Final Architectural Design Studio

BUILING PERFORMANCE & TECHNOLOGY LABORATORY

Designing a Safe Residential High-Rise Building in war zones for Safety and Security in Gaza Strip, Jabalia City

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Universitas Islam Indonesia
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BUILING PERFORMANCE & TECHNOLOGY LABORATORY

Merancang Bangunan Hunian Bertingkat Tinggi yang Aman di zona perang untuk Keselamatan dan Keamanan di Jalur Gaza, Kota Jabalia

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STATEMENT OF AUTHENTICITY

I affirm that this work, titled "Stand Against Bombardment for Safety and Security in Gaza Strip, Jabalia City," is entirely my own, except where specific references to external sources are explicitly provided. No external assistance, whether partial or complete, was involved in its preparation. I further certify that there are no intellectual property conflicts associated with this project. All concepts, ideas, and written content are duly credited to the respective author and supervisor. This project is submitted to the Department of Architecture, Universitas Islam Indonesia, as an original academic contribution for publication and educational purposes.

Yogyakarta 28 June 2025

Omar Khalil

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Stand Against Bombardment for Safety and Security in Gaza Strip, Jabalia City

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PREFACE

Assalamualaikum Wr. Wb.

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To our family and the resilient people of Gaza, our hearts are with you in these painful times. Your courage, patience, and hope in the face of hardship are an inspiration to the world. We pray for your safety, for peace to return to your homes, and for brighter days where children can laugh freely and families can live without fear. You are not forgotten, and you are not alone.

The Author believes that there is always room for improvement and growth. He acknowledges that both the preparation and the final design report are not flawless. Therefore, he is open to any constructive criticism and suggestions, hoping they will guide his on a better path in his future endeavors.

Wassalamualaikum Wr. Wb.

Friday, August 20th 2025



Omar.K.F.A. Khalil

ABSTRACT

This residential project, located in Jabalia, Gaza, addresses the urgent need for safe and resilient housing for civilians continuously exposed to conflict and recurrent airstrikes. The design focuses on maximizing civilian protection through a multi-layered approach, offering different levels of safety according to user groups and building zones.

A major challenge is developing a structural system capable of withstanding direct explosions and reflected blast waves while maintaining the building's functionality and livability. To achieve this, the project integrates reinforced blast-resistant concrete structures, hardened building cores, MAMAD rooms, and underground bunkers designed for long-term occupancy during emergencies. Supporting infrastructure includes emergency power backups, secure water storage, advanced air-filtration systems, and resilient communication networks, ensuring the survival and comfort of occupants. the methods will be applied are both qualitative and quantitative approaches, combining case studies of existing protective housing, structural simulations, and field data analysis to create a context-specific design. also as a challenge the current residential solutions in Gaza lack integrated structural and infrastructural systems that can provide both immediate blast resistance and sustainable long-term shelter during prolonged conflicts. This project aims to fill that gap by offering a holistic and adaptive housing model for at-risk civilians.

Abstrak

Proyek hunian ini, yang berlokasi di Jabalia, Gaza, menjawab kebutuhan mendesak akan hunian yang aman dan tangguh bagi warga sipil yang terus-menerus terpapar konflik dan serangan udara berulang. Desainnya berfokus pada memaksimalkan perlindungan warga sipil melalui pendekatan berlapis, yang menawarkan berbagai tingkat keamanan sesuai dengan kelompok pengguna dan zona bangunan.
Tantangan utamanya adalah mengembangkan sistem struktural yang mampu menahan ledakan langsung dan gelombang pantulan ledakan, sekaligus mempertahankan fungsionalitas dan kelayakan huni bangunan. Untuk mencapai hal ini, proyek ini mengintegrasikan struktur beton tahan ledakan yang diperkuat, inti bangunan yang diperkeras, ruang MAMAD, dan bunker bawah tanah yang dirancang untuk hunian jangka panjang selama keadaan darurat. Infrastruktur pendukung meliputi cadangan daya darurat, penyimpanan air yang aman, sistem penyaringan udara canggih, dan jaringan komunikasi tangguh, yang menjamin kelangsungan hidup dan kenyamanan penghuni. Metode yang akan diterapkan adalah pendekatan kualitatif dan kuantitatif, yang menggabungkan studi kasus hunian pelindung yang ada, simulasi struktural, dan analisis data lapangan untuk menciptakan desain yang spesifik konteks. Tantangan lainnya adalah solusi hunian di Gaza saat ini kurang terintegrasi dengan sistem struktural dan infrastruktur yang mampu memberikan ketahanan langsung terhadap ledakan dan tempat berlindung jangka panjang yang berkelanjutan selama konflik berkepanjangan. Proyek ini bertujuan untuk mengisi kesenjangan tersebut dengan menawarkan model perumahan yang holistik dan adaptif bagi warga sipil yang berisiko.

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Chapter 01

INTRODUCTION

1.1 Design Premise

The project aims to develop a high-rise residential in Gaza with underground safe zone “Bunker” against bombardment as an urgent human crisis. by applying a resilient structural system. The design incorporates ultra-high-performance concrete (UHPC), reinforced concrete cores, shock-absorbing layers, and deep foundations to enhance blast resistance. Additionally, it explores the adaptive reuse of war debris like steel and metal for construction, addressing material scarcity and economic constraints.

1.2 Background

1.2.1 Humanitarian Issues in Gaza Strip post war

The Gaza Strip faces one of the most severe humanitarian crises in modern history, characterized by widespread destruction and displacement. Prolonged conflicts have led to a collapse in housing infrastructure, leaving millions without adequate shelter. Since the 2014 war pass by many wars after that like 2018, 2021 and finally 2023 which is the biggest crisis because of losing more than 55,000 Palestinians and 120,000 were injured, bombardments have caused significant damage to residential buildings, leading to displacement, loss of life, and the urgent need for resilient architectural solutions (Roy, 2016). The ongoing geopolitical instability has necessitated the development of structures that can withstand military attacks while ensuring the safety and security of residents. (Burke, 2024).

1.2.2 Safety and Security of residential buildings in Gaza

In designing a resistance high-rise building in Gaza, a multi-faceted approach is necessary. Structural integrity must be prioritized through reinforced concrete and energy-absorbing design elements. Simultaneously, humanitarian considerations must be addressed, ensuring that buildings provide safe shelter while maintaining livability under siege conditions. The integration of underground shelters, reinforced cores, and self-sustaining energy systems can further enhance security and sustainability in conflict-prone urban environments (Krauss & El Deeb, 2024). during the war 2023 which is the biggest crisis that 66% of the buildings destroyed



Fig (1.1) : Humanitarian crisis in Gaza
Source : https://www.aa.com.tr/en/middle-east/western-countries-oppose-cease-fire-in-gaza-as-humanitarian-crisis-unfolds/3034047

1.2.3 Developing Resistant Building Structures

Gaza lacks resilient infrastructure capable of withstanding bombardments, leading to high civilian casualties and displacement. The absence of structurally resilient housing and emergency shelters has resulted in significant loss of civilian lives. Traditional reinforced concrete structures are insufficient against modern warfare threats, as high-impact explosives cause widespread structural failure. Addressing this issue requires integrating blast-resistant materials, reinforced structural cores, and adaptive design strategies to enhance the resilience of residential buildings in conflict zones (Alexander, 2002; Burke, 2024)..

1.2.4 Users and Activities of the Proposed Approach

The proposed a high-rise residential with underground save zoon in Gaza is designed primarily for displaced families who are occupant in this building. The structure will function not only as a residential space but also as a multifunctional shelter “save zone” equipped with
1-medical facilities.
2-communal spaces.
3-emergency storage for food and water supplies.
The inclusion of underground safe zones will provide additional protection during bombardments, ensuring civilian safety during conflict situations. Daily activities within the shelter will include family living, community engagement, and essential services such as healthcare and education, making it a comprehensive and sustainable solution for long-term displacement scenarios. (Alexander, 2002; Sonnenberg Tunnel Shelter, n.d.; Burke, 2024).

1.2.5 Innovation Design and Integrated Structure

The architectural approach integrates both innovative design strategies and structural resilience to address safety concerns in conflict zones. The use of (UHPC), steel-reinforced cores, and blast-resistant façades ensures the structural integrity of the building against high-impact explosives. Furthermore, the modularity of the shelter design allows for rapid deployment and adaptability to different urban conditions. Non-architectural considerations such as emergency response logistics, water and energy sustainability, and psychological well-being are also embedded within the design strategy, ensuring a holistic and practical response to the humanitarian crisis.



Fig (1.2) : Destroyed residential buildings in Gaza City
Source : https://www.aljazeera.com/features/2023/12/7/no-other-land-is-home-amid-israel-bombs-a-gaza-city-family-wont-leave

1.3 **Literature Review and Originality & Novelty**

HANDBOOK FOR BLAST-RESISTANT DESIGN OF BUILDINGS

This book emphasizes the importance of integrating blast-resistant design principles into architectural planning for high-risk zones. His study outlines how shock waves from explosions affect building structures and suggests that reinforced concrete cores, energy-absorbing façades, and deep foundations are crucial elements in mitigating blast damage. Additionally, Smith highlights the significance of ultra-high-performance concrete (UHPC) and fiber-reinforced polymer composites, which provide superior strength and flexibility in resisting explosive forces. These materials not only enhance the durability of buildings but also reduce the risk of catastrophic failure, making them essential for conflict-zone architecture.

Moreover, Smith's research explores the role of underground safe zones and modular structural reinforcements in ensuring human safety during bombardments. By analyzing case studies from war-affected regions, he demonstrates how underground shelters, combined with shock-absorbing layers and reinforced steel structures, significantly increase the survivability of residential buildings in conflict areas. His findings align with existing architectural strategies, such as Israel's MAMAD and MAMAK systems, which integrate reinforced concrete and advanced air filtration to withstand high-impact blasts. Applying these principles to Gaza's high-rise shelter design will enhance its structural resilience, providing a secure and sustainable housing solution for displaced communities (John Wiley & Sons, 2010).

Author's Name	Title	Year	Typology	Location	Similarities	Differences
Alexander D.	Resilient Urban Infrastructure in Conflict Zones	2002	War-Zone Infrastructure	Oxford University Press	resilient infrastructure in war-torn regions.	Develops structural redundancy frameworks with deep foundation systems and shear walls, ensuring buildings remain operational after partial damage.
Wang et al.	Structural Performance of Underground Shelters	2018	Underground Shelters	Journal of Structural Engineering	Structural behavior of underground bunkers under extreme loads.	Evaluates soil-structure interaction (SSI) models and dynamic load absorption in reinforced underground chambers for maximum blast mitigation.
Burke, J.	Adaptive Reuse of War Debris for Shelter Construction	2024	Post-Conflict Shelter Design	The Guardian (Research Article)	Sustainable reconstruction in post-conflict zones using debris.	using reinforced concrete with fiber-reinforced polymers (FRP) and multi-layered energy-dissipating facades to absorb blast pressure.

1.4 PROBLEM MAPPING

Main Issue

→ Humanitarian Issue

Non-Architectural Problems

1- Thousand of Civilian casualties specially children, women and elderly as a result of the war because of different bombardment and explosion.

2- Displacement from their houses because it's totally destroyed and left to be a refuge at schools, hospitals even making tents in the streets.

Architectural Problems

1-Lack or non existence of safe shelter during the war no only the private safe shelter even there is no existing bunker or shelter that the people in public area refuge to.

2- Existing housing cannot withstand bombing during wars, and thousands of them have already been destroyed.

General Problem

Safety and Security : The lack of protective shelters increases the vulnerability of civilians during conflicts.

1- How a residential high rise be safe and secure, and also used as a shelter during wars ?

2- How can the design integrate multiple security levels and safety zones to ensure civilian protection during conflicts?

Specific Problem / Design Issue

Resilient Structural System : is the urgent issue as it's the main core of dealing with bombardment and explosion

1- How integrated structural system mitigate Resilience against bombardment

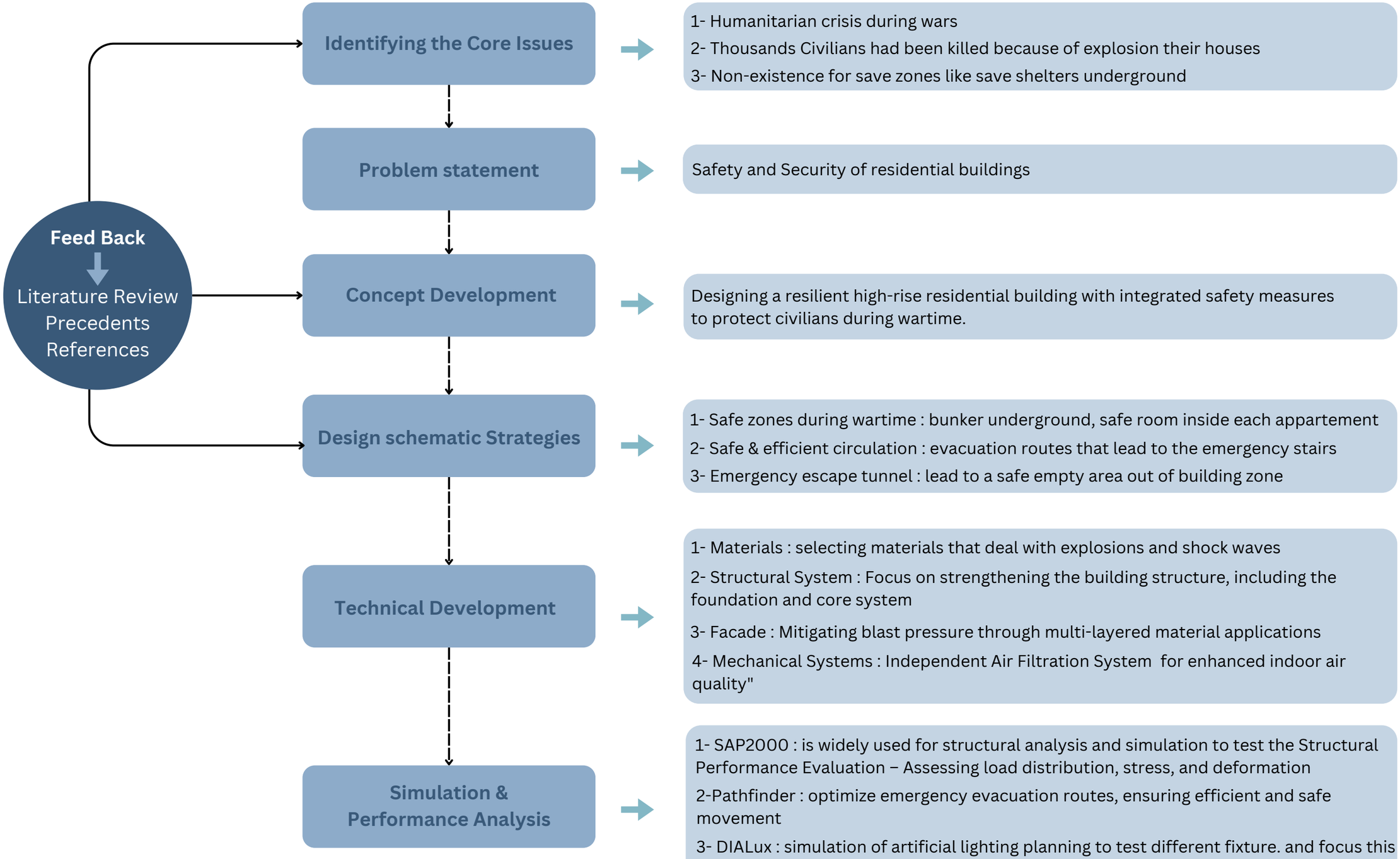
2- What are the most effective materials and construction techniques for bomb-resistant structures?

Objectives and Goals

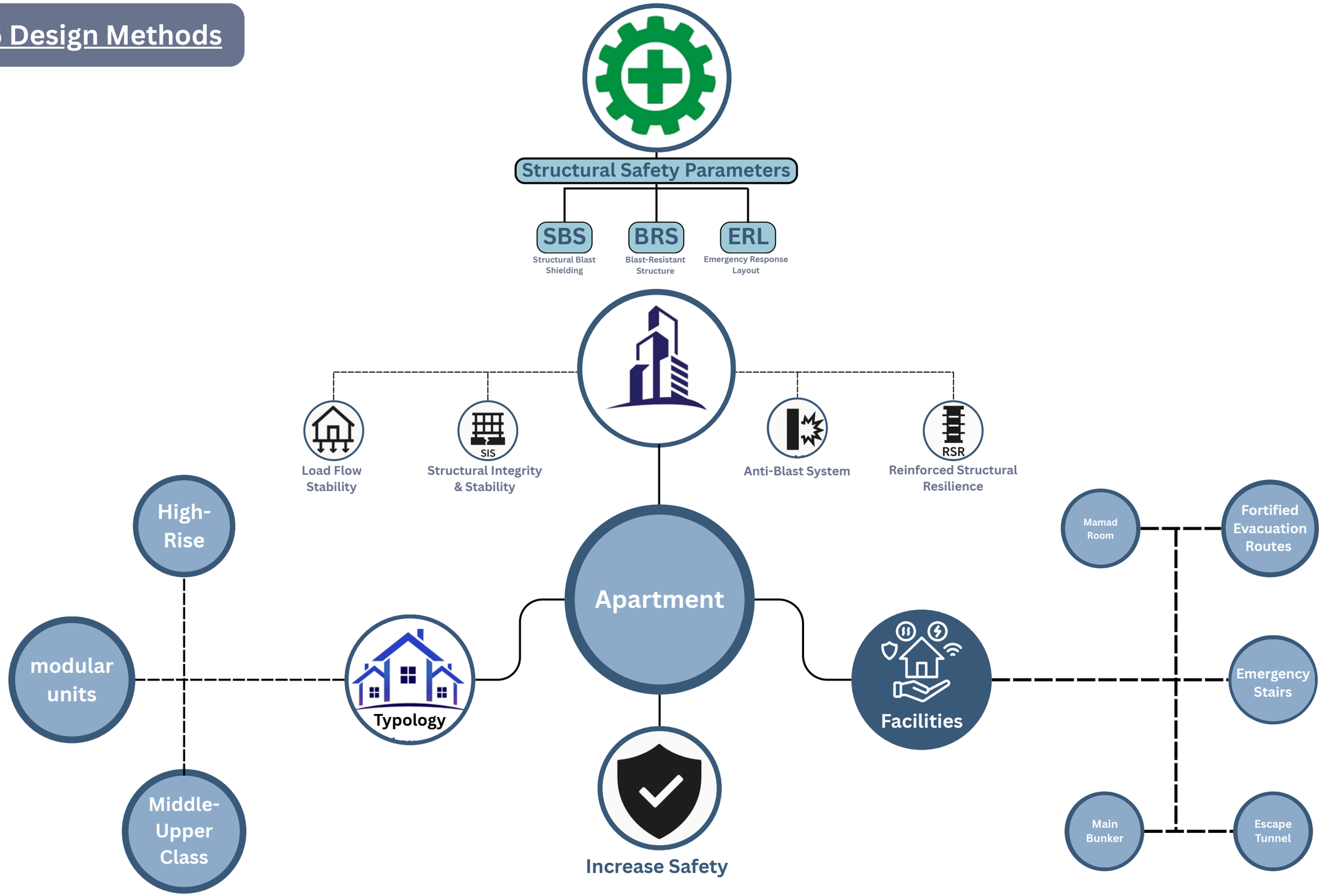
1- Design safe shelters that can withstand bombings and provide a secure space for civilians.

2- Integrate multi-use community bunkers underground each building.

1.5 Design Methods



1.5 Design Methods



1.6 Design Framework

Object → **Resilient Residential High-Rise Building**

Variables →
- **Humanitarian Issue**
  - Displacement & lose of lives
- **Safety & Security**
  - Resilient Residential Design
- **Innovative Design**
  - Technological Integration
  - Structural Resilience

Parameters →
- a Gaza as an Active War Zone
- b Proximity from dangerous sources
- c Absence of safety regulation
- d Innovative Design
- e Material
- f Room Function

Architecture Aspects →
- Neighborhood 1
- Site Development 2
- Building Mass 3
- Resilient Structure 4
- Vulnerable Facade Systems 5
- Room Layout 6

Connection & Relation →
- 1,a,b,c
- 2,b,c
- 3,c,d
- 4,c,e
- 5,c,d,e
- 6,c,d,e,f

Design Concept → Integrated and Innovative Design

Initial Design / Modeling Schematic →
- Schematic Drawing
- Floor Plans
- Sections
- Elevations
- Layout
- Details
- Axonometric Configuration

Design Simulation Test →
- LS-Prepost
- Pathfinder (evacuation)
- DIALux (lighting)

Final Design → Develop into Final Technical Drawing LOD 300 & Simulation Results

Chapter 02

Precedents & Selected Material

2.1 Sonnenberg Tunnel Shelter _ Switzerland (1987)

Public bunker that Constructed during the Cold War era, the Sonnenberg Tunnel was designed to function both as a motorway tunnel and as a massive civilian nuclear fallout shelter. In the event of a nuclear threat, the tunnel could be transformed to accommodate and protect up to 20,000 civilians.
The entire shelter spans approximately 1.5 km in length and covers a seven-story underground facility.

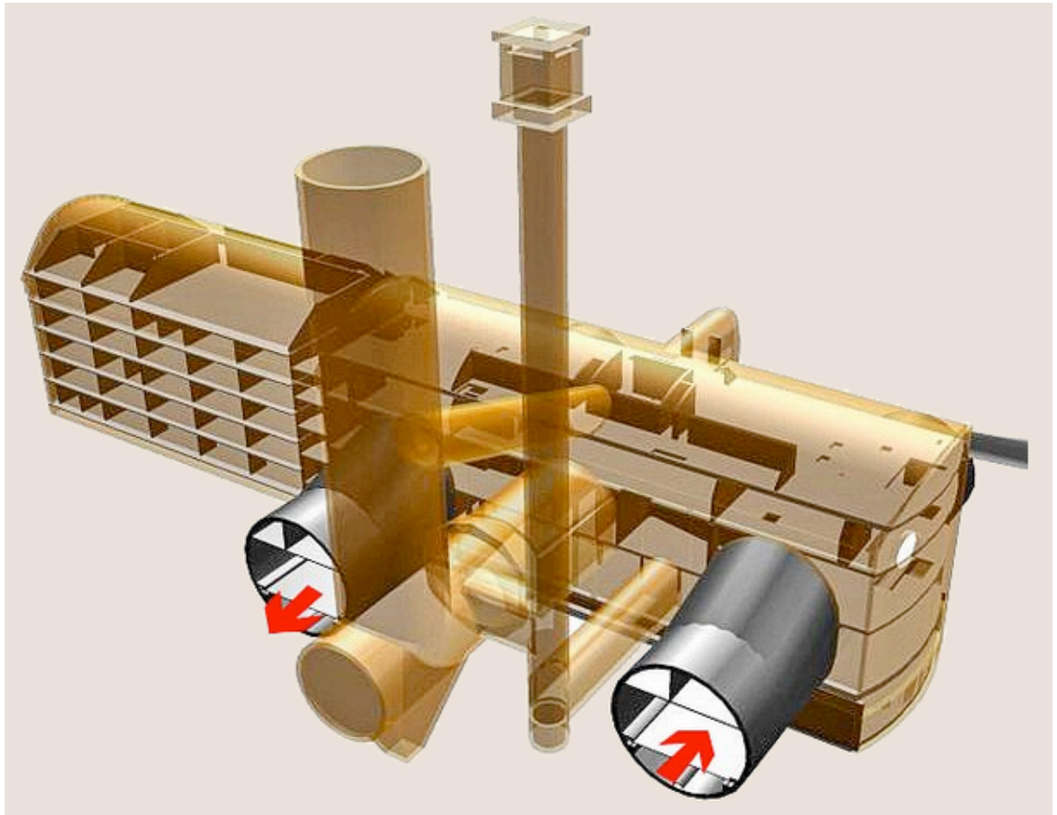


Fig (2.1) : Tunnel Infrastructure System in Ukraine
Source : https://www.swisscommunity.org/en/news-media/swiss-revue/article/sonnenberg-bunker-is-drawing-attention-due-to-the-war-in-ukraine

The shelter is located under 20 meters of rock and concrete, providing substantial protection against nuclear blasts.



Fig (2.2) : Sonnenberg Tunnel entrance showing that it's saved by the mountain
Source : https://en.wikipedia.org/wiki/Sonnenberg_Tunnel



Fig (2.3) : Sonnenberg Tunnel showing the main entrance inside the tunnel
Source : https://unterirdisch-ueberleben.ch/archiv/

Materials and Structural System

Reinforced Concrete: The tunnel's structure is primarily composed of reinforced concrete, providing the necessary strength to withstand potential nuclear blasts.

Massive Protective Doors: The facility features four protective doors, each weighing approximately 350 tons and measuring 1.5 meters in thickness. These doors were designed to seal off the tunnel from external threats effectively.

Ventilation Issue: Tests showed that CO_2 levels would rise too quickly, meaning it could not house 20,000 people for extended periods as originally planned.

Facilities:

Living Quarters: 64 dormitories, bunk beds, private areas.
Medical Services: Hospital, operating room, quarantine zones.
Food & Water: Kitchens, underground water reservoir, ration areas.
Sanitation: Mass toilets, showers, ventilated waste disposal.
Air Filtration: Nuclear/chemical protection, backup oxygen.
Control Center: Monitoring station, radio hub, security office.
Energy: Diesel generators, battery backup.

Limitations: Heavy blast doors, CO_2 issues, never fully operational.

- The Sonnenberg Tunnel Shelter was built in the 1970s and completed in 1976 as part of Switzerland's Cold War-era civil defense strategy.

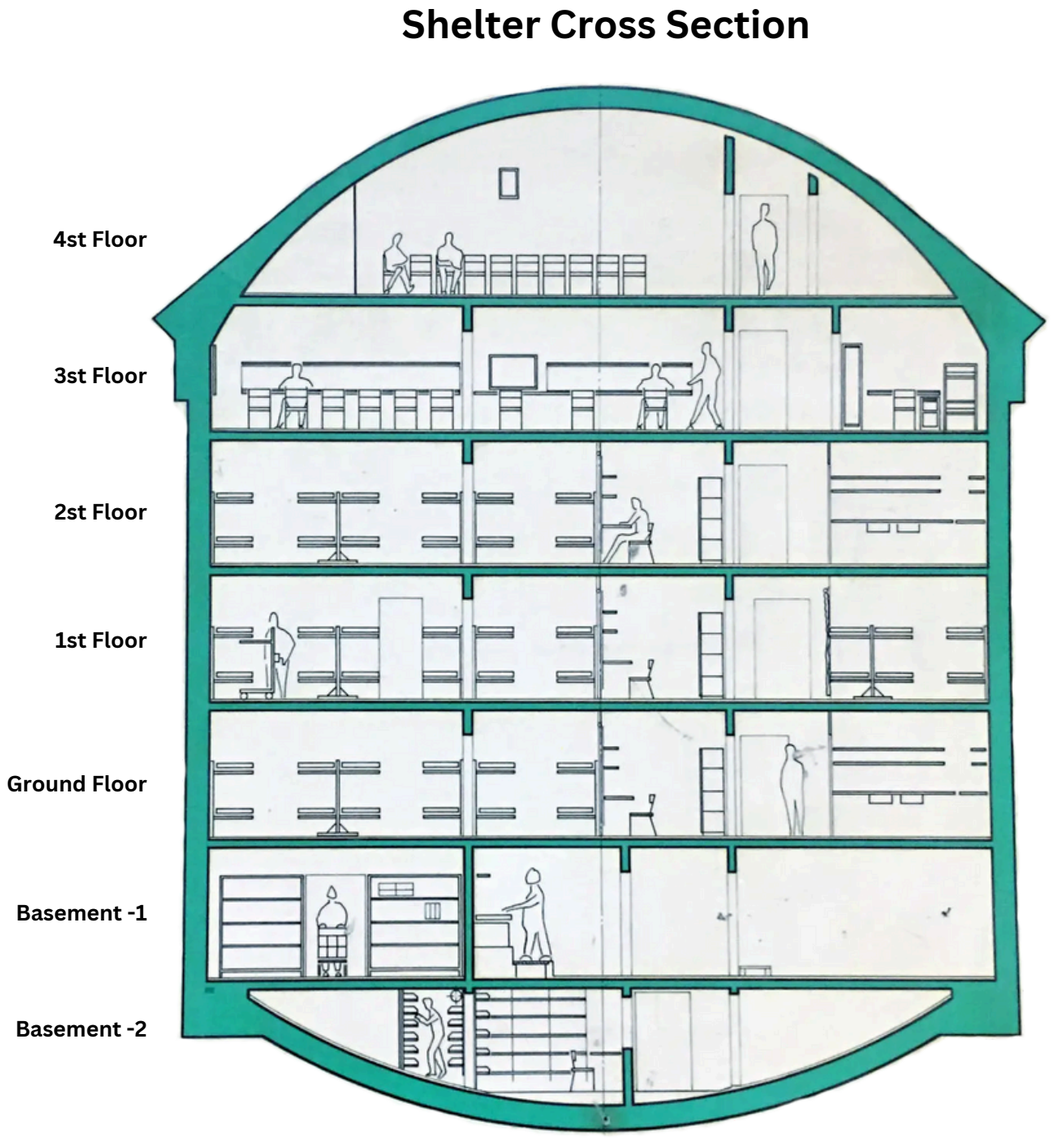


Fig (2.4) : Switzerland's Civil Defense Shelter Systems
Source : https://rb.gy/md8wcv

New Australian Embassy Jakarta / Denton Corker Marshall

• Protective Glass Systems

Blast-Resistant Glazing

1. Laminated glass with multiple layers bonded by polyvinyl butyral (PVB)
2. Designed to absorb and dissipate shockwaves, preventing shattering into dangerous shards.
3. Framed with blast-rated window systems to stay intact under high pressure.

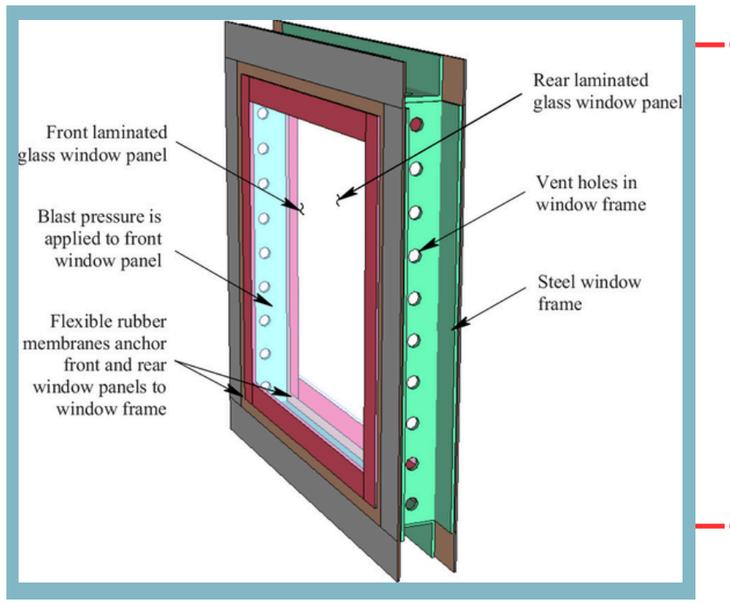


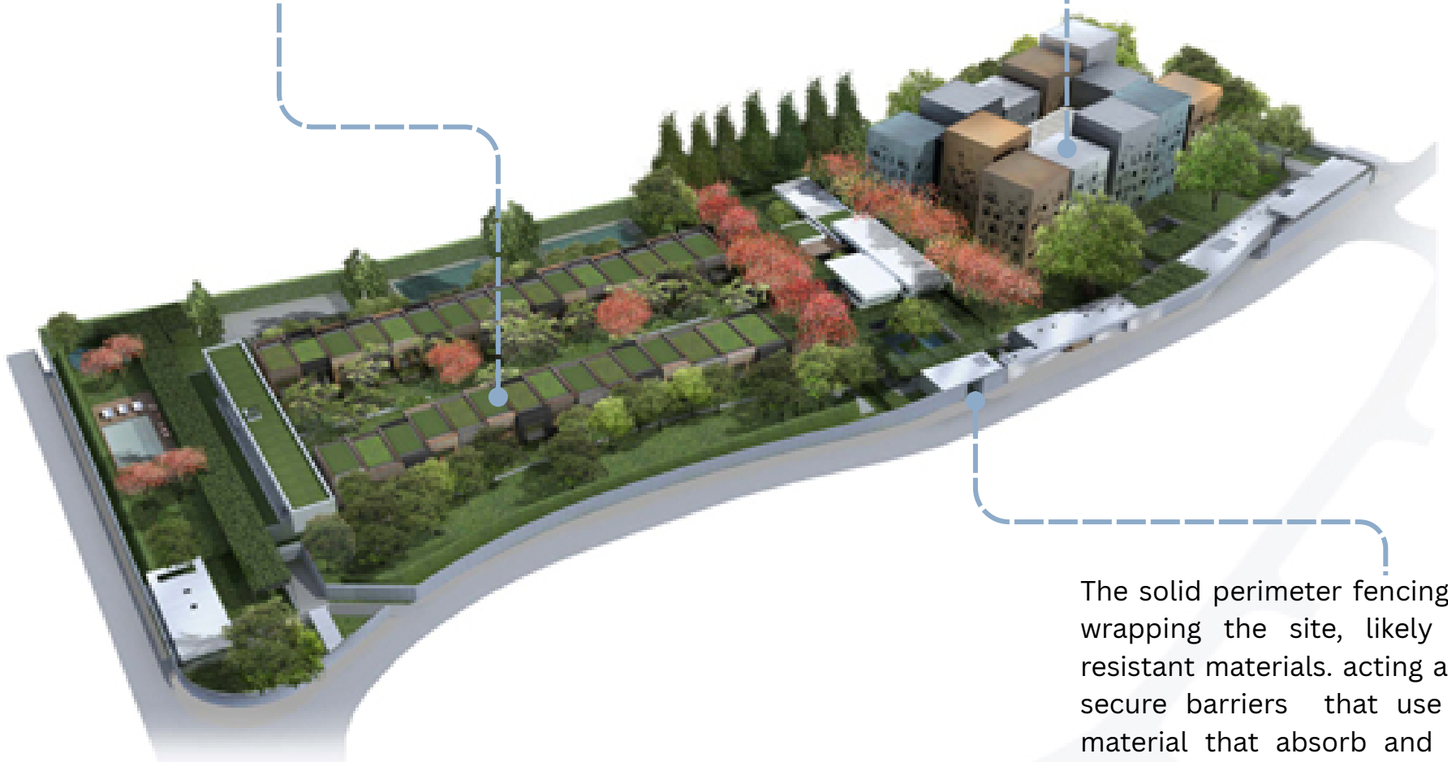
Fig (2.5) : Switzerland's Civil Defense Shelter Systems
Source : https://ascelibrary.org/doi/10.1061/%28ASCE%29ST.1943-541X.0000100

Typical Composition:

1. Outer Glass Layers: Two or more sheets of glass, which can be annealed, heat-strengthened, or tempered, depending on the required strength and application.
2. Interlayer(s): One or more layers of a resilient material, commonly polyvinyl butyral (PVB), ethylene-vinyl acetate (EVA), or ionoplast (SGP). These interlayers hold the glass layers together upon impact, preventing shattering and reducing the risk of injury from flying shards.

The embassy buildings are placed deep inside the site, far from the site boundary so that reduces exposure and gives reaction time in case of perimeter breach or external attacks.

Buffer Zoning Creates physical distance between the main buildings and public streets or potential threat zones.



The solid perimeter fencing with angled walls wrapping the site, likely built with blast-resistant materials. acting as a Protective and secure barriers that use a blast resistant material that absorb and dispersion of the shock waves during any attack. That help minimize structural damage and casualties during explosions.

Fig (2.6) : Buffer Zoning at Embassy of Australia in Jakarta, Indonesia
Source : https://www.theecomuslim.co.uk/2016/03/australia-green-embassy-jakarta.html

2.2 Merkhav Mugan Dirati (Mamad)

home-owned protected space

- Apartment Protected Space: Reinforced security rooms built within individual apartments or private houses. These rooms are constructed with reinforced concrete and equipped with airtight, shock-resistant windows and steel doors, offering immediate access to protection during emergencies.

- The area of the room must be at least 9 square meters. In each protected room, a sealed blast door and window, electrical outlets, and communication outlets for phones and television, must be installed.

Technical Details of Mamad Safe Room

- Protected space area: 3 square meters
- Blast-resistant window 100x100 cm, residential, 18 mm "New Generation," includes a lock for gas sealing
- Residential ventilation and filtration system according to fixed standard, per Israeli Standard 5701
- 4" air release pipe, 25 cm below the ceiling, per Israeli Standard 4422, including valves
- Blast-resistant door, residential, opens to a protected residential space, per Israeli Standard 4422

Window : three layers
1- Outside - steel - hinged window
2- Middle - steel - sliding plate
3- inside - steel - sliding

Door : two layers
1- inside room - steel - hinged door
2- Middle - steel - sliding plate

Reinforced Concrete wall
Thickness : 30 - 40 cm

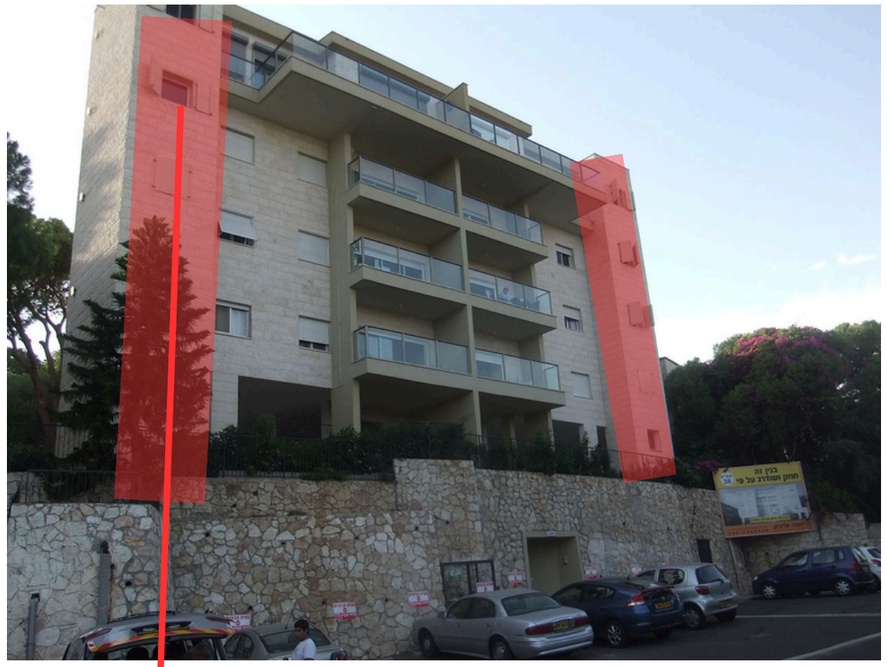


Fig (2.2.1) : Middle -Rise Residential Building in Israel
Source : https://en.wikipedia.org/wiki/Merkhav_Mugan

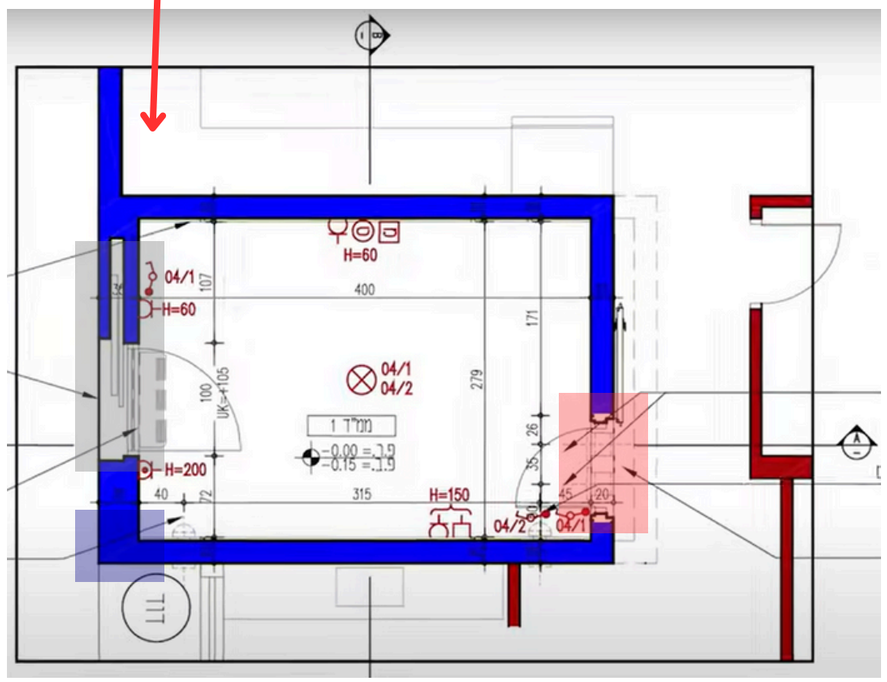


Fig (2.2.2) : Mamad Secure Room inside apartments
Source : https://youtu.be/tFxsqazA9EY?si=a_ECM0-feYtOJ6gh

Materials and Structural System:

Reinforced Concrete Walls: The walls are constructed with reinforced concrete, typically 20 to 30 centimeters thick, to resist blast impacts and shrapnel.

Airtight Steel Doors and Windows:

Each room is equipped with airtight steel doors and windows to prevent the infiltration of chemical or biological agents.

Independent Ventilation Systems:

Mamad rooms have dedicated ventilation systems to ensure a continuous supply of clean air during emergencies.

Regulation of construction

- **Size:** A typical Mamad room must be at least 9 square meters with a minimum wall thickness of 30 cm of reinforced concrete.

- **Depth:** Mamad rooms are above ground, unlike traditional bunkers, allowing quick access but sacrificing deeper protection.

- **Regulation:** Israeli law dictates that Mamad rooms must be built in a way that allows them to function as standard rooms (bedrooms, offices, etc.) without feeling like a military bunker.

- **Ventilation System:** The rooms include a special blast-resistant window that can be quickly sealed in case of a chemical attack.

- Mandatory Installation: Israeli law requires that every new residential unit includes a Mamad, reflecting the country's proactive approach to civil defense.



Figure (2.2.3) : multi wall layer to deflect explosion instead of absorbing
Source : https://www.buyitinisrael.com/news/mamad-room-saves-lives/



Figure (2.2.4) : Mamad safe room’s window from inside & outside
Source : https://www.buyitinisrael.com/news/mamad-room-saves-lives/



Figure (2.2.5) : Mamad room’s door from outside & inside and showing the way of opining
Source : https://jerusalemhillsdailyphoto.blogspot.com/2014/07/welcome-to-my-mamad-bomb-shelter.html

2.3 Miklat – The Bunker System in Israel

Miklat refers to public and private bomb shelters built in Israel as a civil defense system. These shelters are designed to withstand blast waves, shrapnel, and chemical/biological threats

Regulations

Size: Ranges from 50 m² to 500 m²

Wall Thickness: 40–80 cm reinforced concrete

Depth: Typically 2–5 meters underground, some deeper (10+ meters in strategic areas)



Figure (2.3.1) : Miklat Bunker underground
Source : https://www.washingtonpost.com/news/in-sight/wp/2015/03/17/hidden-in-plain-sight-the-anatomy-of-israeli-bomb-shelters/

Materials and Structural System:

1- Reinforced Concrete:
Walls, ceilings, and floors are made of high-strength reinforced concrete (30–80 cm thick) to absorb blast impacts.

2- **Steel Reinforcements:**
Rebars (steel bars) inside the concrete add strength and resistance to structural failure.

3- **Blast-Resistant Doors & Windows:**
Made of thick steel with an airtight sealing system to protect against blasts and chemical attacks.

4- **Shock Absorption Design:**
Uses seismic-resistant engineering and vibration isolation layers to withstand direct hits



Figure (2.3.2) : Miklat Bunker underground
Source : https://www.washingtonpost.com/news/in-sight/wp/2015/03/17/hidden-in-plain-sight-the-anatomy-of-israeli-bomb-shelters/

Construction Process

01

Excavation

Public shelters: Dug several meters underground, depending on the soil type.
Private shelters: Integrated into buildings at ground level or basement level.

02

Concrete Pouring

Walls and ceiling are cast in one continuous pour to prevent weak points

03

Foundation & Reinforcement

Steel bars (rebar) installed to reinforce concrete structures.

04

Final Sealing & Security Features Added

Blast doors & emergency exits installed for quick escape.

05

Ventilation & Filtration Systems Installed

Special NBC (Nuclear, Biological, Chemical) filters to purify air.

Facilities Inside Miklat Shelters

01

Backup Power Supply

Generators or battery-powered systems for lighting and ventilation.

02

Water & Sanitation

Stored water tanks and toilets for long stays.

03

Emergency Food Storage

Dry food and essential supplies.

04

Communication Systems

Radios and emergency phone lines for external contact.

05

Sleeping Areas & Seating

Bunk beds or seating for temporary refuge.

06

Ventilation & Filtration System

Filters toxic gases, smoke, and biological threats.

Requirements for Room Needs

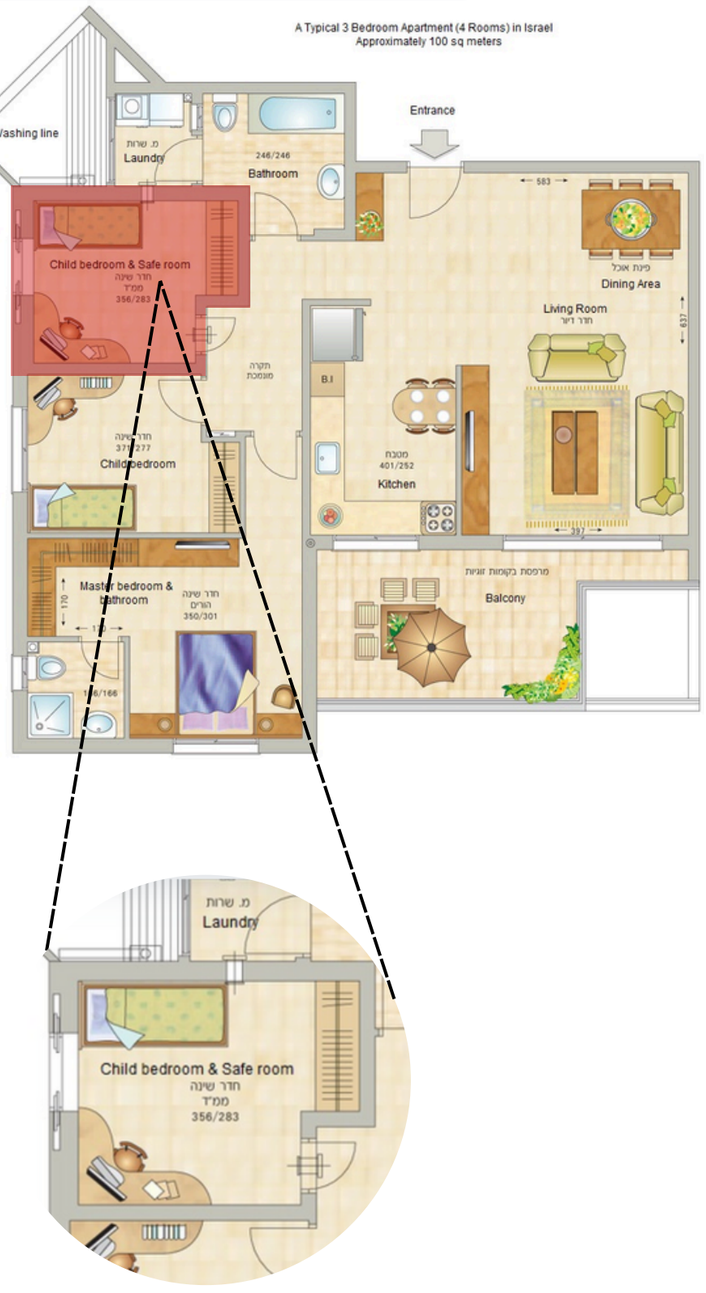
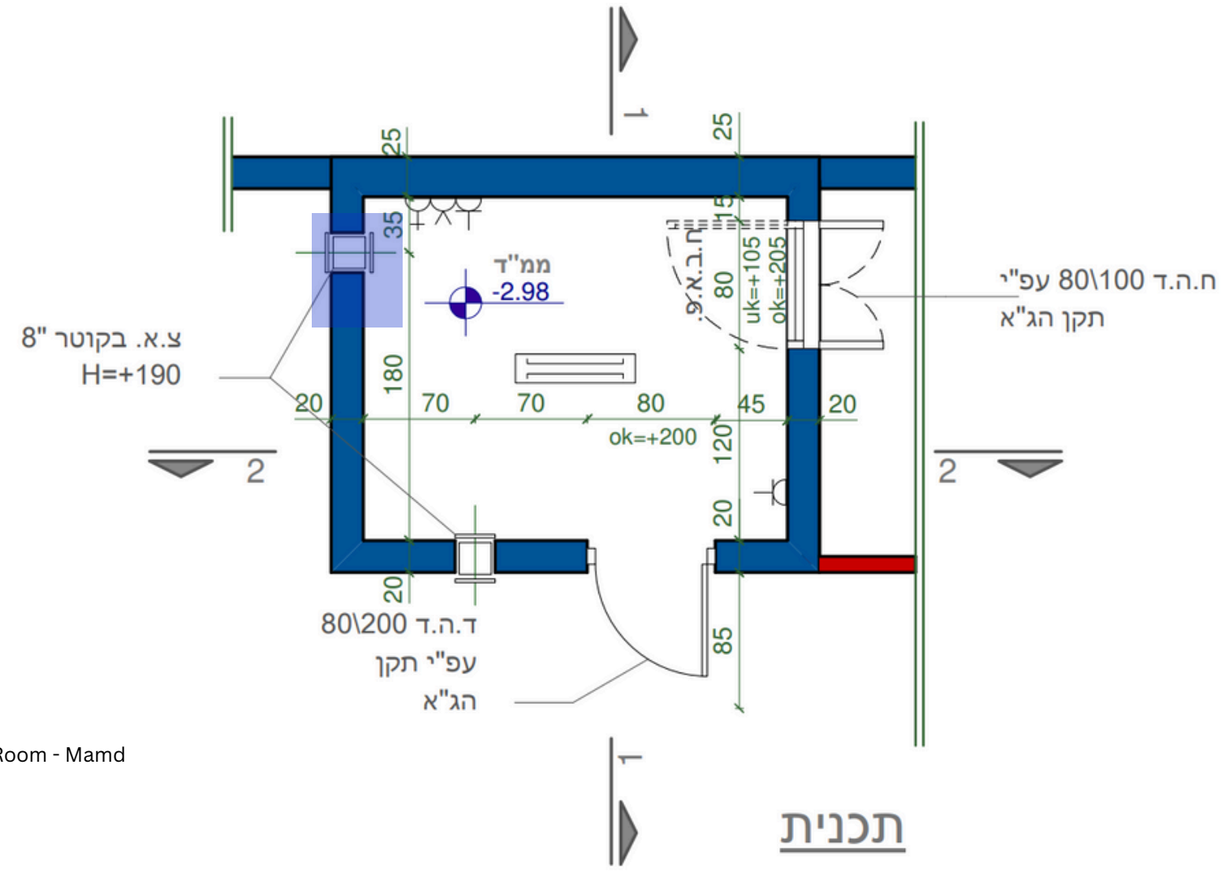


Figure (2.3.3) : Example of Apartments in Israel presenting 3 bedrooms
Source : https://anglo-list.com/floor-plan-of-an-israeli-apartment/



Window : three layers
1- Outside - steel - hinged window
2- Middle - steel - sliding plate
3- inside - steel - sliding

Door : two layers
1- inside room - steel - hinged door
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Reinforced Concrete wall
Thickness : 30 - 40 cm

Figure (2.3.4) : Example of Apartments in Israel presenting 3 bedrooms
Source : https://anglo-list.com/floor-plan-of-an-israeli-apartment/

Existing Residential layout

- **Alternative 01 / Apartment 3bd in Gaza**

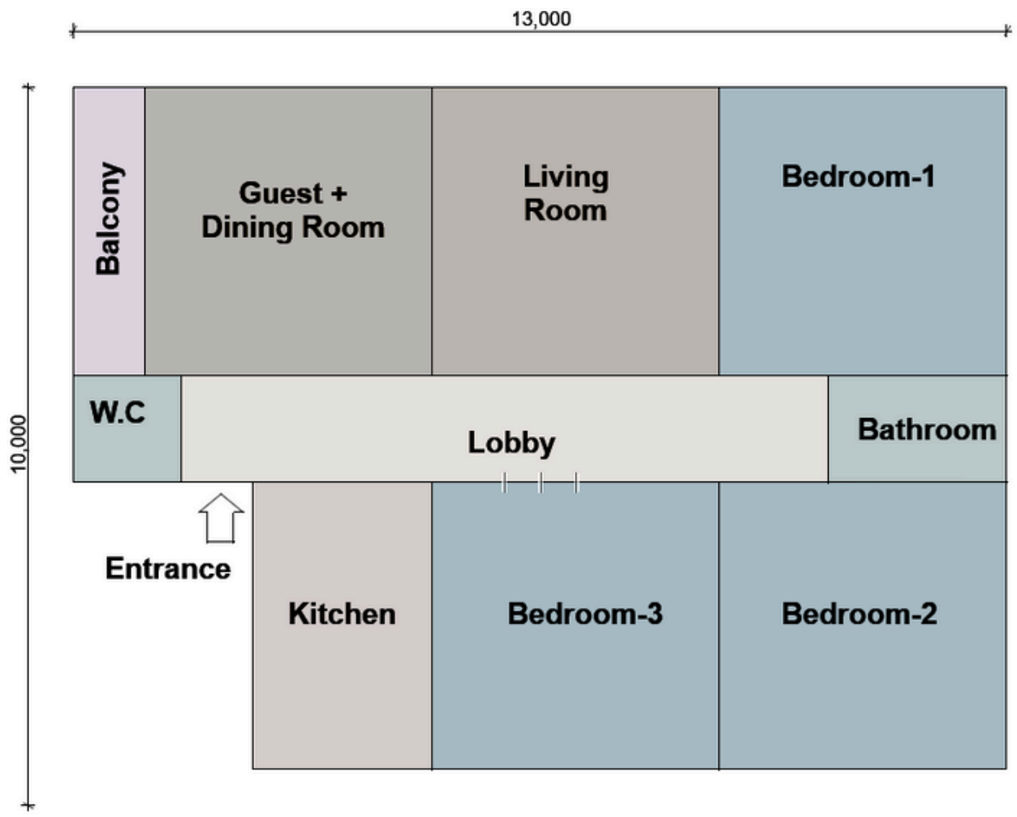


Figure (2.3.5) :A schematic plan for apartment with 3bd
Source : Eliaa Office,Gaza; 2015.

Apartment Size : 120 m2
Capacity : 5 - 6 people

The noticeable in this layout that the people in Gaza care much about privacy by providing a closed kitchen and additional guest toilet

- **Alternative 02 / Apartments 3bd in Israel**

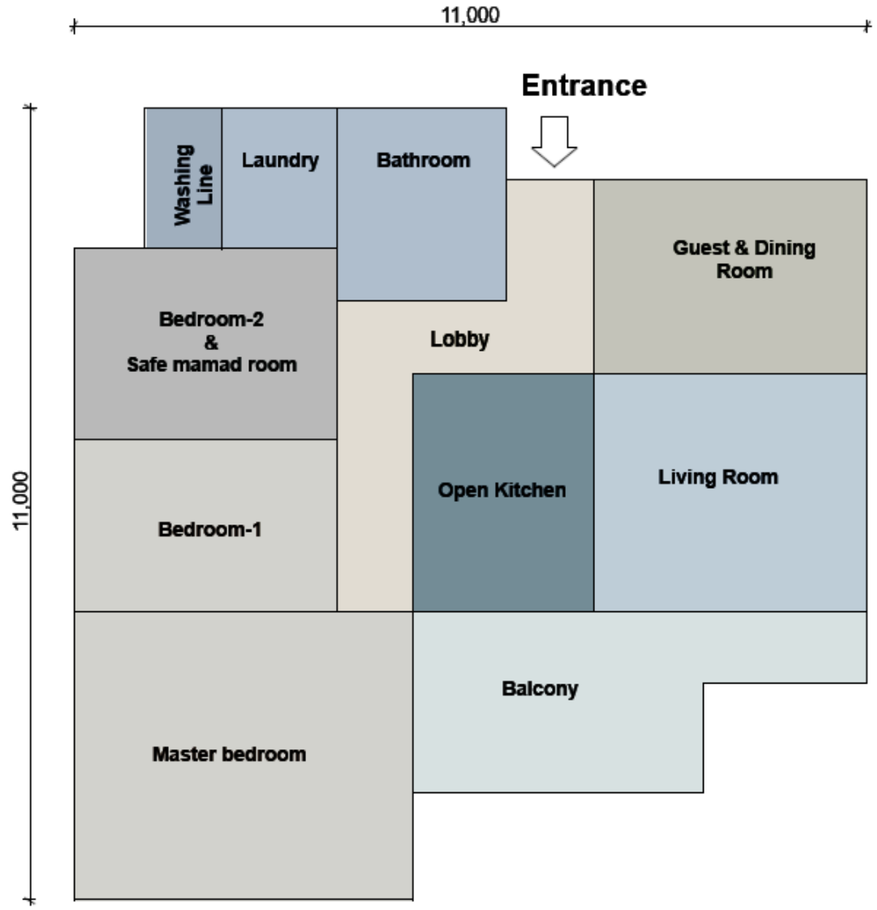


Figure (2.3.6) :A schematic plan in Israel for apartment with 3bd
Source : Eliaa Office,Gaza; 2015.

Apartment Size : 120 m2
Capacity : 5 - 6 people

The most important that this layout providing a save fortified room during active war and could be use as a daily life room for children for sleeping, etc.

Requirements

- **Bunker/Shelter Floor**

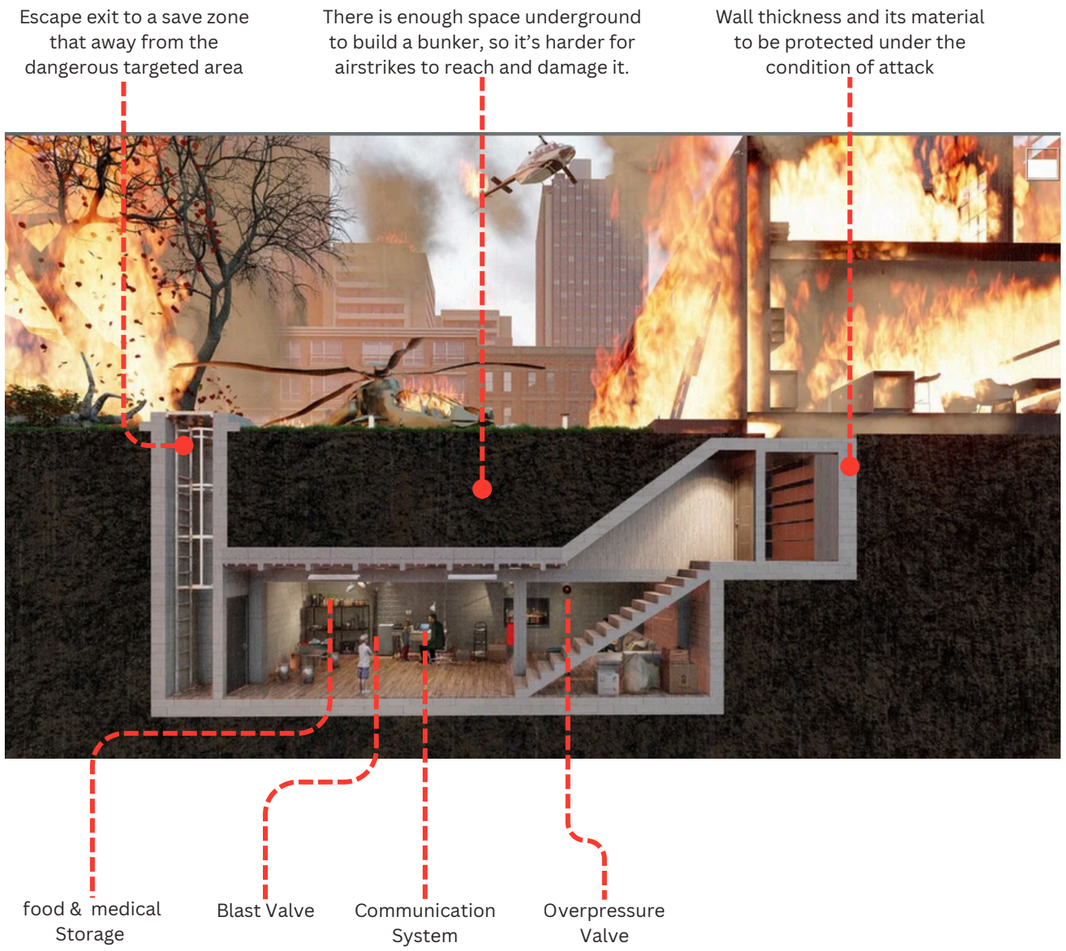
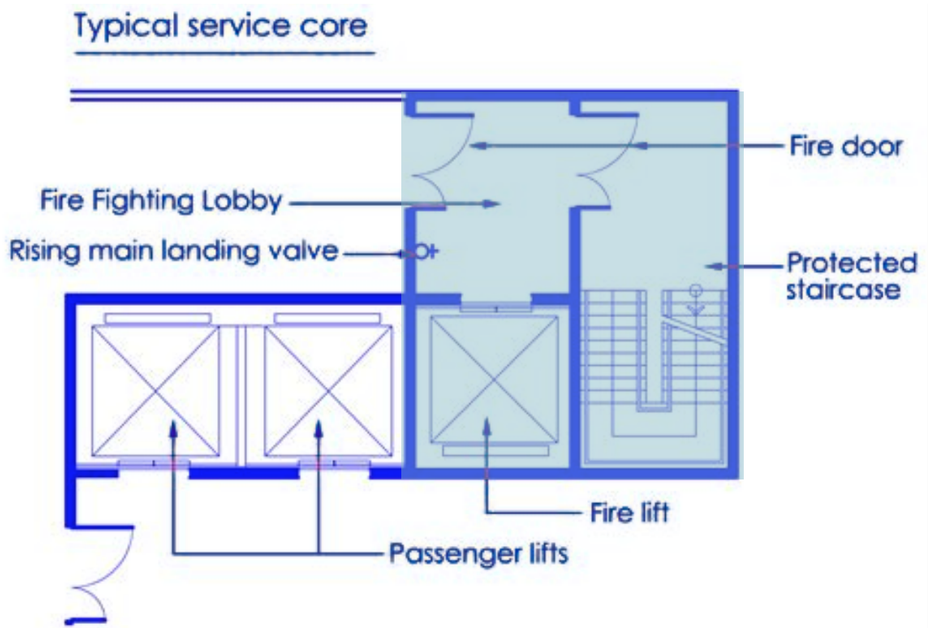


Figure (2.3.7) : The Crucial Role of Fallout Shelters and NBC Air Filtration Systems in Family Survival
Source : https://www.castellex.com/the-crucial-role-of-fallout-shelters-and-nbc-air-filtration-systems-in-family-survival/

- **Emergency Stairs with Fire lift**



- The emergency stairs are the building's lifeline during war, providing a safe, protected route to the bunker. Reinforced and independent, they ensure users can evacuate quickly and safely under any threat.

Figure (2.3.8) : The Crucial Role of Fallout Shelters and NBC Air Filtration Systems in Family Survival
Source : https://www.classiclifts.co.uk/wp-content/uploads/2023/04/Webinar-Slides-Web.pdf

2.3.1 Site Location

The Gaza Strip, also known simply as Gaza, is a small territory located on the eastern coast of the Mediterranean Sea; it is the smaller of the two Palestinian territories, the other being the West Bank, that make up the State of Palestine. (Wikipedia)

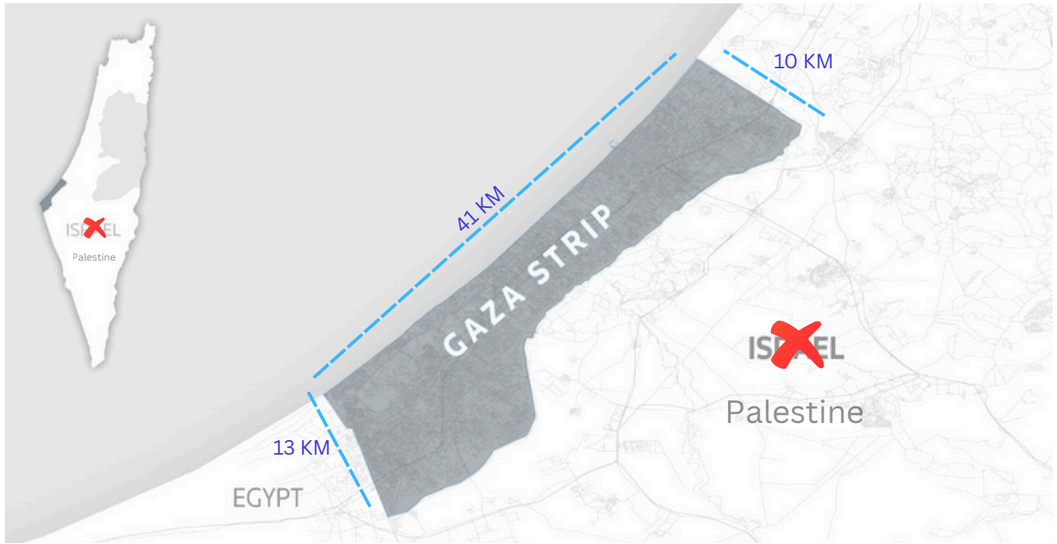


Fig (2.3.9) : Mapping of Gaza Strip
Source : https://www.reuters.com/graphics/ISRAEL-PALESTINIANS/MAPS/movajdladpa/

Area: 360 km²
Population: 2.142 million (2024)
Founded: 1949
Ethnic groups: Palestinian Arabs
Largest city: Rafah

Gaza is an extremely small and densely packed area, covering just 365 square kilometers while housing approximately 2.2 million people. This makes it one of the most crowded places in the world, with very limited space for expansion and development.

Jabalia is located in North Gaza, just north of Gaza City. It is one of the most densely populated areas in the Gaza Strip and is home to the largest refugee camp in the region, Jabalia Refugee Camp.

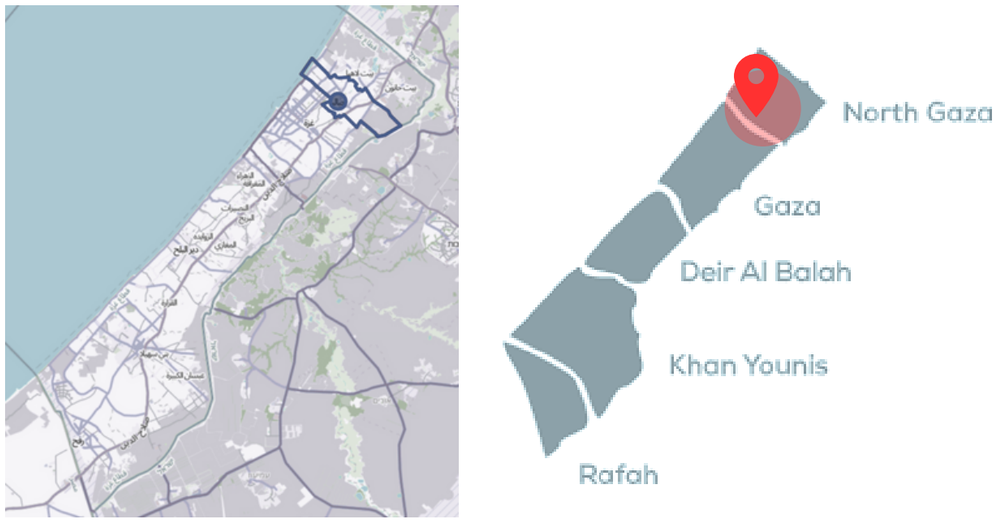


Fig (2.3.10) : Jabalia, North Gaza. Mapping of chosen Location
Source : https://www.doctorswithoutborders.org/latest/whats-happening-northern-gaza

Why Jabalia ?

Jabalia is a critical location due to several urgent factors :-

Preventing the displacement is the urgent and main target not increase the human crisis because of extreme density

- High Population Density & Refugee Crisis
- Severe War Damage & Urgent Reconstruction Needs
- Limited Land & Urban Expansion Challenges
- Strategic Humanitarian Importance

Choosing Jabalia for your project ensures that your design directly addresses urgent humanitarian needs, provides safe and fortified housing, and contributes to the long-term urban resilience of Gaza's most affected communities.

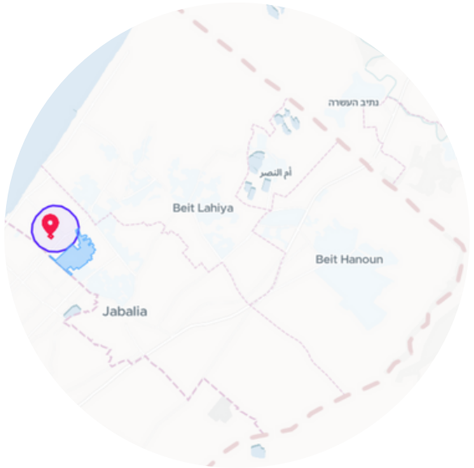
SITE LOCATION

Jabalia City, Gaza Strip

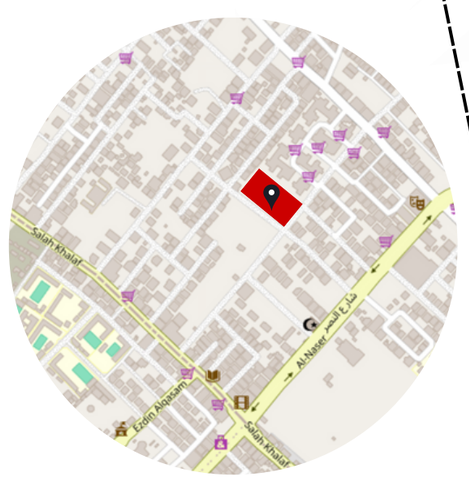
- The site is located in Jabalia, about 1 km from Gaza's northern coastline to be away from the dangerous zone of attack.
- Jabalia's extremely high population density and the presence of one of Gaza's largest refugee camps make it a vulnerable and high-risk area. Despite its distance from the most frequently targeted eastern borders



boundaries of Jabalia City,
North Gaza



Site location compared to
Jabalia city



Choosing and Selecting the site.
vacant land to stablish the new
typology



Site Location
total Area : 7500 m2

Figure (2.3.11) : Alternative Maps of the site the location
Source : Google earth & Author's Documentation

2.3.2 Site Analysis

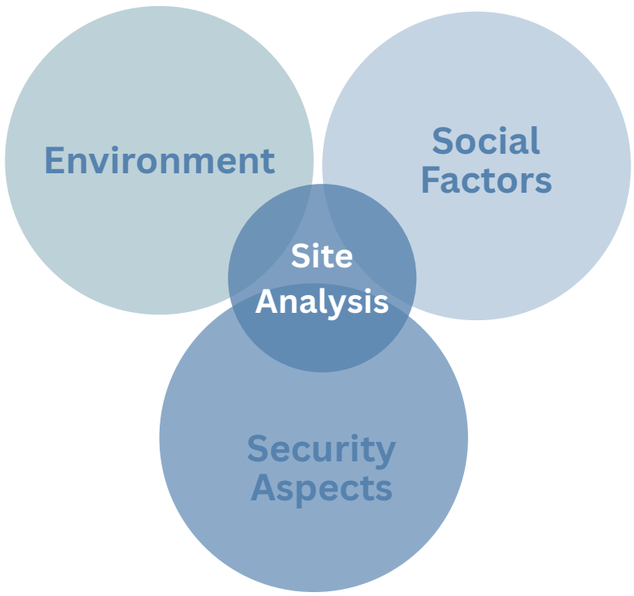


Figure (2.3.12) : Schematic diagram showing the aspects of the site analysis
Source : Author's documentation 2025

The site analysis integrates three critical dimensions—environmental, social, and security aspects—each contributing uniquely to shaping a resilient architectural response. Environmental factors consider the coastal proximity, climate, and urban density; social aspects address population distribution, refugee presence, and accessibility to services.

Environmental Analysis

- **Sun & Wind Direction**

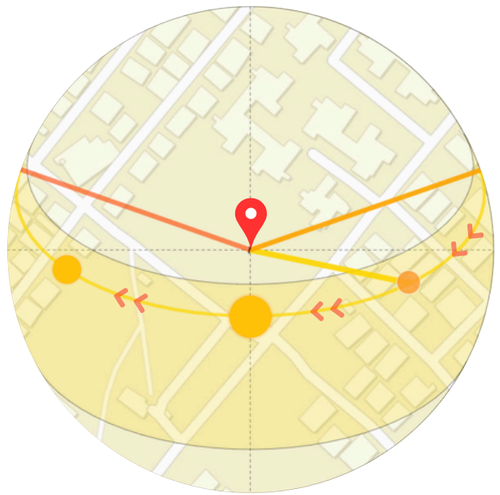


Figure () : Sun Direction
Source : Sun Calc

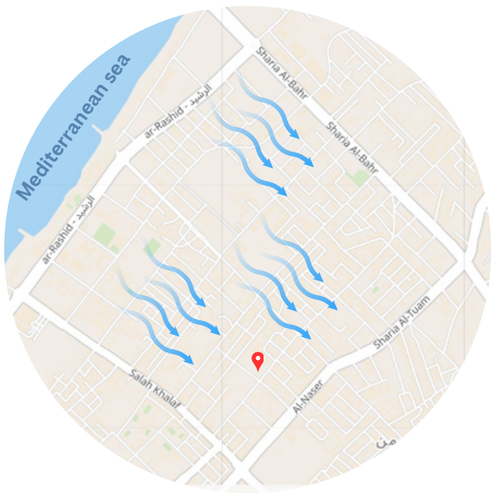


Figure () : Wind diagram orientation
Source : Windfinder



Figure (2.3.13) : Schematic diagram showing the aspects of the site analysis
Source : Author's documentation 2025

The environmental analysis of the site highlights key passive design opportunities. The sun path indicates optimal natural lighting from the southeast to southwest, guiding effective building orientation to maximize daylight while minimizing overheating. Additionally, the wind direction from the Mediterranean Sea provides natural ventilation potential, especially from the northwest, which can enhance indoor comfort and reduce reliance on mechanical cooling.

BH
75m

The Building Height (BH) is capped at 75 meters, enabling the development of a high-rise building of approximately 20 floors, depending on floor height and design. This height is in compliance with local regulations, particularly for plots adjacent to streets wider than 16 meters

BFC
55%

The Built Floor Coverage (BFC) defines the portion of land each upper floor can occupy. At 55%, each floor above ground covers just over half of the plot, helping improve air circulation and reduce the building's overall mass.

BCR
60 - 80%

there is a rule related to street width in Gaza (including Jabalia) when it comes to building regulations.

➔ In general, the wider the street, the higher the building is allowed to be.

➔ If the street width is more than 16 meters, you are usually allowed to build a medium rise building with 12 floors maximum and if the street wider till 24 meters then the regulation allow to build a high rise building which is above 12 stories till 20 based on the regulation

GBC
(10 - 20)%

The Green Buffer Coverage (GBC) sets aside 10% to 20% of the land for landscaping, gardens, and green spaces. This encourages environmental sustainability and enhances the urban living experience by providing shaded areas, reducing heat island effects, and improving the overall aesthetic of the project.



Figure (2.3.14) : Site Regulation
Source : Author's documentation 2025

Site Regulation	Land	BCR	BFC	GBC	Building Height
Percentage / Size	4000 m^2	2400 m2 / 60%	2200 m2 / 55%	800 m2 / 20%	75 m

Social Factors Analysis

- **High-Density**

Over 2.3 million people packed into just 365 square kilometers. This extreme density, exceeding 6,000 people per square kilometer, strains infrastructure, housing, and essential services. The overcrowding worsens living conditions, limits access to clean water and healthcare, and makes urban expansion nearly impossible, further deepening the humanitarian crisis. As a result, planning for vertical development and efficient land use becomes a critical necessity to address these severe challenges.

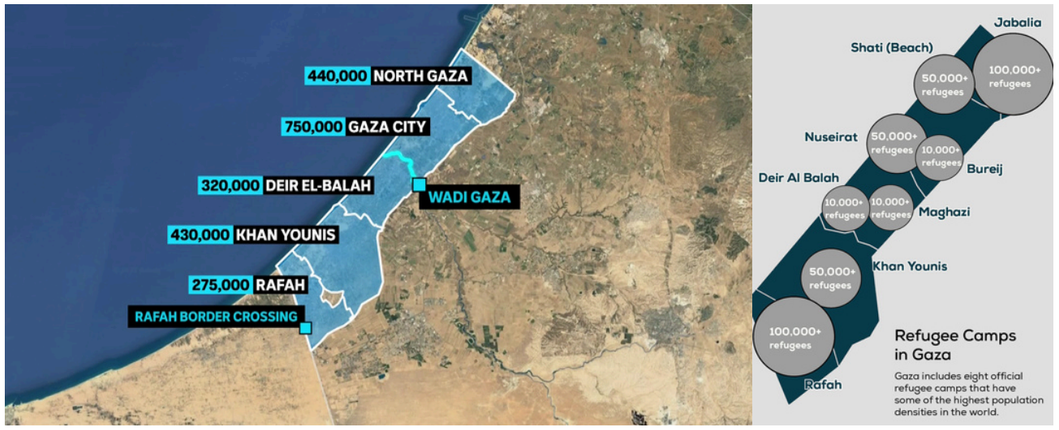


Fig (2.3.15) : High Population Density in Gaza and Its Challenges
Source : (Wikipedia, 2022)

The overcrowding puts immense pressure on infrastructure, housing, and resources, making daily life challenging. Limited land availability forces people to build vertically or adapt underground solutions for safety and space efficiency. The dense urban fabric also complicates emergency responses, transportation, and access to essential services, highlighting the urgent need for sustainable planning and resilient architecture.

- **Population Growth**

Gaza's population has been rapidly growing despite ongoing conflicts and limited resources. With over 2.3 million people living in just 365 square kilometers, it is one of the most densely populated areas in the world. This rapid growth, combined with blockades and destruction from war, has put immense pressure on housing, infrastructure, and basic services, making daily life increasingly difficult for its residents.

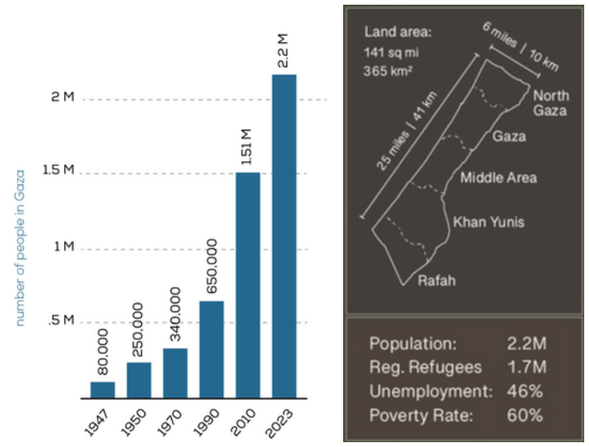


Fig (2.3.16) : Population Data in Gaza Strip over Years till now
Source : https://www.anera.org/how-big-is-gaza/

Because of the increasing in population growth, the more needed for housing, apartment, schools, hospitals, etc... so the strategy is constructing vertically medium and high-rise structural to cover the increasing of population number. This approach helps maximize land use efficiency in densely populated urban areas. Additionally, it allows for integrating essential services within limited space, improving accessibility and community resilience.

Security Aspects Analysis



Figure (2.3.17) : Mapping show the typology and prototype building
Source : Google earth & Author's Documentation



Figure (2.3.18) : Mapping show destruction level
Source : Google earth & Author's Documentation

This Security analysis presents a spatial understanding of the surrounding urban context, focusing on building types and levels of destruction caused by repeated attacks. It categorizes the area based on building heights and illustrates varying damage intensities—ranging from limited to full destruction and total removal. This analysis helps identify the area's structural vulnerability and supports the strategic selection of a site with relatively lower exposure to destruction, guiding resilient and safe design decisions.

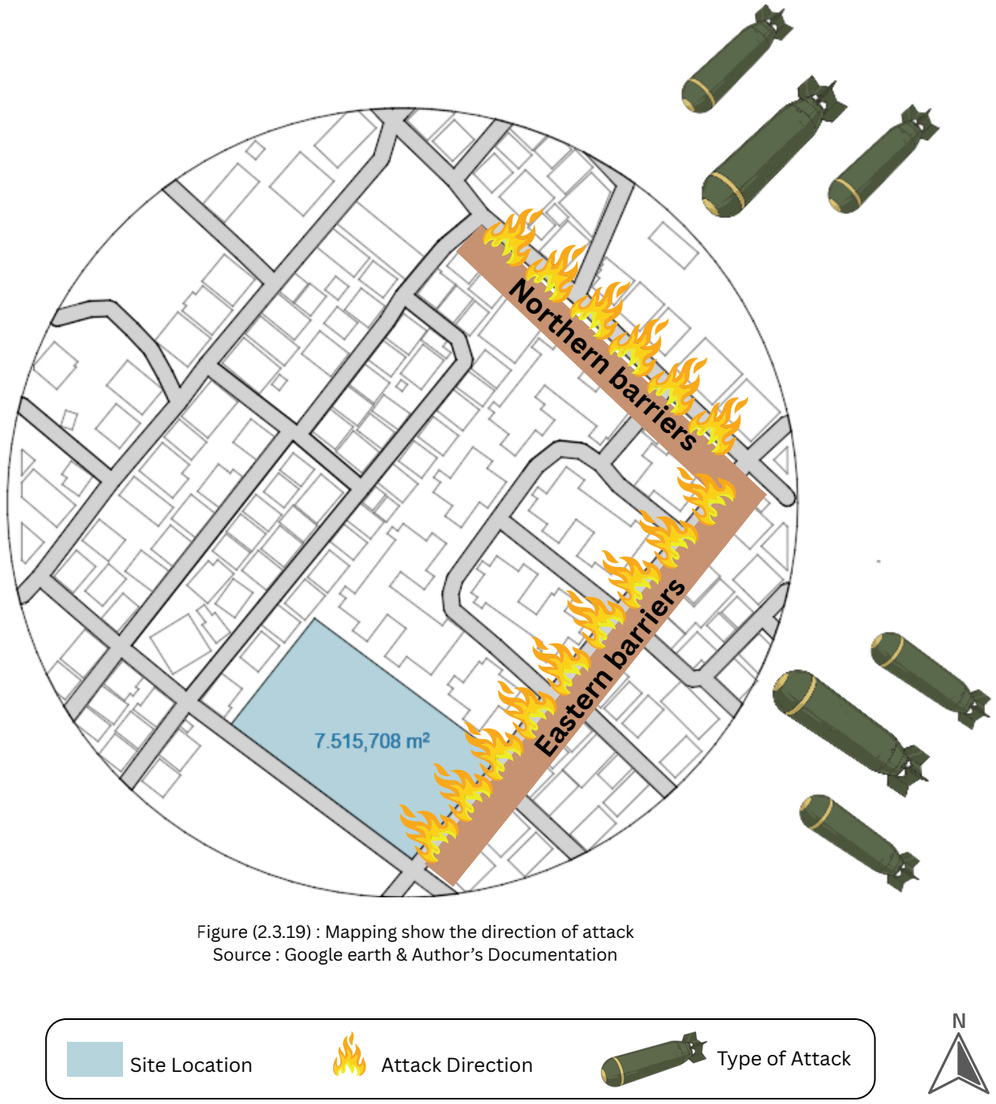


Figure (2.3.19) : Mapping show the direction of attack
Source : Google earth & Author's Documentation

The site's proximity to the eastern and northern borders of Gaza presents a significant security risk, as these directions are common sources of direct attacks due to military operations and surveillance. In addition to horizontal threats from those sides, vertical attacks from above—particularly airstrikes targeting rooftops—pose a critical danger. This multi-directional exposure increases the building's vulnerability, especially for high-rise structures, making it essential to carefully consider protective massing strategies, reinforced roof systems, and setback design principles to reduce the impact of such threats.

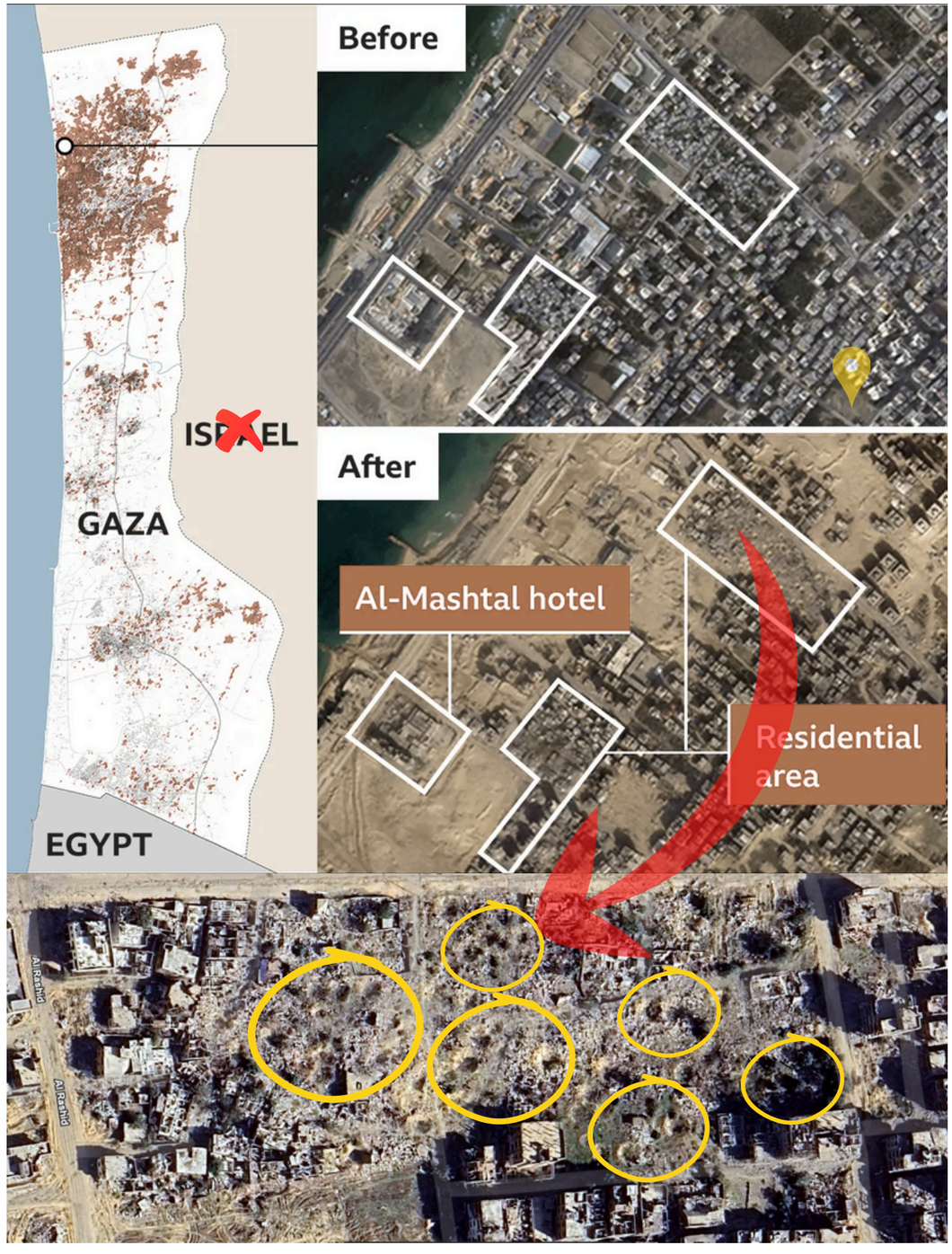


Figure (2.3.20) :The effects of the bombing around the site
Source : Public News BBC & Google earth

Chapter 03

Design Concept

Design Concept

Human-Focused Design

This approach focuses on making the building safe, comfortable, and supportive for the people who live in it, especially during emergencies. It makes sure the design meets daily needs, protects residents during danger, and respects local culture. Spaces are planned to feel private, welcoming, and easy to use for everyone.

- Guideline for accessible circulation
- Safe and secure spaces
- Privacy culture
- Building Interior coloring
- Natural light & ventilation

Innovative Design

This approach brings all parts of the building—like structure, safety, and layout—together in one smart design. while incorporating modern, creative solutions that respond to the unique challenges of Gaza. It aims to deliver high performance and resilience

- Site boundaries
- Building envelopment & Defensive facade
- Multi-Use Spaces
- Safe evacuation routes
- Underground shelter/ bunker

Resilient Residential High-Rise

Integrated Structure System

focusing on applying a resilient structure that absorb and dissipate blast energy caused from explosion sources based on the materials used.

- Frame structure (columns + beams)
- Shear wall system
- Core System
- Load-bearing wall system

Users

looking for safety, privacy and comfort day life activity

- Owners of the apartments
- Staff
- Displaced families
- Surrounding neighbors

Diagram 3.1.1 Design Concept Focus
Source : Author, 2025

3.1 Neighborhood

3.1.1 Neighborhood Under Active War Conditions in Gaza

Using resilient structural buildings to be able to withstand damage from blasts or any explosion sources, strong shelters, and stable roads and services to keep people safe in war zones to access public areas, hospitals, etc.

3.1.2 Lacking of Safety Regulations

Absence of safe underground shelters or bunkers, Scarcity of evacuation zones, no recommended vacant land and difficulties to access main roads because of buildings collapse and causes road blockages



Figure 3.1.2 division of the site location
Source : Author,2025

The neighborhood present a residential medium and high-rise buildings and the chosen site never used for any construction before, with a total area 7500 m² and the selected barriers for the new typology will be 4200 m² from the whole site. so the idea to use the rest of the total area which is 3300 m² as a buffer zone and evacuation land to serve the whole neighborhood during hard wartime

3.1.3 Strategic Near Dangerous Sensitive Zones

Buffer zones and protective barriers are key for defending neighborhoods in high-risk areas. Buffer zones separate buildings from danger by applying empty space around the building that follow the regulation, reducing blast or attack impact.

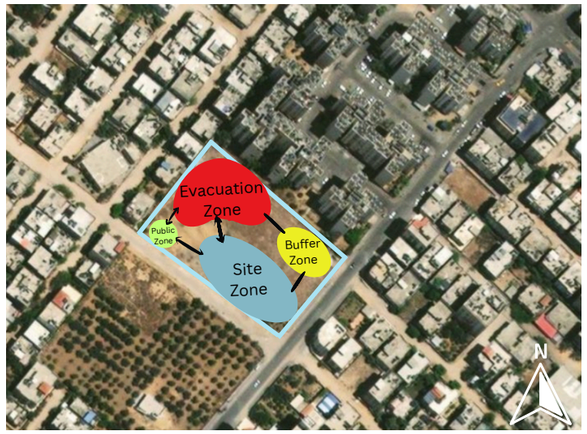


Figure 3.1.3 Main Zoning on the Site
Source : Author,2025

For serious lack of evacuation land during wartime so providing an emergency evacuation land with public services and Fortified Escape Opening from the bunker in the site underground to serve the neighborhood around the site can mitigate the high crisis and displacement



Figure 3.1.4 Alternative 02 for designing surrounded neighborhood
Source : Author,2025

Providing an evacuation land with a protective buffer zoning also public services on the site with two main access to limited the crowed and easy access for relief crews and civilians
whose homes were affected.

3.2 Site Development

3.2.1 Site Development according to Safety Regulations

Based on regulation the building footprint BCR will be 60% and the green area on the site will be 10%. so the building will be centralize on the center of the site so if the building face any attack and part of the building collapse of even most of the building, the backfill does not affect the main roads for accessibility.



Figure 3.2.1 Site Context responding to the Regulation
Source : Author,2025

3.2.2 Site Development according to accessibility

The site located directly to main roads and the width for each is 8m, and the site not nearby any public transportation so the occupants or the owners need between 900m till 1km to reach the nearest station. so based on that many of the users and visitors to the commercial zone will use there own vehicles that's why providing two main entrance one for pedestrians specially the neighbors and the other for the vehicles to access the basement easily and provide comfort for all users.

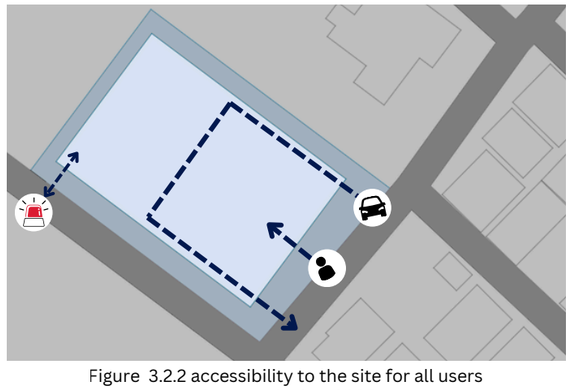


Figure 3.2.2 accessibility to the site for all users
Source : Author,2025

3.2.3 Site Development according Landscaping Strategies for Site Safety and Function

Landscaping can help reduce shrapnel spread at ground level by using trees, or walls to block or slow down flying debris from nearby blasts. It also helps create safer outdoor spaces during daily activity. The fence could be considered as a safety element on the site, so in case any building nearby the site targeted then the fence could absorb or deflect shrapnel and debris.

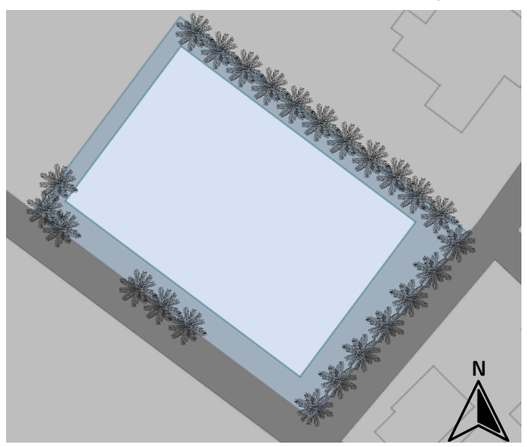


Figure 3.2.3 Vegetation placement to enhance the quality of air
Source : Author,2025

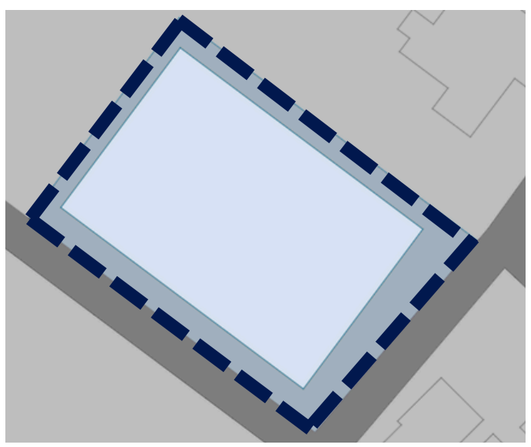


Figure 3.2.4 Site Fence placement responding to safety regulation
Source : Author,2025

By creating a physical barrier between the site and its surroundings. so the fence could be applied into three layers reinforced-concrete and the first defensive line , sand layer can absolutely help slow or absorb shrapnel, as used method in military. and for the third layer could be normal concrete or brick. the fence will not be high that much just normal height and will cover the whole site The benefit from dense trees that acting like a natural buffer can mitigate dust and improves air quality.

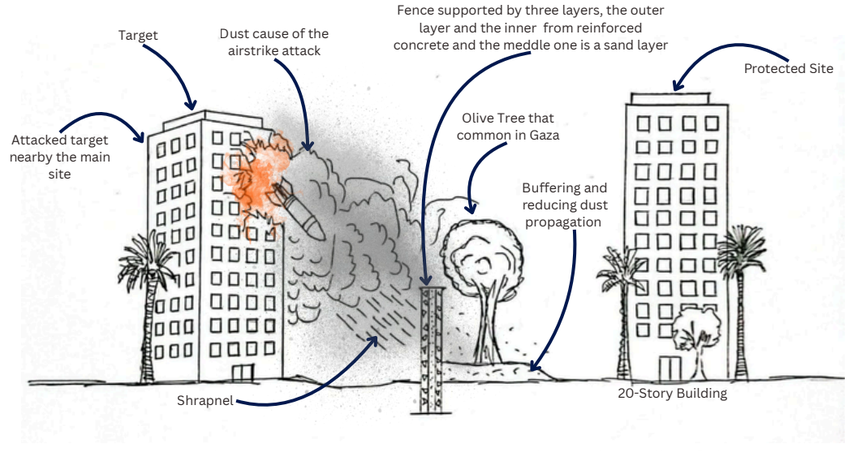


Figure 3.2.5 Vegetation placement to enhance the quality of air
Source : Author,2025

3.3 Property Size

3.3.1 Property Size Concept According to Safety Regulation

According to the international standard ISO 9836 is the only official ISO that directly defines floor area metrics used in architectural planning. also NFPA and IBC codes are widely accepted as the functional international standards for life safety, fire protection, and building access, especially in humanitarian architecture.

The whole tower consist of 21 floors above the ground level, the first 2 for commercial purpose, the last for the roof top and the rest will be for typical apartments and the target is 14 apartments on each floors 7 with 2bd 120m²and the other 7 with 3bd 150 m² and the for the BFC regulation is 55%.

Table 3.3.1 Main property size function and based on the regulation
Source: *Author, 2025*

Main Function Need

Room Type	Standard Area (m²)	Area + Circulation	Amount	Total Area
Podium	2520 m²	-	2	2520 m²
Typical Apartmetns (Residential Floors)	2400 m²	-	18	2400 m²
Basement	2200 m²	-	2	2200 m²
Bunker/Shelter	500 m²	500 + (500 x 30%) = 650	1	500 m²

The podium has no fixed international size standard; its design depends on function, site constraints, and the building coverage ratio. In this project, the two-level podium covers 60% of the site, with about 2,520 m² per floor, allocated for retail, circulation, seating, and services. The basement, totaling 2,200 m² including circulation, accommodates parking, infrastructure, and follows safety regulations. Both podium and basement layouts are shaped by accessibility, functional needs, and local standards.

Table 3.3.2 property size for main supporting function according regulation
Source: *Author, 2025*

Main Supporting Function Need

Room Type	Standard Area (m2)	Area + Circulation	Capacity	Total Area
Mamad Room	9 m²	9 + (9 x 30%) = 12	210	2520 m²
Emergency Stairs	15 m²	15 + (15 x 30%) = 20	2	40 m²
Bunker/Shelter	500 m²	500 + (500 x 30%) = 650	1	500 m²
Escape Tunnel	110 m²	110 + (110 x 30%) = 143	1	143 m²

The Mamad (individual safe room) is integrated into each apartment unit and calculated across all units. Circulation spaces are estimated using a 30% addition to each core function to ensure safe access, following IBC and NFPA spatial guidelines.

3.3.2 Property Size Concept According to Supporting Function

While safety and security are the top priority, the design must also support normal daily life for civilians. Connecting the core concept with this purpose brings hope and resilience. The project includes commercial zones, a basement, bunker system, fortified rooms in each apartment, escape tunnels, and vertical circulation cores for elevators and emergency stairs. It also integrates smart infrastructure for sustainability. Prioritizing safety doesn't mean neglecting comfort—design elements like accessibility, layout, color, and zoning still aim to support a normal, dignified life.

Table 3.3.3 Property size for public function and its circulation according to regulation
Source: *Author, 2025*

Supporting Facilities in the Commercial Zoning)

Facility Type	Standard Area (m2)	Area + Circulation	Capacity	Total Area
Retail Shop	10m * 8m = 80m²	80 + (80x 30%) = 104m²	8	832 m²
Café & Bakery	10m * 10m = 100m²	100 + (100 x 30%) = 130m²	1	130 m²
Restaurant/Dining	10m * 15m = 150m²	150 + (150 x 30%) = 195m²	2	195 m²
Mushola / Praying Room	5m * 6m = 30m²	30 + (30 x 30%) = 39m²	1	39 m²
Storage room	4m * 8m = 32m²	32 + (32 x 30%) = 42m²	1	42 m²
ATM/Bank Branch	2m * 4m = 8m²	8 + (8 x 30%) = 11m²	1	11 m²
Pharmacy	5m * 8m = 40m²	40 + (40 x 30%) = 52m²	1	52 m²
Fitness Studio/Yoga	8m * 15m = 120m²	120 + (120 x 30%) = 156m²	1	156 m²
Daycare Center	10m * 6m = 60m²	60 + (60 x 30%) = 78m²	1	78 m²
Public Toilets	5.2m *8.5m = 44.2m²	44.2 + (44.2 x 30%) = 58m²	1	58 m²
Staff Lockers	5m * 6m = 30m²	30 + (30 x 30%) = 39m²	2	78 m²
Management Office	5m * 5m = 25m²	25 + (25 x 30%) = 33m²	1	33 m²
Janitor/Service Room	2.5m * 4m = 10m²	10 + (10 x 30%) = 13m²	1	13 m²
Void Area + Escalators	12m * 14m = 168m²	168 + (168 x 30%) = 218m²	2	436
Core System	9m * 14 = 126m²	126 + (126 x 30%) = 164m²	1	164 m²
Main Lobby	8m * 12m = 92m²	92 + (92 x 30%) = 120m²	1	120 m²
-	-	-	26	2437 m²

Table 3.3.4 Property size for core system and its circulation according to regulation
Source: *Author, 2025*

Supporting facilities in the Core System

Function	Standard Area (m2)	Purpose	Capacity	Total Area
Elevators	2.4m x 2.4m = 5.76m²	Vertical transportation Typical Floors	5	28.8 m²
Service Elevator	2.2 m x 2.4 m = 6.25m²	Maintenance, goods transport	1	5.28 m²
Fire left	1.1m x 2.1m = 2.31m²	Emergency Access for Firefighters, Evacuation Support	1	2.31m²
Emergency Stairs	2.5 m x 6.0 m = 15m² including landing	Safe evacuation route	2	30 m²
Electrical Shaft	2 m x 1.5 m = 3m²	Power cables, distribution	1	3 m²
Plumbing Shaft	1 m x 1.5 m = 1.5m²	Water & Wastewater Pipes	1	1.5 m²
Mechanical Shaft	1.2m – 2m = 2.4 m²	HVAC ducts, exhaust, fresh air intake	1	2.4 m²
Firefighting Shaft	1m × 1m = 1m²	Fire sprinkler pipes, standpipes	1	1 m²
Communication Shaft	1m × 1.5 m = 1.5 m²	Internet cables, telephone, CCTV wiring	1	1.5 m²
Garbage Shaft	1m × 1m = 1m²	Throwing the rubbish	1	1 m²
Janitor Room	2m * 3m = 6m²		1	6m²
	-	-		112

3.3 Property Size

Table 3.3.5 Property size for Basement function and its circulation according to regulation
Source: Author, 2025

Supporting Facilities Across 2 Basement Levels

Level	Function	Standard Area (m2)	Purpose	Capacity	Total Area
B1	Parking Area	5m * 2.5m = 12.5m² / car	Main vehicle parking		
	Service Staff Room	3m * 5m = 15m²	for janitors, guards, or technical staff	1	6.25 m²
	Storage	5m * 8m = 40m²	building management storage	2	30 m²
	Security Room	4m * 4.5m = 18m²	Surveillance, access control, and communication systems	1	3 m²
	Core Space	8m * 14m = 112m²	elevators, Emergency stairs, shafts	1	1.5 m²
B2	Remaining Parking Area				
	Electrical Room	4m x 10m = 40 m²	Main panels, meters, Cabling, switchboards	1	1 m²
	Mechanical Room	7.5m * 8m = 60m²	pumps, HVAC systems and boilers	1	1.5 m²
	Plumbing/IPAL Room	7m * 8m = 56 m²	Sewage treatment, water control	1	1 m²
	Ventilation/AC Room	5m * 8m = 40m²	Air handling and exhaust system		112
	Water Tank Room	10m * 8m = 80m²	For domestic/fire supply water		
	Fire Equipment Room	5m * 6m = 30 m²	Fire pumps, hydrant panels		
	BMS (Building Management System)	5m * 6m = 30 m²	BMS Controls and Energy		
	Core Space	8m * 14m = 112m²	elevators, Emergency stairs, shafts		

- Circulation for vehicles access is necessary to be fixable and one-way from the entrance to the exit to be more comfort for the users.

- Infrastructure System rooms without circulation 300m²
- Core footprint 208m²

Table 3.3.6 Property size for Basement function and its circulation according to regulation
Source: Author, 2025

Typical Residential Floors - Two Prototype of Apartments

Level	Function	Standard Area (m2)	Purpose	Capacity	Total Area
3bd	Living Room	5m * 6m = 30 m²	Family gathering and activities	1	30 m²
	Dining Area	3m * 4m = 12 m²	Eating area for family	1	12 m²
	Kitchen	3m * 5m = 15 m²	Cooking and preparation	1	15 m²
	Bathroom & Laundry	2.6m * 3.6m = 9,36 m²	Hygiene + washing	1	9,36 m²
	Master bedroom	5m * 8m = 40 m²	Private bedroom with closet	1	40 m²
	Bedroom	4m * 5m = 20 m²	kids/guests	2	20 m²
	Mamad Fortified Room	3m * 3m = 9 m²	Protected Room	1	9 m²
	Balcony	2m * 3m = 6 m²	Outdoor relaxation and washing line	1	6 m²
2bd	Living Room	5m * 6m = 25 m²	Family gathering and activities	1	25 m²
	Dining Area	3m * 4m = 12 m²	Eating area for family	1	12 m²
	Kitchen	3m * 5m = 15 m²	Cooking and preparation	1	15 m²
	Bathroom & Laundry	2.6m * 3.6m = 7.8 m²	Hygiene + washing	1	7.8 m²
	Master bedroom	5m * 6m = 30 m²	Private bedroom with closet	1	30 m²
	Bedroom 01	4m * 5m = 16 m²	kids/guests	1	16 m²
	Mamad Fortified Room	3m * 3m = 9 m²	Protected Room	1	9 m²

- Fortified Bedroom “Mamad” is Protective room for residents during emergencies (rocket attacks, earthquakes, chemical threats)

3.3 Property Size

Table 3.3.7 Property size for Basement function and its circulation according to regulation
Source: *Author, 2025*

Supporting facilities across Bunker/Shelter Level

Safe Zoning during conflict and wars

Function	Purpose	Standard Size (m²)	Capacity	Total Area
Sleeping Area	Sleeping and resting	9m * 20m = 180 m²	2 (both gender)	360 m²
Toilets & Washrooms (Male/Female)	Sanitation and hygiene	4.5m * 5.5m = 24.75 m²	2	24.75 m²
First Aid / Emergency Clinic	Basic medical treatment and emergency care	5m * 6m = 30 m²	2 (both gender)	60 m²
Storage Room	Food, water, medicine, and emergency equipment storage	8m * 12m = 96 m²	1	96 m²
Communication Room	Radio and satellite phone	2m * 5m = 10 m²	1	10 m²
Social Gathering Room	Gathering to eat, do activities	15m * 10m = 150 m²	1	150 m²
Fortified escape Tunnel	Emergency escape route : to escape outside the building in crisis moments	1.2m * 20	1	22 m²

- In designing the underground shelter to ensure both safety and privacy during wartime, two scenarios are proposed. Scenario 1 separates men and women into different sleeping zones, each gender sharing with similar individuals, ensuring cultural sensitivity and privacy. The shelter is designed to accommodate approximately 144 apartments, with each family's sleeping area around 180 m². Scenario 2 offers full privacy by assigning each family a private room ranging from 9 m² to 12 m². In both scenarios, shared facilities include separate toilets and washrooms for males and females, a First Aid/Emergency Clinic, a Storage Room for supplies, a Communication Room for coordination and alerts, and a Fortified Escape Route for safe evacuation. Special attention is given to keeping the core system footprint compact to maximize protection and efficiency underground.

3.2.3 Property Size Concept According to Room Zoning Category

Designing a tower in a hard situation during wartime it's a big challenge specially the tower will serve the civilians either the owners or the visitors. The tower zoning will divided into three main zoning which are public area, semi-public area and private area. this division will create an easy and clear circulation of the building inside and outside and will be precented through a bubble diagram

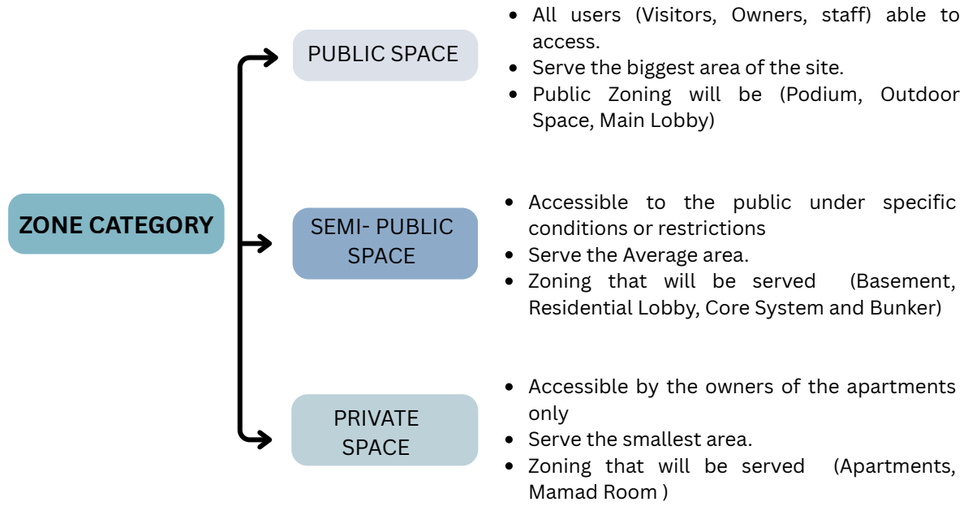


Diagram 3.3.8 Zoning Category according to the space type
Source: *Author, 2025*

3.2.4 Property Size Strategy Based on Functional Room Zoning at Site

Main Zoning in this project divided into four main zoning the first zone is the tower body that consist of different zoning as a public, semi-public and private that separated between different functions like a podium, basement, bunker and typical floors. The second main zone is the buffer zone for safety. The third zone is the parking area for visitors and VIP. The four zone is related to the escape tunnel from Bunker. and through the four main zoning will be arranged into two alternatives to achieve the maximum of safety and easy accessibility.

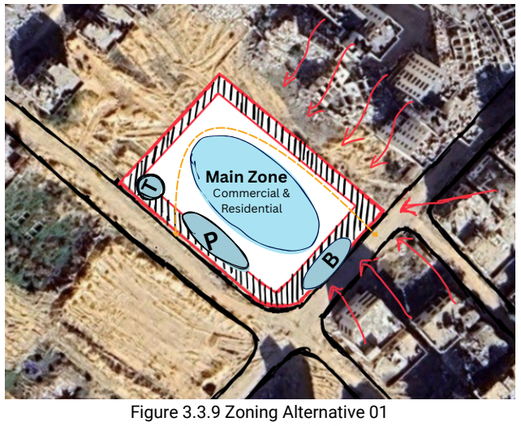


Figure 3.3.9 Zoning Alternative 01
Source: *Author, 2025*

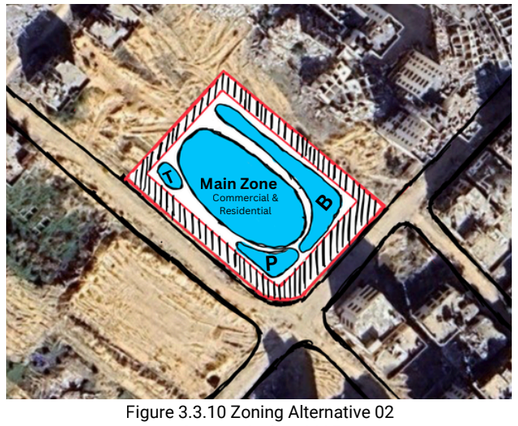


Figure 3.3.10 Zoning Alternative 02
Source: *Author, 2025*

B Buffer Zone **P** Parking & Public Services **T** Tunnel Escape Room

Main Zone "Tower body"

3.2.5 Property Size Concept According to Room Zoning Classification

Table 3.3.11 Main zoning for each Category and its function
Source: *Author, 2025*

Zone Category	Room	Area	Total Area
Podium	Retail 01	80 m²	
	Retail 02	80 m²	
	Retail 03	160 m²	
	Retail 04	80 m²	
	Retail 05	80 m²	
	Cafe Shop	80 m²	
	Restaurant	100m²	
	Public Toilet	80 m²	
	Pharmacy	80 m²	
	Core Space	200 m²	
	Management	80 m²	
Basement	Parking Space L1	2	2200 m²
	Core Space	128 m²	
	Infrastructure Rooms		
	Parking Space L2		
Bunker/Shelter	Sleeping Area/Men	180 m²	1050 m²
	Sleeping Area/Women	180 m²	
	Toilets & Washrooms (Male/Female)	25 m²	
	First Aid / Emergency Clinic	30 m²	
	Storage Room	80 m²	
	Communication Room	6 m²	
	Fortified escape Tunnel	22 m²	

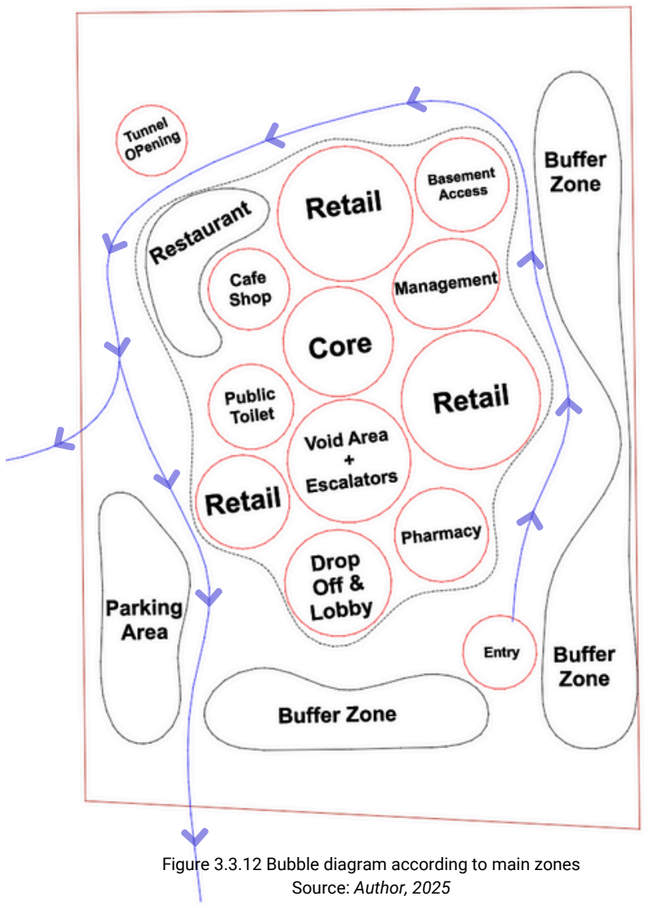
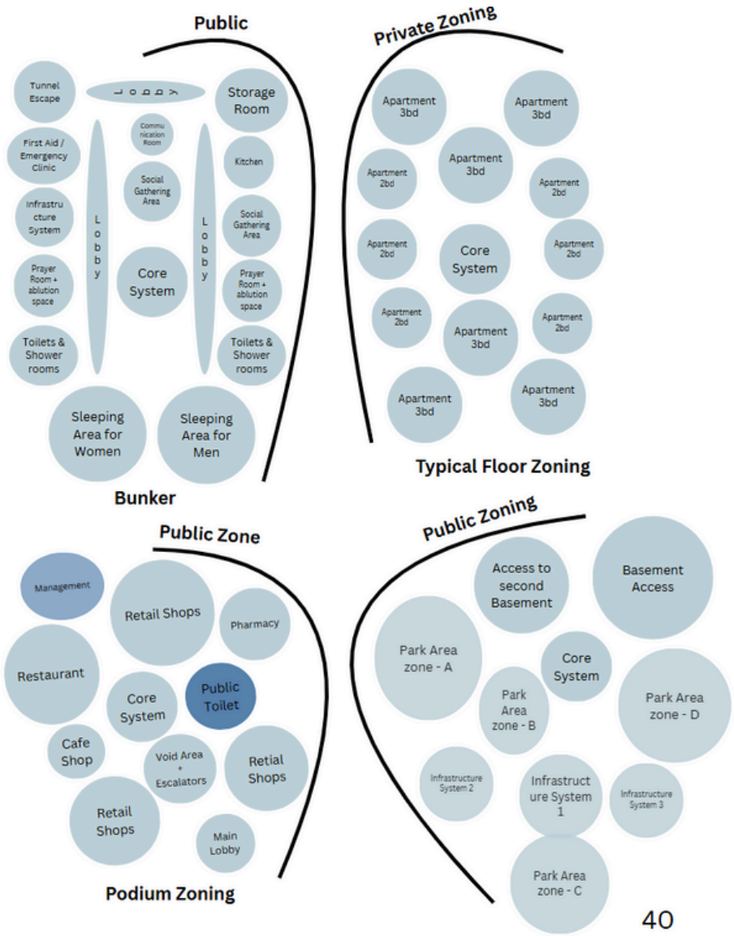


Figure 3.3.12 Bubble diagram according to main zones
Source: *Author, 2025*



Private Zoning Semi Public Zoning Public Zoning

Figure 3.3.13 Bubble diagram according to zoning function
Source: *Author, 2025*

3.4 Building Form

3.3.1 Building Form according to Regulation

The maximum height of the building 75m, 2 basement. and for the safety regulation a new floor under the basement will be added for shelter or bunker.

3.3.2 Building form according to zoning and orientation

Based on the main zones on the site the main orientation of the building must avoid the hard attack and minimize it during wartime so it'll be oriented to the west. as the building located on two roads both has the same characteristic one direct to the east and the other two the west so the entrance still welcoming the users and visitors.



Figure 3.4.1 Alternative zoning 2 for building form development
Source : Author,2025

B Buffer Zone **P** Parking & Public Services **T** Tunnel Escape Room

Additionally, choosing the second alternative zoning because it's using a rectangular form instead of square and direct the smaller interface which is the width elevation towards the eastern side could minimize the danger and damage during wartime.

3.3.3 Building Form Concept according to zoning base and arrangement of massing to respond safety protection

The two alternative will present the idea behind how to make the building form could stand efficiently against any bombardment and how minimize the damage and it's not the final arrangement it's just a primary design for the building form and site circulation.

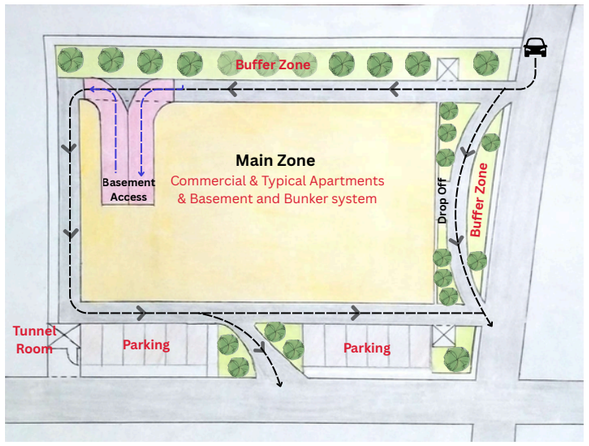


Figure 3.4.2 Schematic layout of massing arrangement responding to function of Alternative 1
Source : Author,2025

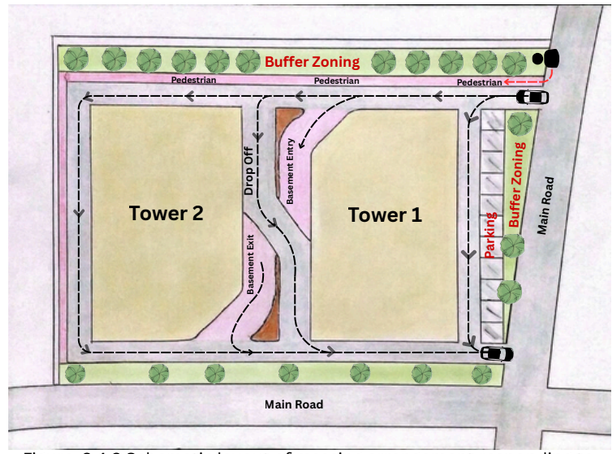


Figure 3.4.3 Schematic layout of massing arrangement responding to function of Alternative 2
Source : Author,2025

Alternative 1

Pros:

Designing the building as one compact mass increases safety by concentrating all functions into a single, well-protected structure. This helps reduce the number of exposed surfaces and weak points, making it more resistant to damage during attacks. The thick, continuous outer walls provide stronger protection, and the buffer space around the building helps absorb shock from explosions. Inside, the layout keeps public, semi-public, and private areas clearly separated, supporting both safety and daily comfort for residents.

Cons:

- A single large mass may be more vulnerable if directly targeted, as all functions are centralized.
- Emergency vertical circulation (e.g., core and stairs) needs stronger internal zoning to avoid congestion during evacuation.
- the weakness of emergency exit from the basement as the entrance and exit from one side

Alternative 2

Pros:

Alternative 1 present two towers that nearby each other so during wartime if any attack happen from the east then the damage could be minimize because the first tower could work as a shield and if any attack happen from the north then the facade for each tower could be the first defensive line and absorb the blast energy cause of the explosion and during the airstrike attack that so the rooftop systems are designed with materials capable of withstanding airstrikes, effectively managing shockwave dispersion and bomb impact.

Cons:

- The close proximity of the two towers may concentrate the target area and reduce evacuation efficiency.
- Circulation space is limited between the towers, which could complicate emergency access.
- Limited buffer zones reduce the chance to redirect or slow attacks before reaching residential masses.

3.4 Building Form

3.3.4 Building Form according to Masing transformation and analysis of each alternative

Massing Transformation of Alternative 01

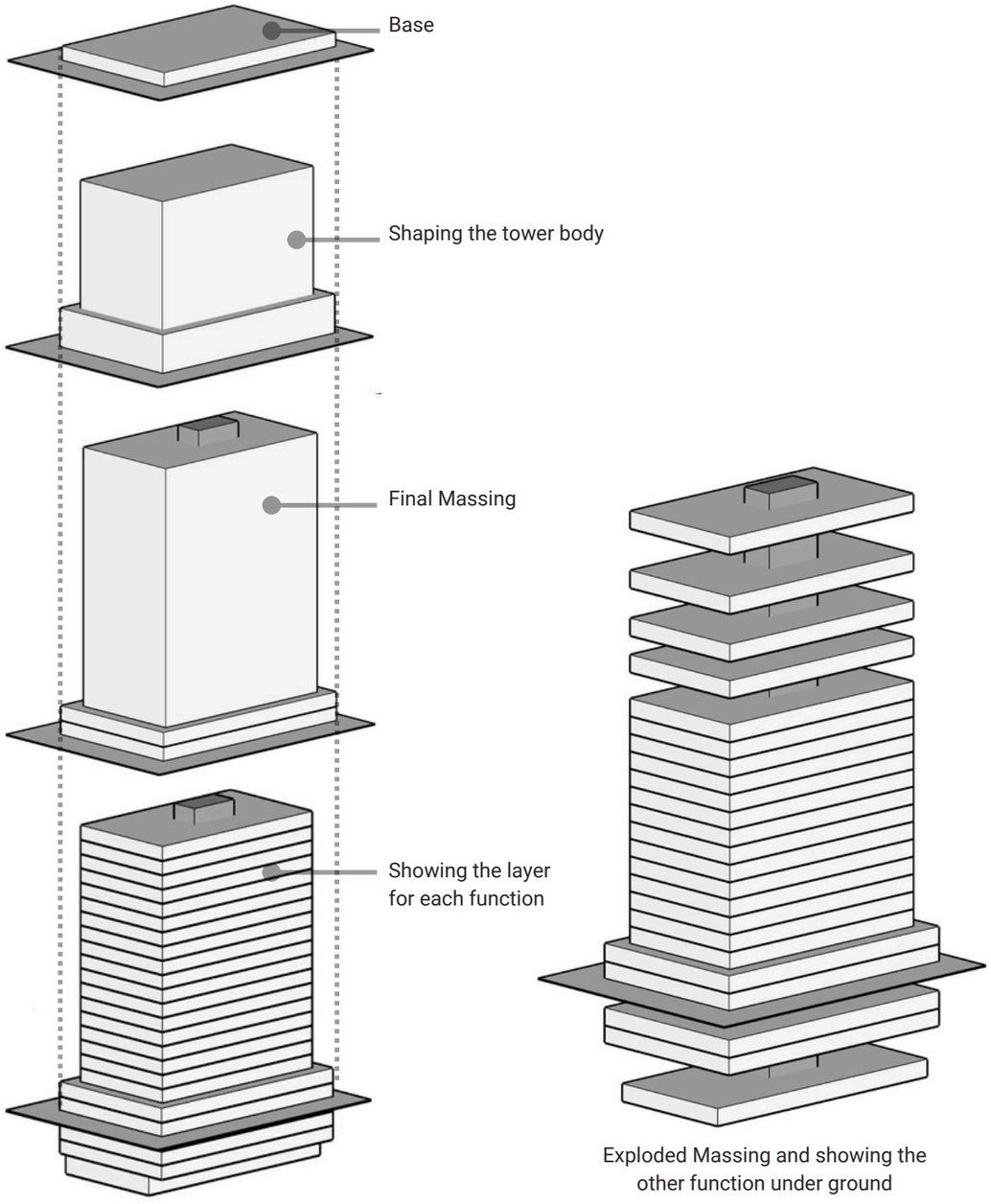


Figure 3.4.4 Axonometric Exploded of Alternative 1
Source : Author,2025

Massing Transformation of Alternative 02

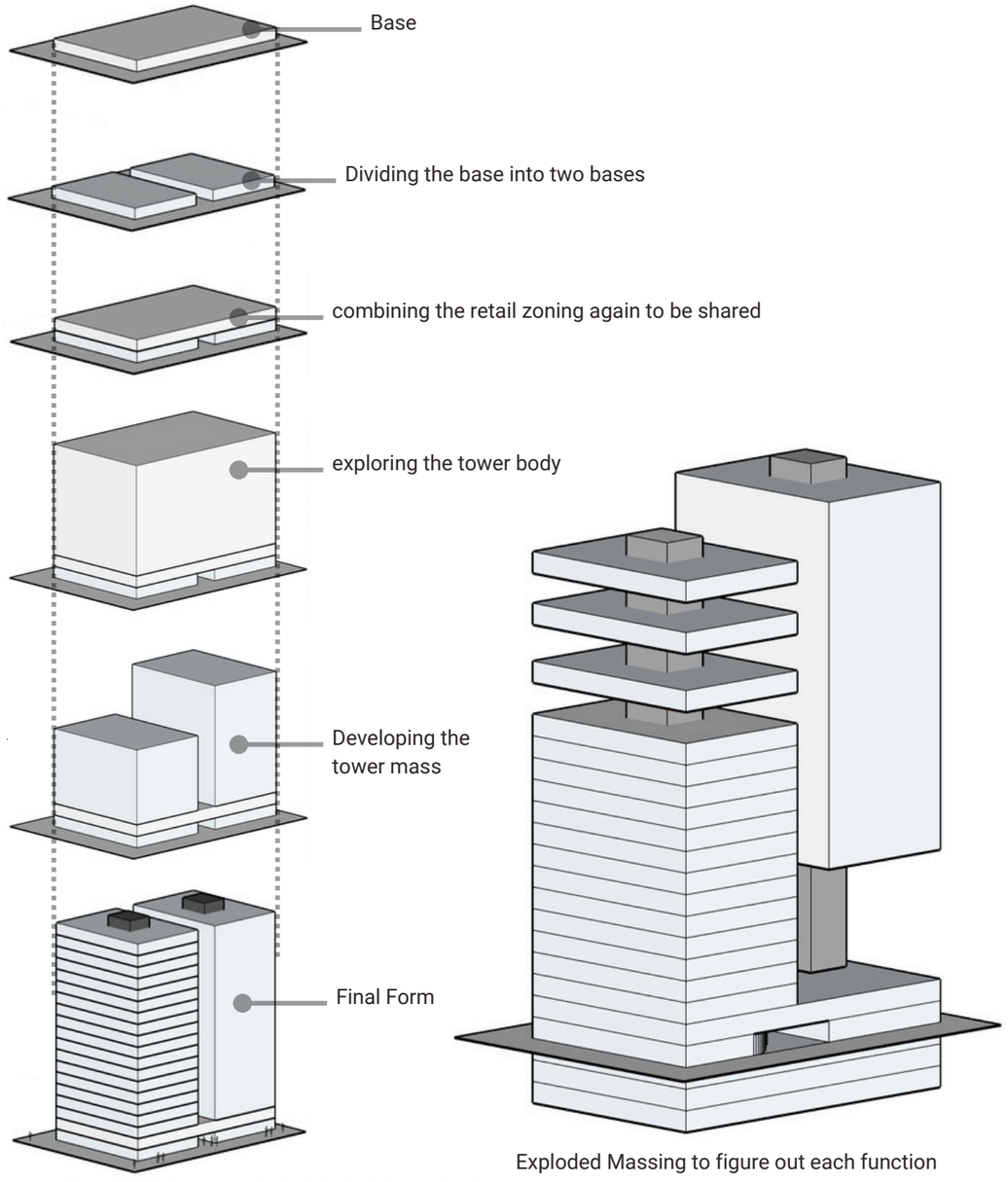


Figure 3.4.5 Axonometric Exploded of Alternative 2
Source : Author,2025

3.3.4 Building Form according to scenario of attacking for Alternative 01 and 02

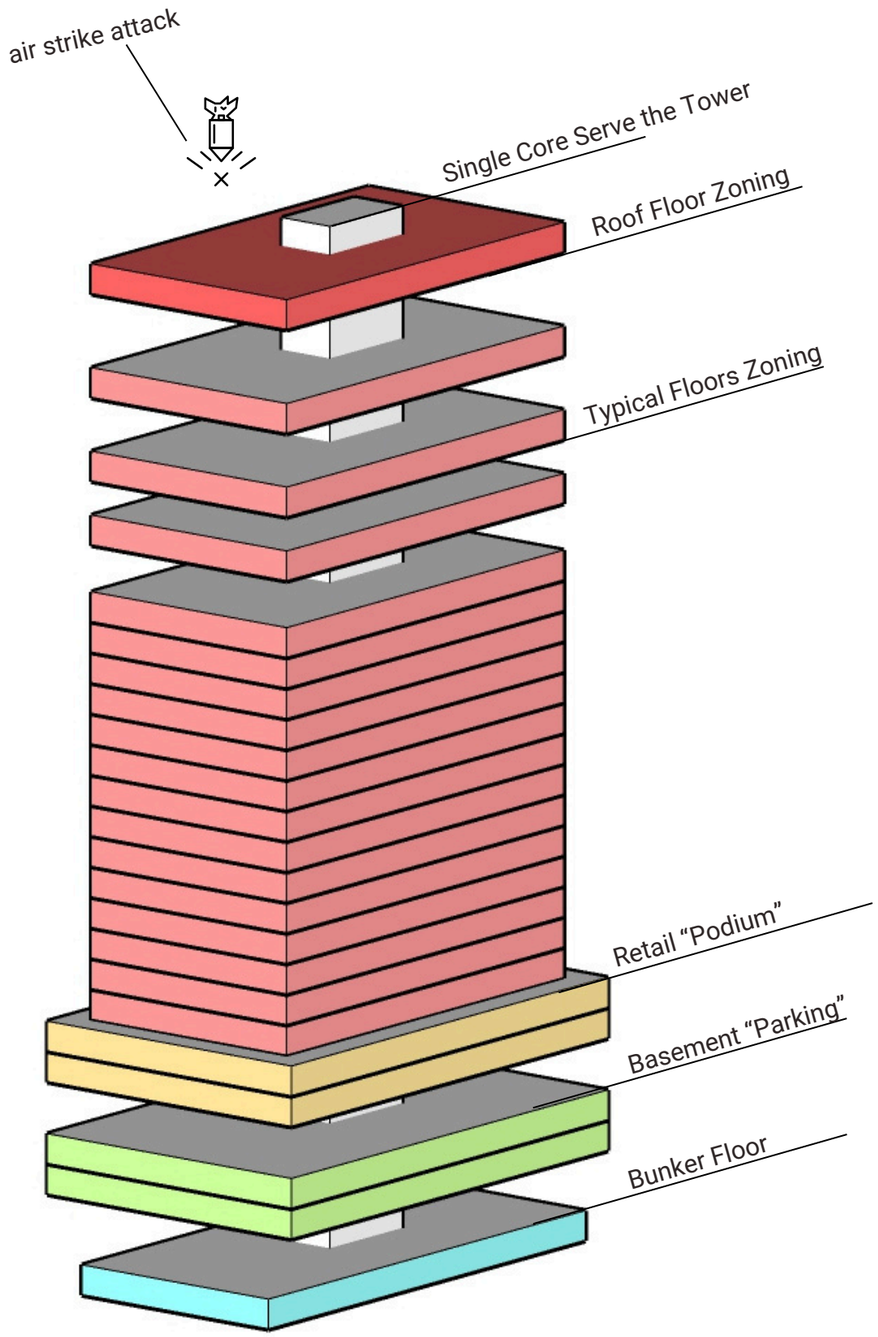


Figure 3.4.6 Axonometric Exploded of Alternative 1 showing the scenario of attacking
Source : Author,2025

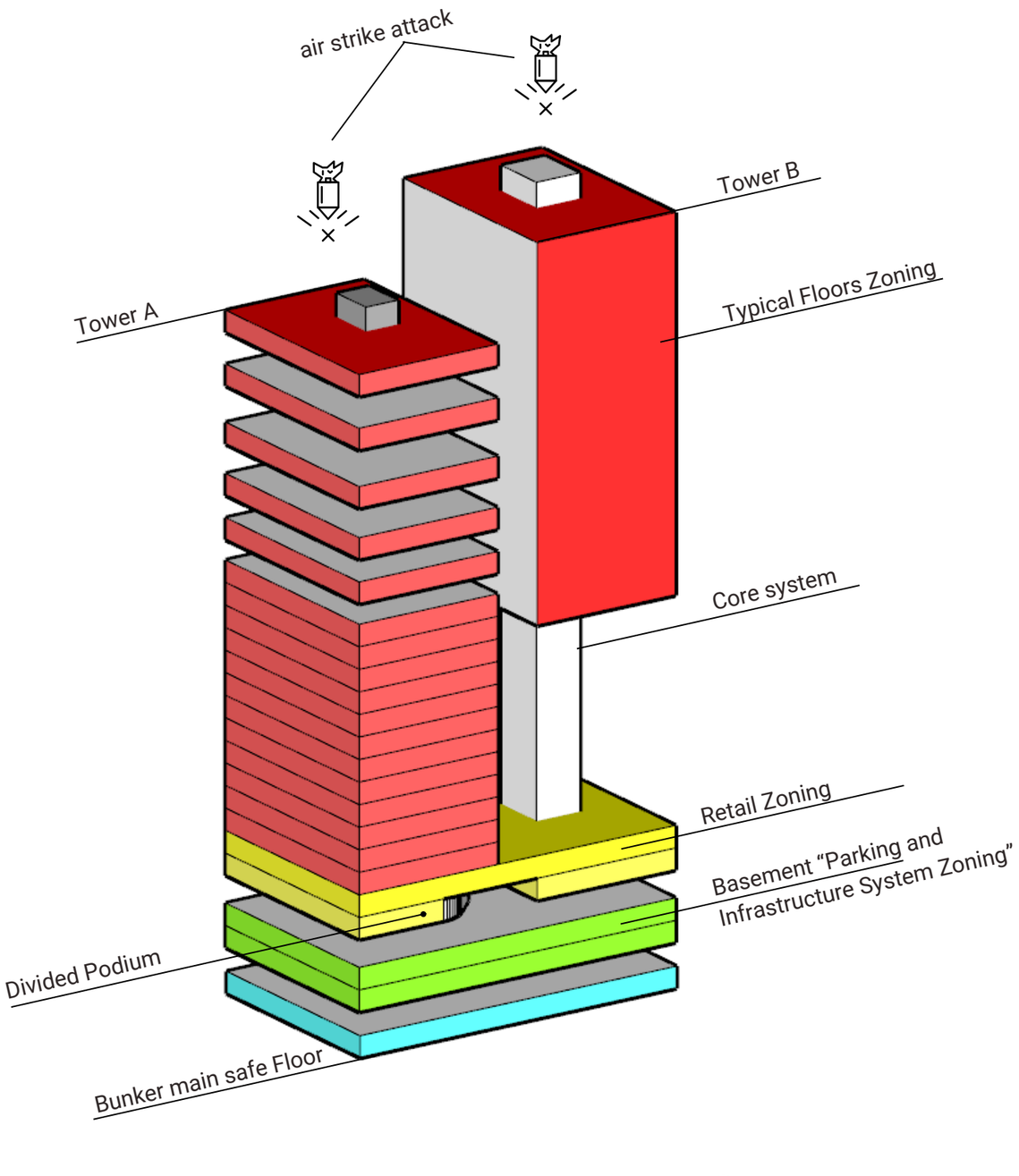
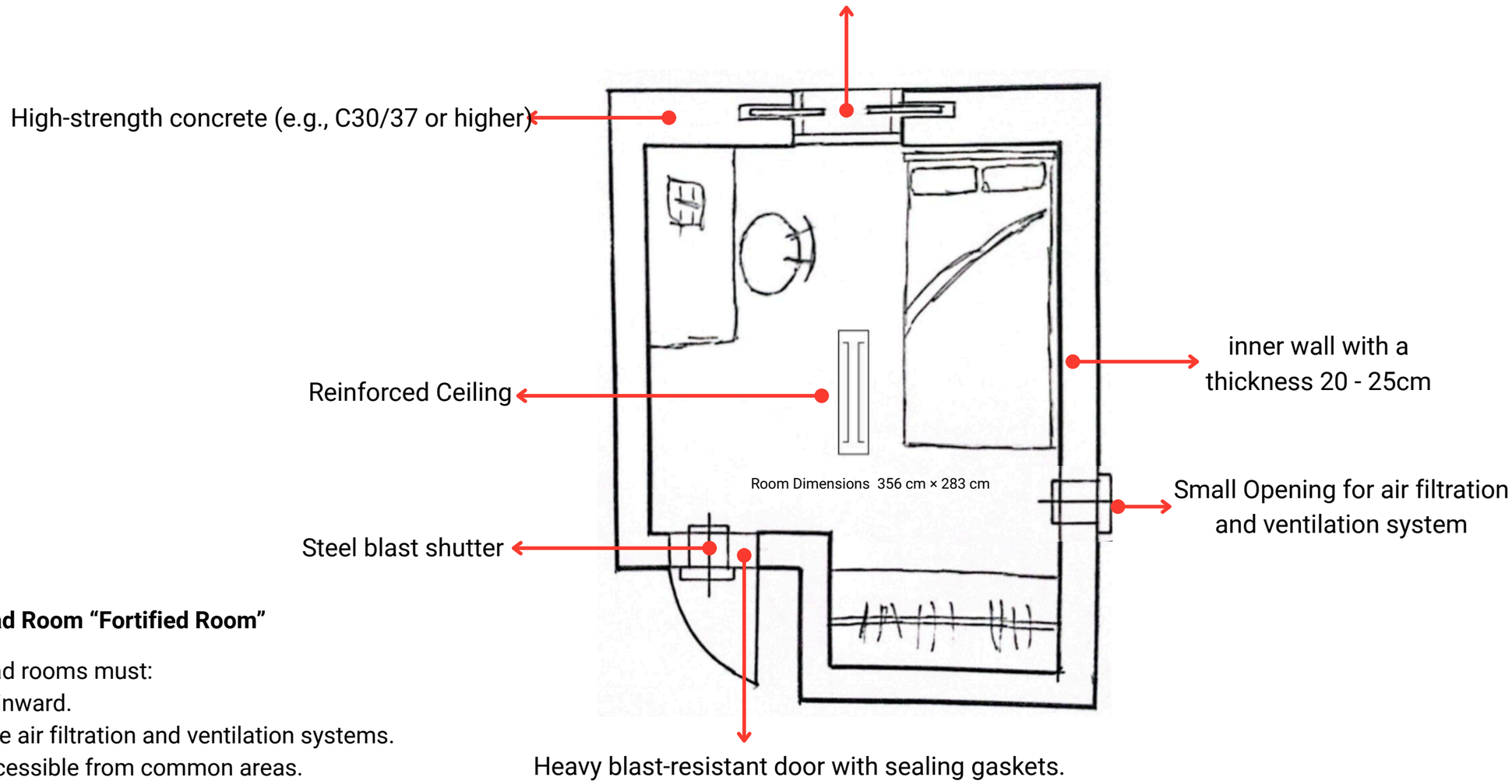


Figure 3.4.7 Axonometric Exploded of Alternative 2 showing the scenario of attacking
Source : Author,2025

3.5 Room Layouts

3.5.1 Room Layout Concept according to Mamad Fortified Room

Blast-resistant doors with sealing gaskets are designed to protect against explosions by minimizing the transfer of blast pressure, debris, and gases. These doors utilize specialized seals and gaskets to create an airtight barrier around the door's perimeter, preventing the entry of hazardous elements.



- **Mamad Room "Fortified Room"**

- Mamad rooms must:

1. Open inward.
2. Include air filtration and ventilation systems.
3. Be accessible from common areas.

Figure 3.5.1 Exploration of Mamad Fortified Room
Source : Author,2025

3.5 Room Layouts

3.5.2 Room Layout Concept according to Emergency stairs two alternatives

- Exploration of two alternative emergency counterclockwise stair

a counterclockwise emergency stair configuration was chosen to enhance safety, efficiency, and spatial integration. This layout allows occupants to naturally follow a left-turning descent, keeping their right hand on the outer handrail, which is intuitive for the majority of right-handed users. It also facilitates smoother evacuation flow by aligning better with common door swing directions and corridor layouts. From a firefighting perspective, it helps separate ascending rescue personnel from descending evacuees, minimizing congestion in emergencies. Overall, the counterclockwise arrangement supports both functional clarity and code-compliant egress.

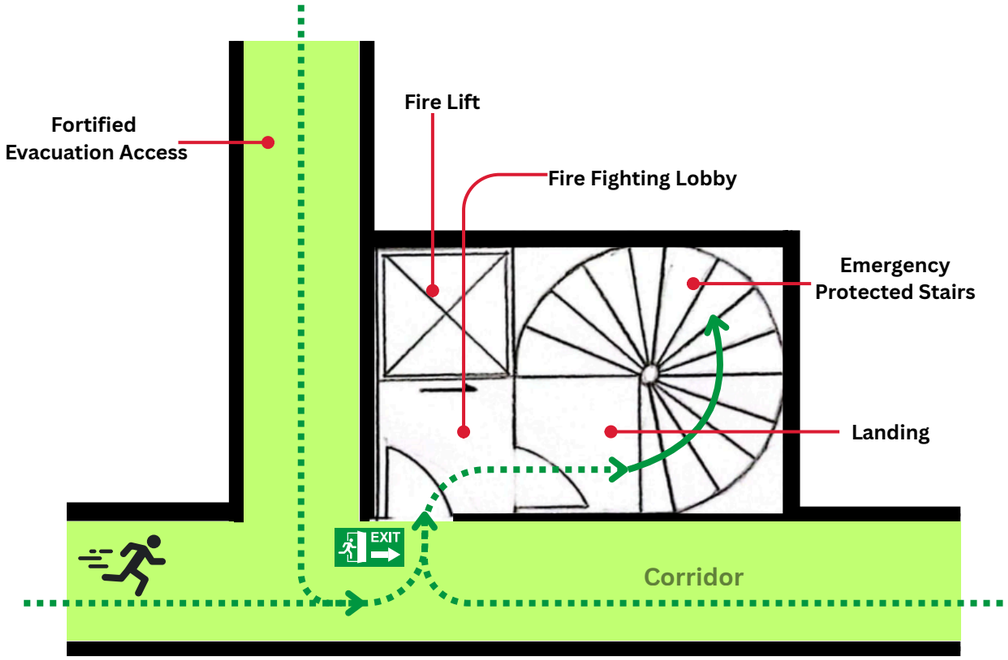


Figure 3.5.2 Exploration of Circular Emergency Stairs
Source : Author,2025

Pros:

- could stand more against bombardment or any attack because of the circular fortified zone that the stairs will in so the form with the material could dispersion shock waves.
- Smooth Traffic Flow: Encourages continuous movement during descent.

Cons:

- Less Practical for High Volume: Narrower treads at the inner radius limit user capacity.
- Difficult for Evacuation of Injured Persons
- More difficult and costly to build and maintain

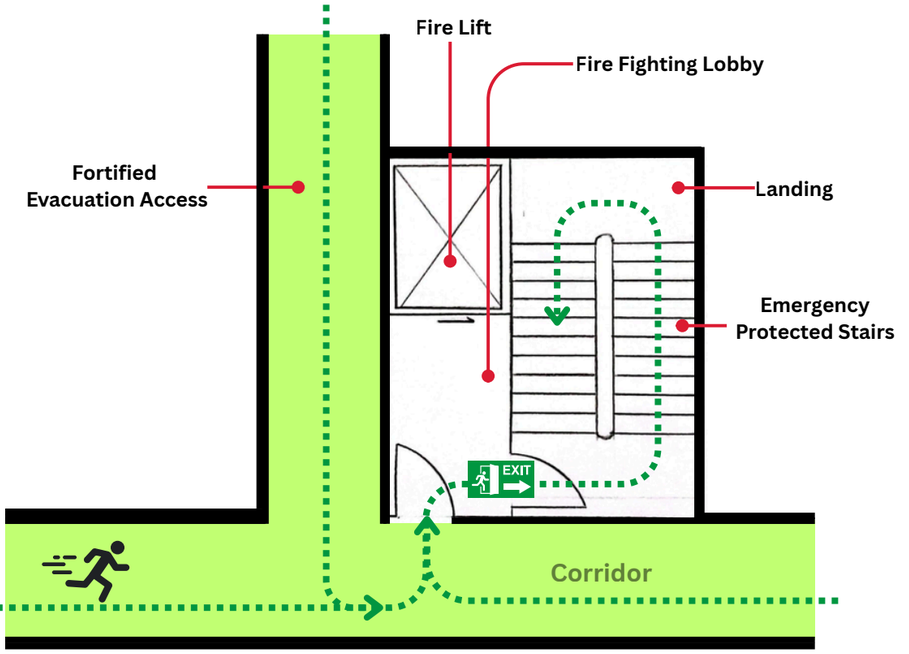


Figure 3.5.3 Exploration of Geometric U Shape Emergency Stairs
Source : Author,2025

Pros:

- Easily accommodates large groups, better for emergency egress.
- Safer and more accessible for all users, including disabled or injured persons.
- Easier and more cost-effective to design, build, and maintain.

Cons:

- Takes more space that requires more floor area compared to circular stairs.
- evacuated limited time could be more than the circular one.

3.5 Room Layouts

3.5.2 Room Layout Concept of Typical residential Floors with Fortified evacuation routes according to function of safety

Alternative 1

From the schematic drawing of alternative 1, found that there are two core system service 12 apartments with two prototypes 2bd and 3bd and each of them include 6 apartments. the layout show how the fortified Mamad “save room” inside each apartment that nearby the evacuation routes so through that strategy the fortified system against bombardment will be close and approximately connected to each other for easy and save access to the emergency stairs in the core and the idea from providing two core to increase safety and save time because that attack happen in limited munities

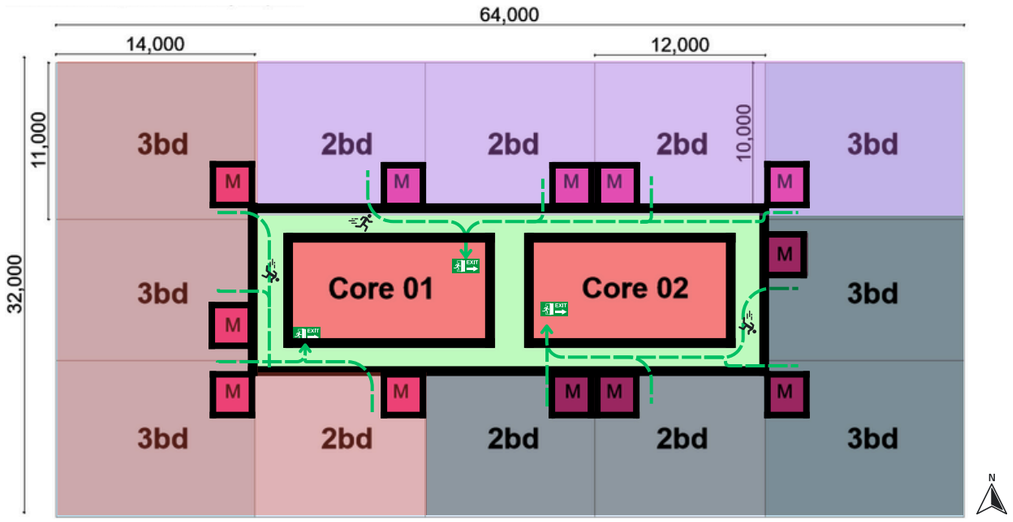


Figure 3.5.4 Alternative 1 of a Schematic Layout for Typical Residential Floor
Source : Author,2025

Pros:

- Shorter escape distance because each apartment is close to one of the two stairs, complying with the 30m rule easily.
- Lower crowd density so occupants or users evacuate in two directions, reducing congestion and confusion.
- Higher repetition in case one core is blocked, the second provides backup.

Cons:

- More area used for circulation, slightly reducing sellable space.
- Higher cost and complexity due to duplication of vertical systems.

Alternative 2

From the schematic drawing of alternative 2, found that there is only one core system service 12 apartments with two prototypes 2bd with 8 units and 3bd with 4 units and providing more two emergency stairs with a liner access through each apartment and the core for more visible access and fast escape to the emergency stairs located in the core or the end of the floor so from each apartment they could access the evacuation fortified route to emergency access then to the bunker system. the layout show how the fortified Mamad “save room” inside each apartment that nearby the evacuation routes so through that strategy the fortified system against bombardment will be close and approximately connected to each other for easy and save access to the emergency stairs in the core and the idea from providing two core to increase safety and save time because that attack happen in limited munities

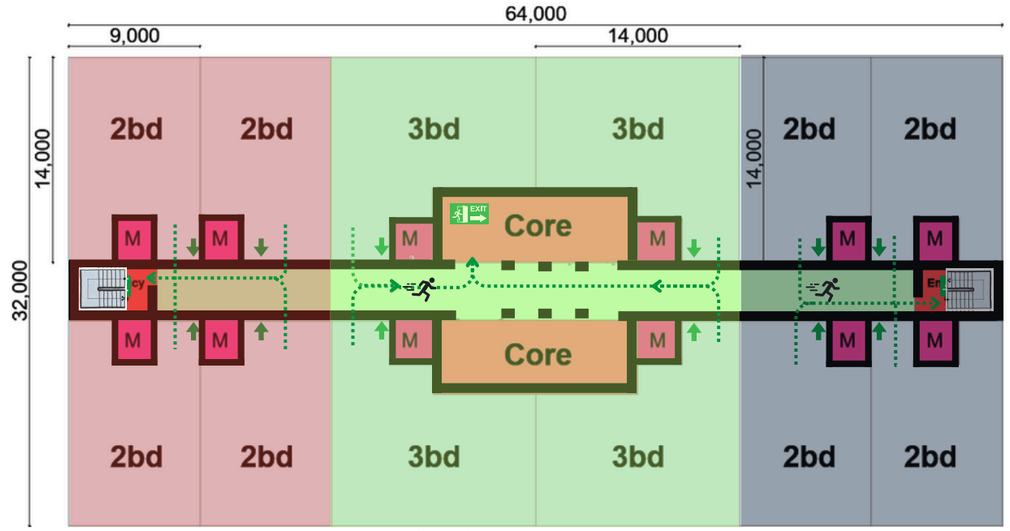


Figure 3.5.5 Alternative 2 of a Schematic Layout for Typical Residential Floor
Source : Author,2025

Pros:

- Simpler core design, easier for structural and MEP planning.
- Linear corridor gives clear wayfinding toward stairs.
- People won’t bottleneck at the core.
- Improves escape speed and reduces panic during emergencies.

Cons:

- Exceeds 30m travel distance for edge units — violates international safety code unless supplemented with sprinklers.
- High congestion risk: All residents funnel into one corridor and one stair during panic.
- No backup route: A single point of failure limits resilience in real threats.

3.5.3 Room Layout Concept of Bunker Floor under ground with Fortified evacuation routes according to function of safety

Alternative 1

The bunker layout is designed to accommodate 800 people efficiently during extended emergencies. It features a two core system for optimal circulation and safety, ensuring all areas are within 30 meters of emergency exits, in line with international standards. Sleeping areas are divided by gender for privacy, while other services such as food storage, kitchen, medical clinics, power backup, and filtration systems—are strategically placed for easy access. Social gathering and prayer spaces support psychological well-being and cultural needs, making the bunker not just a shelter, but a livable, resilient space during crisis.

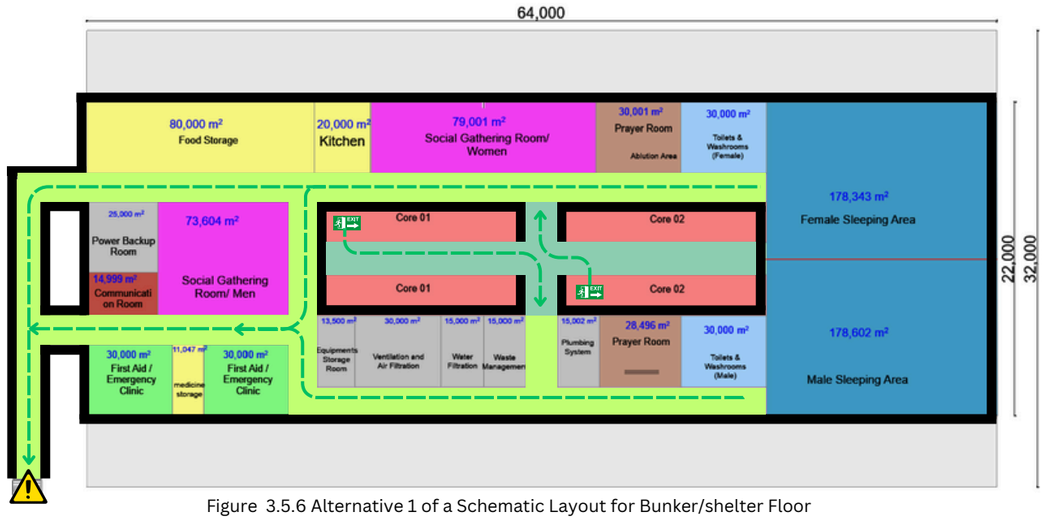


Figure 3.5.6 Alternative 1 of a Schematic Layout for Bunker/shelter Floor
Source : Author,2025

Pros:

- Repetition in circulation: Two cores improve access in case one is damaged.
- Balanced traffic flow: Reduces crowding during emergencies or daily use.
- Better distribution: Facilities are evenly placed near both cores, shortening travel distance.

Cons:

- Takes more space: Two cores reduce usable area for functions like sleeping, storage, etc.
- Higher construction cost: Doubling the core requires more structure, materials, and systems.
- Maintenance load: Increases mechanical and operational systems that must be serviced.

Alternative 2

This layout provides a clear and functional arrangement for an underground shelter designed to serve around 800 people. It includes a single central core for vertical circulation, surrounded by essential spaces such as food storage, kitchen, social gathering room, medical clinics, toilets, and sleeping areas for males and females. Emergency stairs are positioned at both ends for quick access and evacuation. The layout ensures efficient use of space and easy access to vital services, supporting long-term habitation during crisis conditions.

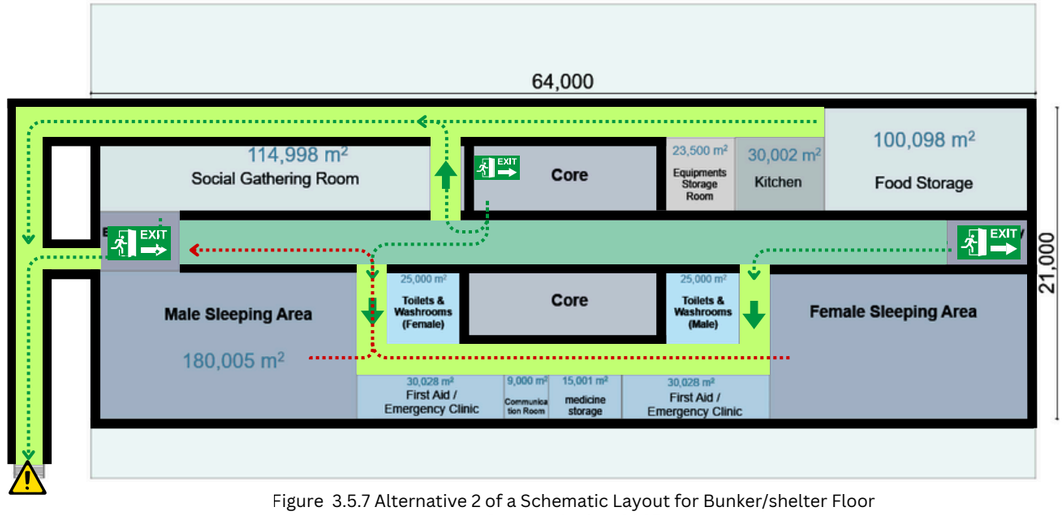


Figure 3.5.7 Alternative 2 of a Schematic Layout for Bunker/shelter Floor
Source : Author,2025

Pros:

- Space efficiency: More net usable area for key functions like sleeping and food storage.
- Simplified systems: One mechanical shaft, fewer ducts and elevators to manage.
- Centralized access: Core is centrally located, making navigation intuitive.

Cons:

- Single point of failure: Damage to the core could block main circulation routes.
- Potential bottlenecks: Higher congestion around one core in emergencies.
- Longer walking distances: For users far from the core, especially during evacuations.

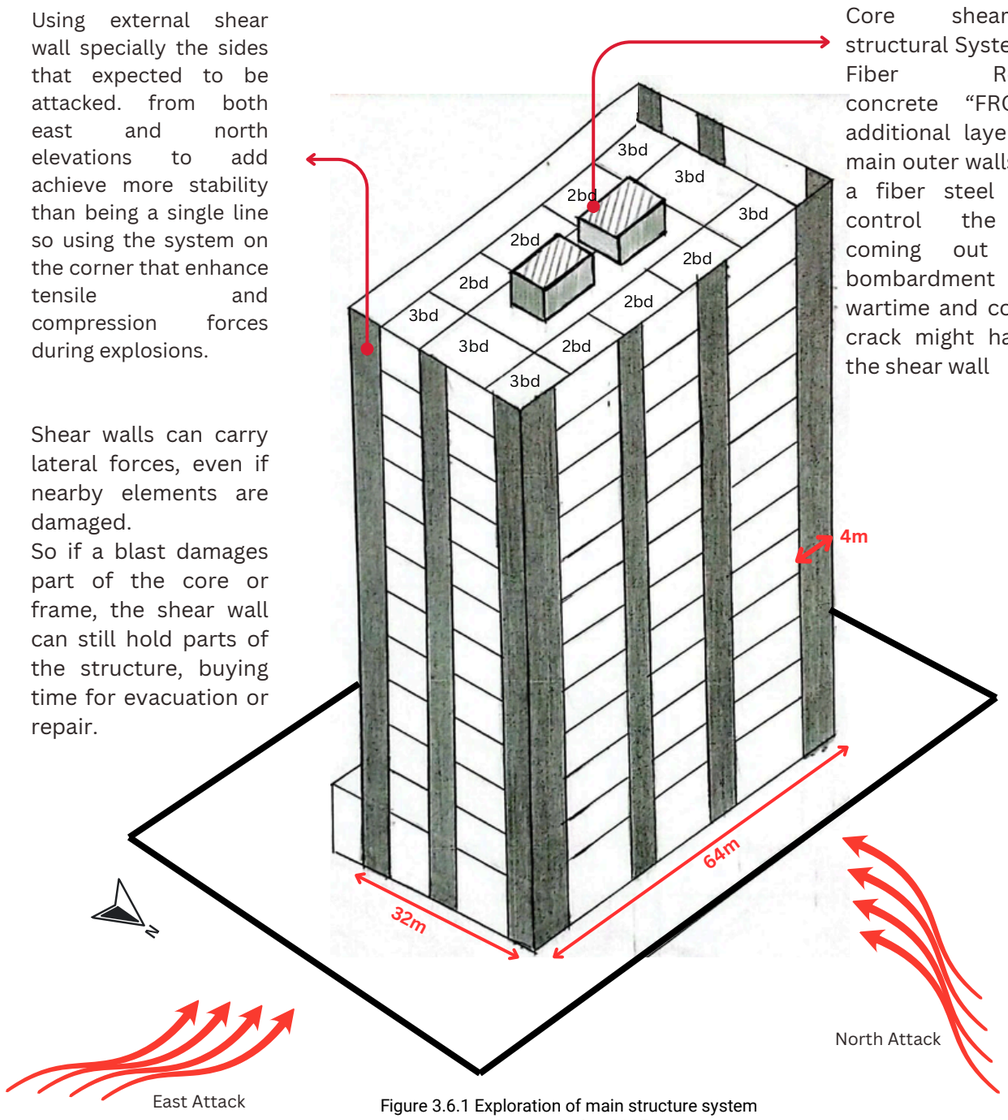
3.6 Building Structure

3.6.1 Structural System according to Resilience and Safety

The structural system follows blast-resistance principles and safety codes by using **a strong central core**, **shear walls**, symmetric framing "**Frame structure** (columns + beams)" and **Braced Frame System**. It is designed to resist collapse even after partial damage, ensuring the safety of residents during and after attacks.

Using external shear wall specially the sides that expected to be attacked. from both east and north elevations to add achieve more stability than being a single line so using the system on the corner that enhance tensile and compression forces during explosions.

Shear walls can carry lateral forces, even if nearby elements are damaged.
So if a blast damages part of the core or frame, the shear wall can still hold parts of the structure, buying time for evacuation or repair.



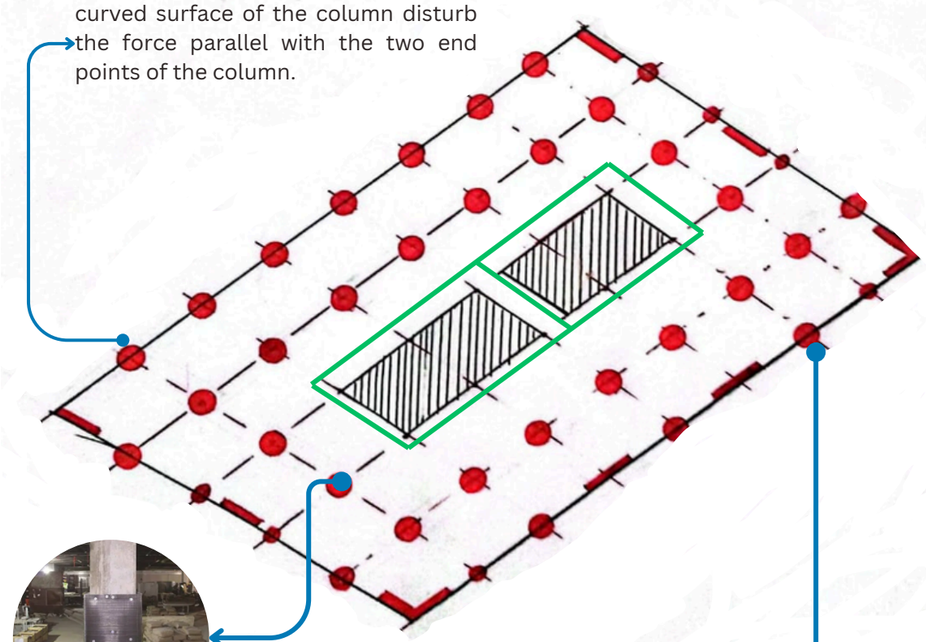
Core shear wall structural System from a Fiber Reinforced concrete "FRC" using additional layer for the main outer walls which is a fiber steel plate to control the energy coming out of the bombardment during wartime and control the crack might happen on the shear wall

Figure 3.6.1 Exploration of main structure system
Source: Author,2025

3.6.2 Structural System according to materials used

- **Columns**

The concept of using circular column instead of geometric on Alternative one that because the circular column disturb the load equally and the outer curved surface of the column disturb the force parallel with the two end points of the column.

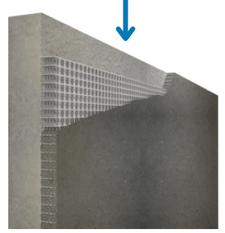


Source: https://www.structuraltechnologies.com/solutions/ducon-micro-reinforced-concrete/

Figure 3.6.2 Structural system planed on the site
Source: Author,2025

Enhancing the column stability and tensile forces against explosions covering the reinforced concrete column with the **DUCON** system allows for the highest level of performance for the most challenging forces and load combinations With its ductility and energy-dissipating qualities.

- Steel mesh layers for fragmentation protection
- Fire-resistant cladding for vertical escape routes
- Rubberized membrane for extra dampening
- Bulletproof inserts in vulnerable areas



Ducon System layers

3.7 Building Facade System

3.7.1 Vulnerable Facade System according to Innovative Design

Focuses on reshaping facades to reduce damage during attacks by using **fragmented surfaces**, **angled walls**, or **recessed openings** that deflect blast pressure rather than absorb it directly. so the shape of the facade can work as a defensive system by reshaping it in a strategical method. by knowing the natural of the explosion forces and the nature of the facade shape which is different from a shape or a form to another.

- **Exploration of two alternative's facade**

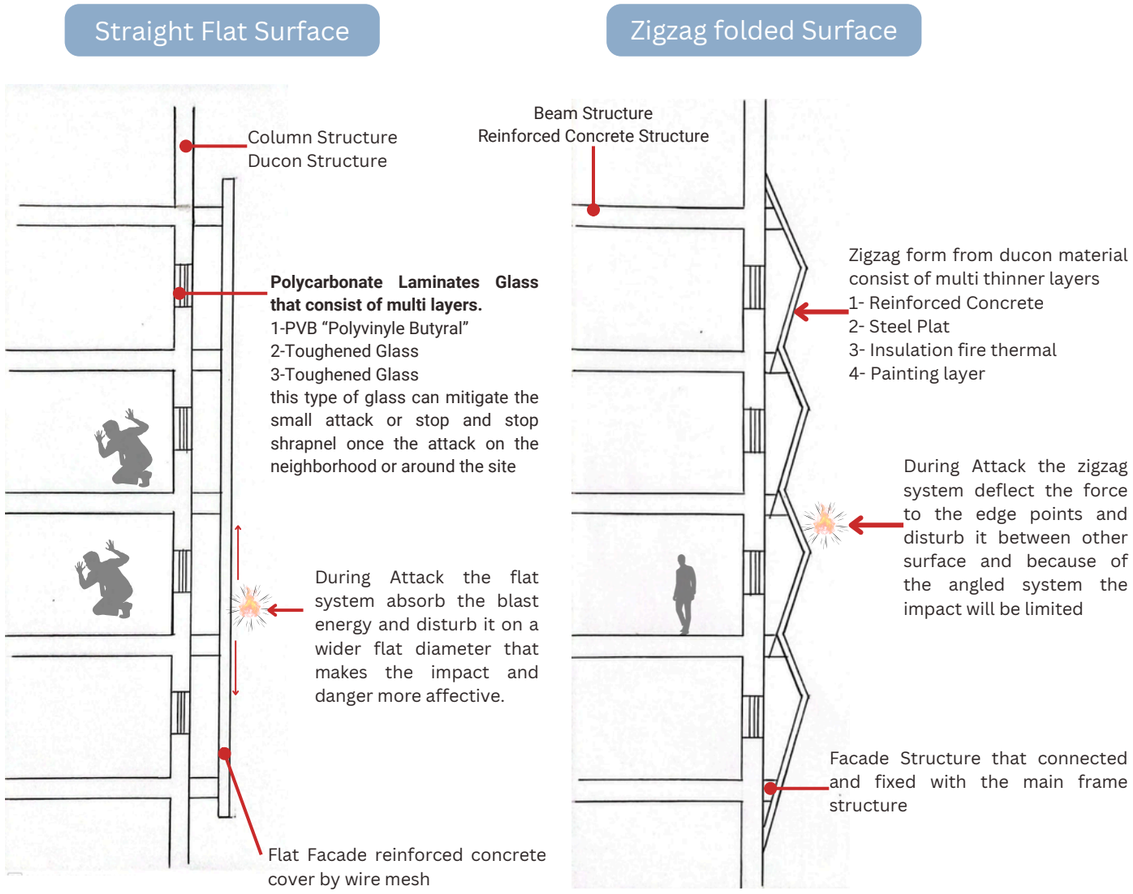


Figure 3.7.1 Schematic Design for alternative 01 and 02 according to facade shape
Source : Author,2025

- **analysis of the forces that exerted on each alternative and the response from its surface.**

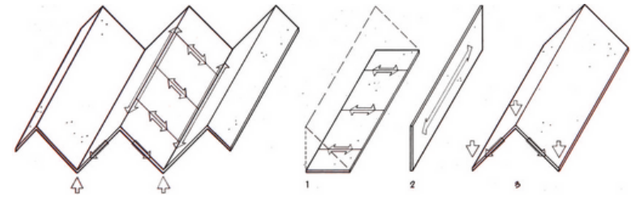


Figure 3.7.2 Schematic Design for alternative 01 and 02 according to facade shape
Source : https://rb.gy/kuonrz

Structural Behavior of Folding or Zigzag surface that deflect the force not like the flat surface that absorb the pressure or the load.
Load Distribution process:
1- At first, the external forces are transferred to the shorter edge of one folding element.
2- There, the reaction as an axial force is divided between the adjacent elements.
3- Then the forces transferred to the bearings.

- **How Zigzag Alternative work!**

Deflection of Blast Waves

- Zigzag geometry naturally creates angled surfaces, which can deflect blast waves rather than absorb them head-on.
- Unlike flat surfaces that absorb the full force of the pressure, zigzag surfaces disperse the energy at angles, reducing the direct impact on any one section.

3.7.2 Facade Material according to performance strategy

Materials should be tested under recognized standards like **ISO 16933**, EN 13541, or UFC 4-010-01 to ensure certified performance.

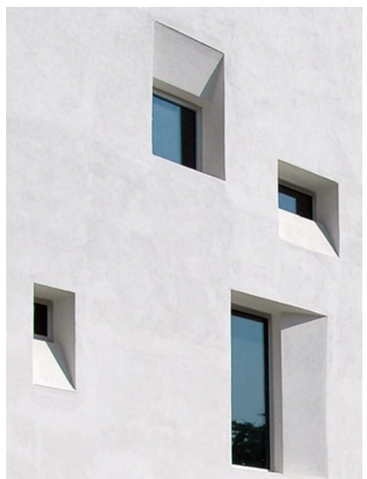


Figure 3.7.3 Laminated Glass Window
Source : https://www.archilovers.com/projects/18569/gallery/gallery?239941

In blast-resistant design, façade materials must balance structural strength, flexibility, and energy absorption. Laminated glass with interlayers such as PVB or SentryGlas is crucial for minimizing shrapnel and preventing glass breakage from becoming deadly debris. Frames should be made of high-strength aluminum or steel with secure anchoring systems to withstand blast pressure. Panels like Ducon or fiber-reinforced concrete add mass and damping, helping absorb shockwaves.

3.8 Material

3.8.1 Blast Resistant Structure

A blast-resistant building is a structure that has been designed to withstand significant blast events. These buildings are often constructed with thick steel walls and interior features and fixtures designed to withstand the heightened psi levels associated with small to large blast events.



Figure (3.8.1) : Processing the Blast Resistant Structural Wall
Source : https://www.structuremag.org/article/innovative-steel-stud-walls-for-blast-resistance/

- By incorporating blast-resistant technology, your Miklat-based shelter project can offer stronger protection, reduced structural damage, and better living conditions, making it more resilient and adaptable for future threats.

3.8.2Using as a resilient Structure

- Protection Against Explosions & Airstrikes

Enhanced Structural Integrity: The multi-layer system absorbs shockwaves, preventing structural collapse.
Debris Mitigation: Interior ballistic layers (Kevlar, composite materials) reduce injury from shrapnel.
Pressure Resistance: Reinforced concrete and steel layers withstand high-pressure blast waves.

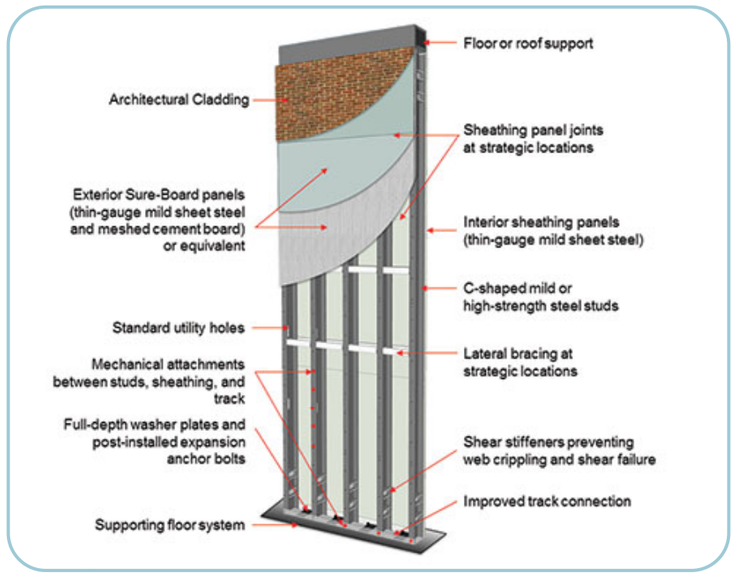


Figure (3.8.2) : Layers Components of wall blast
Source : https://www.structuremag.org/article/innovative-steel-stud-walls-for-blast-resistance/

- Underground Shelter Reinforcement

Wall Thickness Optimization: Blast-resistant walls reduce the need for excessive concrete thickness while maintaining protection.
Soil Adaptation: These materials can be designed to work effectively with Israel's sandy-loam and clayey soil, preventing structural failures.
Deep-Buried Protection: Can be integrated into Miklat shelters, reinforcing them against aerial threats.

- **3.8.3 Comparison between RC & BRS**

Reinforced Concrete (RC)

1- Strengths:

- Made with steel reinforcement (rebar) inside concrete for added tensile strength.
- Good at withstanding compression forces and impacts.
- Can be thickened to resist penetration.

2- Weaknesses:

- Not designed to absorb blast energy efficiently.
- Can crack and collapse under high-impact shockwaves.
- Less flexible—prone to brittle failure under extreme explosions.

Blast-Resistant Structures

1- Strengths:

- Uses multi-layered materials (steel plates, fiber composites, shock-absorbing layers).
- Designed to dissipate blast energy, reducing structural failure.
- More flexible and resistant to both shockwaves and penetration.
- Can incorporate geometric designs (angled walls, blast deflectors) to redirect force.

2- Weaknesses:

- More expensive and complex to construct.
- Requires specialized materials and engineering.

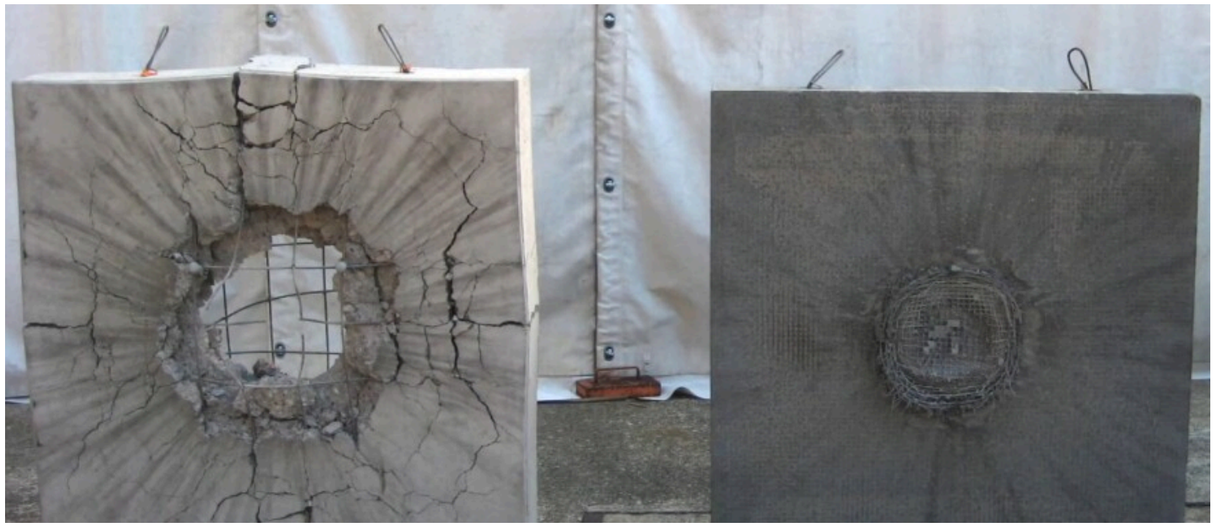


Figure (3.8.3) : Enhancing Structural Resilience by comparing between reinforced concrete and blast structure using multi-layered material
Source : https://www.architectmagazine.com/technology/products/how-to-make-a-building-blast-resistant_o

How to Make a Building Blast Resistant" from Architect Magazine discusses strategies to enhance building resilience against explosions. It emphasizes that while increasing the "standoff distance"—the space between a building and potential blast sources—is ideal, it's not always feasible. Therefore, selecting materials that can withstand explosive forces becomes crucial. The term "blast-resistant" is preferred over "blast-proof," acknowledging that complete immunity to blast damage is unattainable. Notably, many fatalities in explosions result from "secondary fragments," where building materials become hazardous debris due to the blast's shockwave. To mitigate this, constructing a secure building envelope with enhanced reinforcing is recommended. For instance, Ducon's micro-reinforced concrete systems utilize multiple layers of densely spaced "MicroMat" steel reinforcement, offering high ductility and energy absorption, thereby increasing blast resistance.