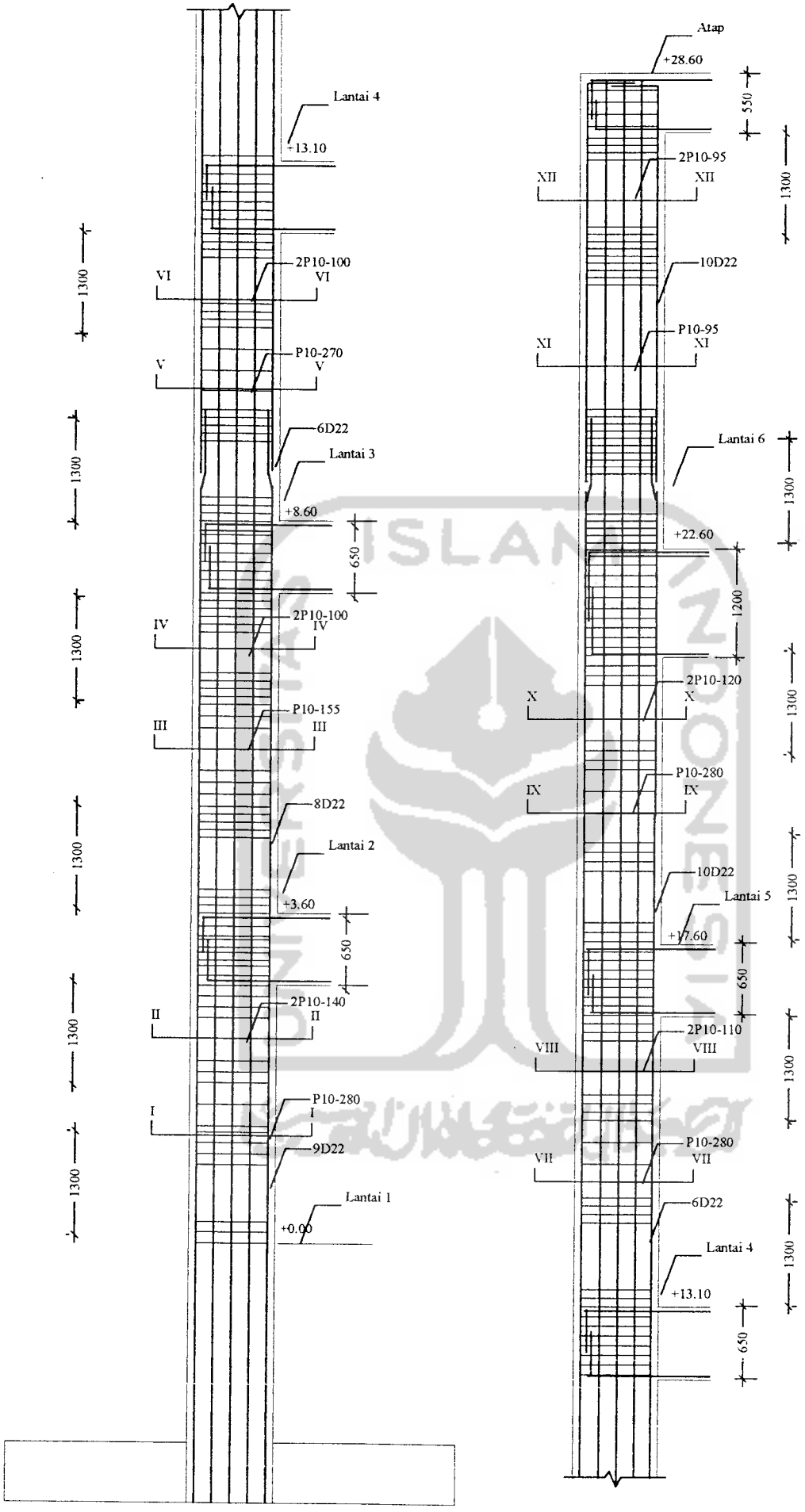
POT XI-XI



POT XII-XII

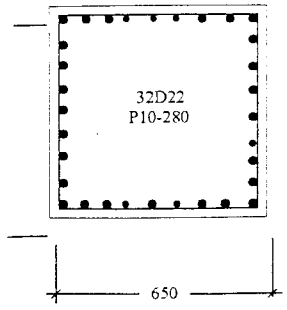


DETAIL KOLOM 9

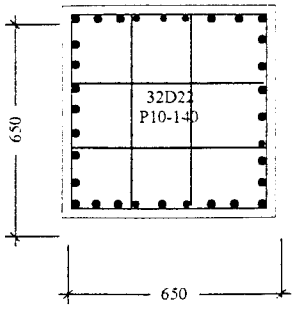


RENC. KOLOM 10

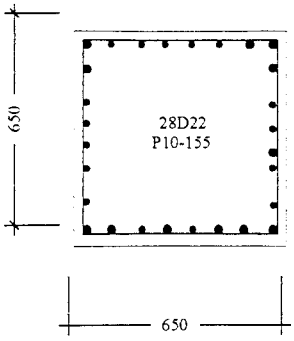
POT I-I



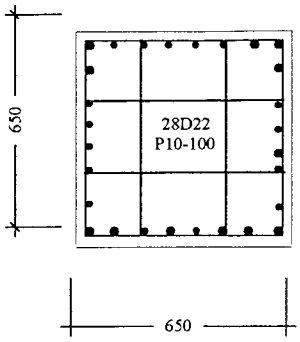
POT II-II



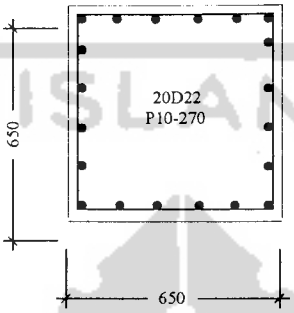
POT III-III



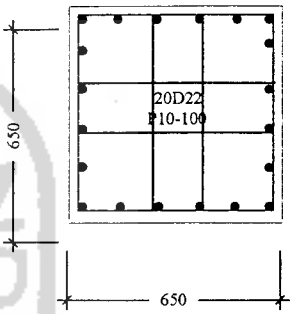
POT IV-IV



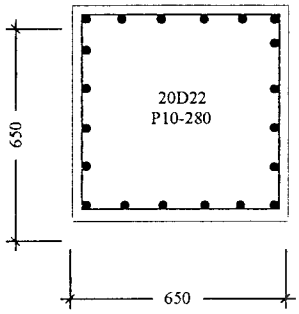
POT V-V



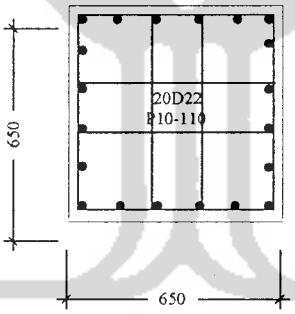
POT VI-VI



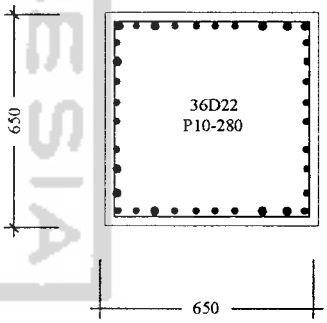
POT VII-VII



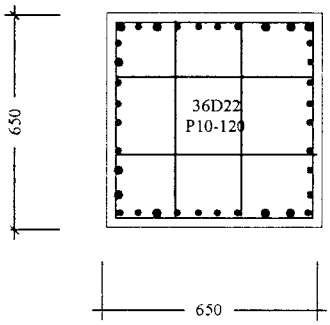
POT VIII-VIII



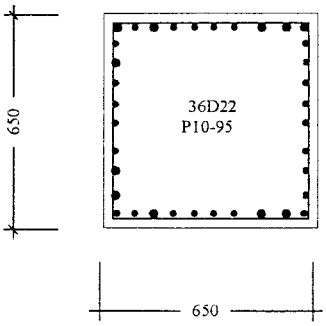
POT IX-IX



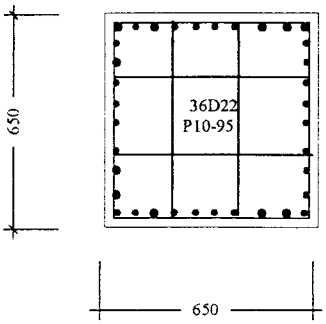
POT X-X



POT XI-XI



POT XII-XII



DETAIL KOLOM 10