FAHIMEH FOTOUHI

ARCHITECTURAL PORTFOLIO

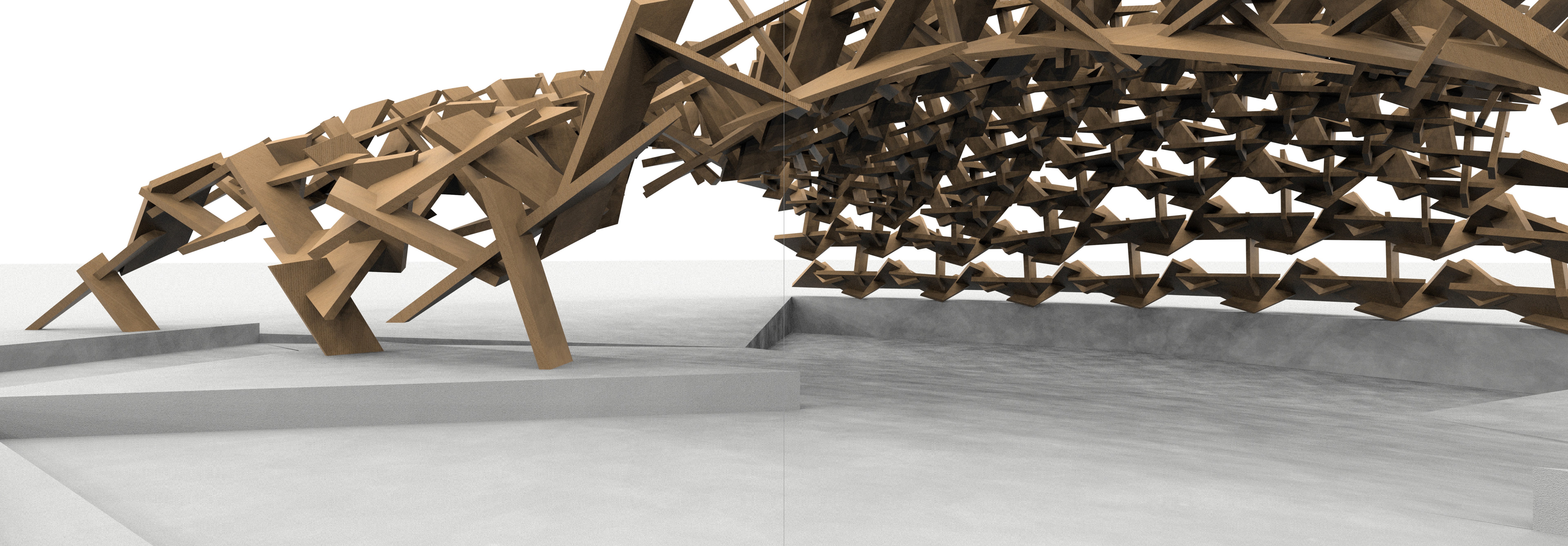
fahim.fot@gmail.com
+358 458544425
Maistraatinkatu 2 A 8, Helsinki
www.linkedin.com/in/fahimeh

Fahimeh Fotouhi started her architectural studies in Iran and is graduated as a master of architecture with excellent grade from Shahid Beheshti University, Tehran. She continued her studies in Finland in Wood Program and received her second master in sustainable architecture from Aalto University, Finland, in December 2018. During her recent studies she got interested in parametric design approach and digital fabrication techniques applied to architecture. She conducted studies, design and research in this area in several studios and finally her master thesis. The research of her master thesis is presented and published under the title “Flex Skin: Developing a material system based on interlocking wooden panels” in the proceedings of the 4th Int. Conf. on Structures and Architecture (ICSA 2019), Lisbon.

CONTENTS

FLEX SKIN

DEVELOPING A MATERIAL SYSTEM BASED ON INTERLOCKING WOODEN PANELS



Flex Skin represents a customizable material system that can adapt to free-form target surfaces. It is capable to generate holistic solutions responsive to different architectural and performative aspects of a design problem. Flex Skin has a part-to-whole approach and simultaneously performs on architectural, structural and environmental levels. The goal of the system is to produce a building envelope with specific performative characteristics that is formed in a systemic procedure.

Flex Skin is constituted of planar wooden components in simple geometries that are grouped and joined through an interlocking process and create an integrated double-layered shell. The staggered arrangement of the panels provides the opportunity for direct natural light in a controlled way and creates a playful pattern of light and shadow. Flex Skin is developed as part of a design research project that is carried out in three main stages of empirical studies. Each stage develops different aspects of the project and accordingly employs related design and analytical tools. The performative qualities of the system are both on a structural and an environmental level. Changing the size and orientation of the panels, as well as their staggered arrangement, allows to control the quantity and quality of incoming daylight within certain limitations. Digital analysis tools help to evaluate the environmental performance of a given configuration during the design phase and create feedback loops that consequently lead to an optimized solution. These modifications have impact on different levels of the system. A comparative study, based on three different climatic scenarios, demonstrates the system's capacity for adaptation.

GEOMETRY PRINCIPLE

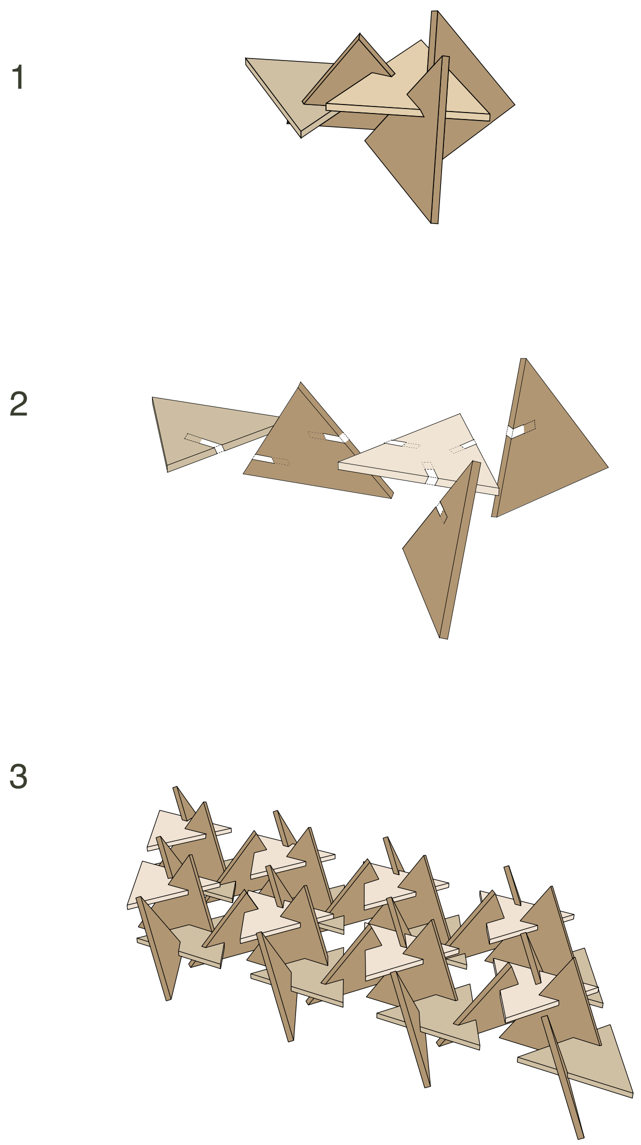


Figure 1: 1 & 2: Basic module of the triangular shell. 3. a 4x4 piece of the skin

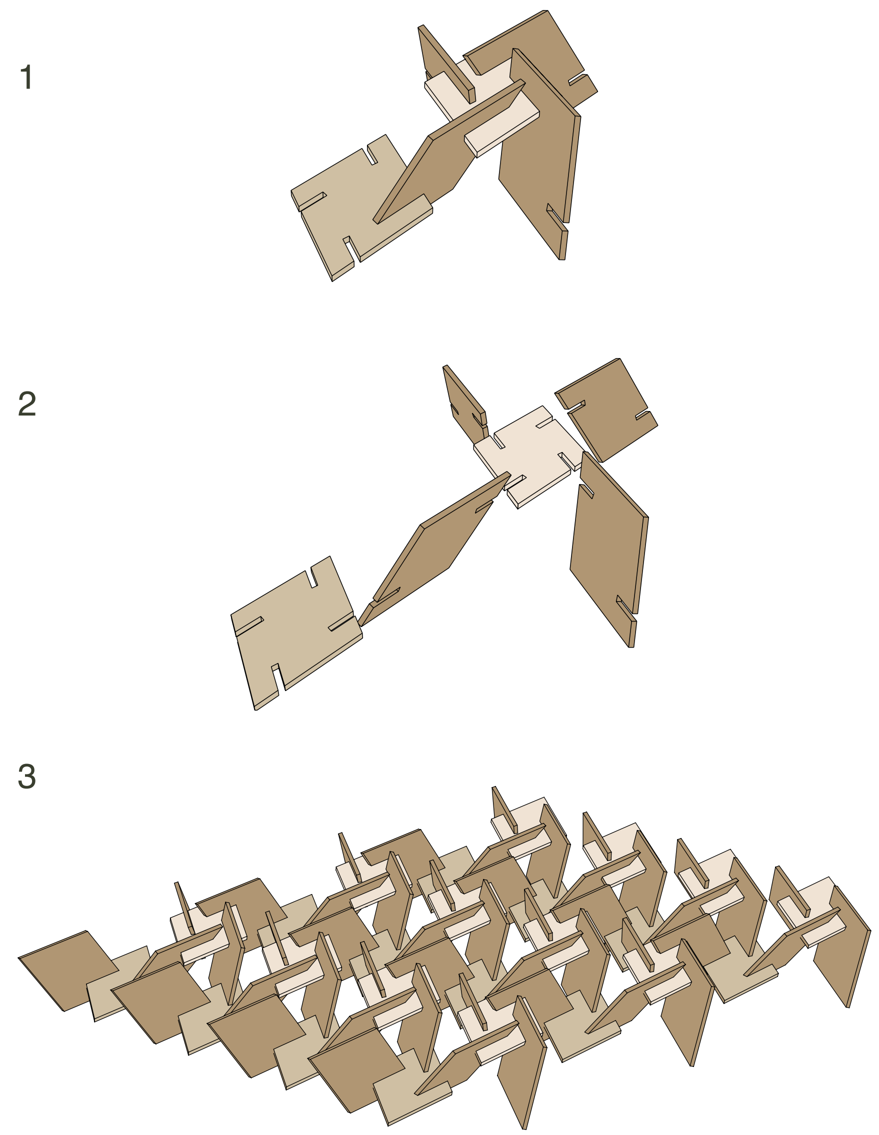


Figure 2: 1 & 2: Basic module of the rhombic shell. 3. a 4 x 4 piece of the skin

Alternative 1: Triangular Panels

The geometric principal of Flex Skin is studied in two alternatives. In the first alternative, the spatial surface is made out of triangular panels arranged in two categories of main layers and connecting layers (Figure 1).

An equilateral triangular grid is used as the base of the model. The grid forms two sets of complimentary panels, which are placed in different vertical levels and form the main layers of the shell. A third set of triangles is interlocking with panels of the main layers. The connecting panels rotate 30° vertically towards the center of the adjacent main panels. The rotation strengthens the shell against horizontal and torsional loads. The panels of the main layers move accordingly to make a fixed magnitude of interlocking depth with the connecting panels.

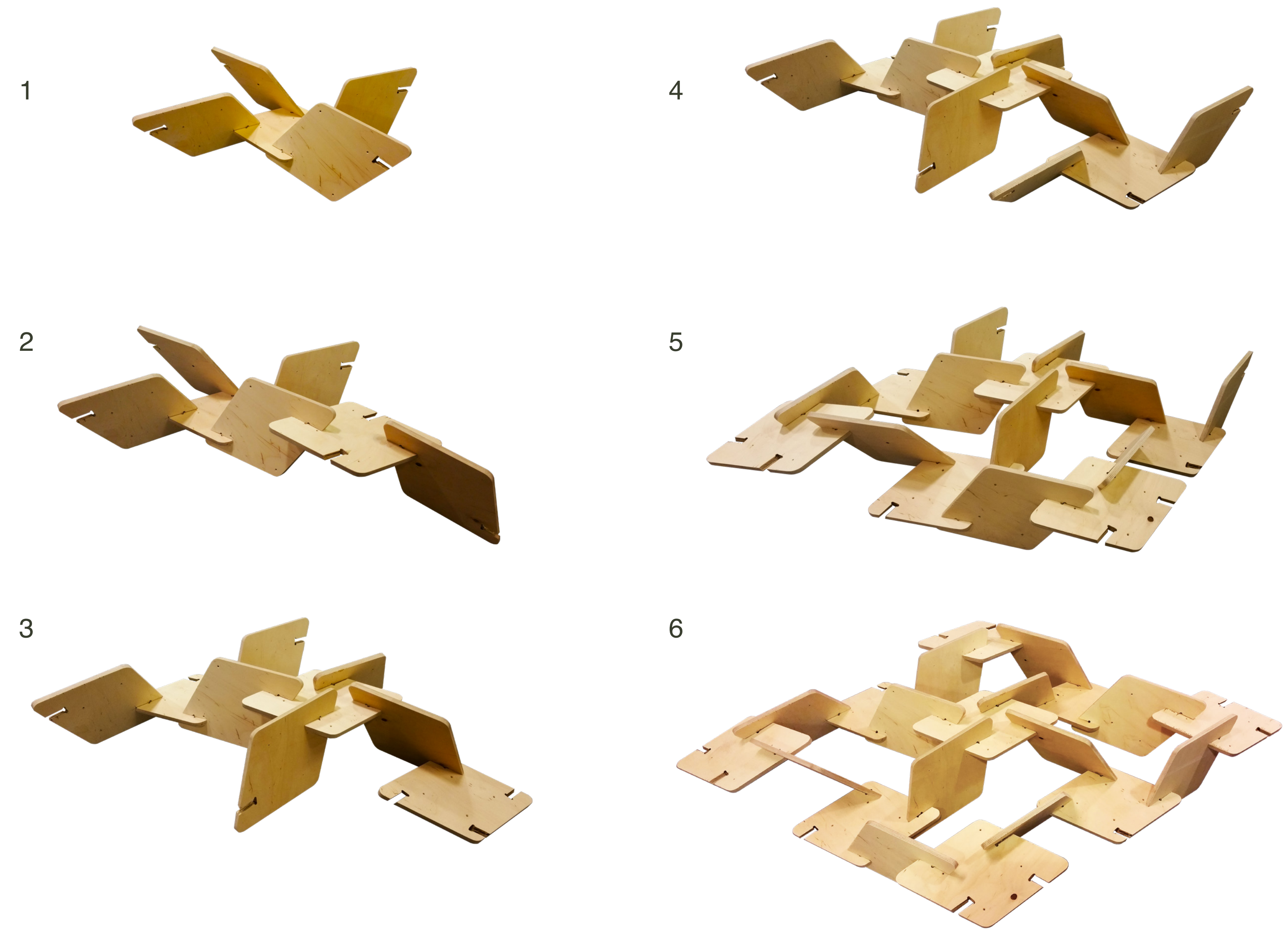


Figure 3: Assembly steps of the 3x3 prototype, rhombic shell

Alternative 2: Rhombic Panels

In the second alternative, the same geometric principal is tried using rhombic panels instead of triangular ones. In this alternative, similarly the spatial surface is made out of rhombic panels arranged in two categories of main and connecting layers (Figure 2).

A prototype model of the rhombic shell made of 3x3 grid is made out of 1.2 mm plywood. The design and cutting process are automated and done in ADD Lab Aalto University by robot. The assembly process is done manually (Figure 3). Comparing the structural features and combining the strenght factors of the two alternatives, a new version of the shell is createad which sets up the first version of Flex Skin and is explained in detail in the coming pages.

LAYERING OF THE SYSTEM

A computational framework comprising different material characteristics and geometric properties of the system is designed in Grasshopper to develop the form of the system. This framework creates a double-layered structure on top of a given surface that is targeted to be covered (Figure 4 & 5).

1 - Designing the Basic Surface (1)

a) Triangulate the basic surface (2)

2 - Formation of the First Layer

b) Offset the basic surface based on its curvature in the vertices of the triangulated network (3)

c) Transfer the vertices of the triangular network from the basic surface to the offset one

d) Form a new triangulated network on the offset surface

e) Divide the triangles into two complementary sets

f) Apply one of the complementary sets of triangles to the First Layer of Flex Shell (4)

g) Scale down the triangles; the factor of scaling influences the transparency of Flex Shell (5)

3 - Formation of the Second Layer

h) Offset the basic surface based on its curvature in the vertices of the triangulated network to its second side (3)

i) repeat the stpes b-g for the new offset surface

4 - Formation of the Connecting Layer

j) Scale down all the triangles in the First and Second Layers to half size

k) Appoint the vertices of scaled-down triangles as the anchor points of the connecting axes

l) Connect each surface in the First and Second layers to three adjacent surfaces from the other layer with three lines (5,7,9)

m) Form planes including the connection lines & perpendicular to corresponding side of each surface

n) Form the connecting surfaces on the above planes; relative dimension of the connecting surfaces depends on the form and features of the basic surface and the whole structure (6,8,10)

Figure 4. Formation steps of the structure on a simple basic surface

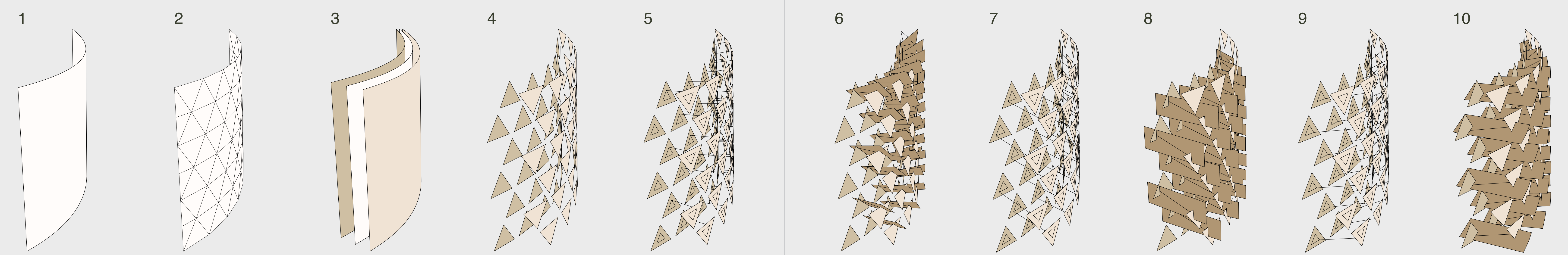


Figure 5. Formation steps of the structure on a simple basic surface. 1 - 10 Show the formation steps described in the diagram above (Figure 4).

As it is explained, the parametric setting of Flex Skin is applicable on various free-form surfaces. In this case study, the setting is applied on a vertical surface to create an exhibitional stand. The stand demonstrates the applicability of the system on highly curved geometries (Figure 6 & 9). In its parametric setting, Flex Shell reacts to various degrees of curvature at different points on the given surface. With regard to shell structures, the idea is to have greater thickness (structural height) in points with higher curvature, which strengthens the structure in its critical points (Figure 8). A physical model of the case study, exhibition stand, is 3d printed in size of 20 x 30 x 13 cm. The texture of the structure creates a remarkable shadow pattern that is used to optimize the environmental performance of the system in the next steps (Figure 7). Flex Shell was selected in Aalto Festival 2017. It was exhibited in the Aalto University's main building 15 May to 30 September 2017 from the group of Design of Structures, architecture department.

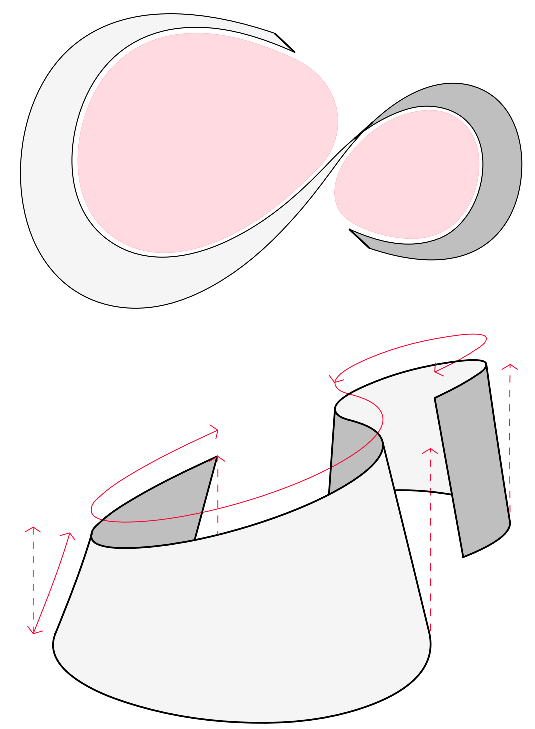


Figure 6. The basic surface forms an s-shaped wall with two spatial pockets.

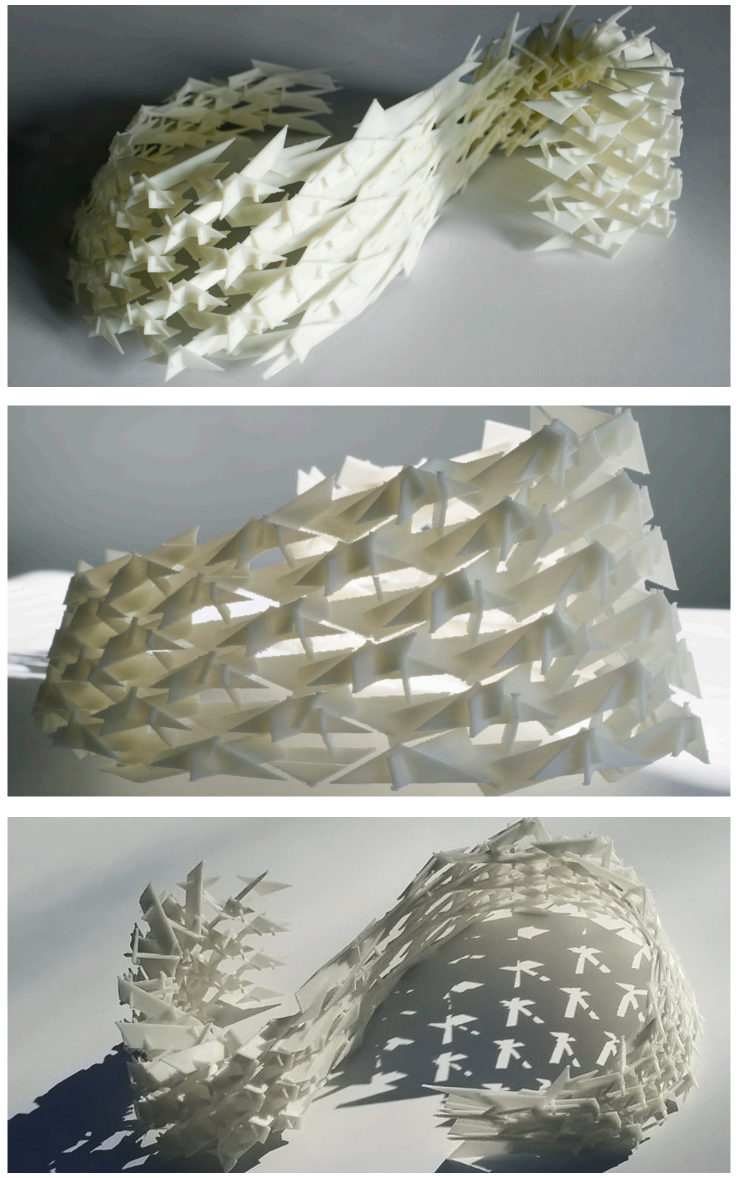


Figure 7. The texture of the structure creates a beautiful shadow pattern.

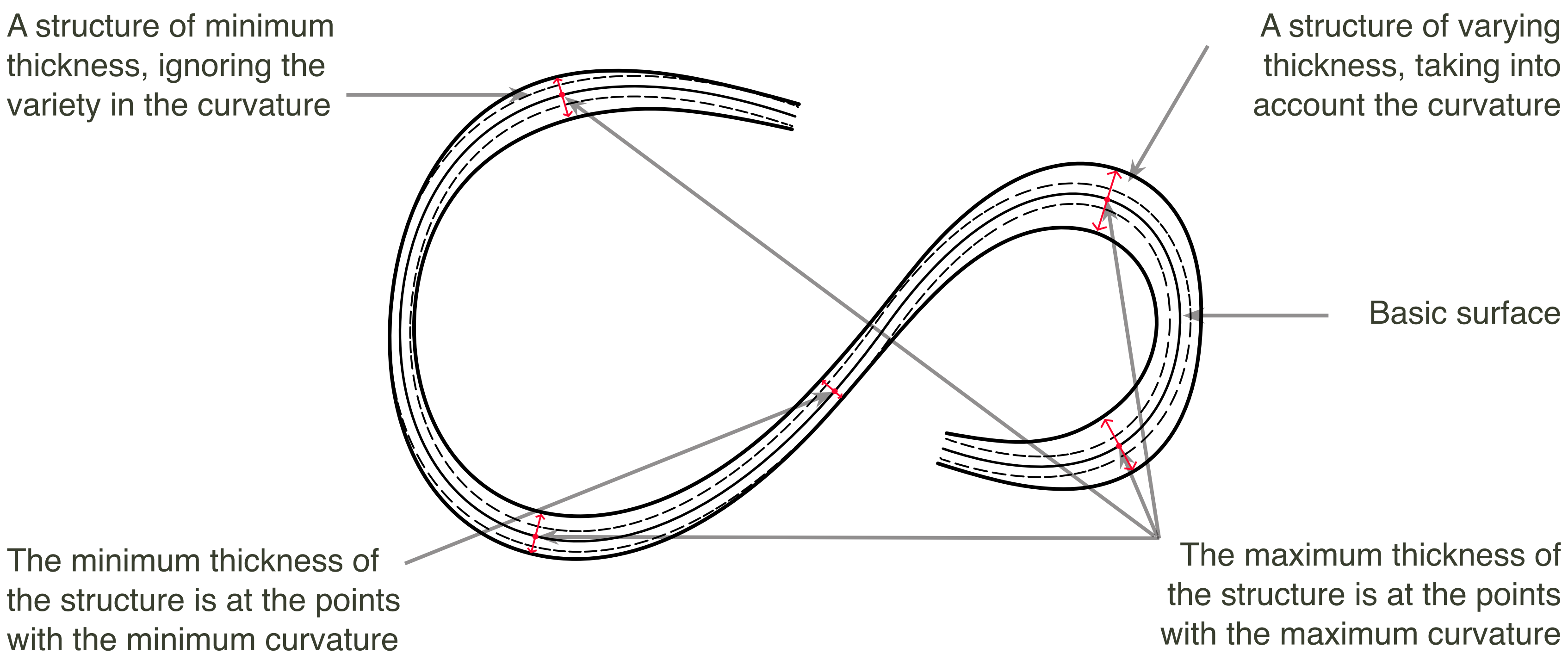


Figure 8. The horizontal diagram of the exhibition stand shows how the section of the structure responses to its curvature

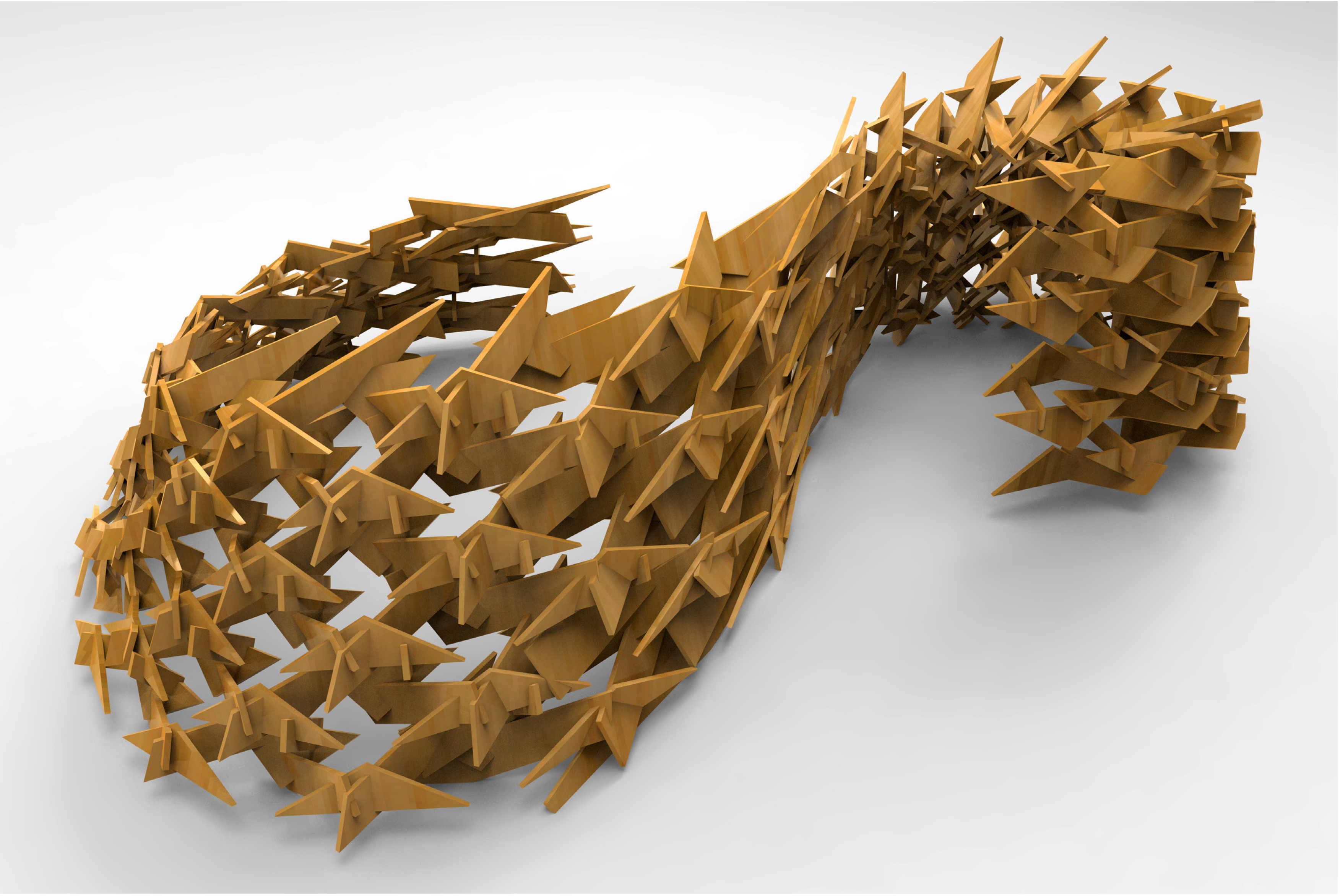


Figure 9. Flex Skin - the exhibition stand consists of about 500 panels, two complementary sets of 3 x 36 triangles and the rest are connecting panels that interlock with them to form an integrated structure.

FLEX SKIN PAVILION

The Flex Skin pavilion is intended for open space. Its basic surface determines the global form of the shell and is designed in a previous process of form-finding by RhinoVAULT. The surface is dome-shaped and has two adjacent spatial pockets specified by its form. It meets the ground in five points (Figure 10).

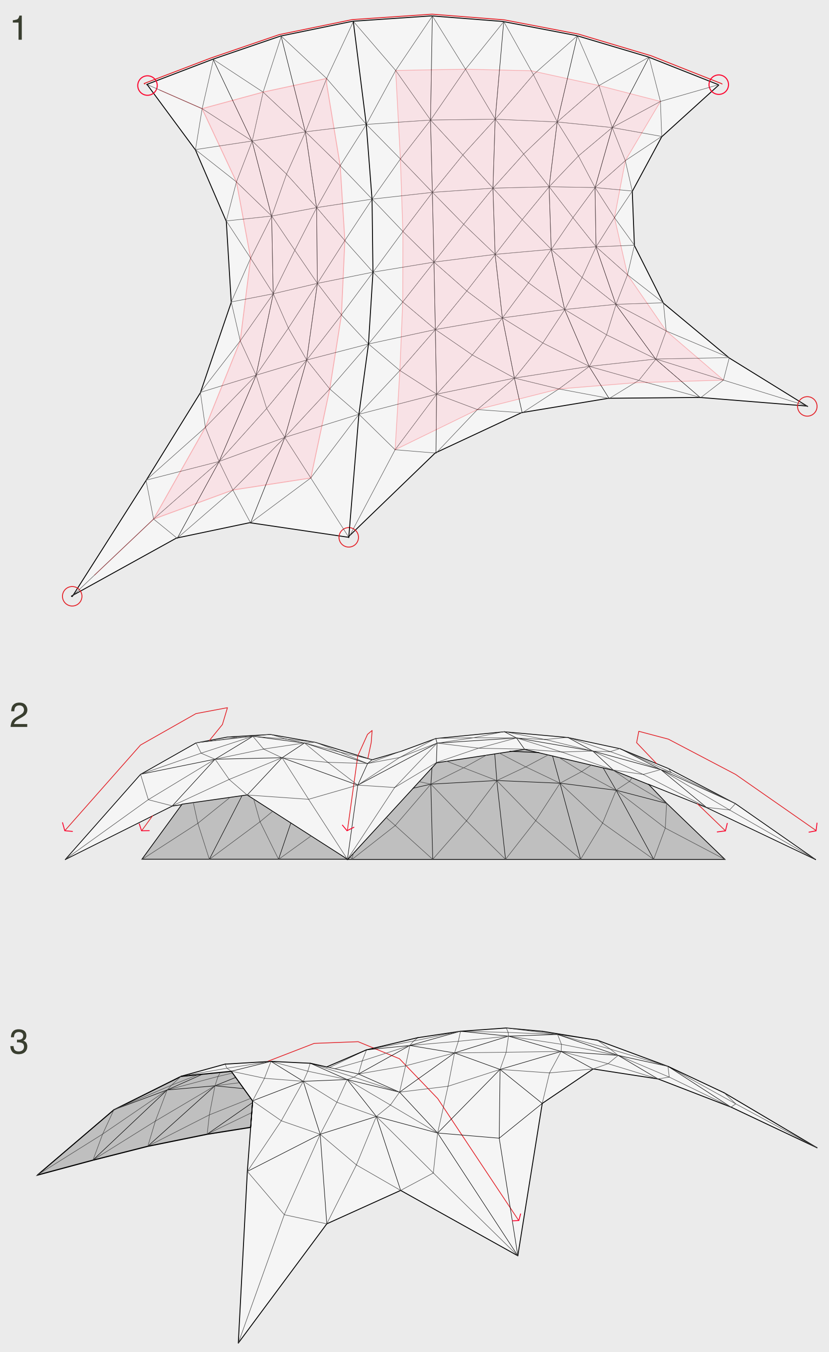


Figure 10. Diagrammatic description of Flex Skin Pavilion's basic surface made by RhinoVault:
1. Top view. 2. Front view. 3. Perspective view

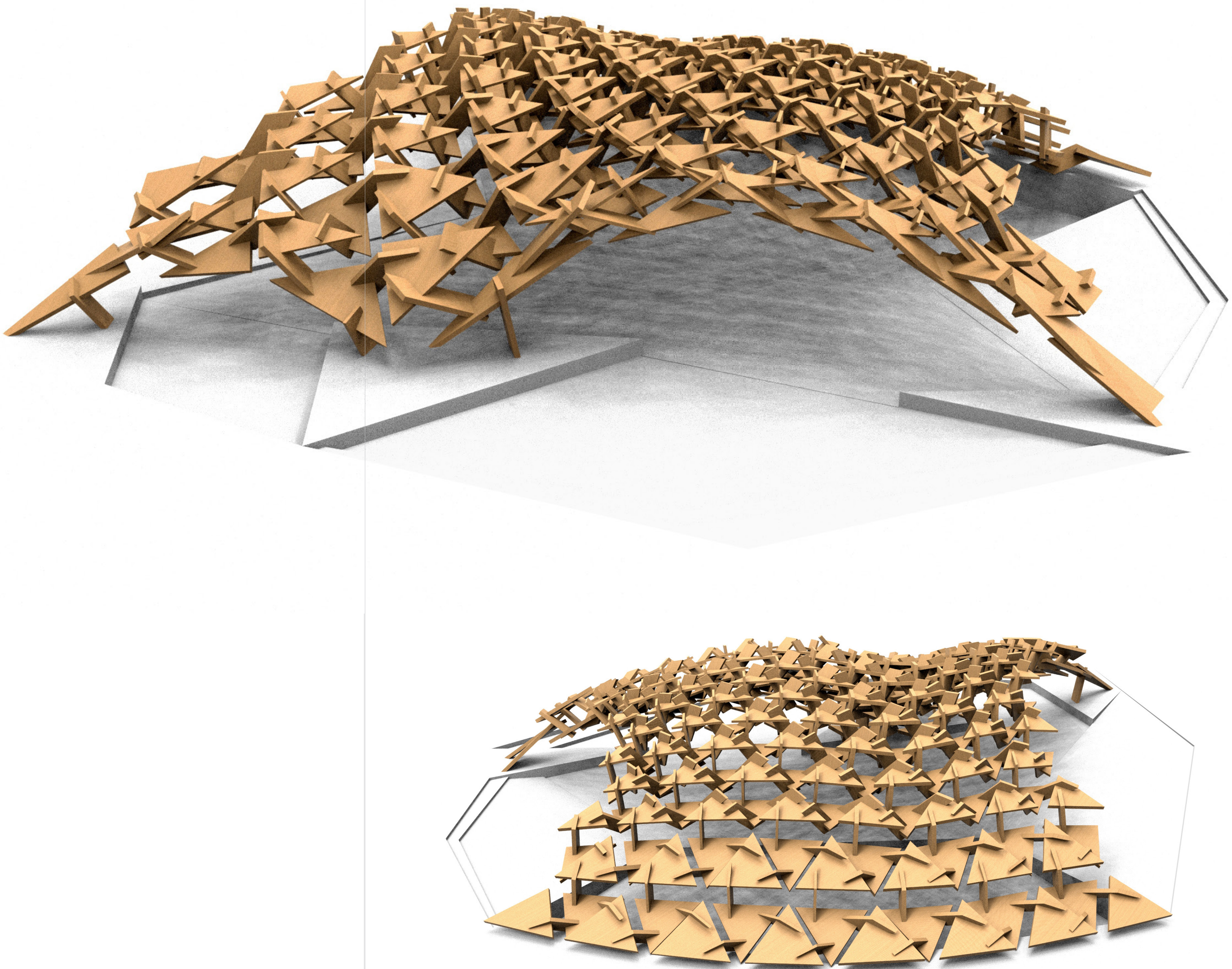


Figure 11. Flex Skin Pavilion, front and back views

STRUCTURAL ANALYSIS

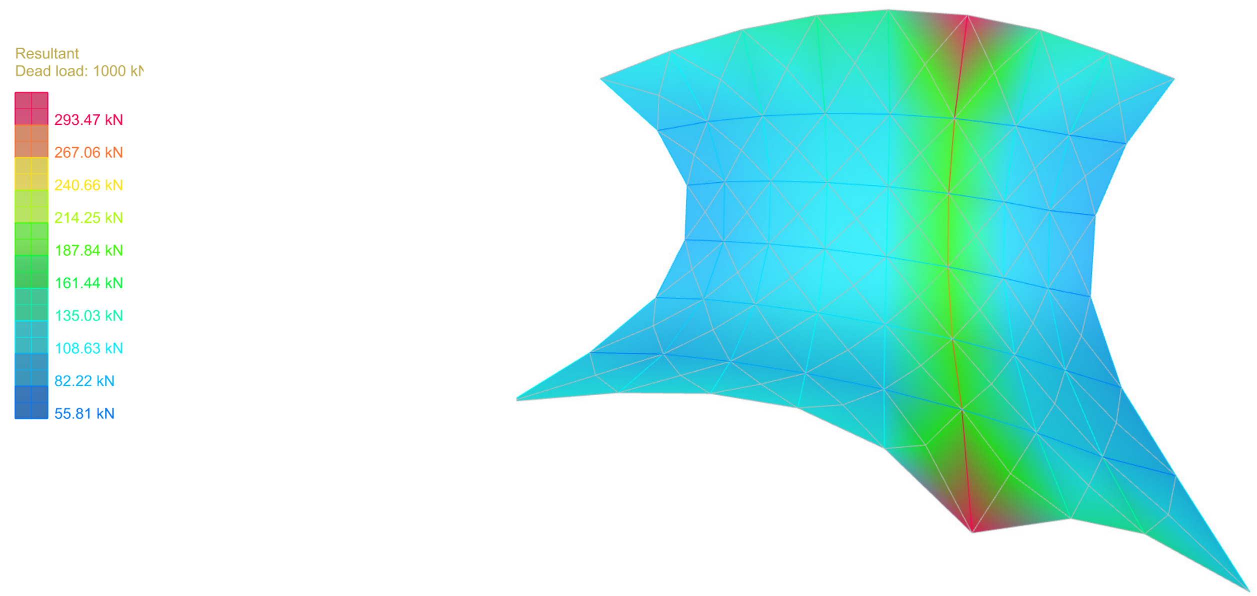


Figure 12. The structural analysis of the basic surface: the color codes show the critical points of the mesh generated by RhinoVAULT.

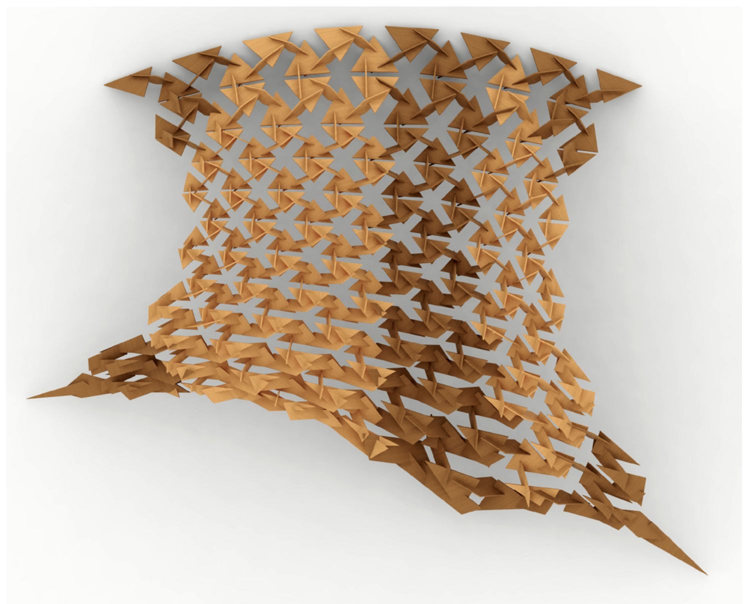


Figure 13. The structural optimization of the generated shell. Dark color symbolizes different material used for the corners and high stress areas of the envelope.

The structural analysis is carried out by RhinoVAULT, it calculates and specifies the level of structural stress on the basic surface. Eventhough, RhinoVault does not analyze the surface or calculate the forces precisely, gives a rough approximation of its structural behavior (Fighre 12). By generating the particle-based material system, the structural behavior and method of transferring forces in the structure are changed, but still the surface analysis provides an initial and rough idea about the high-stress areas of the shell. To reinforce the structure in its high-stress areas, it is suggested to use stronger material with higher tolerance for the shell's panels in its critical areas, as well in the areas that shell meets the ground (Figure 13).

ENVIRONMENTAL ANALYSIS

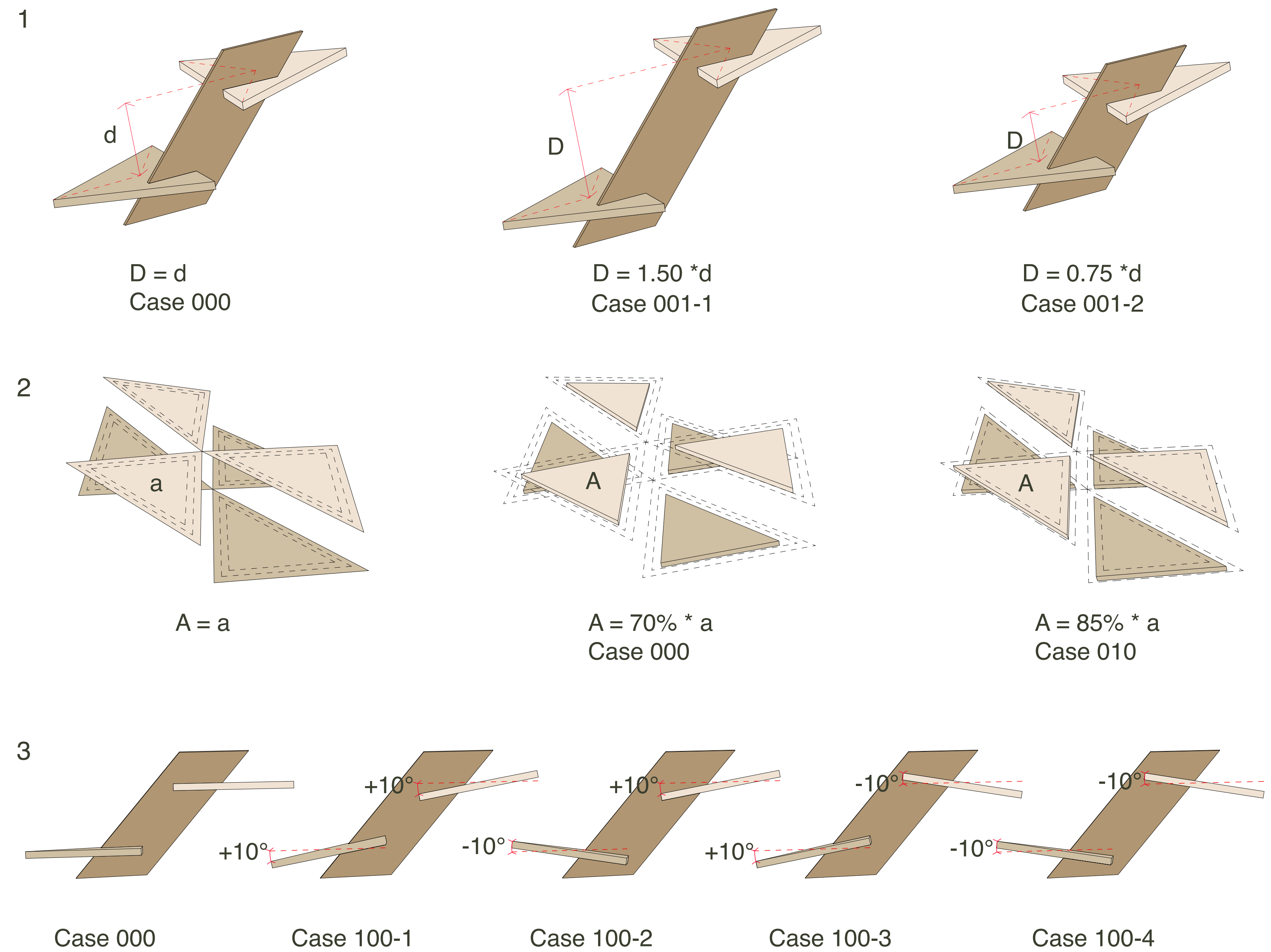


Figure 14. Three parameters involved in the parametric setting of the system examine the environmental performance of the skin. 1. Distance, b. Size, and c. Angle of the covering panels.

The environmental analysis aims to optimize the environmental performance of Flex Skin using the real-time feedback loops in Ladybug and applying relative modifications to the settings of the system to increase its performance. It adjusts different configurations of the skin's panels, using the parametric setting of the system. This process is repeated for couple of times until an optimized performative result is attained. Three parameters involved in the parametric setting of the system are selected to be examined for their effect on its environmental performance. These parameters include the distance, size and angle of the panels in the covering layers of the skin (Figure 14).

ENVIRONMENTAL ANALYSIS PART 1

City	Day	Zone	Solar Radiation Gain %							
			Case 000	Case 001-1	Case 001-2	Case 010	Case 100-1	Case 100-2	Case 100-3	Case 100-4
Helsinki	Midsummer Day	Ground	100	91	96	84	98	104	102	108
		Panels	100	76	81	93	104	97	99	89
	Midwinter Day	Ground	100	89	98	86	96	99	100	103
		Panels	100	75	86	90	109	100	100	83
Lisbon	Midsummer Day	Ground	100	92	101	79	100	103	102	106
		Panels	100	83	83	95	100	97	98	94
	Midwinter Day	Ground	100	85	95	86	92	98	98	107
		Panels	100	67	78	85	112	95	98	74
Singapore	Midsummer Day	Ground	100	91	101	79	113	113	113	113
		Panels	100	82	82	94	94	98	98	100
	Midwinter Day	Ground	100	90	98	82	98	102	101	106
		Panels	100	78	81	93	191	97	98	91

Table 1. Solar radiation gained by the envelop and the ground under it in a summer and a winter representative day in three diffenet cities of Helsinki, Lisbon andd Singapore for eight different case studies. The highlighted blocks represent the most desirable result.

Different versions of Flex Skin Pavilion is created to be examined in different conditions for their environmental performance. The cases are created using diffenent magnitudes for the distance, size and angle of their covering parameters in setting of the system (Figure 14).

The analysis is accomplished in two parts. Part 1 includes analysis for eight cases with different setups in a summer representative day and a winter representative day in three cities of Helsinki, Lisbon and Singapore. The analysis focuses on the sun path and shadow patterns of the skin. It controls the solar heat and direct sunlight affecting the space covered by the pavilion. Regarding the clamatic condition of each city the environmental optimization targets to moderate the conditions of the shell in summer or winter time. The best result gained by different cases in each city are shown in the table above (Table 1).

ENVIRONMENTAL ANALYSIS PART 2

City	Day	Zone	Solar Radiation Gain %				
			Case 000	Case 001-1	Case 010	Case 100-1	Case 111
Helsinki	Midsummer Day	Ground	100	91	84	98	76
		Panels	100	76	93	104	127
	Midwinter Day	Ground	100	89	86	96	80
		Panels	100	75	90	109	136
Lisbon	Midsummer Day	Ground	100	92	79	-	66
		Panels	100	83	95	-	132
	Midwinter Day	Ground	100	85	86	-	81
		Panels	100	67	85	-	111
Singapore	Midsummer Day	Ground	100	91	79	-	78
		Panels	100	82	94	-	129
	Midwinter Day	Ground	100	90	82	-	80
		Panels	100	78	93	-	125

Table 2. Solar radiation gained by the envelope and the ground under it in a summer and a winter representative days in three diffenet cities of Helsinki, Lisbon andd Singapore for four case studies with better environmental performances from part 1 analysis. The highlights represent the best result.

In the environmental analysis part 2, the cases with better environmental performance for each city obtained in analysis part 1 are selected and their features in the parametric setting are combined to create a new case, Case 111, for each city. The analysis part 2 then tests these new cases and confirms that they have the best environmental performance in their context.

In addition, the analysis show the dynamic-relational set-up of the system allows for the optimization of the performance during design process. Studies of the environmental performance of the system confirms its flexibility and adaptability to different climatic condition. The result of this study is presented and published in proceedings of the 4th International Conference on Structures and architecture (ICSA 2019) held in Lisbon under the title: “Flex Skin: Developing a Material System Based on Interlocking Wooden Panels”.

MONKS' LAND 2045

SUSTAINABLE CONNECTION
URBAN PLANNING PROJECT

The project is to rethink the urban strategy in the ending of Turunväylä and the adjacent neighborhoods in border of Helsinki and Espoo municipalities. The project is done in a team of four students and in six steps. The tasks are divided between all group members and my main role is to design and develop the local master plan based on the defined objectives and design strategy; in addition, to collect and categorize the background data and arrange the reports of every step of the project.

The character and development of the site have been strongly affected by dividing the municipal border and the highway. The planning area consists of the highway surroundings between Huopalahdentie and Ring Road I: Munkkiniemi, Munkkivuori, Tali, Talinranta, Pitäjänmäki, Pajamäki, Ruukinranta and Perkkaa. Most of the land-use consists of scattered housing areas. Commercials, public services and industrials spread along Ring Road I, Huopalahdentie and in Pitäjänmäki industrial area. The highway not only separates the residential sites, also causes significant noise and pollution to the surroundings. Over 30,000 vehicles use the road on a daily basis. From the environmental point of view the area is marked as very valuable because of its biodiversity and natural state. The valuable species in the area include bats, flying squirrels and reptiles. The coastline and the Mätäjoki area are classified very valuable habitat for different kinds of migratory birds.

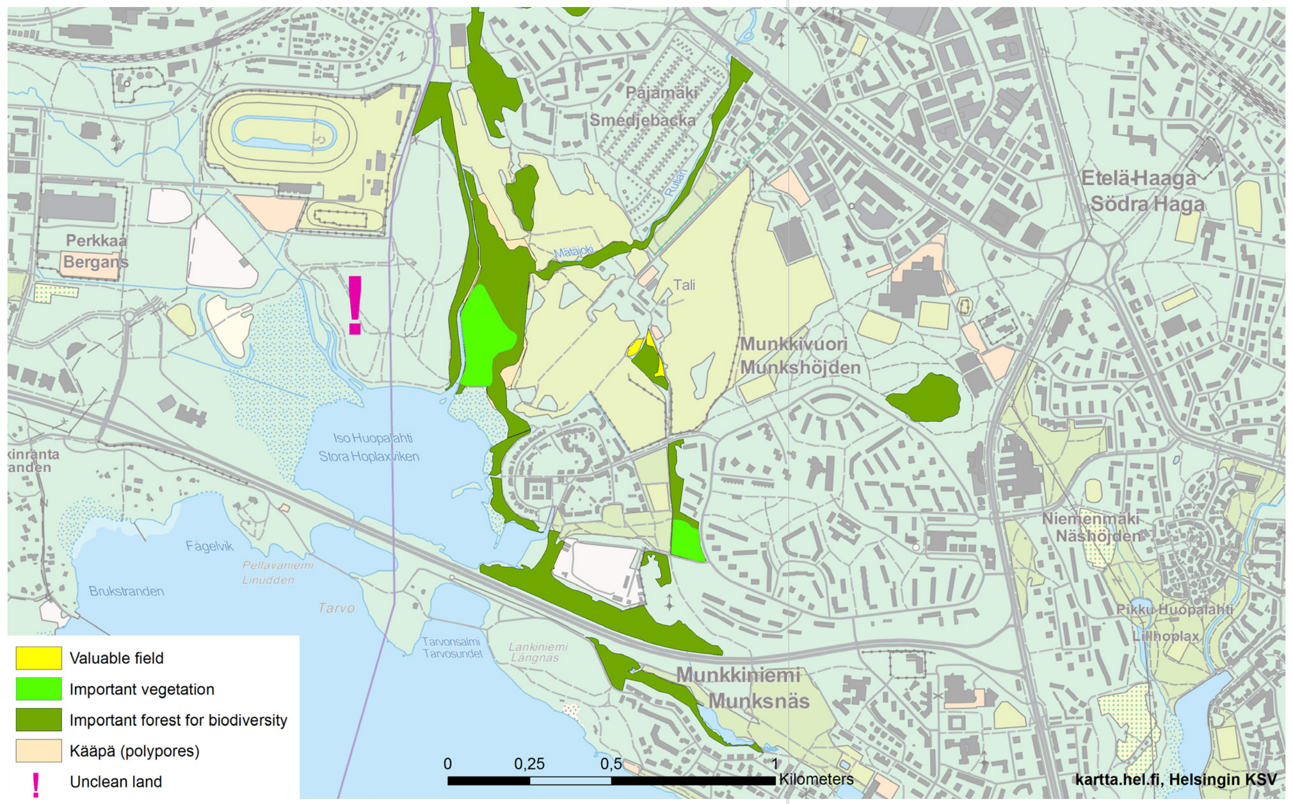


Figure 1: The valuable vegetation in the area

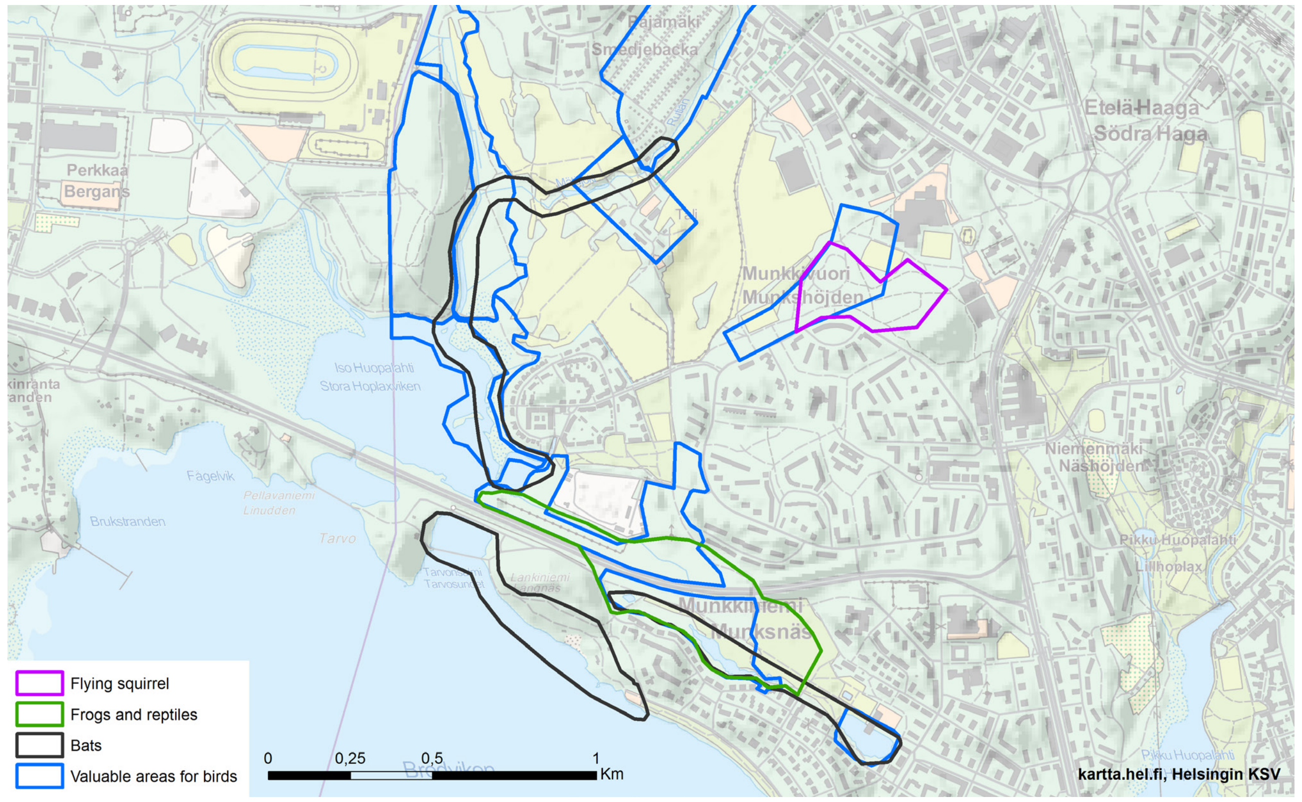


Figure 2: The valuable species in the area

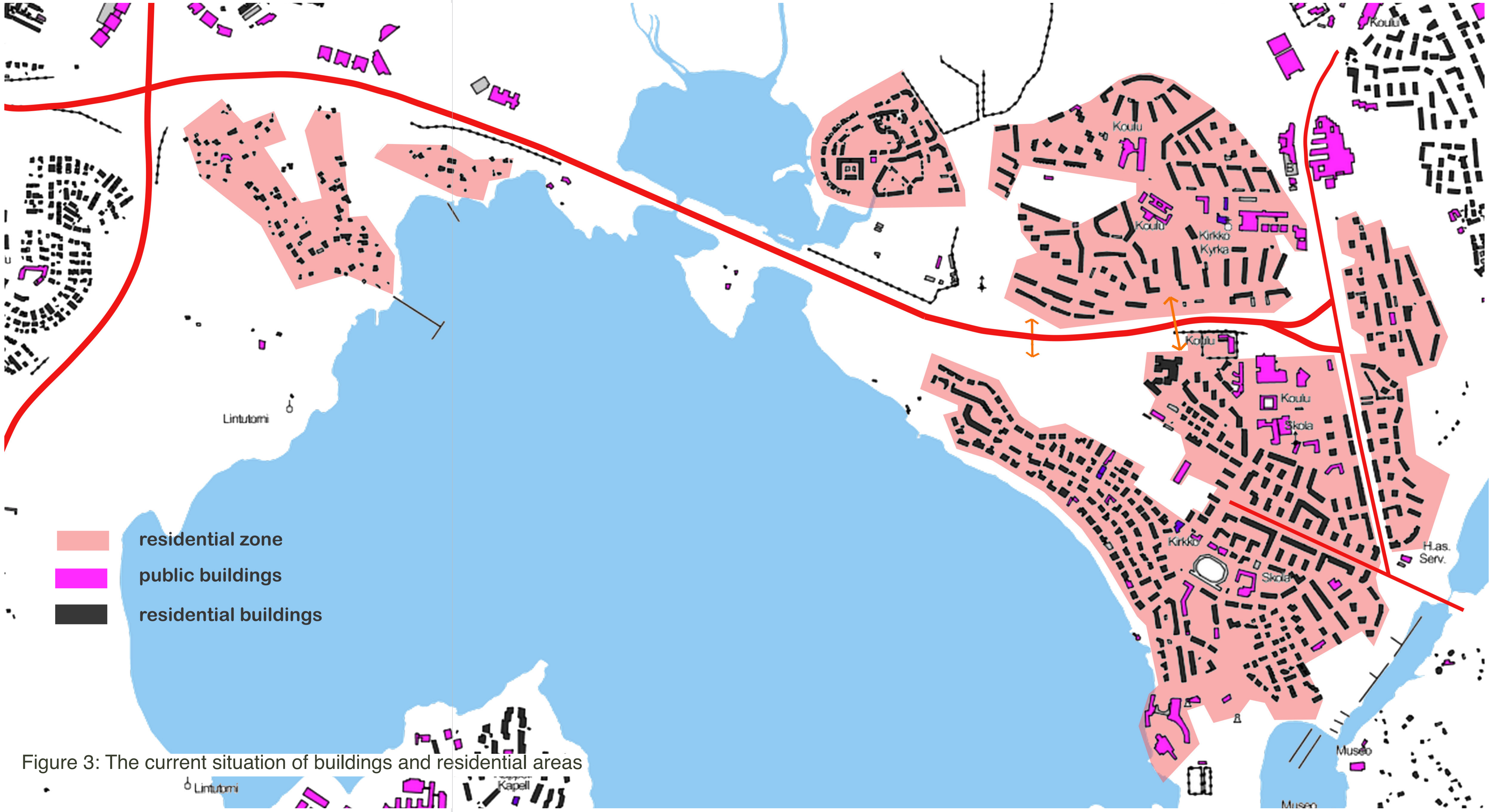


Figure 3: The current situation of buildings and residential areas

Figure 4: Vision 2045 - Sustainable Connection

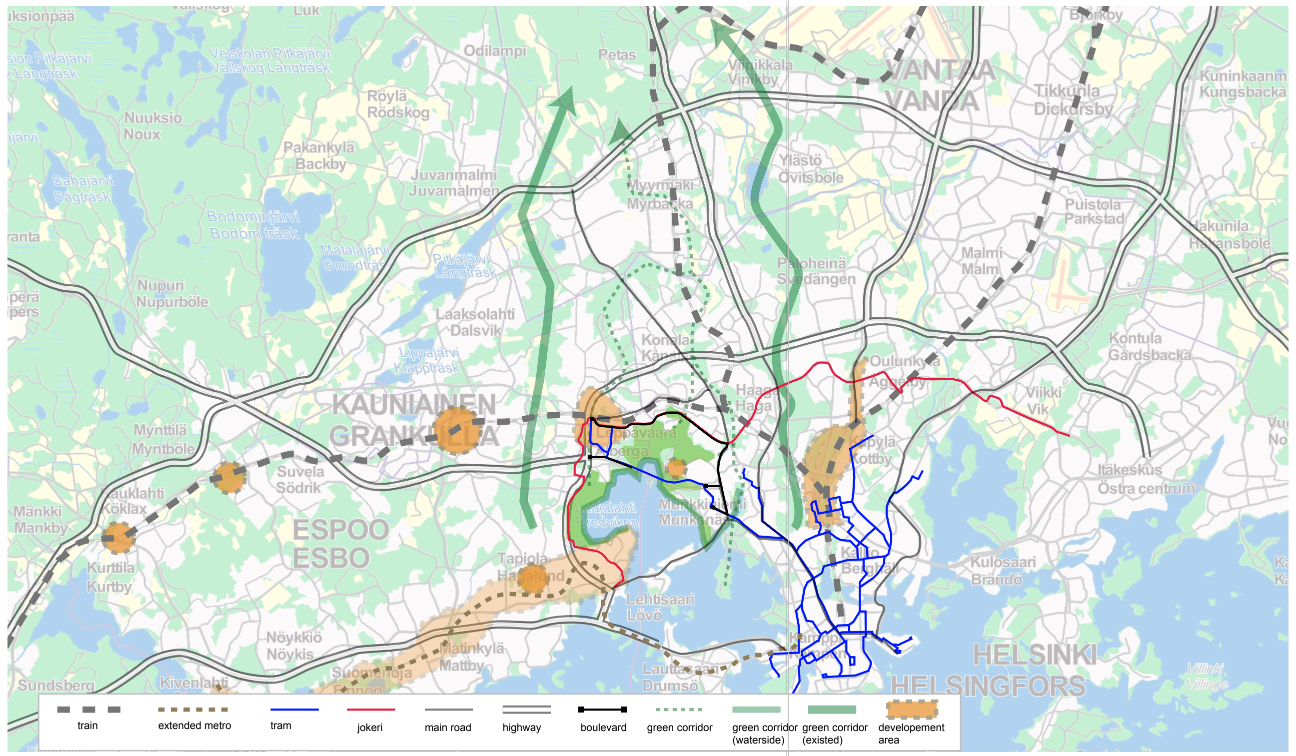


Figure 5: Regional map - vision 2045

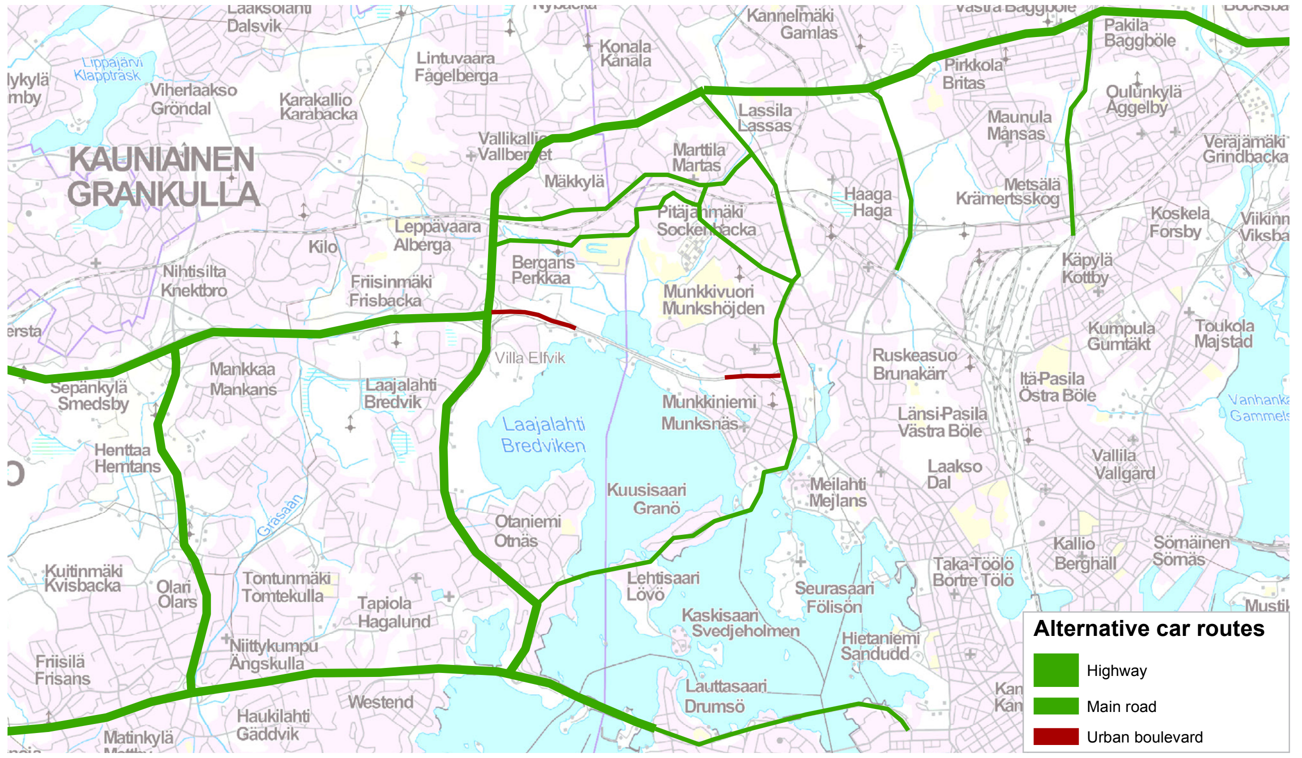


Figure 6: Alternative car routes 2045

THE VISION 2015 - 2045
OBJECTIVES AND GOALS

- Connecting the previously disconnected housing areas into vibrant and sustainable neighborhoods
- Increasing the use of public transport and bikes on trips between the cities of Espoo and Helsinki
- Creating safe and pleasant environments for pedestrians and cyclists
- Ensuring the prerequisites of the operations of different businesses in the area
- Generating jobs by creating a demand for new local services
- Preserving and creating cohesive green networks where function of ecosystem services are ensured
- Allowing the surrounding areas of the highway to heal from its impact
- Answering to the demands of the inner-city-like housing
- Designing possibilities for producing and using local energy

Figure 7: Green connection - leisure map of 2045

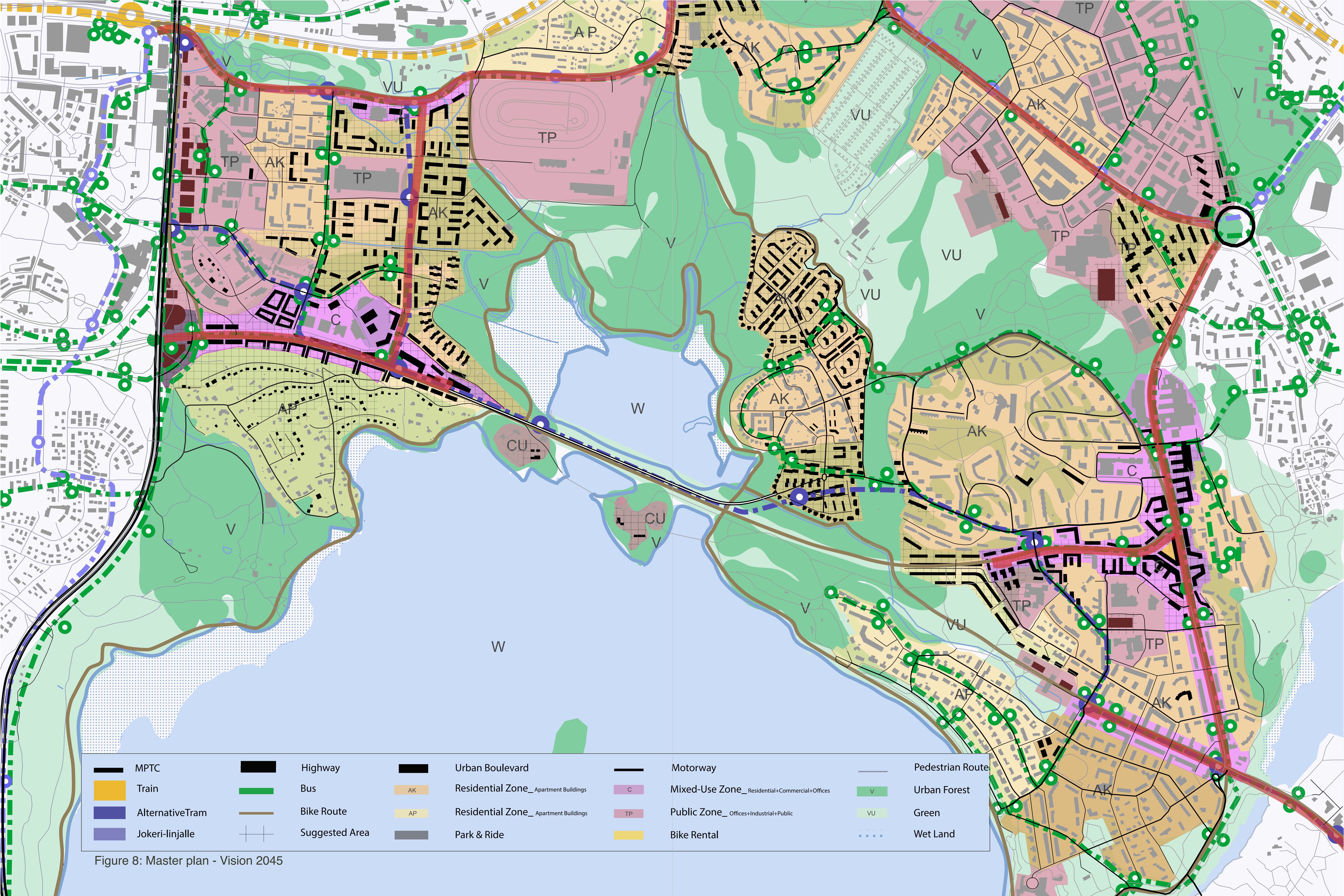


Figure 8: Master plan - Vision 2045

Figure 9: Multi-purpose transportation corridor - Vision 2015 - 2045

The design's main strategy is to keep and develop the green connectivity within the site and to connect it with the green network of the city. The green connectivity ensures the function of ecosystem services and helps to preserve the site's natural resources. Due to the special location of the site and its important natural zones, it is decided to block the end part of the highway. In return, two new boulevards are designed in both sides of the bridge to develop the urban environment. The boulevard characteristics are continued in the current streets in Huopalahdentie and Munkkiniemen puistotie. New buildings with mixed functions are built around the boulevards and residential sector is developed. Although the private cars are prevented to pass the bridge, the public transport is significantly strengthened. A new multipurpose public transportation corridor (MPTC) is designed on the bridge to connect the Leppävaara center and western parts of Espoo to the Helsinki central area (Figure 9). There are parking areas allocated adjacent to Ring I, which help travelers switch between their private car and public transport.

Figure 10: New area development - Talinranta - Vision 2015 - 2045

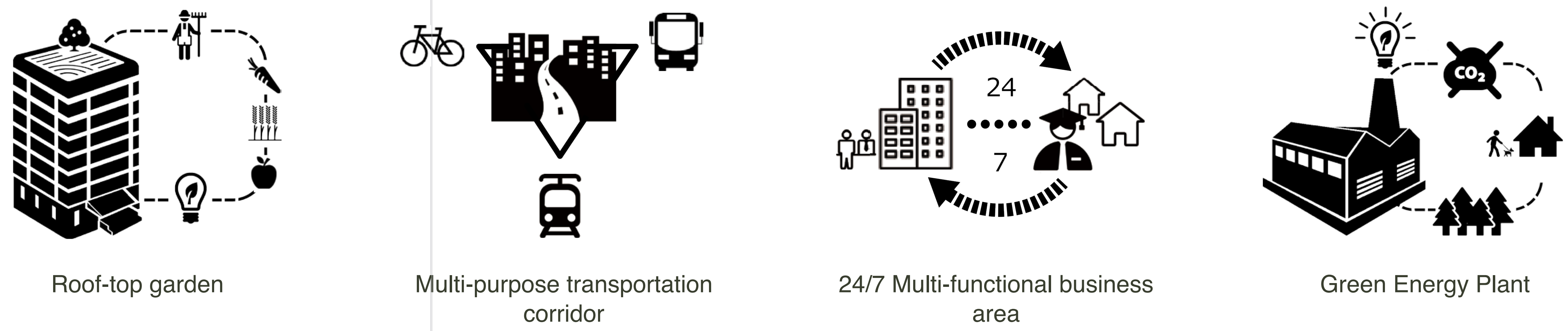
One of the main objectives of the new plan is to generate opportunity for new jobs by creating a demand for new local services. New residential buildings provide more customers for these services (Figure 10). The public transport corridor will be built around the extension of the tram 4, which can reach both the Jokeri tram line and the center of Leppävaara. In addition to trams, the public transport corridor is used by local and regional bus lines, on-demand bus services and emergency vehicles. The new plan has significant impact on regional level. The major impact is due to the car traffic taken away from the current highway. Depending on their destination, the drivers coming from west need to choose an alternative route to the city center either from south or north. The alternative routes may face increased traffic. In regards of the regional services, the most significant consequence of the highway removal is the fact that it takes longer for private cars to get to Meilahti hospital center from Espoo. The highway removal would also have an effect on the real estate markets outside the planned area.

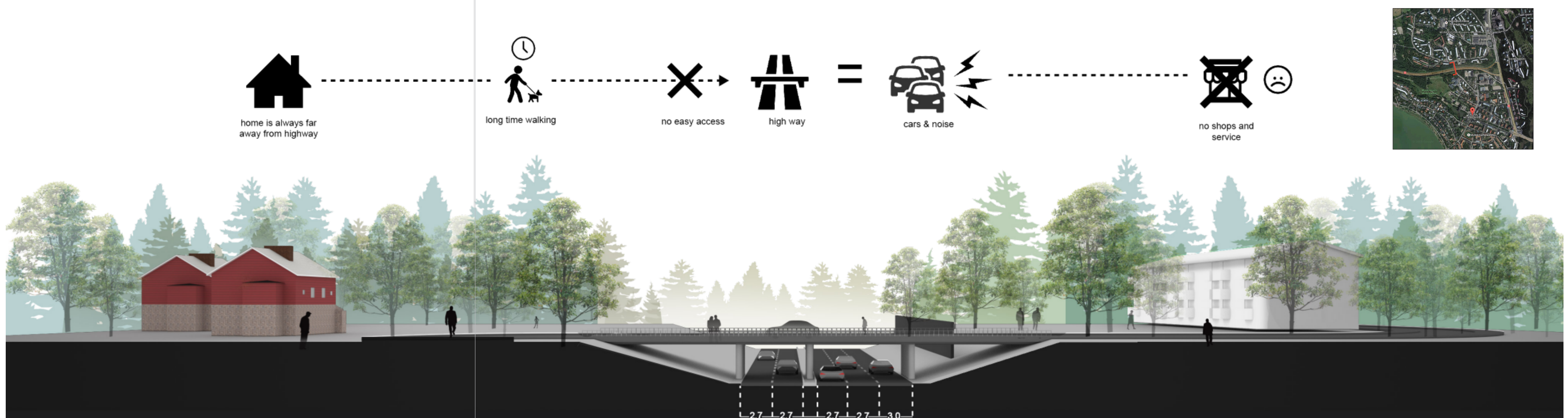
IMPACT ASSESSMENT

Comparison between Sustainable Urban Connection vision 2015 - 2045 and the Helsinki Official Master Plan

Our proposed plan is summarized as follow:

+ Providing more inhabitants and more jobs
+ Reducing the necessity of accessing Helsinki center for the travelers from west
+ Enhancing conglomeration effect both in Espoo and Helsinki sides
+ Encouraging the use of public transport on both local and regional levels
+ Removing the highway: removing air and noise pollution and the drive-through traffic
+ Preserving the green connectivity and ecological connection
+ Healing the ecosystems of the bay area
+ Improving recreational possibilities
+ Planning the area as a whole, regardless of the municipality division
+ Improving public transport connection
+ Less built surface area in general compare to the official plan
+ Similar economical achievement compare to the official plan
- Enhancing rush hour traffic flow in some alternative routes





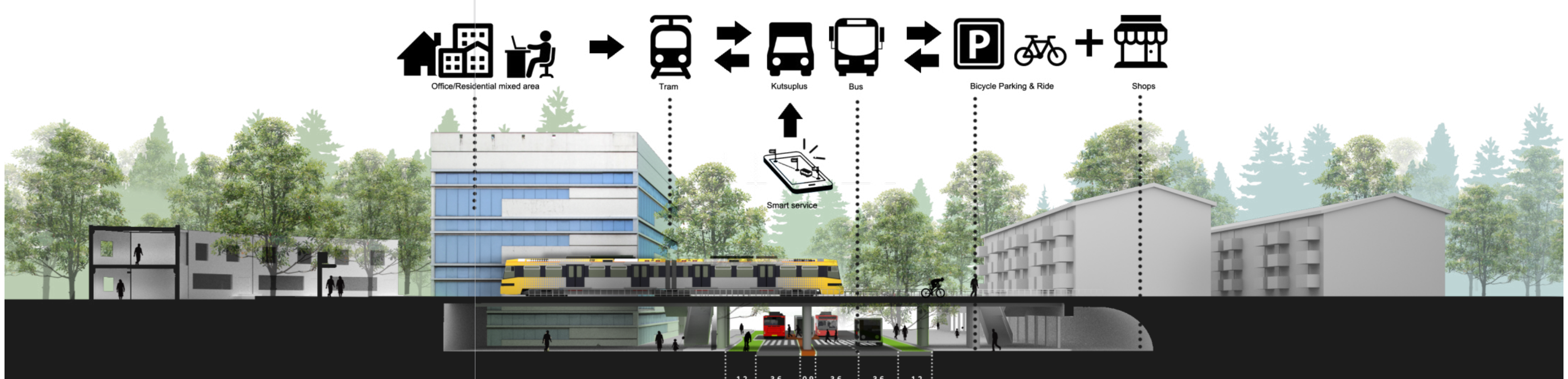
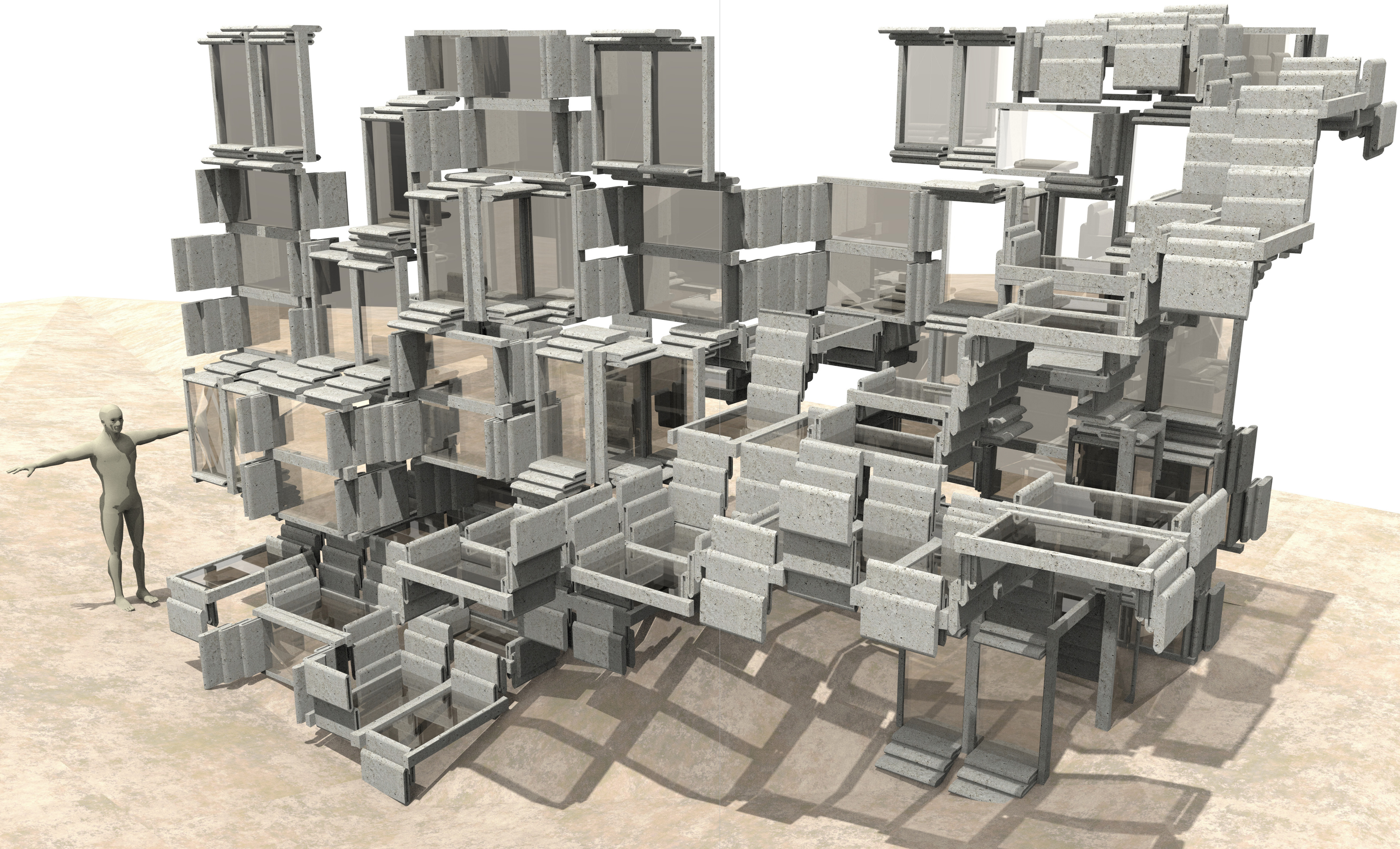


Figure 11: Boulevard Infill, Densification of current urban area Munkkiniemi & Munkkivuori Area - Vision 2015 - 2045

MEREOLOGICAL TECTONICS

A DIFFERENT STUDY ON FACADE DESIGN



FACADE ELEMENT

The general idea is to develop a new approach in designing facade as the performative envelope of the buildings; to consider facade as an envelope that gives form to the spatial entity and the structure of the building simultaneously. The project started by studying and analyzing different facade systems, specifically examining the formation of corners in facades, and try to challenge and rethink its concept.

The project has started by designing a main element for the facade. The main element is a window, which is designed consisting of a normal window frame and two layers of glass. Three pieces of horizontal shades are placed in the up and bottom edges of the frame. These shades can slide freely over each other (Figure 1). The window is used as the main design element and is repeated to create bigger facade elements and surfaces. Arrangment of the repeating elements in addition to sliding shades provides an opportunity to form a back and forth surface and generate various levels and different configurations in it. Therefore, a flexible surface with different architectural possibilities is created (Figure 2 & 3). This surface had the potential to produce an intelligent building envelope that adapts to different climatic conditions or answers different spatial requirments while used as an exterior envelope or an interior element.

Figure 1. Stages of developing the main facade element - the window

Figure 2. Surface made of combining 8 windows

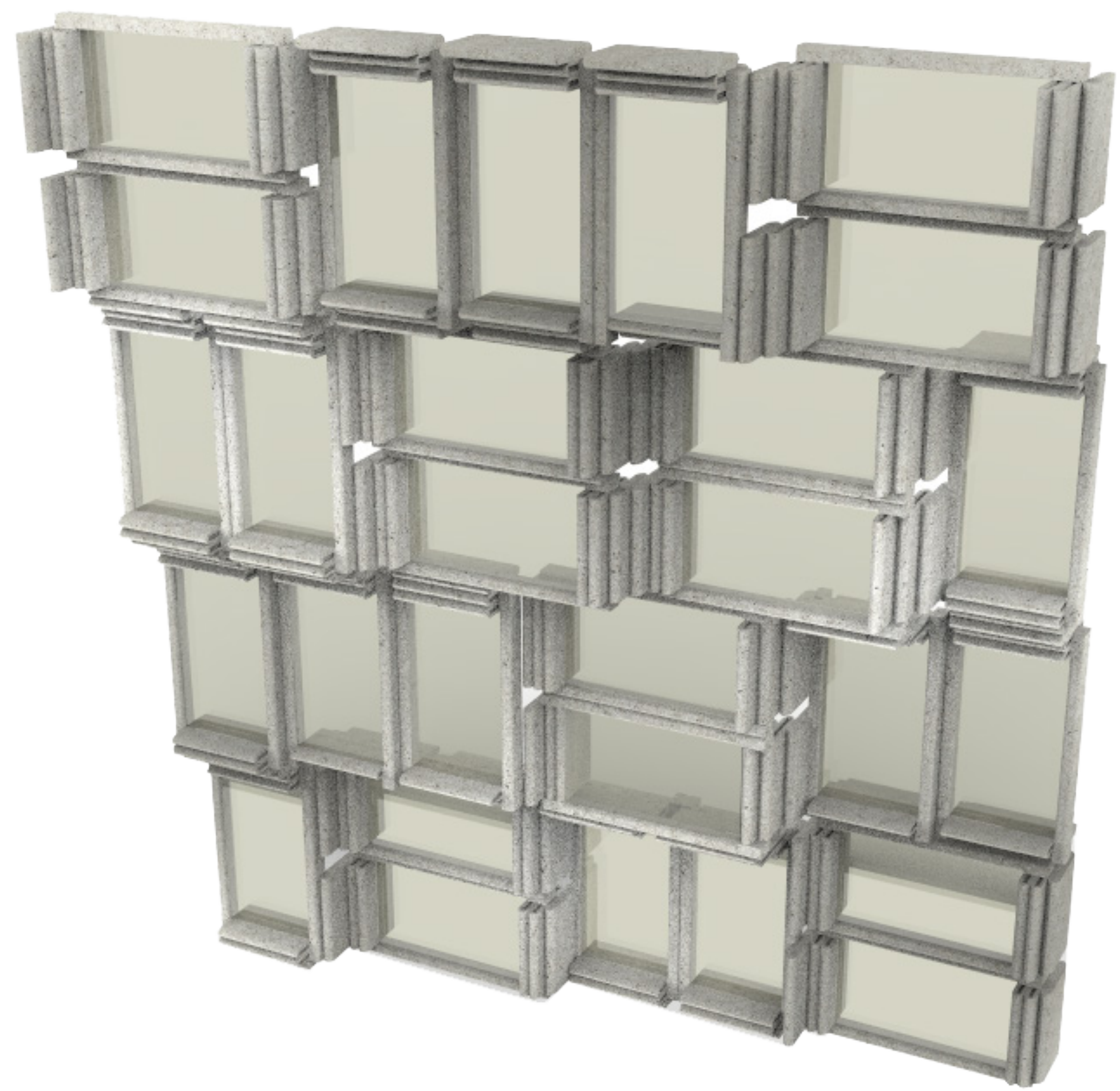


Figure 3. Creating a bigger and generative surface by combining 28 of the main facade element, the window

CORNER FIGURATION

Different configurations of the surface elements create various alternatives for the surface with different architectural features. Repeating the simple facade unit - the window - and arranging its sliding shades in different directions and positions, made it possible to create extremely diverse surface forms. This element becomes part of a wall, floor or a column. Different types of openings are created by sliding the shades and result in forming numerous different three-dimensional configurations, surfaces and volumes (Figure 4.1 & 4.2). To be able to create random or semi-random variations of positioning the units of a specific surface, Unity software is employed. Unity could generate the variety of options by using a semi-automatic system sliding the shades.

In the next step, two different surfaces produced by this method were combined in perpendicular positions to form a new spatial configuration. As above, this creates numerous different spatial alternatives, that are traditionally referred to as **corners** (Figure 4.3 & 4.4). However, corners have completely different spatial qualities in this project. The created space is very diverse and includes different gradients towards inside or outside, from one side to the other side of the surface. In the last step two of these corners were combined to form a spatial entity (Figure 4.5).

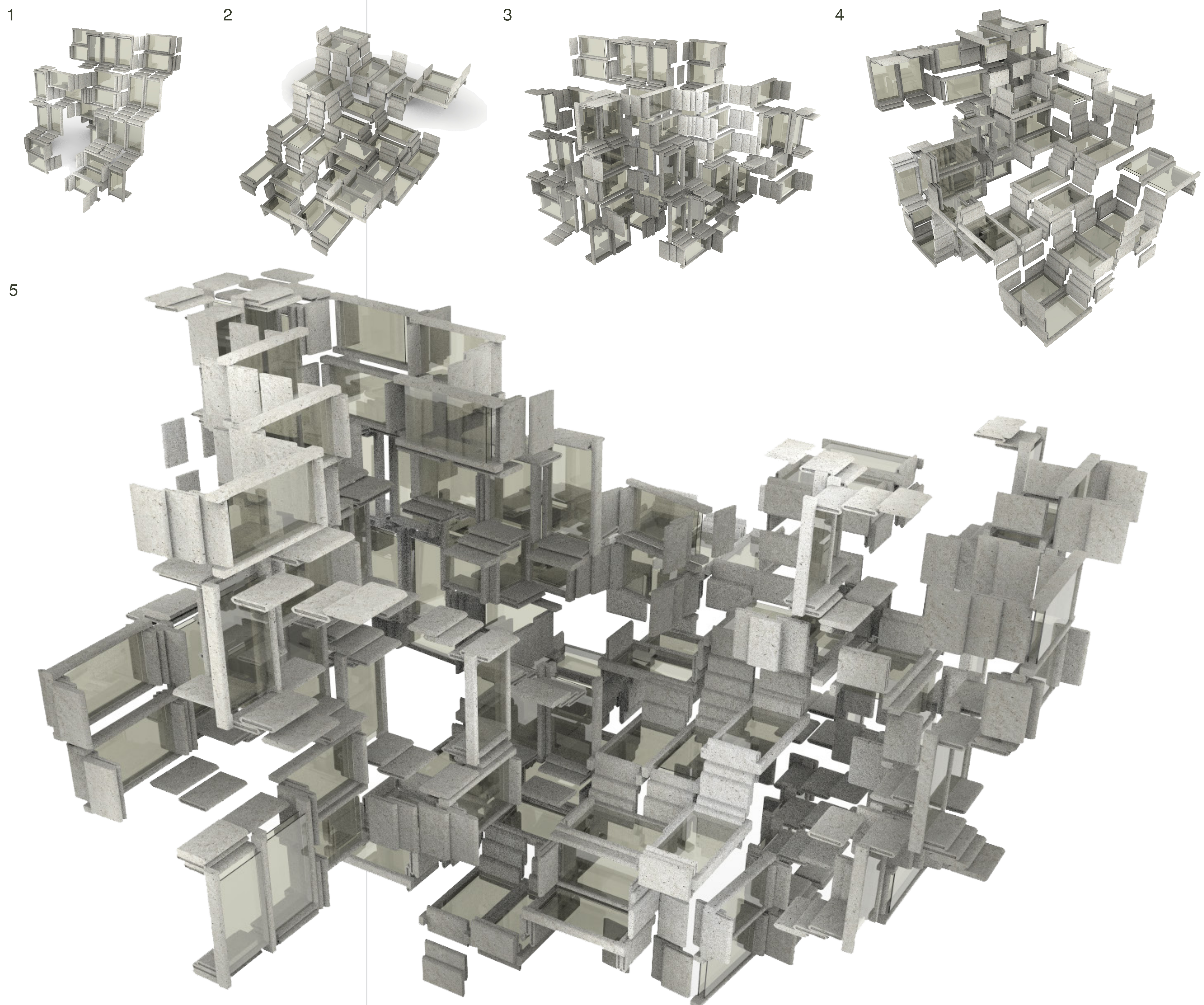


Figure 4. Formation of the corner with various spatial qualities in a process of combining three perpendicular surface elements

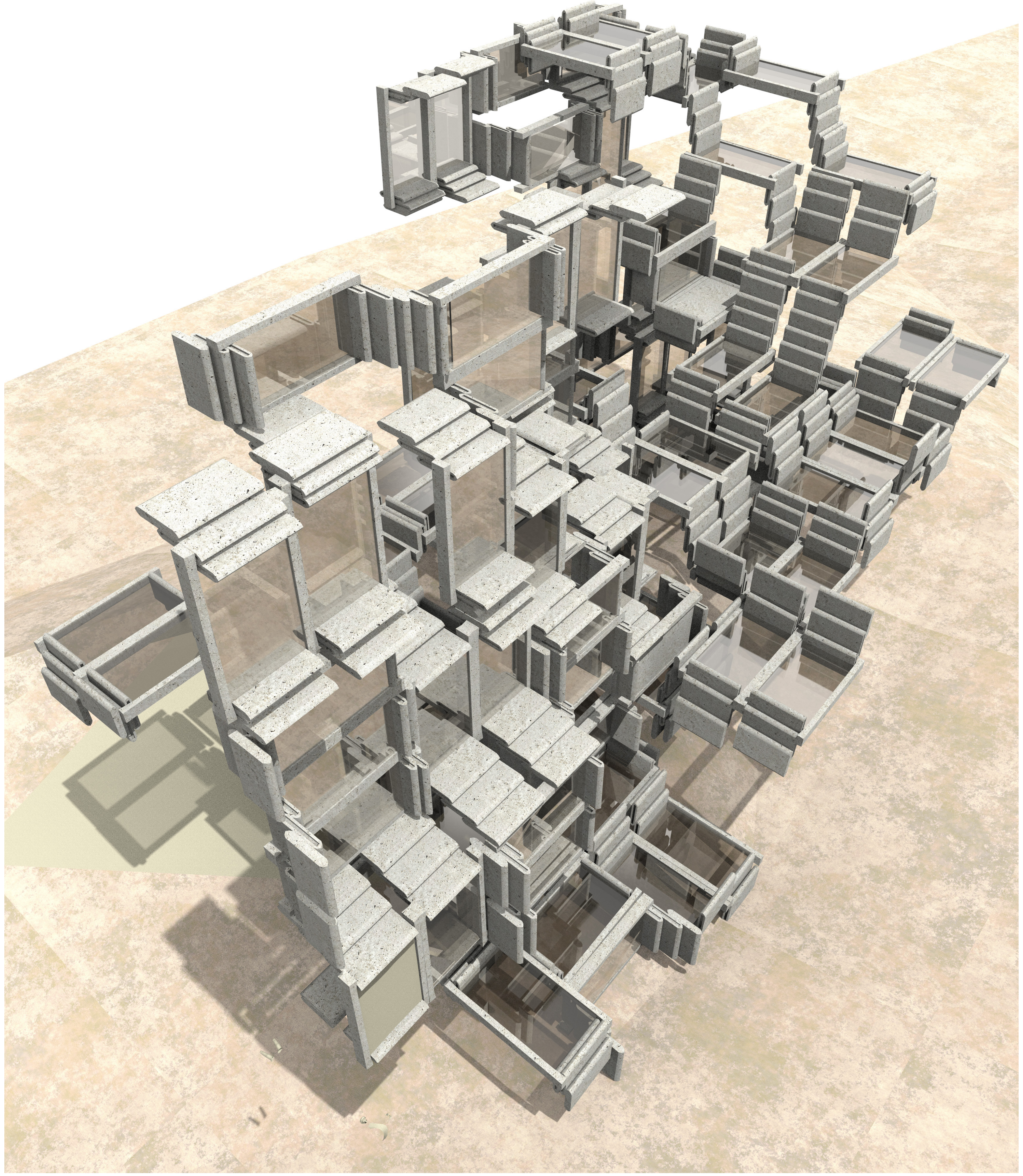
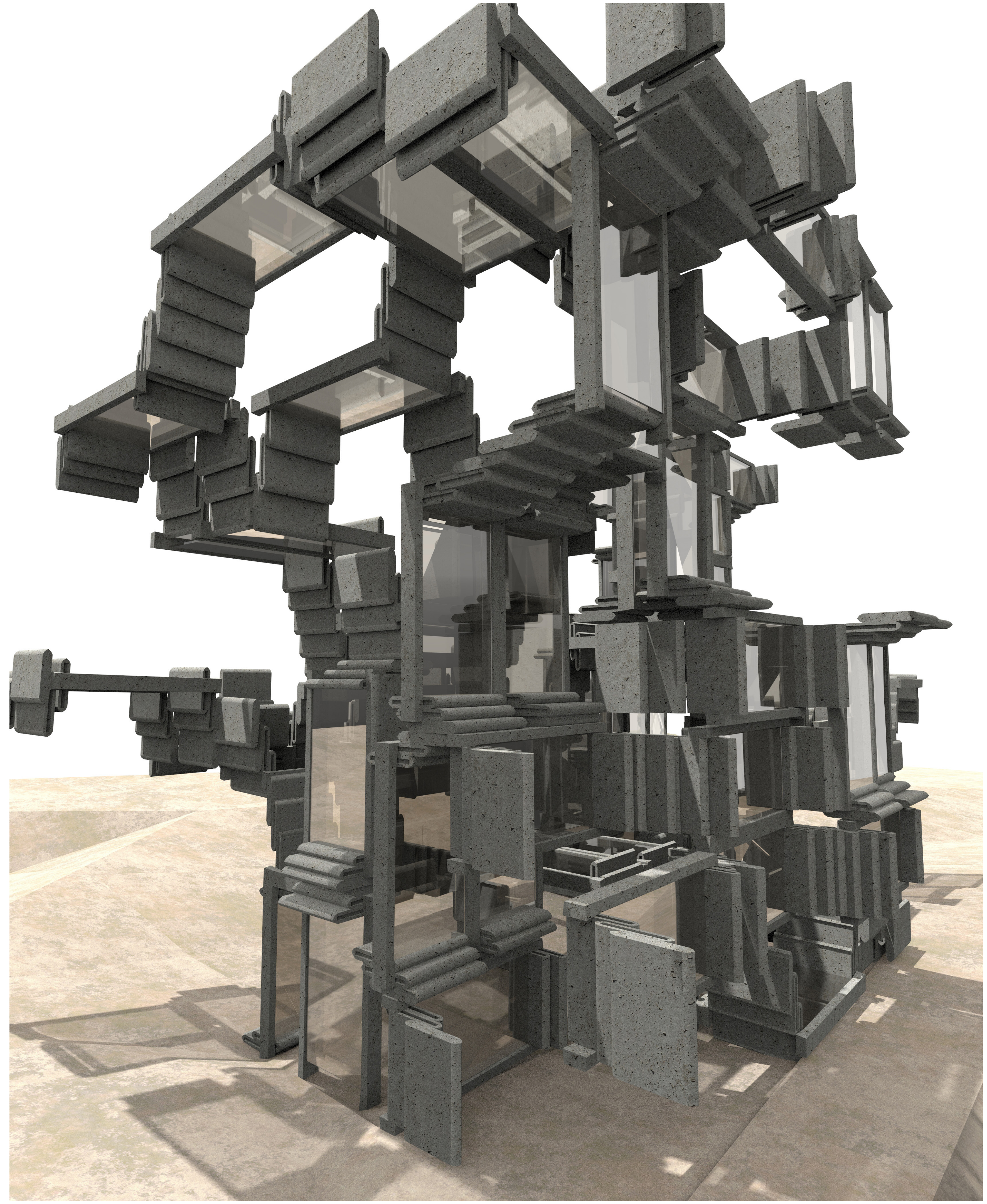


Figure 5 and 6. The result is an envelope created with very diverse spatial and architectural qualities.



The project may meet more functional requirements which requires further studies and development.

ARCHITECTURAL FORM

A DIFFERENT STUDY

FORMAL TRANSFORMATION

Knowing the intrinsic quality of constructive elements is an essential knowledge for architects. In architectural discourse, any basic configuration has its own language and specific inner logic. However, being overconfident on the primitive role of these elements or the traditional methods of using them often limits the creativity of today's architect. This project explores an inherent interpretation of a simple configuration of basic geometrical forms and develops it in the context of architectural and structural design. It is the state of the art study on architectural form and its structural potentials.

The project starts with studying the basic geometrical elements of line, ellipse and NURB curve. Each study starts with four elements of one basic geometry, and then transforms it to a new configuration in a step by step sequence. The target is to find an inner logic for the transformation process by defining a changing parameter and a changing operation. This project has been done in a group of two students. It starts with a set of four simple NURB curves that are transformed step by step. The changing parameter is the NURBs' position of control points, shifted one unit in either X or Y directions. The changing operation includes one step transformation of one element based on the changing parameter (Figure 1). The new configuration has new characteristics with various spatial qualities in the architectural discourse (Figure 2). The key principle of the transformation process is to control each step according to the inner logic of transformation as well as the figure-ground information.

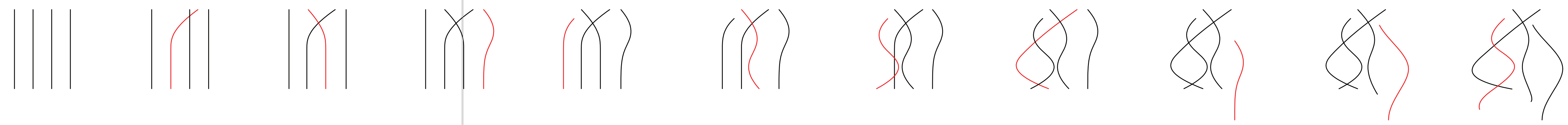


Figure 1: Step by step transformation of a set of basic NURBs based on an internal set of rules leads to creates a new configuration. The changing element in each step is shown in red.

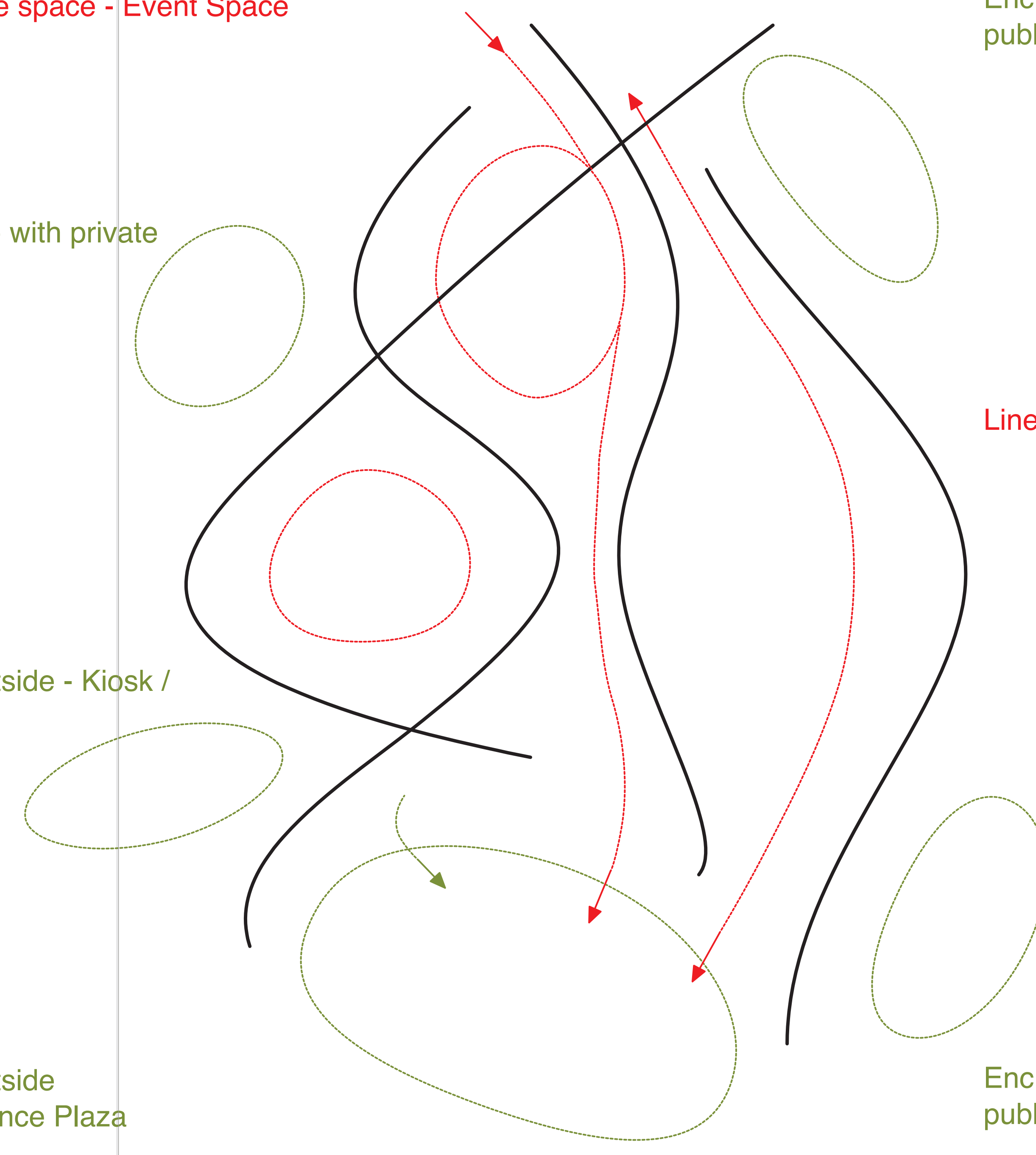


Figure 2: The new configuration has specific spatial qualities that can be interpreted in the architectural discourse.

STRUCTURAL CONFIGURATION

The form has to respond to its requirements on a given urban context. The two-dimensional configuration is extended to produce a three-dimensional form based on its internal logic (Figure 3 & 4). Arising the form, all the curves are developed using the same strategy to create linear volumes at four different heights with various slopes. Two of the volumes are selected for structural development as cantilever structures. The intention is to challenge the limits of traditional cantilever and create a radical one covering a wide span (Figure 5).

Studying examples of cantilever structures in buildings and bridges shows that cantilevers mostly adopt the strategy of overhanging. To safeguard the design, the basic mechanical characteristics of cantilever structures are analysed and three principal strategies are combined to ensure the structural strenght of the project including (Figure 6):
1. Employ a support to hold the cantelever
2. Twist the whole homogeneous structure
3. Reduce the load at the cantilever's free end

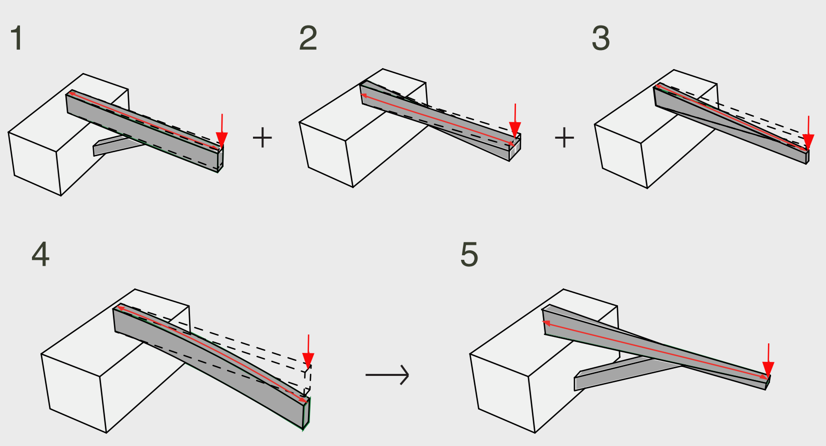


Figure 6: Combination of three structural strategies adopted in the design of the cantilever structure,

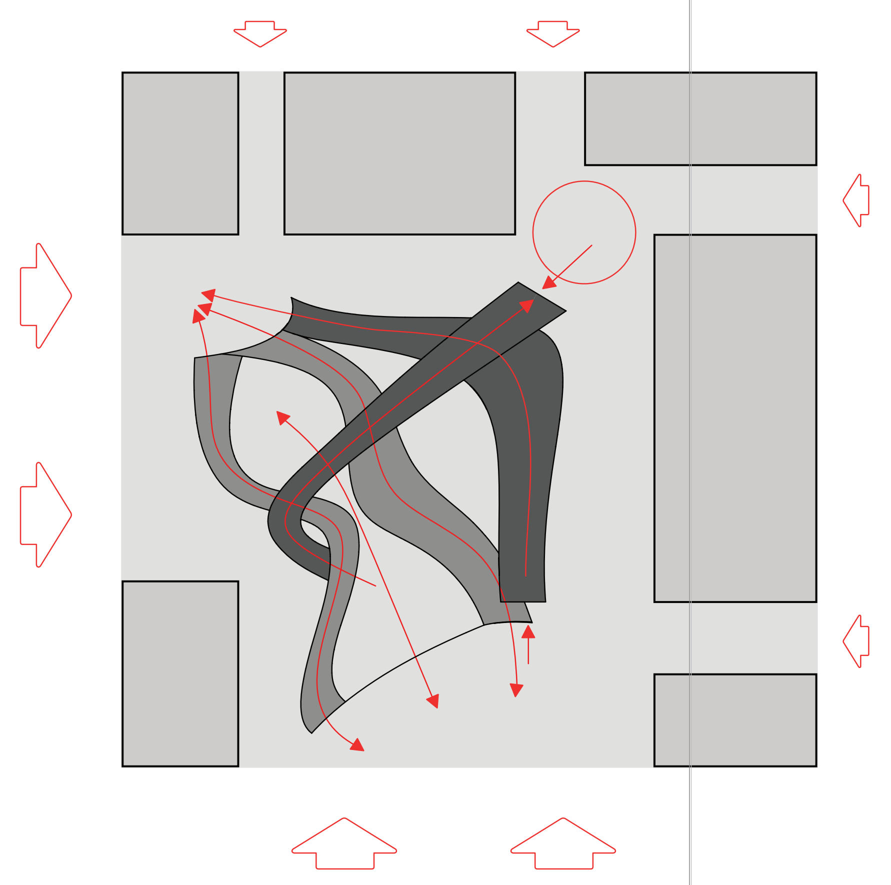


Figure 3: Locating the two-dimensional configuration in the given urban context

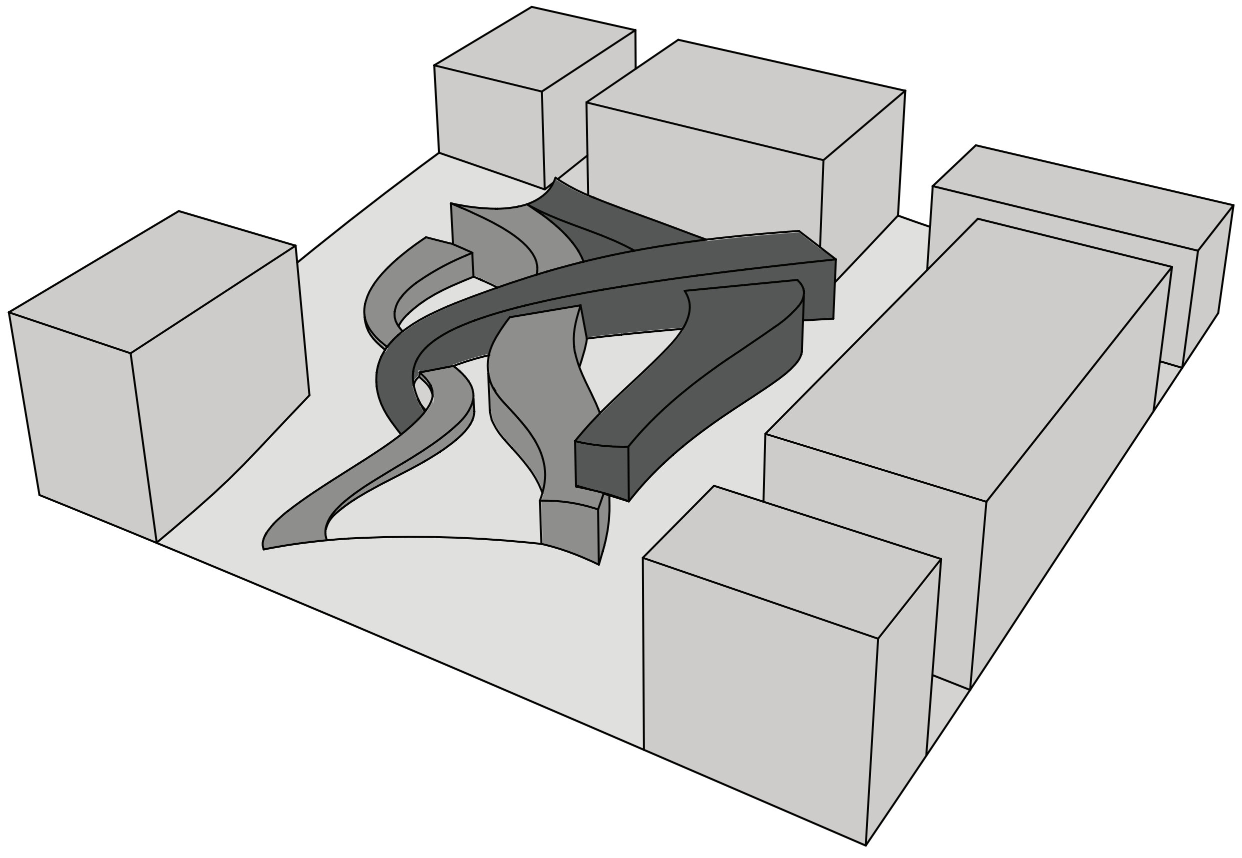


Figure 4: Three-dimensional extension of the configuration in the given urban context

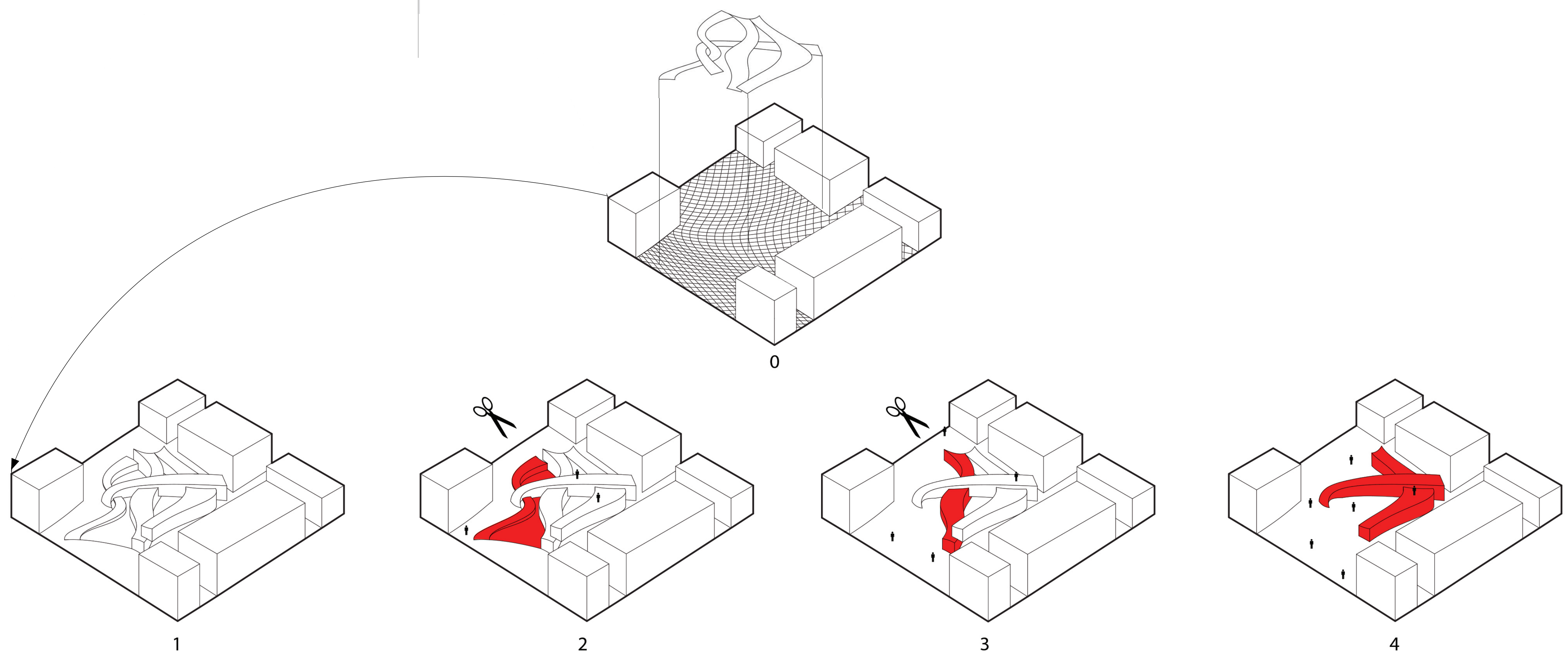


Figure 5: External set of rules based on the urban context influence the architectural form in the other hand.

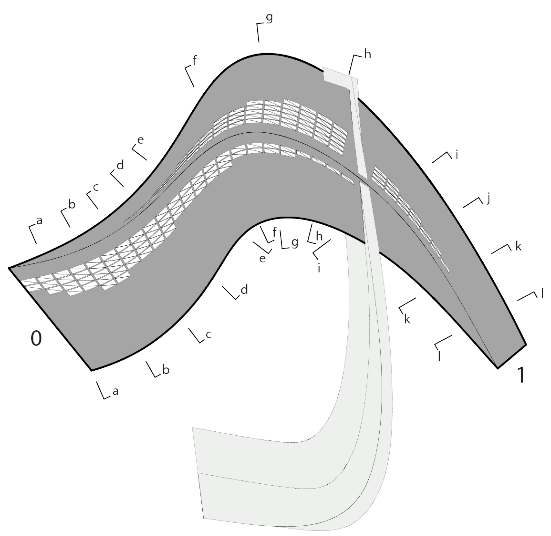
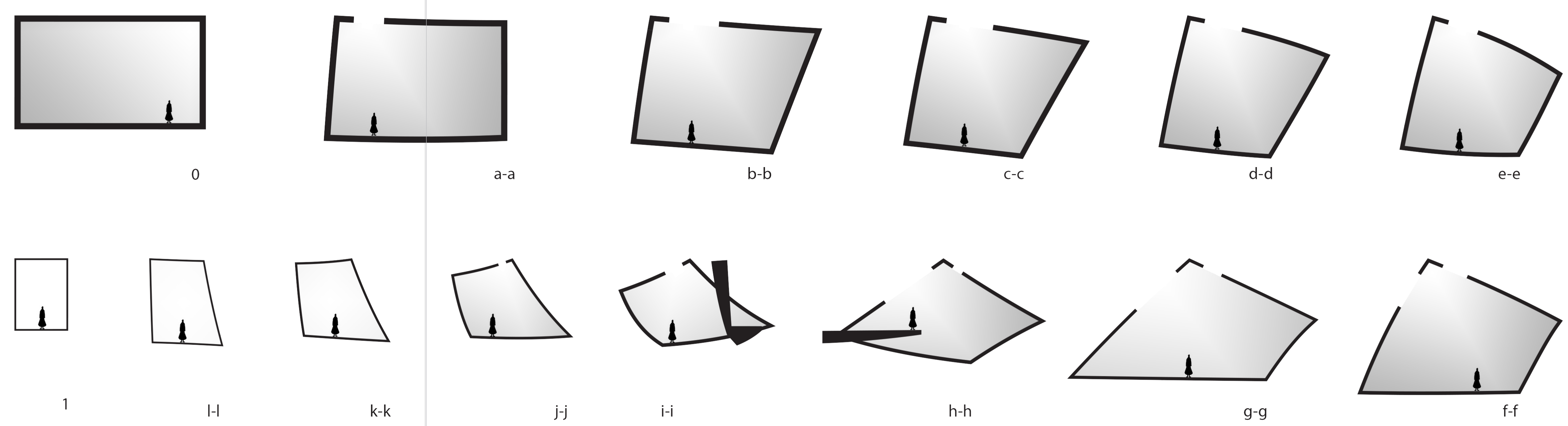


Figure 6: Section series of the main volume



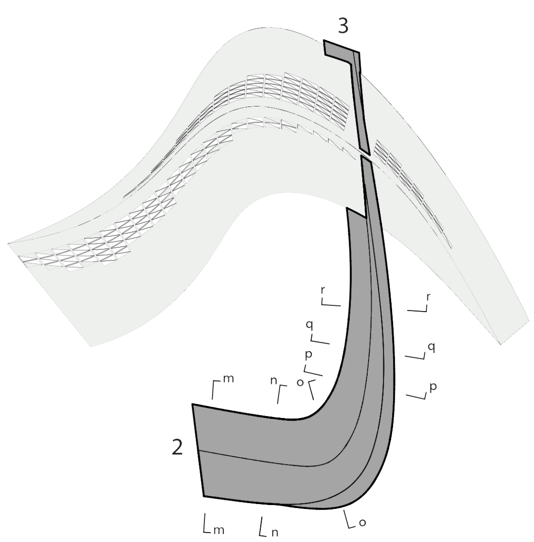


Figure 7: Section series of the smaller volume

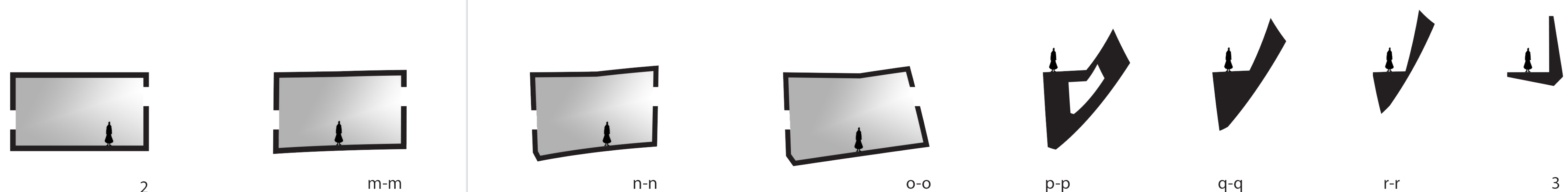


Figure 8: Roof plan

The final architectural form consists of two cantilever structures that are laying on different levels of a steep cliff and intersect in the middle (Figure 8). The relationship of the two volumes is extensively studied and discussed during the design process to consider both spatial and structural aspects. The volumes are suspended visually while support each other structurally. The upper volume is laid on the smaller one in their intersection point in a hight of about 12 m and The smaller volume plays the role of a structual support to it. The bigger volume has a structure of steel skeleton, while the lower - smaller one is made of concrete. The foundations of both volumes buried deep in the ground provide the main structural support against their suspended weight.

The building is an exhibition and includes a viewing deck at the end of the main volume which is distinguished from the exhibition space by passing through the intersection point. The interior space reflects the structural transmission and emphasizes the hierarchy and peculiar spatial rhythm (Figure 6). Walking through the smaller volume the concrete walls are visible untouched and in pure concrete. Due to the twisted form of both structures, there is no distinction between wall, ceiling and floor in the interior space. They are converting to each other smoothly by walking further inside (Figure 7).

Figure 9: Interior space in the intersection point of the two volumes

FAMILY HOUSE

DESIGN AND TECHNICAL DRAWINGS

Nuottamiehentie 5, 02230 Espoo
Plot size 1000 m²
Build area160 m²

SITE ANALYSIS, BUILDING AREA AND THE LEGAL ISSUES

The site is located in a beautiful peaceful residential neighborhood in Matinkylä, east of Espoo (Figure 1). The big plot is about 2900 m² and by law has maximum 560 m² building area allowed. By dividing the plot into two pieces the Family House has a plot of about 1000 m² and is allowed to build maximum of 180 m². The Family House is 160 m² and is planned in two floors. A separate house is designed for storage and parking in 20 m² (Figure 2).

Figure 1: Photos of the site

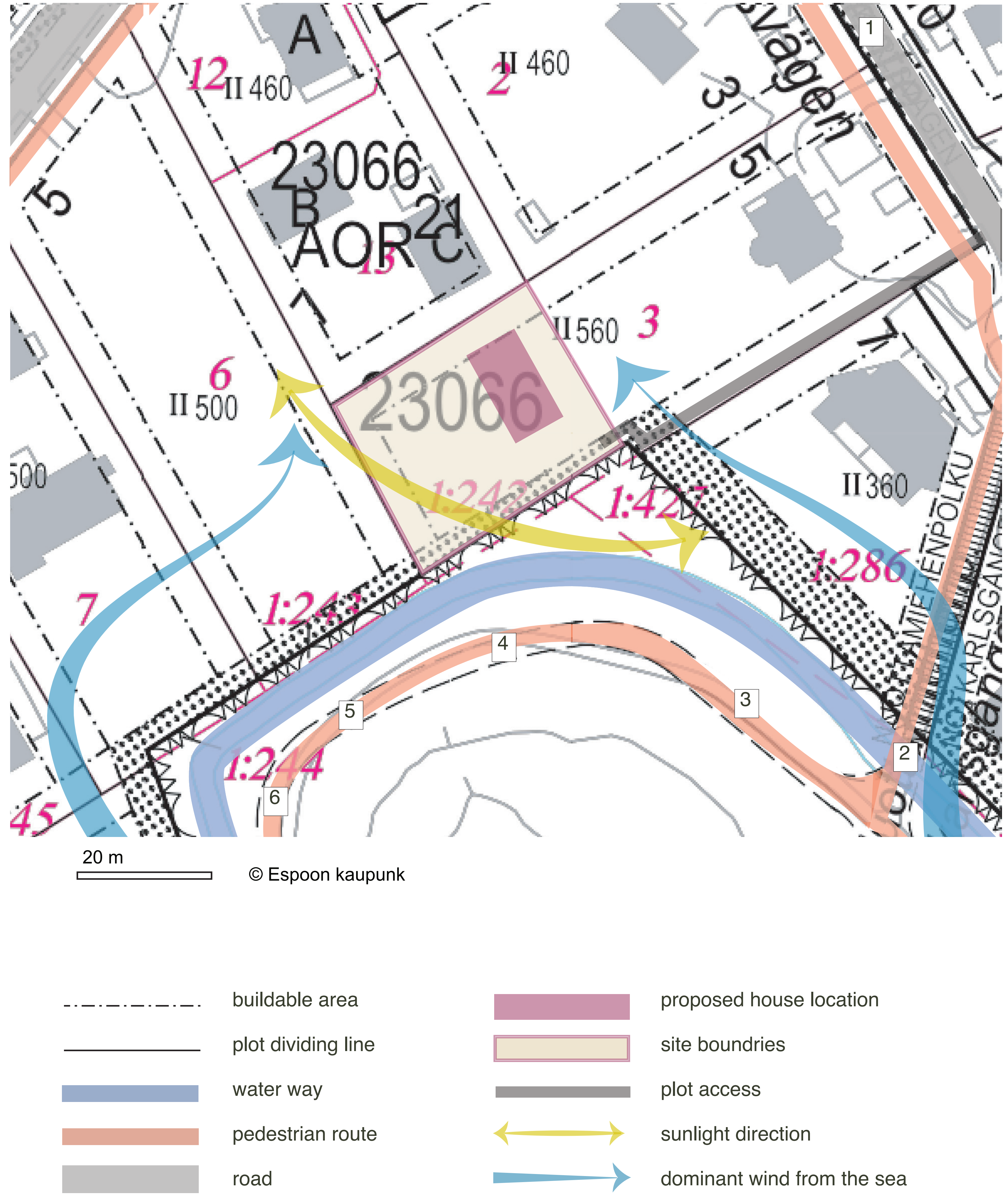
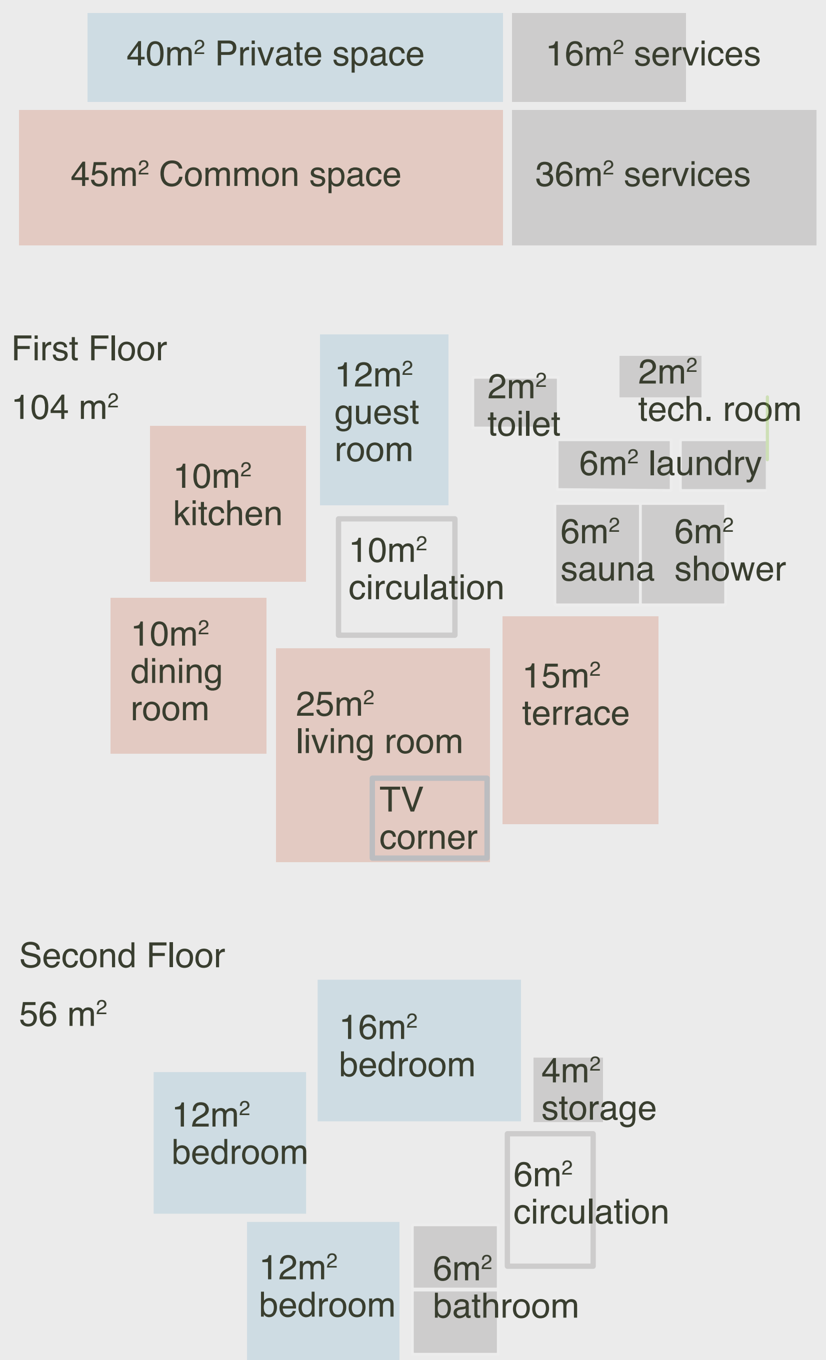


Figure 2: SIte plan analysis

PROGRAM



The client is a family of four, a couple and two kids. The program is set based on the family's needs and desires. The design emphasizes on common spaces to gather the family around for different daily activities, while provides the private space for each family member seperatley. A glazed terrace is designed as the transition between house's common area in the first floor and private area in the second floor. It aims to make a maximum use of sunlight all year around, provides a viewpoint and a protected space in direct contact to nature.

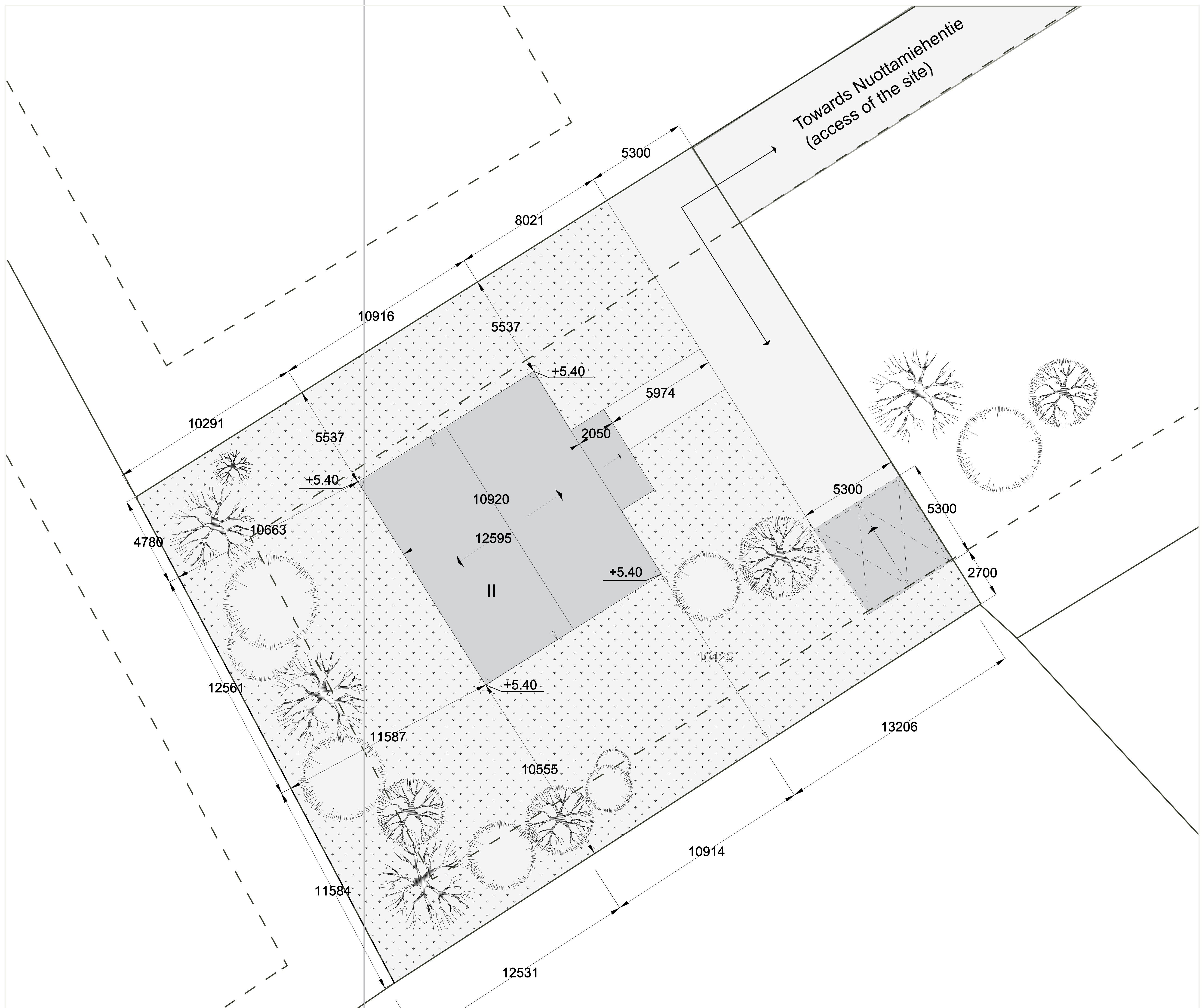


Figure 3: Courtyard and site plan

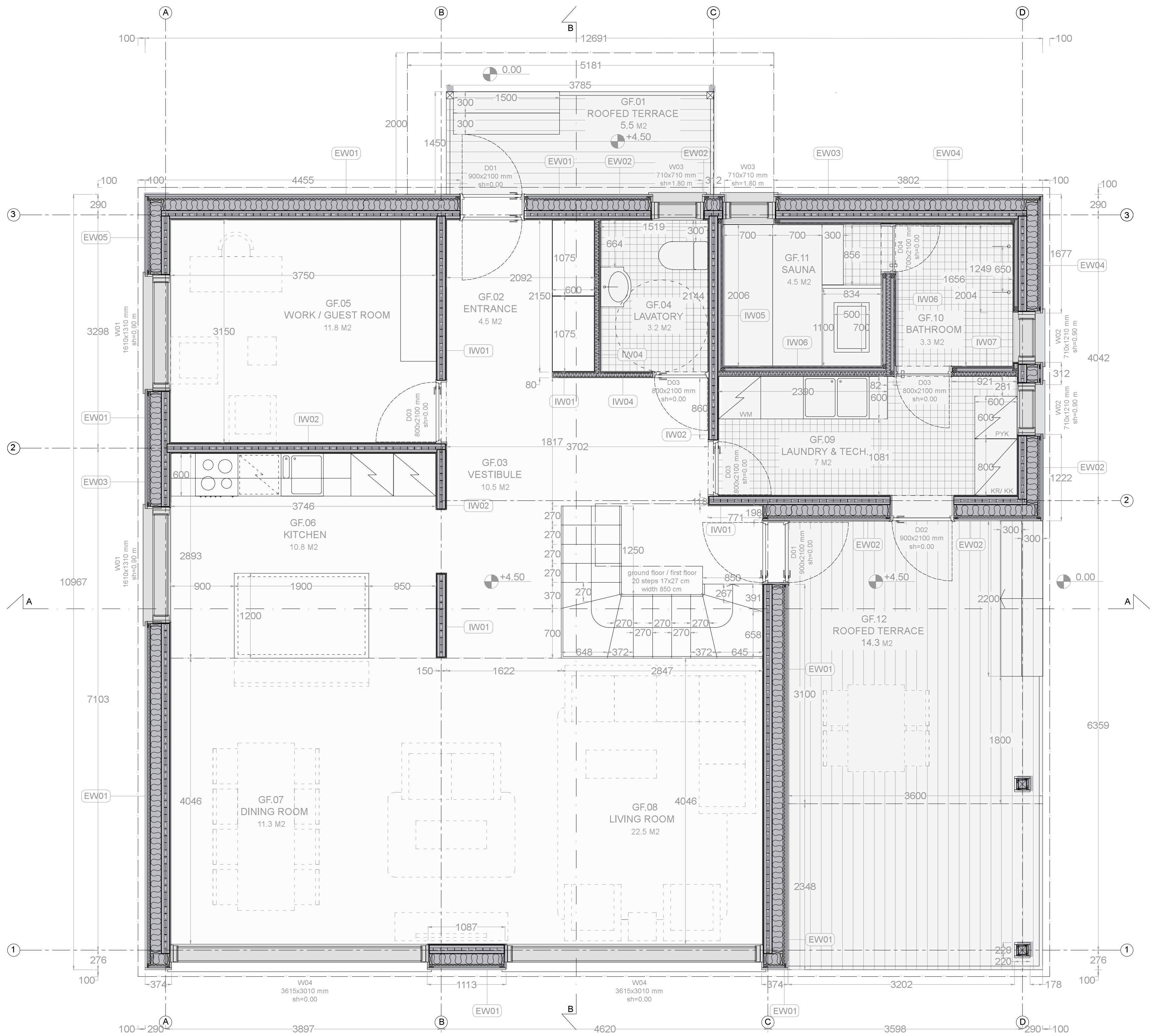


Figure 4: First Floor Plan

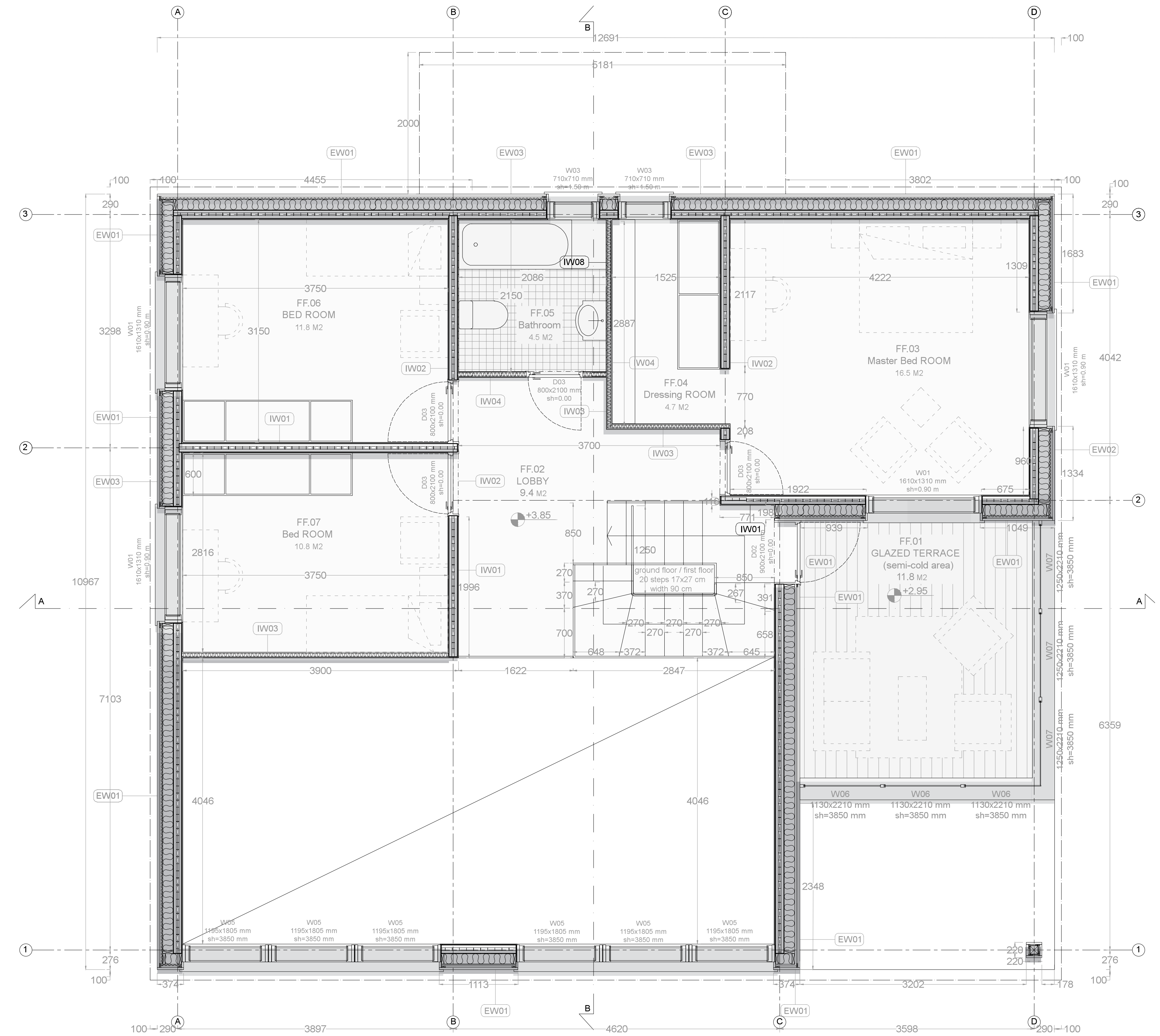


Figure 5: Second Floor Plan

FLOOR AND ROOF TYPES
and their constitutive layers

F01 (exterior)

timber floor planks	15 mm
cement screed incorporating heating pipes	75 mm
impact sound insulation	30 mm
concrete slab	100 mm
vapor control layer	1 mm
rigid insulation, extruded polystyrene	100 mm
gravel drainage layer	400 mm

F02 (interior)

timber floor planks	15 mm
cement screed	75 mm
impact sound insulation	30 mm
CLT floor panel	140 mm
air gap	135 mm
insulation	50 mm
CLT ceiling panel, precut	80 mm
gypsum board	13 mm
paint	2 mm

F03 (interior)

granite tiles 20 x 20 cm	15 mm
cement screed	75 mm
impact sound insulation	30 mm
CLT floor panel	140 mm
air gap	135 mm
insulation	50 mm
CLT ceiling panel, precut	80 mm
gypsum board	13 mm
paint	2 mm

Roof 01

vertical timber cladding	28 mm
timber roof battens horizontal	40x40 mm
timber roof battens vertical	40x40 mm
waterproof membrance adhered	1 mm
rock wool termal insulation	45 mm
between 60x200mm LVL beam, structure	60 mm
vapor control layer	1 mm
CLT panels	60 mm
gypsum board	13 mm
paint	2 mm

VERTICAL SECTIONS

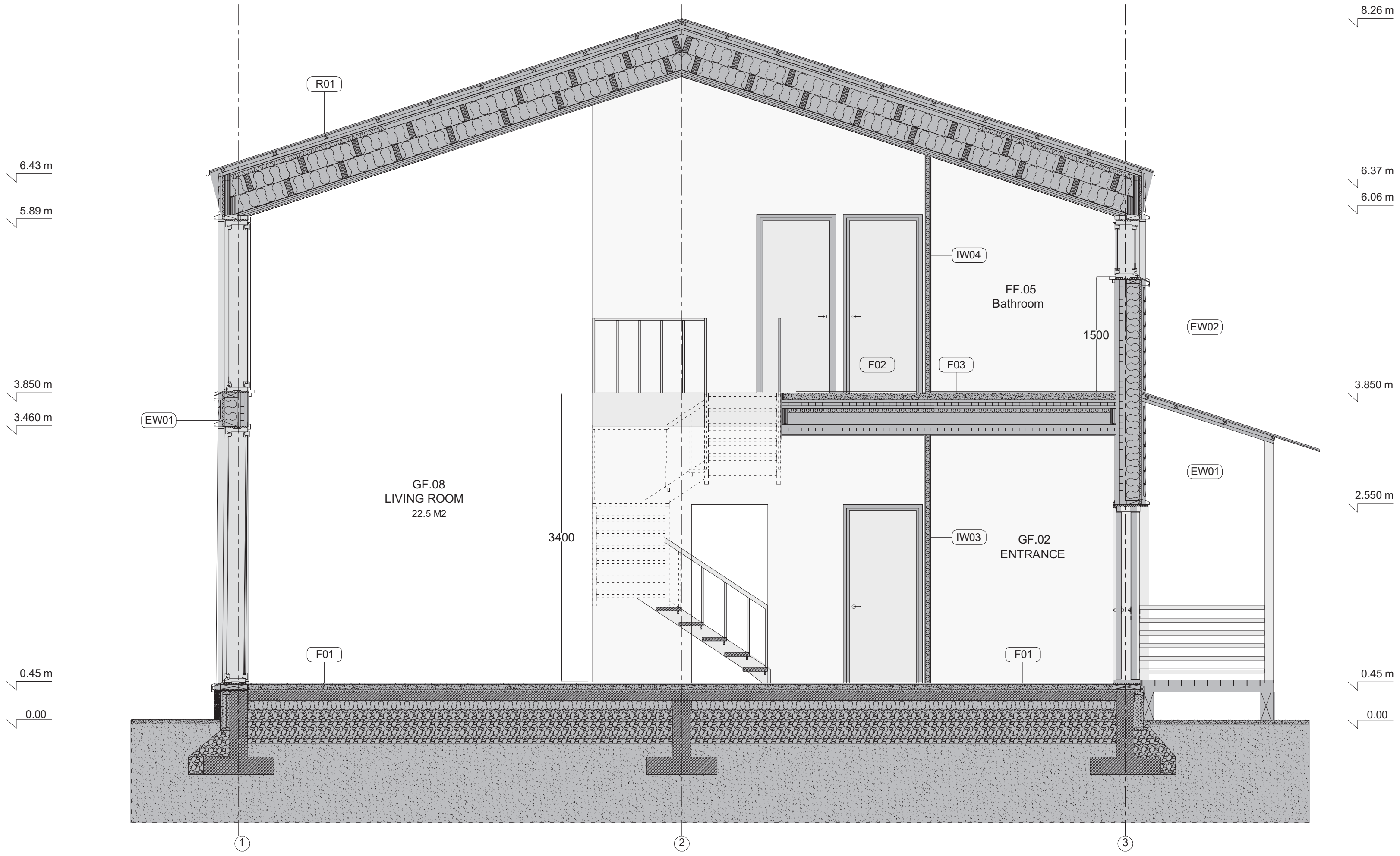


Figure 6: Section A

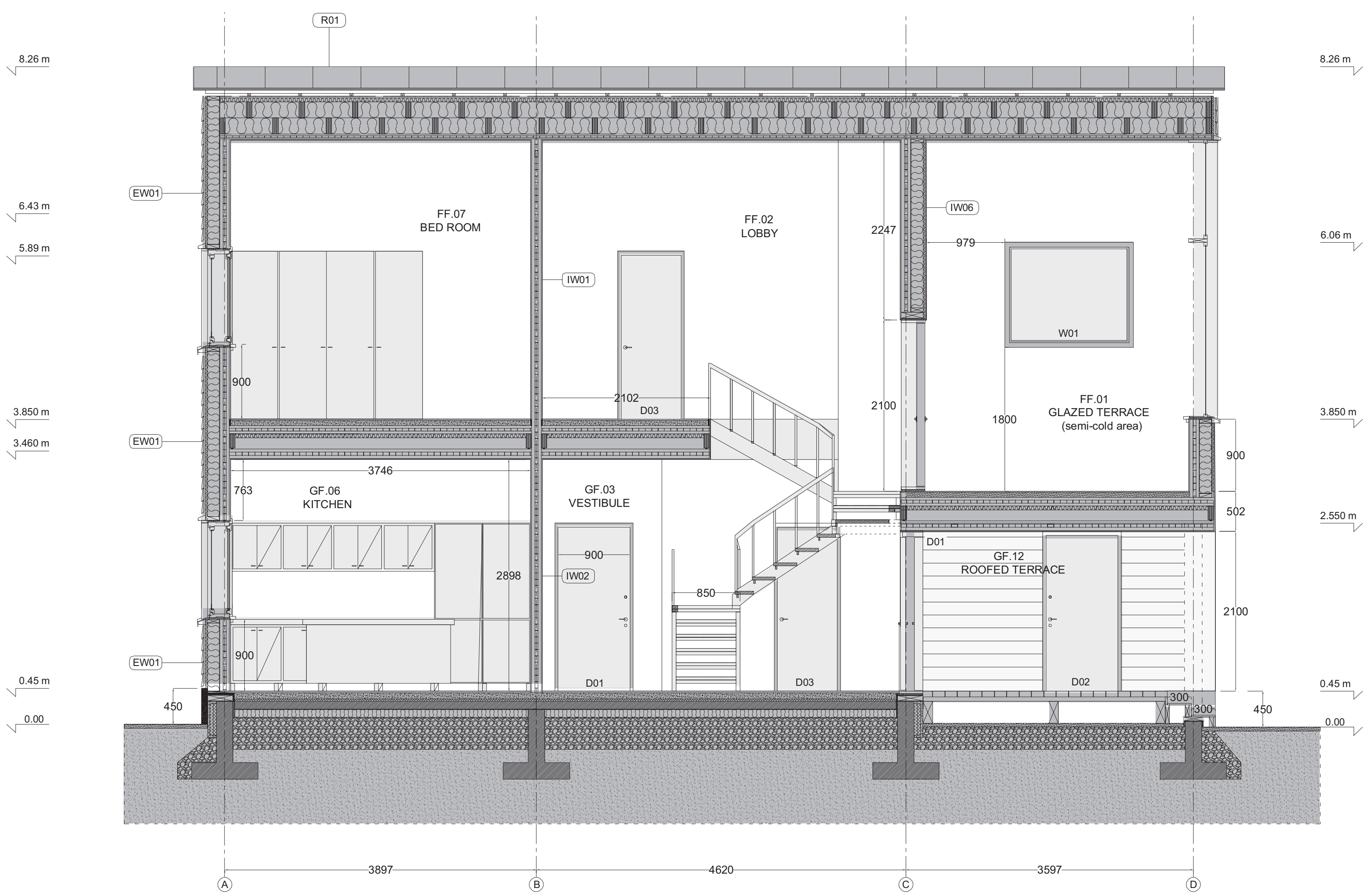
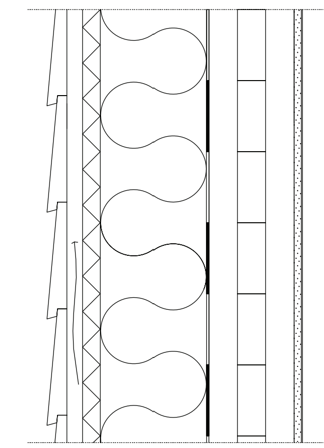


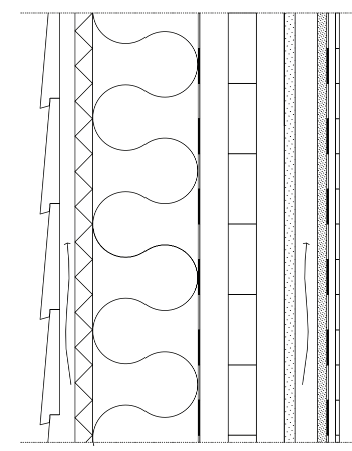
Figure 7: Section B

WALL TYPES AND CONSTITUTIVE LAYERS
(few examples)



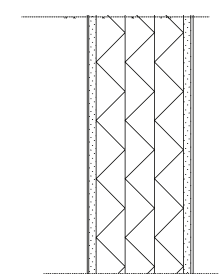
EW01 - Structural (exterior)

horizontal timber cladding (treated with scorched surface)	28 mm
ventilation interval (timber battens 22x60 mm every 600mm)	22 mm
timber mullions (wind shield)	25 mm
Cefil single waterproof membrane	1 mm
wool thermal insulation (studs 20x150 every 600 mm)	150 mm
vapor barrier	1 mm
CLT structural panel, precut	120 mm
gypsum board	13 mm
interior wall surface (paint)	2 mm



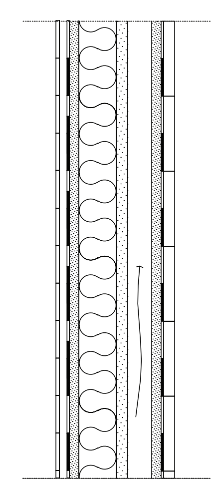
EW04 - Structural (exterior)

horizontal timber cladding (treated with scorched surface)	28 mm
ventilation interval (timber battens 22x60 mm every 600mm)	22 mm
timber mullions (wind shield)	25 mm
Cefil single PLY waterproof membrane	1 mm
wool thermal insulation (studs 20x150 every 600 mm)	150 mm
vapor barrier	1 mm
CLT structural panel, precut	120 mm
gypsum board	15 mm
air gap (timber batten 32x60 every 600 mm)	32 mm
wet area board	13 mm
moisture and vapor barrier	1 mm
tile adhesive	10 mm
ceramis tiles	5 mm



IW02 - Structural (interior bathroom)

wall surface, paint	2 mm
gypsum board	13 mm
CLT structural panel, precut	120 mm
gypsum board	13 mm
wall surface, wet paint	3 mm



IW06 - (interior wet area - sauna)

ceramic tiles	5 mm
tile adhesive	10 mm
moisture and vapor barrier	1 mm
wet area board	13 mm
wood fiber insulation (timber frame 50x66 mm every 600 mm)	50 mm
gypsum board	15 mm
air gap (timber battens 32x60 mm every 600 mm)	32 mm
moisture resistance board	13 mm
vapor barrier foil	1 mm
spruce paneling	15 mm

ELEVATIONS

Figure 8: South Elevation

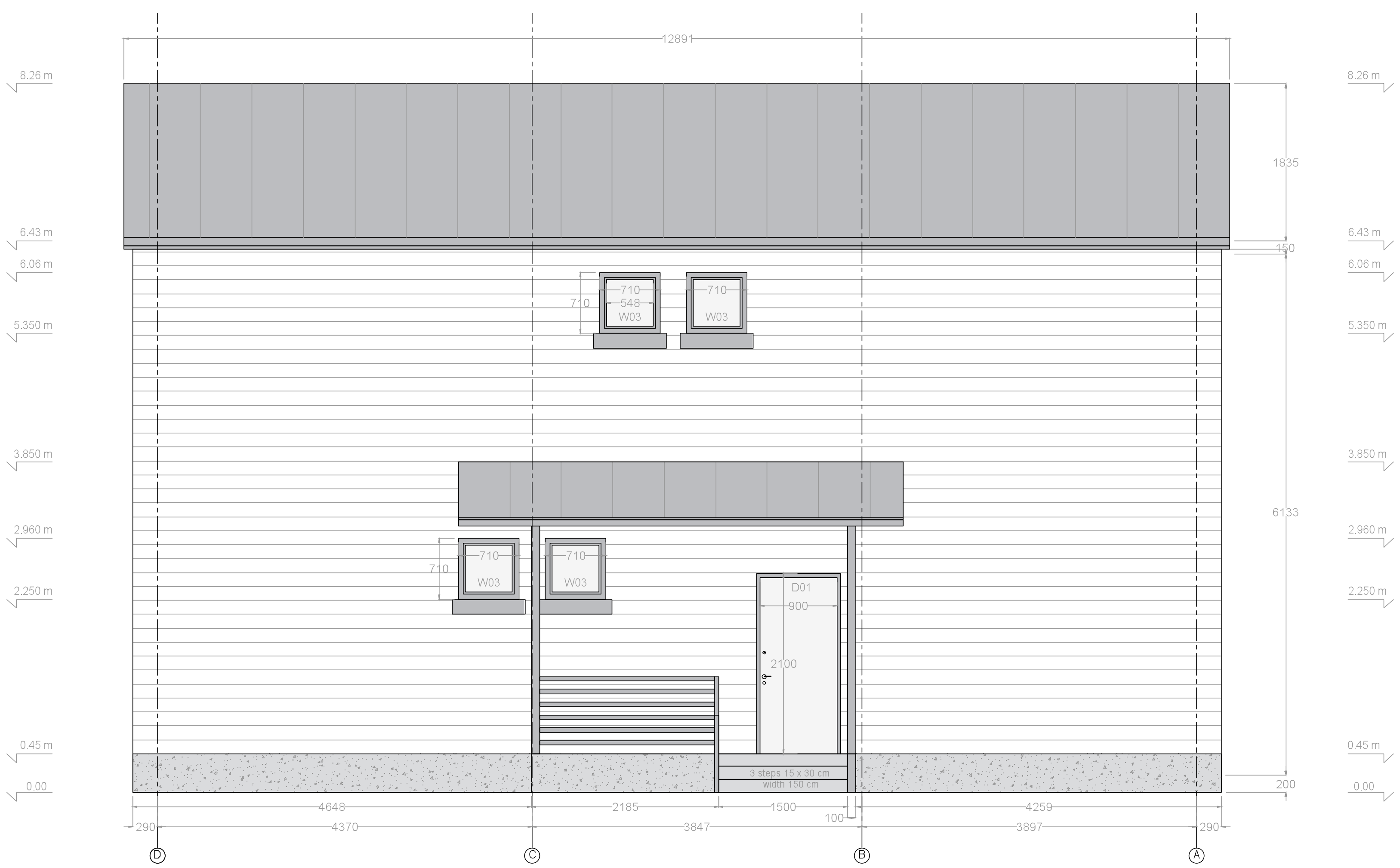


Figure 9: North Elevation

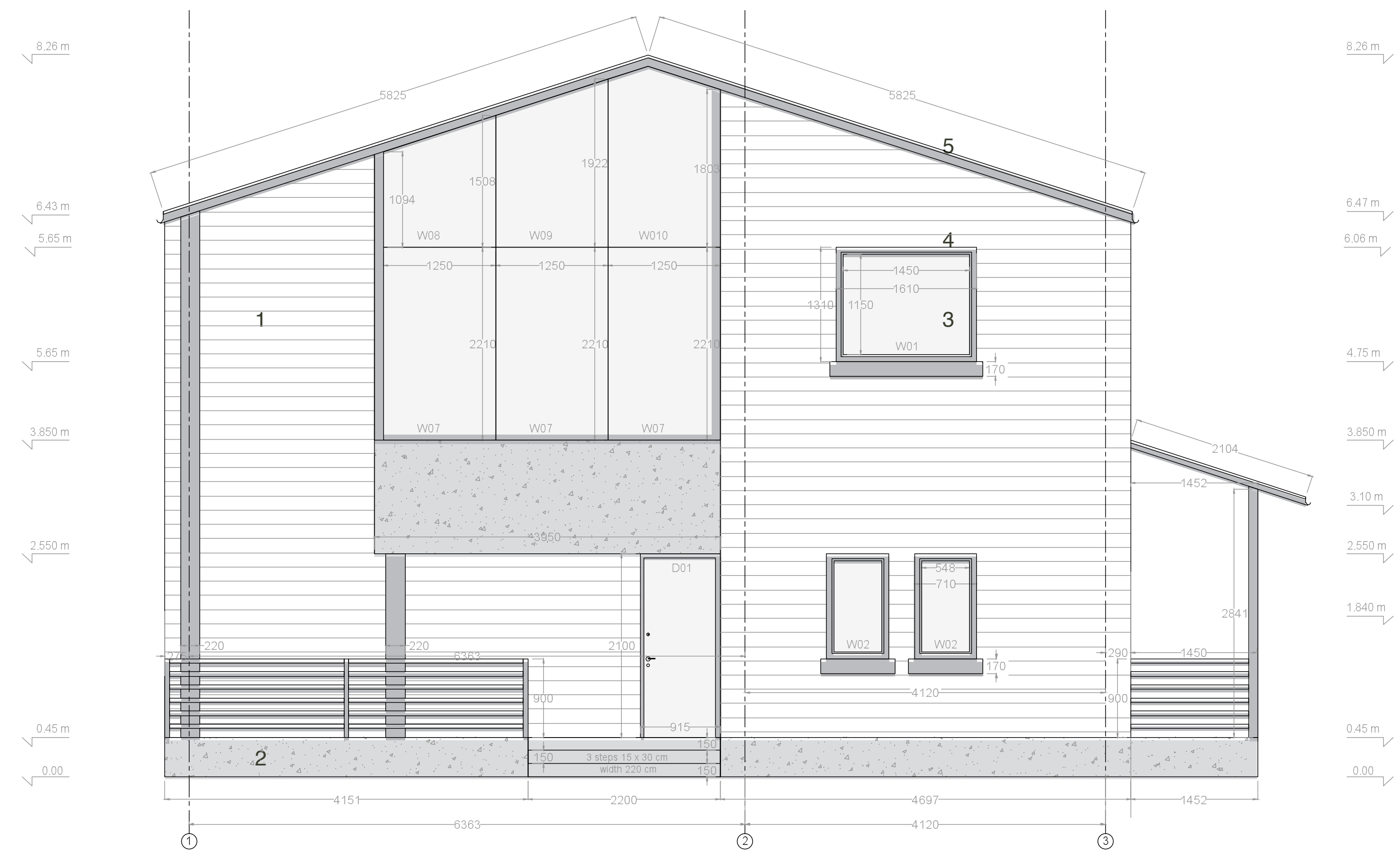


Figure 10: East Elevation

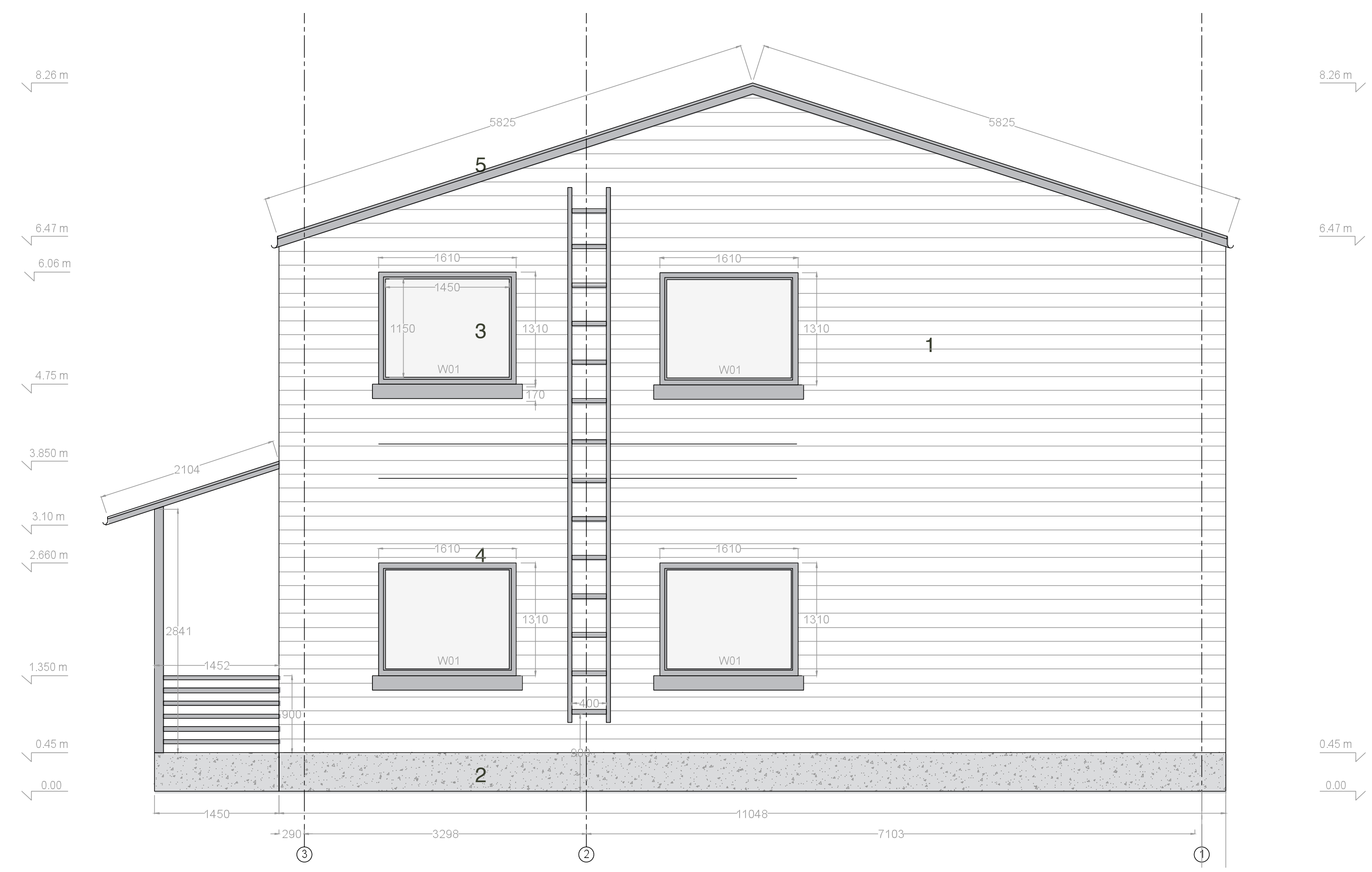


Figure 11: West Elevation. Facade Surface Materials: 1. Timber cladding with scorched surface. 2. Cement plinth. 3. Energy efficient triple glazed low-e glass. 4. Engineered timber frame. 5. Folded aluminum

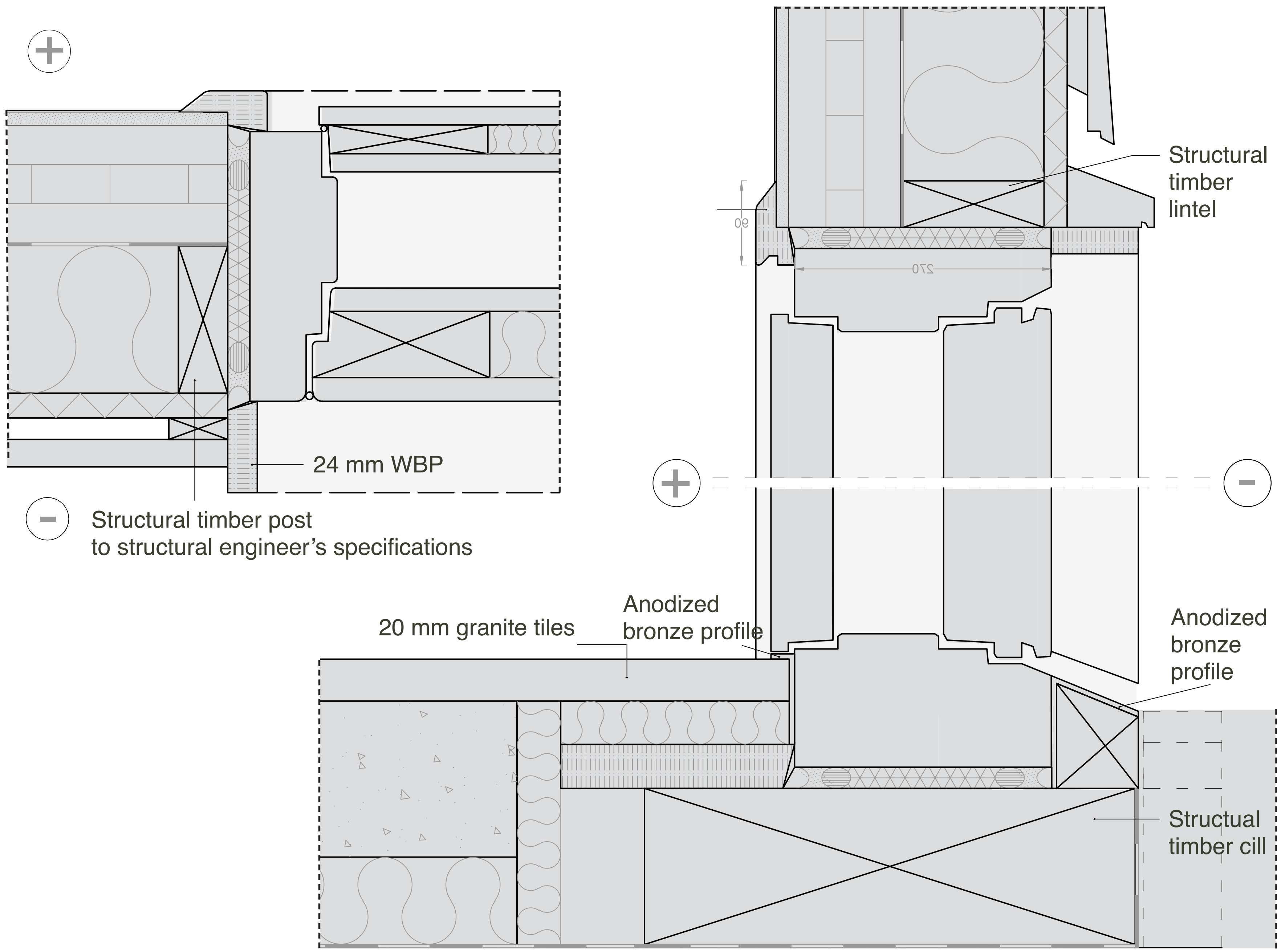


Figure 12. D01 fitting diagram, horizontal section on left, vertical section on right

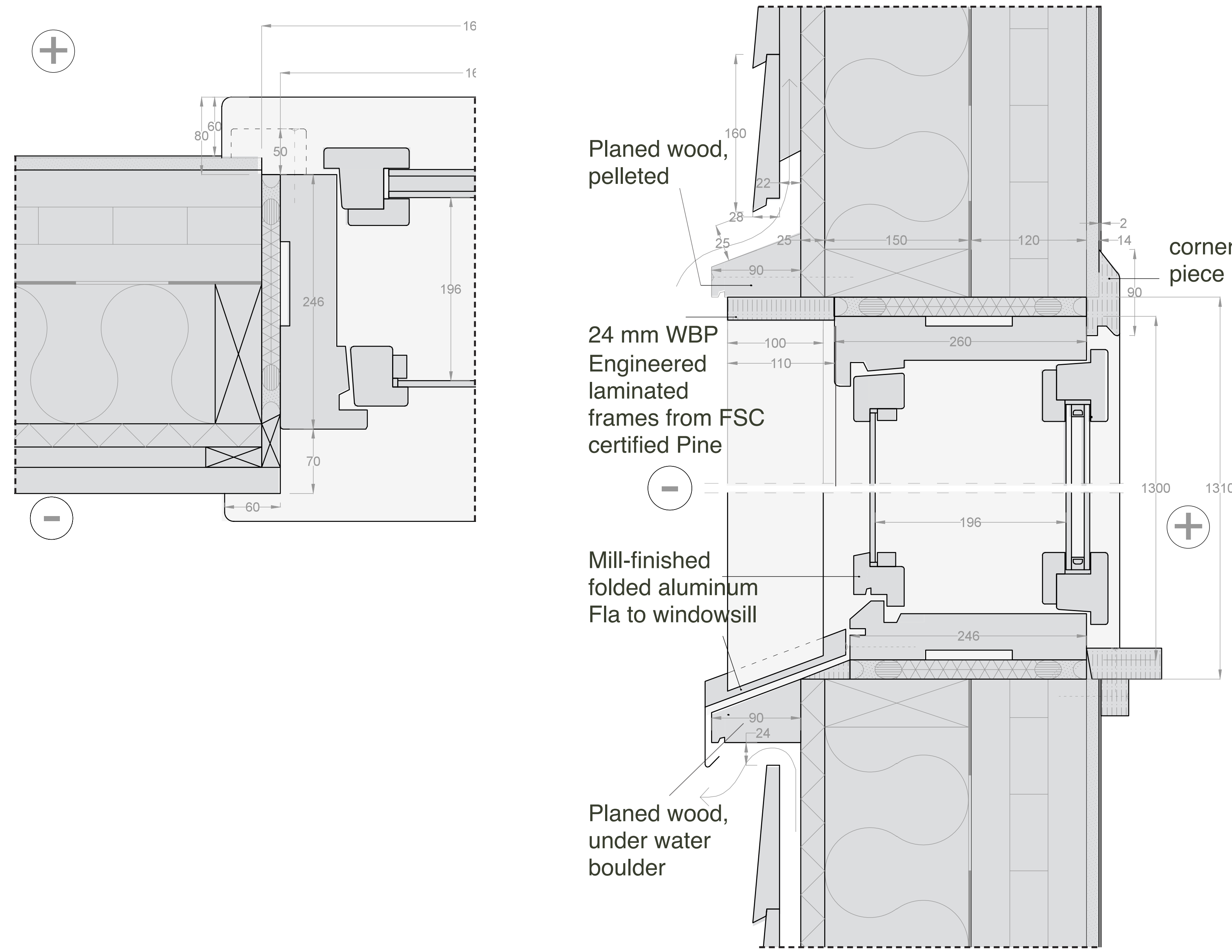


Figure 14. W01 fitting diagram, horizontal section on left, vertical section on right

DOOR MOUNTING (D01 x 2)

D01 diagram including fitting

- External door fitting to the exterior wall
- Double door, total width 300 mm
- Opening towards exterior and interior
- Bottom base
- Exterior of the door arm in the outer surface of the windshield

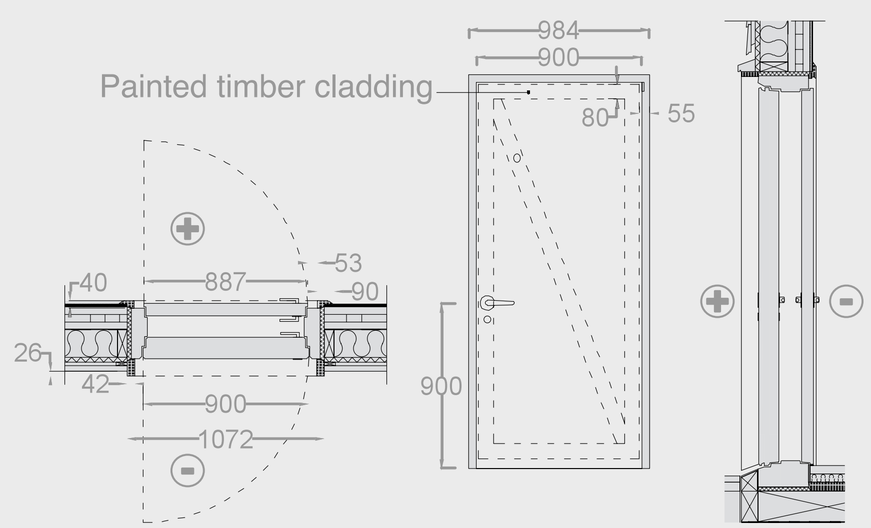


Figure 13. D01 diagram, plan, elevation, section

WINDOW MOUNTING (W01 x 6)

W01 diagram including fitting

- 260 mm frame width
- Opening towards interior
- Energy efficient triple glazed low- e glass
- Right-handed window
- Window frame from engineered laminated profiles of pine timber with factory applied stain.

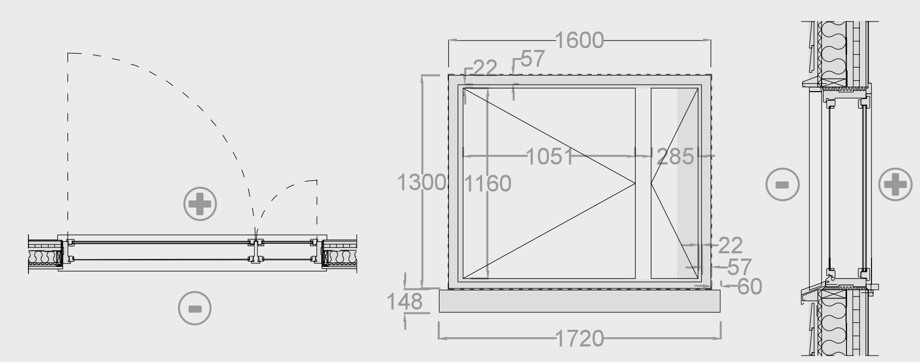


Figure 15. W01 diagram, plan, elevation, section

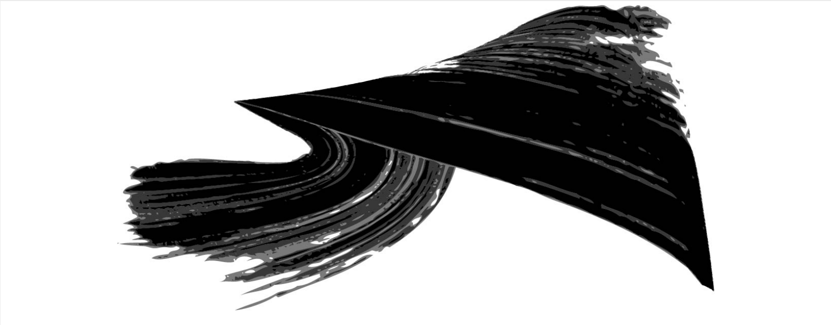
KIERRE

TAF 2014 · ENTRANCE PAVILLION

KIERRE

TAF ENTRANCE PAVILION 2014

Aalto University Wood Program



https://www.facebook.com/KierrePavilion/

Kierre is an entrance pavilion designed and built by Aalto University's 2013 - 2014 Wood Program students, a team of 15 students. It is conceived to mark the entrance to TAF's Millennium Pavilion. Located in the center of Helsinki, just meters away from Steven Holl's Kiasma Museum and Alvar Aalto's Finlandia Hall, Kierre guides visitors to the site and puts itself on display as an emblem of international collaboration and Finnish wood construction technology. The Pavilion had been on display in Kansalaistori, Helsinki, from 28 April to 14 May 2014.

Figure 1 & 2: Kierre Pavilion

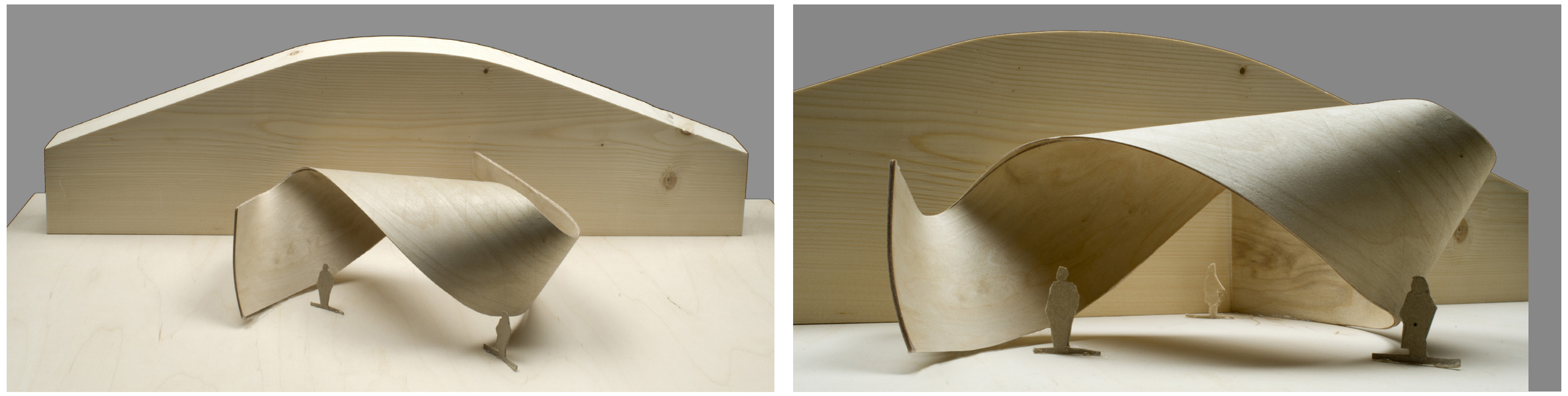


Figure 3: Kierre's initial idea, the twist

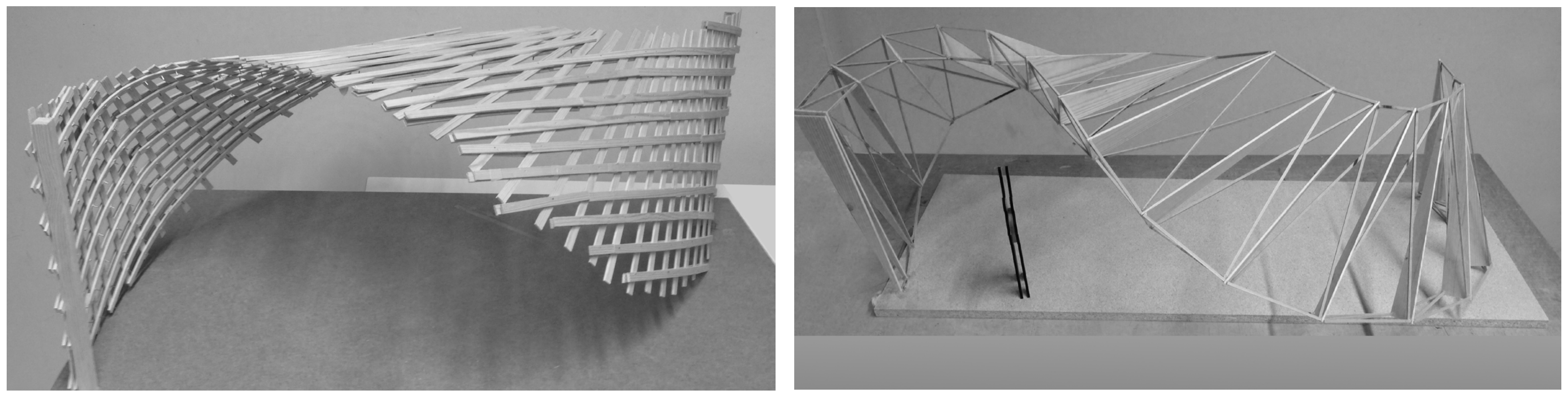


Figure 4: Structural studies examine different systems for constructing Kierre

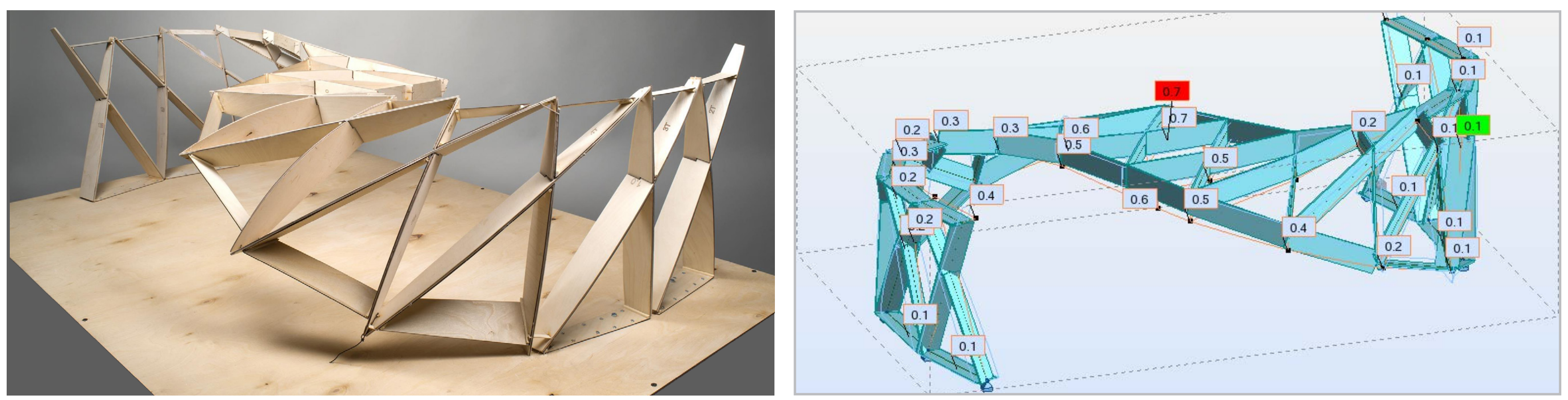


Figure 5: The selected structural system is examined by complex structural analysis

ARCHITECTUAL FORM AND STRUCTURAL ANALYSIS

Kierre in Finnish means twist. The initial idea of kierre is a twisted ribbon-like linear form (Figure 3). This twisted form creates a high level of complexity in structural analysis as well in production process. Several structural systems are studied for creating the intended form and one option is selected for advanced development and structural analysis (Figure 4 & 5). The developed system is composed of 14 stars, made up of two interlocked notched LVL (laminated veneer lumber) blades that fit into an edge beam through a tongue-and-wedge system (Figure 6).

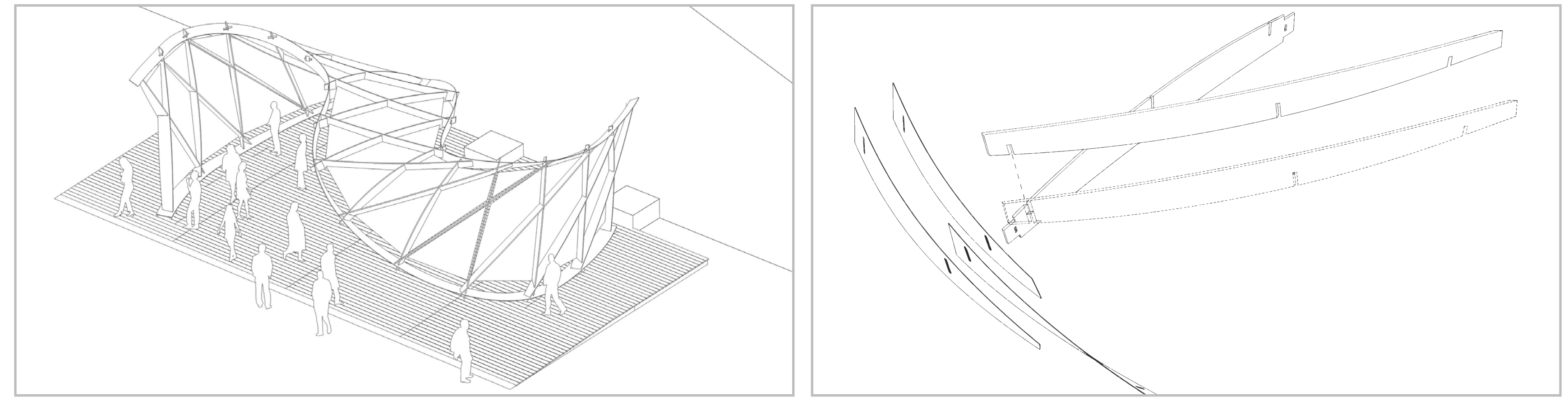


Figure 6: The final form of Kierre and the details of the joints between the blades and the edge beams

Figure 7: The CNC-cutting process and cut, labaled parts of Kierre ready to transfer to the workshop

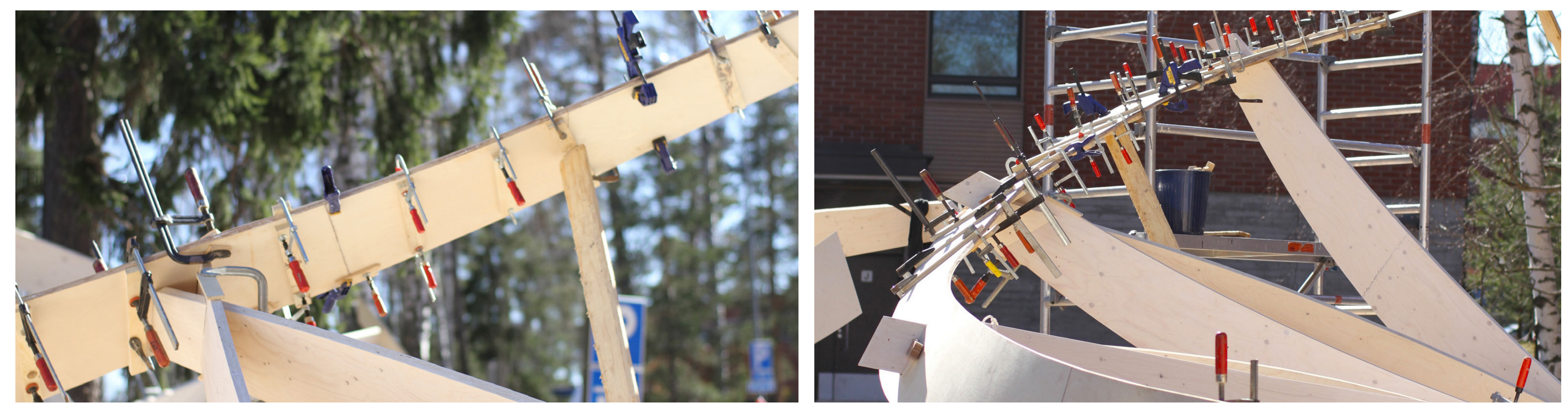


Figure 8: The process of pre-assembly of the structure in three main modules

MANUFACTORING PROCESS

In order to produce the neat exact form, accurate cutting of the wooden pieces and their joint is essential, CNC-cutting is employed for this purpose. The end result is a ready-to-assemble kit of 120+ unique interconnecting elements (Figure 7).

The ready and detailed labled kit of the pieces is then transported to the workshop for a pre-assembly process.The manufacturing process includes a lot of gluing and clamping of the edge beams that are made of three layers of birch plywood (Figure 8).

TRANSPORTATION AND ON-SITE ASSEMBLY

Very tight on-site time constraints pushed the assembly process to be inseparable from the design. While pre-assembly of the structure in three main modules got done in the workshop, the modules were transported to the site and assembled together (Figure 9).

Figure 9: Transportation and on-site assembly

DETAILS OF THE FINISHED PRODUCT

The structural system includes both the joint connecting the blades, and a construction jig that held each piece at its correct position (Figure 10). The final assembly includes a skin for shading made of woven polyester base cloth with weldable PVC coating, metal plate footings of the structure and a 150 m² heat-treated spruce ramp that leads to the main Pavilion (Figure 11 & 12).

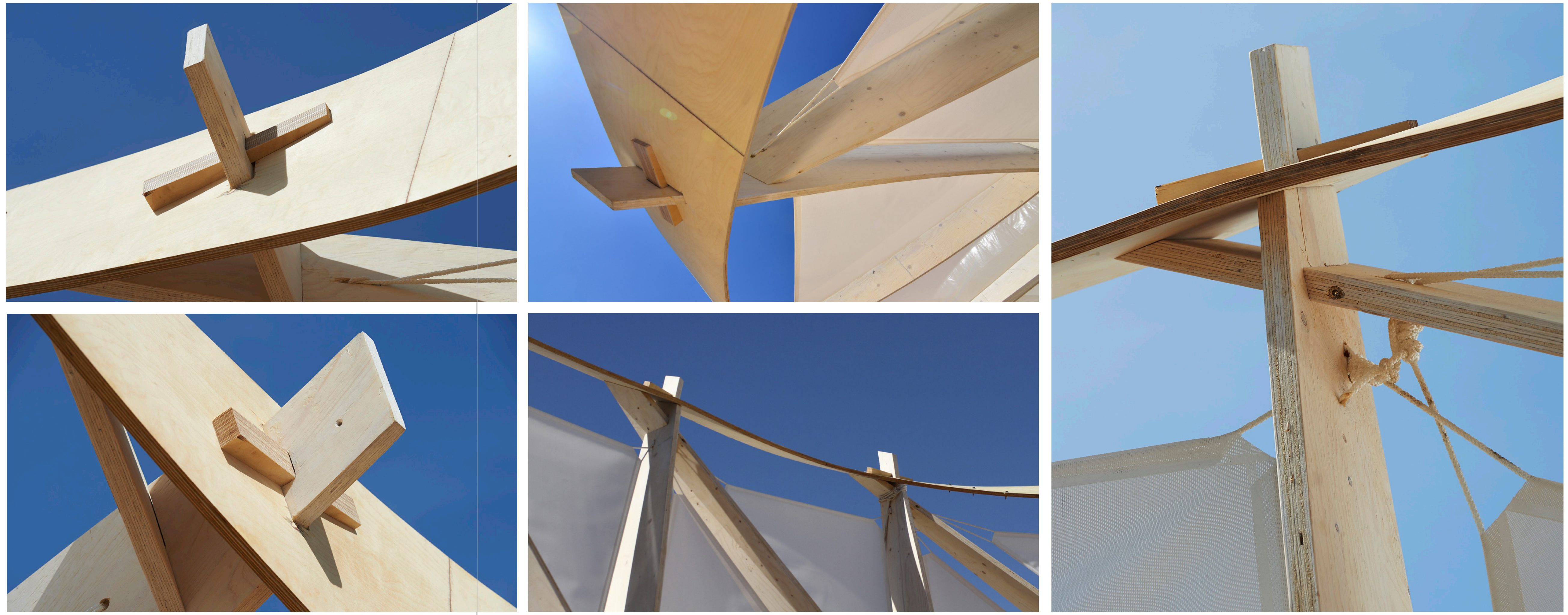


Figure 10: Joints details, joints between the star blades and the edge beams

Figure 11: A skin made of woven polyester cloth provides shading for the structure

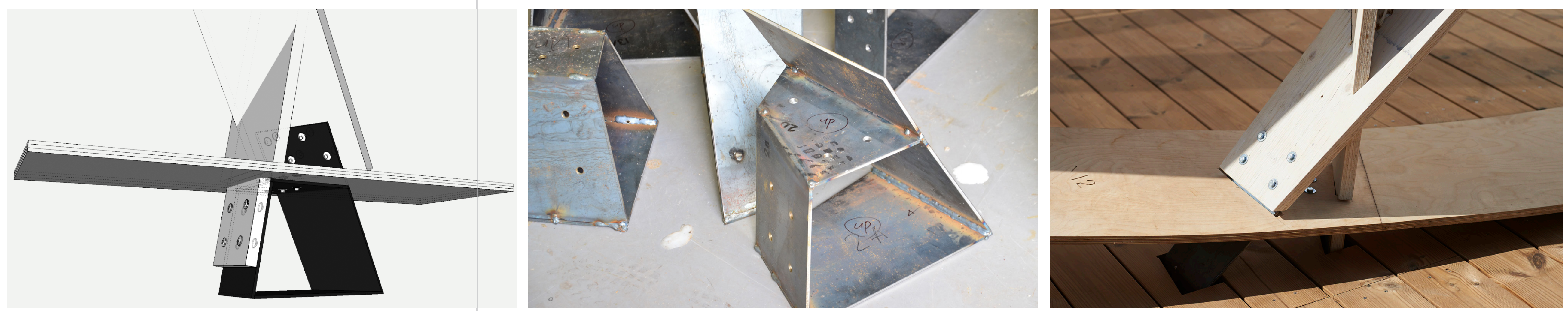


Figure 12: Metal plate footing provides the stability and weave the structure into the ground

THANK YOU FOR YOUR TIME!

FAHIM.FOT@GMAIL.COM