MASTER-/DIPLOMARBEIT

Move it: An interpretation of the courtyard house in Benghazi, Libya

Haus bewege dich: Eine Neuinterpretation des Hofhauses in Benghazi, Libyen

ausgeführt zum Zwecke der Erlangung
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Abstract

The idea of this project was inspired by the destruction of the old city center (old Medinat) in the city of Benghazi, Libya created from the Second Libyan Civil War (2014-present). Despite the destruction and devastation, the removal of the old has created new opportunities to rethink the role the old city and its housing, especially considering the long-forgotten traditional one to two storey Arab courtyard houses. This project takes an experimental interpretation of the courtyard house on a site that was once rich with this local housing typology. We propose a residential low rise apartment and housing complex, with communal and mixed use spaces. The driving themes of the project were cultural factors, flexibility, individuality and modularity. The prospect of the project aims to showcase how heritage can be combined with modernity to jump into the future while keeping identity.

Die Idee zu diesem Projekt kam durch die Zerstörung des alten Stadtzentrums (alter Medinat) in Benghazi, Libyen, durch den Zweiten Libyschen Bürgerkrieg (2014-heute). Trotz der Zerstörung und Verwüstung hat die Beseitigung des Alten neue Möglichkeiten geschaffen, um die Rolle des alten Stadtzentrums zu überdenken, insbesondere der seit langem vergessenen traditionellen ein bis zweistöckigen arabischen Hofhäuser. Dieses Projekt erfordert eine experimentelle Neuinterpretation des Hofhauses an einem Ort, der einst reich an dieser lokalen Wohnraumtypologie war. Wir schlagen einen Wohnkomplex von Apartment- / Haustypologien, mit kommunalen- und gemischten Nutzungsräumen vor. Die Hauptthemen des Projektes waren kulturelle Besonderheiten, Flexibilität, Individualität und Modularität. Die Perspektiven des Projekts sollen zeigen, wie Vergangenheit mit Modernität kombiniert werden kann, um auch in Zukunft Identität bewahren zu können.

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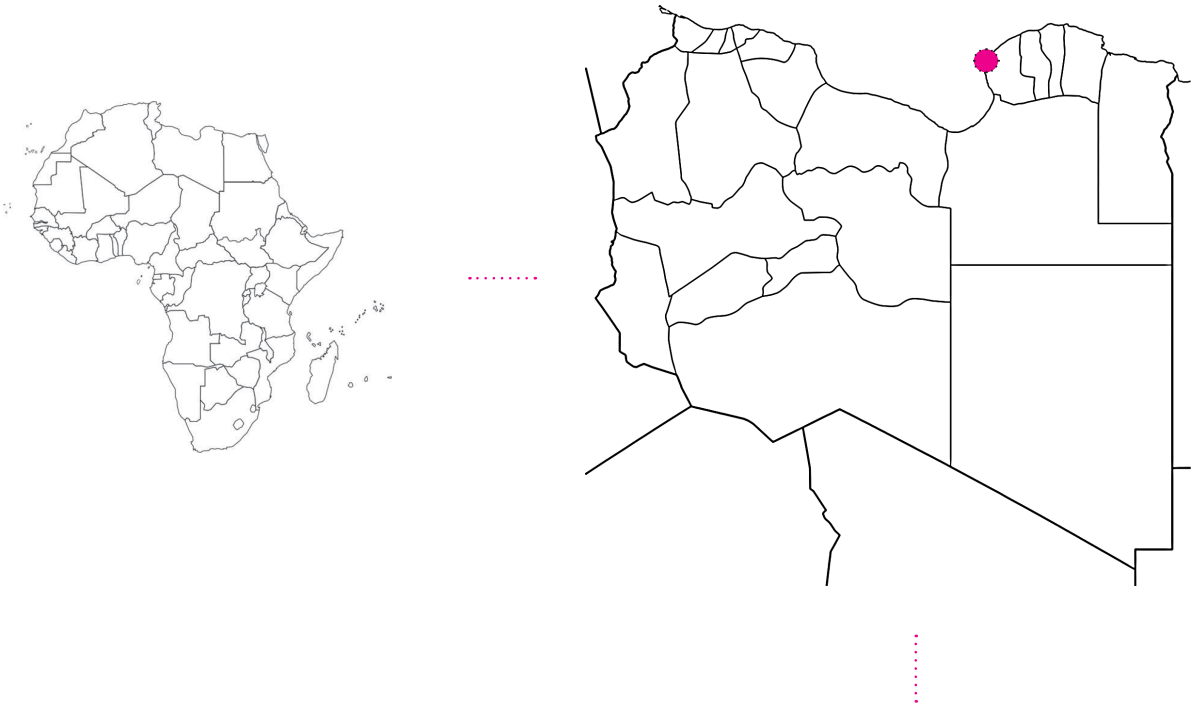
01 introduction



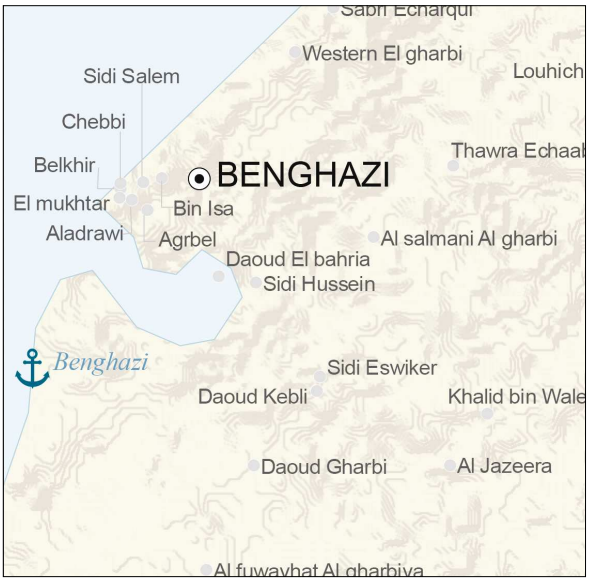


Figure.1.1: Map of Location
Figure.1.2: Map of Benghazi Region

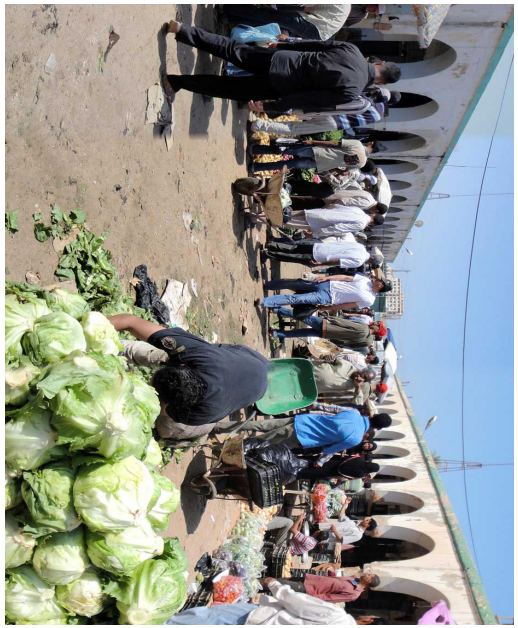
1.1 Location

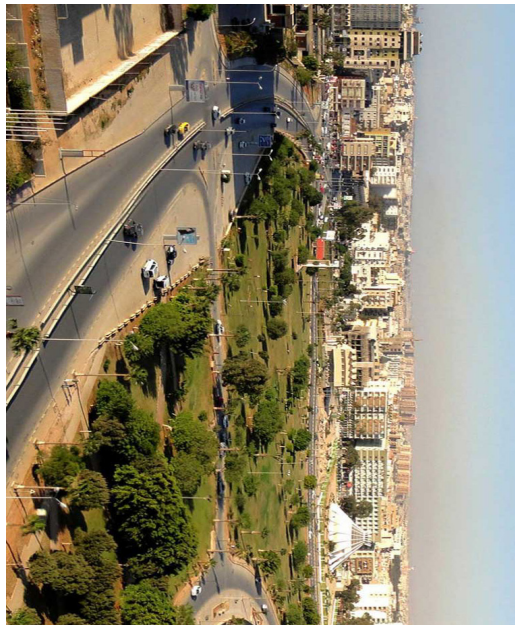
The Benghazi sub-region borders along the Mediterranean coastline on a relatively flat plateau-like terrain. It then rises abruptly towards the north east to meet the Al Jab Al Akhdar Mountains. The sub-region's fertility makes it an important agricultural factor for the region and the rest of the country. The fertility and vegetation becomes less abundant to the east and to the south towards the Sahara.

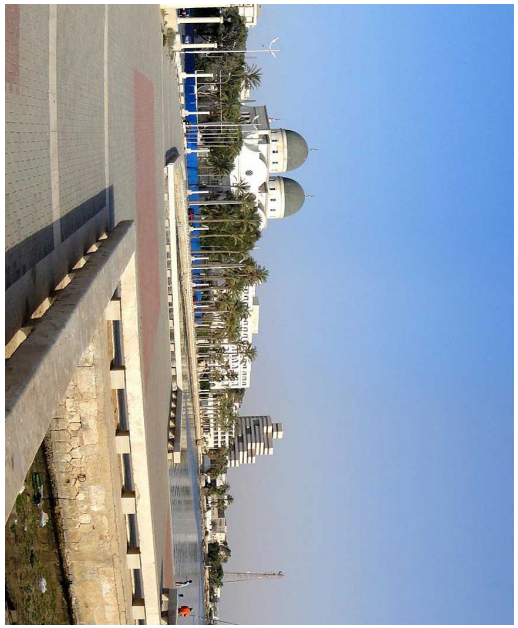
According to the census of 2017, the regions population has reached a population of 1,400,000 which represents 25 percent of the population of Libya. The region‘s economic life depends on the agriculture, construction and community service industries and a smaller portion of fishing and tourism industries. 65 percent of the population are living in urban areas.

There is one airport in the Benghazi sub-region, Banina Airport which is sufficient for the regions transport movement. A railway system is envisioned but no programme exists at the moment. There are several small ports and marinas in the region, the biggest port being in Benghazi city. The majority of the movement within the region happens with locally owned cars and local bus route.

The settlement pattern of the region is very dispersed and sporadic. For example, services, social services and housing have large distances which consequently increase public investment, costs, time, traffic congestion therefore decreasing the life quality of the inhabitants. Large part of the rural settlements contribute to the national and local economies. The biggest part of the Benghazi Sub Region is not populated.







1.2 Benghazi city

Benghazi is the second largest city in Libya with a population of 640,000 people. The city is sprawling along its approximately 20km coastline and into the desert. Benghazi is the commercial, administrative, medical, recreational and educational center of the region. The only harbour, university and International airport are making the city even more central to the region. Trade and existing oil production links has widened Benghazi's role on the international stage. In the last 30 years, the population of Benghazi has doubled, with a continuously decreasing growth rate. The population growth estimate for 2025 is 1.80% with a household size of 5 members. Additionally it is estimated that 7 percent of the population will be Non-Libyan.

Around 85 percent of the sub-regional employment centers around the city of Benghazi, making it the economical center of the region. Additionally 80 percent of the regions population agglomerate in the Benghazi metropolitan area. The petroleum industry is the domineering sector for the Libyan economy, generating more than 70 percent of the GDP, however the oil and gas sectors provide only 3 percent employment. Public services such as health and education provide 50 percent of employment, while agriculture and tourism between 5-8 percent. Petroleum and agriculture are the most important sectors in the region, while construction is also becoming increasingly important. Due to tight government control and policies, the majority of investments and employment opportunities came from public sources, giving private businesses little space to thrive. Industries of the Benghazi metropolis are located outside the 5th Ring road towards the southeast and north of the city. The larger establishments are cement and metal factories while smaller factories produce mostly textile and food goods such as biscuits and pasta.

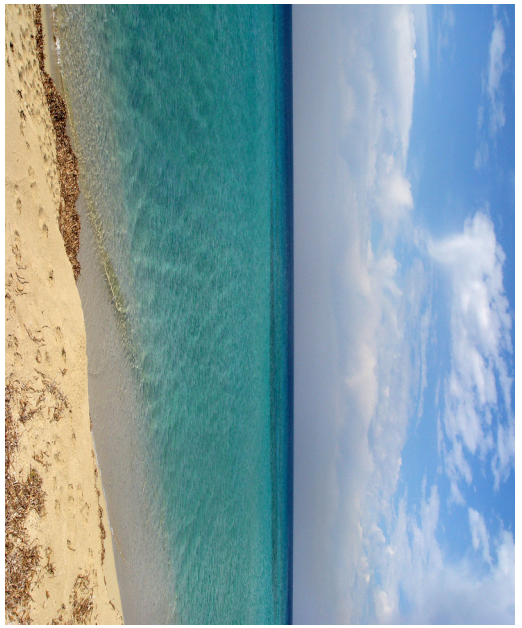
Figure.1.3: Views from around Benghazi Old city (the Lake, Al Fundouk Farmers market, the Italian Cathedral, Arcaded Souq)

1.3 context & economy

Libya has gone through several waves of conflict since the beginning of the February 11th Revolution in 2011. This has affected millions of people. Currently, the country struggles with power divisions between territories held by rival governments, factions and militias causing a geographical and political division between the East, West and South.

Between 1970 and 2010, the economy of Libya depended on oil for almost all of its export earnings. This was 80 percent of the governments revenue and half of its GDP. Based on the World Bank, in 2010 the per capita income was one of the highest in Africa and higher then the MENA (Middle East, North Africa, Afghanistan, and Pakistan regions) average. The governments policy was aiming for a similar social structure as other Arab nations, by providing free health care, education, public sector jobs, food and fuel subsidies and giving limited speech and freedoms. More than 80 percent of the formal labor force worked in the public sector. The very limited private sector was crippled by domineering state institutions, which in turn created a very poor job market and only created an overinflated public sector with a high dependency for expatriate workers. After the 2010/2011, Libya‘s crude oil production has fallen for more then 70% since the uprising and the overall output of the country remains low due to disruptions in the supply chain, insecurity and lack of investments. Per capita income from 2012 has also fallen more than 60%. Lack of funding for imports, especially food imports, fed an increase in black market activity and storing food at home. The unemployment rate has also reached an unprecedented high. The economic crisis unfortunately fuels for more instability.

Figure.1.4: Views of Benghazi City



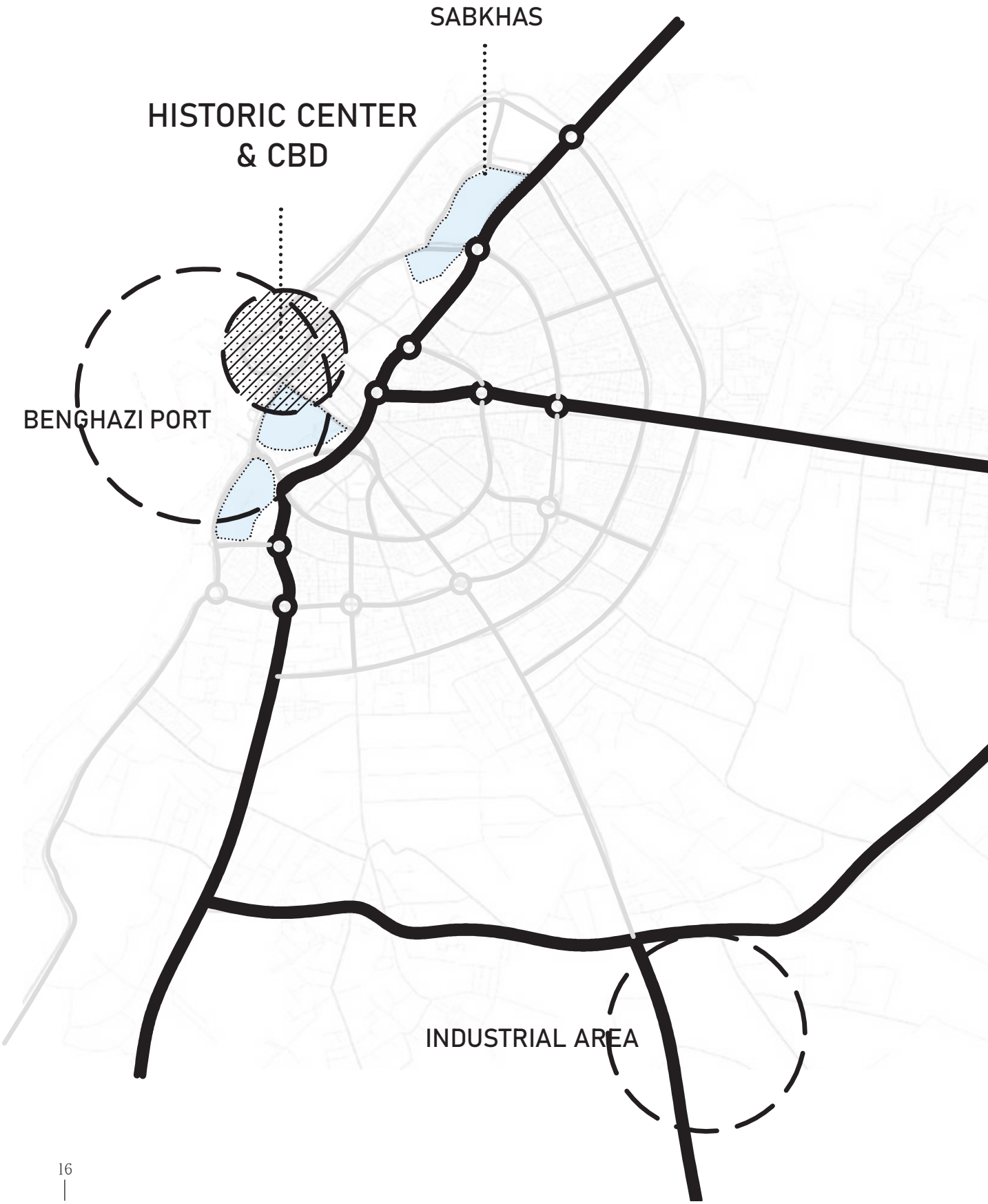
1.4 nature

The region has different climatic conditions, being affected by both the humid sea and the dry desert micro-climates. The coastal areas to the north have very comfortable conditions with reasonable rain coverage. The southeastern area is semi-arid with scarce vegetation and few other resources limiting its suitability for settlement. A climatic feature of the region are the southern 'qblis' or hot desert winds which occur mainly in the summer, bringing a large quantity of sand and drastic changes in temperatures. Sand is everywhere.

The city was developed mainly on the coastal semi-arid flat plain (Benghazi plain). This plain extends 30km along the coast and 20km southwards. The eastern, northeastern and south eastern formations consist mainly of limestone and calcareous clay. The grounds in the southern parts of Benghazi consist of alluvial sediments (mainly loam, silt, gravel and cemented gravel) while coastal zones are composed of sabkha sediments (salty clay and sand materials), coastal sediments like beach sands, cemented dunes, and marine calcareous deposits (largely siltstone and clay).

The main vegetation of Benghazi consist mainly of palm trees around the northern coastal areas, while the eastern zones are relatively bare with small desert scrubs. The southern zones are occupied by cultivated farmland (mainly grass fields and orchards of olive and eucalyptus groves). The coastline of Benghazi is largely made of saline and soft land (salt marshes, lakes and swamps), coastal sediments like beach sands, cemented dunes, and marine calcareous deposits (largely of siltstone and clay). This geological makeup increases the likelihood of temporary or permanent flooding,

Figure.1.5: Impressions of nature (the sea, the sandstorms, the marshes)



1.5 urban structure

The modern concentric compact form of the city has been mainly influenced by two Masterplans from Doxiates Associates. Initially, Benghazi's early urban development has been largely formed by the geological landscape of coastal marshes (sabkhas), confining its growth to a narrow strip of land between the sea and the sabkhas, leading all development to grow towards a southern plain. The first 1966 Masterplan from Doxiades aimed to centralize the administrative, commercial and business activities in a Central Business District (CBD) into the historical old town. This overall plan included an intricate concentric road network with many ring roads, major radials and a loop surrounding the CBD. The second Masterplan of 1988 from Doxiades aimed at to reduce urbanization, improve land use systems, help reduce the dependencies of external imports and workforces and to promote better population distribution and conserve natural resources. With these goals in mind, the port and the airport were expanded, the agricultural zoning to the east and south was expanded and large industrial zones were built in the wider Benghazi area and along the coastal belt. Most importantly, due to an increase in population and an inadequate amount of agricultural land and water resources, all the developments aimed to keep in mind the vital decentralization strategy of the city. Residential use is the most extensive land use in Benghazi, covering around 60% of the developed land in the city. This is followed by education areas with 12% and public administration areas with 11%. After the second World war, an economic boom (mainly due to the oil discovery) led to a fast development of the inner city areas with residential buildings, commercial businesses and souqs. This consequently led to problems of connectivity and traffic issues.

Figure.1.6: General plan of the urban structure of Benghazi

1.6 housing

Around 60 percent of the city's developed land is used for residential buildings. Commonly found patterns throughout the city, is to have either isolated residential units or units within a mixed use commercial block. The housing sector is categorized into mainly villas, houses and apartments. Approximately 41 percent are houses, 12 percent are villas and 46 percent are apartments. Houses are usually one storey buildings, usually with one or 2 rooms opening up to a central courtyard. Ground floors of the houses are sometimes used for commercial purposes.

The typology of the so called Hawsh (house with a courtyard) was a common typology in the city center, but because urban sprawl, pure hawsh districts do notreally exist anymore.
Another common typology is the villa typology which is usually composed of a one or two storey building, with a garden on a plot of around 500m^2. This typology usually has a high masonry wall to create more privacy. There has also been a rise in one storey attached and semi detached rowhouses.
In the medium to high density areas, the apartment typology is the most common dwelling type. Typically an apartment block consists of 2-4 storeys, usually including private balconies, often with a shared backyard and/or side light wells. The most recent development are multi-storey blocks, primarily initiated by the public sector, containing 8-12 storeys, with private balconies on each side and often the ground floors left communal facilities like car parking.

Figure.1.7: Impressions of various housing typologies

Figure.1.8: Impressions of modern Libyan architecture

1.7 modern Libyan architecture

Like many developing countries, Libya experienced rapid economic growth and a rapid increase in population which triggered a construction boom and the construction of contemporary single family houses mainly influenced by western models. The modern construction boom triggered a rise of many uniform reinforced concrete structures all over the country with little regard to the climatic and cultural barriers present. This lead to both uncomfortable spaces but also spaces that did not fit with the local cultures and habits.

In my personal opinion, Libyan architecture is little formless. A mere copy paste from styles foundd modern day magazines, with no consideration for local culture or climatic conditions. A largeg glass facade, imported decorated materials combined with an absence of courtyards are the new characteristics of the Libyan building form. I find in most Libyan cities and towns there is a lack of coherence, harmony and character which shows a clear absence of identity. Weak institutions, a lack of planning regulations, standards and undefined urban planning character has created a growth of bad and random architectural features and informal developments.

As an oil-rich country, importing expensive materials and infrastructure components was encouraged and through this process traditional building methods and local layouts were slowly forgotten. In my observation, many new buildings are lacking identity and are not conforming to accepted architectural features. The focus is on the openness to the outside instead of the inner courtyard, in turn removing any sense of privacy which.

On a general note, Libyan architecture can be seen as a composition of abstracted, geometric forms that elaborate the structural massiveness of the often used concrete or stone blocks. It is lacking external ornamentation, emphasizing on form, the soundness of structural mass and expressive abstract shapes.

1.8 the courtyard house

The courtyard house is a fundamental and traditional building characteristic in the Mediterranean and in climatically hot regions. It has been used by many urban and rural civilizations throughout history and it is still in use today in many Asian, North African, South American and European countries. The courtyard house is a very typical model for Mediterranean countries. Its building techniques were introduced to Libya by the Romans and the Phoenicians. The East Muslim and Ottoman architecture continued to reinforce this influence of the courtyard house. In the 16th century Andalusian people (Bashas and Beys immigrants) brought similar versions of their courtyard houses to Libya.

The courtyard is a very flexible space where most of the family activities take place. It supports community and family life. Its central location gives security and privacy to the residents and brings daylight and air movement into the rooms around it. There are often trees, plants and a shallow pond or pool in the courtyard that creates a comfortable micro-climate. This model can be characterized as inward looking, having often very few outdoor windows which further respects the harsh climate and the cultural and social factors.

The main functions of the courtyards are:

- showing the limits of the properties;
- a defined place of privacy for the family;
- unifying all the spaces and elements of the house;
- circulation unit;
- garden, pool and cool space;
- ventilation unit.

courtyards are also:
a quiet place;
a shaded place;
a gathering place;
a safe area for children;

Figure.1.9: Impressions of the courtyard house typology

Some important considerations about central courtyards are:

- it can be difficult to use in adverse weather; a covered spaces is much more usable.
- difficulty in using air-conditioning;
- association with poverty, slums
- considered old fashioned

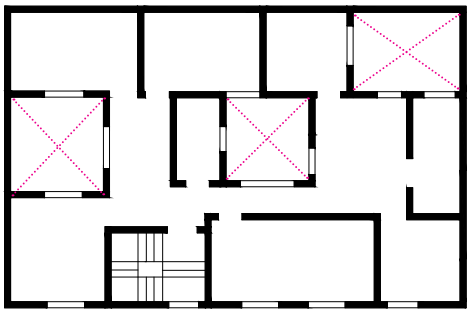
On the other hand, with a covered courtyard the following problems emerge:

- a lack of lighting and air-movement;
- increased humidity and temperature levels;
- lack of a connection to the outdoors;
- loss of trees and ponds as climatic and beauty features.

It is therefore very important to find a balance between modernizing traditional courtyard houses, redefining it to fit contemporary lifestyles and work with the technological and socio-economic changes, all while keeping its vernacular style and climatic advantages.

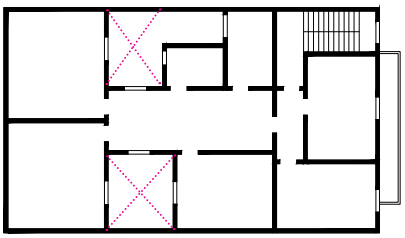
Two-Story Courtyard Building

Plot:	189m²
Apartment:	156m²
Courtyard size:	33m²



Three Story Courtyard Building

Plot:	240m²
Apartment:	197m²
Courtyard size:	31m²
Storys:	G+2 (3 dwellings)



Four-Story Courtyard Building

Plot:	67m²
Apartment*:	36m²
Courtyard size:	12m²
Storys:	G+3 (shop +3 dwellings)

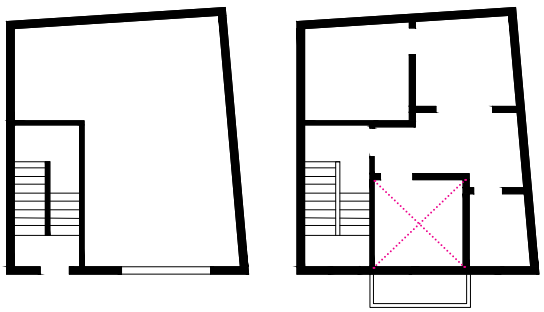


Figure.1.10: Plan of courtyard buildings

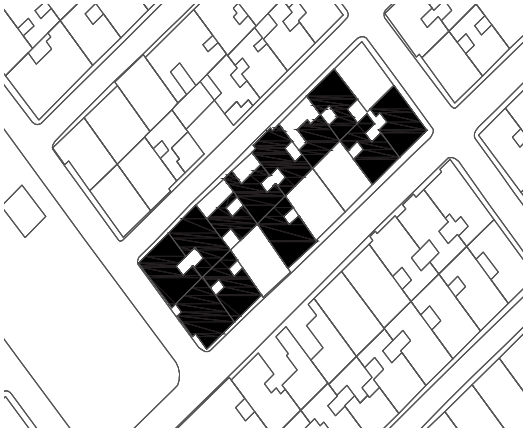


Figure.1.11: Exterior views of courtyard buildings

Figure.1.12: Interior views courtyard houses in Benghazi

the courtyard house

The traditional Arab dwelling is about 150m^2, comprising of 1-2 storeys, with an open central courtyard surrounded by the sleeping and living rooms. The inner courtyard is usually rectangular, square or trapezoid between the sizes 25-50m^2. The room heights range between 3-4m and generally most dimensions remain uniform and within human proportions. Narrows living and sleeping quarters are surround the courtyard which acts as the main circulation between the rooms. Bathrooms and kitchens are often located on the southern sides to allow for cross ventilation with high level window openings over the streets (often no more then 50x50cm openings). The layout includes angled entrances to prevent women from being seen from the outside and to create more privacy for the domestic life. There is often a men reception area called the Marboaa and often a separate women living room too. In two-storey houses there is often a female living room on the top floor and a male living room on the bottom floor. The domestic life is very inward looking, focusing most of its activities in the courtyard. It is the core of the house, for both the activities and a circulation unit. The layout reinforces the cultural aspect of domestic living, privacy and gendered rooms.

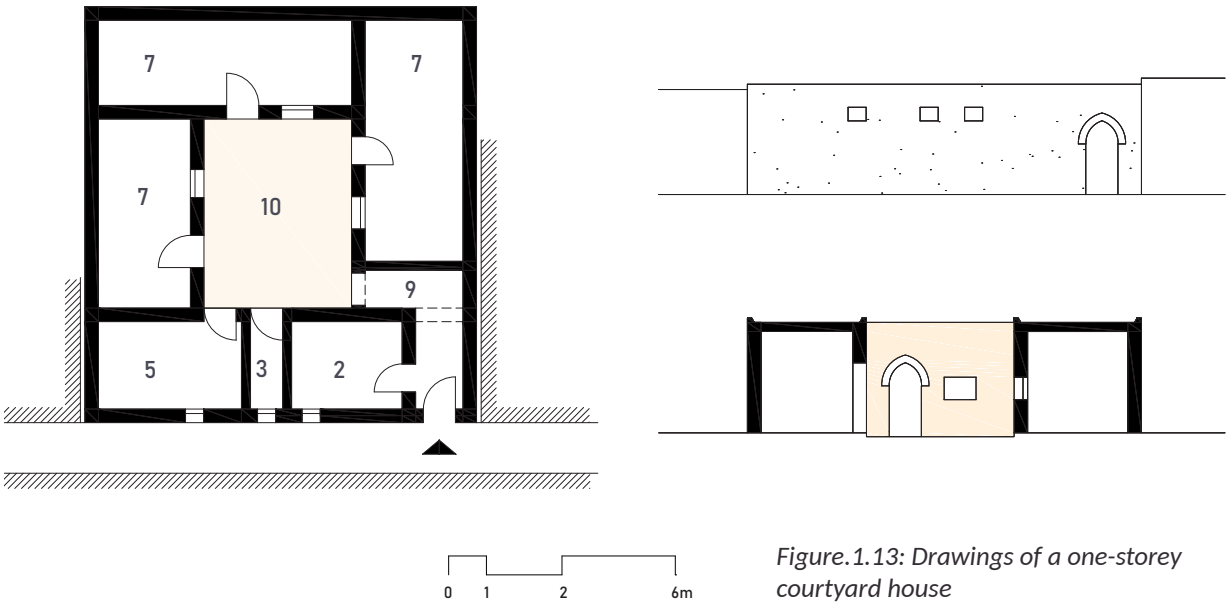


Figure.1.13: Drawings of a one-storey courtyard house

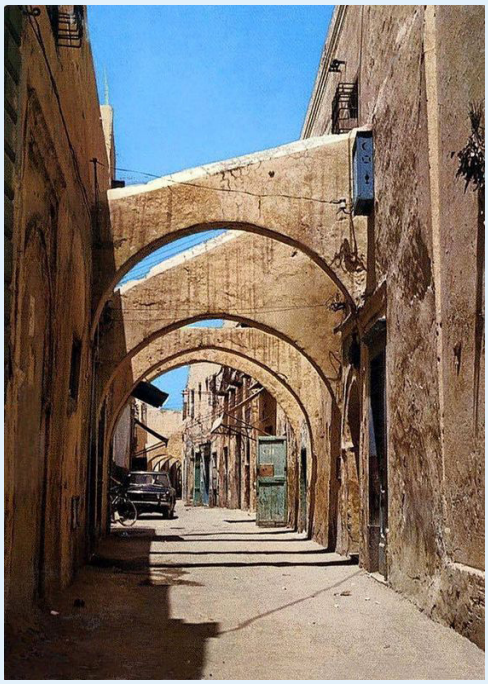
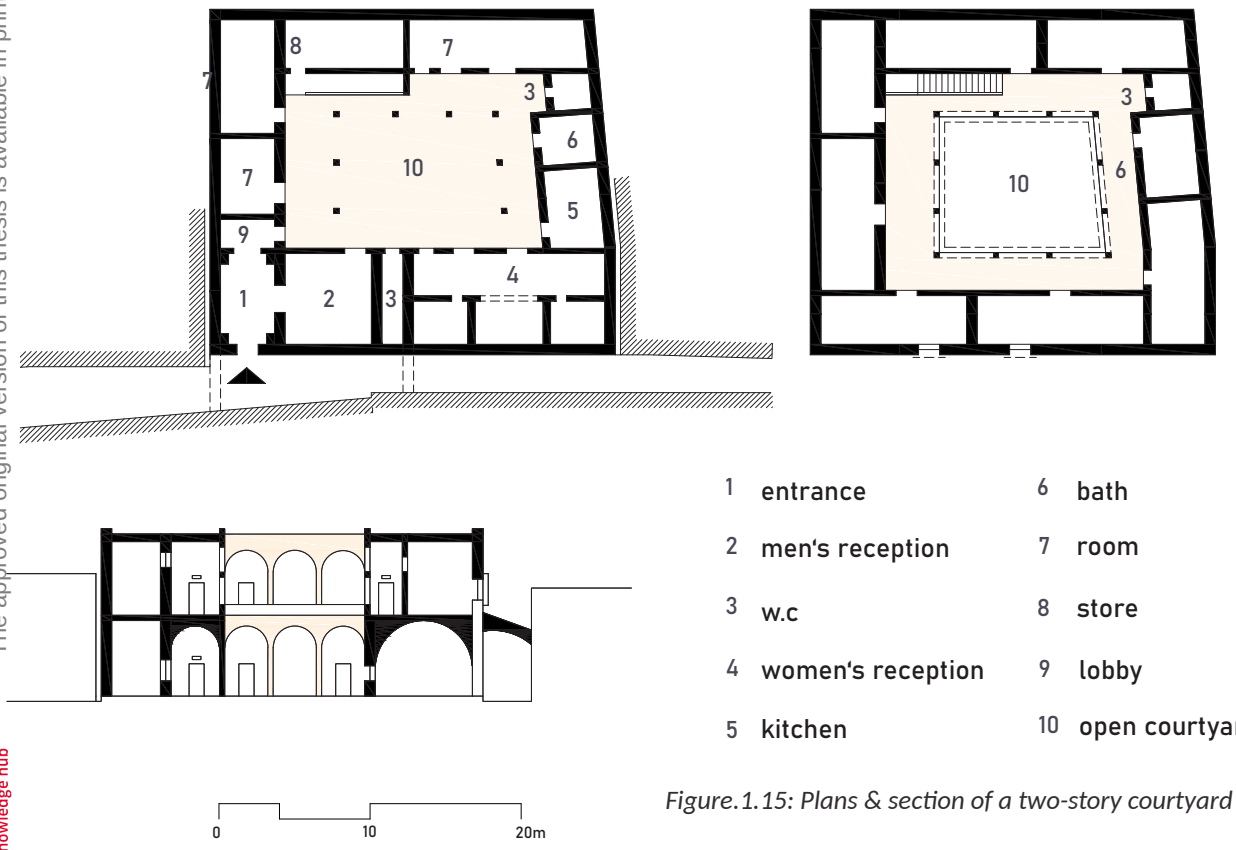


Figure.14: Courtyard houses in Benghazi

The courtyard also gives important climatic properties to the house which are vital for its exposure to temperature extremes, sunlight, as well as dust and sand. The courtyard acts both as a light well and a very important ventilation unit for the whole house. The courtyard is often kept cool from the shade generated by the building- which in turn helps keep the rest of the house cool.

The compact shape of the house helps protect against undesirable heat and wind. The alleyways are small, sometimes not wider then the room height. The shade of the building keeps these alleyways cool which in turn help keep the indoor house temperatures regulated. Building materials are stone and mud plastering with thick 50cm internal and external thick walls and no columns or beams. The thick walls reduce the transfer of heat from the outside to the inside. Wood and palm tree trunks are used for the roof and can sometimes be found between room walls. The clay shutters, the so called the Mashrabias are typical.



1	entrance	6	bath
2	men‘s reception	7	room
3	w.c	8	store
4	women‘s reception	9	lobby
5	kitchen	10	open courtyard

Figure.1.15: Plans & section of a two-story courtyard house

Gharyan Traditional House

Gharyan: A city of about 90km south of Tripoli, sitting on the mountain chain called the 'western mountains', is about 1000m above sea level. Most of the houses in these region are compactly grouped, with relatives often living together. The center of the old settlements were the mosque and the storehouse from the time of early Islam. The climate in Gharyan is very hot and dry in the summer (temperature average of 35 degrees) and cold and rainy in the winter (temperature average of 10 degrees).

The traditional dwelling of Gharyan: The region has two traditional dwelling types, both suited for the high temperature changes of the climate. The first dwelling type is the so called Aboskefa which is constructed completely underground. The second dwelling type is the named the Al-Feseal which is partially underground. They are made as caves or cubic holes which are manually dug by workers. These underground houses often consist of 8 large rooms, where each room is a home for one family since often relatives live all together in one dwelling. The bedrooms often have the shape of a trapezoid, with an entrance wall of only 1.90m. This represents the smallest width of the trapezoidal wall whih than expands up to 5m. The room is often divided by curtains into 3 parts. The first room is the living space, the second room is the children space and the last room is the couples room, where also the bathroom is located. Each functional space is marked by an additional 15cm raised floor to add to the feeling of spatial partition. The room heights are usually around 2.30m. The total area the house can go up to 500m^2. The house shown here has a courtyard size of 10 x 10 m and a depth of around 9.50m.

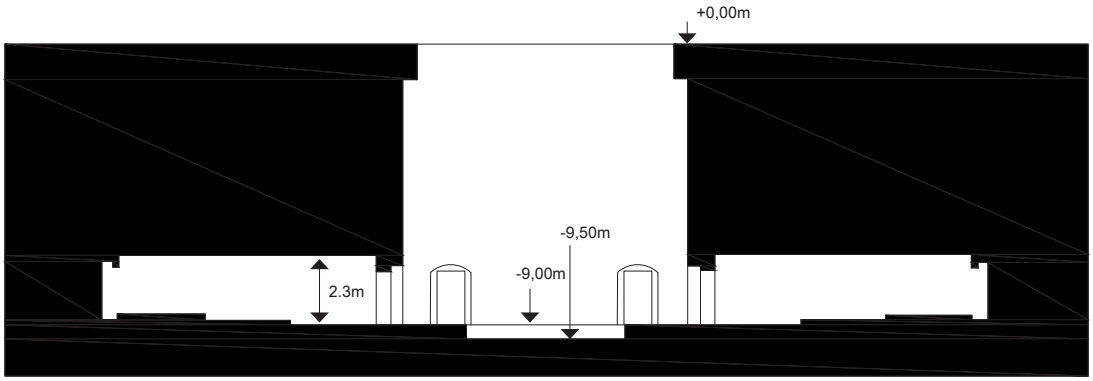
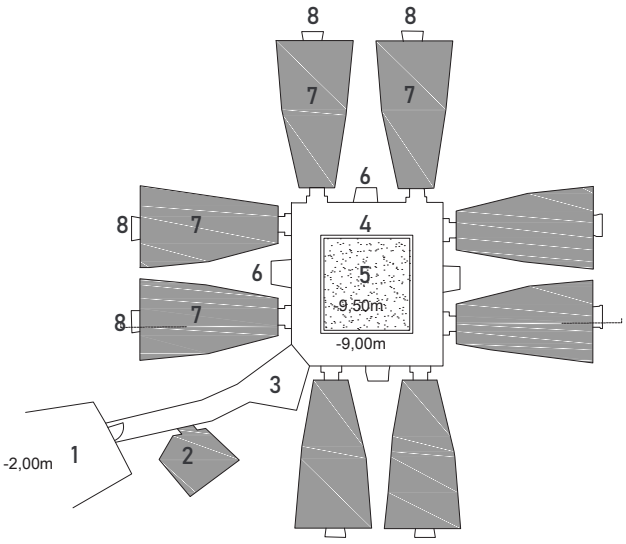


Figure.1.16: Section of a typical Gharyan house

By allowing movement between rooms without connecting them, the courtyard serves circulatory purpose. It also serves a social purpose by being a gathering space for all the family members. It often contain plants, trees and as we see in the picture, also contain a well.

Material and Thermal Comfort: These houses are carved in limestone on site. This type of dwelling does not need a lot of construction material but is very labor intensive. This building typology is environmentally friendly as it dooes not unobstruct the landscape. The system of natural ventilation keeps the interior temperature relatively constant. The stability of the underground temperatures provides good heat isolation during the hot summers and cold winters, creating pleasant conditions year round.

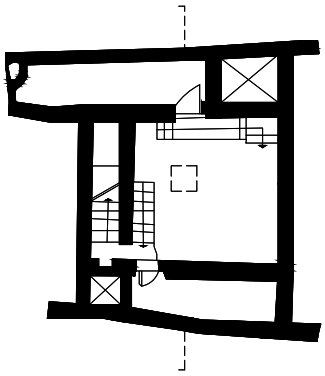


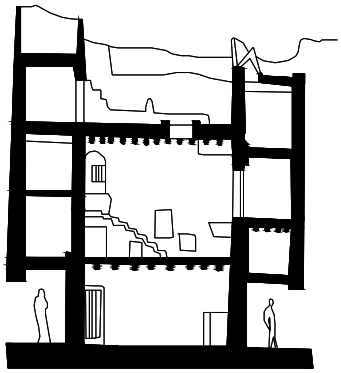
1 entrance
2 3.4 x 3m men‘s salon
3 hall
4 10 x 10m courtyard
5 planted area
6 1.6 x 1.8m kitchen
7 9 x 5m rooms
8 1.7 x 1.5m W.C

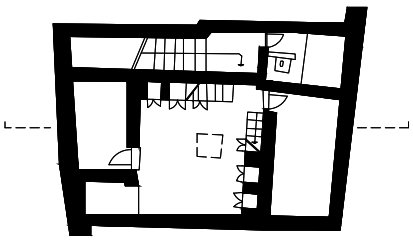
Figure.1.17: Plan of a typical Gharyan house

Figure.1.18: Impressions of a Gharyan house

0 10 20m







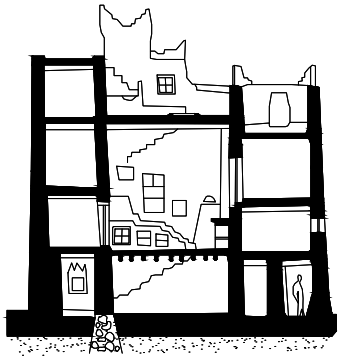


Figure.1.19: Plans & sections of Ghadames houses
Figure.1.20: Dense urban structure and rooftops of Ghadames old city

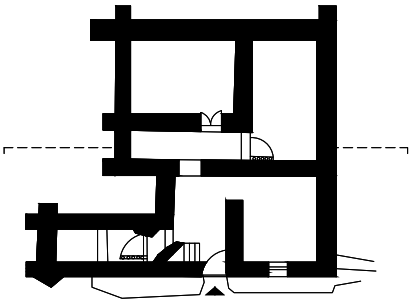
The Ghadames House

The oasis of Ghadames is located in the northern part of the Saharan Desert, approximately 650 km south of the Mediterranean sea and Tripoli. It is around 300m above sea level. Ghadames is one of the oldest cities in Libya, with some of its housing being 3000 years old and still being occupied today. These traditional houses within the old settlement comprise about 11% of the total residential zone.

Climate: The city of Ghadames goes through temperature extremes throughout the day, from very hot days to very cold nights. During the winter, the climate remains warm due to the desert sand. The mean maximum temperature from May to October is between 35 Celsius to 48 Celsius.

Urban form: The urban layout of the city is highly compact and dense, with a unique form of layout and building form. Sheltered spaces and alleyways form the circulating streets of the old town, protecting the inhabitants from the extreme weather conditions. The alleyways are covered, narrow passages (widths varying from 1.5m to 3m) that are characterized by sharp curves which help for ventilation purposes by breaking the strong winds into gentle breezes. The shade of the alleys also create cool spaces for people to meet, rest and walk comfortably, while still providing a high level of privacy. Openings in the alleyroofs reinforce the ventilation process and provide a source of light for these passages. The distance between each opening is about 15m.

Materials and Thermal Comfort: The people of this desert region often used granite stone for the foundation of its buildings. Sun-dried bricks of clay are used for the walls and stumps of the palm trees are used for the ceilings covered by clay and limestone. The stumps are also used for trusses and beams. The structural system is supported by load-bearing walls between the houses. This provided additional support and insulation from the external conditions. The outer and inner walls are thicker at the bottom and decrease in thickness as the go higher up, with the thickness ranging between 70cm at the bottom and 40cm at the top. External walls are often in very light and pale colors to increase the surface reflectivity. The extreme climate leads the house design to remain relatively compact.



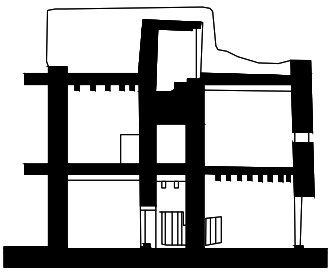


Figure.1.21: Ghadames old city views
Figure.1.22: Plans & sections of Ghadames houses

The Ghadames House

Single family houses: The traditional Libyan house of the Ghadames region follows a vertical design, using local materials and adjusting to the harsh climate. Single family houses can have a total house area between 200-300m^2, with it varying depending on economic situation and location. The rooms of the house can vary from fully shaded to totally exposed like the roof which is often also the kitchen. The house consiss of usually 3 storeys. The entrance is usually 0.95m x 1.80m. The male area is usually on the ground floor, next to a storage space. The central hall (common dimensions 5x6m) is at the mezzanine level with the bedrooms. The rooms are often very narrow, for example, the depicted rooms are 2.17 x 7m and 1.60 x 3.90 m.

The roof is often used as the main kitchen and summer shed. The roof plays an important role in the vernacular house and its family life since it is the only private outdoor space of the family. It is used as a kitchen (to help get keep the house clean of heat and smoke outside the house) and as a place for women daily activities. High exterior roof walls add privacy and protection from the dust and winds. There are even passageways on the roofs made especially for women to meet and greet. The houses stand often wall to wall. There are no windows in the external walls with the only light source provided by skylights in the living room. With the help of mirrors and reflective surfaces, the light is dispersed throughout the salon and other rooms. This also helps with the circulation of fresh air and eliminates heat accumulation. The ceiling heights can go up to 2.50m in the rooms while storage units often go to 1.60m.

The majority of houses in Ghadames share similar design, differing only in their size and decoration depending on economic situations. The architectural design clearly values privacy and the personal social life, especially for women.

Figure.1.23: Food market in Benghazi showcasing the importance of alleyways for daily life

1.9 local cultural considerations

Important socio-cultural considerations for internal and external spaces in Libya:

- Large family sizes (between 5-6 people).
- Privacy in the Libyan household and society is a important.
- The separation of age, sex and guests (defined roles within a family).
- Extended family and elderly people have a high status.
- The kitchen, storage spaces and preparation spaces are very important.
- Safety and security

Proposed architectural solutions:

- Living room for men and women.
- A guest bedroom.
- Terraces that can eventually be extended into a room.
- Living room has access to the courtyard.
- Staircase entrance to the family area, basement and first floor.
- Kitchen and toilets on the west side (to prevent excess heat)
- Courtyard in the center.
- Extendable rooms
- Using staircase as wind trap by orientating it toward the north.
- Use of musharabias (perforated clay or wood panel) in balconies for privacy, shading and air.
- Sun utilization
- Dual use terraces
- Multiples entrances with internal and external staircases

02 site analysis

FACTS AND FIGURES

hectares	161
approx. total buildings	3,472
approx. total residential/commercial buildings	3,301
estimated population (2015)	30,000
average household size	4.7
average number of households	6,400

2.1 Benghazi old city

The old city is partially built on the Hellenistic, later Roman city of Berenice. Much of the ancient city was destroyed during the Ottoman as well as Italian periods, but remnants of the ancient city still remain in the site of Sidi Kremish but it is likely that they could be found underneath the whole city. The old city has many cultural and architectural overlays, from remains of small Arab houses, to monumental Italian collonades and Italianesque facades of the 1930's to Ottoman arched windows and decorative doors.

The old city of Benghazi was the city's central business district housing the main governmental offices, services and banks. It also sustained a rich commerical life with various shopping streets, several smaller Souqs (market) and one big farmers market. Before the February 11th Revolution, the old city was one of the most vibrant and popular hubs in the city. Its lively mixed use environment, its diverse social composition and the active street life were some of its most important characteristics. Due to its centrality and popularity, the industrial port activities and the lack of traffic planning access, the center suffered from car congestion, noise and air pollution and extensive roadside parking which reduced the quality of life of visitors and residents alike.

Figure.2.1: Satellite map of Benghazi old city

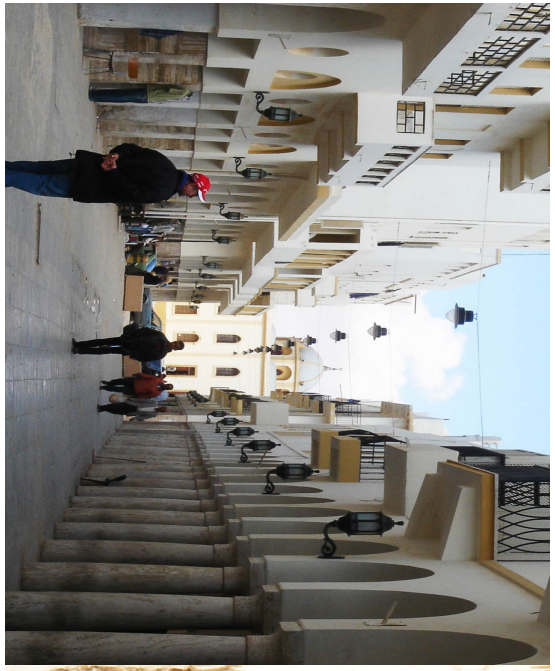





Figure.2.2: Impressions of the old city of Benghazi

2.2

ottoman mosques

ottoman municipality

fish souq markets

revolution square

old italian building

italian palace

italian lighthouse

omar muktar square

italian cathedral

points of interest

archaelogical area

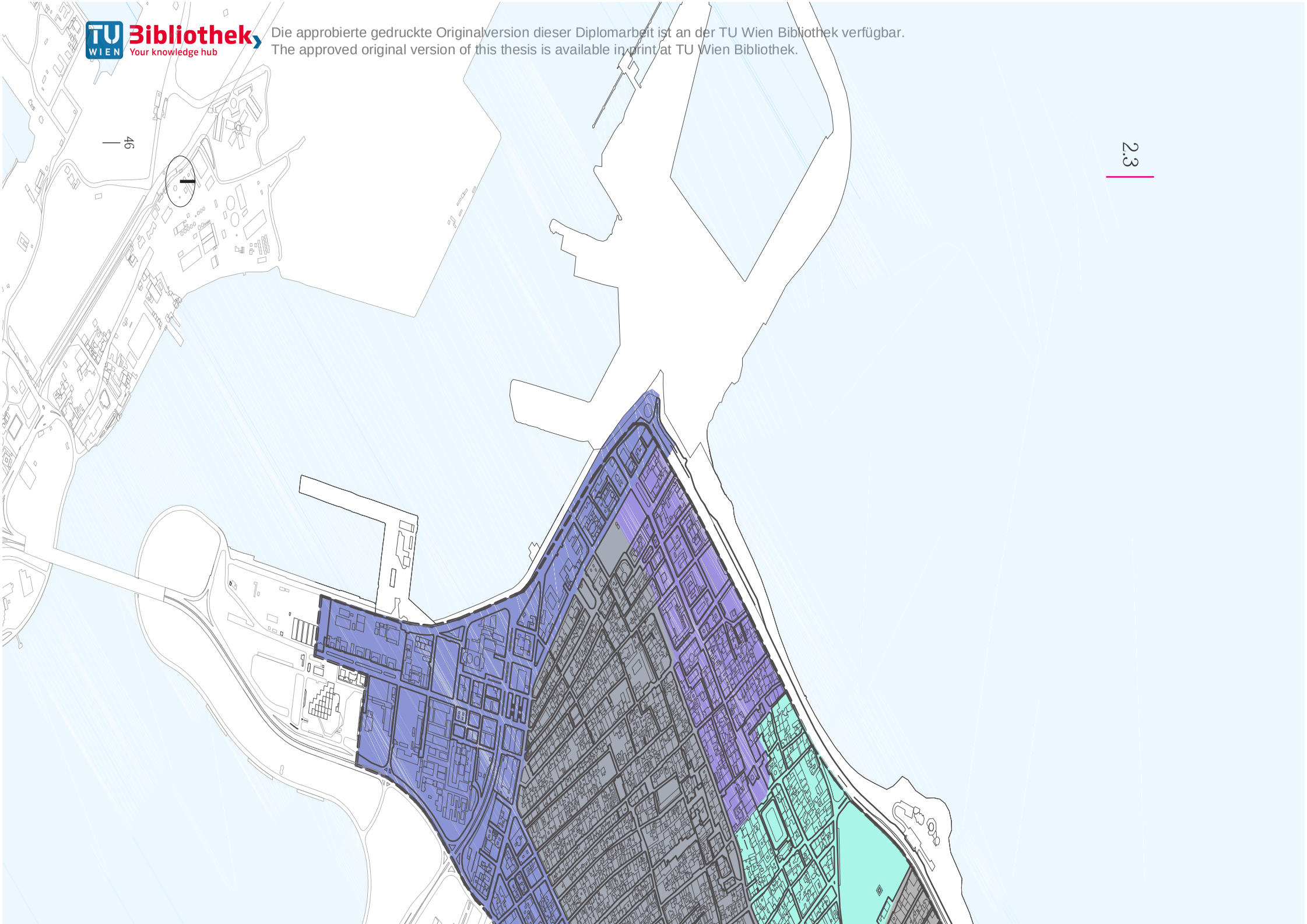
landmarks

important streets

arcaded streets

0 50 100 200m

Figure.2.3



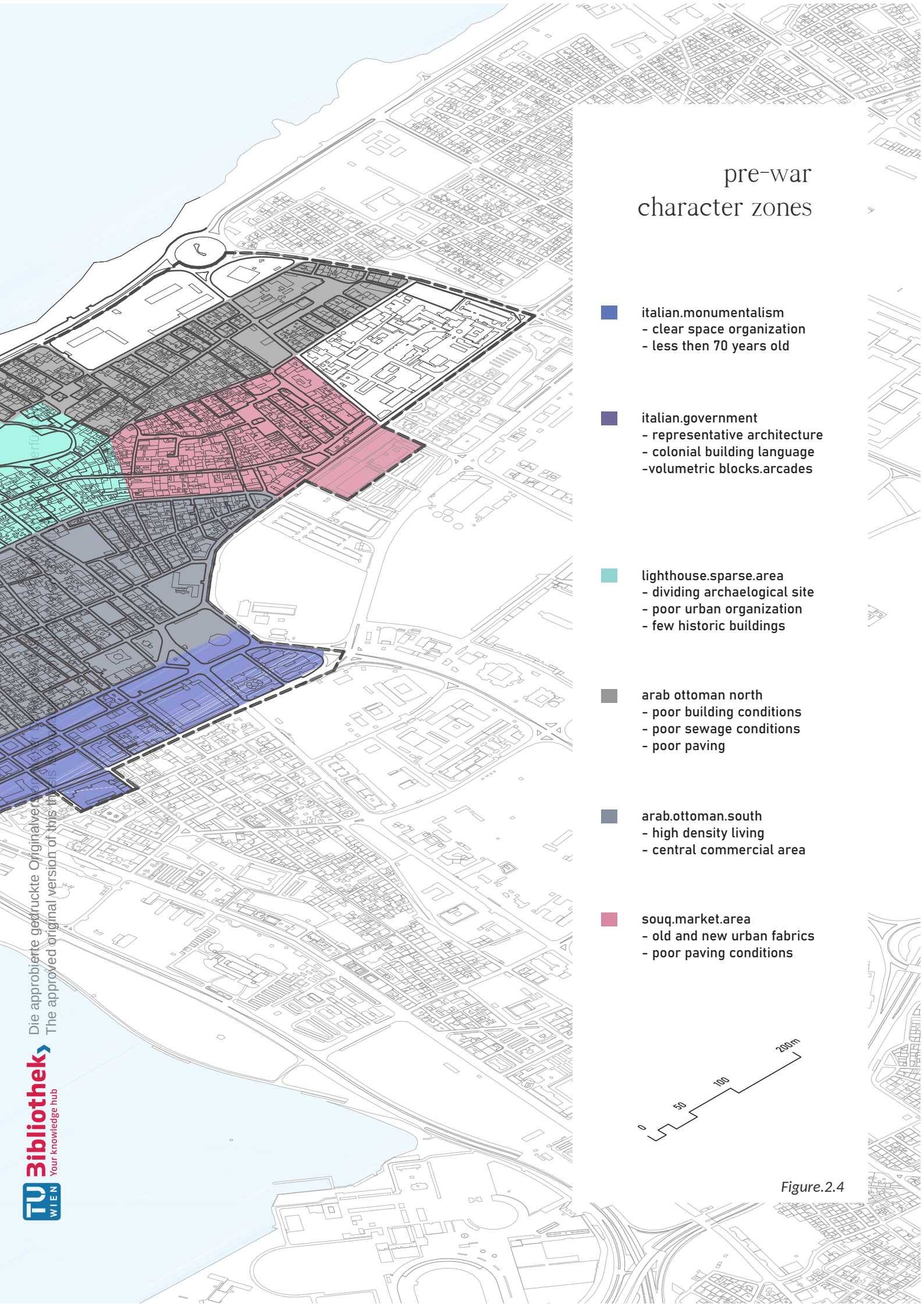
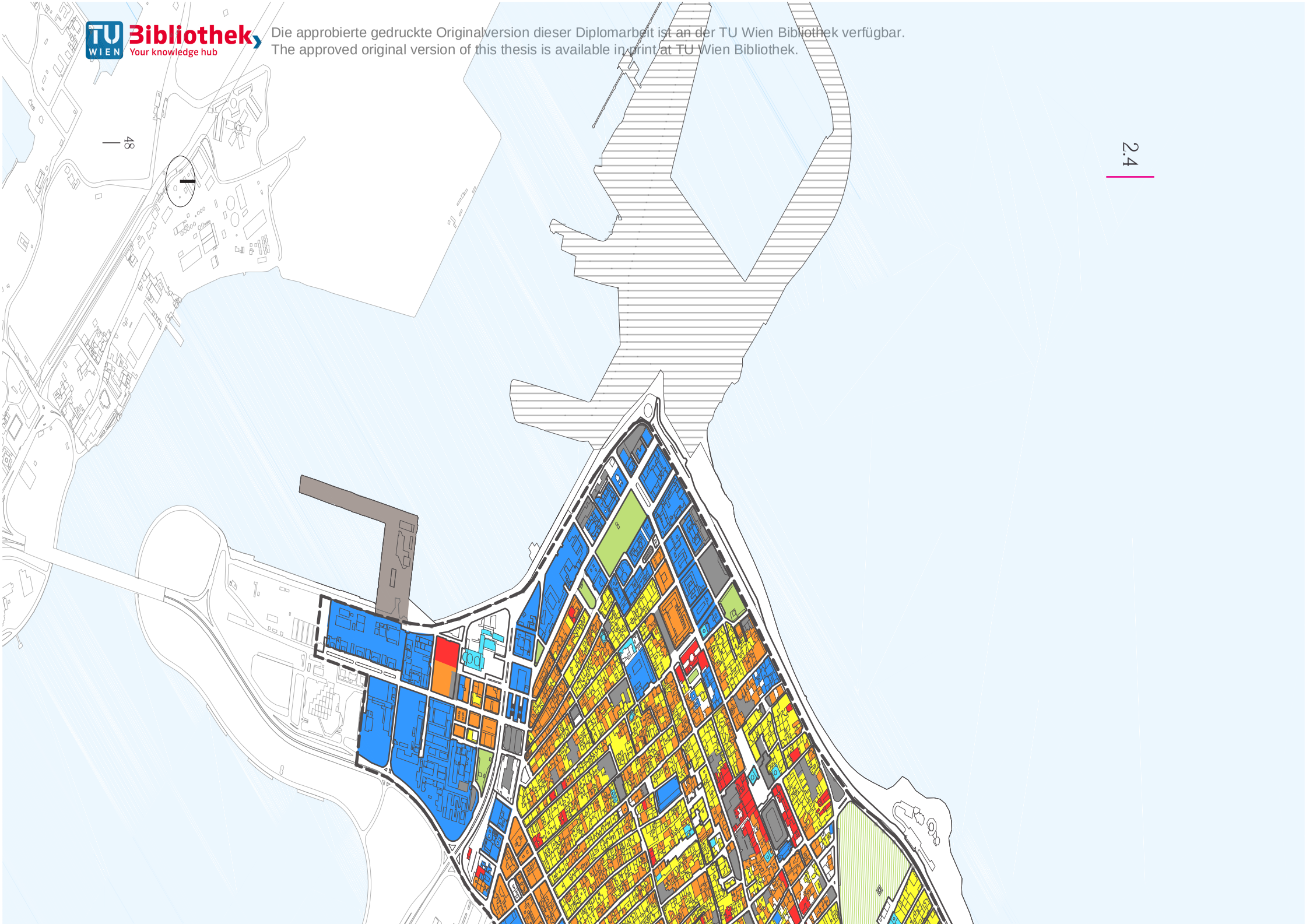


Figure.2.4



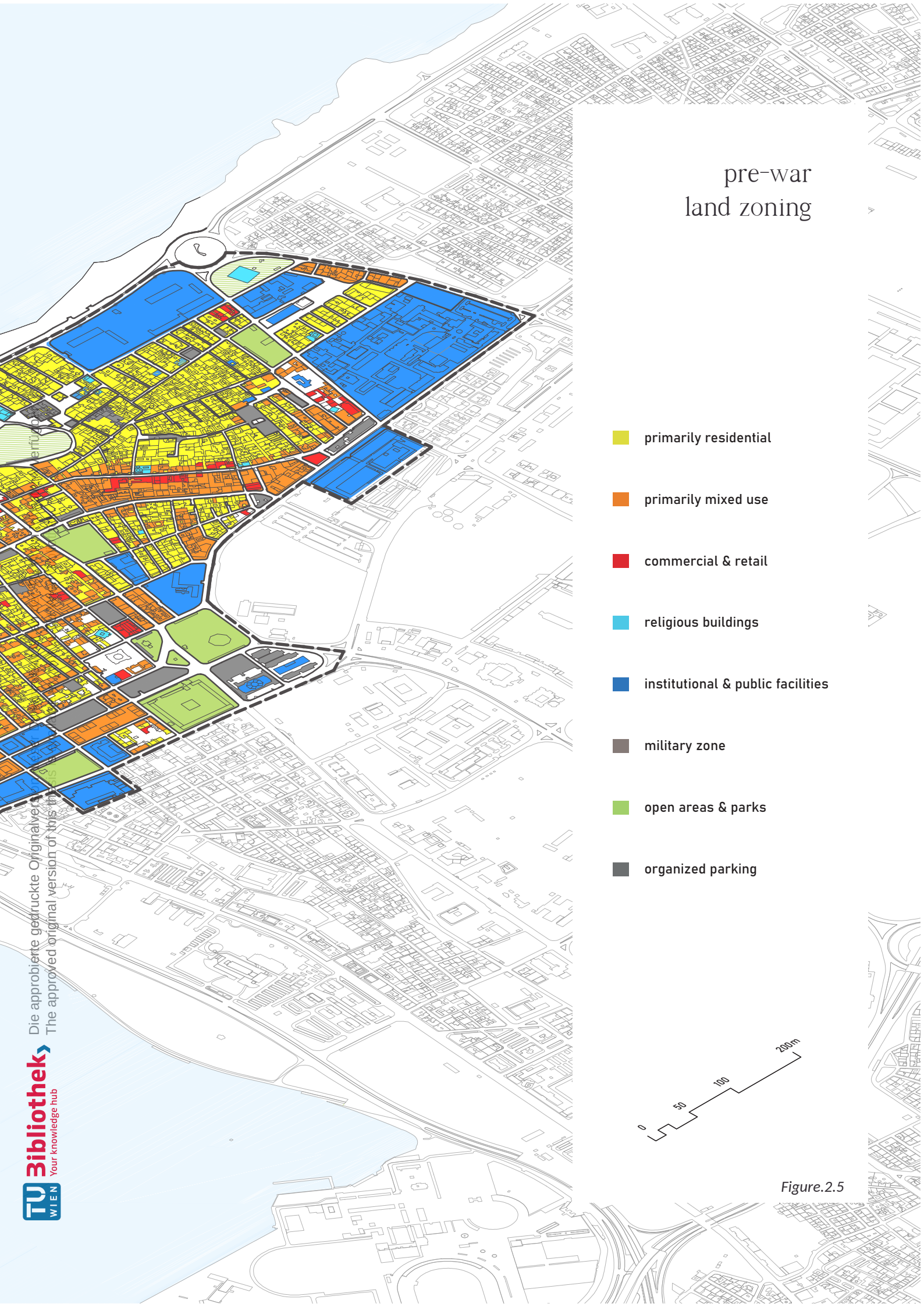
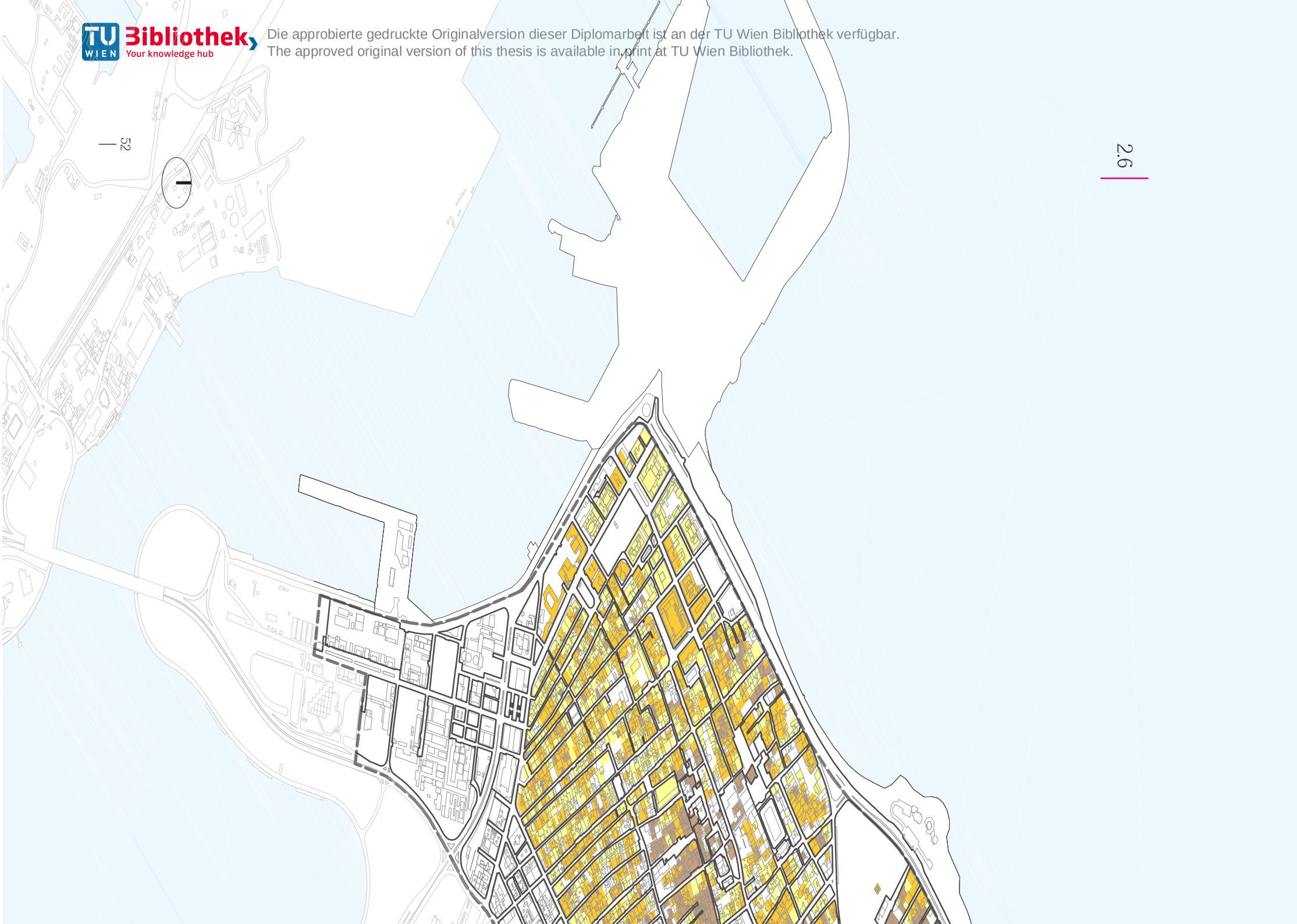
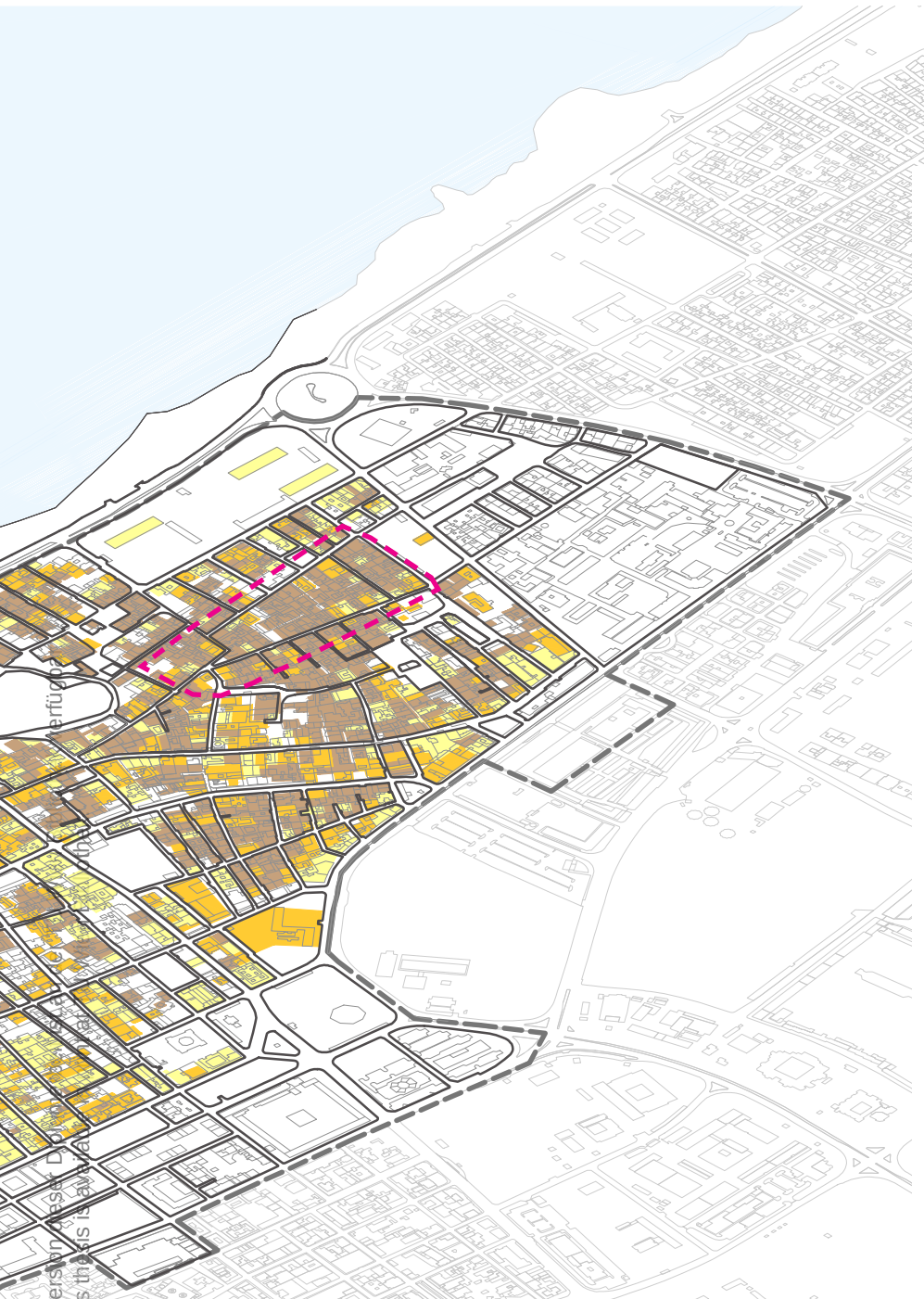


Figure.2.5

Figure.2.6





age of buildings in 1990

FIRST PERIOD
1700-1850

SECOND PERIOD
1851-195

THIRD PERIOD
1951-1989

site starting point

note on reconstuction

It is important to mention that a new heritage law was introduced in 2010: "Anything constructed or produced by human being as related to human heritage and goes back more than one hundred years need to protected." Therefore anything built from 1910 onwards is protected. This highlights a need from the local autorities to protect and cherish their cultural and architectural heritage.

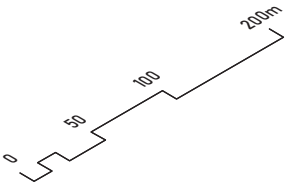


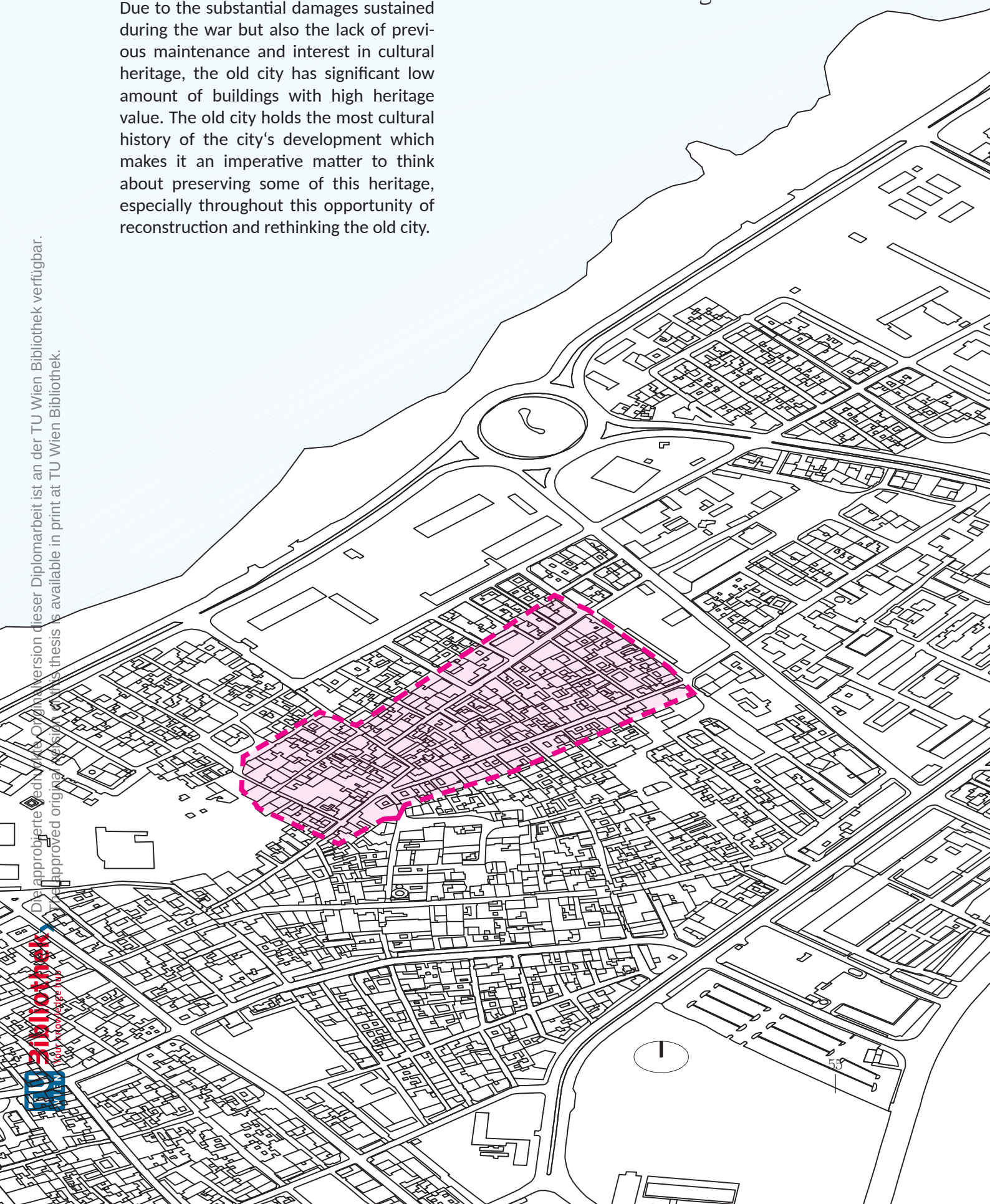
Figure.2.7

2.7

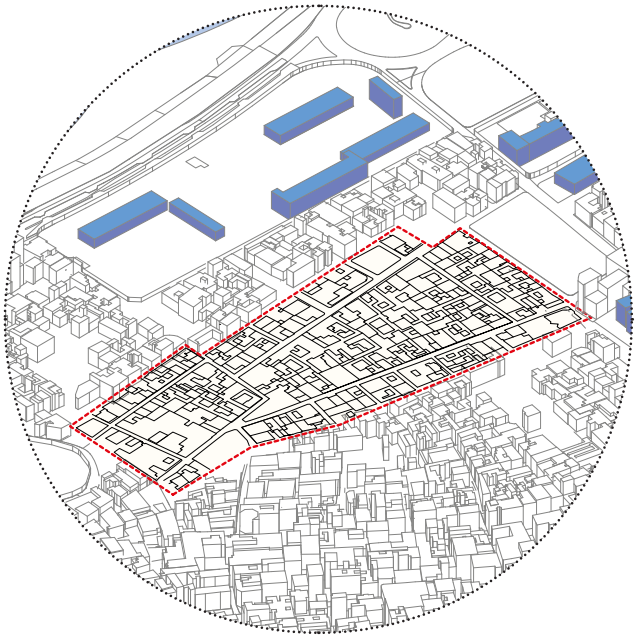
Figure.2.8: Satellite image of Benghazi old city

heritage site

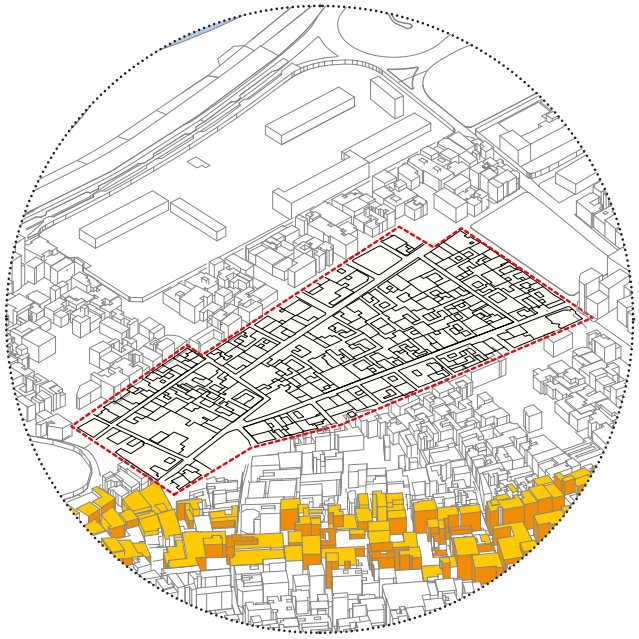
Due to the substantial damages sustained during the war but also the lack of previous maintenance and interest in cultural heritage, the old city has significant low amount of buildings with high heritage value. The old city holds the most cultural history of the city's development which makes it an imperative matter to think about preserving some of this heritage, especially throughout this opportunity of reconstruction and rethinking the old city.



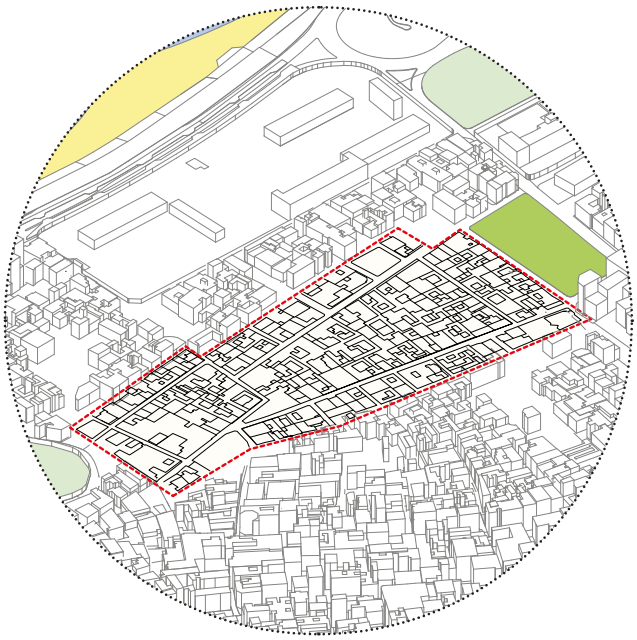
public buildings



mixed-use zone



open spaces



arcaded streets

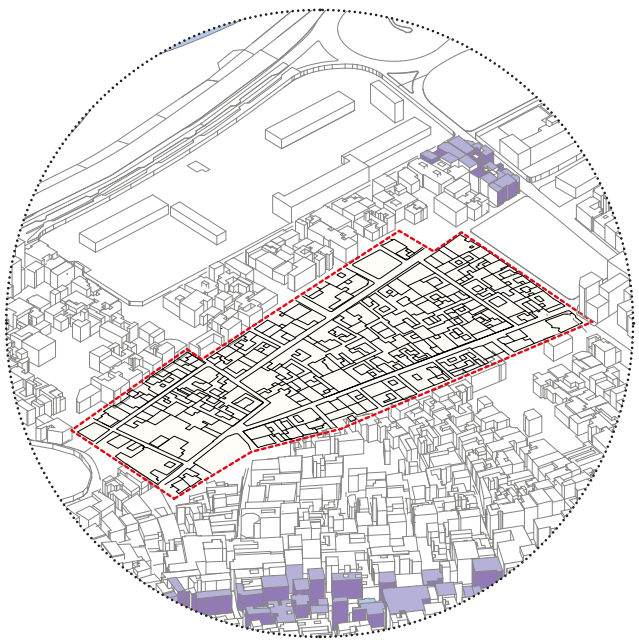
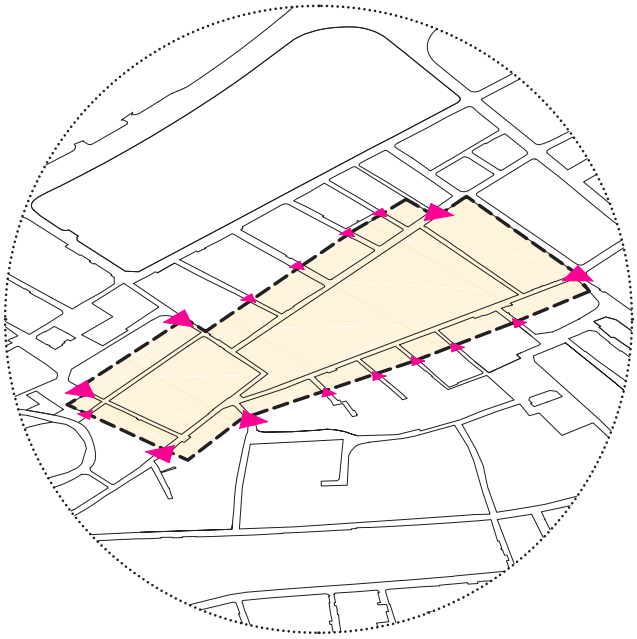


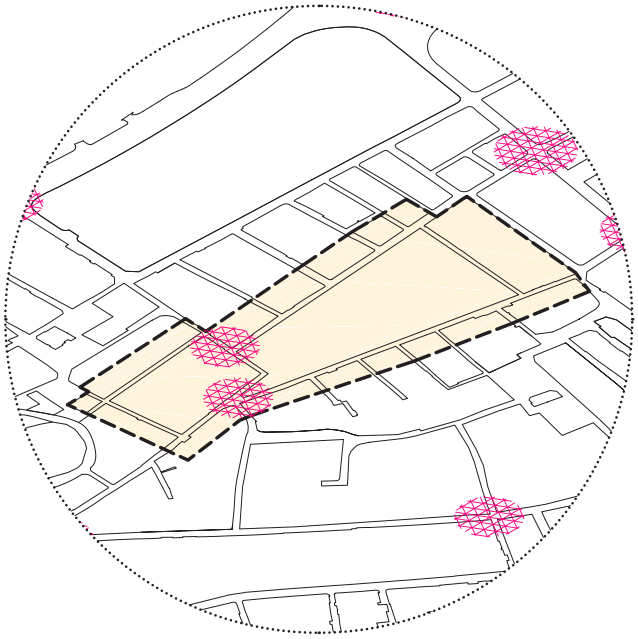
Figure.2.9: heritage site conditions analysis

heritage site conditions

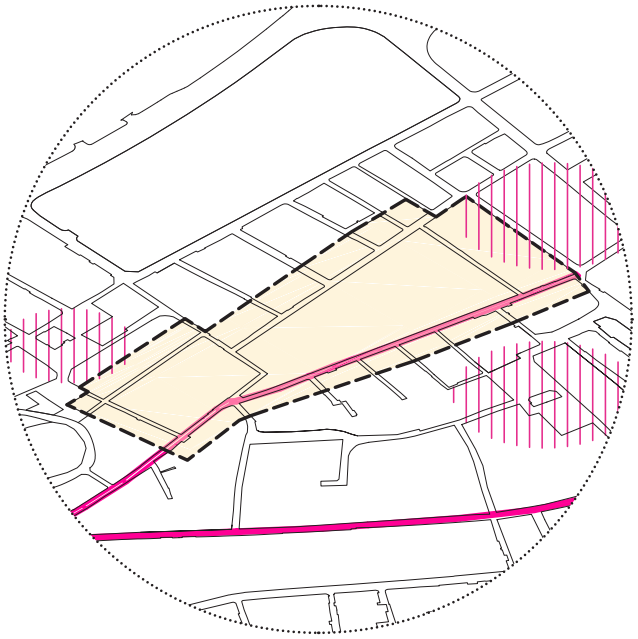
access points



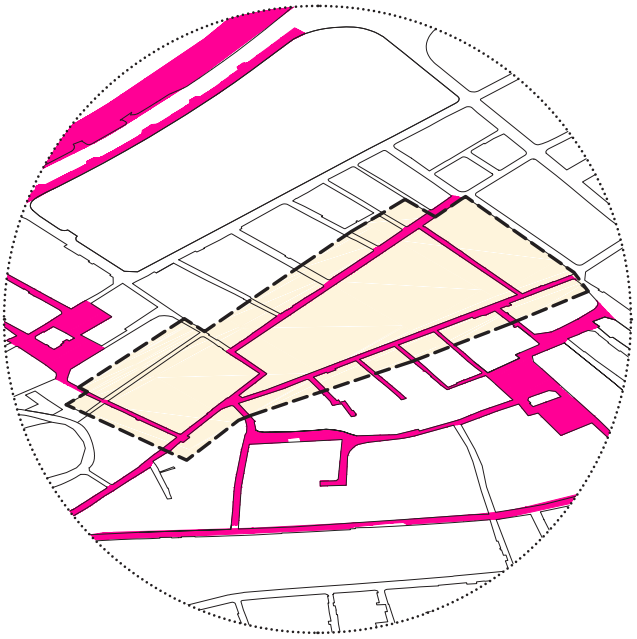
intersections



points of interest



projected pedestrian zones



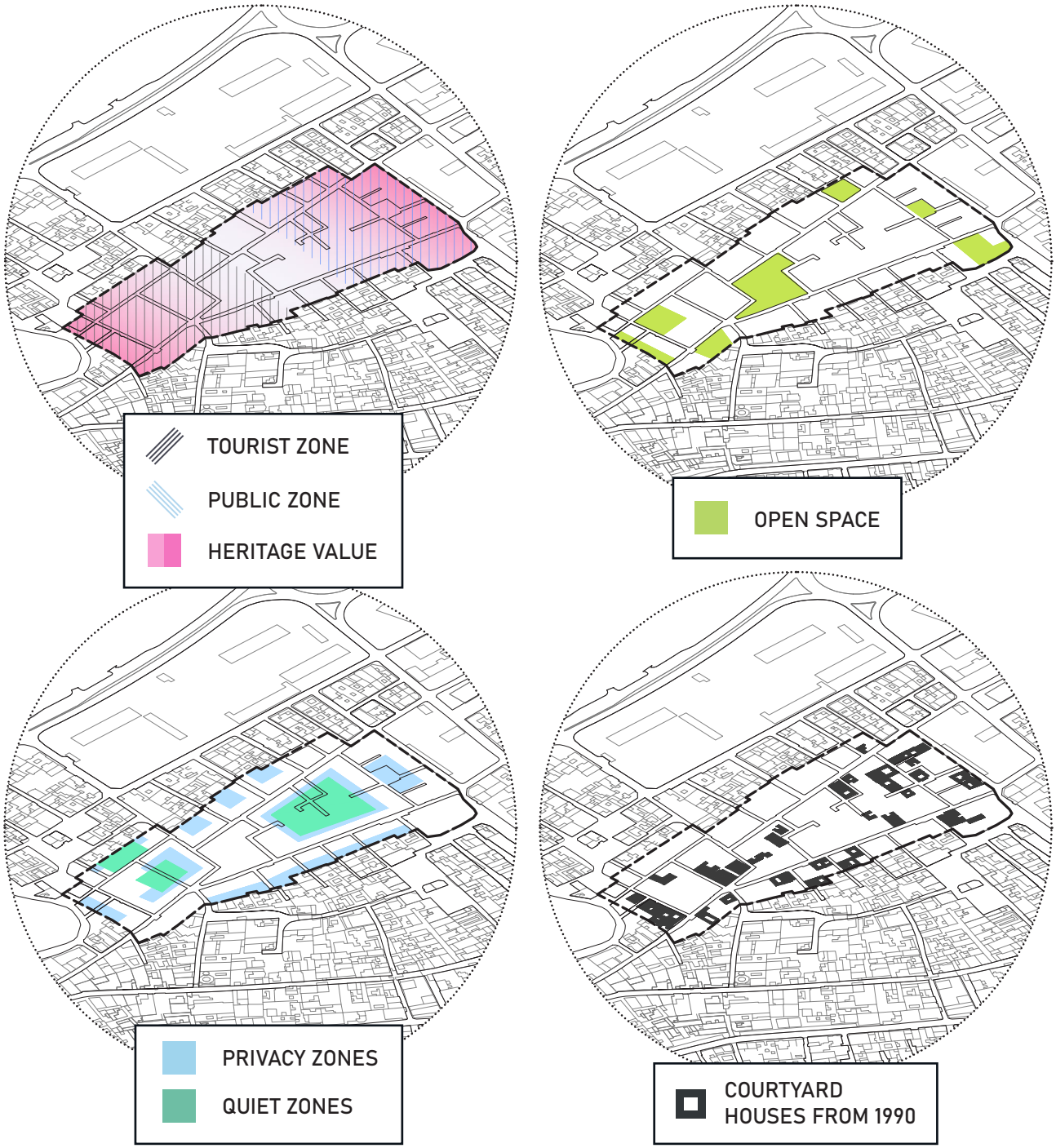
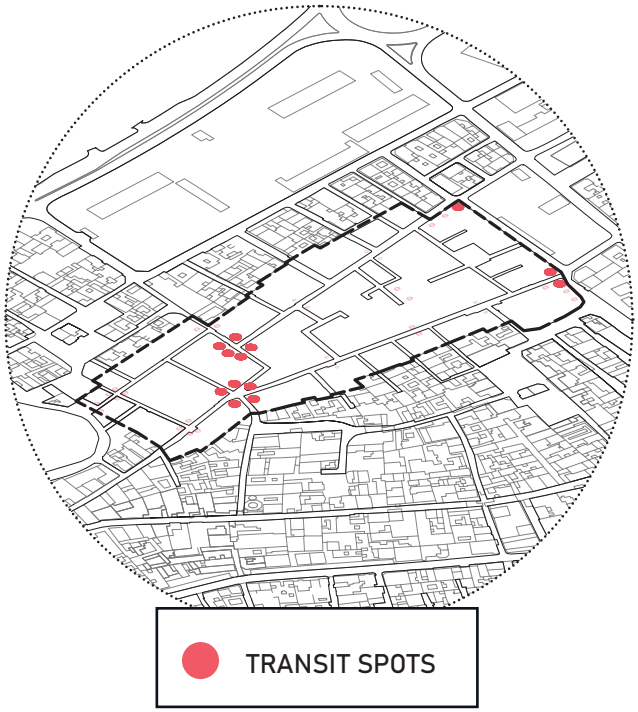
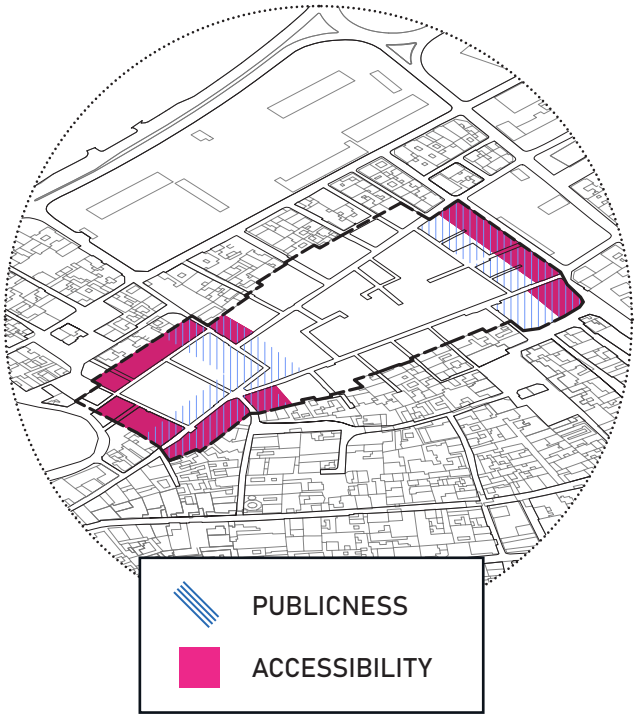


Figure.2.10: heritage site conditions analysis

heritage site conditions

After looking at the site conditions, certain criteria were chosen that might be beneficial in understanding the potential of the site overall. The following analysis shows different characteristics of the location of the site and it could help trigger certain understandings of potential relationships with the rest of the old city.





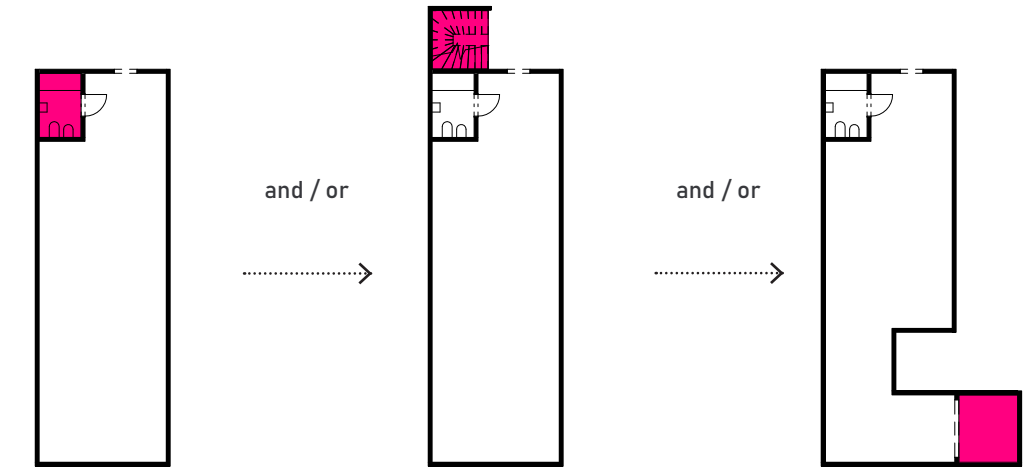
03 project goals

- provide flexible, private and adaptable living spaces with the use of courtyards and loggias
- continue the mixed use framework on the ground floor to help reactivate streets
- maintain the mixed housing typologies & mixed social situations
- connect the heritage zone with the use of arcades

04 methodology and approach

4.1

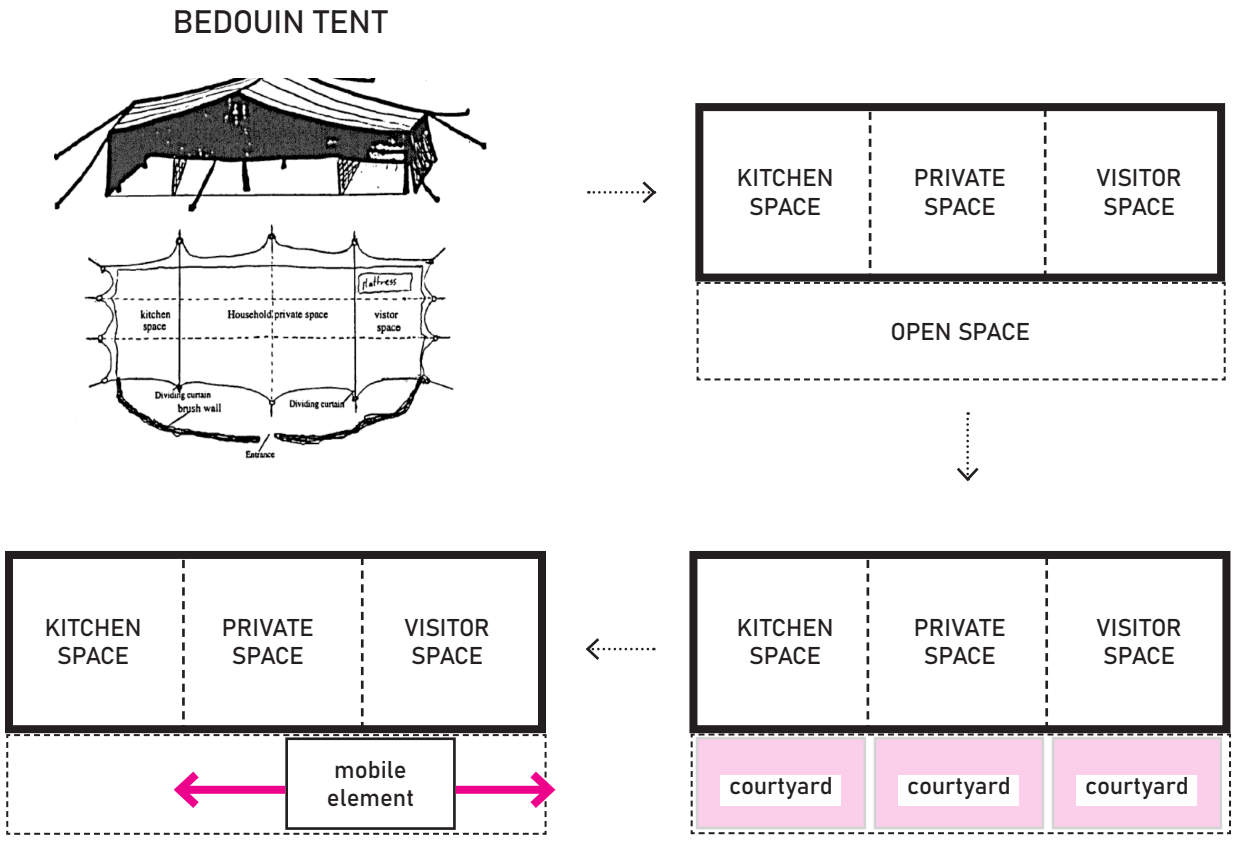
modular expansion and individualization



Through a modular system of construction, greater flexibility and possibilty of growth can be achieved by allowing elements to be easily removed or added to the structure according to the residents needs. As families grow or shrink, as professional or personal needs change, so do spaces. A series of modular housing/apartment types can be enlarged through a loft floor. Additionally, the interior by adjusted by removing/adding walls or adding flexible units like sliding/folding wall panels.

The set units would be a toilet/shower cubicle and a staircase unit that can be added on the exterior or chosen to have it as an interior inbuilt unit. With no load bearing walls, the interior layouts can be adjusted according to the users will. The users will be free to design the interior according to their needs. A staircase module would also be available for growing families that can have a second floor or a loft built if necessary.The individual housing units will be partially seperated through a permeable facade and roof system that will allow users to utilize the flat roofs as an extension of their courtyards. With both private courtyards and more public loggias, a combination of open spaces is created.

housing concept 1



moving courtyard spaces : creation of flexible micro spaces, internal alleyway for cross ventilation, moving rooms towards wind or sun, spatial separations and multiple entrances.

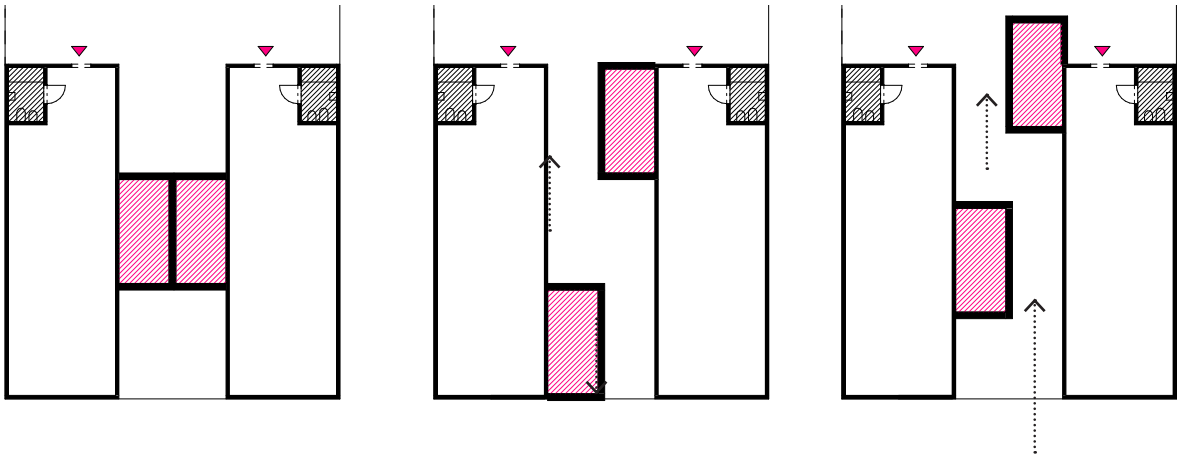


Figure.4.1: Apartment type 1 schematics

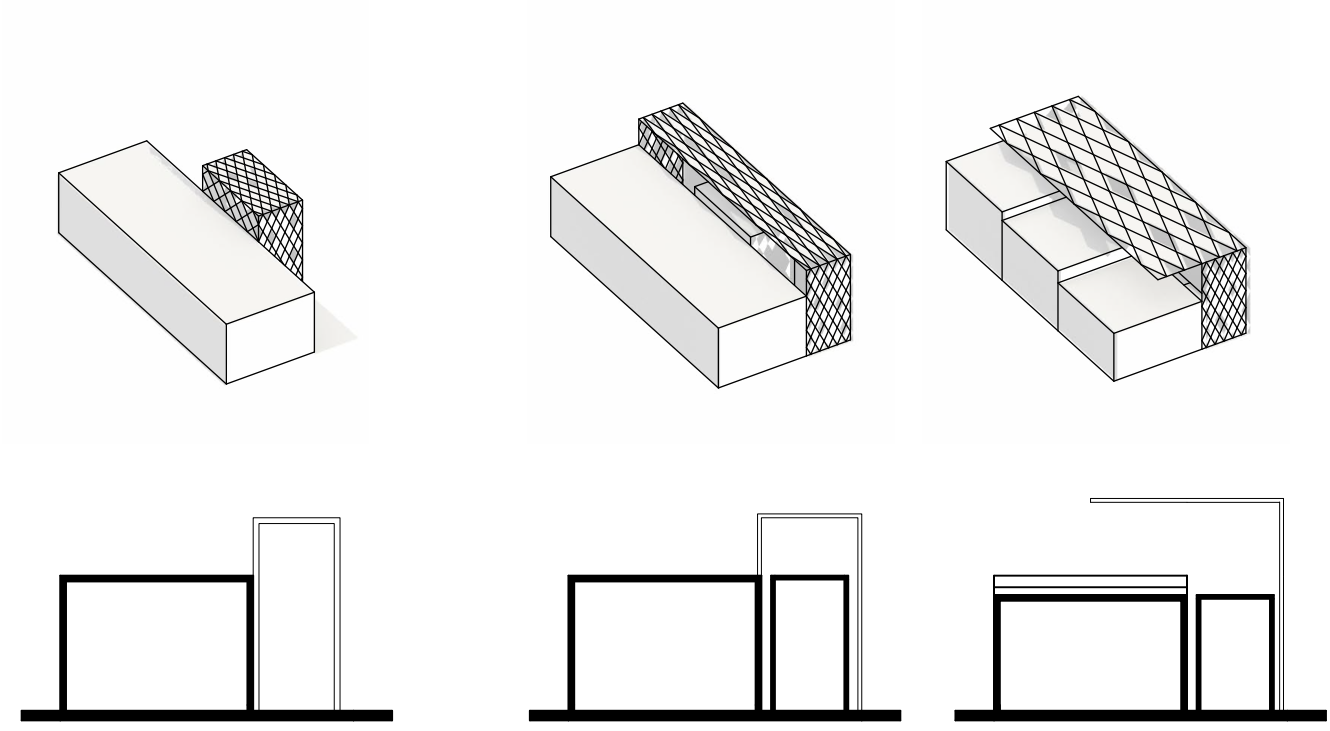
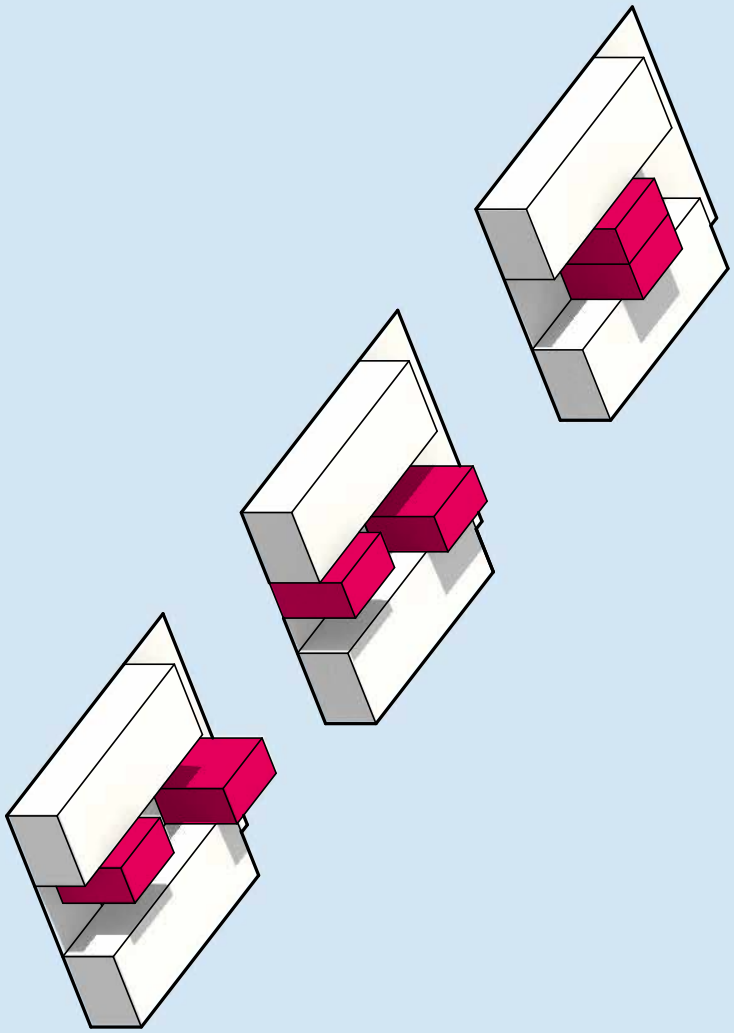
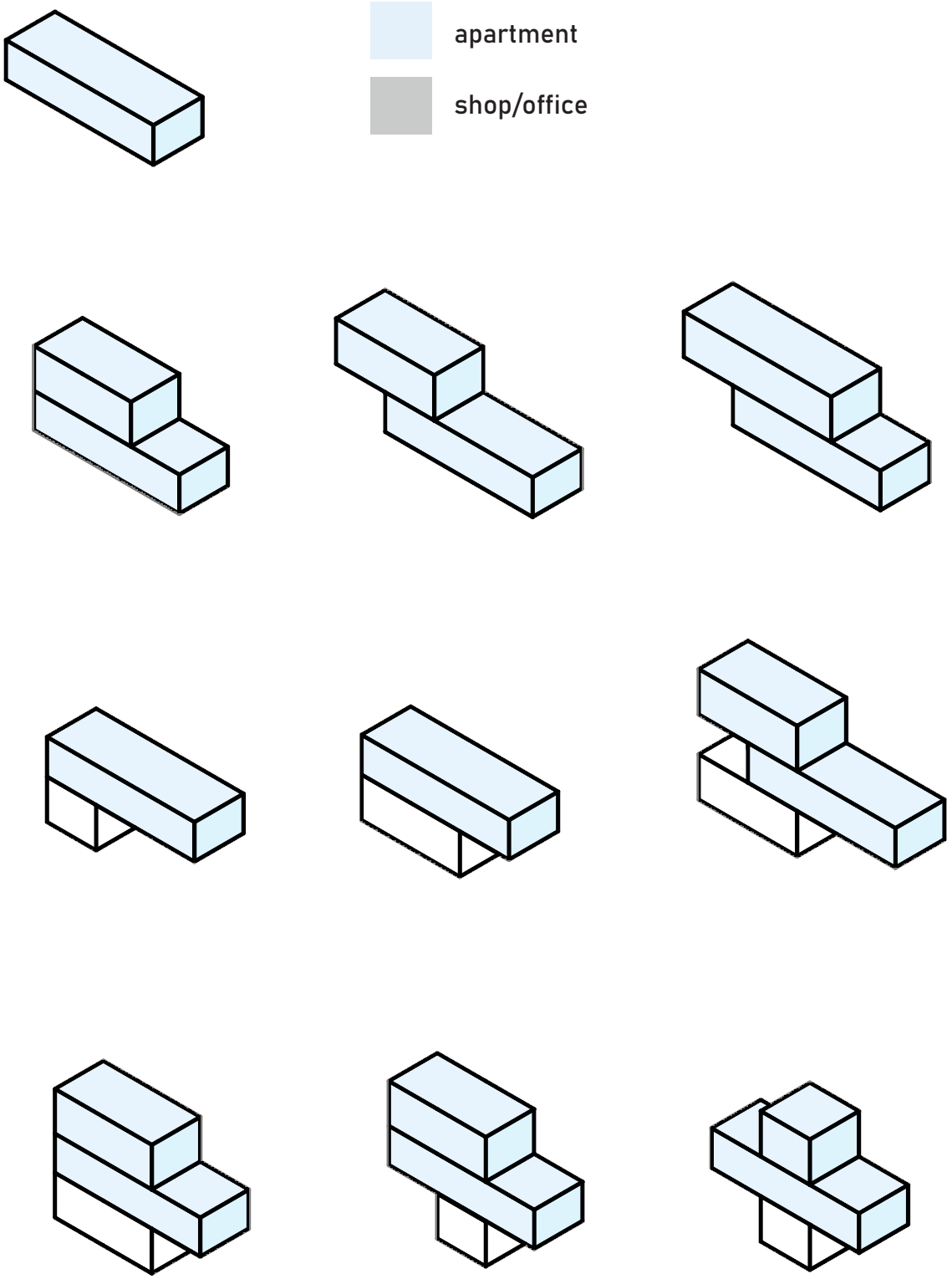
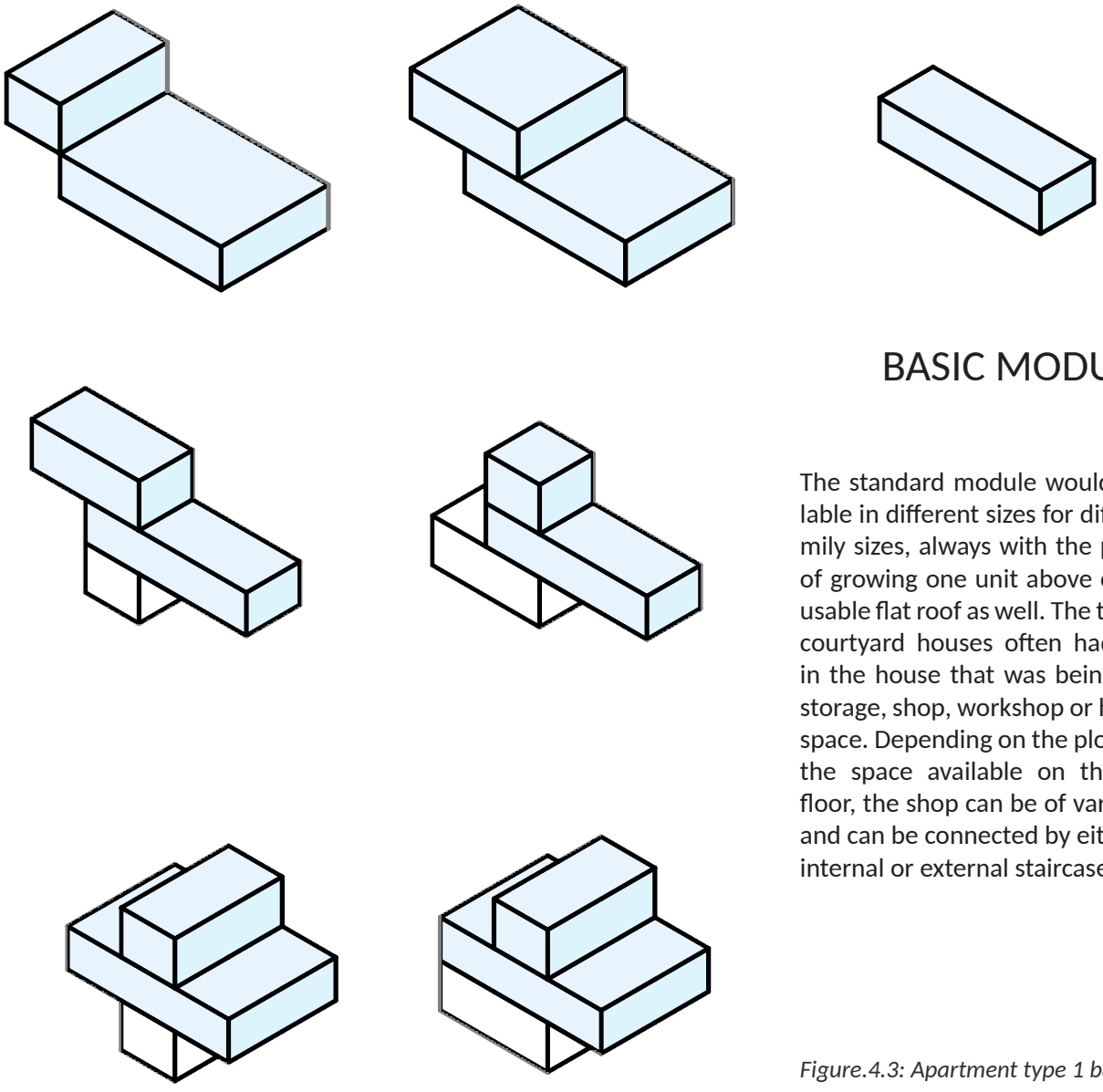


Figure.4.2: Apartment type 1 idea developments graphics



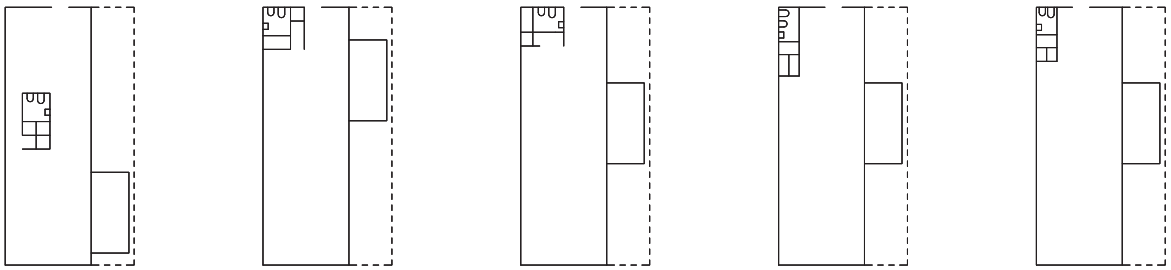




BASIC MODULE

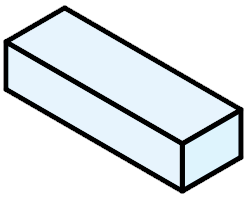
The standard module would be available in different sizes for different family sizes, always with the possibility of growing one unit above creating a usable flat roof as well. The traditional courtyard houses often had a room in the house that was being used as storage, shop, workshop or handicraft space. Depending on the plot size and the space available on the ground floor, the shop can be of various sizes and can be connected by either an internal or external staircase.

Figure.4.3: Apartment type 1 basic module



The basic module can have some variations of where the toilet unit would be placed based on location and preference. This also allows a variety of arrangements to be planned that will allow the residents to optimize their spaces. The moving module will have a standard rectangular shape, however it would also be possible have other shapes too. The module would also be available in different sizes.

apartment
(2-4 BEDROOM)
75m² + 37.5m²



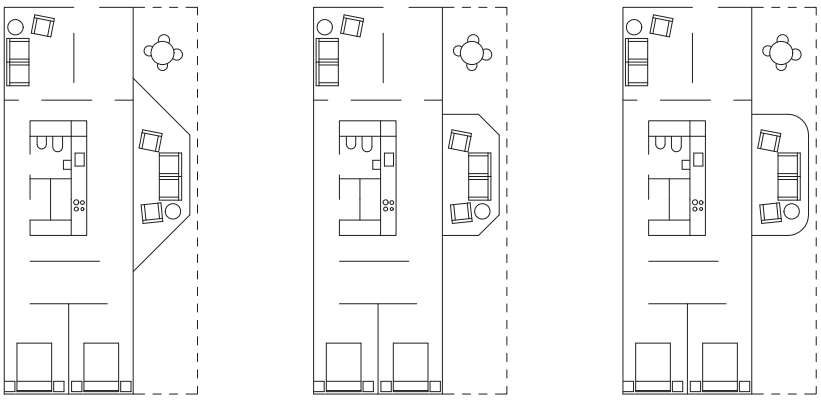
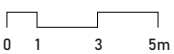
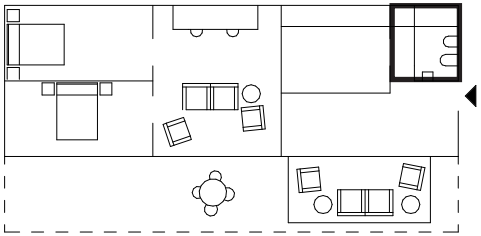
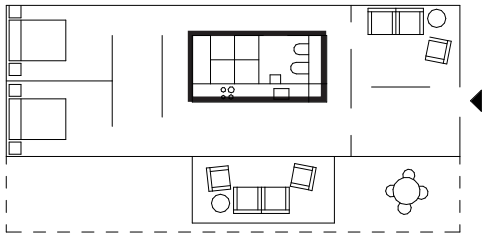
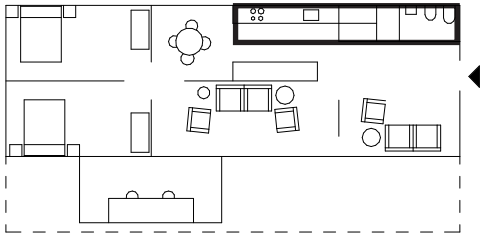
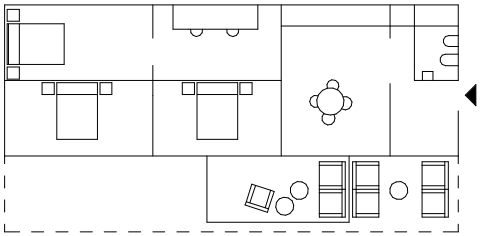
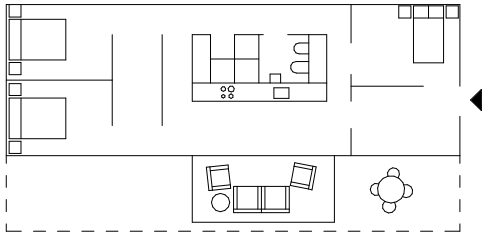
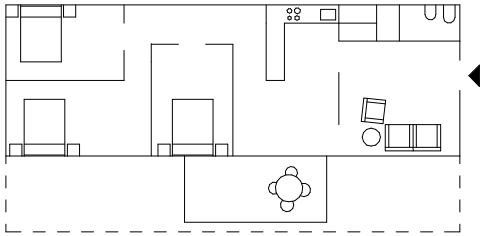
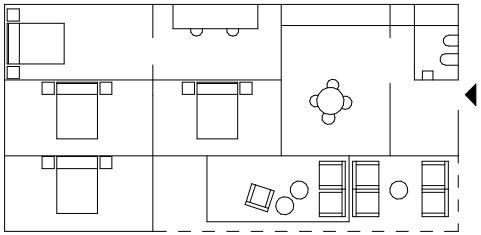
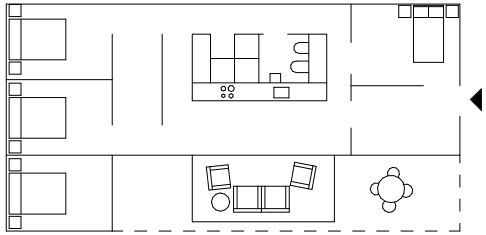
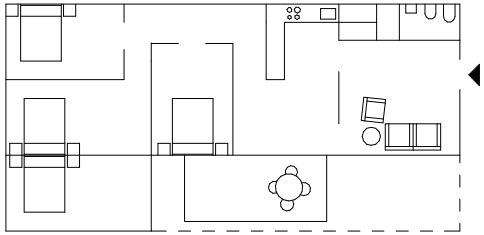


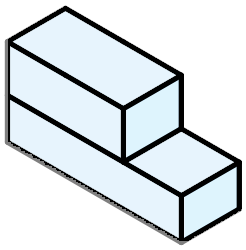
Figure.4.4: Floor plan alternatives



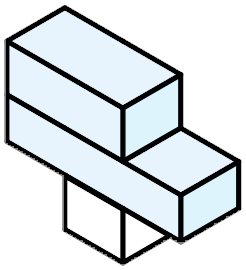
PROFESSION AND HOME OFFICES

apartment
(2-4 BEDROOM)
112.5m²



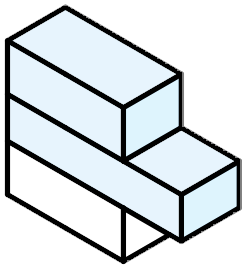
apartment
(2-4 BEDROOM)
162.5m²

shop/STORAGE
34m²



apartment + loft
(2-4 BEDROOM)
162.5m²

shop/office
55m²



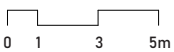
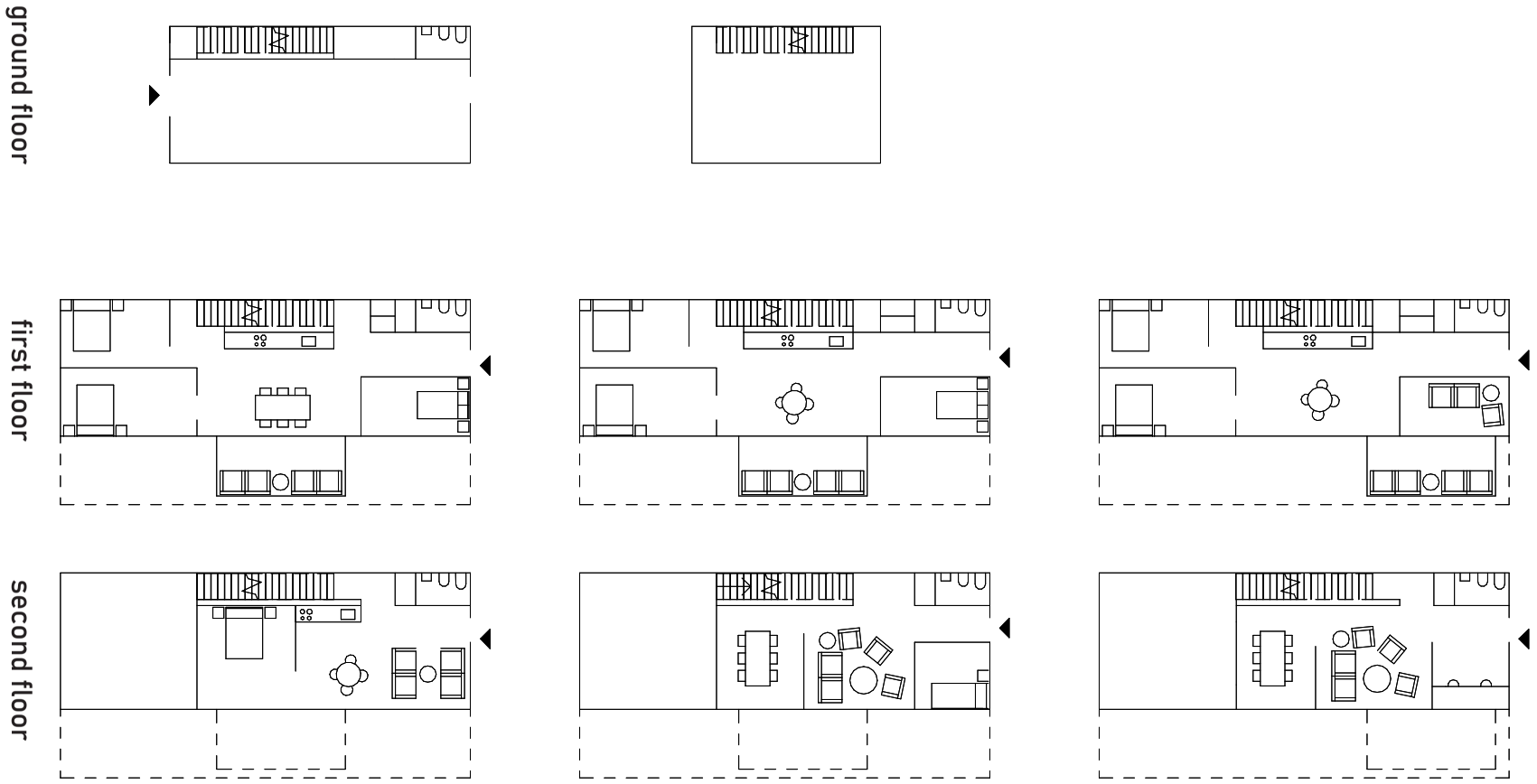
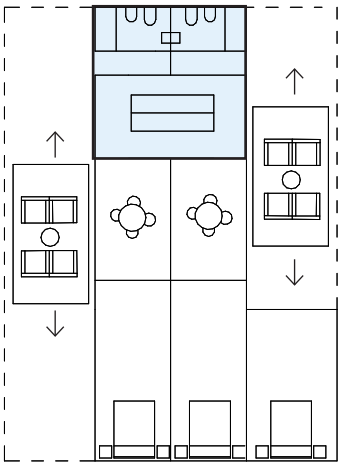
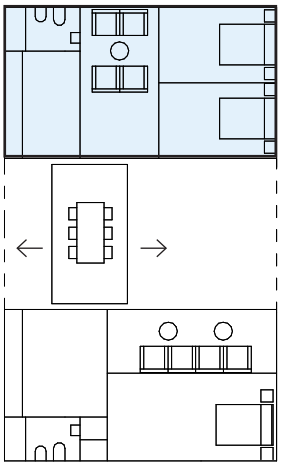


Figure.4.5: Floor plan alternatives

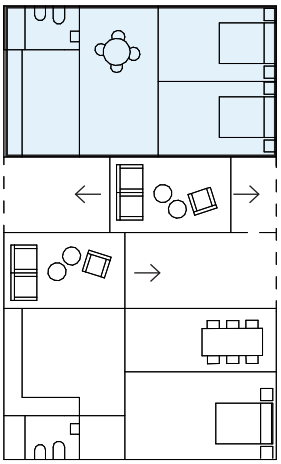




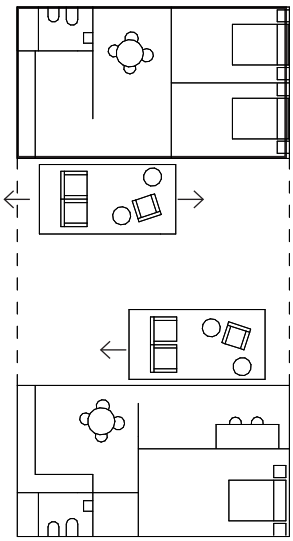
shared service area



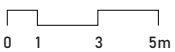
separate apartment + shared dining area



separated apartments & living area



separated apartment + enlarged courtyard zone



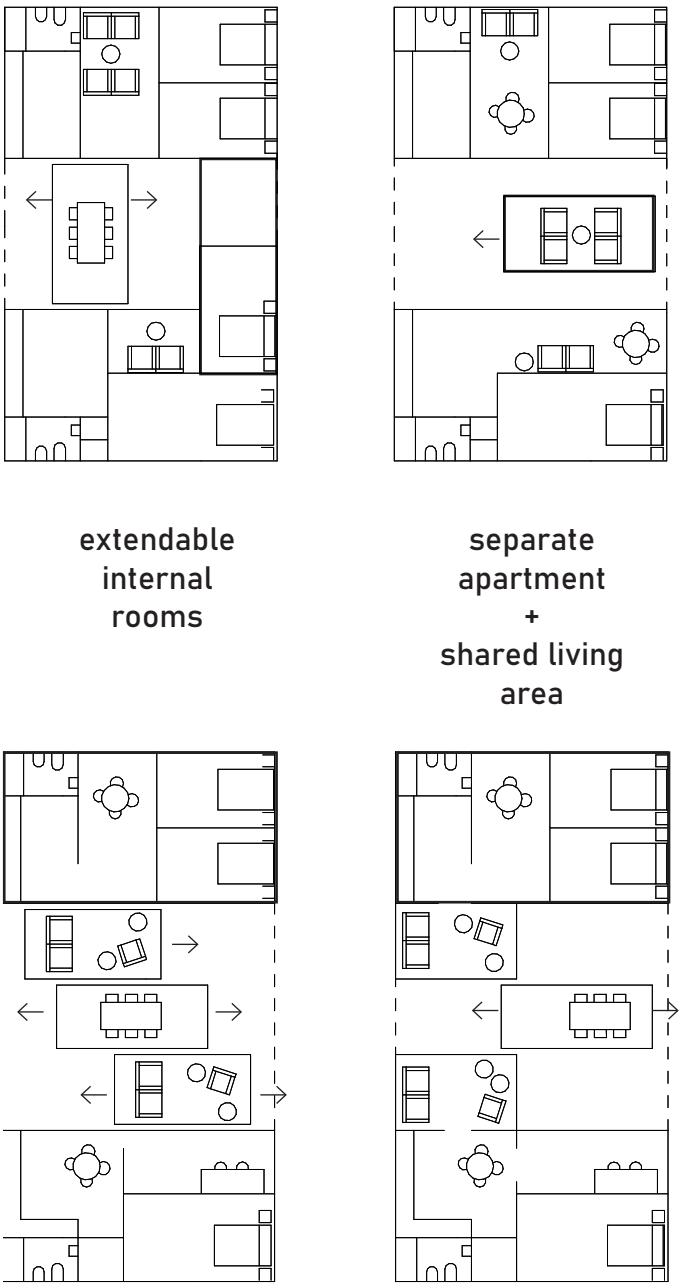
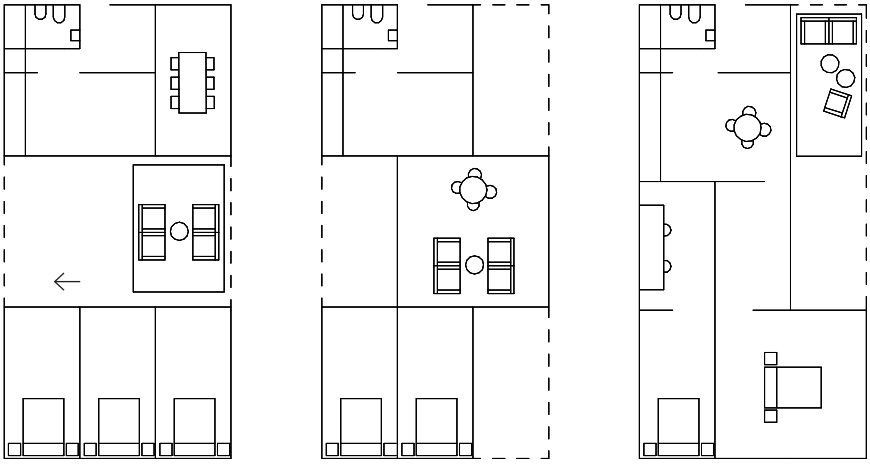
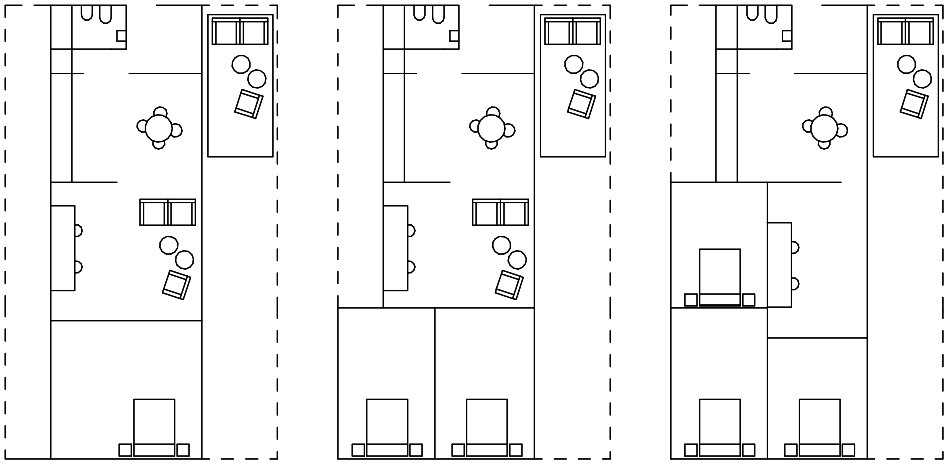


Figure.4.6: Floor plan alternatives

ALTERNATIVE LAYOUTS IDEAS



FAMILY SIZES AND INDIVIDUALISM



possible family growth and regrowth
with house flexibility layout

0 1 3 5m

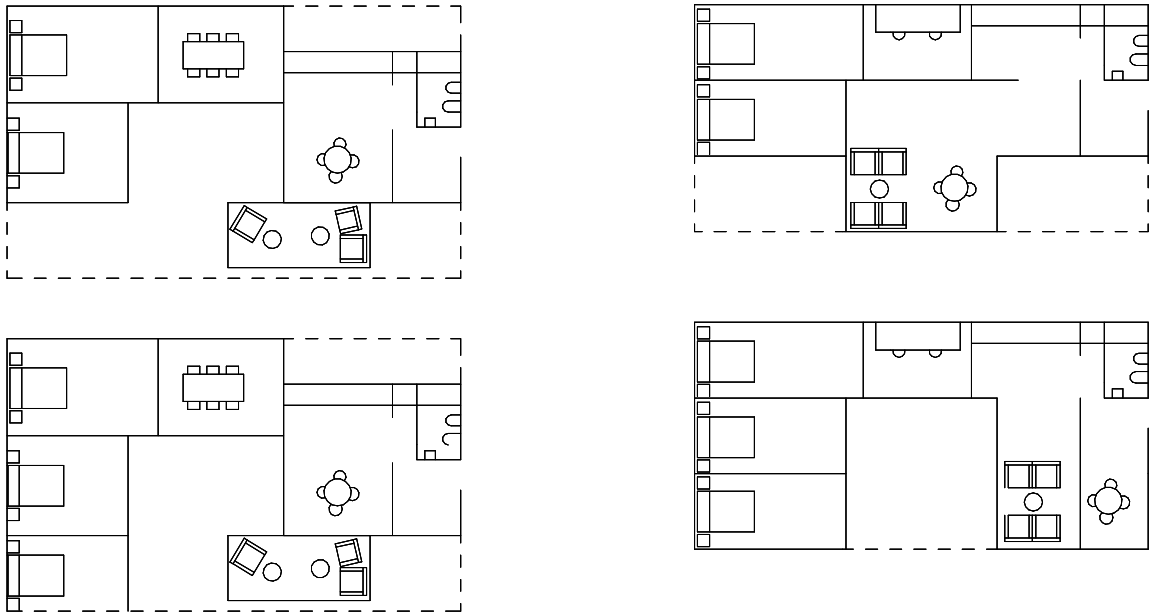
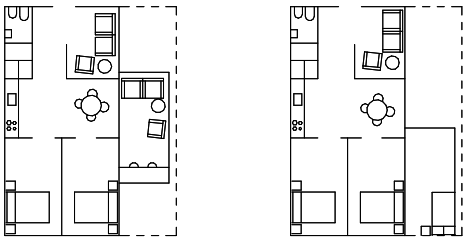
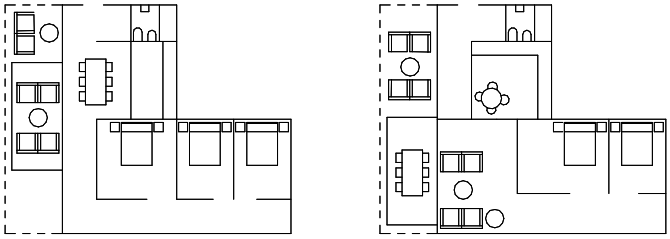


Figure.4.7: Floor plan alternatives

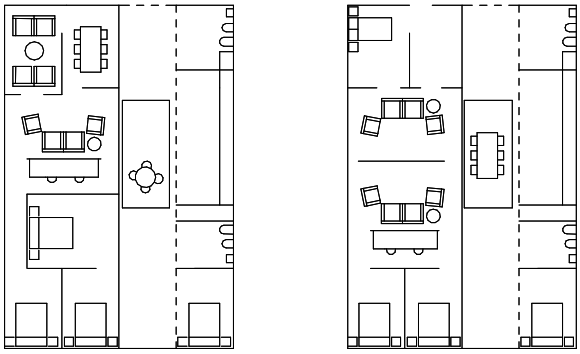
SOCIAL DIVERSITY



Box apartment
(2 BEDROOM)
75m²



L - apartment
(2-3 BEDROOM)
100m²



Strip - apartment
(2-5 BEDROOM)
150m²

0 1 3 5m

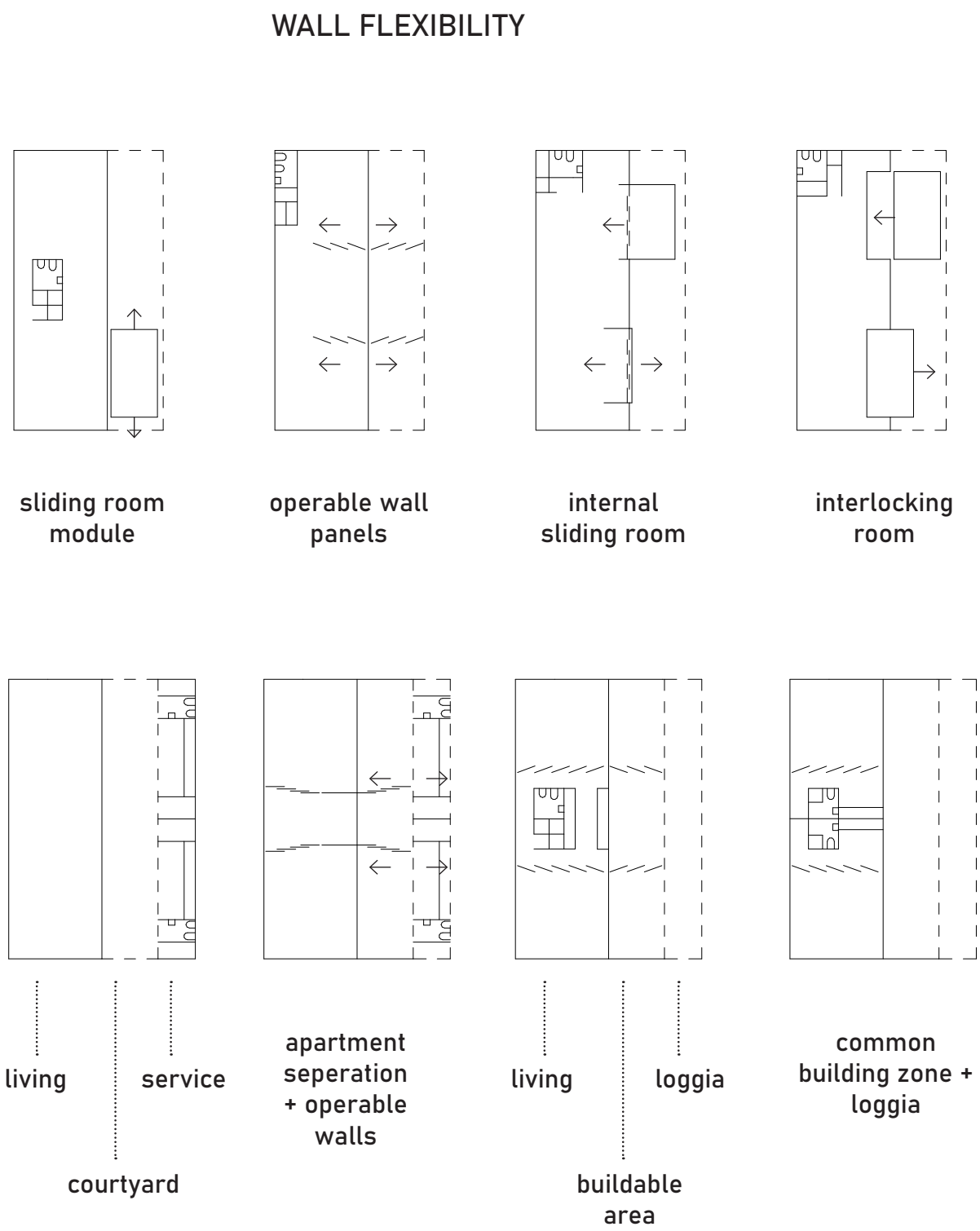
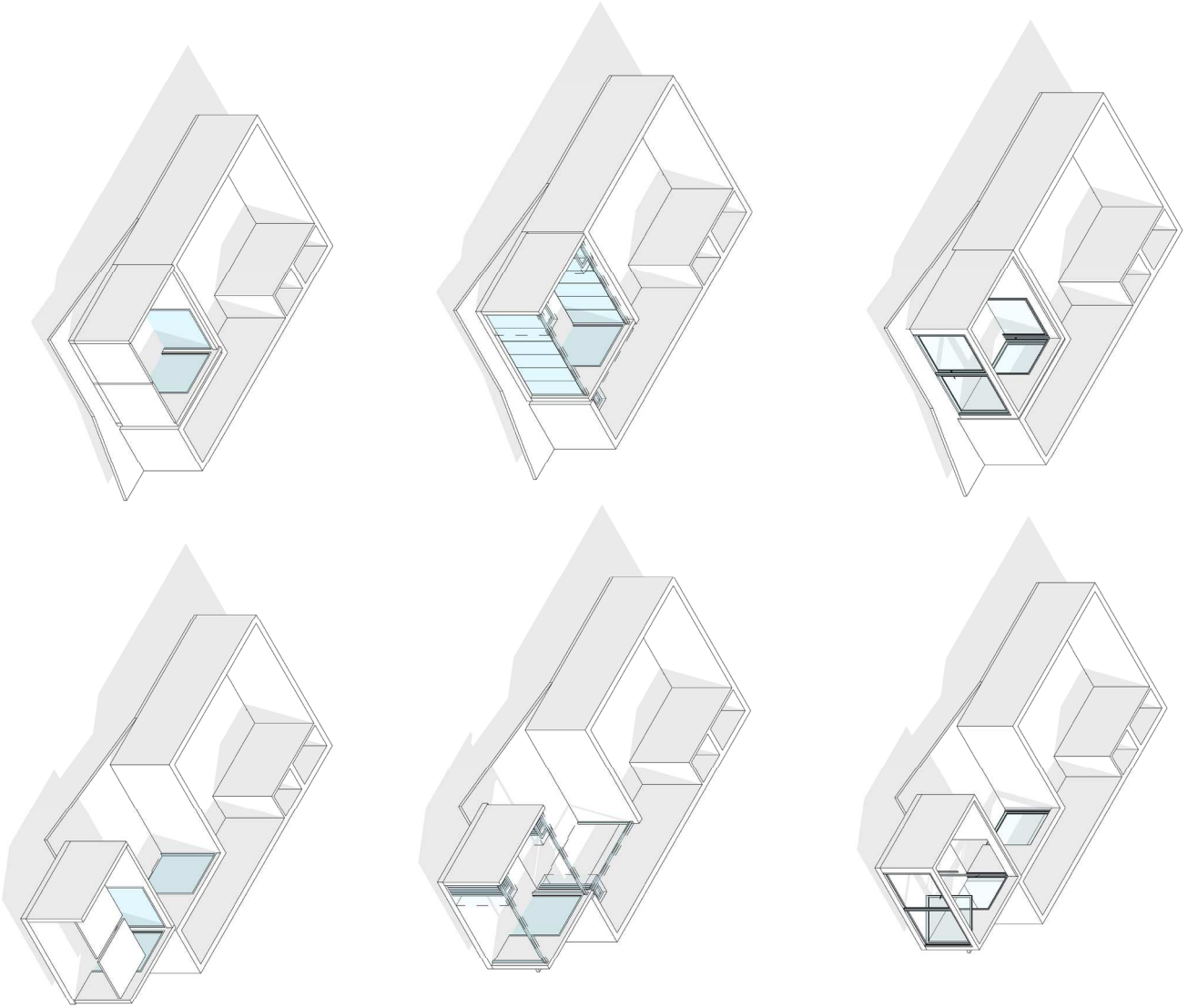
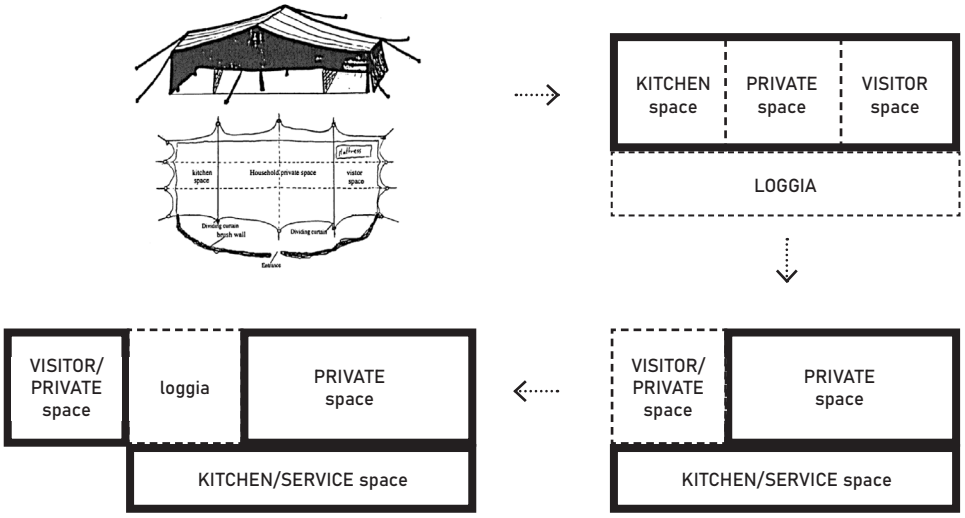


Figure.4.8: Floor plan alternatives



apartment type 2



By rearranging these previously mentioned 4 spaces (loggia, private, visitor, kitchen/service) , a new arrangement is created with the moving module elsewhere. By keeping the service/kithen space along the semi-private flexible loggia space, the private space can be situated opposite while allowing part of the rectangular basic module to be moved inwards and outwards to create a loggia space

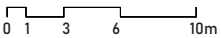
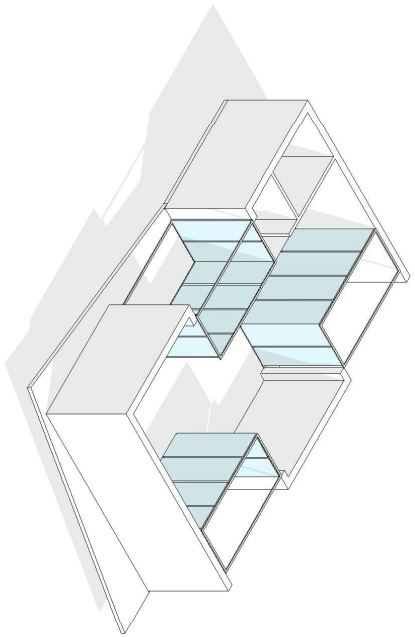
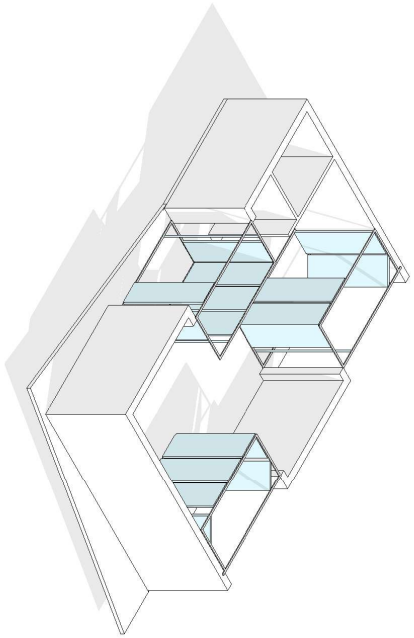
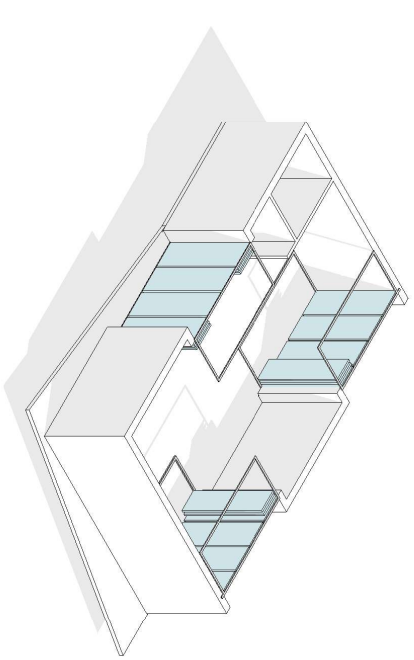
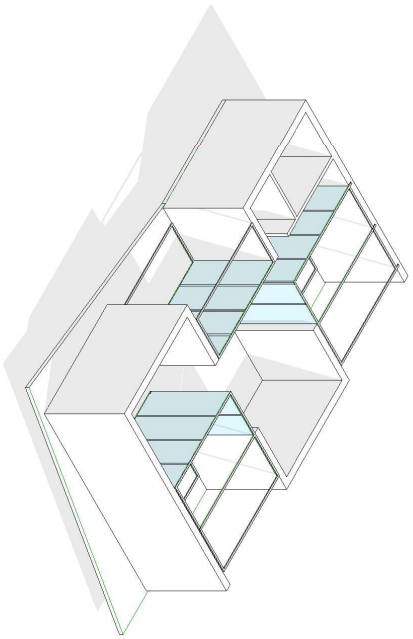


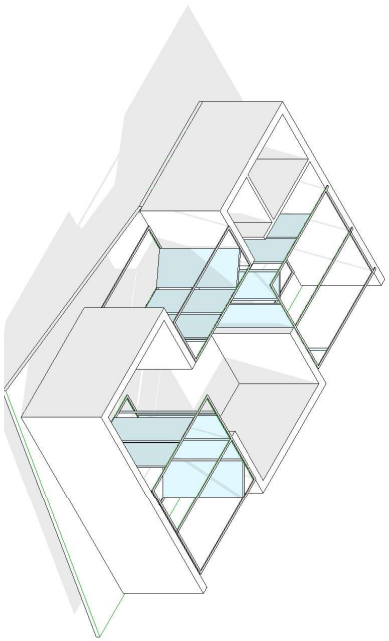
Figure.4.9: Apartment type 2 schematic floor plans

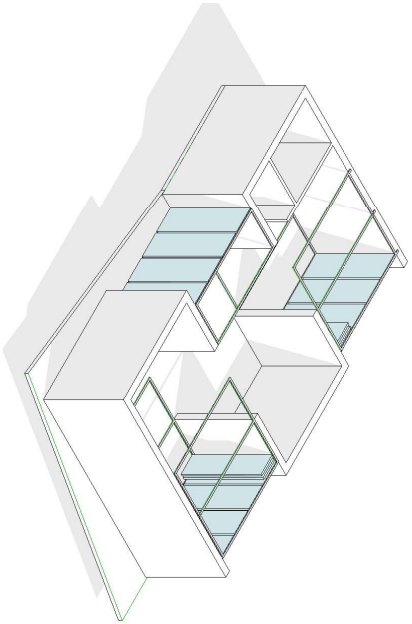




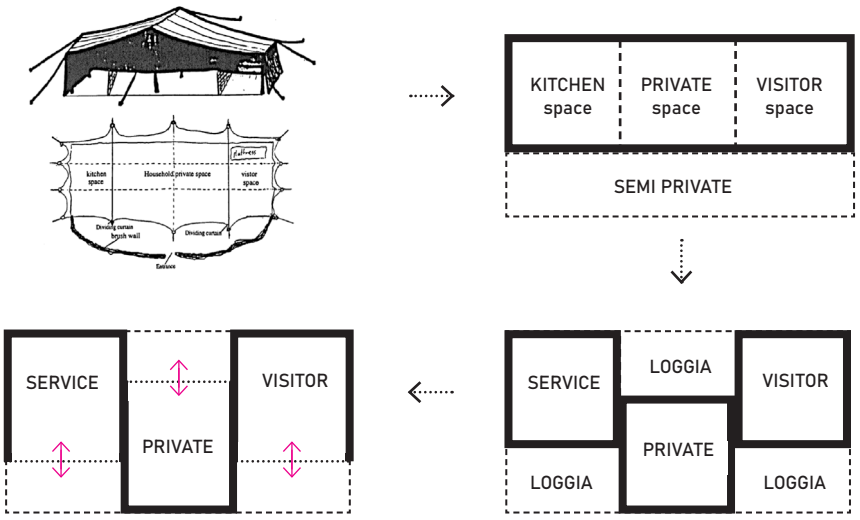








apartment type 3



The shifting of these 3 spaces (private, visitor, kitchen/service) has created 3 flexible loggia spaces. The use of a sliding wall system can make the loggia spaces smaller or larger. The wall system consists of operable panels (translucent, transparent, opaque or a mix depending on user preferences) which allows additional spaciousness to be created.

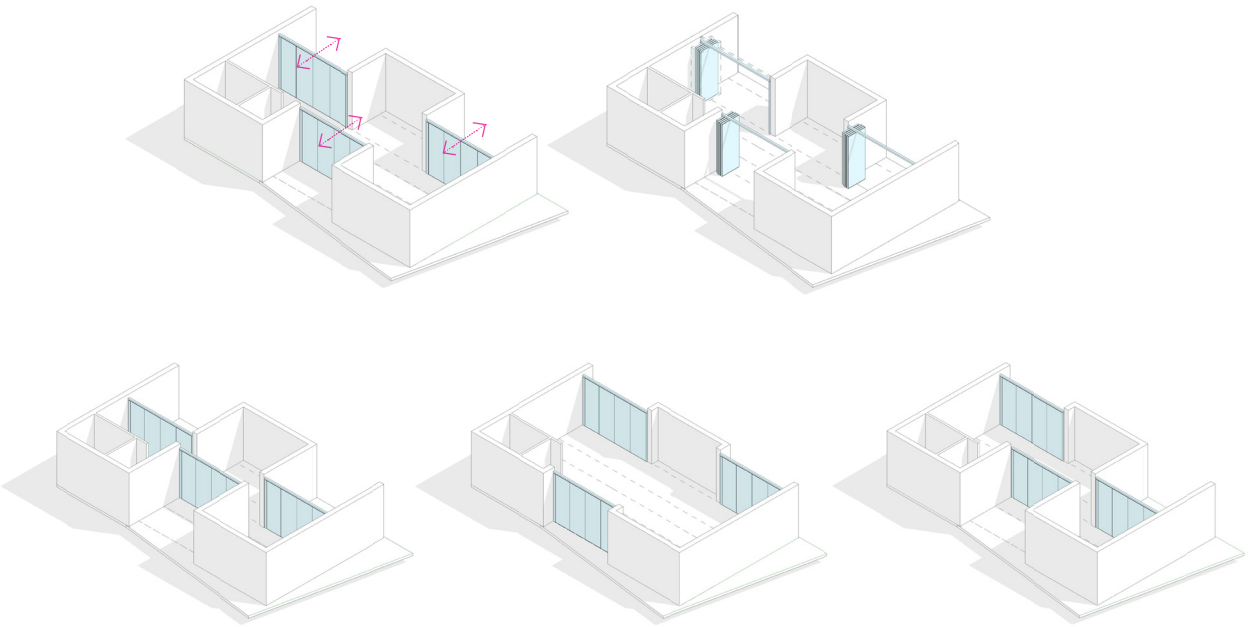
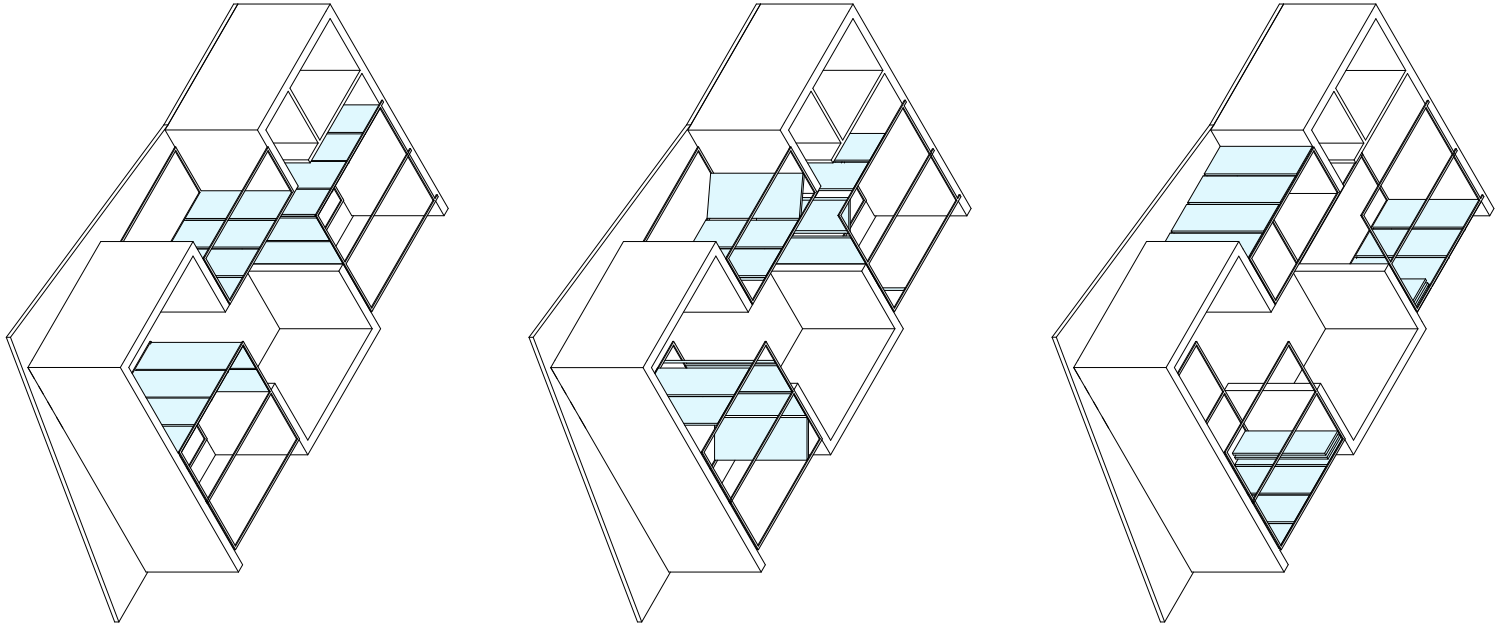
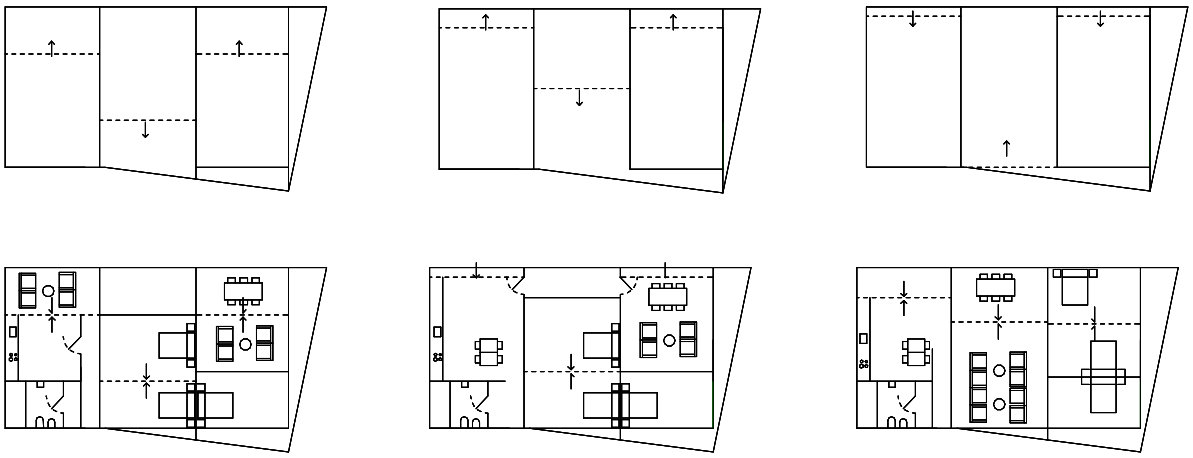


Figure.4.10: Apartment type 3 schematis



sliding walls



sliding module + sliding walls

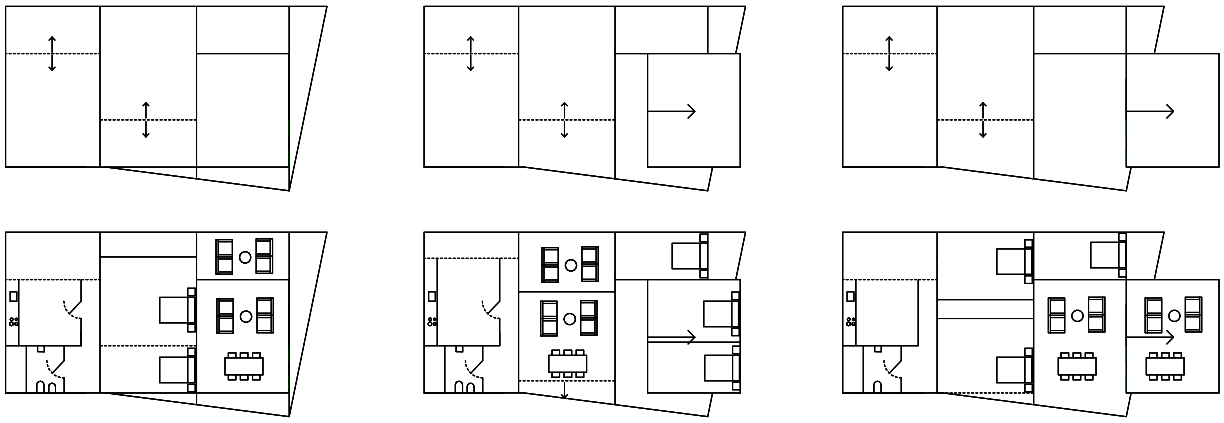
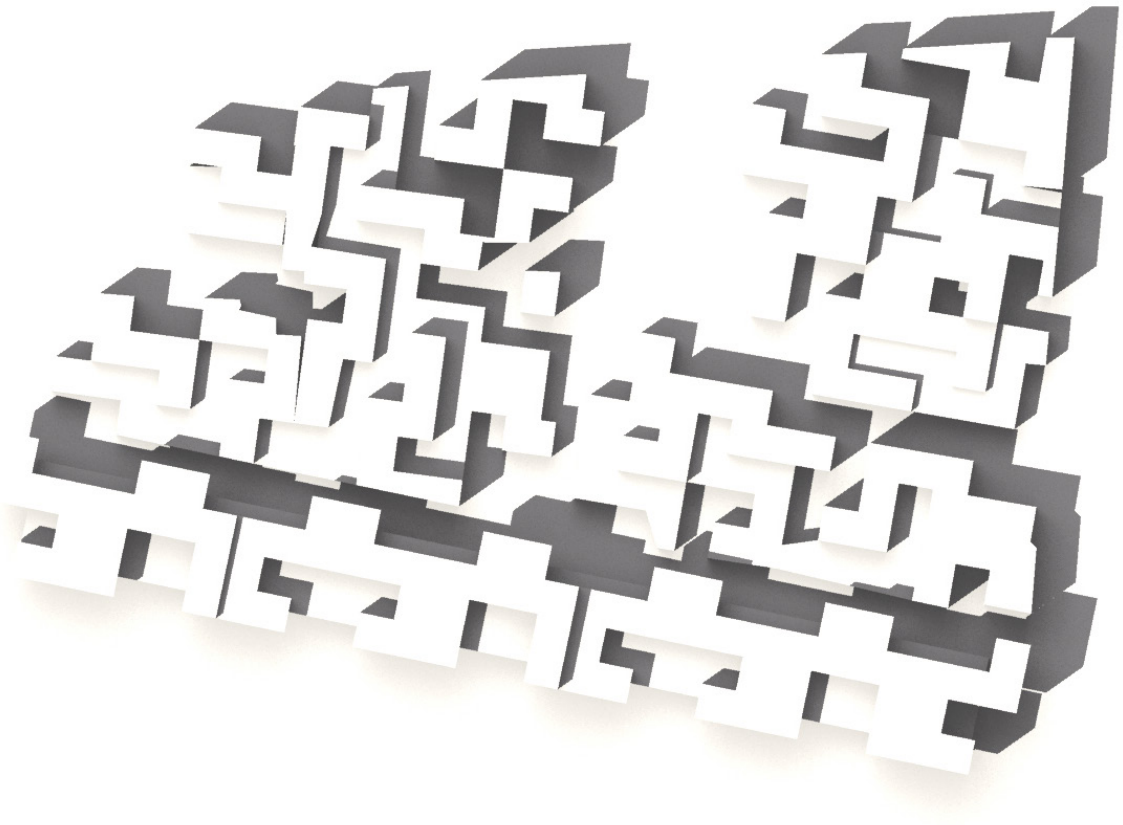


Figure.4.11: Apartment type 3 schematic floor plans

4.5



The tesselation pattern has has been used as the base for the urban masterplan. It allows to be repeated and connected with each other in different constellations. By removing the singular unit of the pattern and by changing its heights, different spatial relationships can be created.

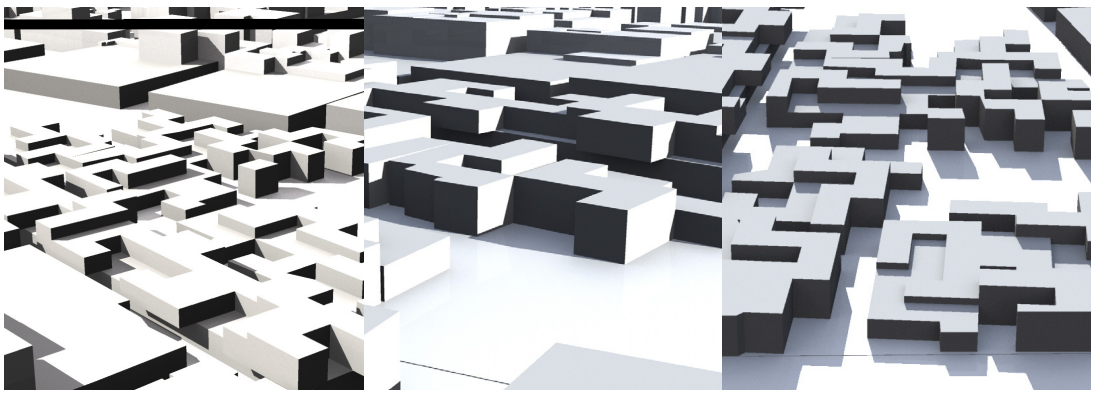
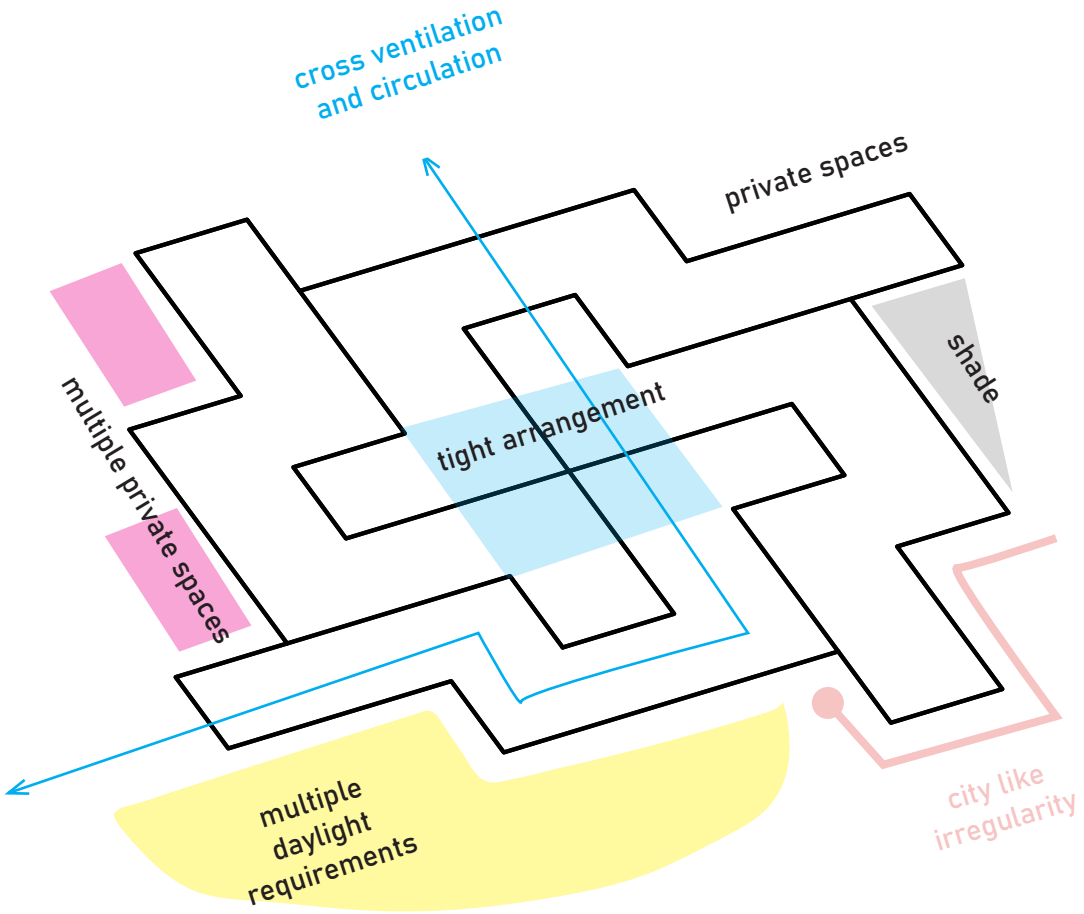


Figure.4.12: Urban Concept Schematics

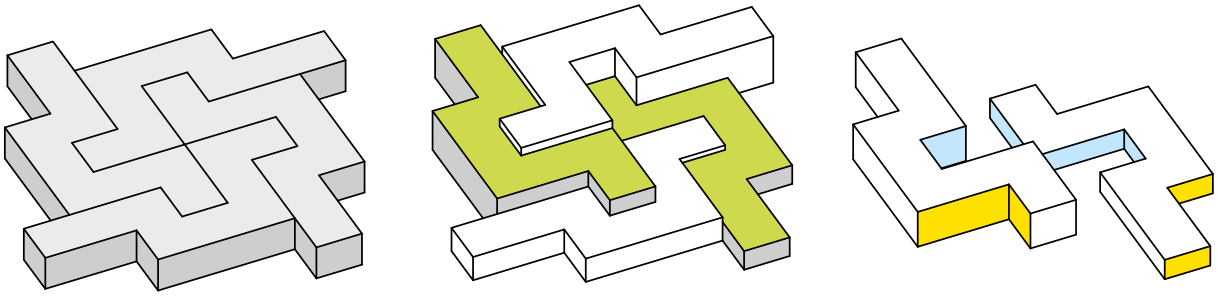
urban concept



irregular city-like growth and connectivity

various heights per module to create more individualized roof-tops as well more privatized loggia spaces and shaded spaces

breaking up individual modules for private/public internal courtyard spaces aswell



To further modularize the tesselation pattern, the singular shape has been broken down to the most important residential components , the living space (the dwelling units), the circulation units and the communal units. This will help to further rearrange the modular parts in different locations where necessary.

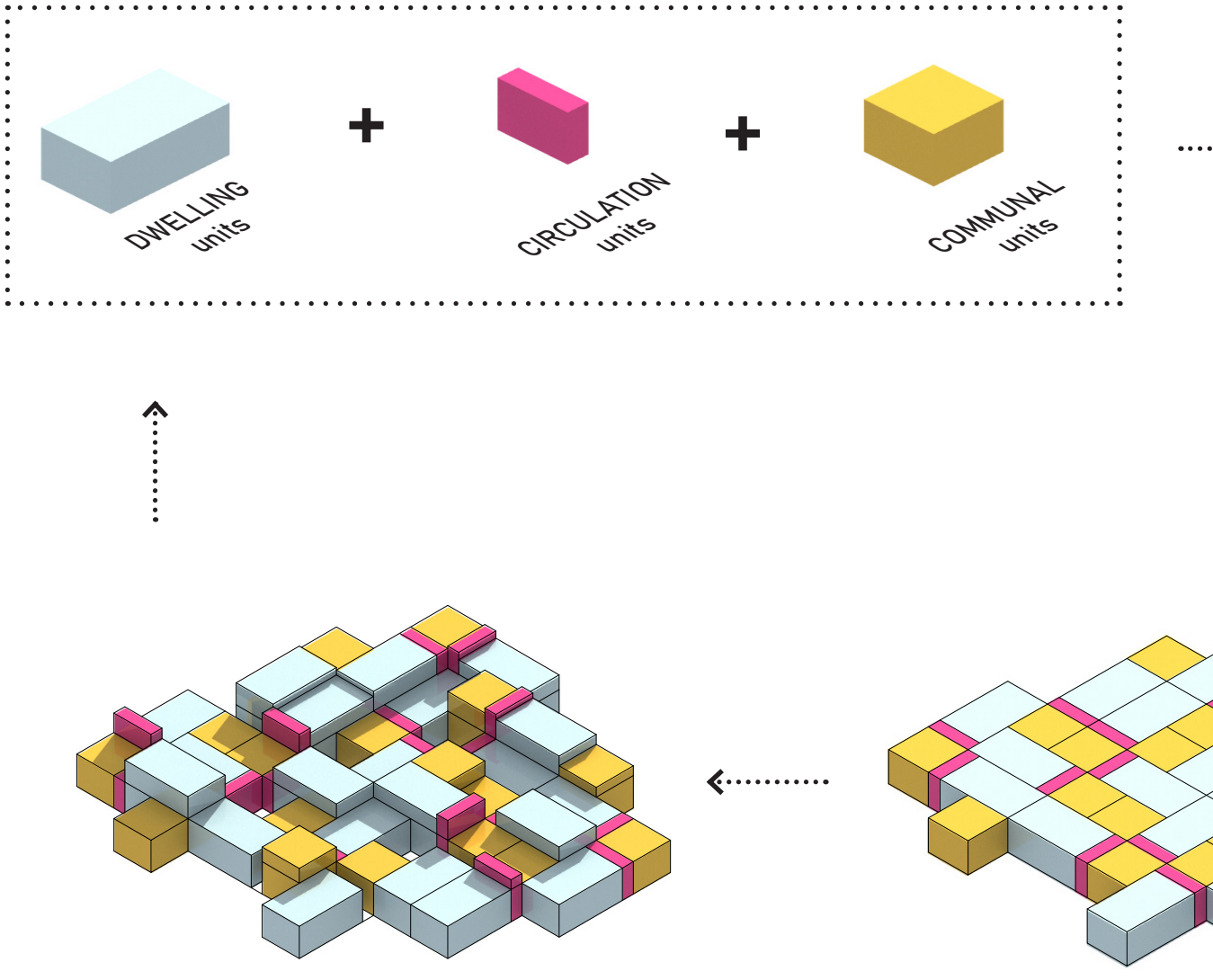


Figure.4.13: Urban concept modular pattern

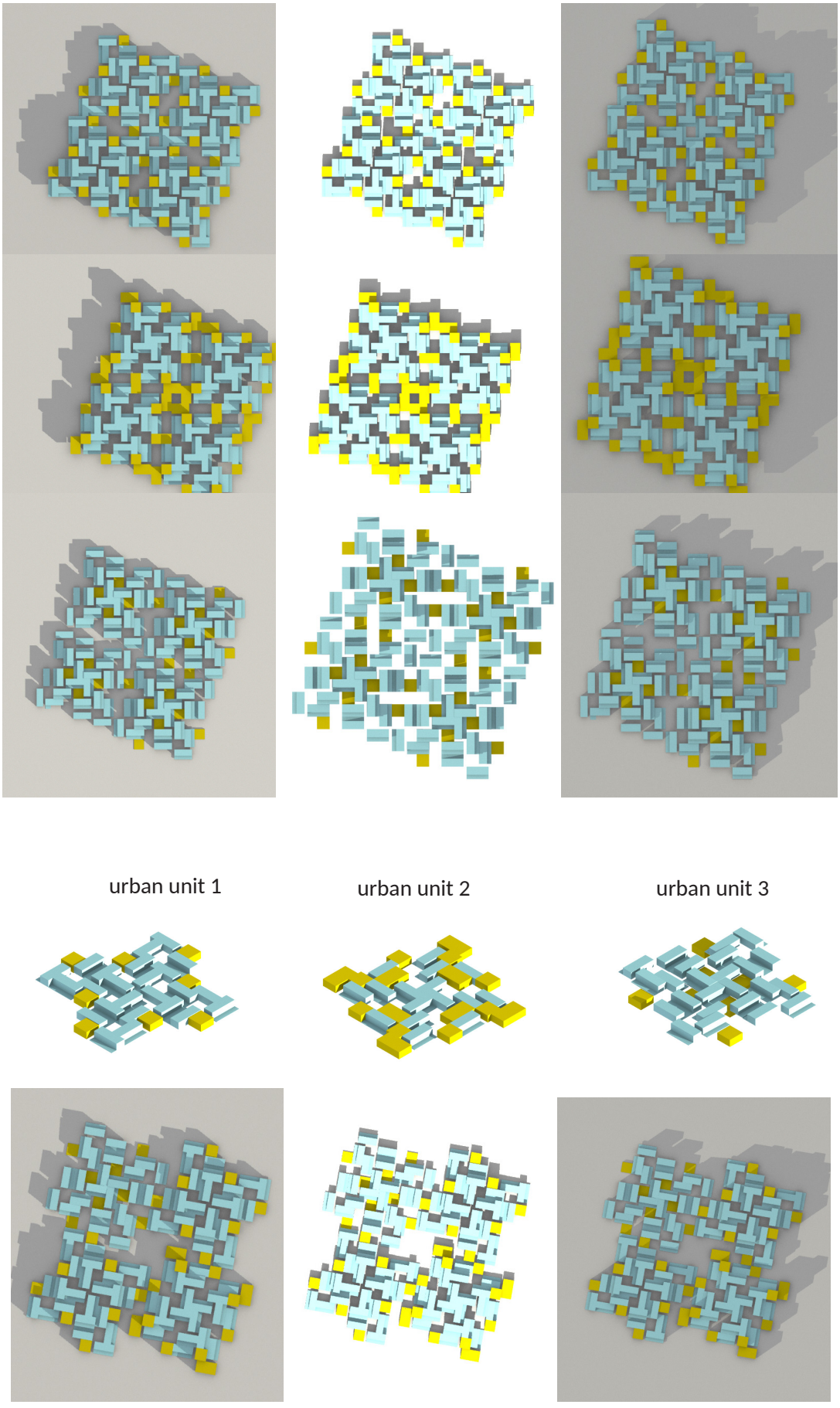
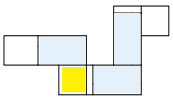
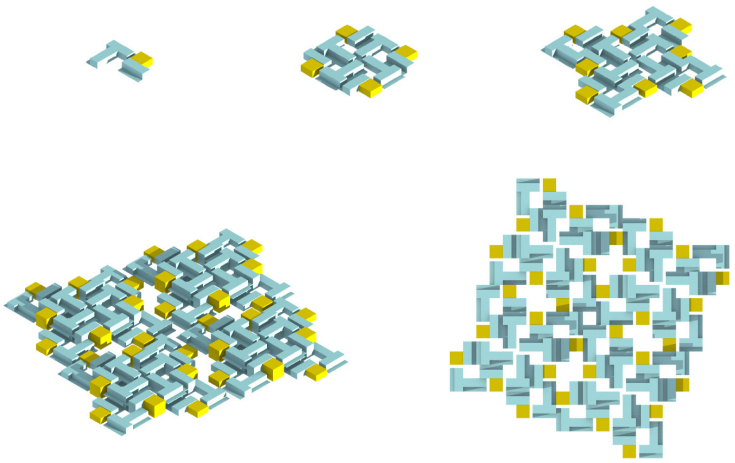


Figure.4.14: Urban units - interlocking patterns with daylight studies

urban unit 1

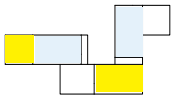
3 apartment units
2 communal unit
2 circulation units

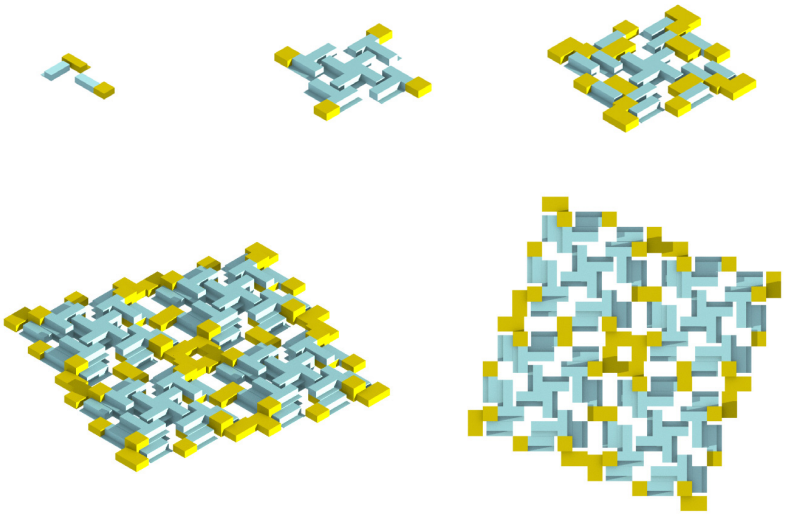




urban unit 2

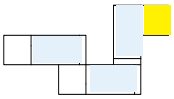
2 apartment units
2 communal units
2 circulation units

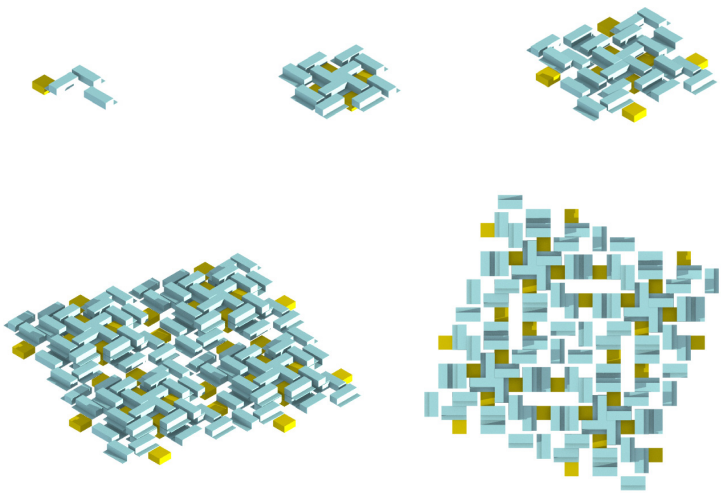




urban unit 3

3 apartment units
1 communal unit
3 circulation units





4.6

precast concrete components

Precast concrete elements can also be a fast and cheap modular construction approach because all the elements are fabricated off site and rapidly erected on site. Elements can include frames, beams, walls, columns and floors. Recycled concrete can be used and existing modular elements can also be re-used due to their durability. Modular composite systems like precast insulated concrete panels are made of an insulation layer between two layers of concrete. The panel is held together by shear stands and prestressed steel strands. This would also be an alternative for a precast wall panel system.

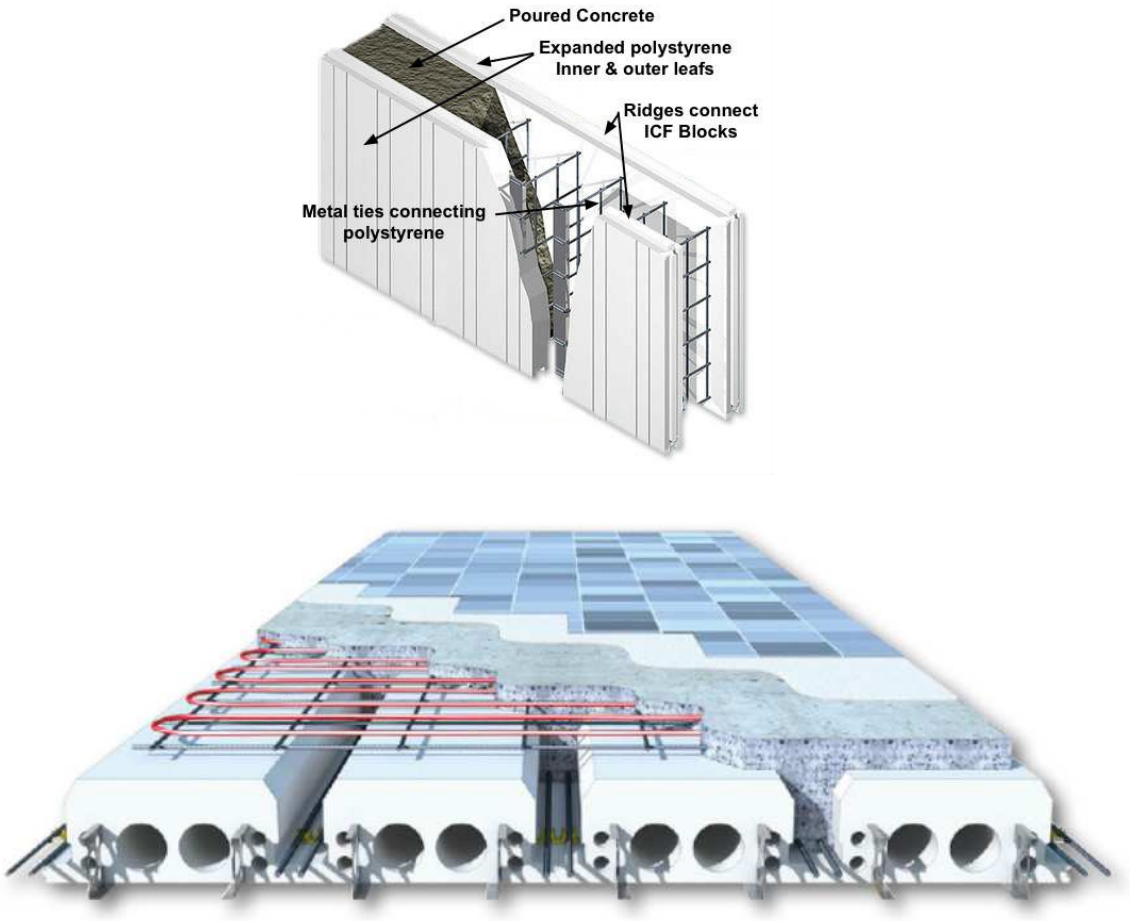


Figure.4.15: Insulated Concrete Formwork (ICF) sections and illustrations

insulated concrete formwork

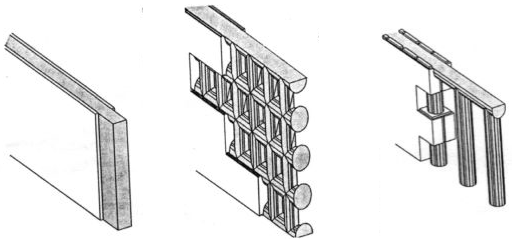
Insulating concrete forms (ICF) building systems are made of modular large polystyrene blocks that interlock to form the desired building shape. Concrete is than poured inside the blocks of the wall structure to bond them to each other. Each block is made of two insulation pieces connected together by metal ties. Before the blocks are filled with concrete, the walls are supported with shuttering which braces the polysterene before and after the pouring of concrete, otherwise it would burst. The forms are designed to provide insulation, nailing surfaces, and a vapor barrier all at once.ICF can come in the form of a block (similiar of concrete masonry unit), panel or as a plank.

Benefits of ICF include:

- modular building product
- major structural component, exterior and/or interior
- excellent insulation properties/ high performance thermal resistance
- excellent air tightness (minimum amount of joints) / Vapor and Air barrier
- liquid moisture resistance barrier /reduces cold bridging
- high thermal mass capacity (slows down heat transfer)
- low U-Value and Fire resistance rated assembly
- could be made of recycled polystyrene
- long term sustainability and economical
- low skilled labour required
- Sound attenuation rated wall
- Substrate for direct application of exterior and interior finishes
- Safer construction site with less waste

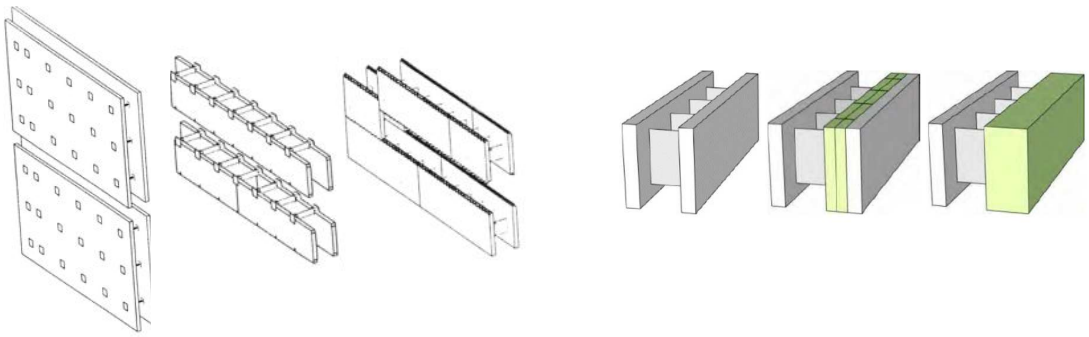
Types of ICF walls

1) flat wall 2) grid-grid 3) post and beam



Types of ICF forms

1) panel 2) plank 3) block EPS sizes can be optimized



Doors and Windows: A wooden or vinyl buck is installed around the opening before the concrete is poured.

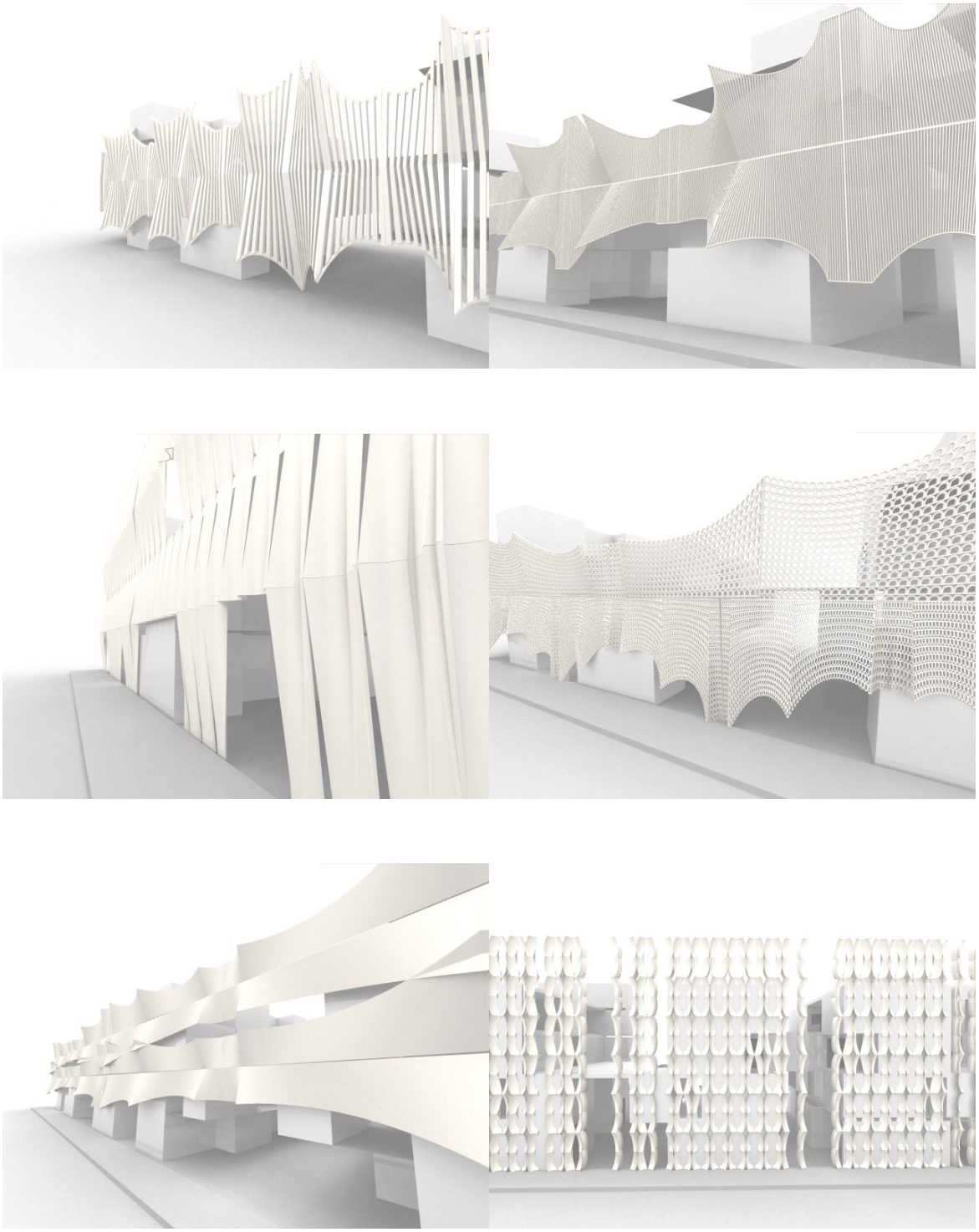
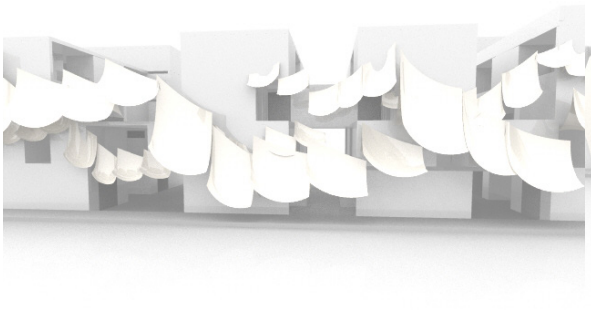
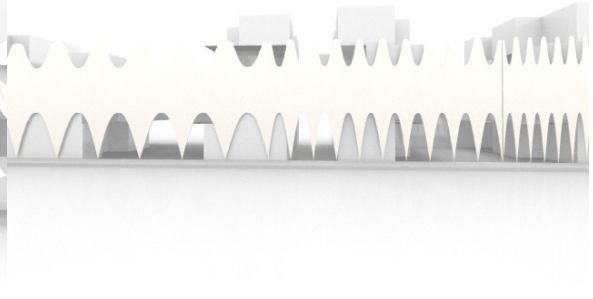
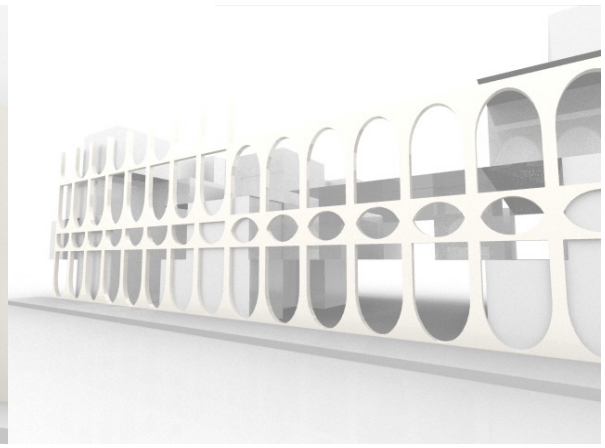


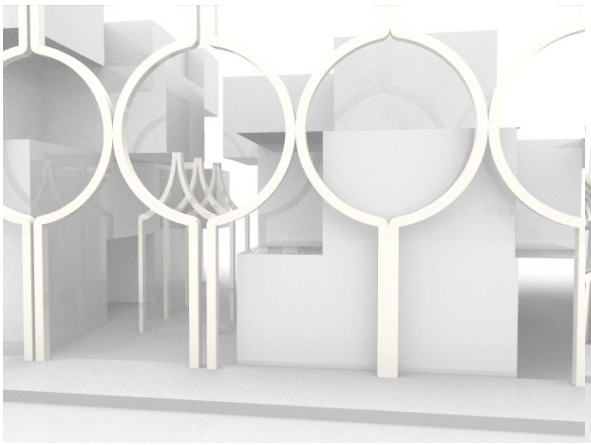
Figure.4.16: Facade experimentations

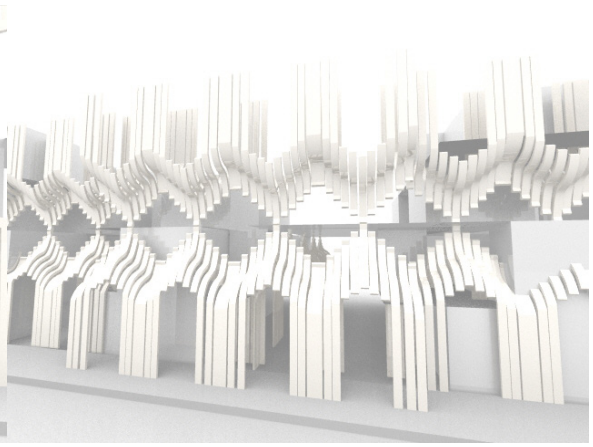
facade experimentation











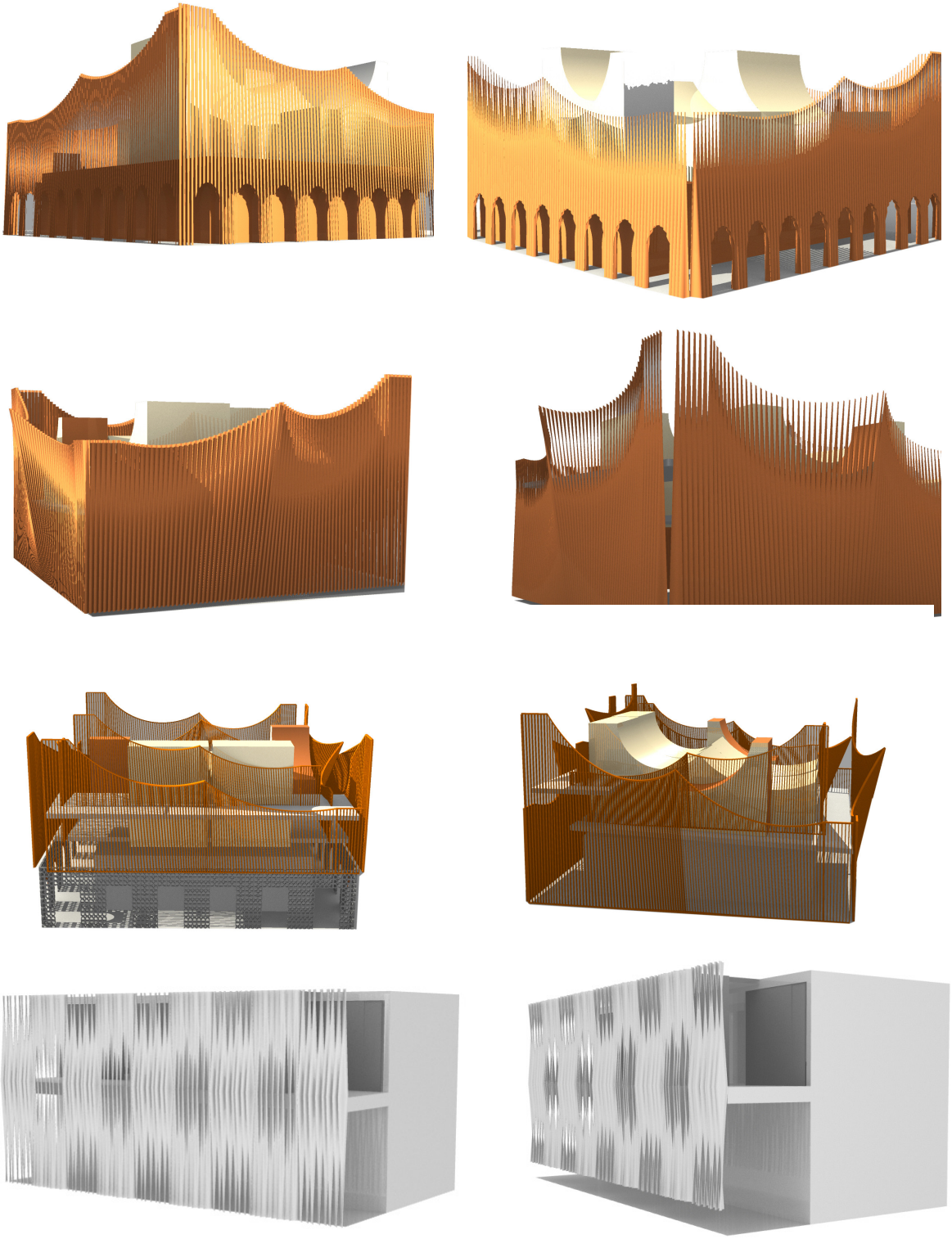
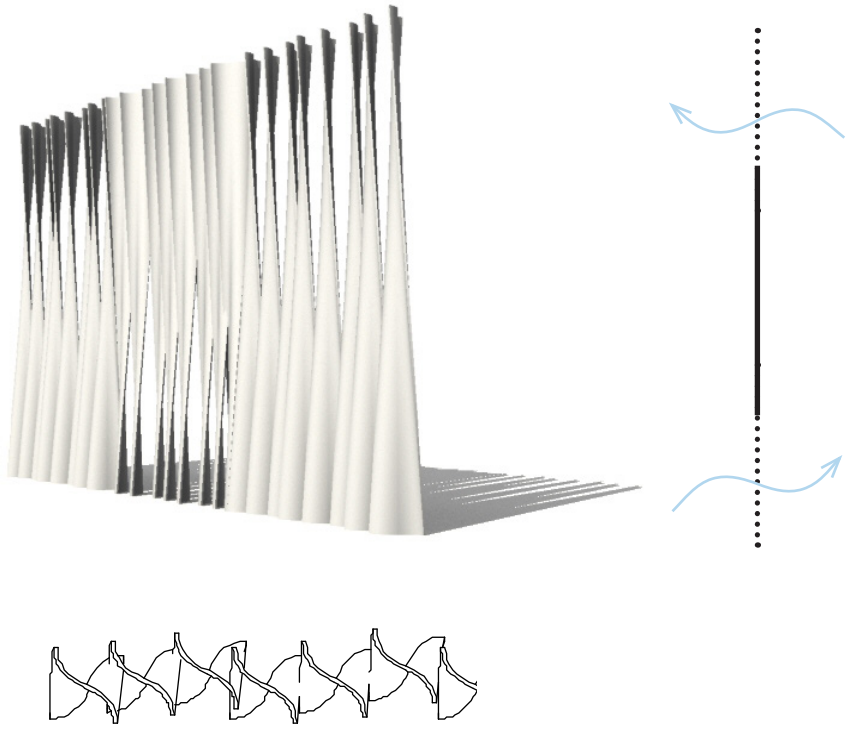
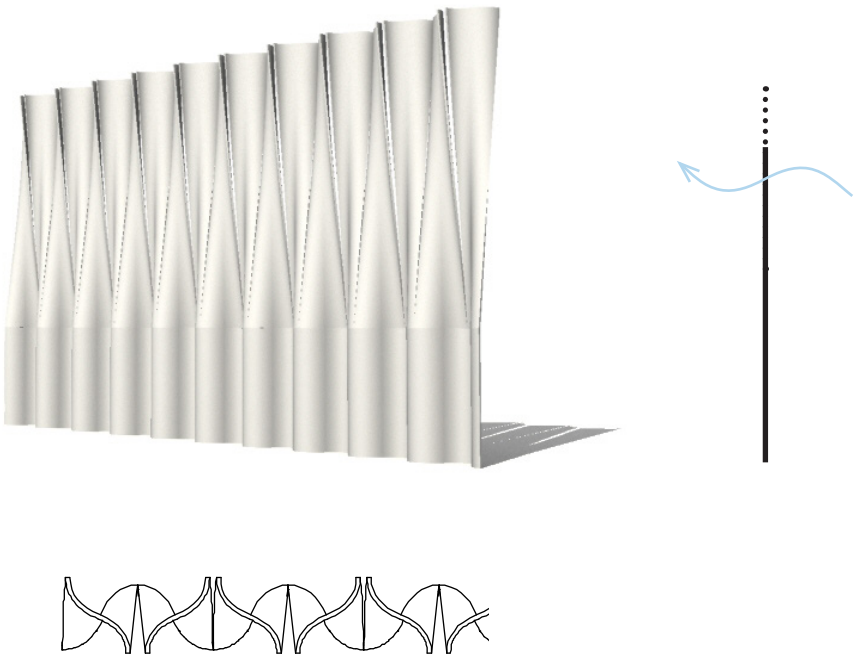
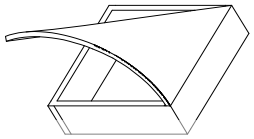
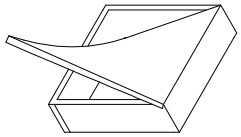
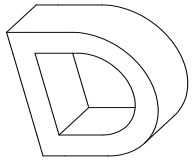
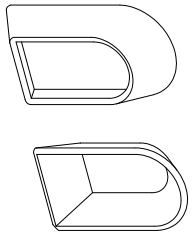
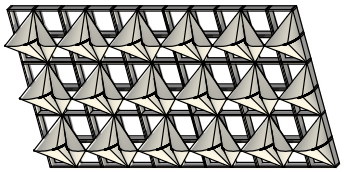
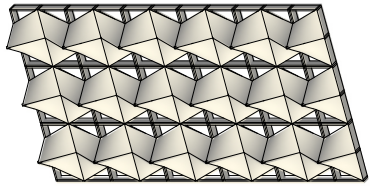
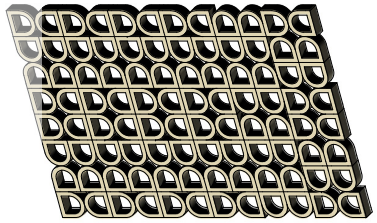
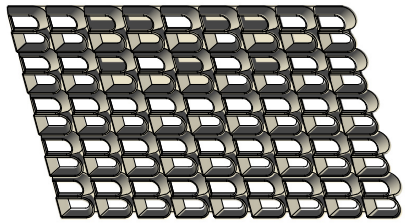
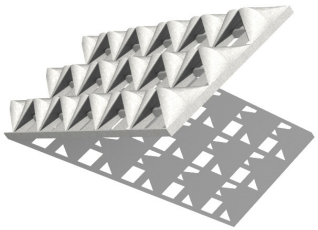
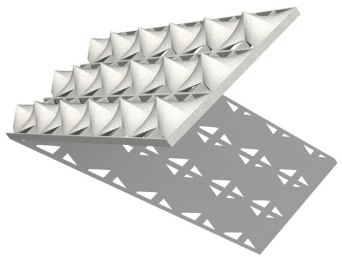
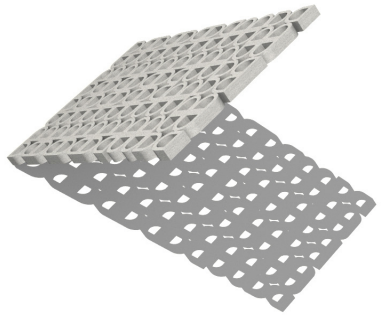
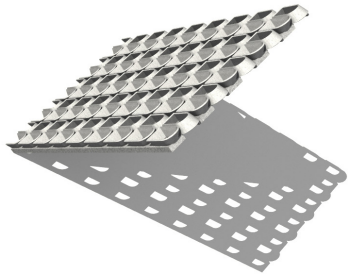


Figure.4.17: Louvre facade experimentations

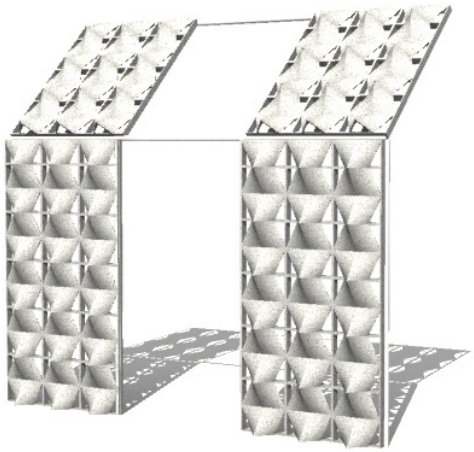
louvres ideas



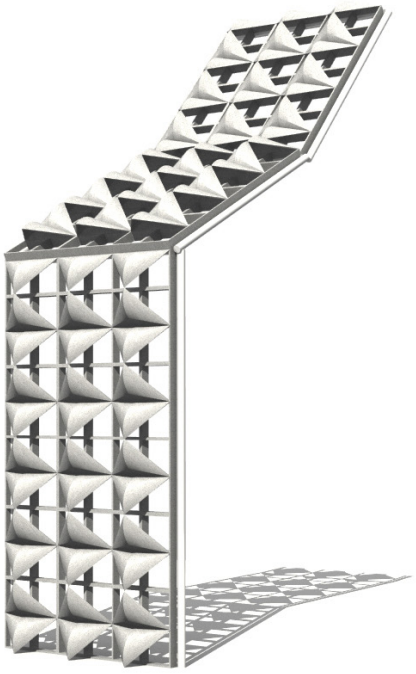


perforated concrete blocks

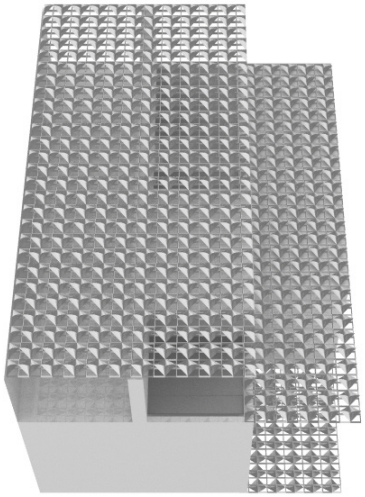


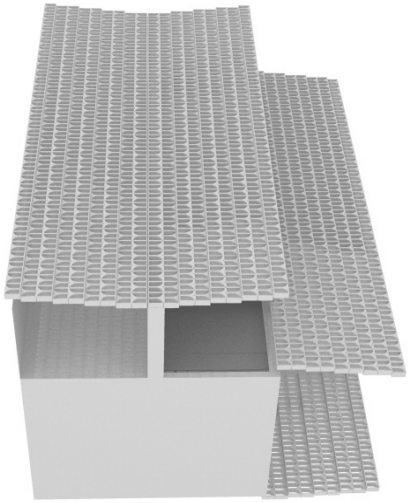
Ventilation or breeze blocks are an old aesthetic and functional architectural intervention, especially for hot climates that allows air and light to enter the space while creating a certain degree of privacy. This approach allows for a multidimensional facade play where residents can also take part on which mold form their prefer. They can be manufactured from concrete, ceramic or even terracotta. Different stacking arrangements, similar to stacking bricks with different bonds and thickness can bring various results to further individualize the process.

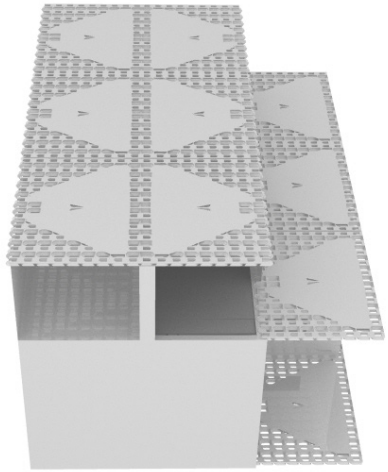


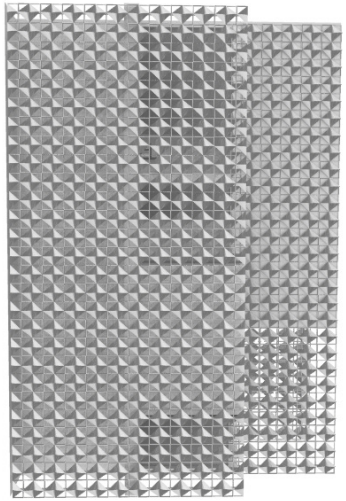
Perforated concrete/cement blocks can be joined like brick masonry in various types of bonds and various degrees of porosity. Concrete masonry units (CMU) of varying sizes can also be joined vertically to create a perforated cladding system. Due to high density fibre and high performance concrete, perforated concrete panels can be punctured in different shapes and sizes and to varying thickness to create a perforated facade system. Architectural decorative concrete blocks can also be stacked to create a perforated facade. These can be made by hand with a simple mold and a variety of sizes of machinery exists to automate the process. They can be made at low cost, easily manufactured and provide security, diffused light and airflow. With architectural decorative blocks, molds can be individualized and building appearances can be further personalized based on preferences.

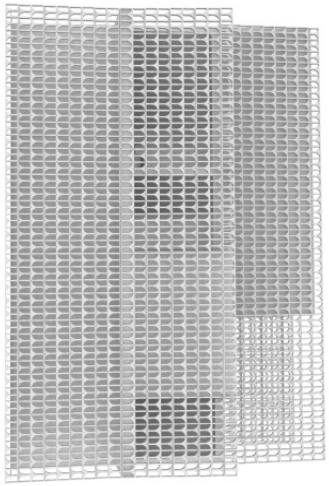
Figure.4.18: Concrete block experimentations

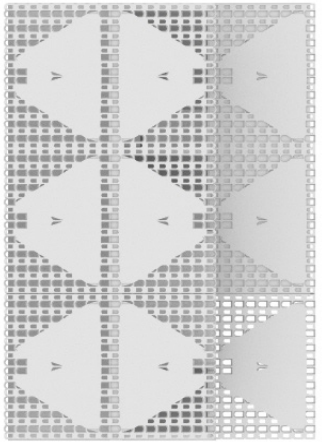












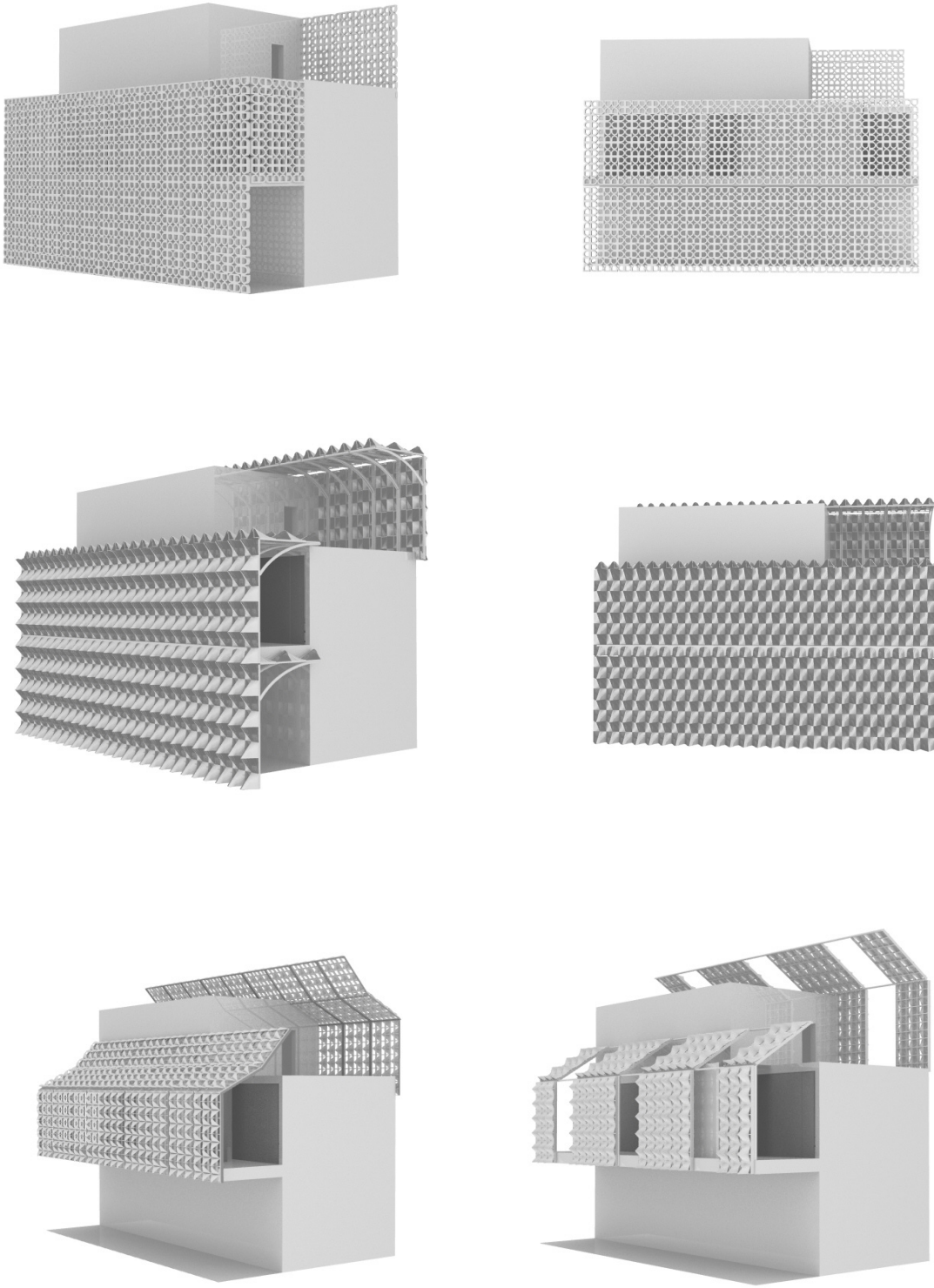
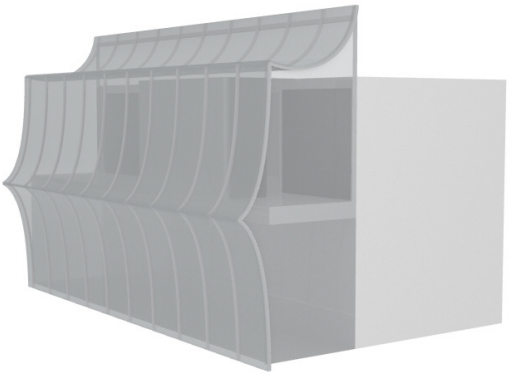
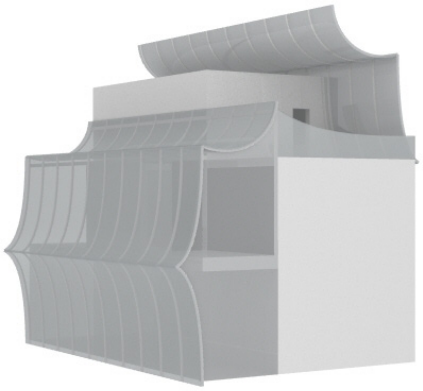
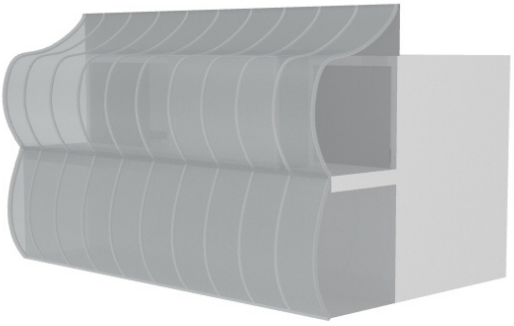
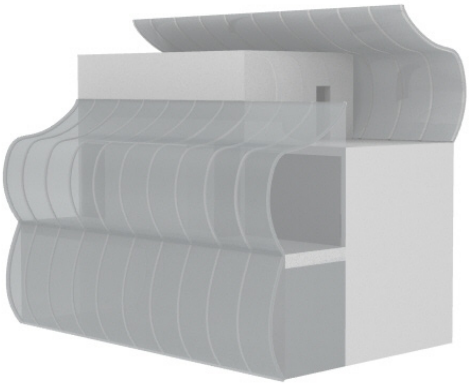


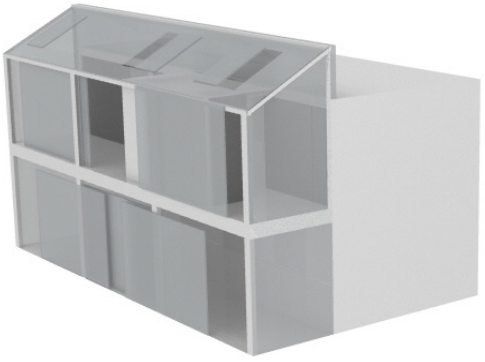
Figure.4.19: Concrete block facade experimentations

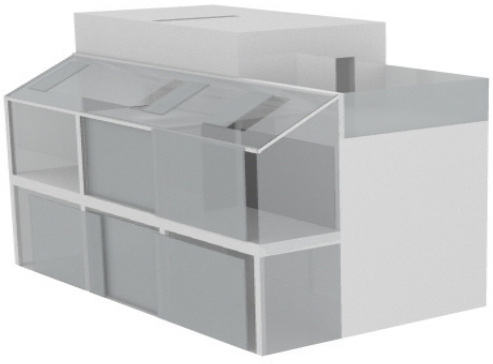


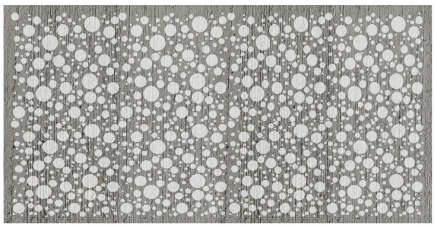












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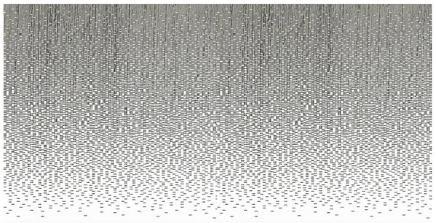
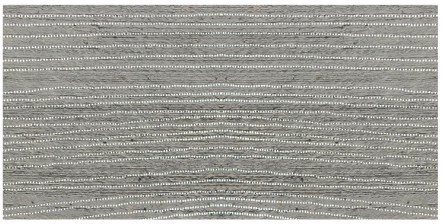


gradient



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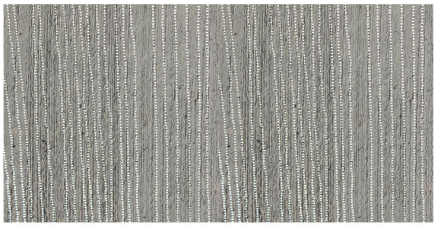

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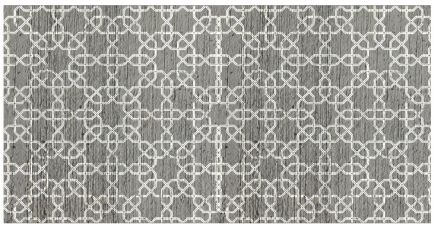


pattern

image

translucent concrete

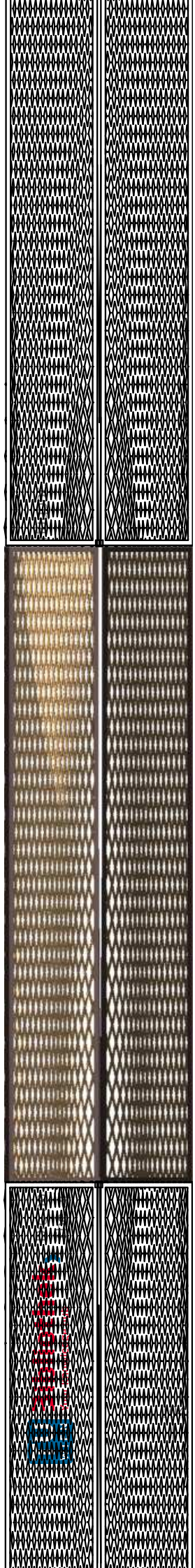
Translucent concrete was invented by architect Losonczi in 2001 and his formula uses very fine gravel aggregate to encase optical fibers that then allow light to transmit from one side of a block to the other side. Translucent concrete has light transmissive properties which is given by the uniform distribution of Plastic Optical Fibres (POF) throughout the concrete body. Optical fibres are hair thin cylindrical fibres of glass or other transparent material which act as open slits carrying the light through the concrete.

The manufacturing process of translucent concrete is not too different from regular concrete. Concrete is usually poured in a mold and on top of each layer, a layer of fibres are infused. 4 to 5% of optical fibres by volume are added to the concrete mixture. Common densities range between 2100-2500 kg/m^3. Transparent concrete is most commonly seen as prefabricated blocks and panels (thicknesses between 20 and 500mm) and can be used as floors, load bearing walls and partitions walls as well as ceiling.

Transparent concrete integrates energy savings by introducing more light and less concrete weight into the building. It provides a high UV value, structtral stability and aesthetic appeal. Costs are generally high, however routine maintenance is not required and costs are expected to decrease.

Figure.4.20: Translucent concrete permeability designs
Figure.4.21: Translucent concrete as sliding panels

4.11



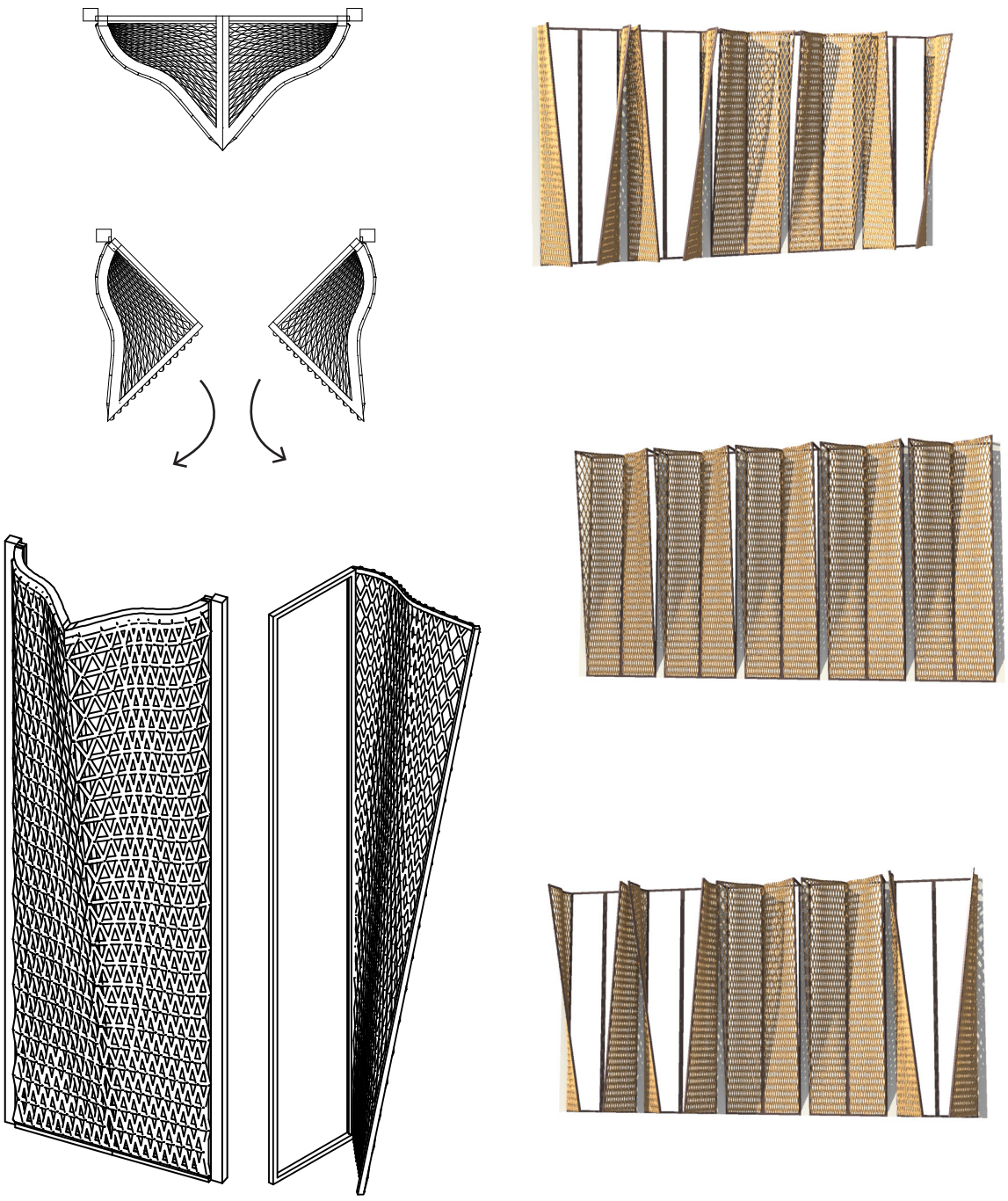


Figure.4.22: Operable/rotating panel from wicker/palm tree/bamboo

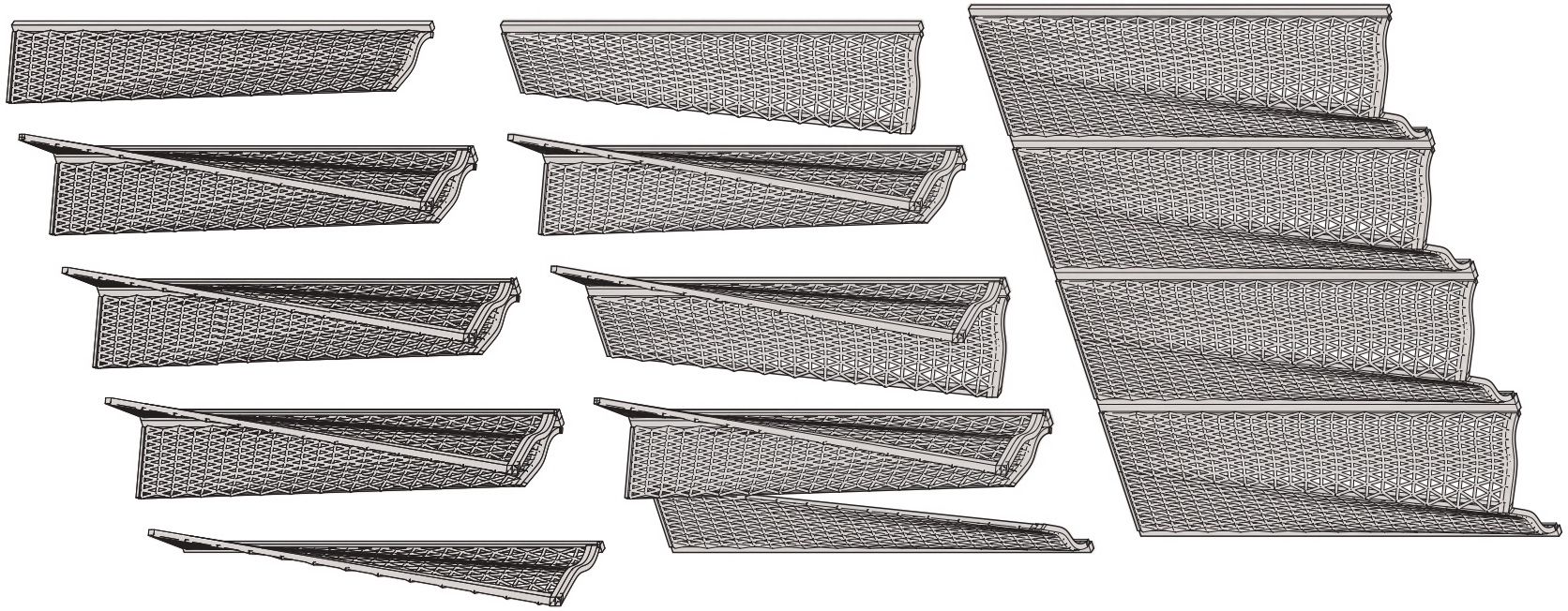
local craftsmanship and palm tree weaving

Traditional Beduin arts and crafts has a history of using the palm tree wood, especially the leaves for making fine crafted baskets, bowls and furniture. This local approach to utilizing a local material is a cultural and social aspect which can be cherished and help enrich the local memory, history and heritage.

Taking this into consideration, my proposal for, primarily the facade, is a paneling system composed of steel panel frames filled with a palm tree leaf weaved lattice. Similar to wicker panels, these panels will be made of palm tree leaves intertwined in traditional bonding method. To strengthen the connections a steel wire mesh framework can be used as a basic to work on.

This approach aims to help reactivate local methodologies and local materials in a modern approach, while using and training local craftsmen to also help reactivate the local arts and crafts scene. The old city center was very rich with arts and crafts workshops and shops, especially focusing on palm tree art, leather goods, jewellery and furniture making. With this in mind, a palm tree paneling facade in the old city will help capture a sense of place and local identity within the residents. Another idea would also to have the palm tree paneling workshop and its employees live and work in this housing complex.

Figure.4.23: Images of Weaving references



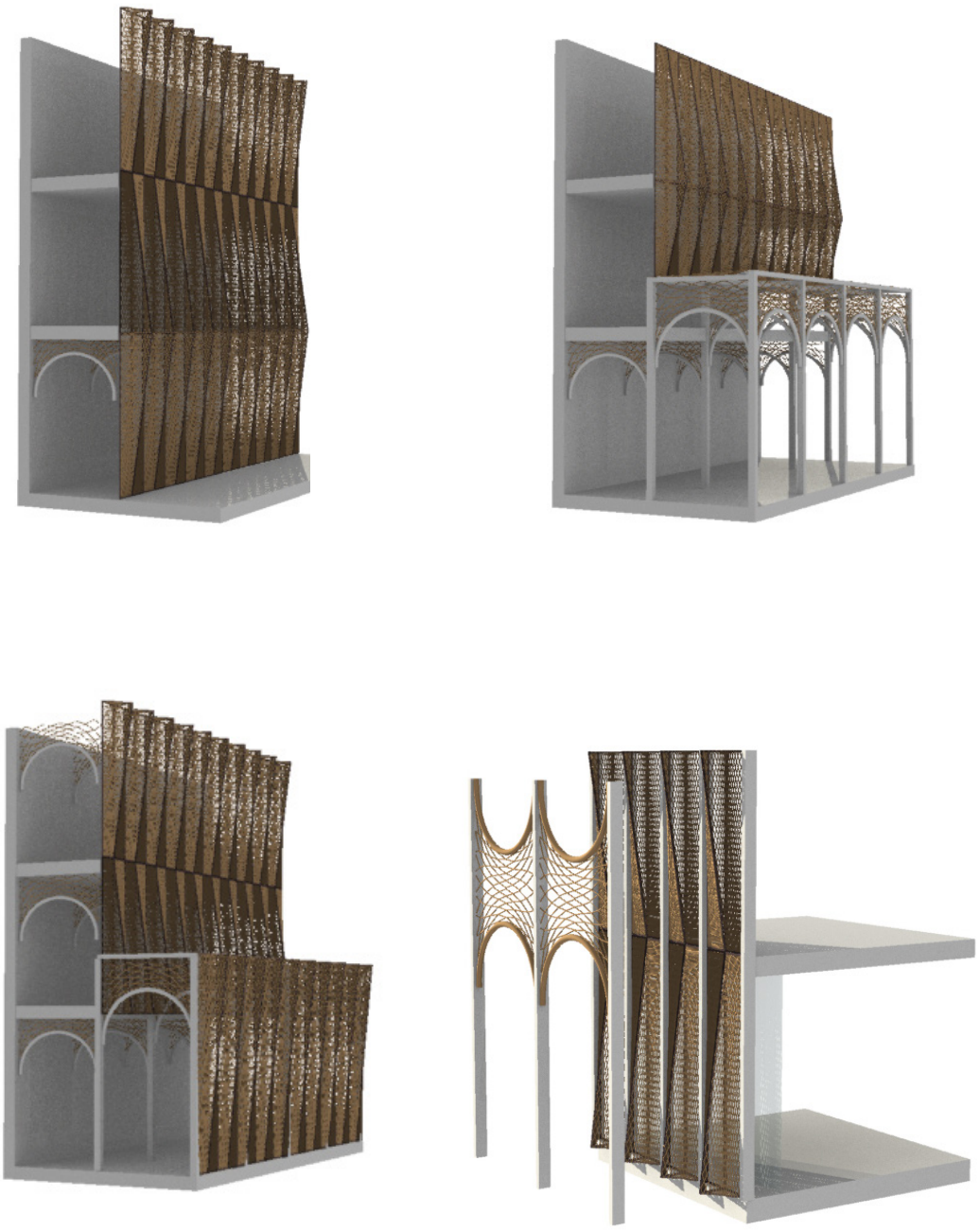


Figure.4.24: 3D representations of weaved wicker

05 project proposal

5.1

Figure.5.1: Site plan

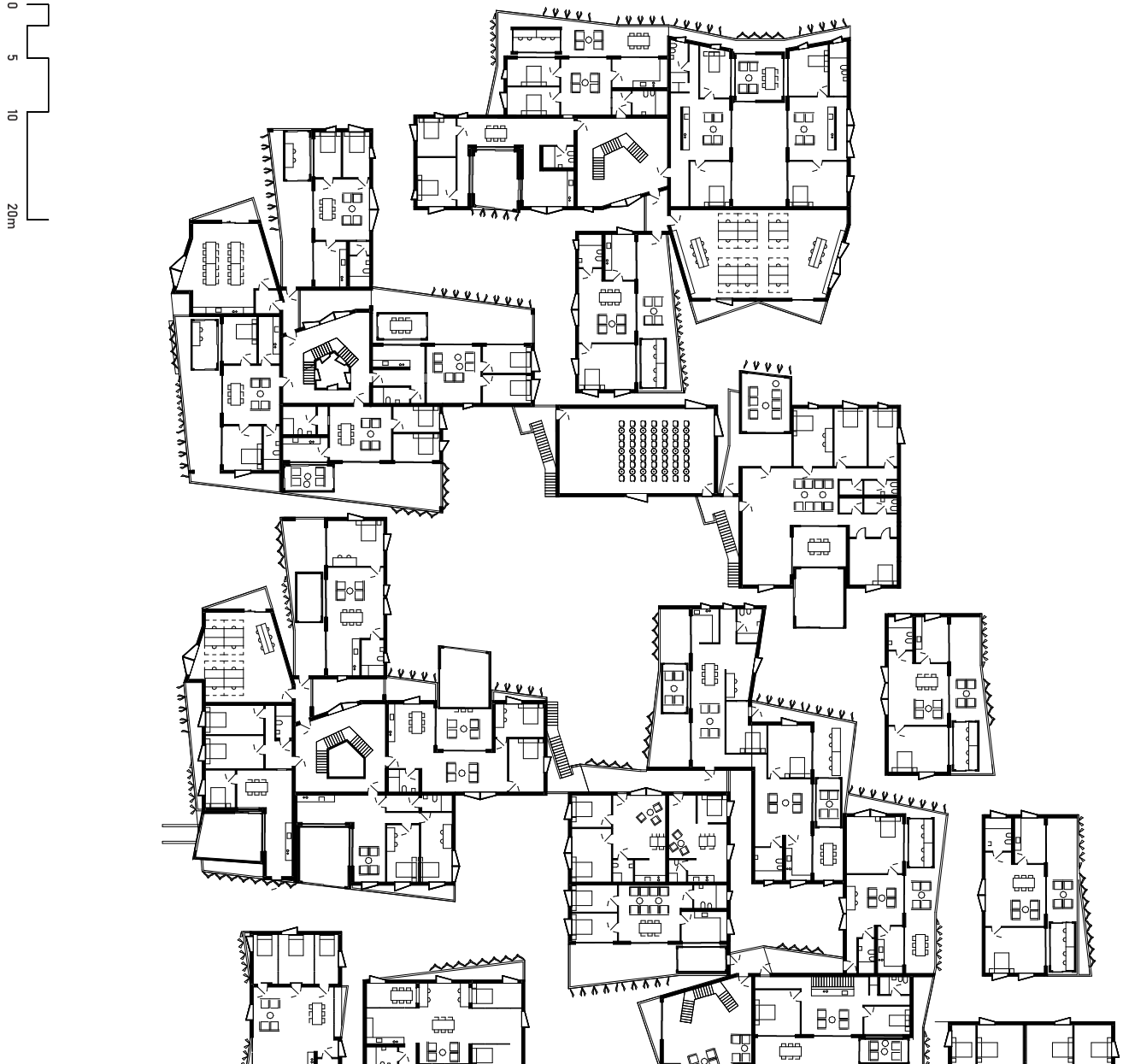
site plan

0 10 20 60m

1:2000

ground floor masterplan

Figure.5.2: Ground floor masterplan layout **(±0.00m)**



first floor

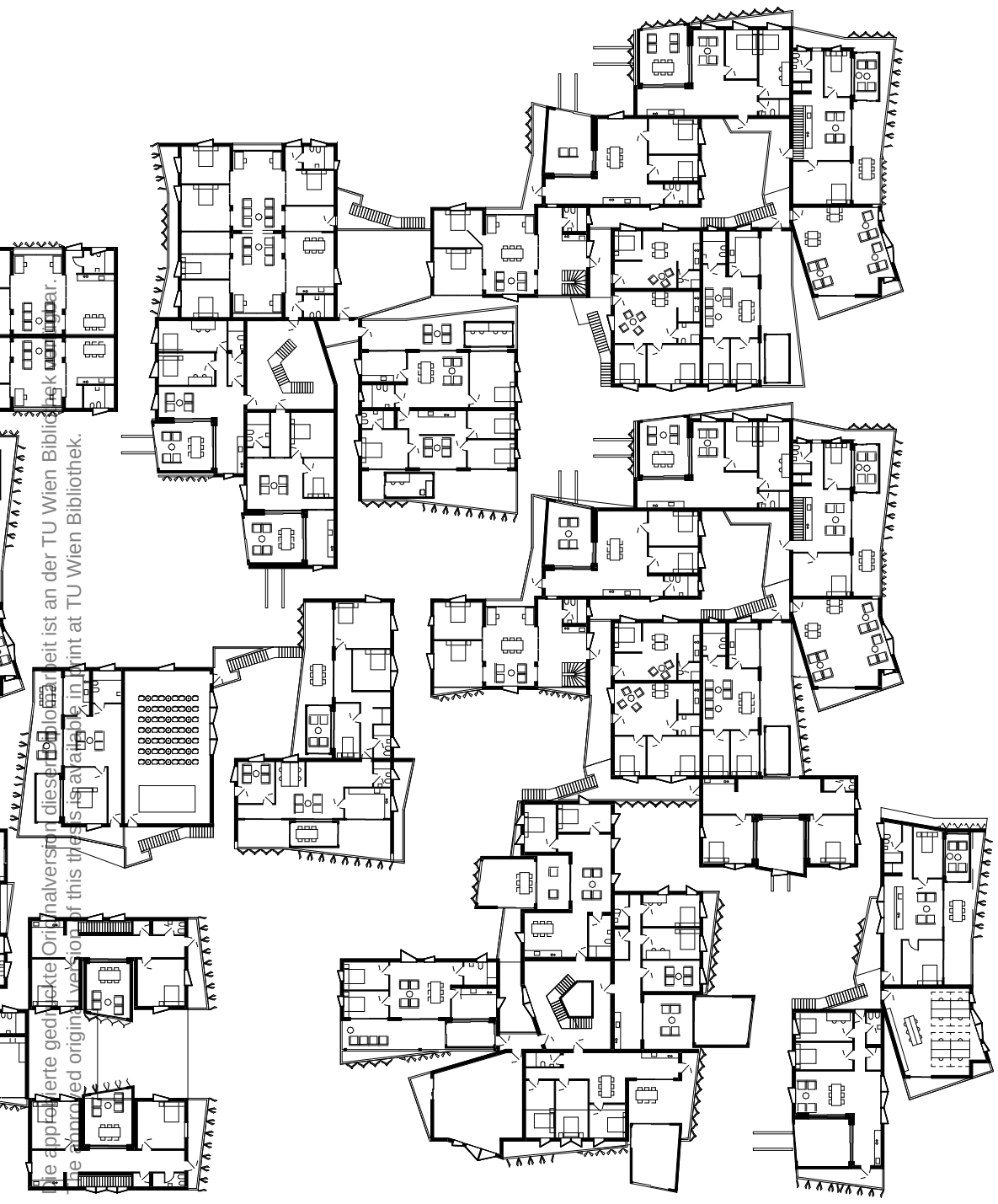


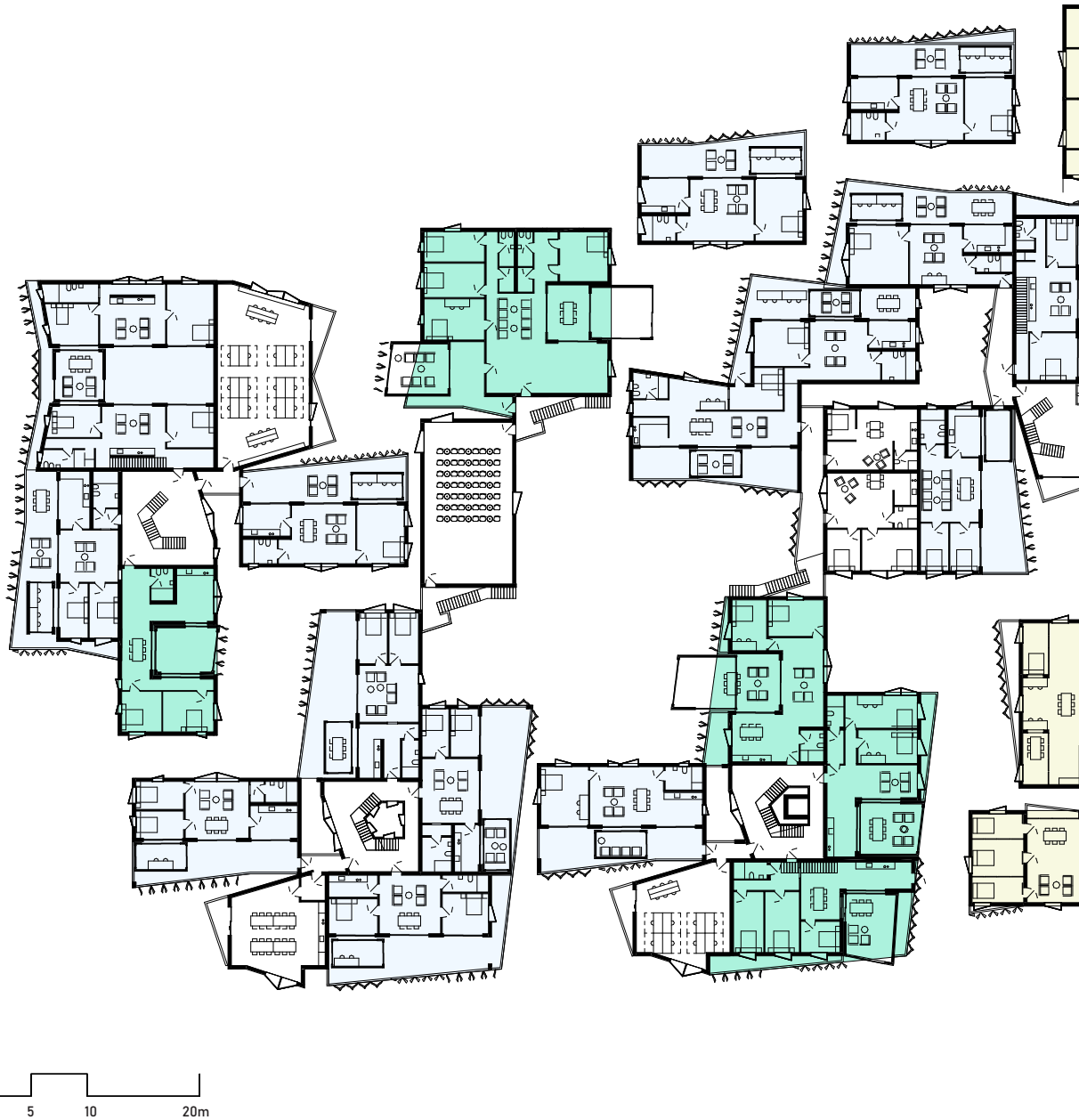
Figure.5.3: First floor masterplan layout **(+4.000m)**

5.4

apartment types 1

apartment types 3

apartments types 2



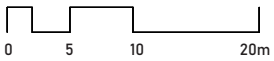
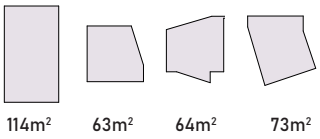
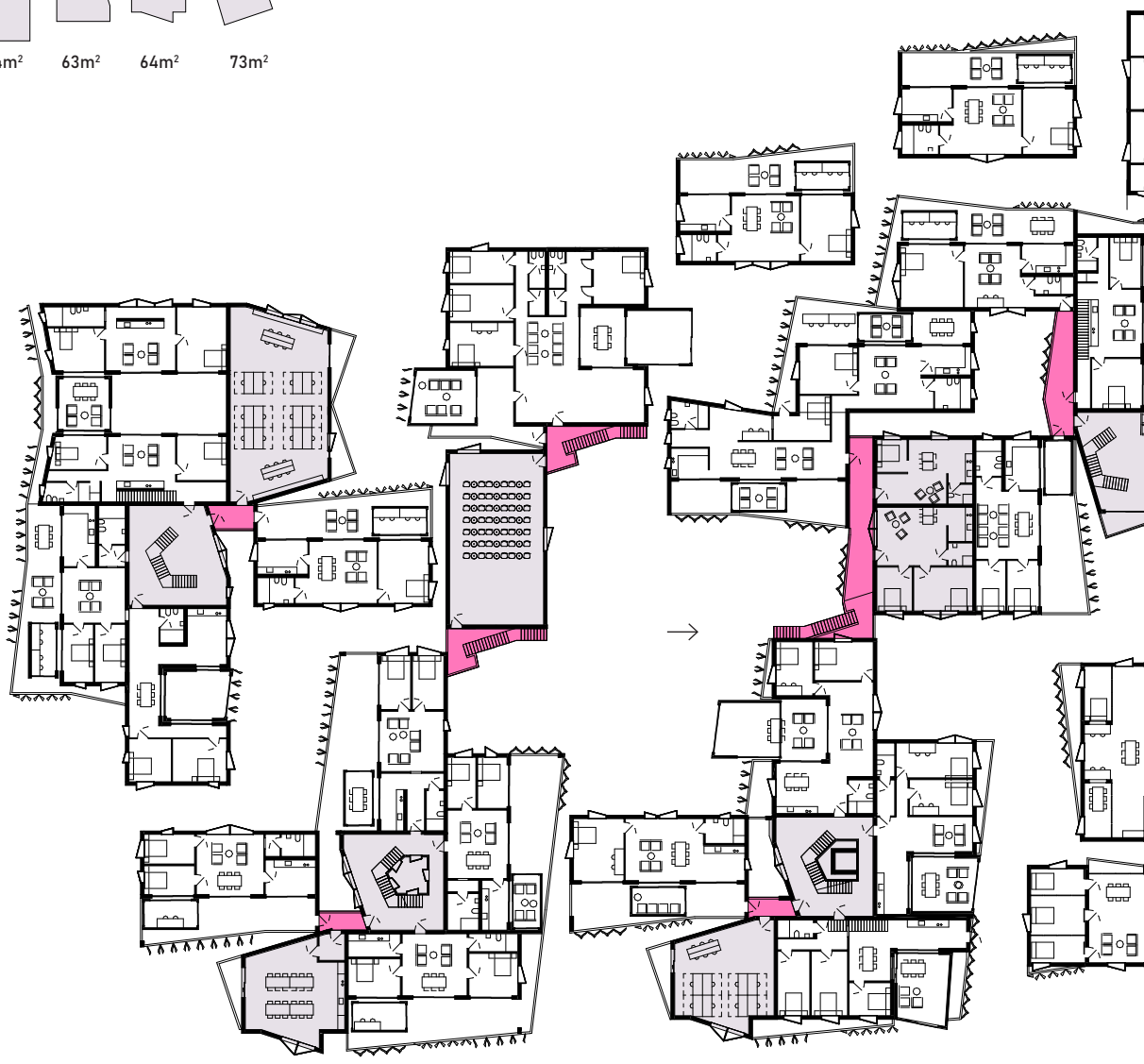


Figure.5.4: First floor masterplan layout **(+4.000m)**

communal

circulation





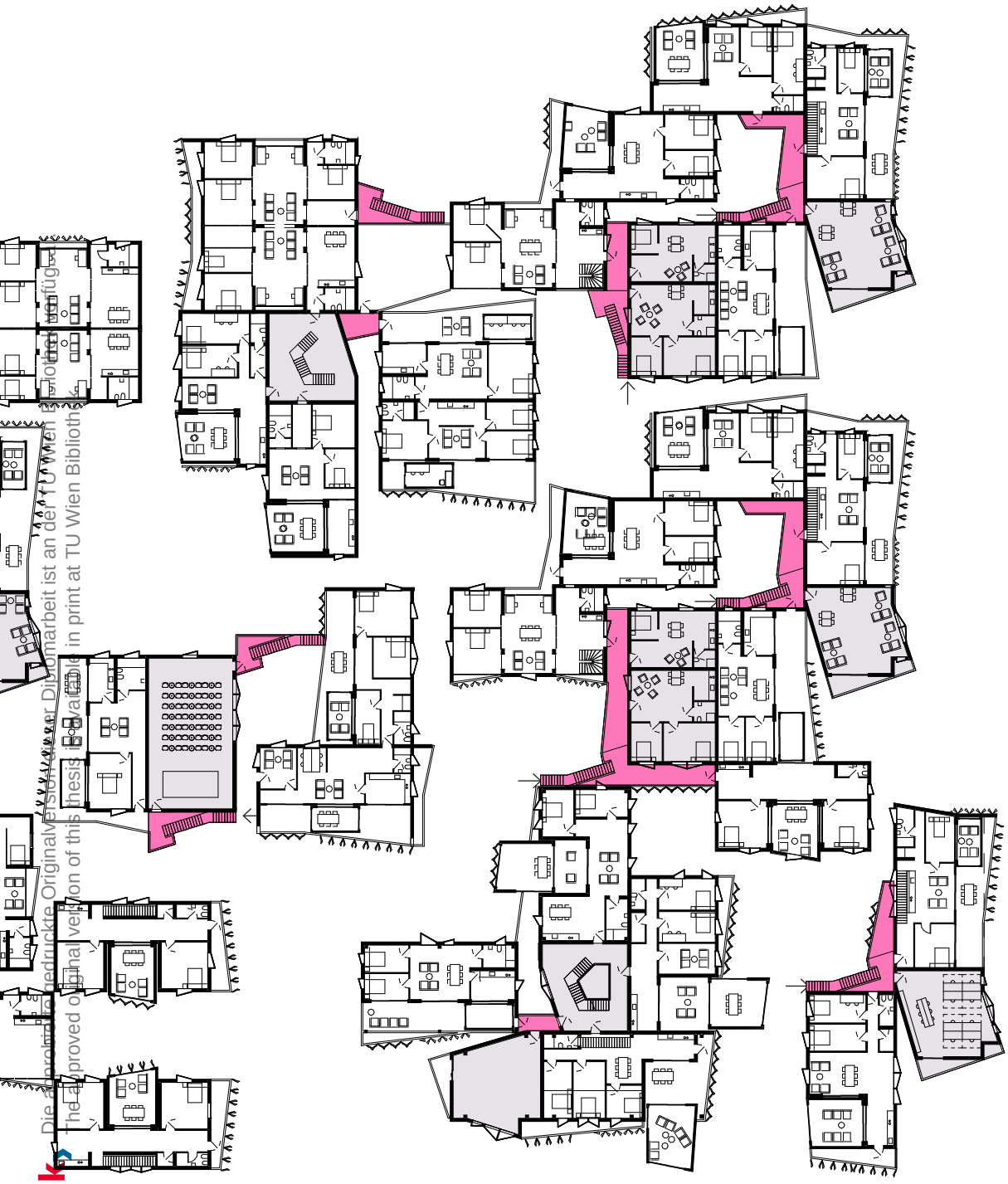
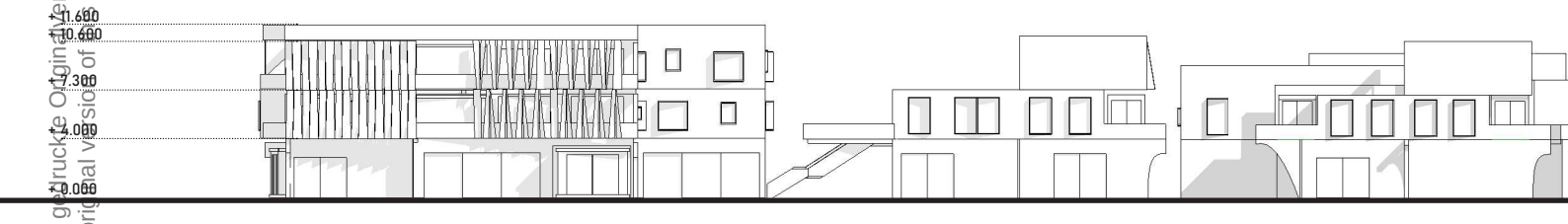


Figure.5.5: First floor communal and circulation areas (+4.000m)

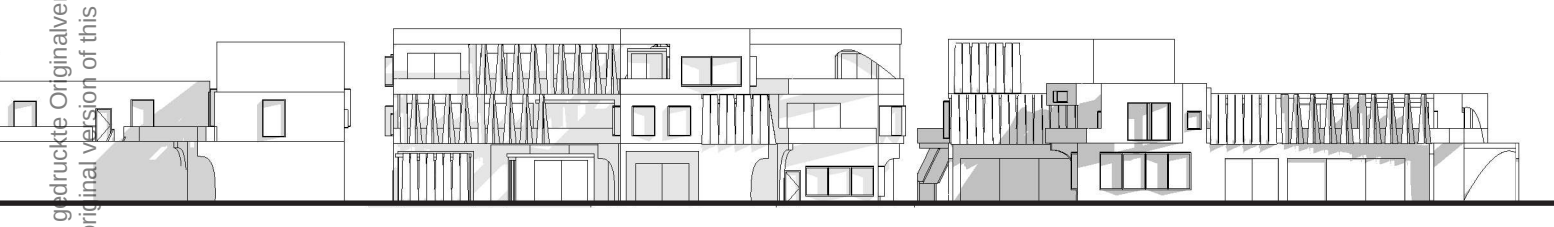
1. masterplan street elevation

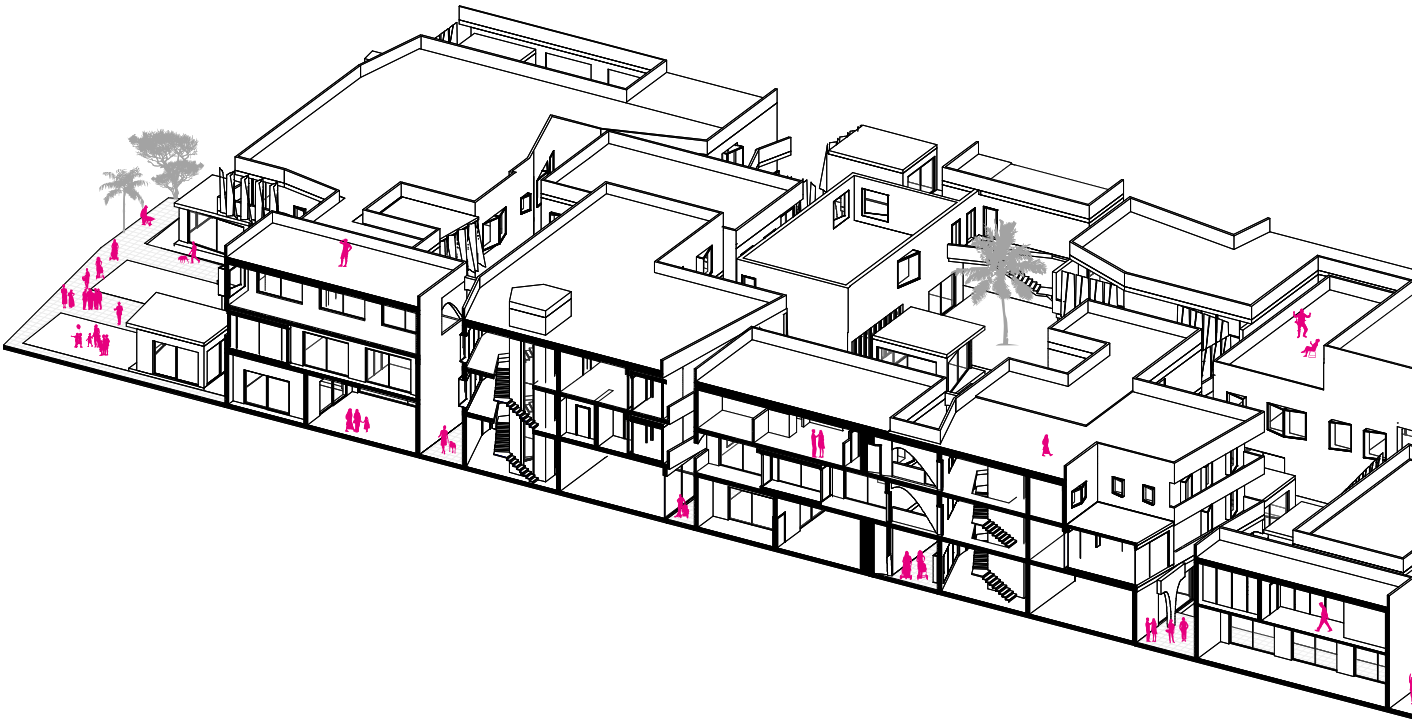


individual collage of modules elevations

Figure.5.6: Masterplan elevations and individual module elevations

elevations





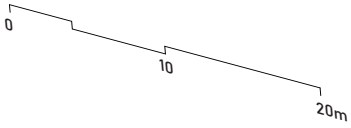
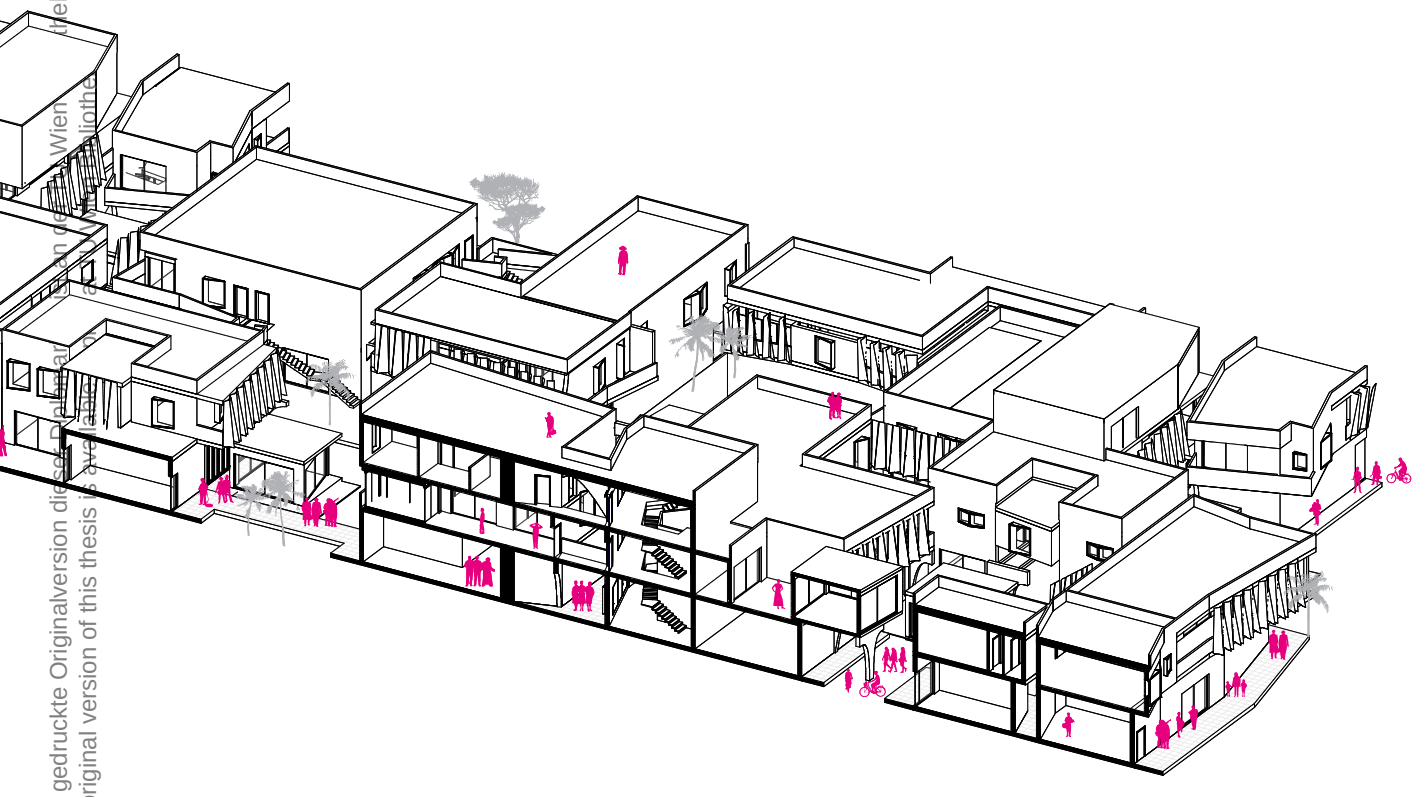
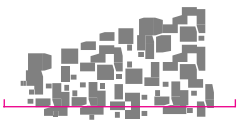
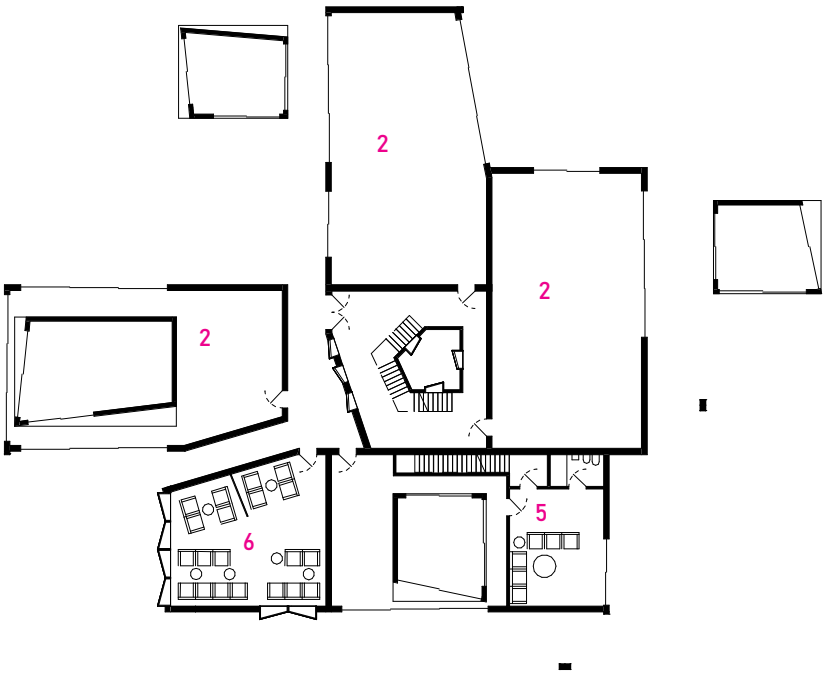


Figure.5.7: Masterplan axonometry section

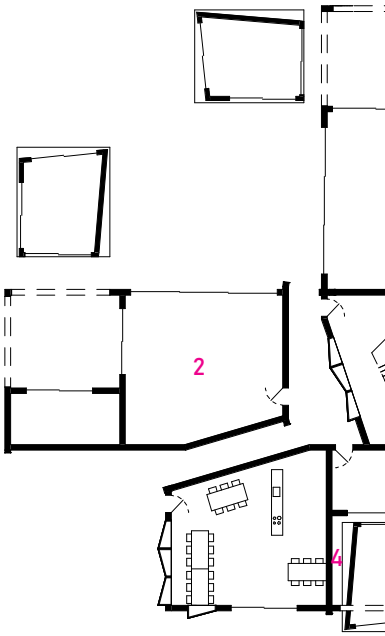
site section

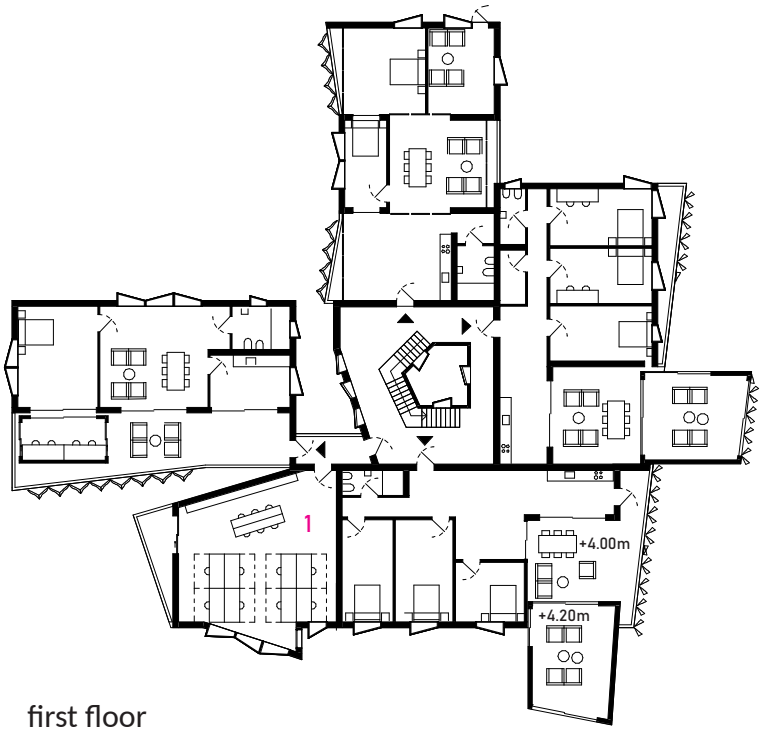




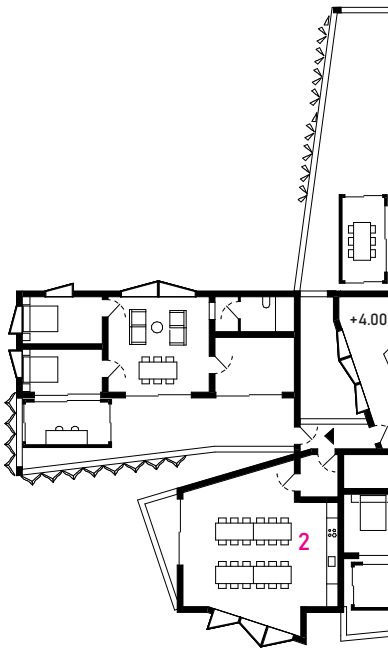


ground floor





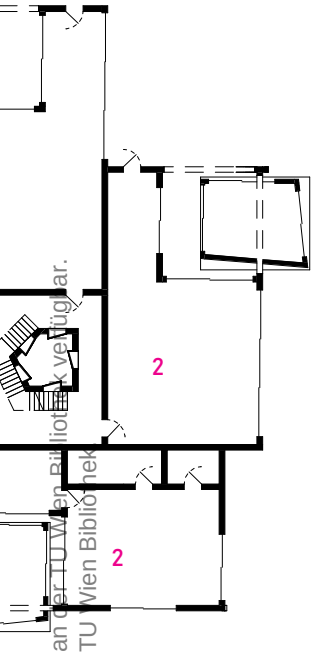
first floor



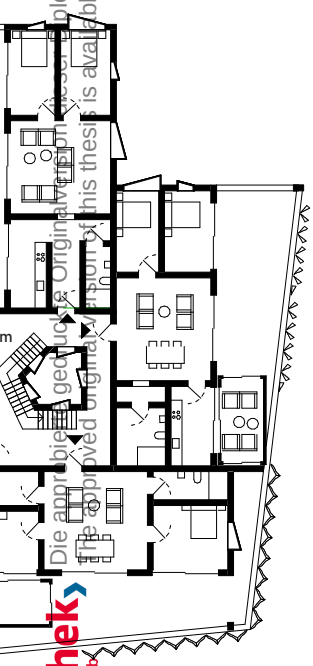
0 1 3 6 10m

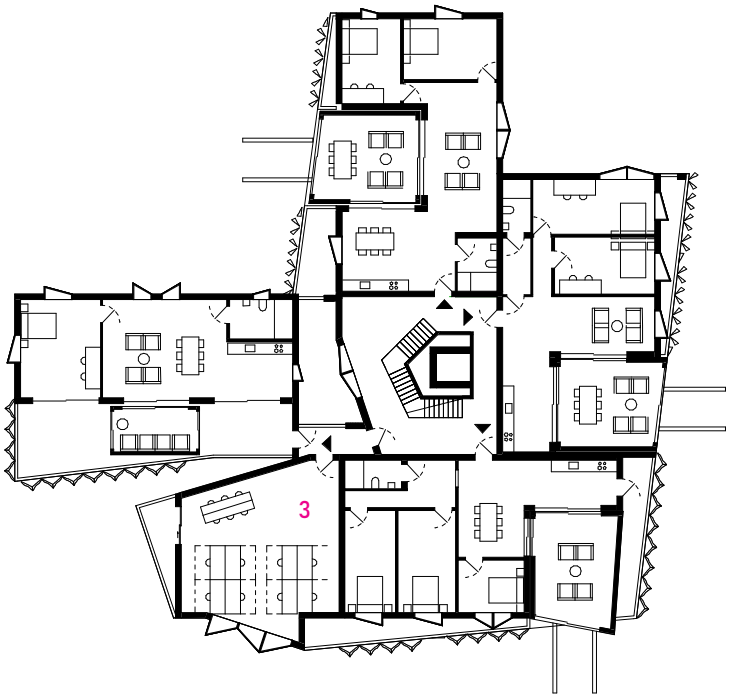
Figure.5.8: Modular block 1

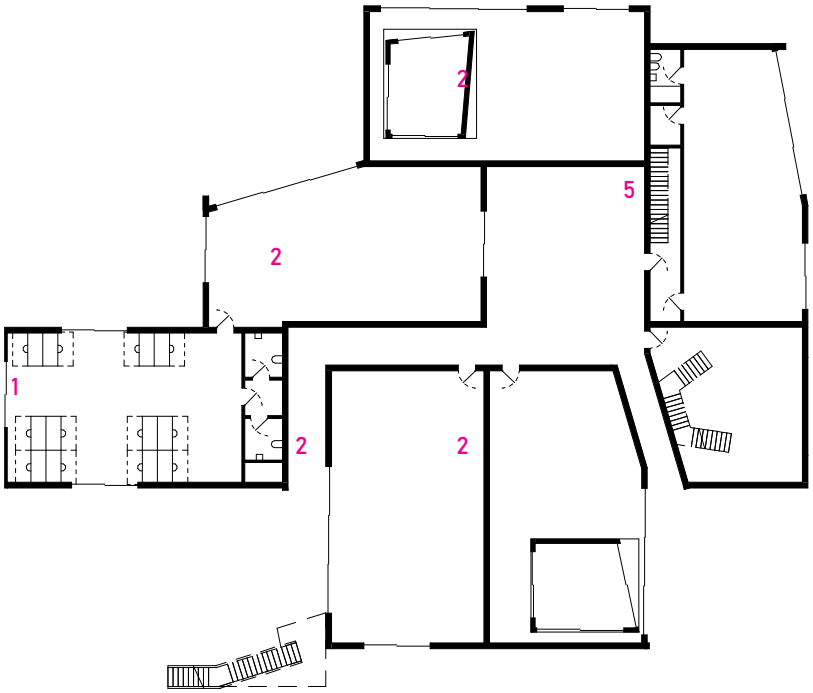
module block 1



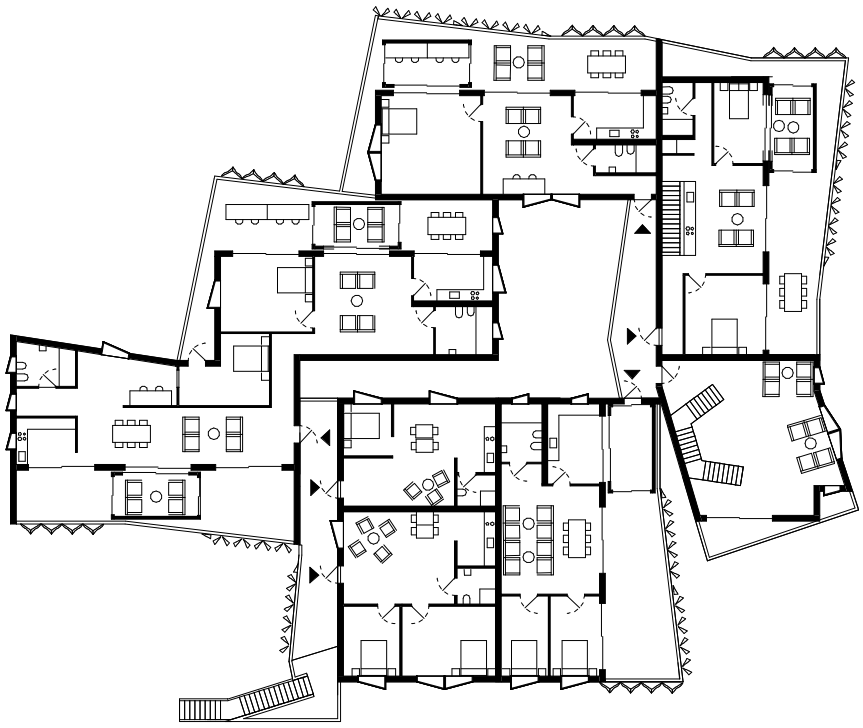
1. communal co-working/office space/rental workspace
2. mixed use-commercial-office-private - gastronomy use
3. communal library
4. communal kitchen space/cooking workshop
5. residential extenstion (eg:male areas)
6. community cafe
7. community guest rooms/guest apartments
6. community garden







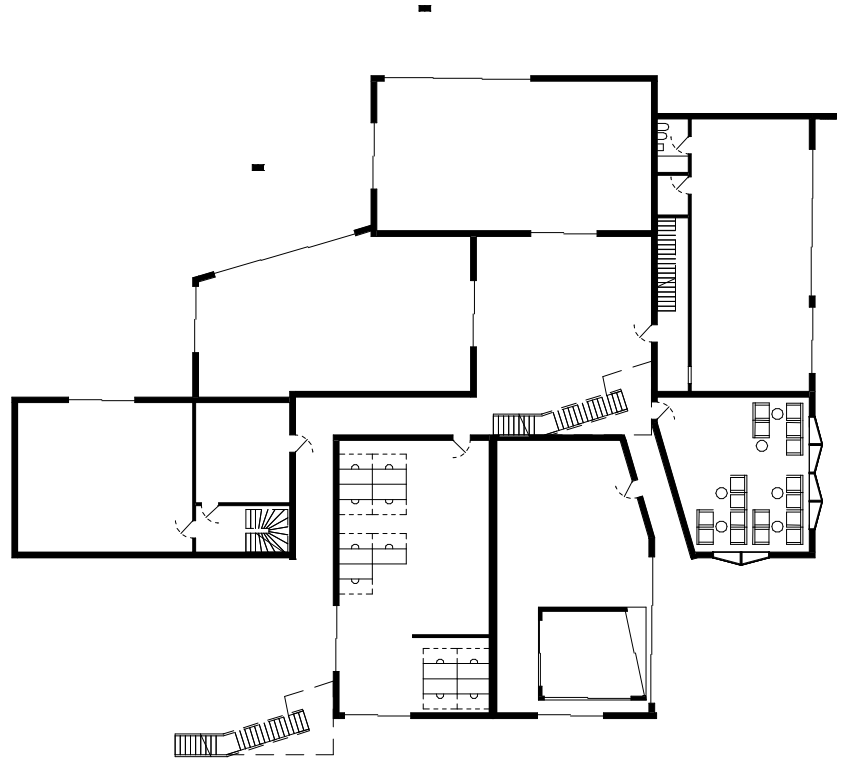
ground floor

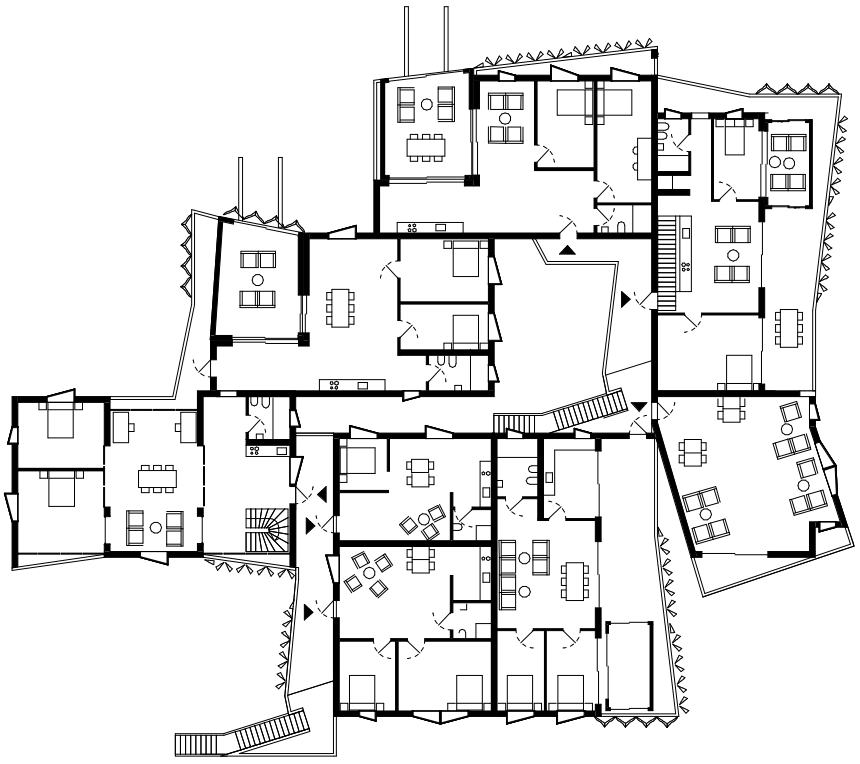


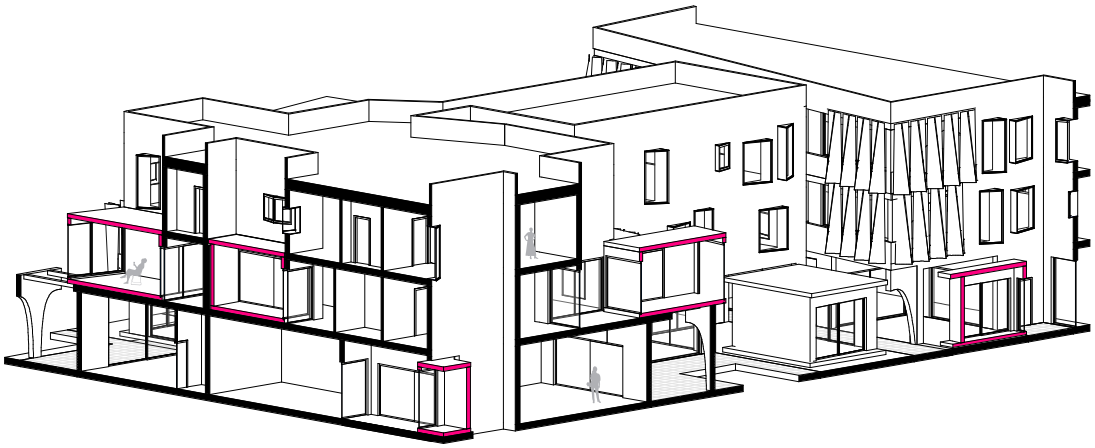
first floor

0 1 3 6 10m

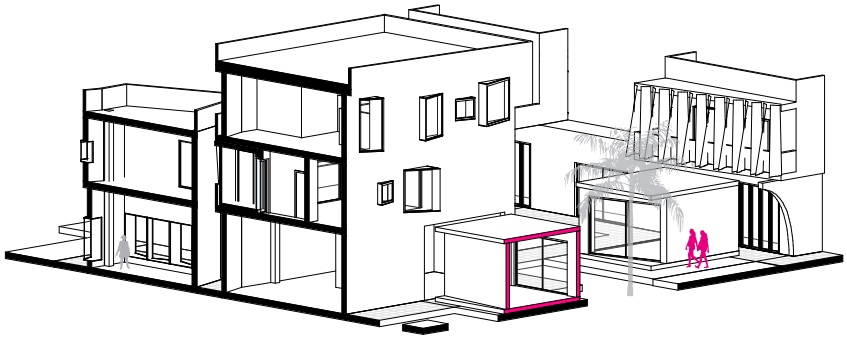
Figure.5.9: Modular block 2



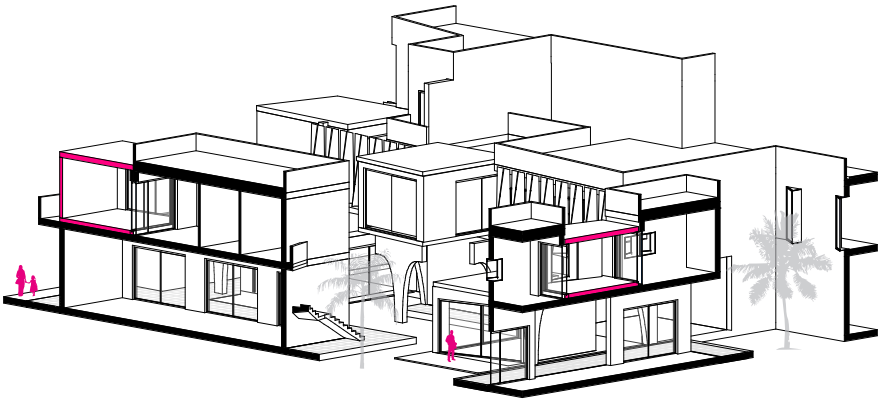




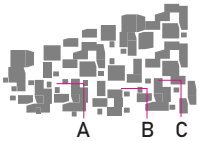
Section A



Section B



Section C



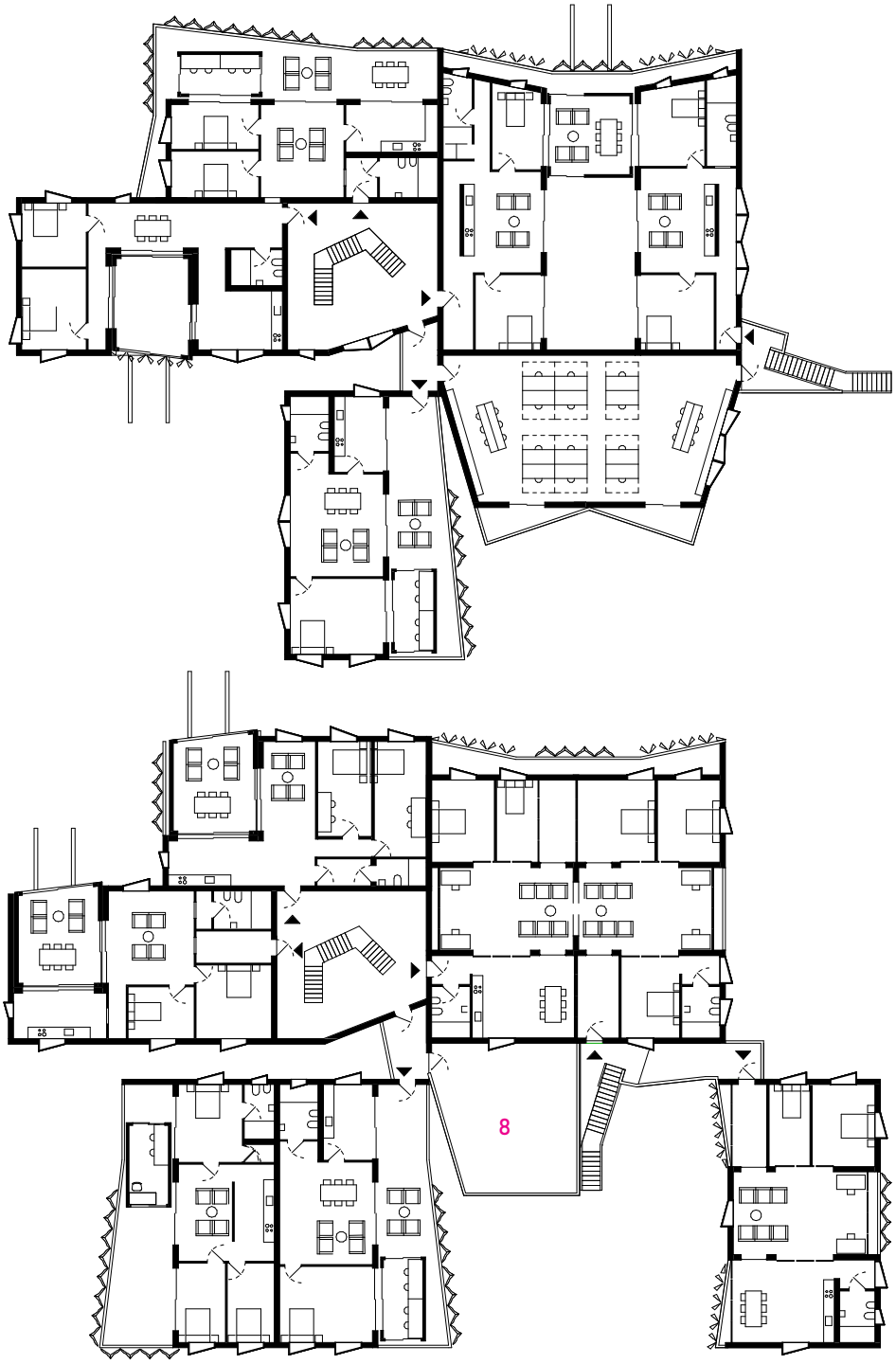
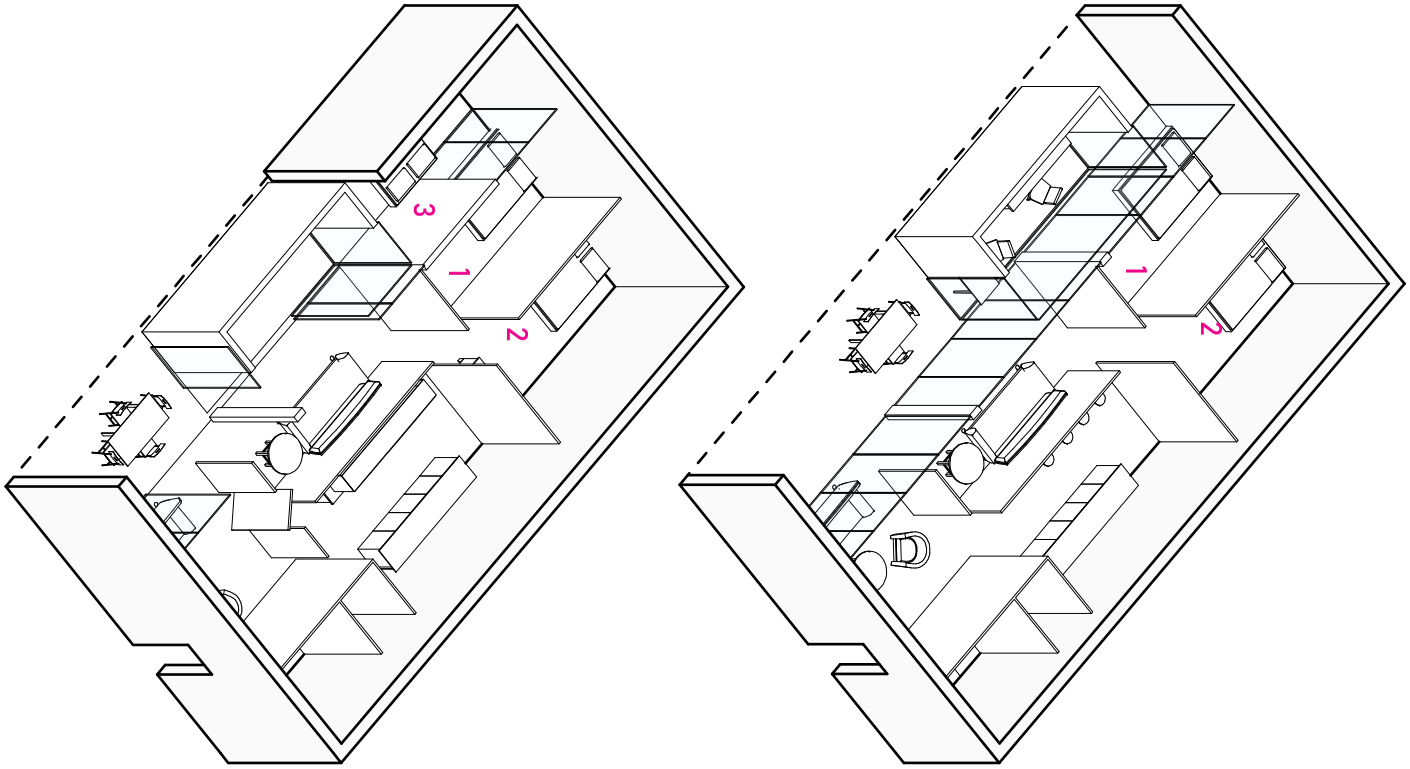
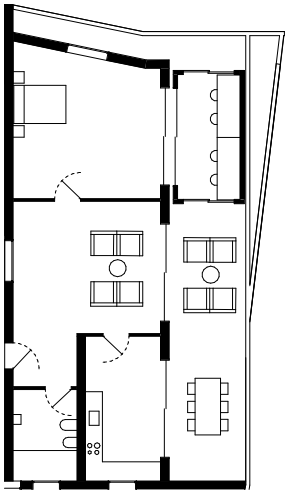


Figure.5.10: Modular block 3 - first floor

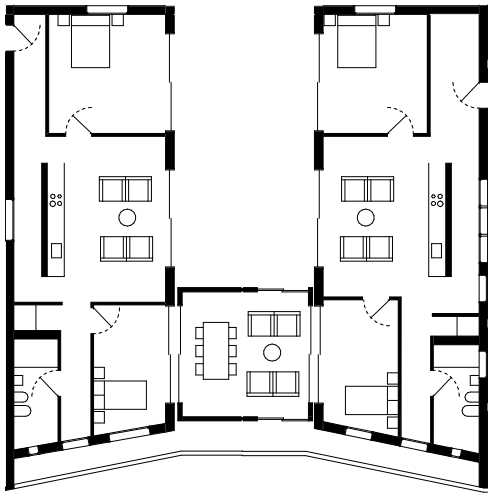


apartment type 1

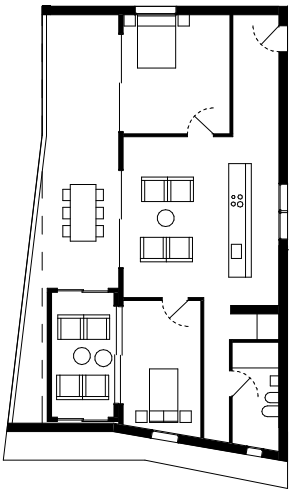
1a



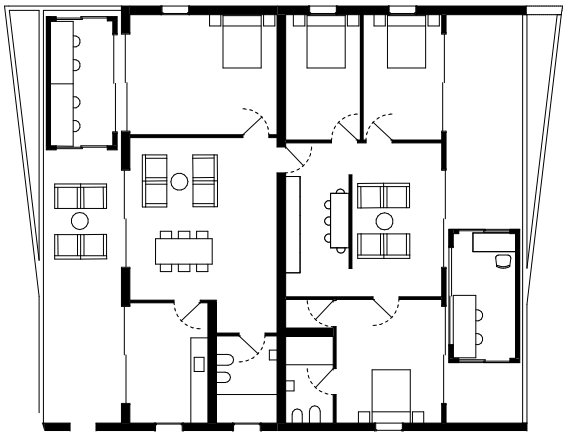
1c



1b



1d



Apartment Type 1a 127m²	Apartment Type 1b 242m²	Apartment Type 1c 149m²	Apartment Type 1d 127m²
(1-3 BEDROOM) 77m² + 10m² balcony loggias 30m²	(1-3 BEDROOM) 77m² + 10m² balcony loggias 28m² shop 115m²	(1-5 BEDROOM) 77m² + 19m² balcony loggias 53m²	(1-3 BEDROOM) 153m² + 20m² balcony loggias 60m²

Figure.5.11: Apartment type 1 floor plans and axonometry

0 1 3 5m

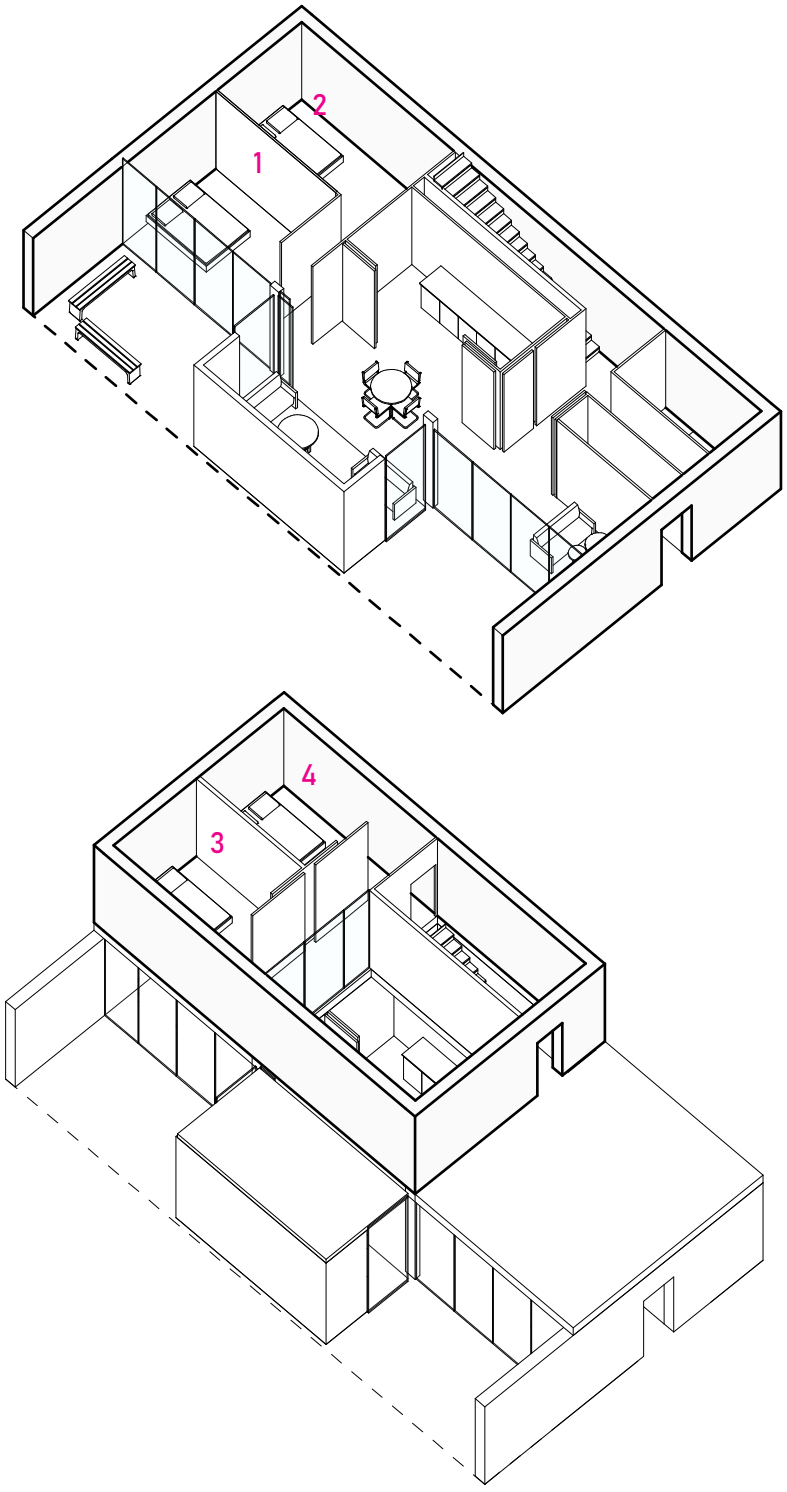
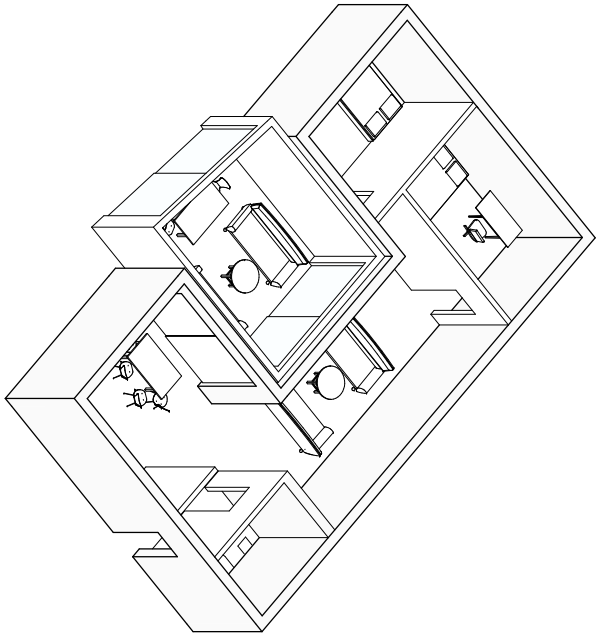
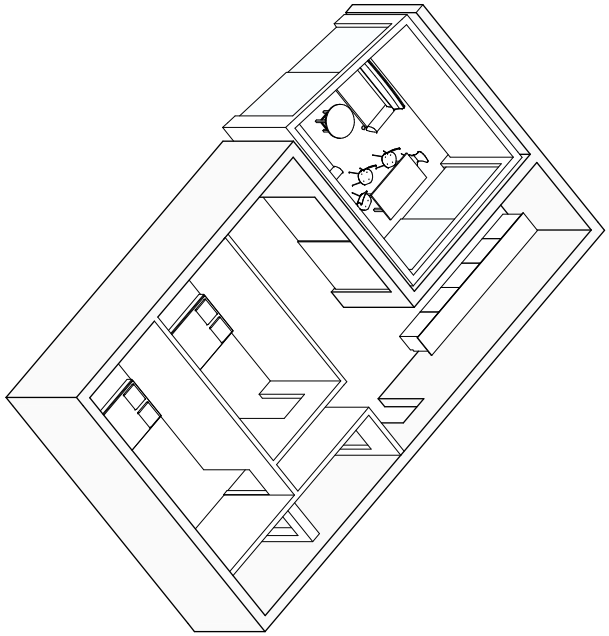


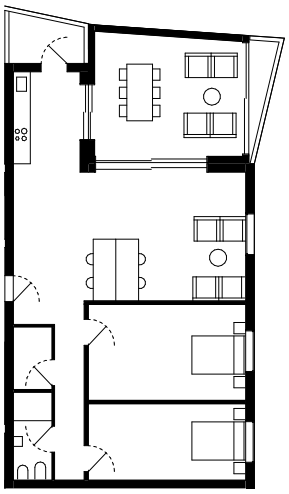
Figure.5.12: Apartment type 1 3D

Figure.5.13: Interior perspectives of apartment type 1

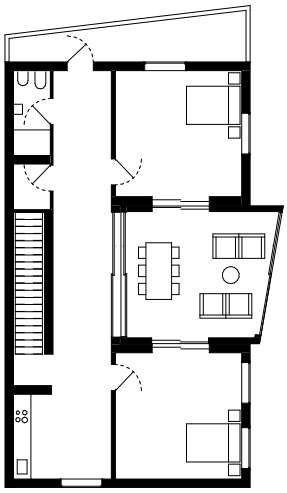




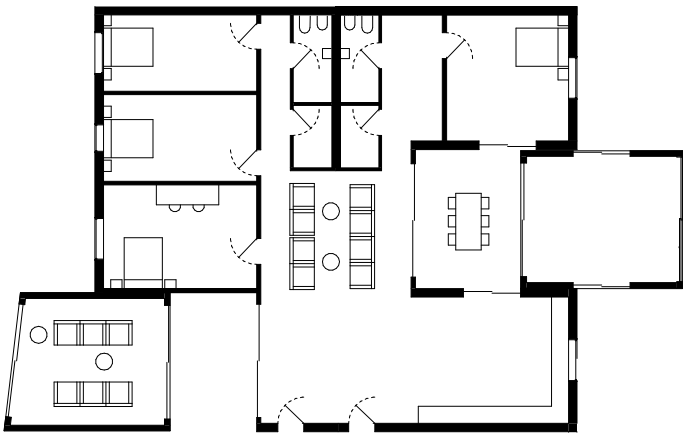
2a



2b



2c



Apartment Type 2a
145m²

(1-3 BEDROOM)
97m² + 22m²
balcony loggias
26m²

Apartment Type 2b
146²

(1-3 BEDROOM)
91m² + 22m²
balcony loggias
33m²
(+ shop 115m²)

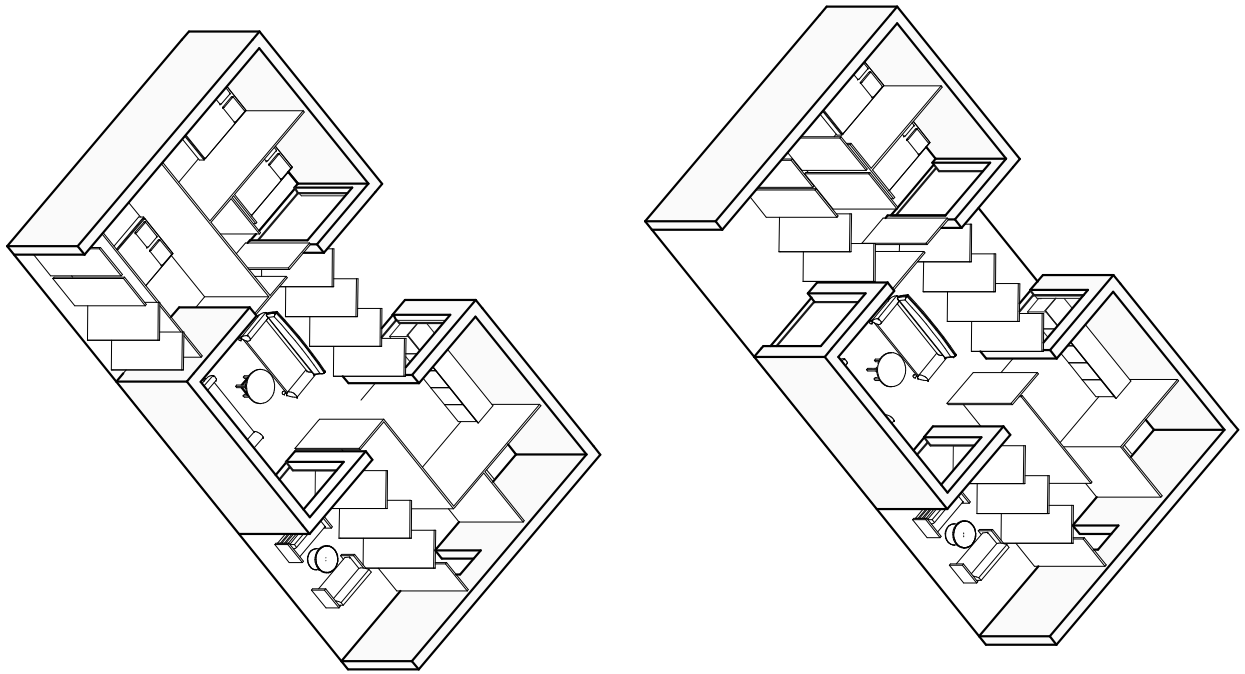
Apartment Type 2c
290m²

(1-5 BEDROOM)
188m² + 44m²
balcony loggias
44m²

Figure.5.14: Apartment type 2 floor plans and axonometry

0 1 3 5m

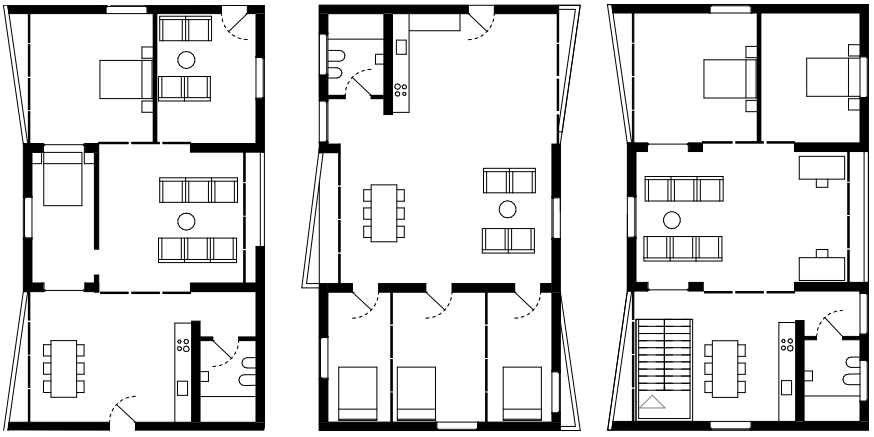
Figure.5.15: Interior perspectives of apartment type 2



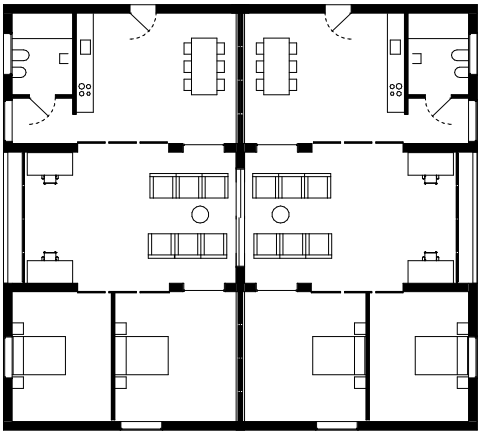
apartment type 3

3a

3b



3c



Apartment Type 3a

(1-3 BEDROOM)
114m²

Apartment Type 3b
229m²

(1-3 BEDROOM)
114m²
shop 115m²

Apartment Type 3c

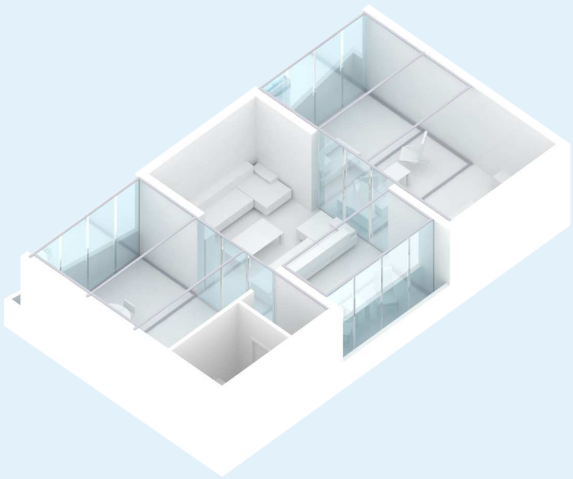
(1-5 BEDROOM)
231m²

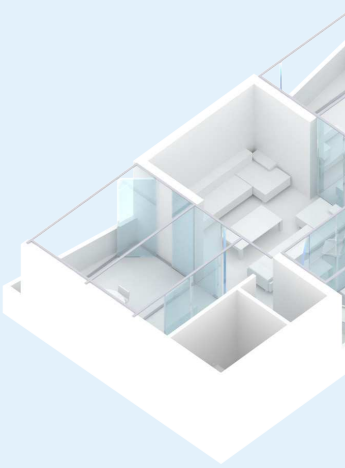
Figure.5.16: Apartment type 3 floor plans and axonometry

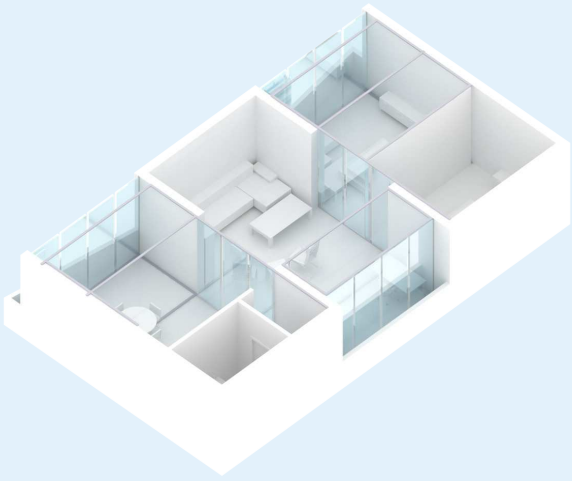
0 1 3 5m

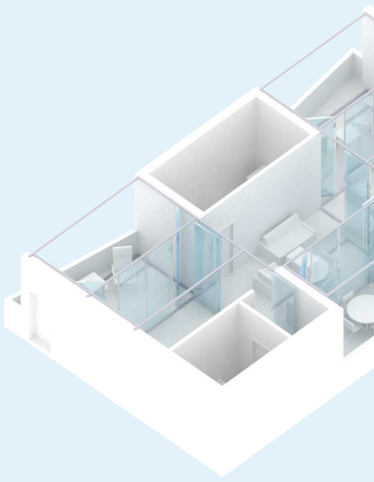
Figure.5.17: Interior perspectives of apartment type 3

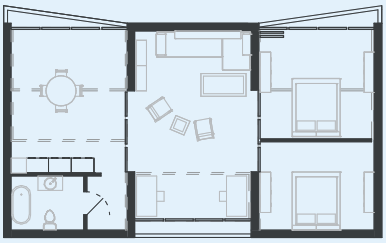
Figure.5.18: Interior perspectives of apartment type 3











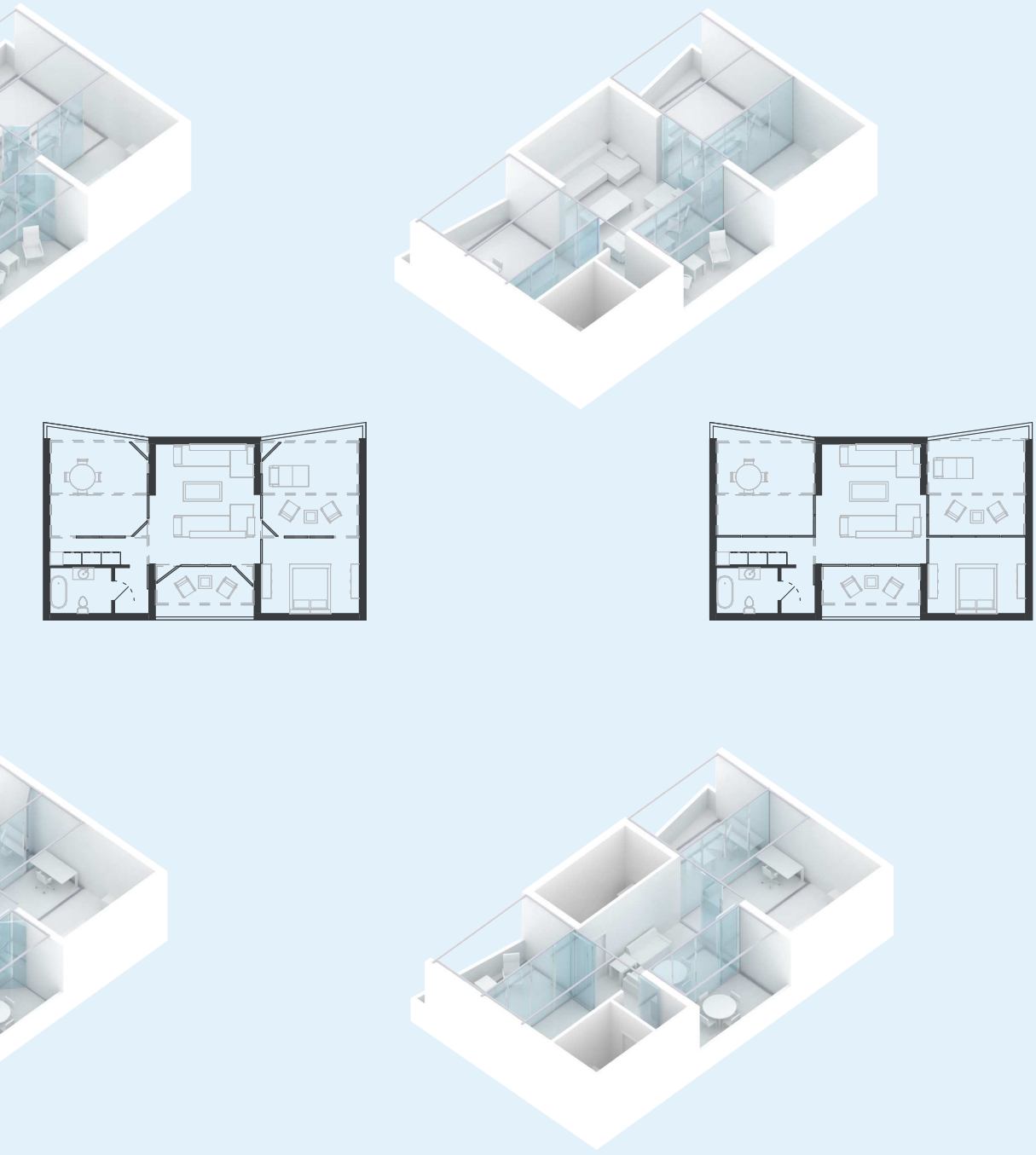


Figure.5.19: Apartment type 3 floor plans and axonometry

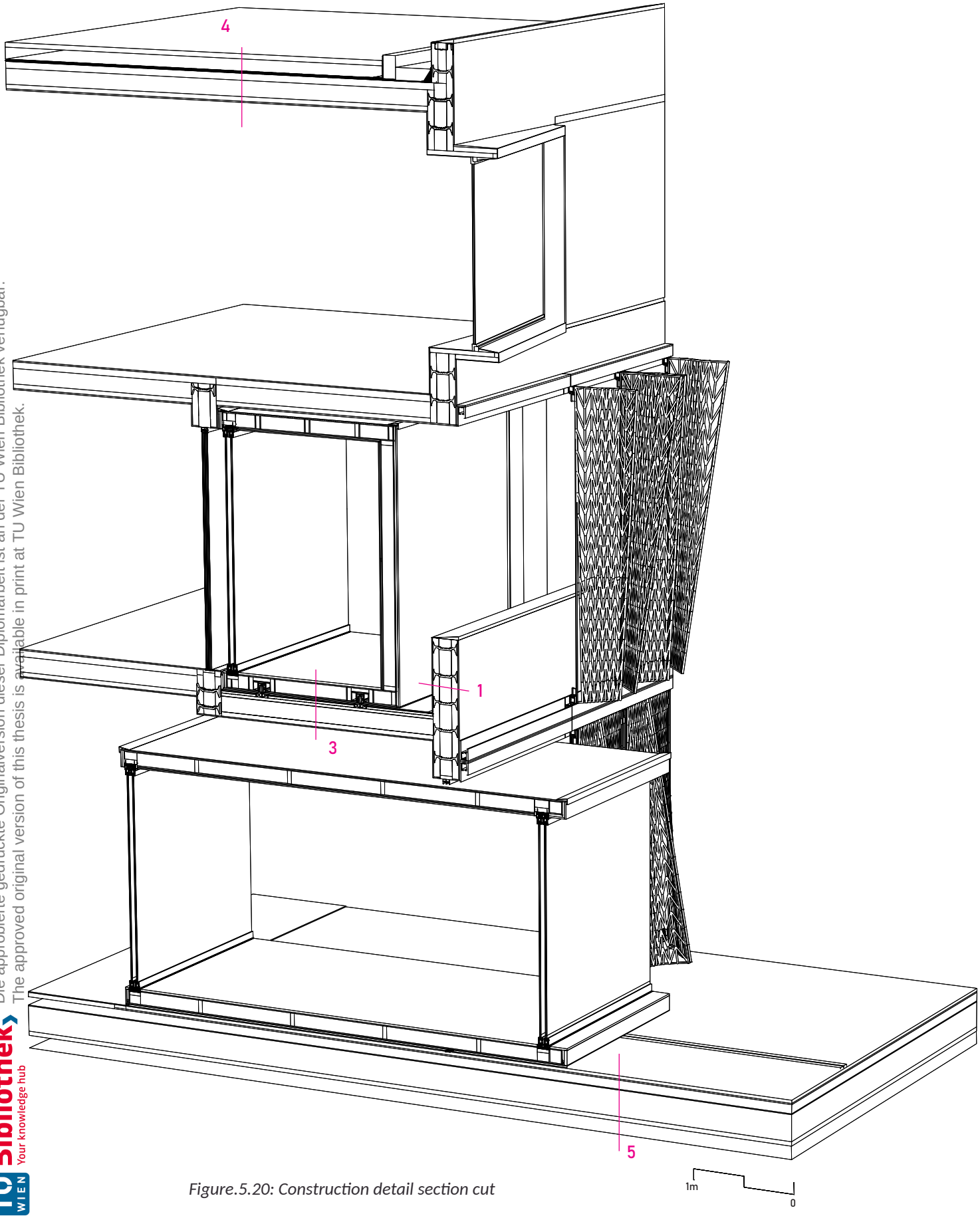


Figure.5.20: Construction detail section cut

mm

1. Wall

12.5	Plastered Wall/Verputzte Wand
79	EPS Insulation Panel (ICF Block)/ EPS-Dämmung
75.5	Reinforced concrete (ICF Block)/ Stahlbeton
79	EPS Insulation Panel (ICF Block) EPS-Dämmung
12.5	Plastered Wall/Verputzte Wand

2. Ceiling

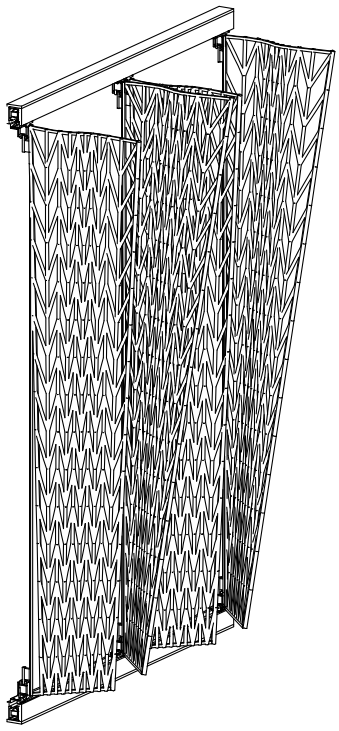
	Steel frame supporting pergola + hanging rail tracks
	Stützender Metallrahmen für Pergola + Hängeschiene
18	Treated timber cladding/behandelte Holzbekleidung
	Roof underlay membrane/Bettungsschicht
	Control membrane roof sheathing
	25 x 50mm batten/ Lattung
50	Ventilated cavity/Diffusionsoffene schicht
	Reflective breathable membrane
169	Aluminium Composite Panels/ SIP Panele
12	Service batten/ Service Lattung
	Vapour control Layer/Dampfsperre
12.5	Plasterboard/ Gipskartonplatte
12.5	Plastered ceiling/Verputzte Wand

3. Floor

10	Parquet/ Parkett
	Breather membrane/ PE Folie-Trenn/Schutzlage
169	SIP Floor panel with 2x 11mm OSB Panel
6.5	Protective aluminium plate/Schutzplatte
	Sliding Track and V-Wheel System
	Linearführungschiene mit V- Laufrollen
10	Floor tiles/ Fliesen
25	Screed (2%)/ Estrich
	PE/ PE Folie-Trenn/Schutzlage
30	Rigid Insulation/Trittschalldämmung
55	Reinforced concrete/ Stahlbeton
227.5	ICF Floor Panels/ Schallungssteine
	Bodenelemente
12.5	Plastered ceiling/Verputzte Wand

4. Flat Green Roof

	Grass/Small vegetations/Vegetation
125	Soil.Vegetation support layer/Vegetationstragschict
	Microfabric Layer / Filterflies
12.5	Drainage Board/ Dreinageschicht
	Protection membrane sheet / Schutz oder Trenn Schicht
	Waterproofing membrane / Dampsperrfolie Dachabdichtung
75	Reinforced concrete Deck Joist/Stahlbeton Deckenträger
228	ICF Deck Panels/Schalungsplatten aus EPS
12.5	Plaster roof finish / Verputzte Decke



5. Ground Floor

10	Floor tiles/ Fliesen
50	Screed/ Estrich
	Breather membrane/ PE Folie-Trenn/Schutzlage
5	Rigid Insulation/Trittschalldämmung
	Waterproof membran/ Sperrenschicht
300	Reinforced concrete/ Stahlbeton Sohlplatte
	PE Foil/ PE Folie-Trenn/Schutzlage
50	Screed/ Sauberkeitschicht
	Gravel/ Schotterschicht

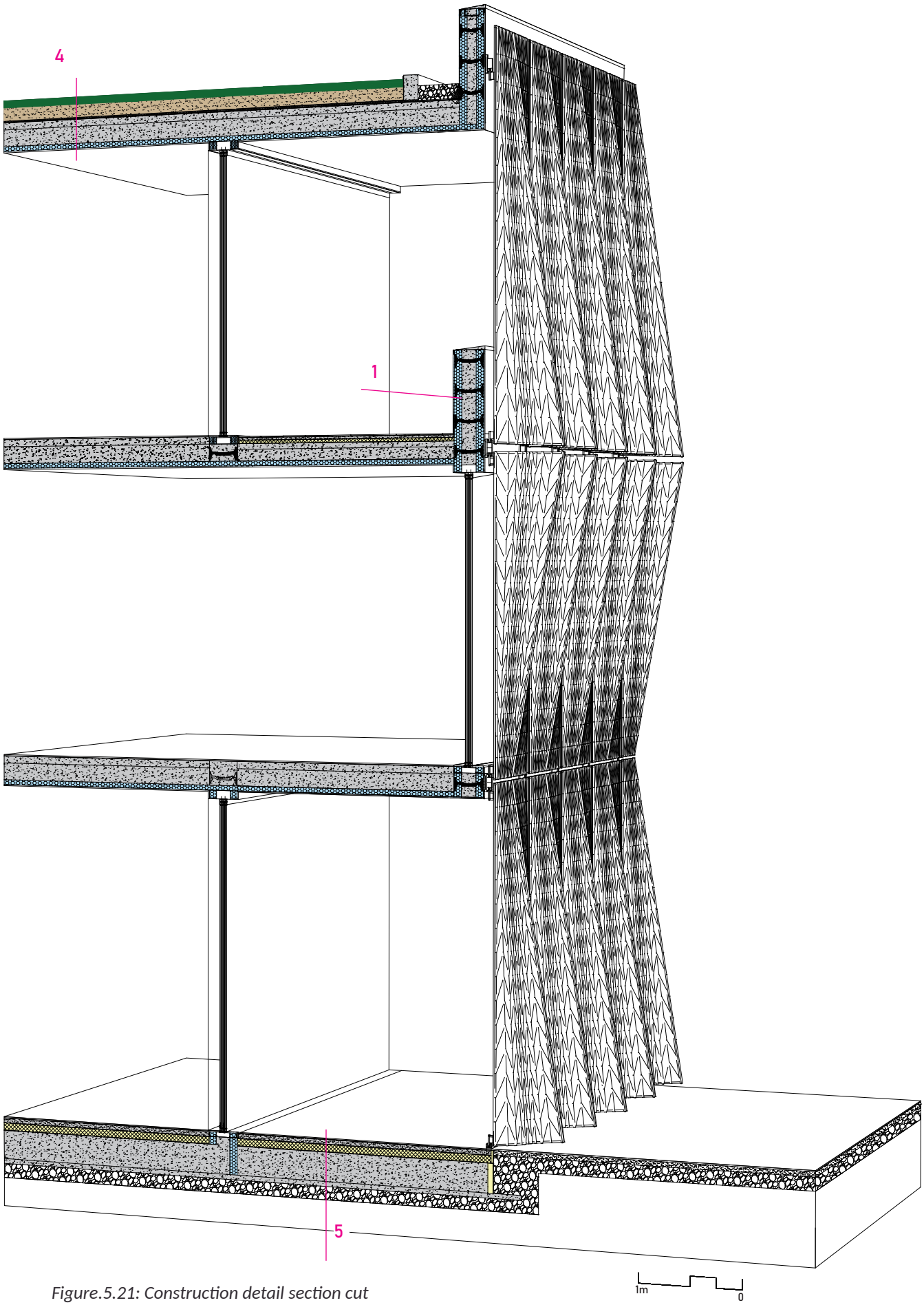
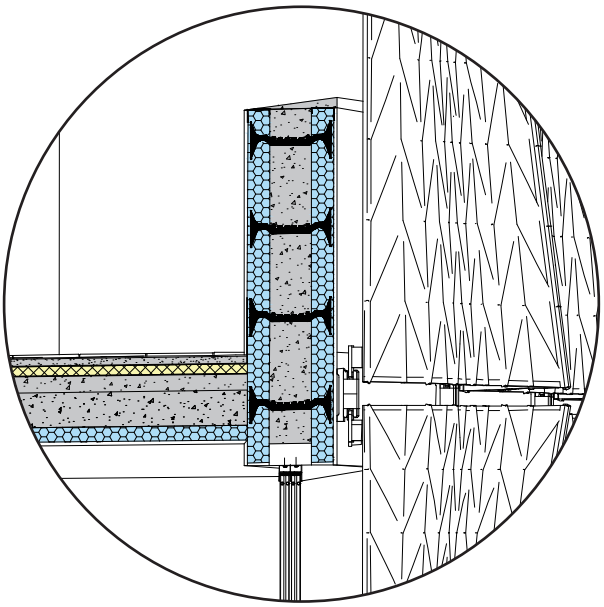
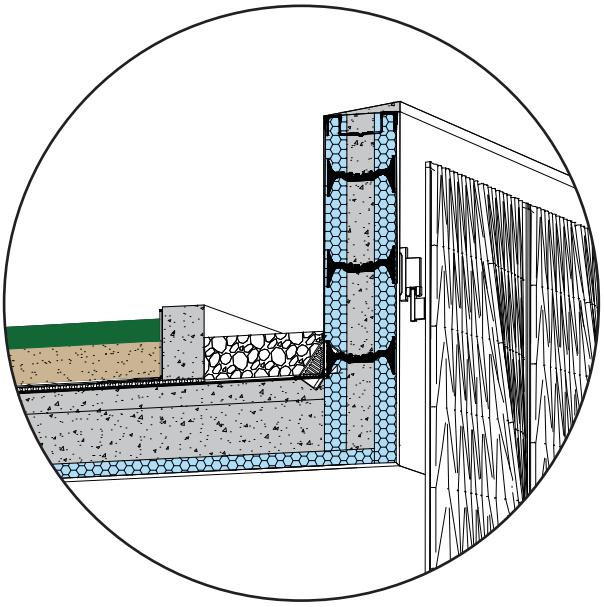


Figure.5.21: Construction detail section cut



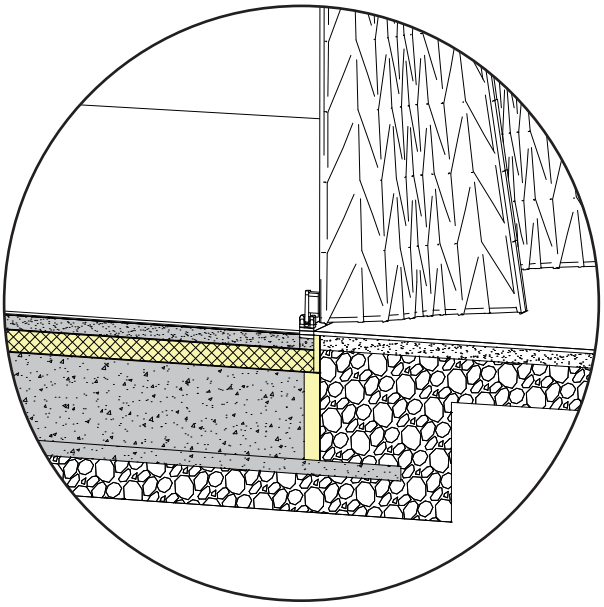
1. Wall

2.5	Plastered Wall/verputzte Wand
79	EPS Insulation Panel (ICF Block)/ EPS-Dämmung
75.5	Reinforced concrete (ICF Block)/ Stahlbeton
79	EPS Insulation Panel (ICF Block) EPS-Dämmung
12.5	Plastered Wall/verputzte Wand



4. Flat Green Roof

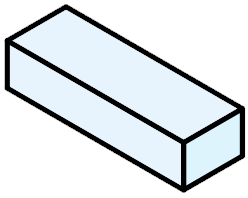
	Grass/Small vegetations/Vegetation
125	Soil.Vegetation support layer/Vegetationstragschict
	Microfabric Layer / Filterflies
12.5	Drainage Board/ Dreinageschicht
	Protection membrane sheet / Schutz oder Trenn Schicht
	Waterproofing membrane / Dampsperrfolie Dachabdichtung
75	Reinforced concrete Deck Joist/Stahlbeton Deckenträger
228	ICF Deck Panels/Schalungsplatten aus EPS
12.5	Plaster roof finish / Verputzte Decke



5. Ground Floor

10	Floor tiles/ Fliesen
50	Screed/ Estrich
	Breather membrane/ PE Folie-Trenn/Schutzlage
5	Rigid Insulation/Trittschalldämmung
	Waterproof membran/ Sperrenschict
300	Reinforced concrete/ Stahlbeton Sohlplatte
	PE Foil/ PE Folie-Trenn/Schutzlage
50	Screed/ Sauberkeitschicht
	Gravel/ Schotterschicht

BASIC 15m X 8.5m FIX MODULE COMPOSITONS



1 optional roof solar panels
2 protective high roof walls
3 ICF roof deck panels (228cm panels)
4 ICF wall panels (311cm panels)
5 ICF floor deck panels (228cm panels)
6 Door system (sliding or stack) & double glazing reflective glass & optional additonal sliding panel

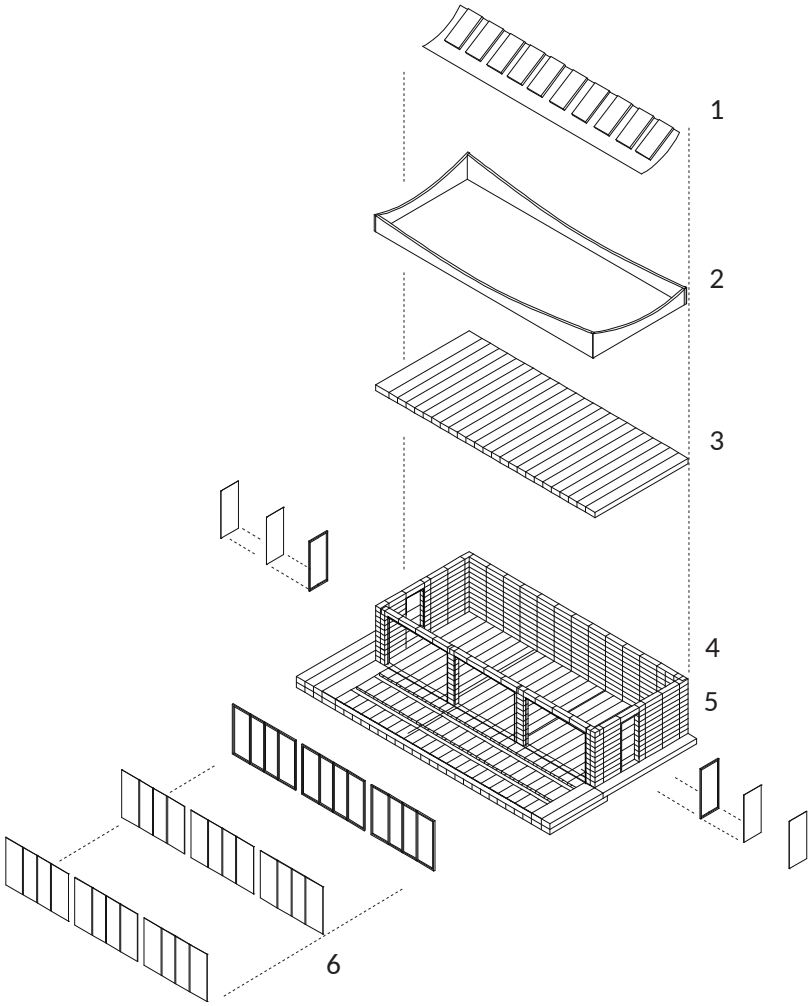
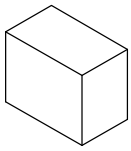
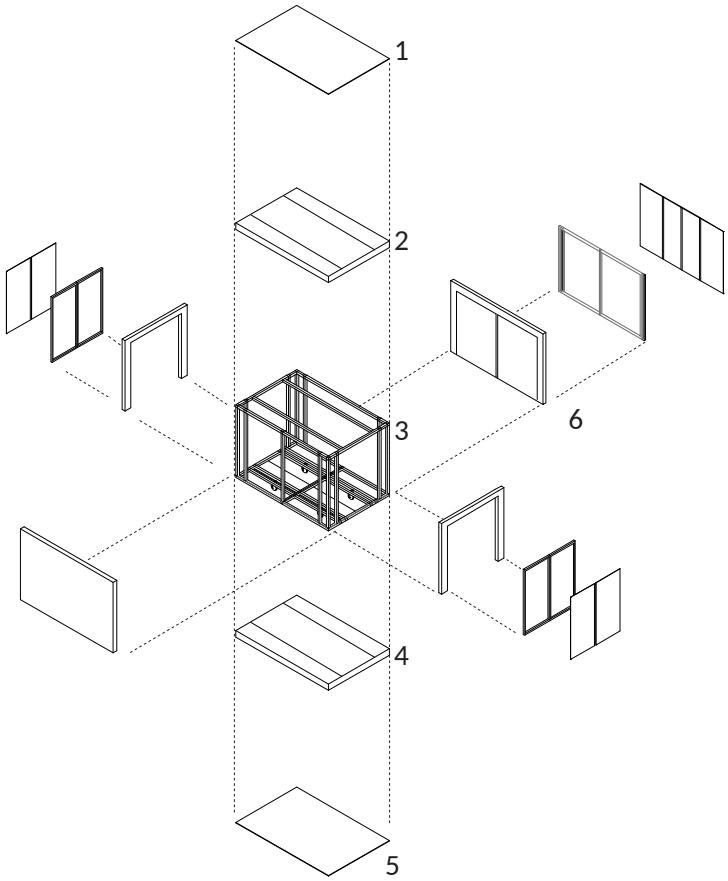


Figure.5.22: Basic module exploded axonometry

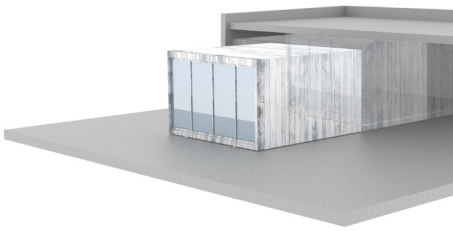
BASIC 5m x 3m MOVABLE UNIT

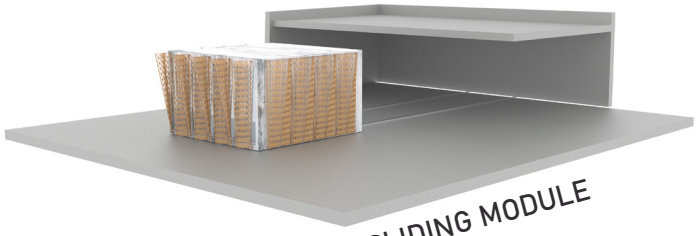


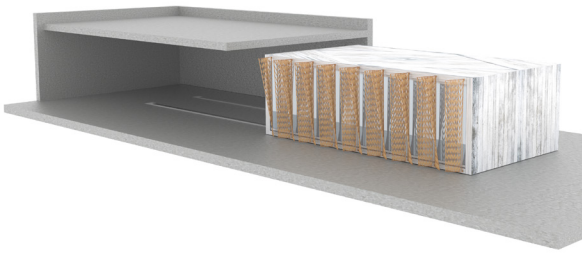
1 Protective sheet
2 Aluminium composite panels
3 Steel frame structure
4 Aluminium composite floor panels
5 Aluminium protective sheet
door system (sliding or stack) & double glazing reflective glass & optional additonal sliding panel



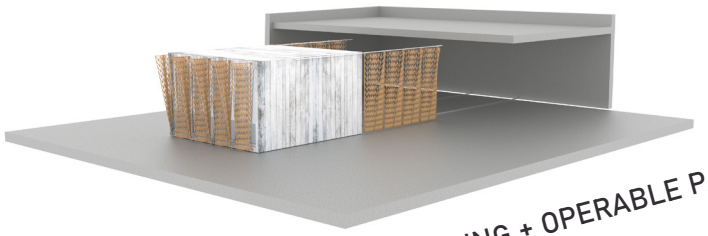
The ground floor main activities would be mixed use, with a focus on commercial and office functions. The ground floor module will be able to be mechanically or manually pulled out onto an existing platform outside of the mixed use facility. The modules can vary in size depending on the location. Minimum dimension would be 5.7 x 4.8m and maximum dimensions are 11 x 5m.

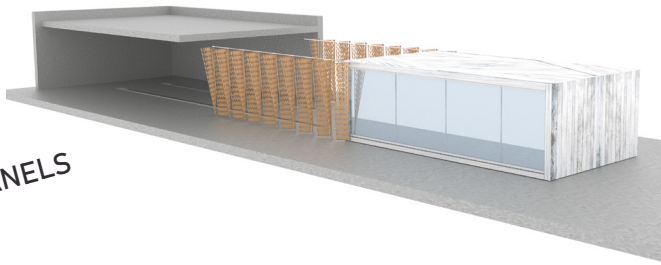






SLIDING MODULE





with SLIDING + OPERABLE PANELS

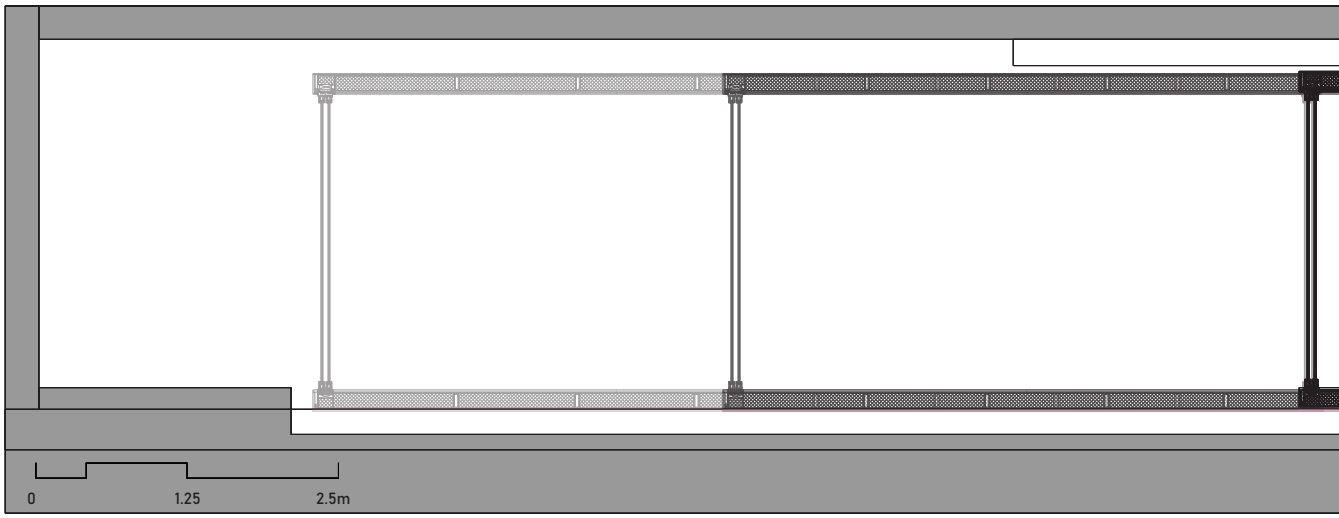
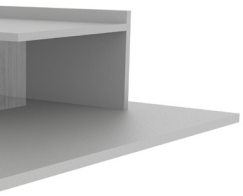
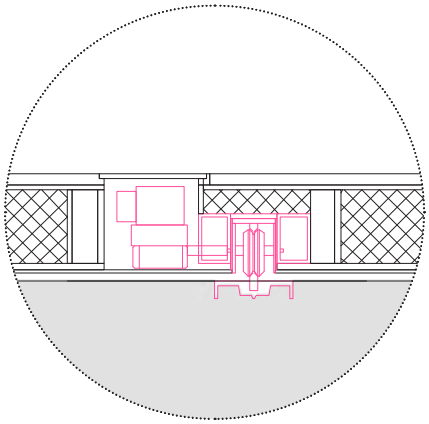


Figure.5.23: Ground floor sliding module construction

ground floor sliding module



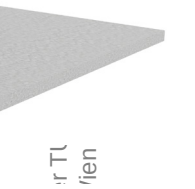


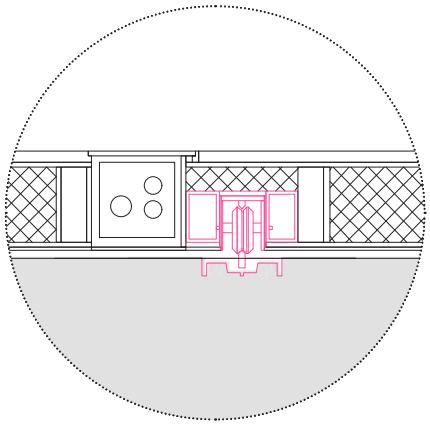
Variation 1

Use: Sliding Track and V-Wheel System
Linearführungschiene mit Laufrollen

Type: V-Wheel/Groove with Ball bearings with
Rack & Pineon Drive Mechanim
V-Führungsrad mit doppelreihigem Schrägkugellager
mit Zahnstange-ritzel Antrieb und Motor

Fixing: Steel beams connected to wheel plates
Steel mounting stud on wheel plates connected to
V-Wheel/Groove and Ball bearings. (2)
Stainless V-Wheel slides on single edge track.
Track is connected to reinforced concrete (3)
Stahlträger mit den Wagenplatten verbunden
V-Führungsrad auf eine einseitigen Laufschiene.
Stahlbetonfundament als Basis

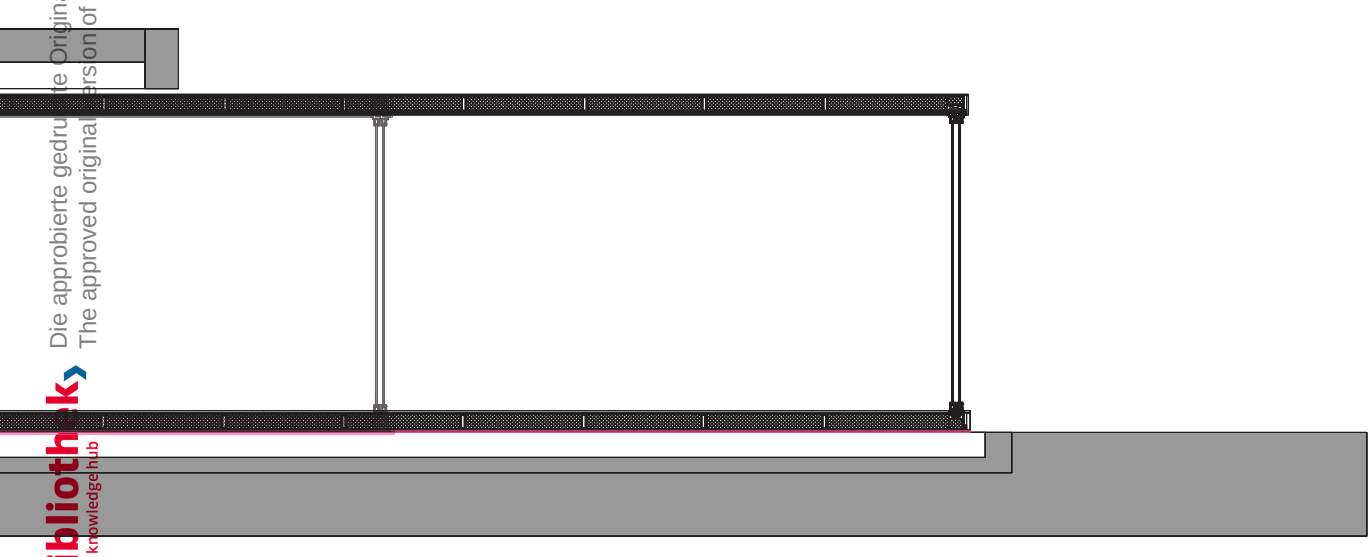


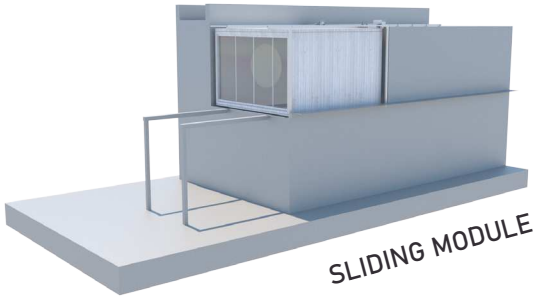


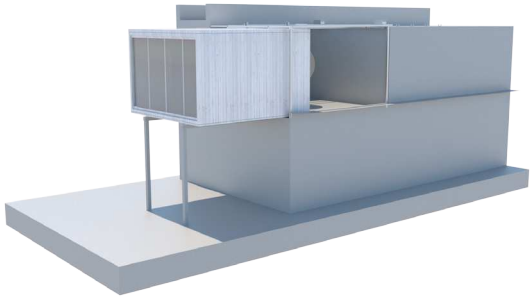
Variation 2

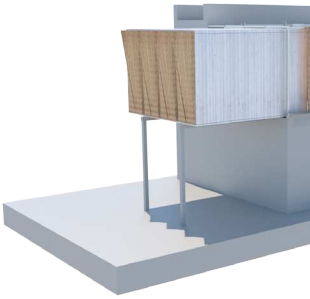
Use: Sliding Track and V-Wheel System
Linearführungschiene mit Laufrollen

Type: V-Wheel/Groove with Ball bearings with
a openable service space for piping
V-Führungsrad mit doppelreihigem Schrägkugellager
mit Serviceraum für Rohrleitungen





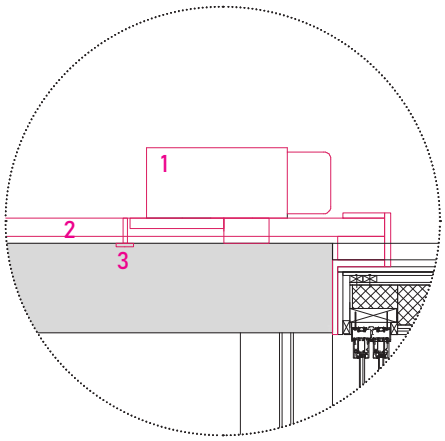


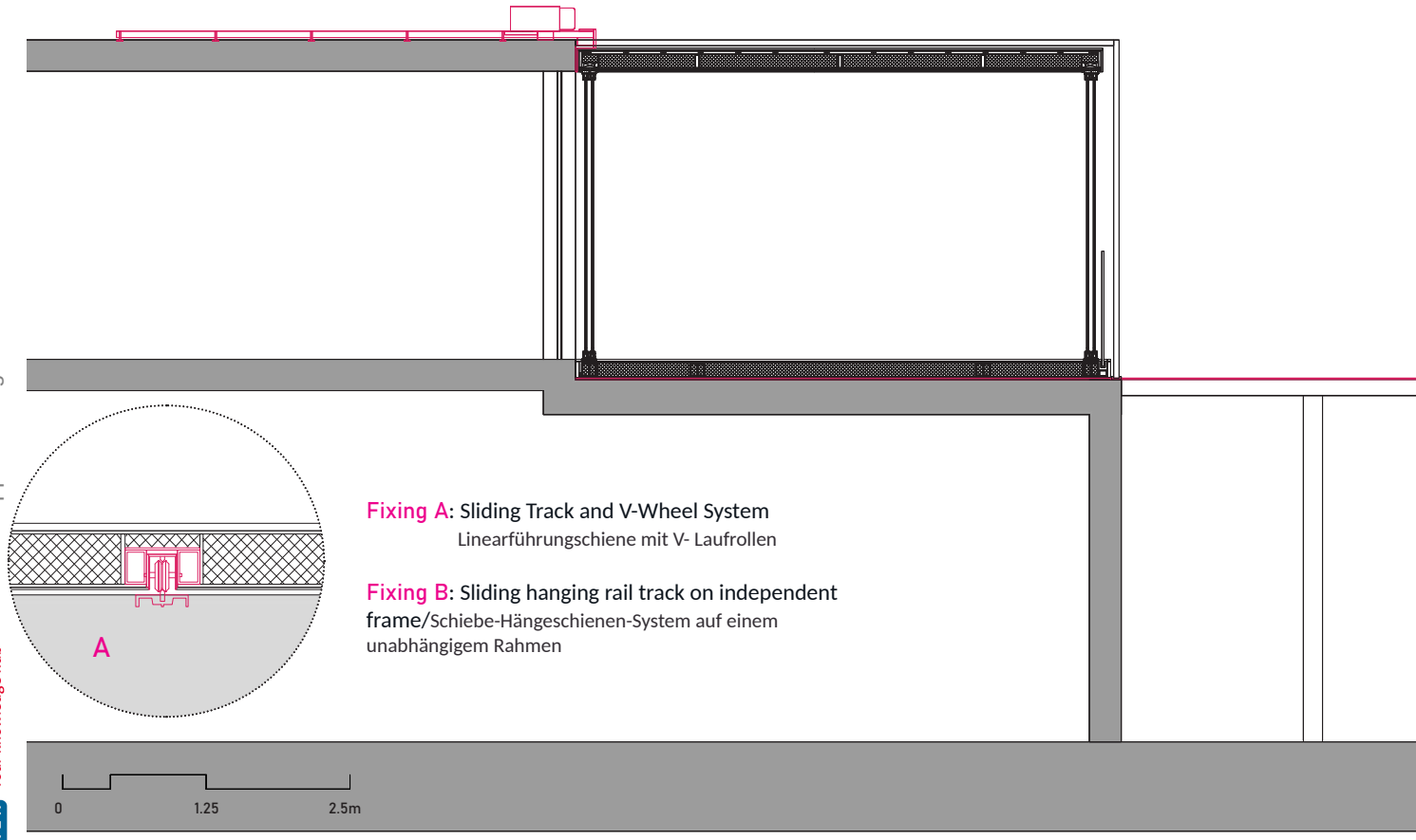


Pushing Mechanism

Rack & Pineon Drive Movement Mechanim
Zahnstange-ritzel Bewegungsantrieb mit Motor

1- Roof mounted motorized gear/module control
2- Rack bar
3- Roof mounted angle support brackets



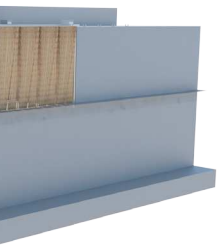


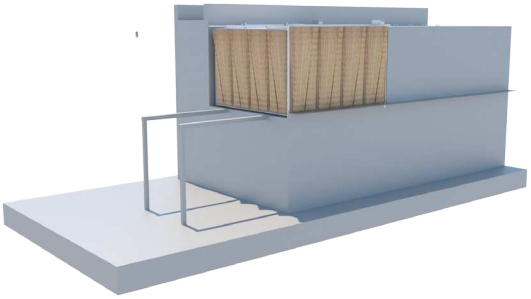
Fixing A: Sliding Track and V-Wheel System
Linearführungschiene mit V- Laufrollen

Fixing B: Sliding hanging rail track on independent frame/Schiebe-Hängeschienen-System auf einem unabhängigem Rahmen

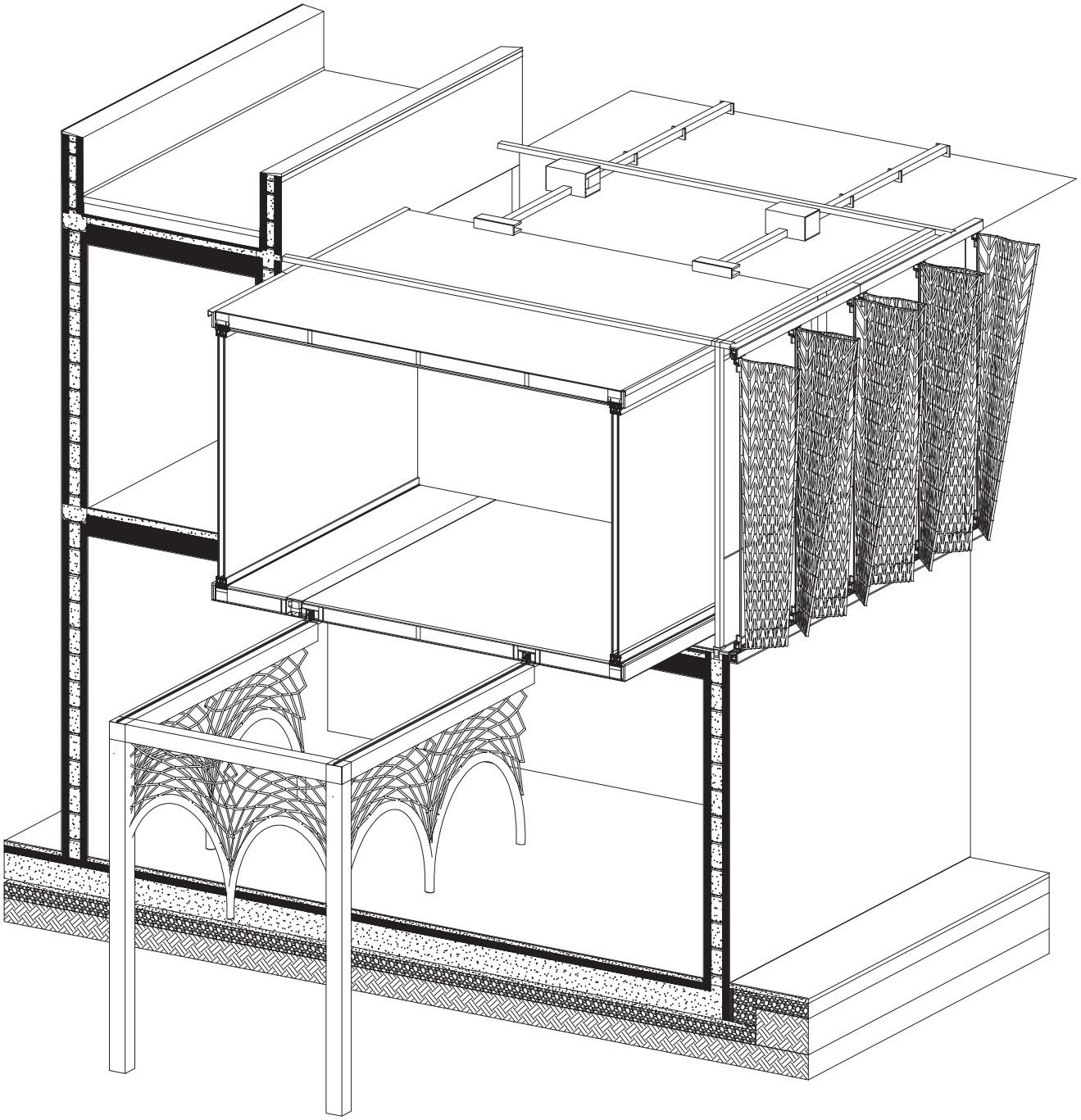
Figure.5.24: Top floor sliding module sections and 3D

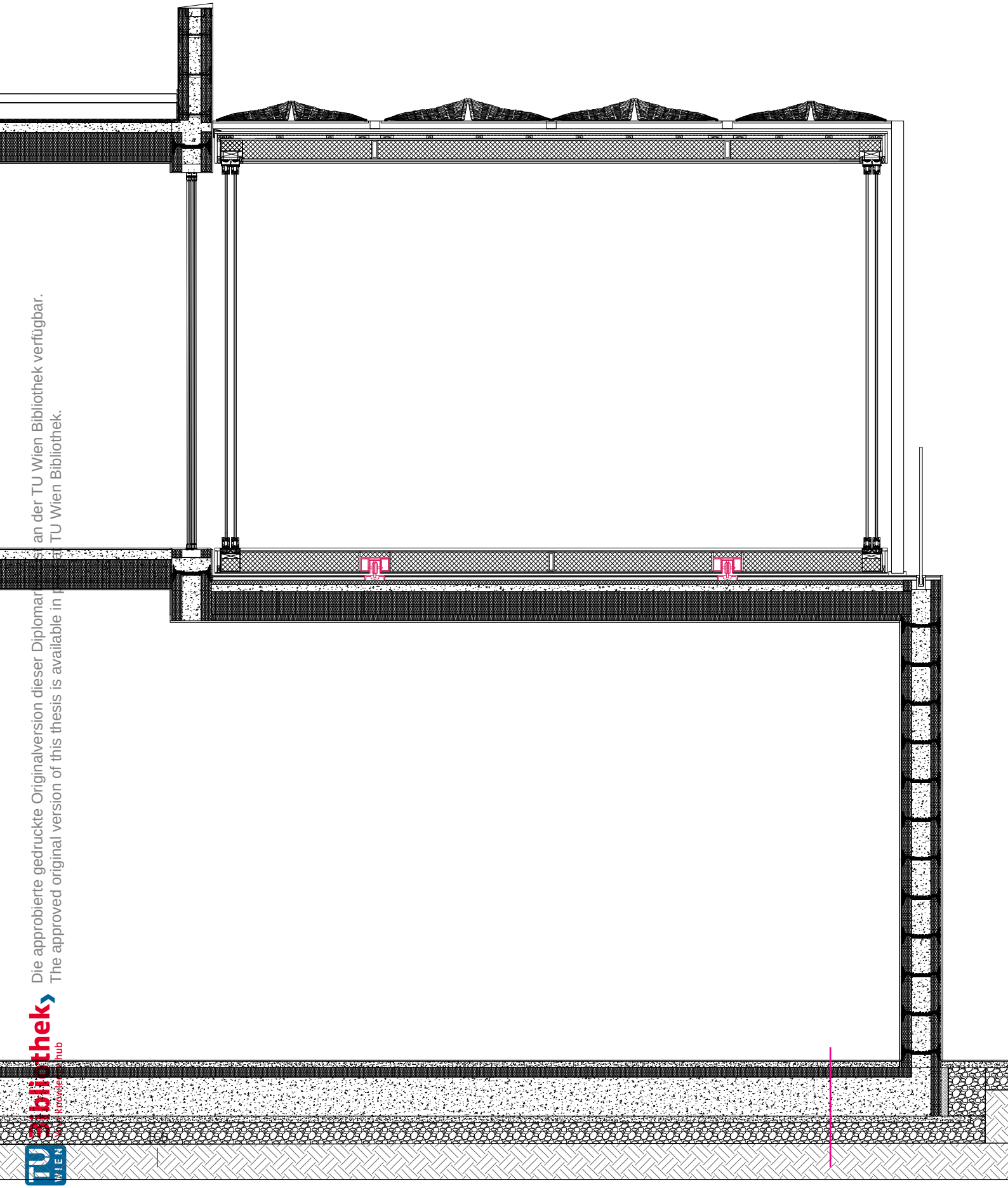
apartment type 2: sliding module





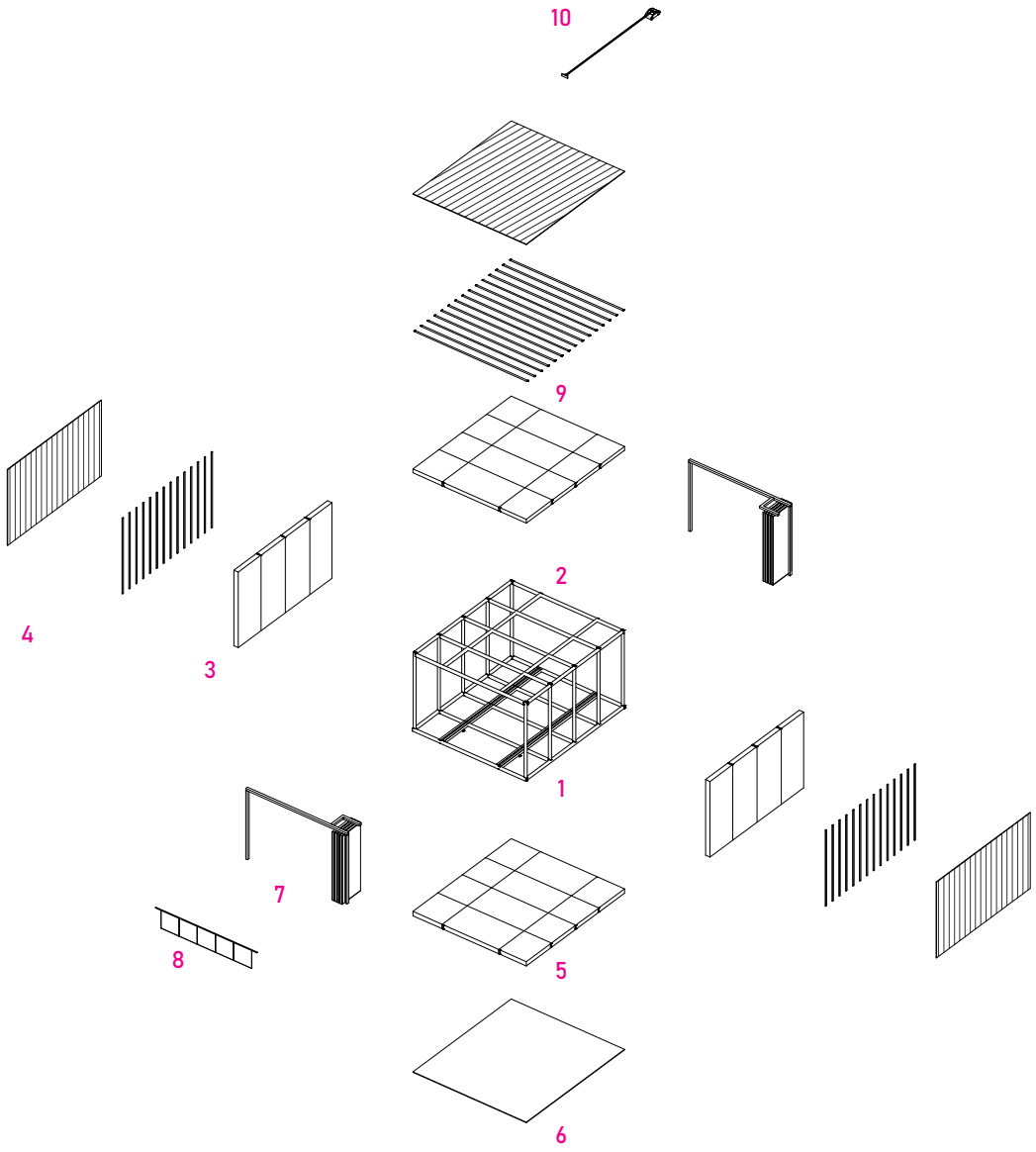
with SLIDING + OPERABLE ROOF PANELS





0 1.25 2.5m

Figure.5.25: Construction detail section cut



1. Sliding Track/V Wheel system
2. Light-weight steel frame
3. Aluminium Composite Wall panels
4. White washed Wood Composite Panel cladding
5. Aluminium Composite Floor panels
6. Aluminium protection plate
7. Stackable glass wall system or other door system
8. Glass railing
9. Aluminium Composite Roof panels
10. Motorized gear/piton push system

Figure.5.26: Top floor sliding module exploded axonometric

1. Wall

12.5mm	Plastered Wall/verputzte Wand
79mm	EPS Insulation Panel (ICF Block)/ EPS-Dämmung
75.5mm	Reinforced concrete (ICF Block)/ Stahlbeton
79mm	EPS Insulation Panel (ICF Block) EPS-Dämmung
12.5mm	Plastered Wall/verputzte Wand
75mm	Steel rotating connector bracket
	Palm tree weaving net (bamboo,wicker or palm)

2. Balcony Floor

9mm	Floor tiles
19mm	Screed (2%)
25mm	Rigid Insulation
	Breather membrane
12.5	Reinforced concrete
228mm	ICF Floor Panels (Schallungsteine Bodenpanelle)
12.5mm	Ceiling Plaster/verputzte Wand

3. Floor

9mm	Floor tiles
228mm	ICF Floor Panels (Schallungsteine Bodenpanelle)
12.5mm	Ceiling Plaster/verputzte Wand

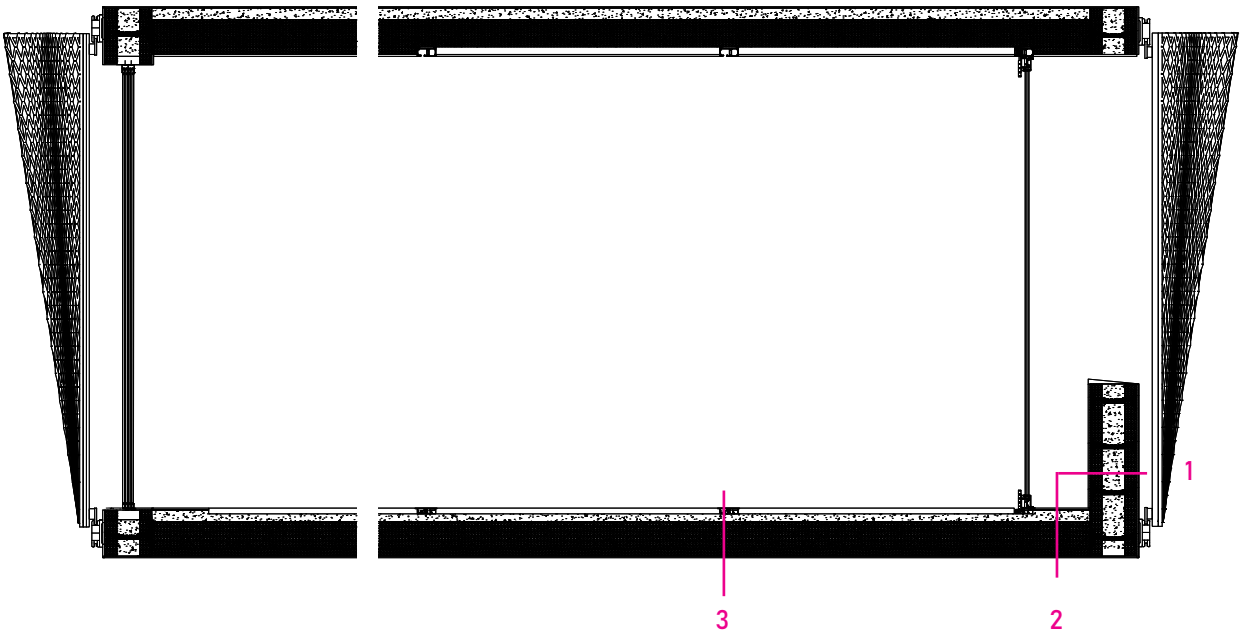


Figure.5.27: Construction detail section

apartment type 3: flexible walls

5.11

Figure.5.28: Exterior perspective

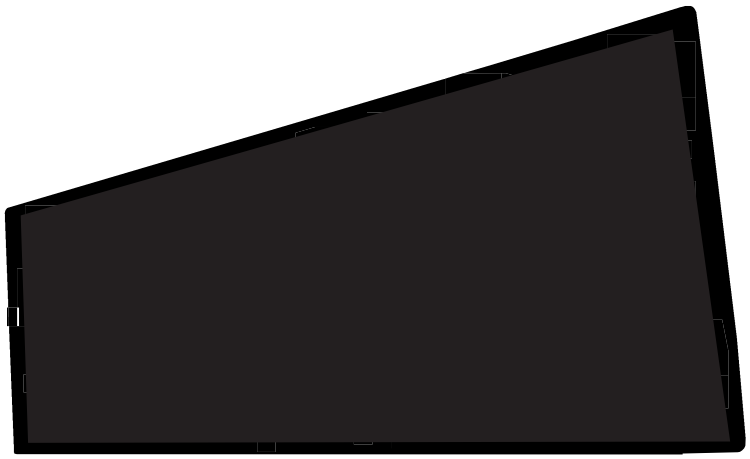
visualizations

Figure.5.29: Exterior perspective

Figure.5.30: Exterior perspective

Figure.5.31: Exterior perspective

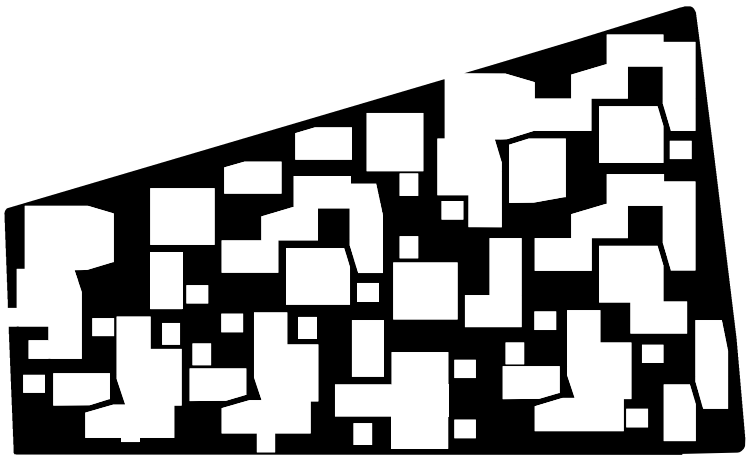
Figure.5.32: Exterior perspective



Plol Area	17 541m² 100%

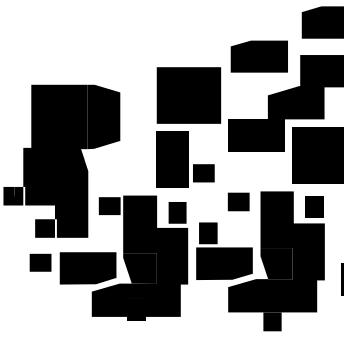
07 areas calculations

Figure.7.1: Ground floor calculations

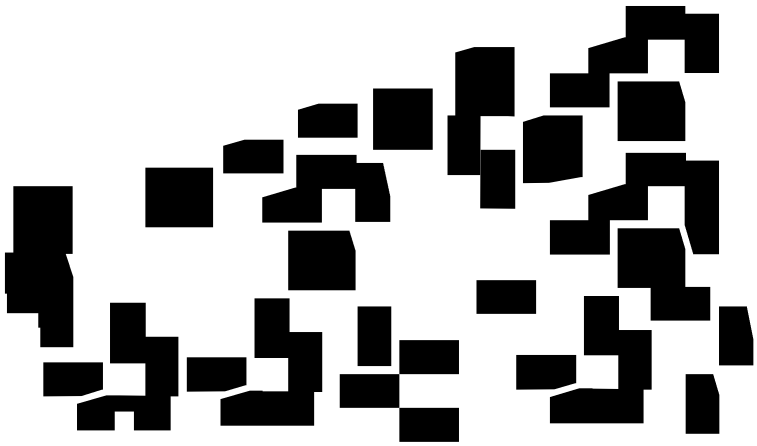


Plot free area

8631m²
49.2% from plot area

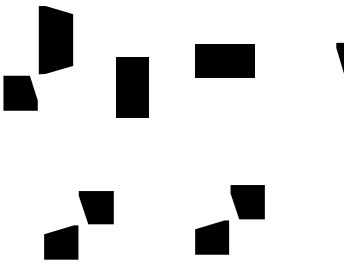


Gross Area



Mixed-use areas Netto

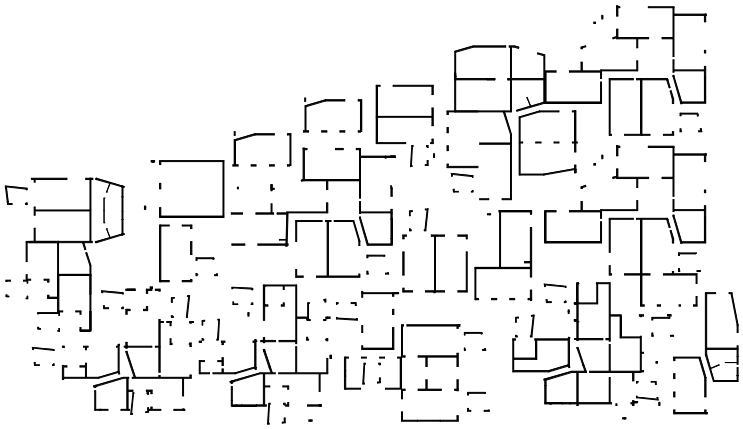
6036m²
67.7%



Communal + Circulatio

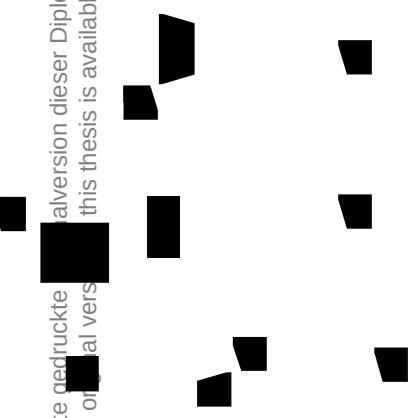
ground floor

8910m²
100%

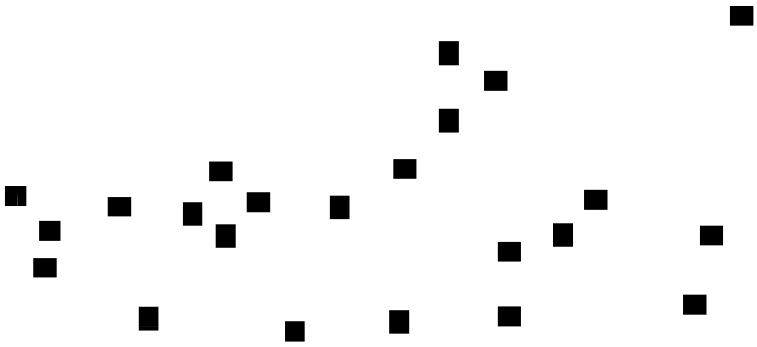


Construction Area

762m²
8.6%



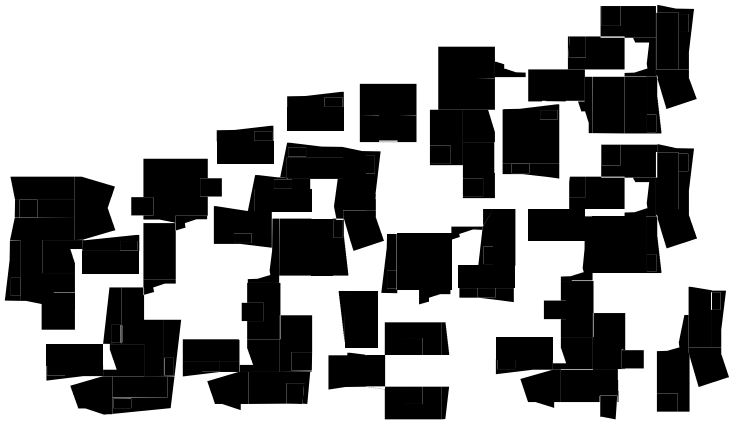
1613m²
18.1%



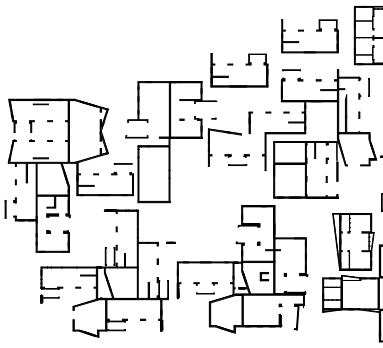
Moving Module Netto

499m²
5.6%

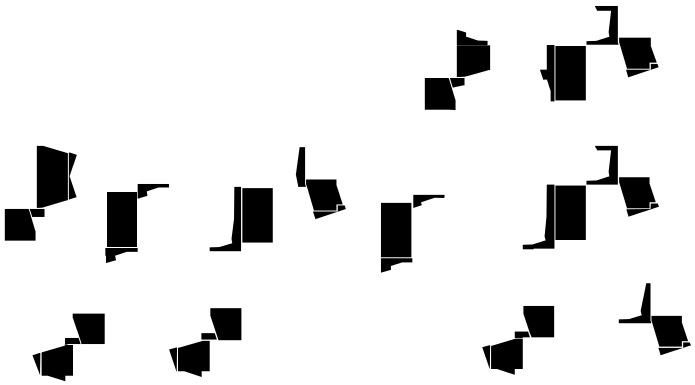
Figure.7.2: First floor calculations



Gross Area 8689m² 100%

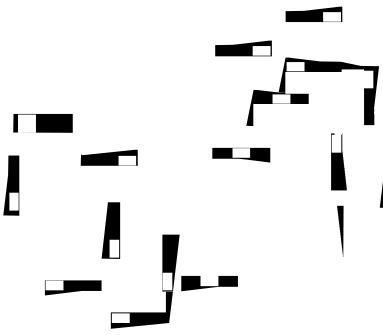


Construction area Netto



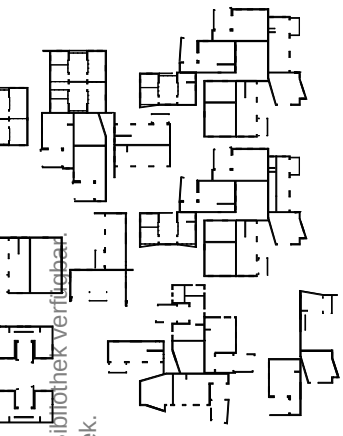
Circulation Netto 370m² 4.3%

Communal spaces Netto 1595m² 18.4%

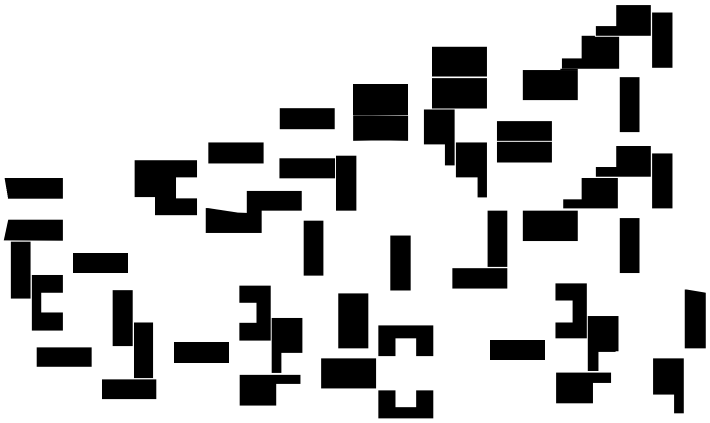


Loggia Netto

first floor



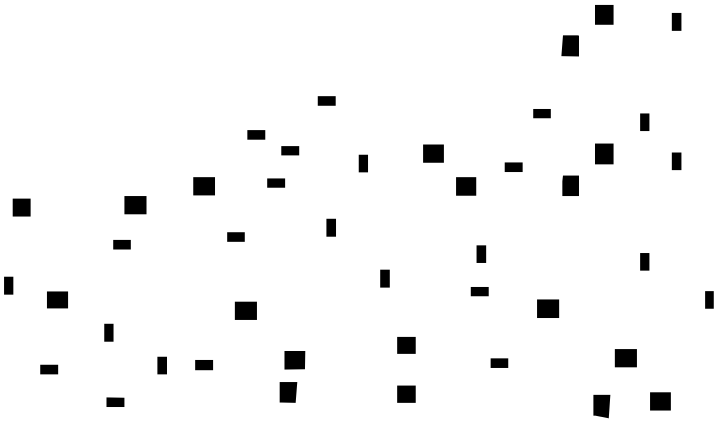
450m²
5.2%



Main living space Netto

4583m²
52.7%

1097m²
12.6%



Moving module Netto

594m²
6.8%

08 conclusion

This residential complex aims to showcase one approach of how part of the old city of Benghazi could be transformed to low density residential living spaces with elements of courtyard traditions in mind. The urban tesselation concept takes advantage of its characteristics of repeatability, modularity and flexibility, allowing for the removable and addition of module parts when necessary, depending on site conditions. The urban pattern helps create a system of connectivity between the apartment units via circulaltion and communal spaces as well as open spaces. The individual apartment and housing blocks allow for the individualization of the living and loggia spaces, through adding or removing walls, through the movement of the modules of tracks and through the variation of sliding panels where found necessary. The moving modules can be personalized according to the residents expectations and eventually also replaced with time. The ground floor public/semiprivate spaces gives room for residents and shop owners alike to utilize the spaces, whether for commercial or private uses. The ground floor mixed use spaces could be connected to the top floor apartments, giving residents an additional space for capitalization. This helps with the flexibility of multiple entrances per apartment, which takes into consideration the presence of gendered spaces. The vision of the project wants to showcase a communal living situation with elements of the traditional courtyard house and mixed use/commercial dynamic of the site with a modern touch. The prospect with the modularity and flexibilty of the moving modules is for the community to be able to create their on spaces according to their changing needs.

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Fig 1.6: General plan of urban structure of Benghazi, Lilian Mandalios, Autocad, 2019
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Fig 1.9: Impressions of the courtyard house, https://es.wikipedia.org/wiki/Archivo:Regionalismo_onubense.jpg
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Fig 1.14: Courtyard houses in Benghazi, Pinterest
Fig 1.15: Plans & section of a two-story courtyard house, Lilian Mandalios, Autocad 2018 (redrawn)
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Fig 2.5: Plan graphics, Lilian Mandalios, Autocad 2019
Fig 2.6: Plan graphics, Lilian Mandalios, Autocad 2019
Fig 2.7: Plan graphics, Lilian Mandalios, Autocad 2019
Fig 2.8: Satellite Image, http://www.geomatics.gr/en/
Fig 2.9: Illustrations, Lilian Mandalios, Autocad 2019, Adobe Illustrator, Rhino 5.0
Fig 2.10: Illustrations, Lilian Mandalios, Autocad 2019, Adobe Illustrator, Rhino 5.0

Fig 4.1: Illustrations, Lilian Mandalios, Revit 2019, Adobe Illustrator
Fig 4.2: Illustrations, Lilian Mandalios, Revit 2019, Adobe Illustrator, Rhino 5.0
Fig 4.3: Illustrations, Lilian Mandalios, Adobe Illustrator, Rhino 5.0
Fig 4.4: Plan graphics, Lilian Mandalios, Revit 2019
Fig 4.5: Illustrations and plan graphics, Lilian Mandalios, Revit 2019, Adobe Illustrator, Rhino 5.0
Fig 4.6: Plan graphics, Lilian Mandalios, Revit 2019
Fig 4.7: Plan graphics, Lilian Mandalios, Revit 2019
Fig 4.8: Plan graphics, Lilian Mandalios, Revit 2019
Fig 4.9: Illustrations and plan graphics, Lilian Mandalios, Revit 2019, Adobe Illustrator, Rhino 5.0

Fig 4.10: Illustrations and plan graphics, Lilian Mandalios, Revit 2019, Adobe Illustrator, Rhino 5.0
Fig 4.11: Illustrations and plan graphics, Lilian Mandalios, Revit 2019, Adobe Illustrator, Rhino 5.0
Fig 4.12: Illustrations and Renderings, Lilian Mandalios, Autocad 2019, Adobe Illustrator, Rhino 5.0
Fig 4.13: Illustrations, Lilian Mandalios, Autocad 2019, Adobe Illustrator, Rhino 5.0
Fig 4.14: Renderings, Lilian Mandalios, Autocad 2019, Rhino 5.0

Fig 4.15: Image, https://www.quadlock.com/, https://www.eco-home-essentials.co.uk/icf-homes.html, http://www.cementcounciloftexas.org/residential/what_is_icf.htm
Fig 4.16: Rendering, Lilian Mandalios, Autocad 2017, Rhino 5.0
Fig 4.17 Rendering, Lilian Mandalios, Autocad 2017, Rhino 5.0
Fig 4.18 Rendering, Lilian Mandalios, Autocad 2017, Rhino 5.0
Fig 4.19: Rendering, Lilian Mandalios, Autocad 2017, Rhino 5.0
Fig 4.20: Graphic, Lilian Mandalios, Adobe Photoshop
Fig 4.21: Rendering, Lilian Mandalios, Autocad 2017, Rhino 5.0
Fig 4.22: Rendering, Lilian Mandalios, Autocad 2017, Rhino 5.0
Fig 4.23: Image, www.pinterest.se pin 564568503260859879, www.adwonline.ae 43550-2, www.conranshop.co.uk round basket natural
Fig 4.24: Rendering, Lilian Mandalios, Autocad 2017, Rhino 5.0

Fig 5.1: Plan, Lilian Mandalios, Revit 2019
Fig 5.2: Plan, Lilian Mandalios, Revit 2019
Fig 5.3: Plan, Lilian Mandalios, Revit 2019
Fig 5.4: Plan, Lilian Mandalios, Revit 2019
Fig 5.5: Plan, Lilian Mandalios, Revit 2019
Fig 5.6: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.7: Axonometry section, Lilian Mandalios, Revit 2019
Fig 5.8: Plan, Lilian Mandalios, Revit 2019
Fig 5.9: Plan, Lilian Mandalios, Revit 2019
Fig 5.10: Plan and sections, Lilian Mandalios, Revit 2019, Rhino 5.0, Adobe Illustrator
Fig 5.11: Plan and axonometry, Lilian Mandalios, Revit 2019, Rhino 5.0, Adobe Illustrator
Fig 5.12: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.13: Plan and axonometry, Lilian Mandalios, Revit 2019, Rhino 5.0, Adobe Illustrator
Fig 5.14: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.15: Plan and axonometry, Lilian Mandalios, Revit 2019, Rhino 5.0, Adobe Illustrator
Fig 5.16: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.17: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.18: Plan and axonometry, Lilian Mandalios, Revit 2019, Rhino 5.0
Fig 5.19: Construction detail, Lilian Mandalios, Rhino 5.0, Autocad 2017
Fig 5.20: Construction detail and 3D, Lilian Mandalios, Rhino 5.0, Autocad 2017
Fig 5.21: Axonometry, Lilian Mandalios, Rhino 5.0
Fig 5.22: Construction detail and 3D, Lilian Mandalios, Rhino 5.0, Autocad 2017
Fig 5.23: Construction detail and 3D, Lilian Mandalios, Rhino 5.0, Autocad 2017
Fig 5.24: Construction detail, Lilian Mandalios, Rhino 5.0, Autocad 2017
Fig 5.25: Construction detail, Lilian Mandalios, Rhino 5.0, Autocad 2017
Fig 5.26: Construction detail, Lilian Mandalios, Rhino 5.0, Autocad 2017, 3dsmax 2019
Fig 5.27: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.28: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.29: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.30: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019
Fig 5.31: Rendering, Lilian Mandalios, Revit 2019, Photoshop CC, 3dsmax 2019

Fig 7.1: Area Calculation, Lilian Mandalios, Revit 2019
Fig 7.2: Area Calculation, Lilian Mandalios, Revit 2019

Fig 10.1-10.9: Illustrations, Lilian Mandalios, Rhino 5.0, Revit 2019, Autocad 2017, Adobe Illustrator

contact details

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skills

Software:
Revit, AutoCAD, 3dsMAX, Sketchup, Rhino, Archicad
Photoshop, CorelDRAW, Indesign, Illustrator

Languages:
English, German, Greek, Spanish Basics, Arabic Basics

extracurricular

AIESEC
Vienna, Austria
OUTGOING EXCHANGE COORDINATOR
Nov. 2014 - June 2015

Displaced - Space for change
Vienna, Austria
Oct. 2015 - June 2016

hobbies

Swimming: inspired since childhood.
Painting: inspired since childhood
Yoga: since a few years

curriculum vitae

education

Technical University of Vienna
Vienna, Austria
M.S. IN ARCHITECTURE
2014- 2020

University of Kent
Canterbury, United Kingdom
B.A. IN ARCHITECTURE
2010 - 2013

University of Indianapolis
Athens Campus, Greece
GENERAL STUDIES
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work experience

plandata
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Stasek Licht Design
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LIGHT PLANNING ASSISTANT, July 2018 - December 2018

LEEAD Consulting
Athens, Greece
JUNIOR ARCHITECT, January 2018 - June 2018

Blaulicht Vis-à-Vis Wien
Vienna, Austria
SALES AND LIGHT CONSULTANT, July 2017 - December 2017

Bakalowits Light Design
Vienna, Austria
GRAPHIC DESIGNER, June 2017 -December 2017

SiT Bolig
Trondheim, Norway
ARCHITECTURE INTERNSHIP, July 2016 - September 2016

10 appendix

additional developmental exercises

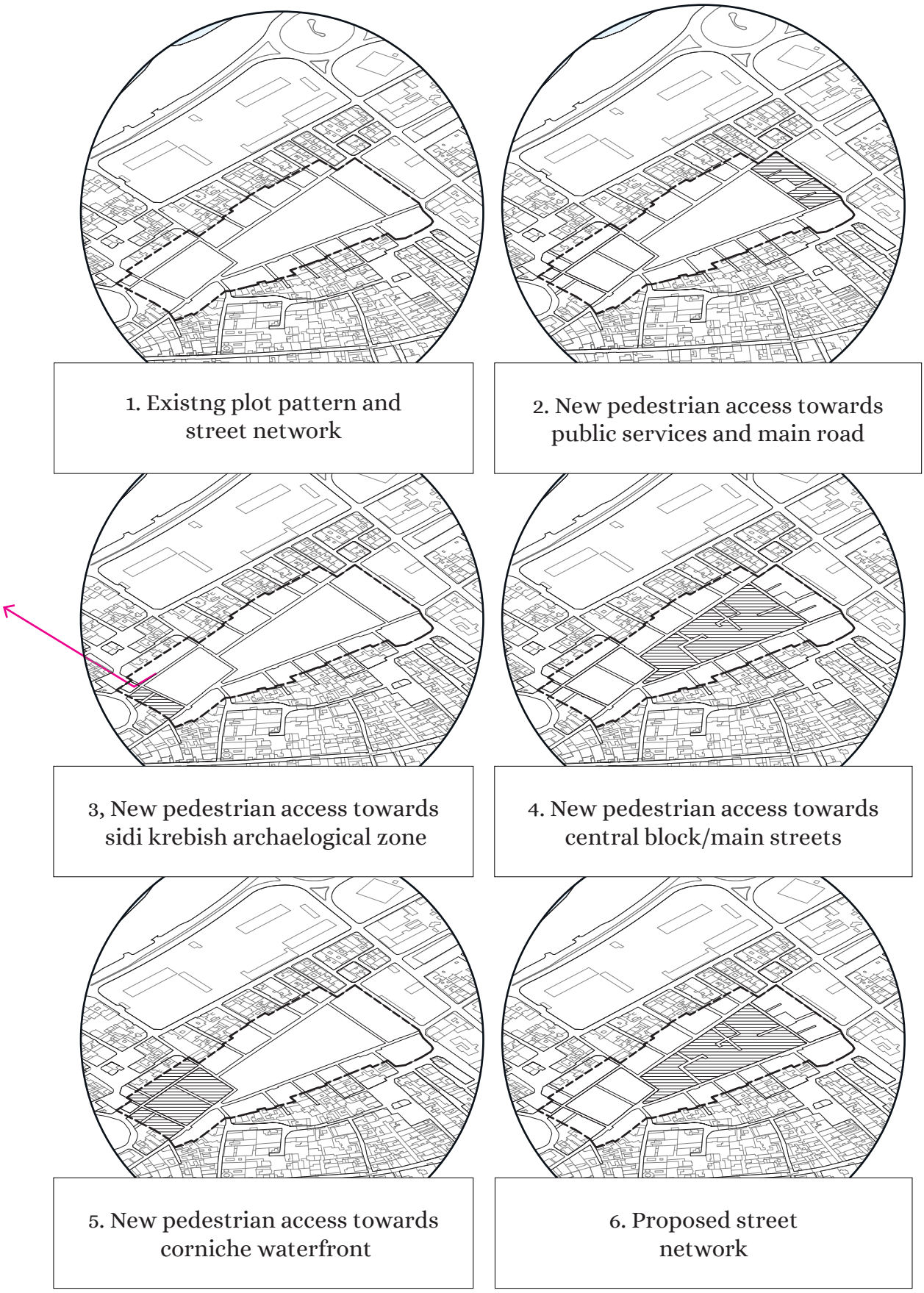
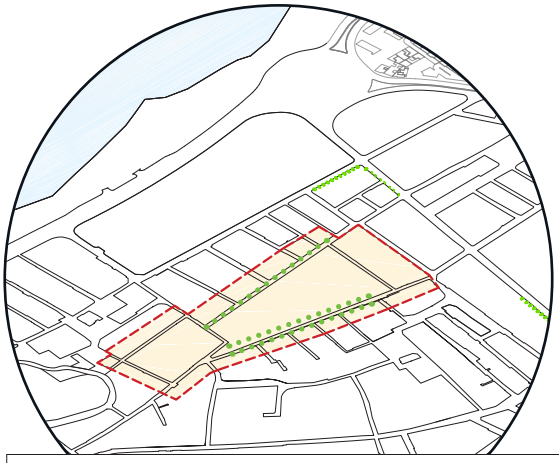


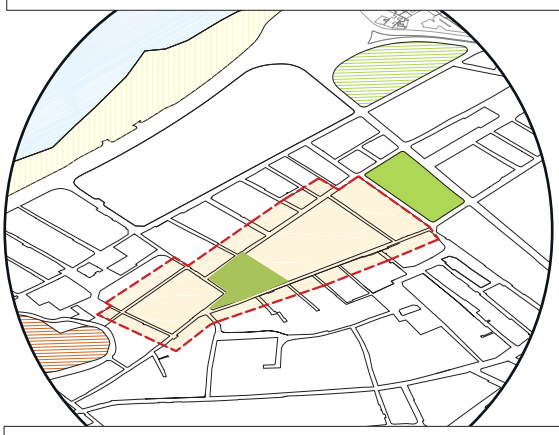
Figure.10.1: site plan-urban brainstorming concepts

continue the mixed use framework
& reactivate important street

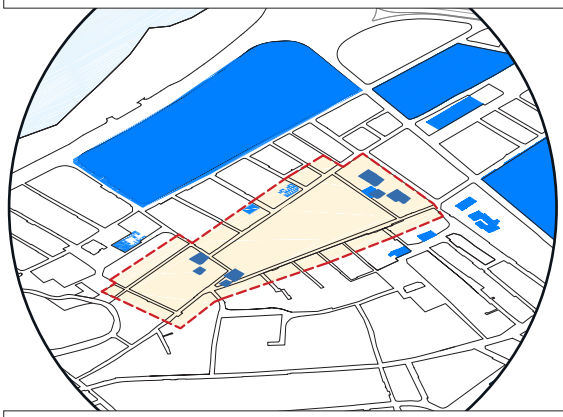


connect the heritage zone
with the use of arcades

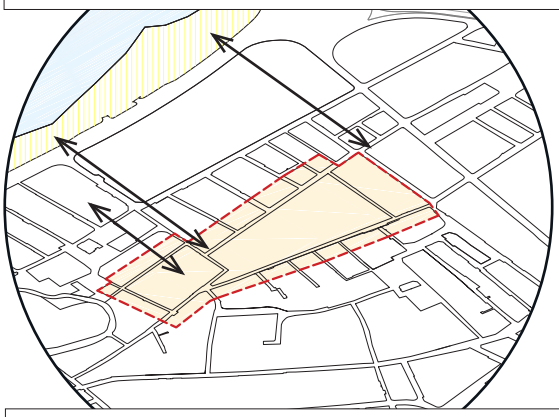
maintain the mixed housing
typologies & mixed social situations



create a central green space
for the heritage zone

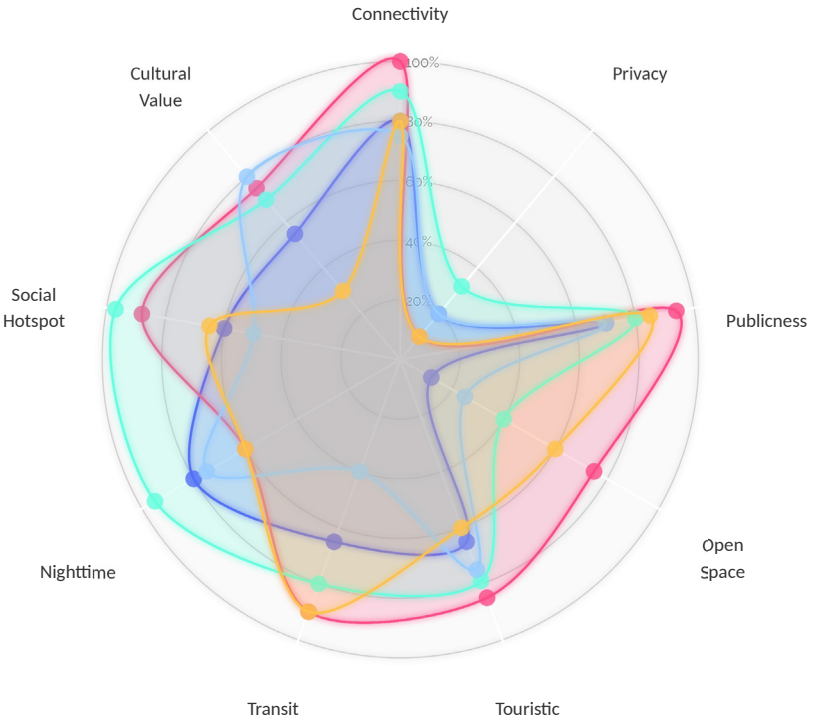


provide more well connected
social and cultural activities



create a connection with the
waterfront corniche

NIGHTTIME ACTIVITIES



COMMERCIAL

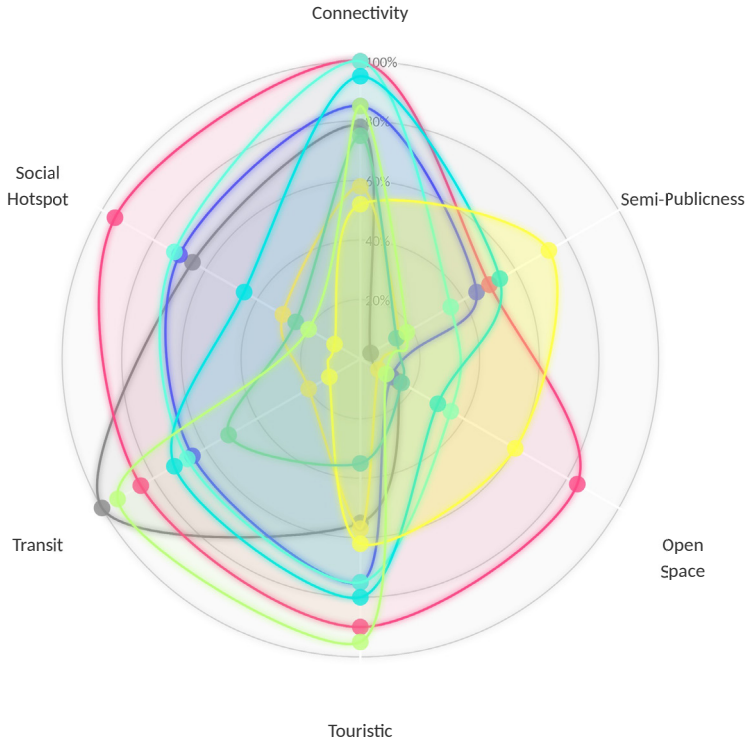


Figure.10.2: programmatic radar charts

PUBLIC OFFICES

- LOCAL SCHOOL AND KINDERGARTEN
- TOURIST INFORMATION CENTER
- HERITAGE MUSEUM
- HERITAGE ZONE PUBLIC UTILITY CENTER
- HERITAGE ZONE PUBLIC SERVICE CENTER
- OPEN AIR MUSEUM COURTYARD HOUSE
- TRAINING CENTER FOR HERITAGE ZONE
- PUBLIC WC ROOMS
- OLD CITY ADMINISTRATION

CULTURE & LEISURE

- HERITAGE MUSEUM
- CLASSROOMS/WORKHOPS
- LOCAL FOOD MARKET
- CULTURAL CENTER/CONFERENCE HALL
- EXHIBITION CENTER
- LOCAL LIBRARY
- HORSE CARRIAGES CENTER

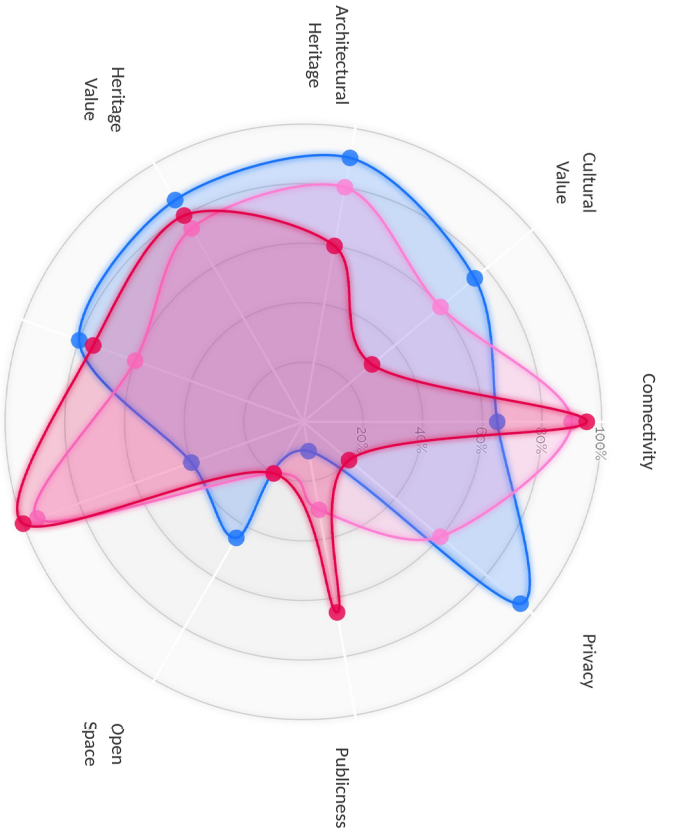
COMMERCIAL & RETAIL

- SNACK BARS
- TRADITIONAL SWEET SHOP
- LOCAL FOOD MARKET
- CAFES AND RESTAURANTS
- HERB AND PHARMACY SHOP
- TRADITIONAL BAKERY
- FURNITURE/CARPENTER/LEATHER SHOPS
- LOCAL JEWELLERY AND COSTUMES SHOPS
- SOUVENIR SHOPS

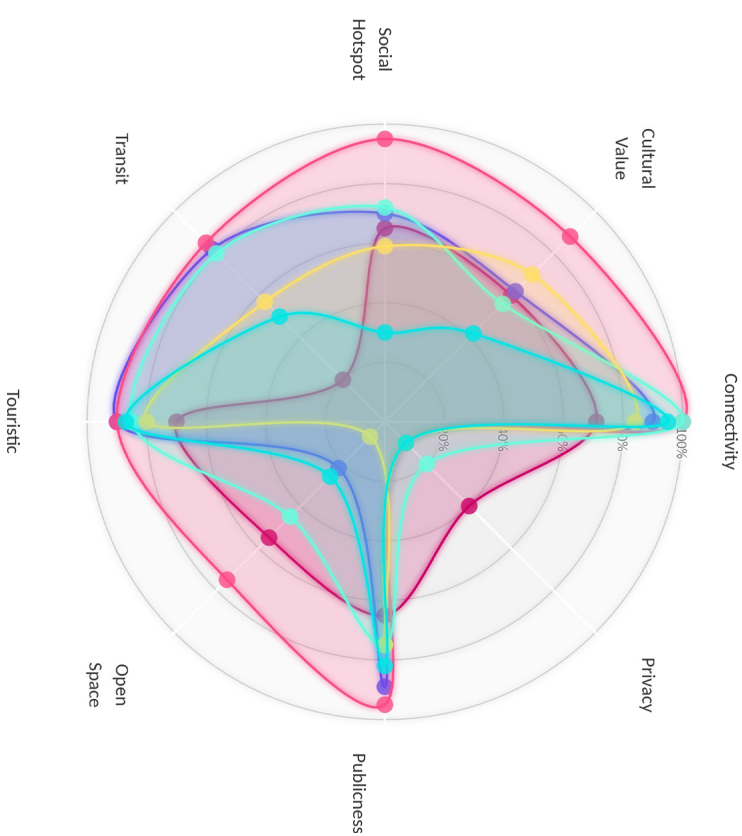
RESIDENTIAL

- COURTYARD HOUSES
- BOUTIQUE HOTELS
- ROOMS/APARMENTS FOR RENT

RESIDENTIAL

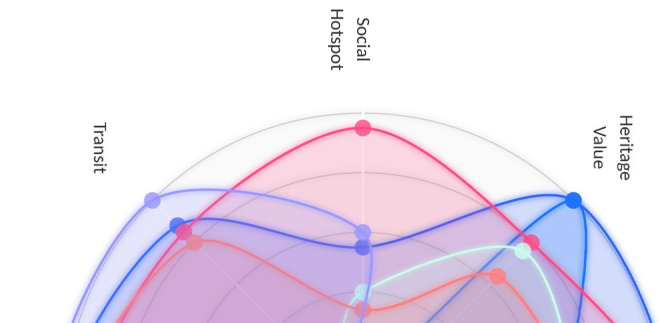


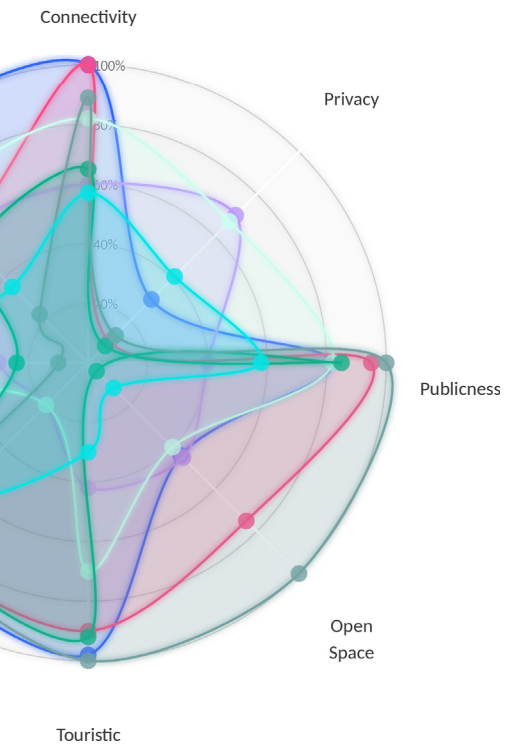
FOOD LOVERS



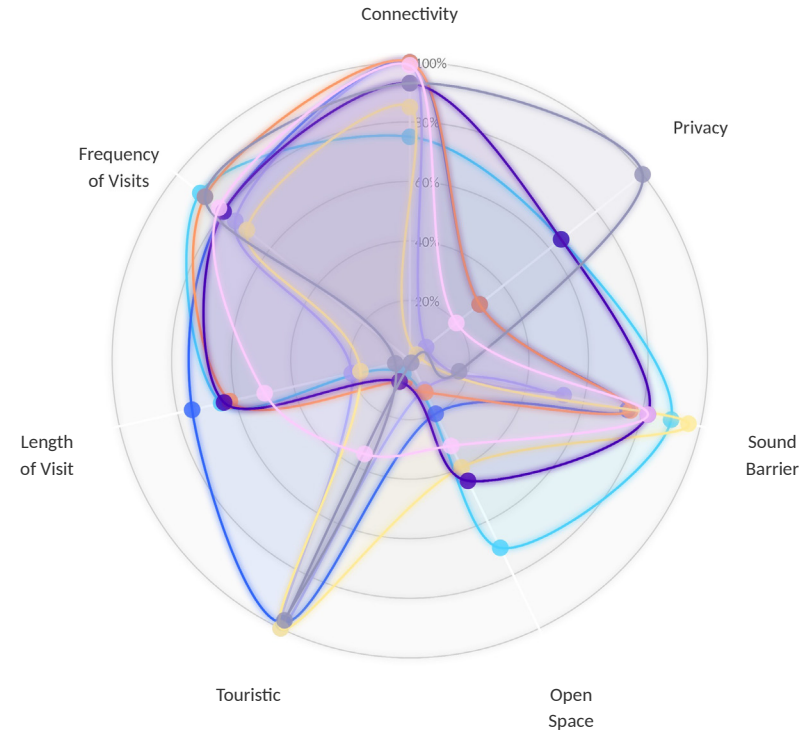
CULTURAL

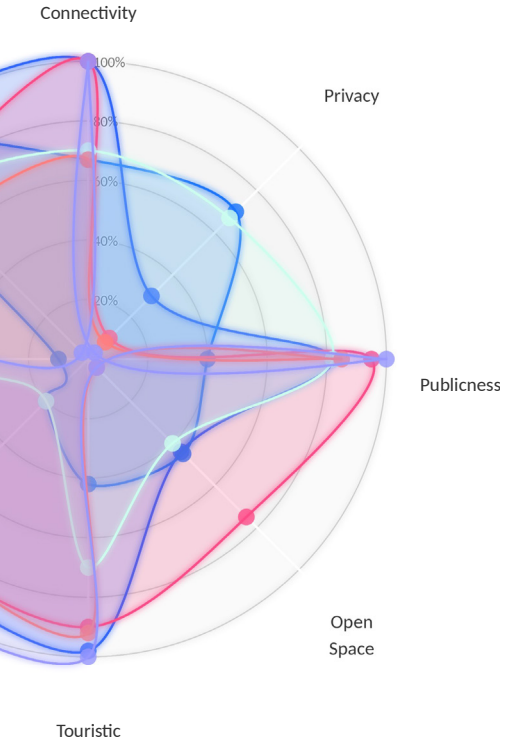
HERITAGE EXPERIENCES



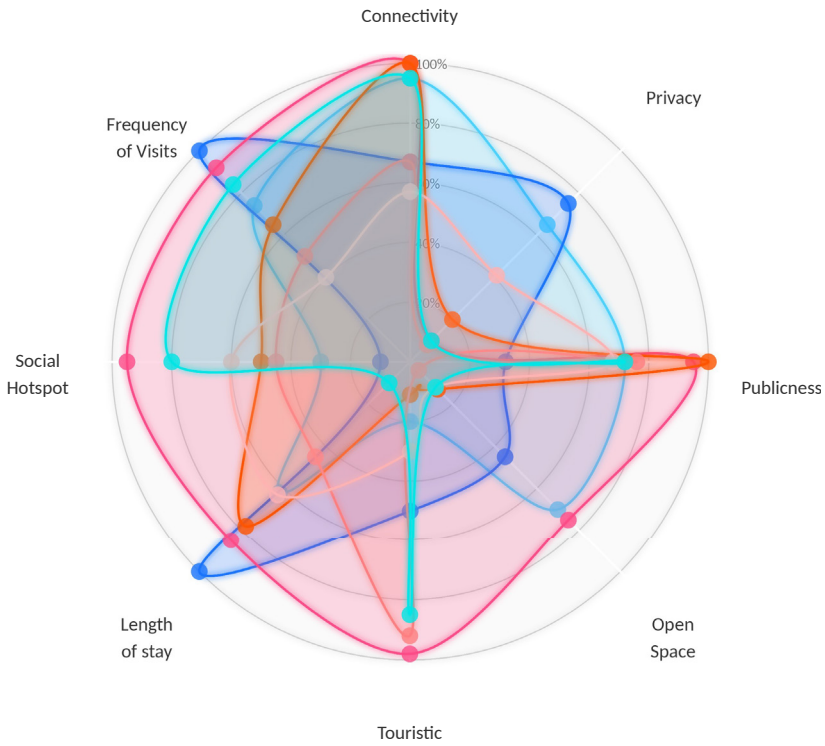


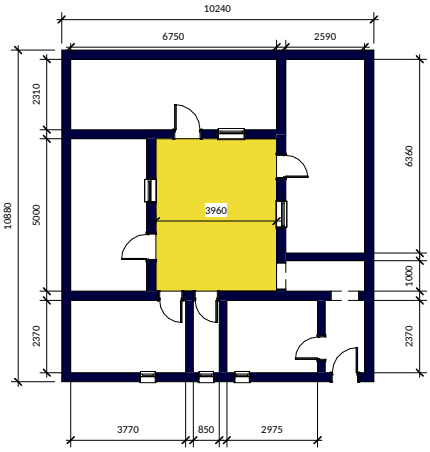
PUBLIC FACILITIES

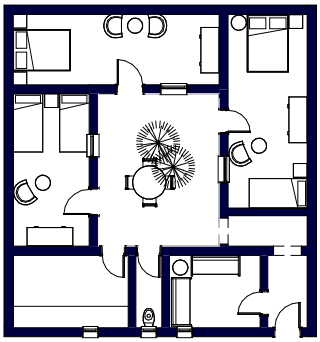




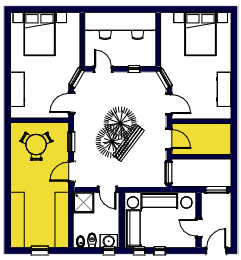
LIKE A LOCAL



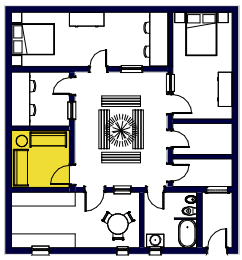




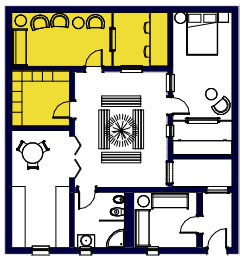
getting intouch with the old one-story courtyard floor plan through layout alterna-tives



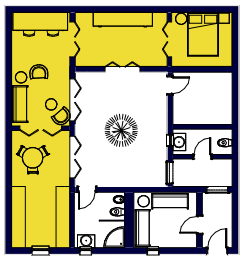
large kitchen family



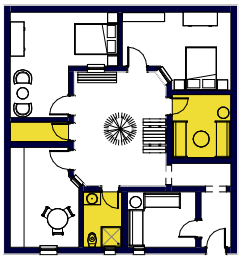
common living room space family



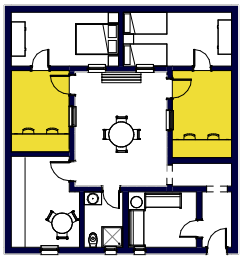
newlywed couple



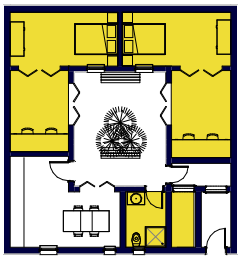
modern plan ne-wlyweds



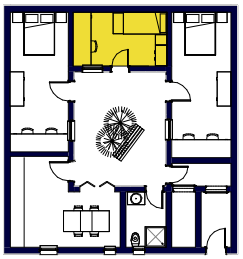
small family house



home office family



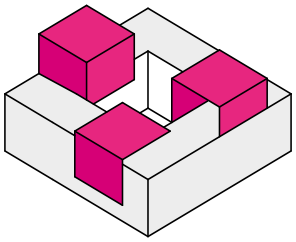
modern home office family



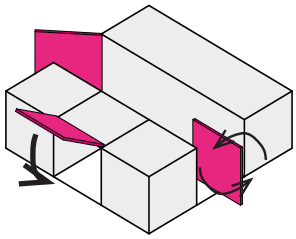
shared living

Figure.10.3: developmental exercise illustrations

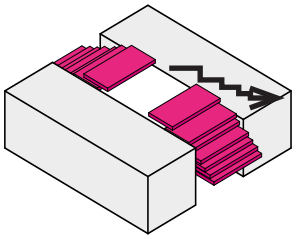
courtyard roof idea illustrations



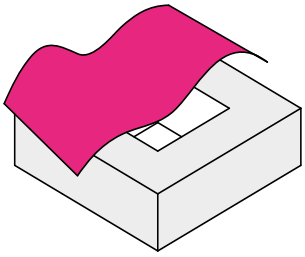
PORTRUDING COURTYARDS



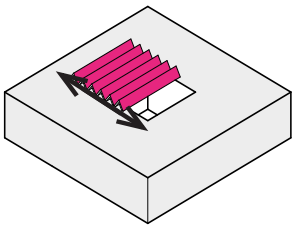
FLIP/ROTATE WALLS PANELS



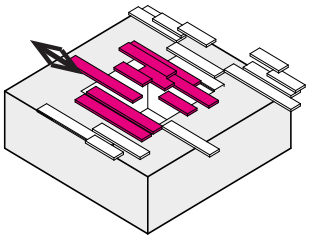
CLOSING ROOF STAIR/PLATEAU



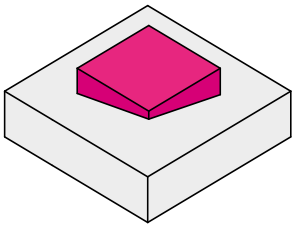
FLYING CARPET ROOF



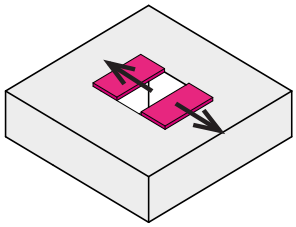
FOLDING LOUVRE SYSTEM



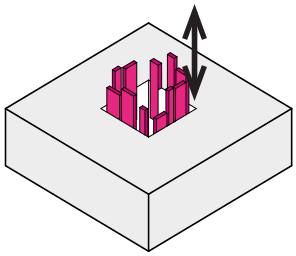
SLIDING SHADE PANEL



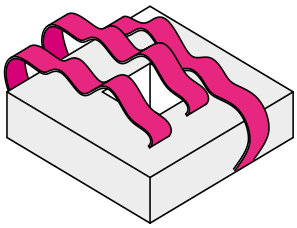
MULTI-LEVEL YARD



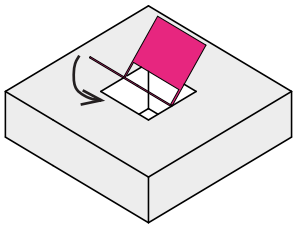
SLIDING ROOF



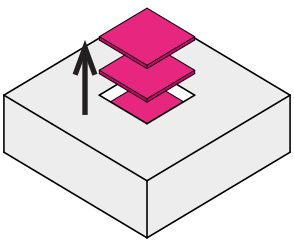
VERTICAL SLIDING SHADES



HOVERING SHADES



FLIP ROOF



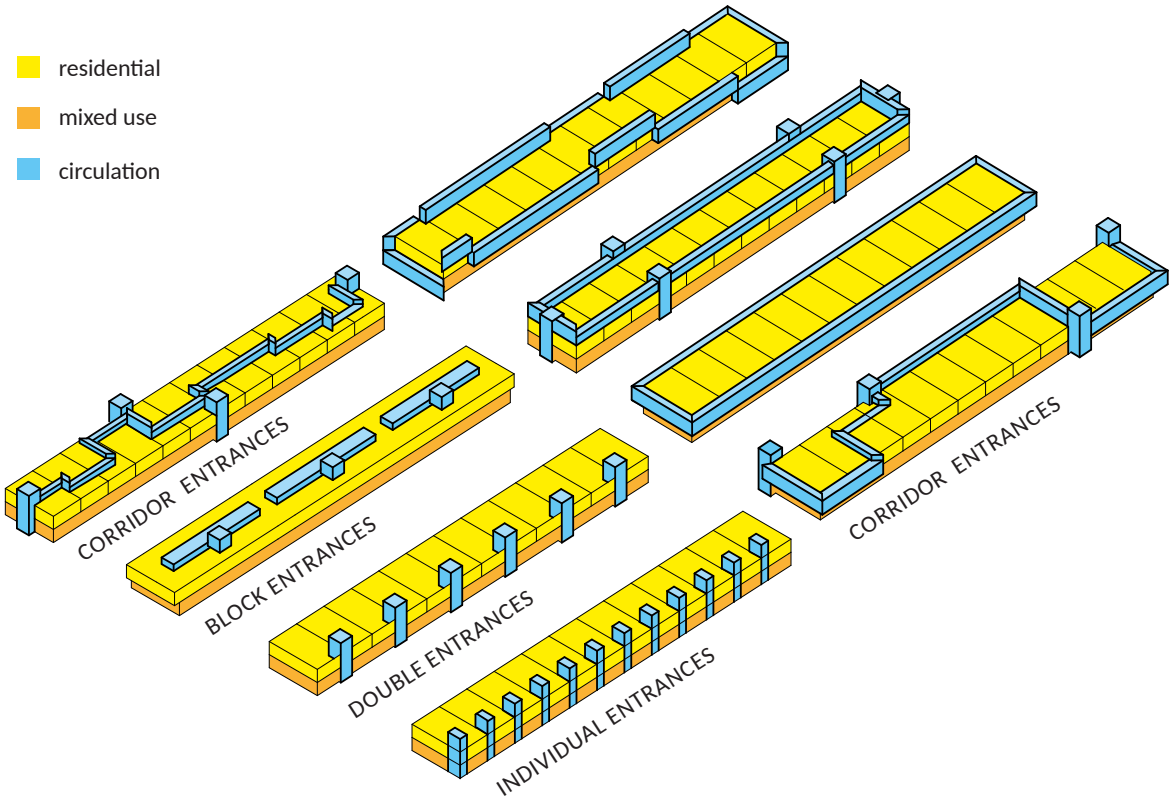
MOVABLE COURTYARD

typology lego illustations

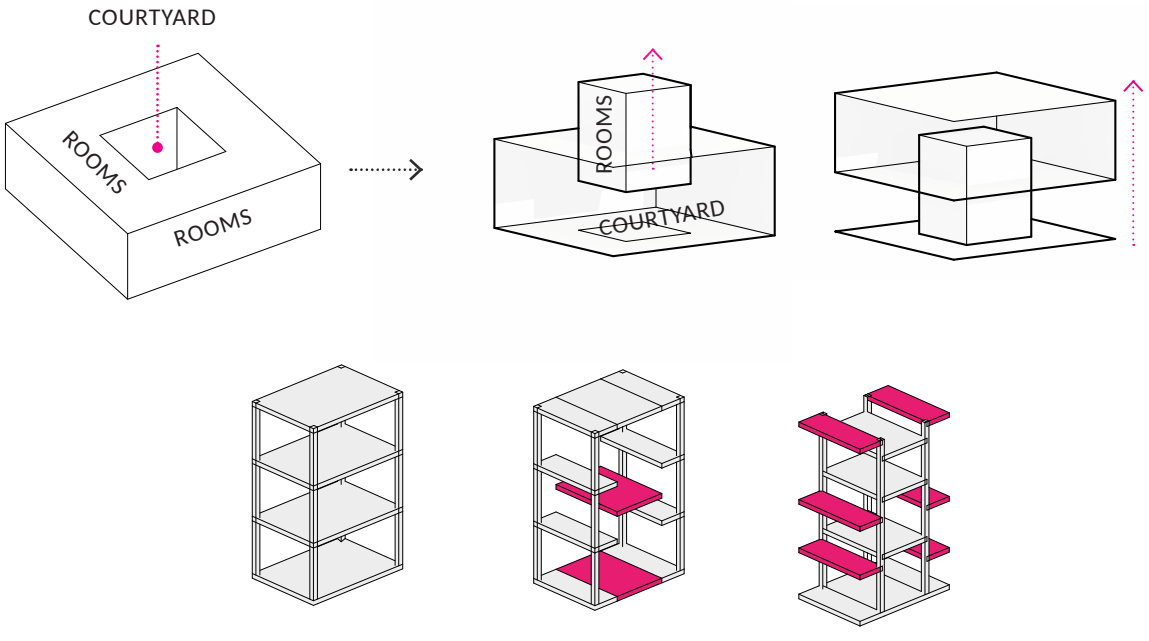
bringing light in - courtyard section cuts

Figure.10.4: developmental exercise illustrations

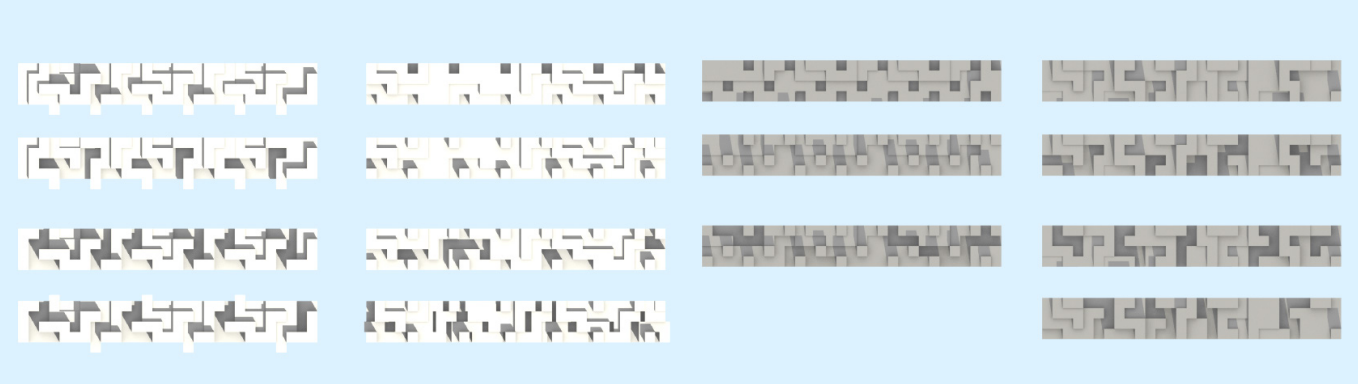
circulation idea illustrations



anit-courtyard concept

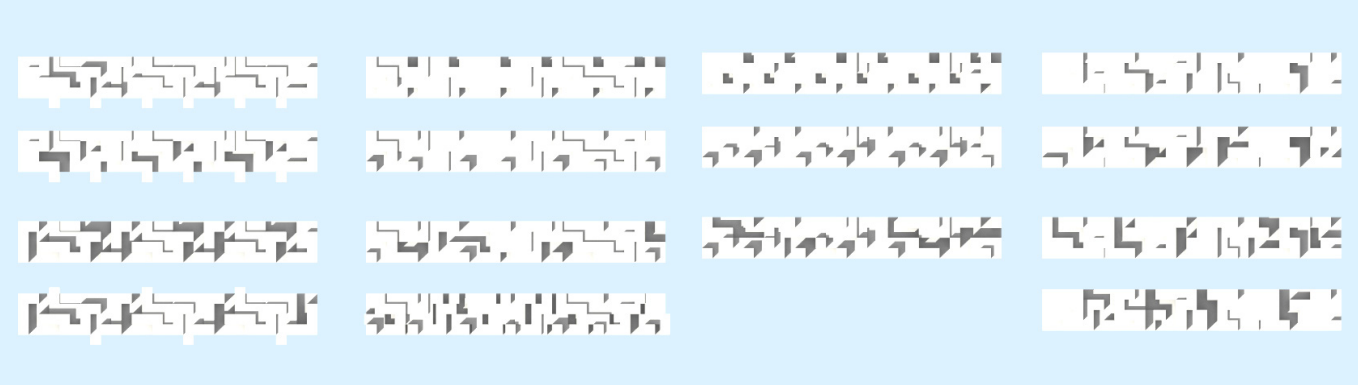


various singular blocks - sunlight studies



Sep. 8am

Dec. 8am



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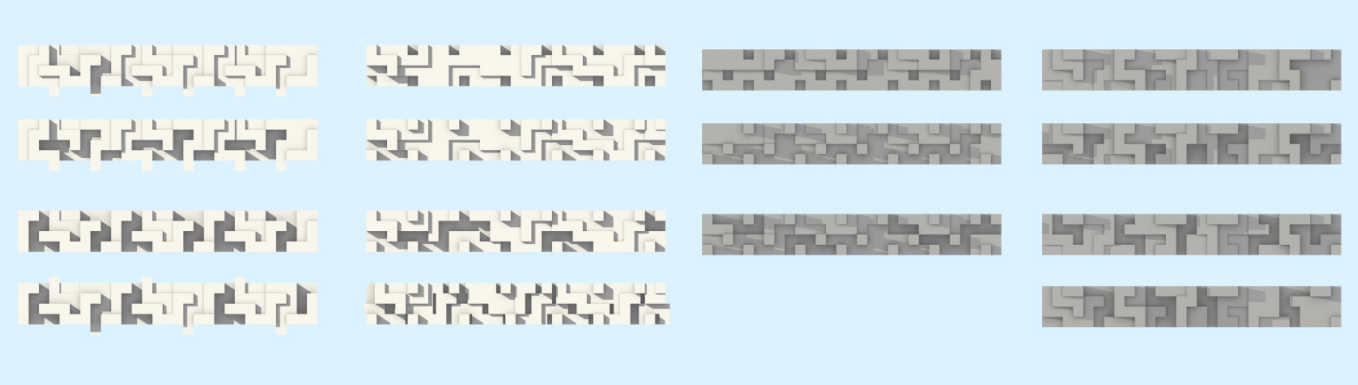
Dec. 12am

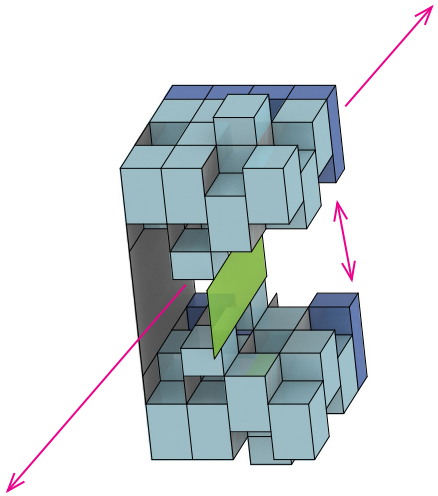


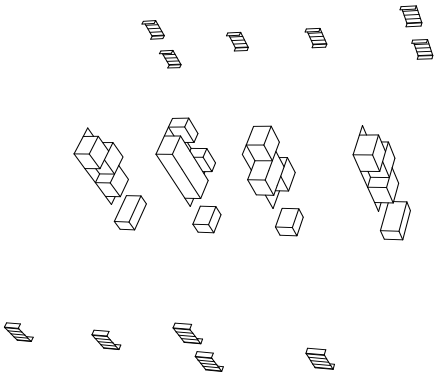
Sep. 4pm

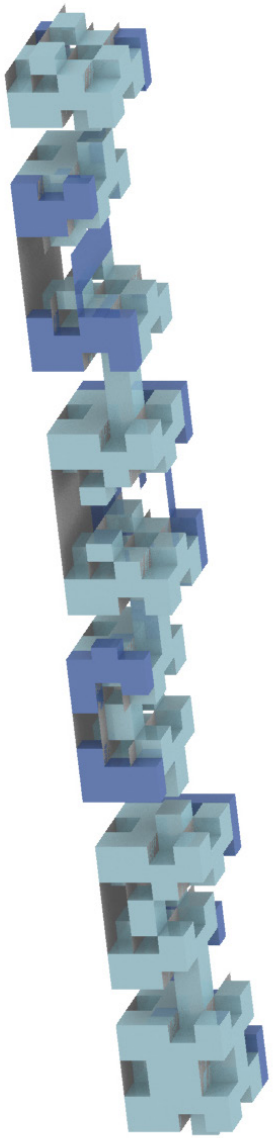
Dec. 4pm

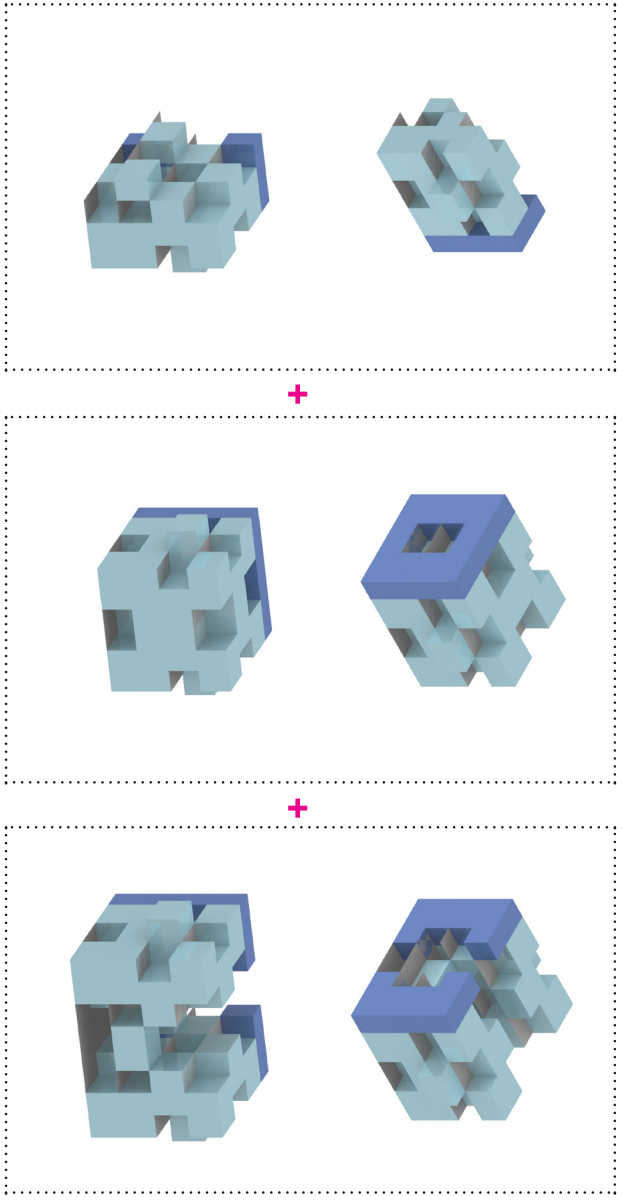
Figure.10.5: urban developmental exercises

tesselation urban experiments

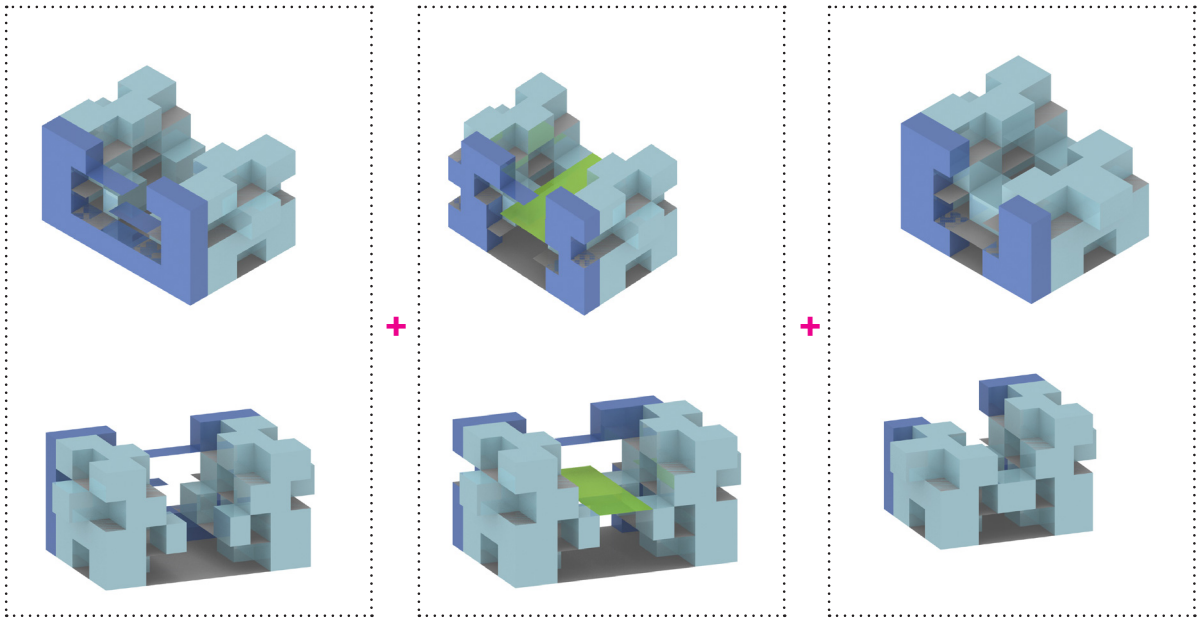


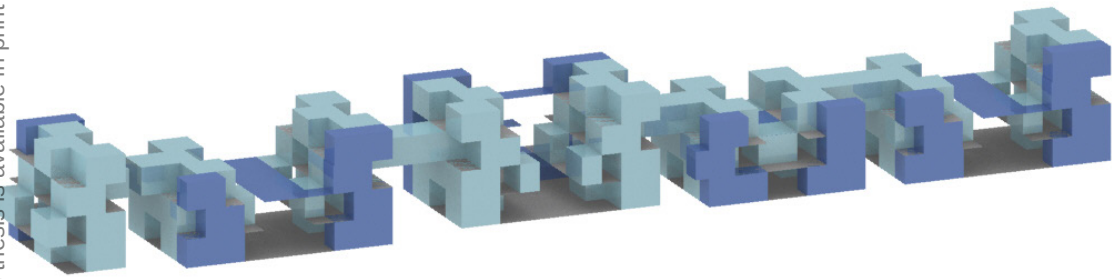


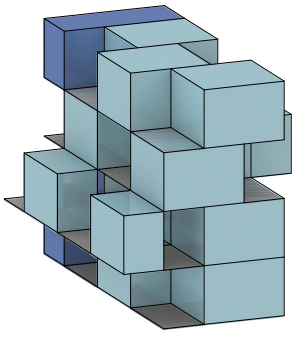




interlocking block units



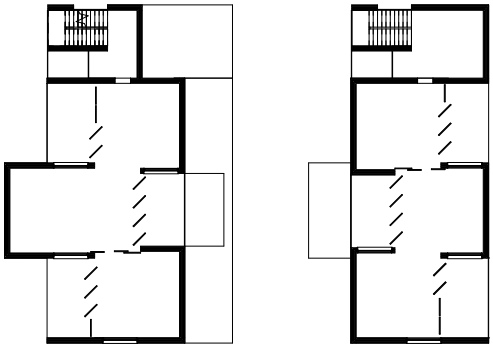


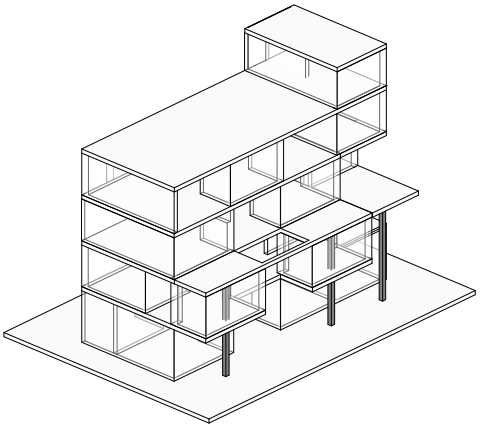


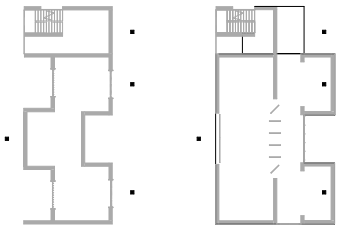
BASIC MODULE

interlocking units that help activate ground floor activites and residential and communal interactions on the top floors. The unit can come together in various formations depending on site conditions

Figure.10.6: interlocking block concept

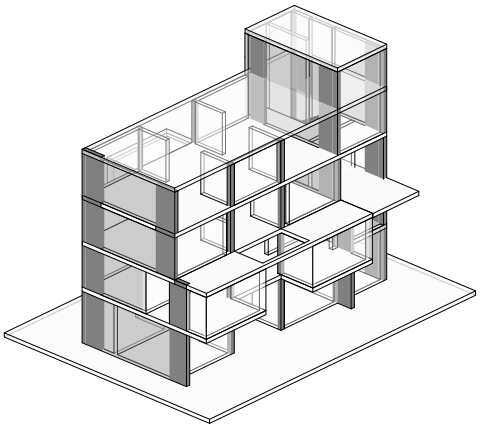


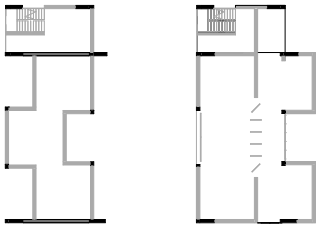




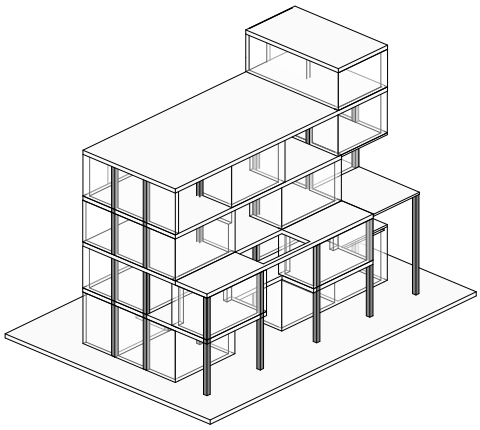
ICF reinforced walls as main
load bearing elements

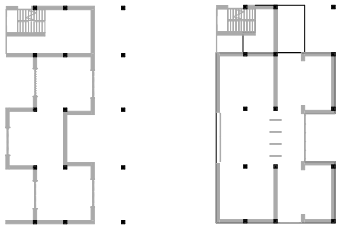
Single Columns in
at balcony overhangs were necessary



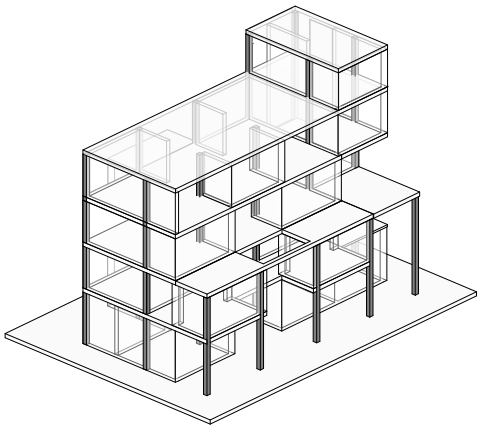


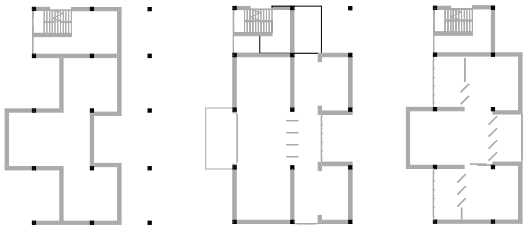
Primary reinforced ICF walls along street edges
while internal column support for longitudinal
room flexibility



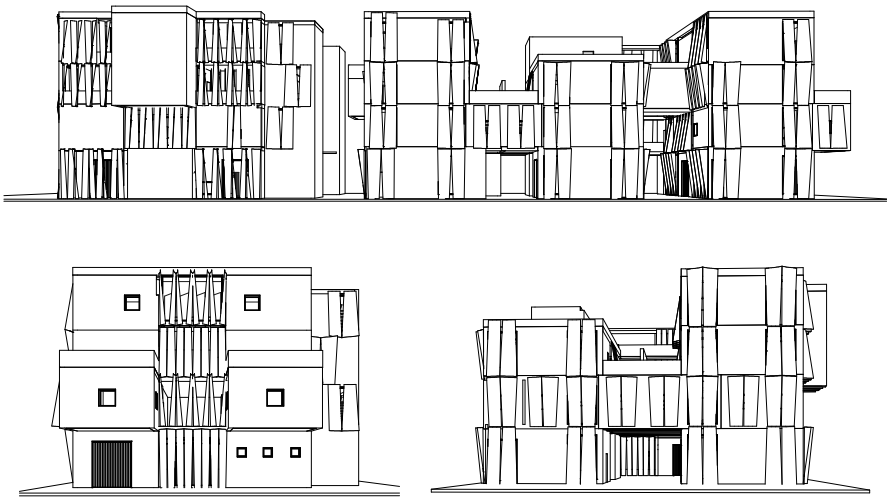


Irregular grid as supporting structure to reduce use of rebar

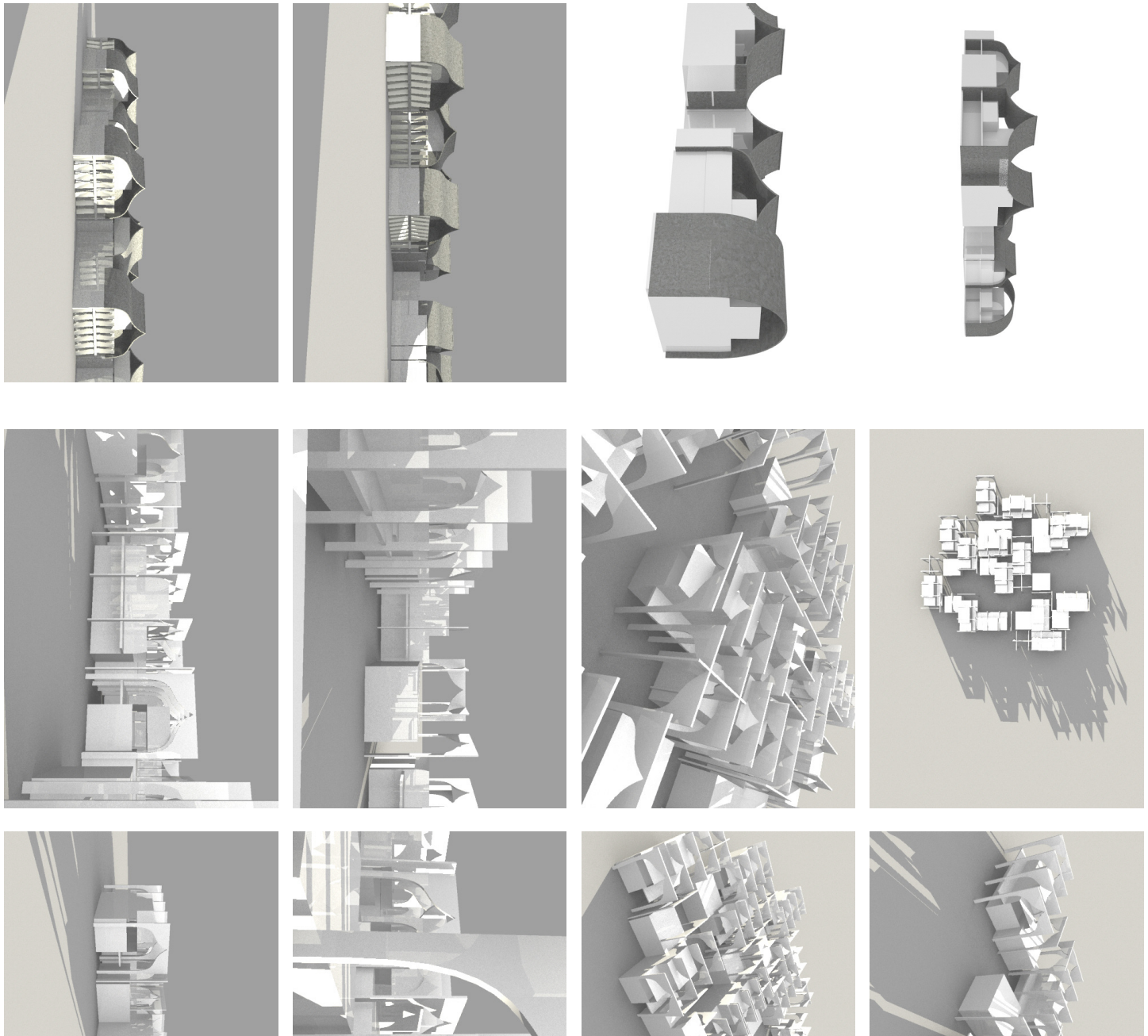




Reinforcment rebar of ICF wall panels can can be reduced using a supporting concrete grid of 5.3m
*gives option of alternative wall paneling



schematic elevation perspectives



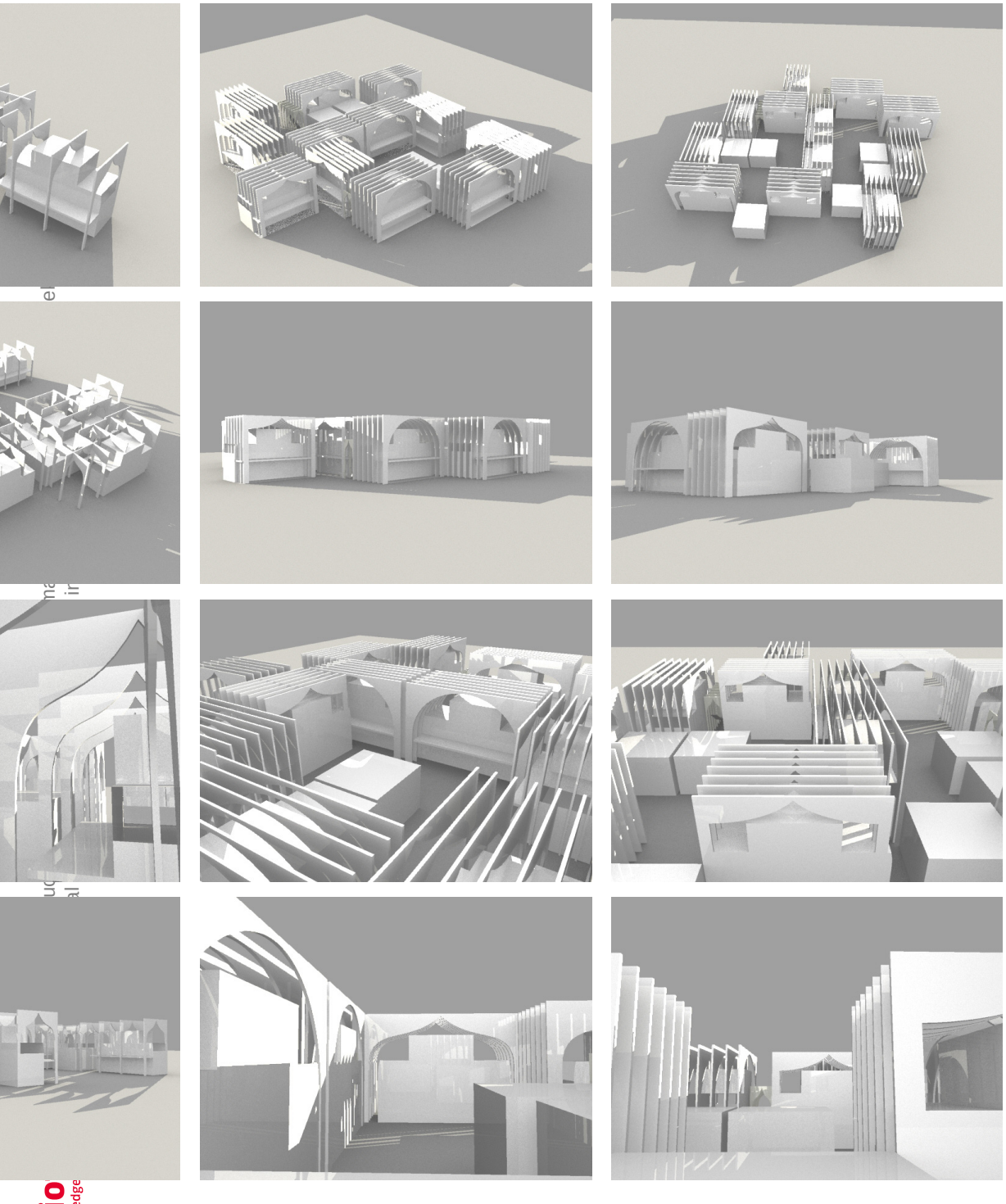
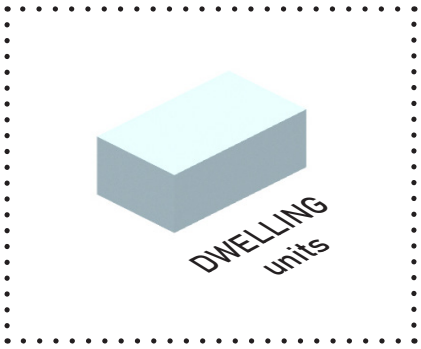


Figure.10.7: other urban experiments



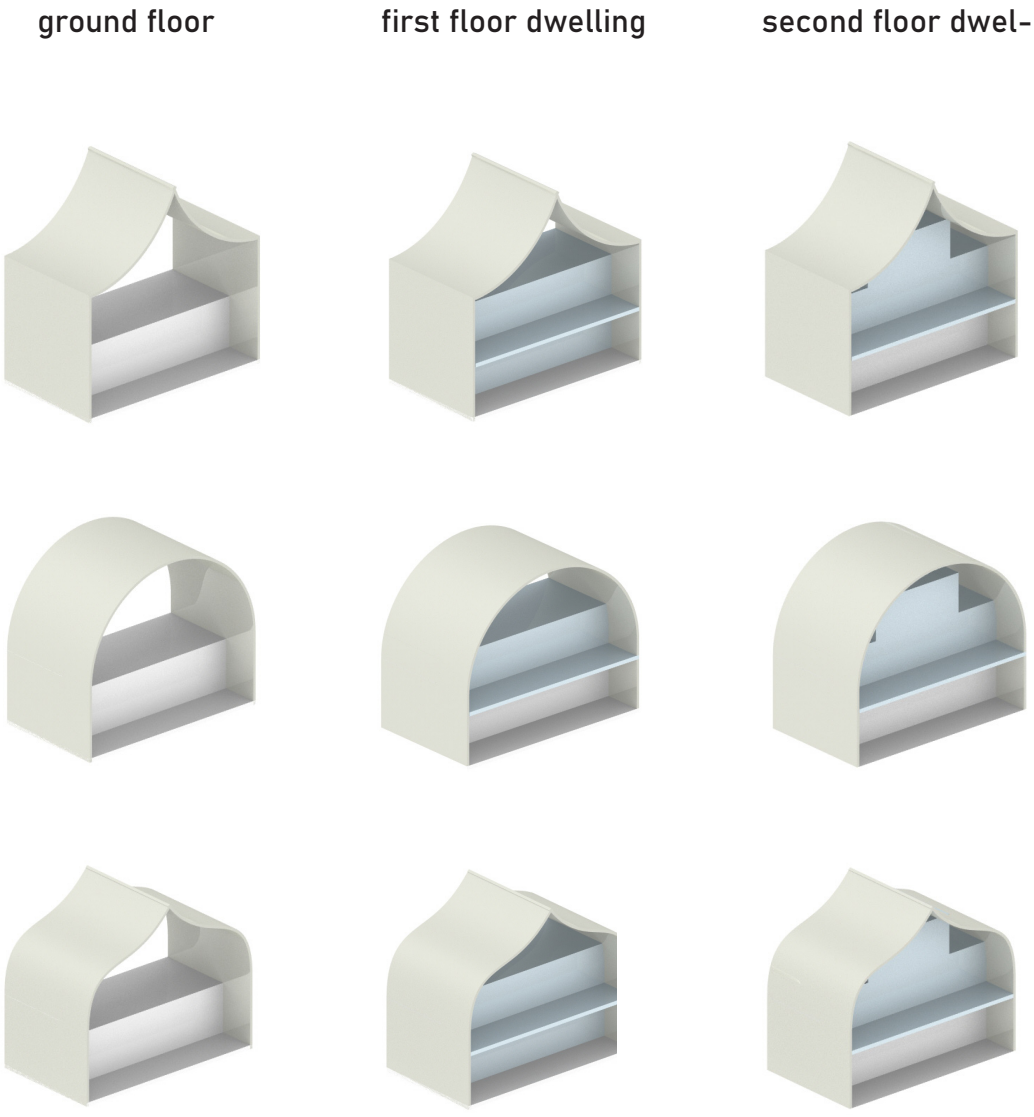
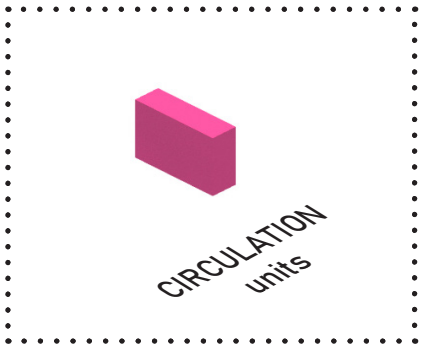
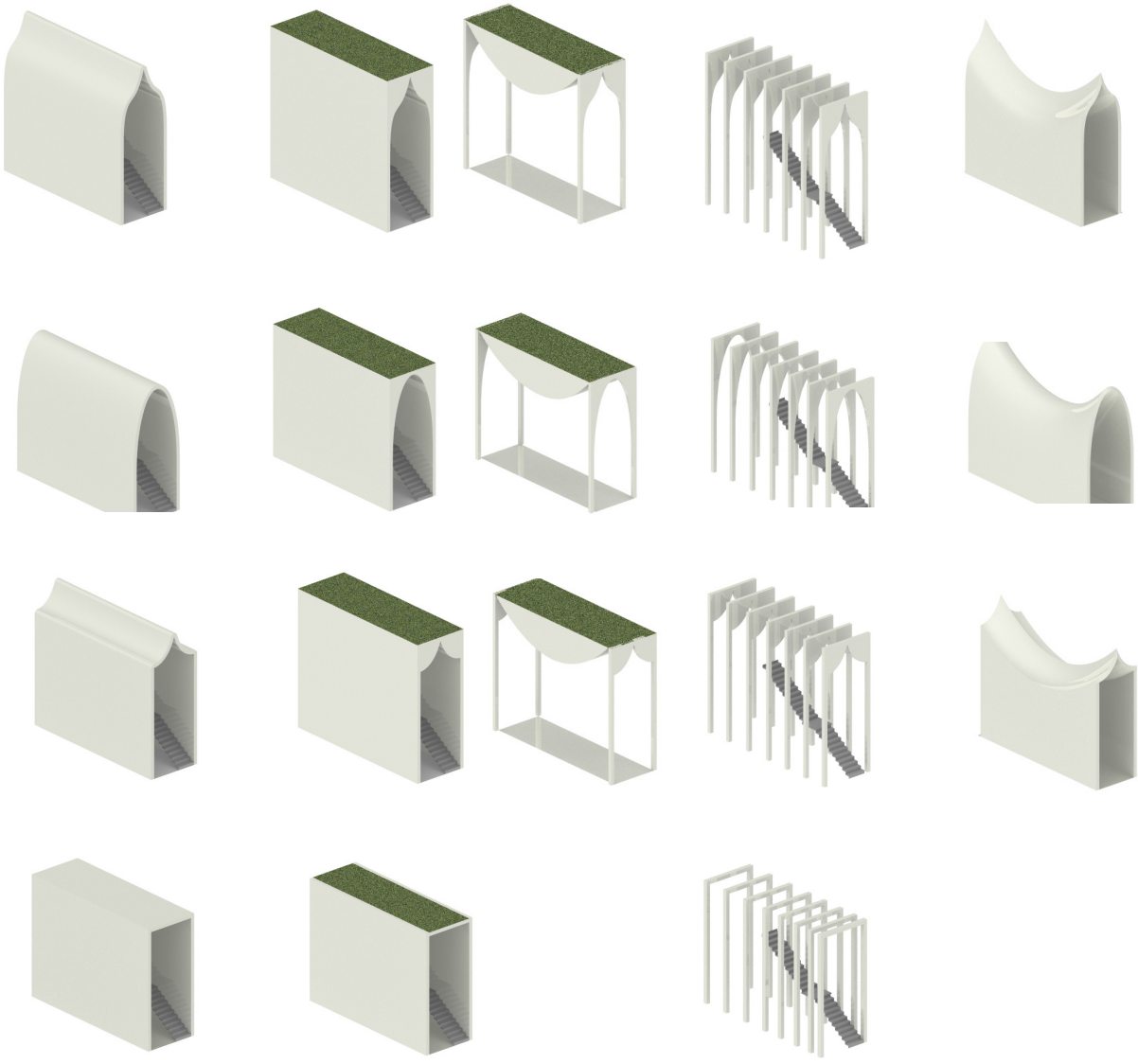
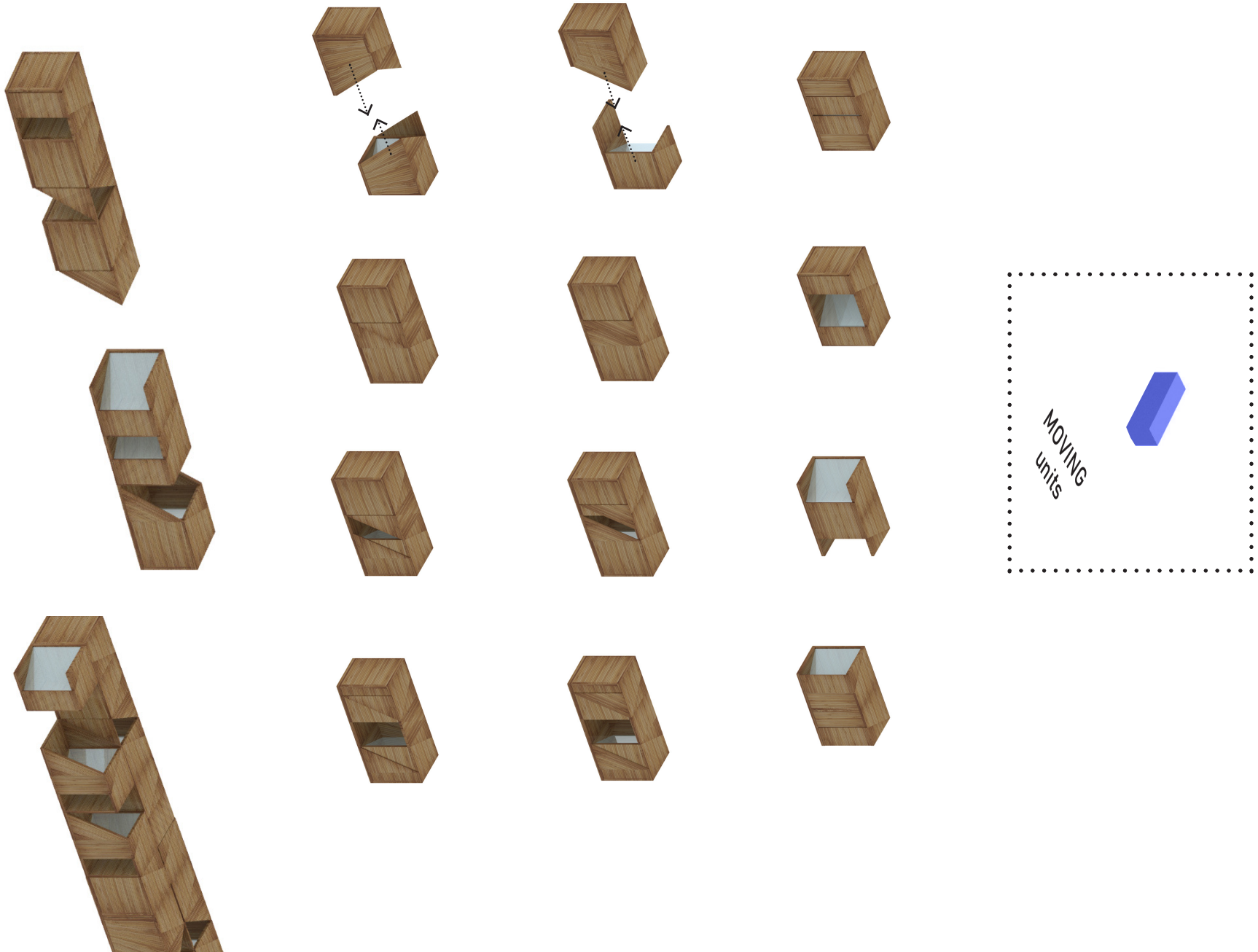


Figure.10.8: other urban experiments







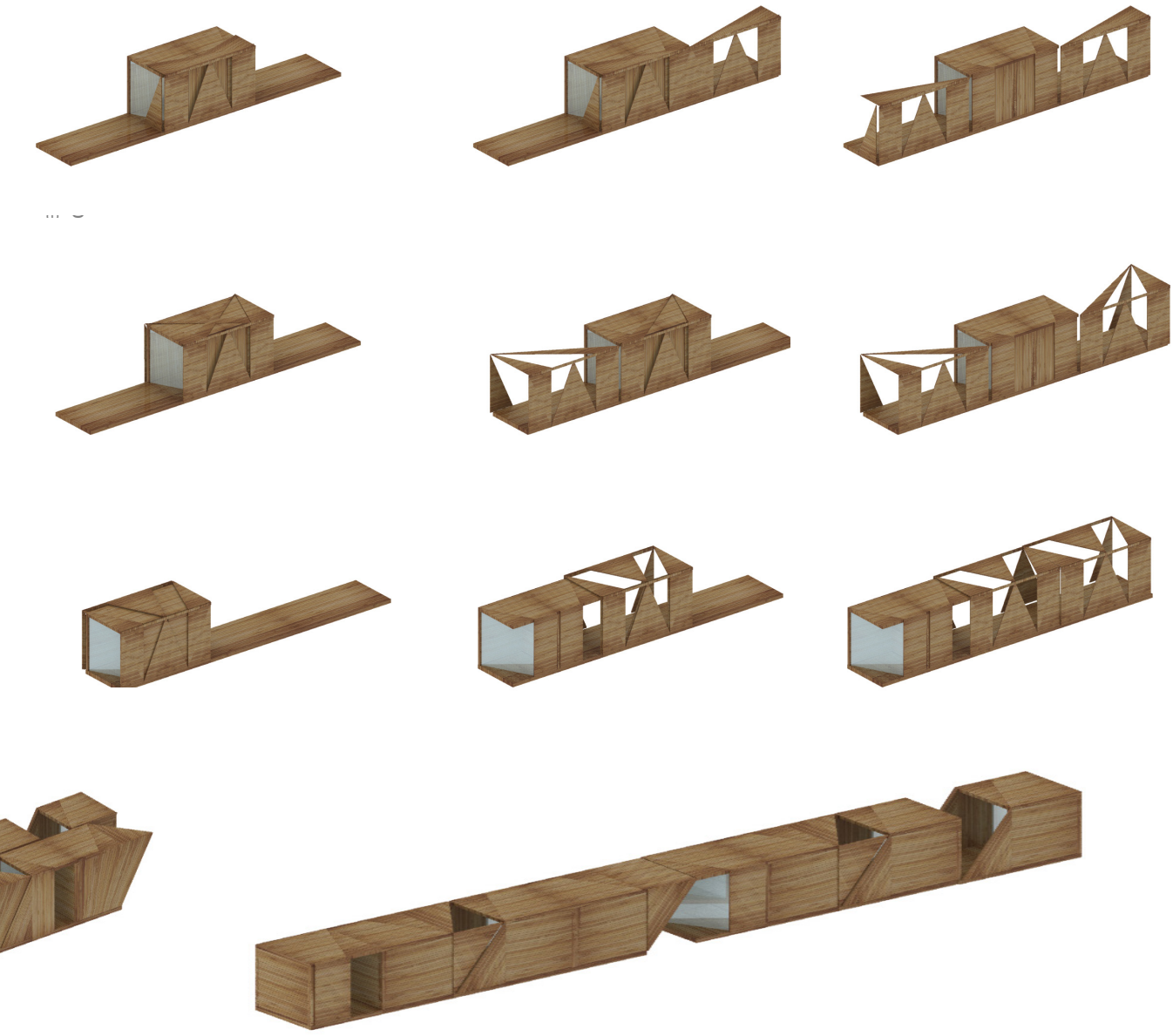


Figure.10.9: other urban experiments

Acknowledgements

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