Architectural Portfolio

Selected works

Aniket Sonawane

B - Arch (Mumbai University)

Masters in advanced architecture - MAA 02 (Iaac - Barcelona)

Contents

1. Introduction and resume

2. Designing

Academic 2.1 *Proxima area verde*

Academic 2.2 *Lights of fortune*

Academic 2.3 *Falling water 2021*

Academic 2.4 *Climb*

Professional 2.5 *Urban housing*

3. Fabrication

Academic 3.1 *Time*

Academic 3.2 *Robotic stereotomy*

Academic 3.3 *Print and place*

My name is Aniket Sonawane. I've completed my bachelors of architecture (B-Arch) from Mumbai University and recently completed my Masters in advanced architecture (MAA-02) from the Institute for Advanced Architecture, Catalonia, Barcelona.
I have worked for 2 years and gained experience in designing residential projects, from private bungalows to residential building complexes.
During my master's degree, I learned computational and parametric design, as well as digital fabrication of these algorithmic complex geometries.
Currently, my interest lies in using parametric design and advanced construction strategies in the built environment we live in.

Aniket V Sonawane

Masters in advanced architecture - MAA02
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Education

2020 - 2022
MAA - 02 (Masters in Advanced architecture)
Institute for Advanced architecture Catalunya (IAAC Barcelona) .

2012 - 2017
B.Arch.
Hiray college of Architecture (Mumbai University, Mumbai).

Research

2021 - 2022
Print N Place.
Thesis research on developing clay 3D printed interlocking blocks for compressive structures.

Award

2021
Institute for advanced architecture Catalunya
Sulf sufficient building award - Best studio project

Experience

2018 - 2019
1 year
Junior Architect in M. S. Bakshi and Associates (Thane).
Designed various residential apartment buildings according to by laws of Thane.

2017 - 2018
1 year
Junior Architect in M.A.D.S (Morphogenic Architectural Design Studio) (Pune).
Designed private residences and interiors.

2016
4 months
Intern at ADS4 Architecture Design Studio(Bangalore) Ar. Durga Prasad.
Facade designing for residential buildings and site visits for on-going projects

2015 - 2016
4 months
Intern at RamamurthiHombaliAssociates (Bangalore) Ar. Arunachal Hombali.
Conducted various surveys and gathered data for urban designing of Indian institute of Science , Bangalore

Skills

Software
Rhino
Grasshopper
Revit
Auto Cad
Sketch Up
Animations and video editing
Premier Pro
Rendering and visualisation
V - Ray
Lumion
Adobe creative suite

Fabrication
Robotic arm manufacturing
Concrete and Clay 3D printing
Lazer cutting
CNC milling
3D printing
Physical modeling

Languages
Marathi (Native)
Hindi (Fluent)
English (Fluent)
Spanish (Learning)

Workshops

2015 *LBC - Laurie baker workshop on sustainable low cost building technology*
2016 *Earth institute - Understanding compressed earth blocks.*
2019 *Desing intervantions - Online workshop for rhino and grasshopper*
2018 *Climate consultant - Online workshop for climate analysis for architecture.*

2.1 PROXIMA AREA VERDE

The architecture of algorithms

Project discription

Studio project - Iaac
Objective is to design using continous minimal surfaces.
Software - Rhino, Grasshopper (Mesh subd)
Digital fabrication - Lazer cutting
Material - polypropylene sheet

Abstract

Proxima area verde - The next green space

Proxima Area Verde is the next green area and cultural habitat located in Poble Nou. The project is understood to be an extension of an extensive network of green spaces and biodiversity within the city of Barcelona, following the development movement of Placa de les Glories. With this intervention, we intend to build an open space for people from creative and cultural disciplines to work, exhibit, and introduce their creations into the public realm. Using the methodology of continuous surfaces, and using tools for complex forming and other tools of algorithmic architecture, we attempt to create a space, that in its character expresses the qualities and complexities of a jungle. The jungle, as we know, is the most biodiverse space on our planet, and we try to incorporate three of its distinct characteristics – Entanglement, Permeability, and Layers. The objective is to identify the difficulties and constraints offered by the site, to turn them into opportunities, and to develop programmatic interventions to overcome them. With that in mind, we also attempt to bridge the gap between the two neighborhoods—both physical and cultural. With Proxima Area Verde, we marry the cultural aspect of the typology to the green aspect of the morphology by developing a sustainable green space using bio-receptive concrete for the structure to facilitate the growth of bryophytes (moss) to tackle environmental problems such as air pollution and urban heat islands.

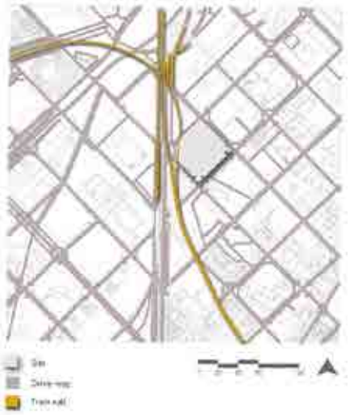
Scan !!!

Animations and blog post

Site analysis

Vehical and pedestrian movement

Train route



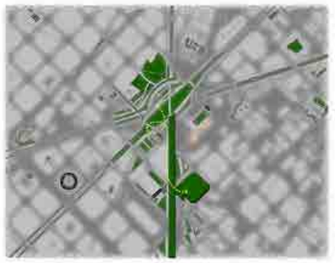
Bus stops

Footpaths

Opportunities

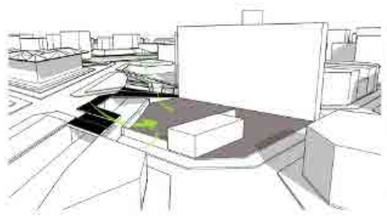
Green infiltration

1. Disconnect between the two sides of the Diagonal.
2. Site is a neglected space waiting to be a part of the green axis with Glories.
3. According to Barcelona green infrastructure and biodiversity plan, Site is marked as the next green area.



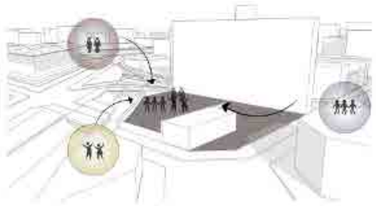
Bridging the gap

1. Major level difference around the site due to the tram line.
2. Issue of road block.
3. Pedestrian access only on one side.



Public engagement

1. Lot of artistic spaces in Poblenou because of the 22@ plan. But they are limited and formal spaces.
2. There is a potential on the site to create a congregation for artists.



Objectives

1. Become a part of the green line across Glories as the Proxima Area Verde.
2. Convert this neglected space and merge it with the green corridor.

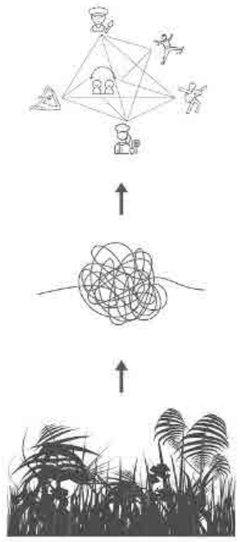
1. Connect the levels around the site.
2. Fix the issue of road block
3. Connect it using audio+visual means.

1. Locate and identify the different activities around the site.
2. Bring in different activities and congregation spaces on the site.

Concept - Jungle

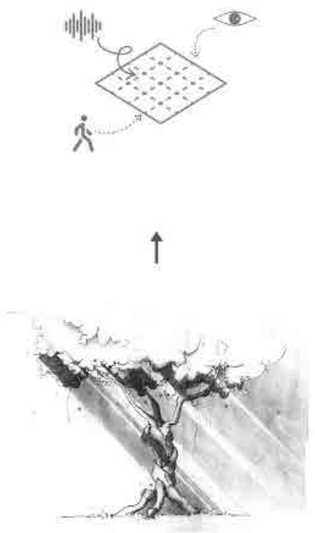
The jungle is the most bio-diverse region on the earth and all the plants and animals help eachother matain the ecosystem.
Entanglement, Permiability and layers are some major characteristics of the jungle.
Like every organism resonates withwith every element of nature, the structure also entangles itself with the nature.

Entanglement



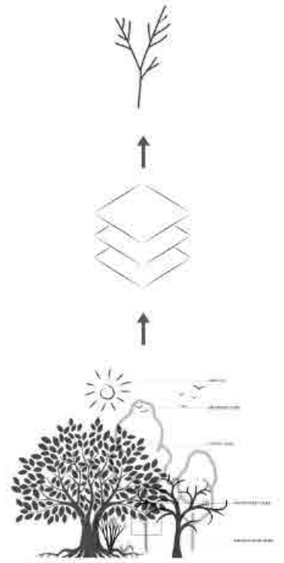
Derieved into program

Premiability



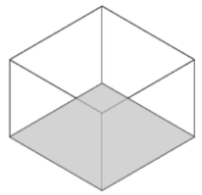
Derieved into objectives

Layers

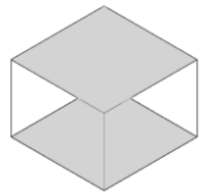


Derieved into design

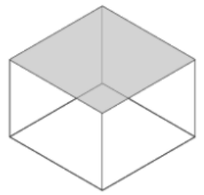
Program



Floor



Floor and Roof

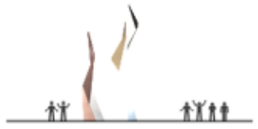


Roof

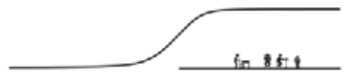
The floor acts as pathways, Dog walk-ways, connection of the gap outside the site

The spaces where floor and roof merge can act as gallery and exhibition spaces

The roof forms the green channel accross the site connecting the bigger scale Glories project



The spaces without roof can act as open air theatres or spaces for art installations.

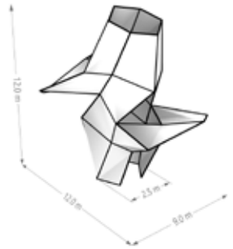


Spaces where Floor and Roof exist act as leisure and refreshment areas with cafeterias and congregation spaces

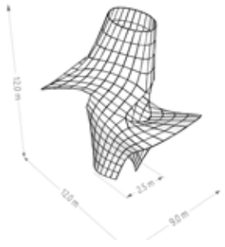
The roof also acts as ramps, connecting the different layers of the site

Initial form development

Form development in lowpolygon



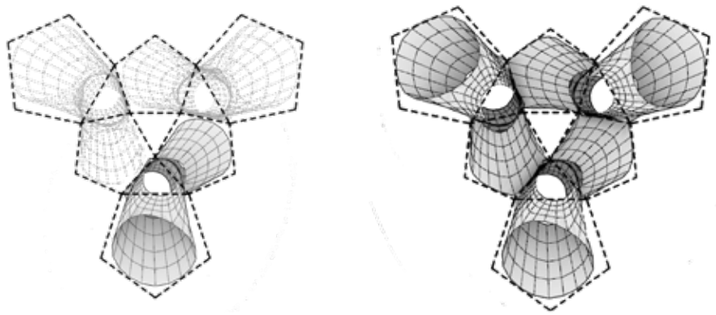
Lowpolygon form



Highpolygon form

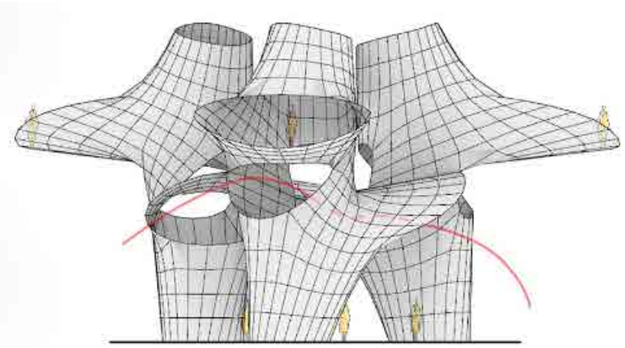
Strips (u direction) *Strips (v direction)* *checkerboard* *Valence* *Curvature*

Aggrigation methodology

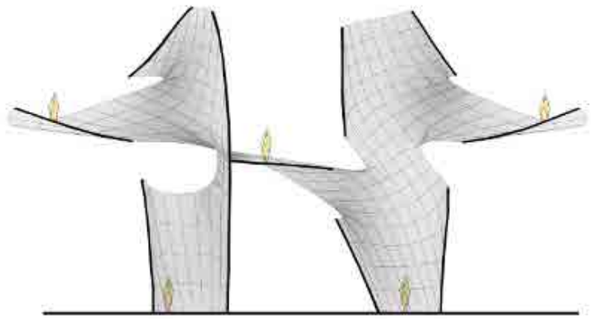


Final aggrigation

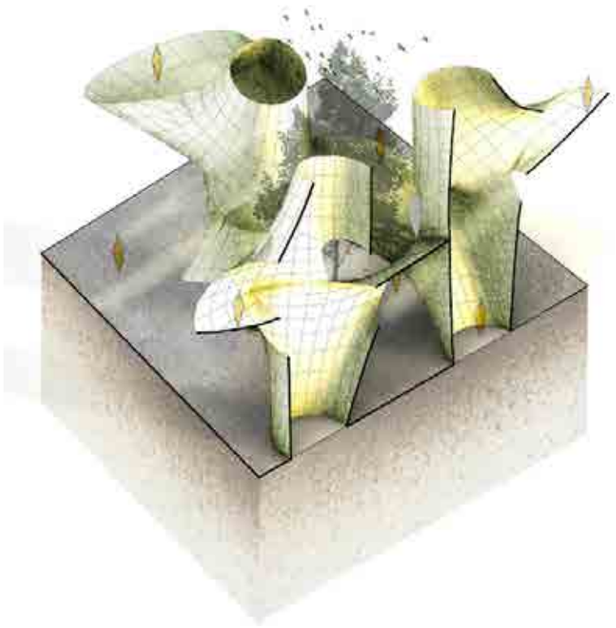
Strips (u direction) *Strips (v direction)* *checkerboard* *Valence* *Relaxed mesh*



Model visualisation



Section

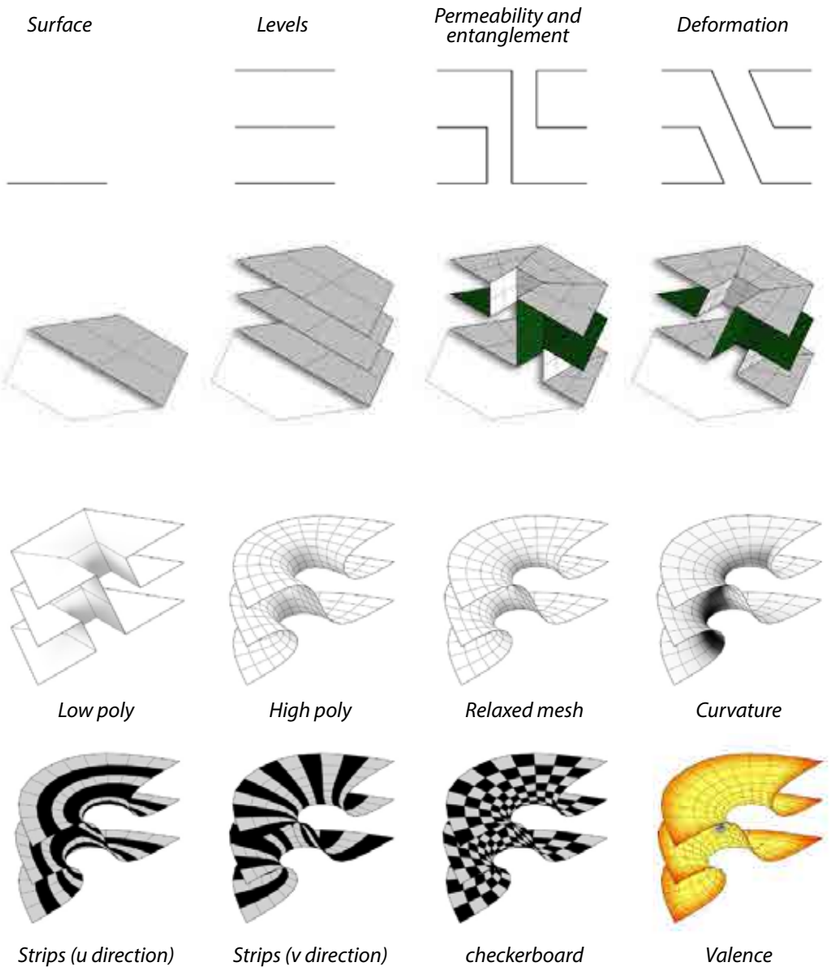


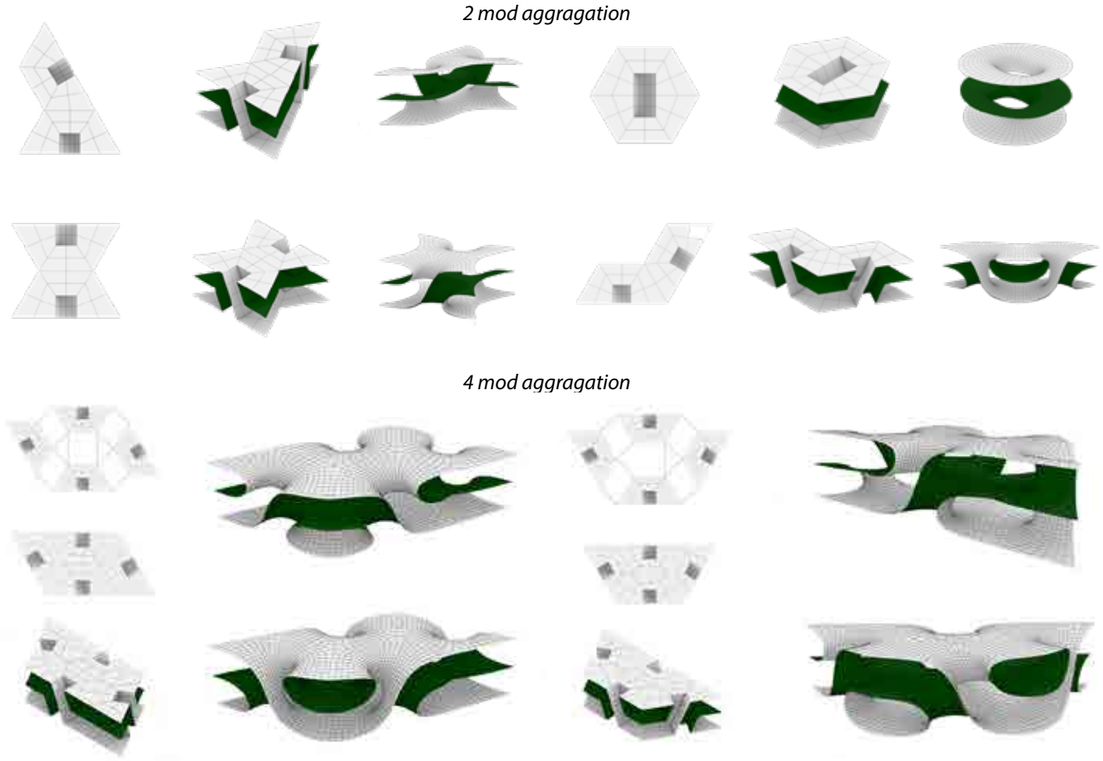
Model visualisation

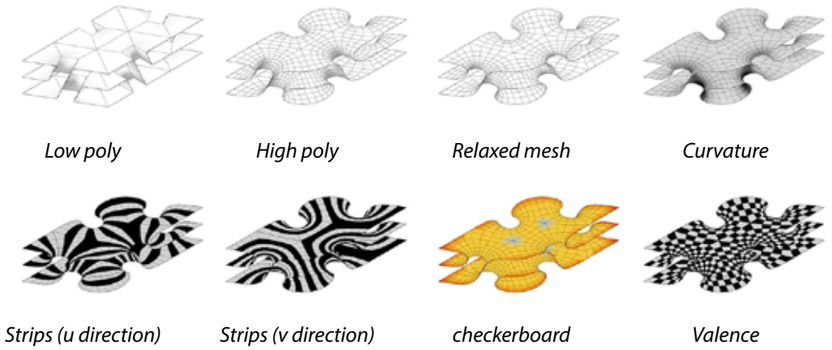
Prototypy

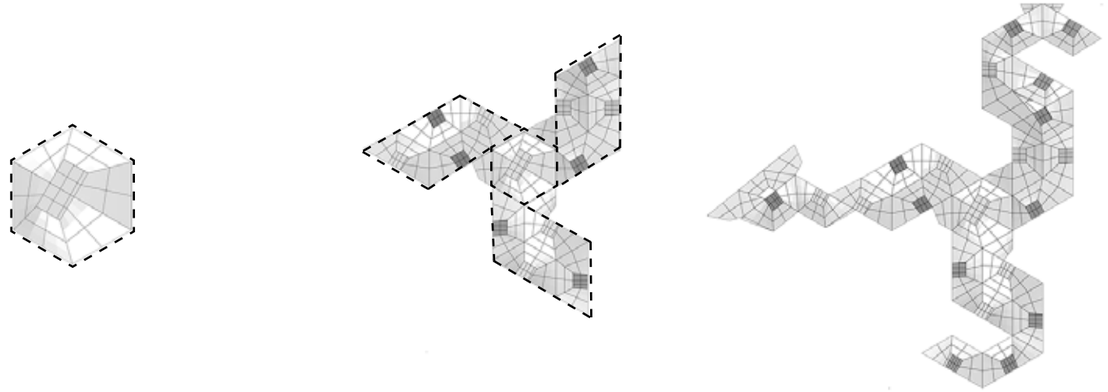
Material : Polypropylene transparent (1050x 750)mm - 2 sheets
Number of strips : 25 + 27 (52 strips total in both directions combined)
Number of holes : 432
Connectors : 280
Cut time : 1.5 hours
Assembly time : 4 hours
Final model dimensions : 290 L x 145 W x 350 H

Design development





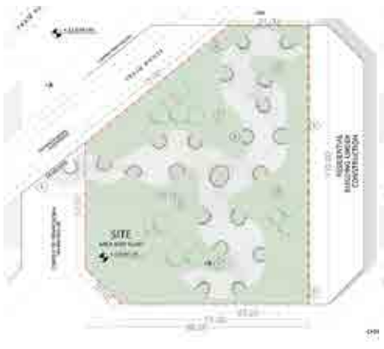




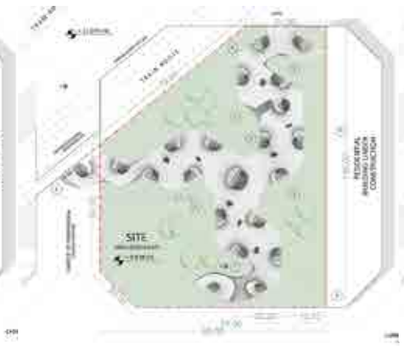
Site

3 directional access

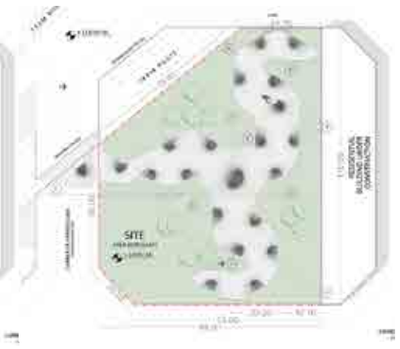
Bridging the gap



Ground level plan



First level plan

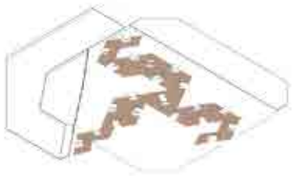


Roof plan

Ground lvl

First lvl

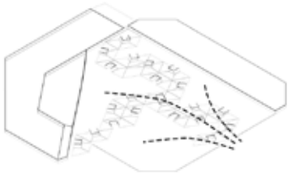
Second lvl



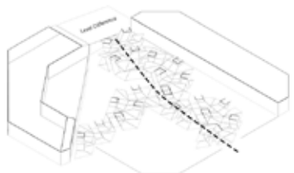
Leisure and commercial space

Perfoemance and visual space

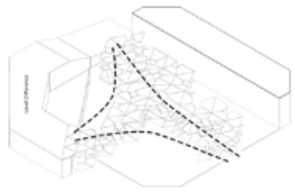
Green park



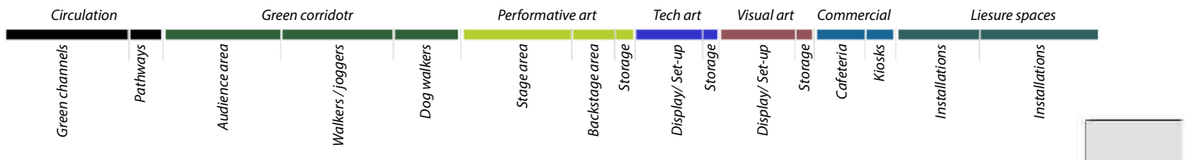
Ent to park and sapces

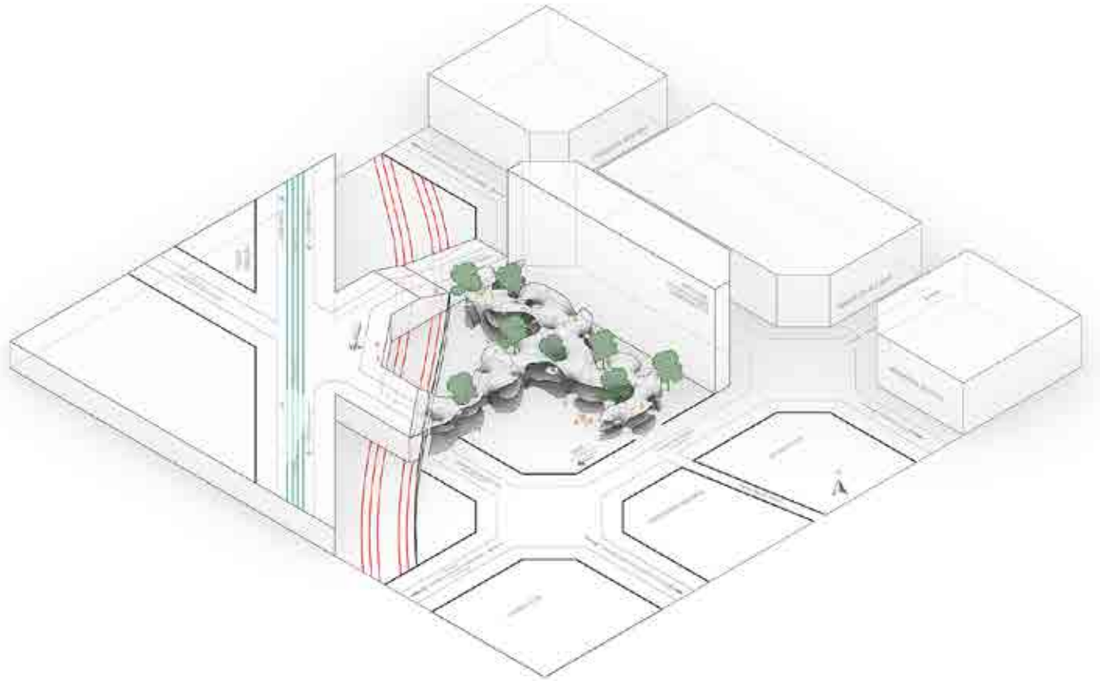


connecting Ent and bridge



Connecting all levels





Axonometric view

2.2 LIGHTS OF FORTUNE

After Gaudi

Project discription

Studio project - Iaac
Objective is to design by carving out the shape of hyperboloid from a wall to optimise radiation and light.
Software - Rhino, Grasshopper
Physical Fabrication - Sculpting
Material - polypropylene sheet

Abstract

Lights of fortune

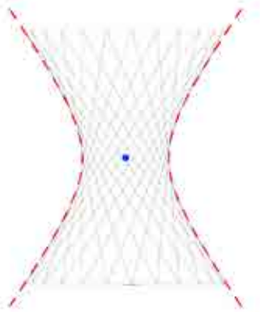
A hyperboloid, or hyperbola in revolution, is a shape generated by revolving a hyperbola around a center. The hyperboloid is a self-supporting shape and is primarily used as a structural member for its excellent load distribution properties.
Contrary to traditional architectural thinking, Antonio Gaudi implemented hyperboloid in a totally different way. In Gaudi's eyes, the hyperboloid is perfect for light passing through because of its funnel-like shape with two wide-open ends. He placed hyperboloid structures either on the walls or roofs as windows, serving for illumination. When light comes from the exterior, it is first compressed and then diffused into the interior.
The project Lights of Fortune uses this concept to derive light for the exterior to get diffused light to create a pleasant ambience in the interior in the harsh sun of Singapore, as well as get direct light in a pattern for a divine experience.
The hyperboloids are used to carve the shapes in a wall to get the desired output by arranging the location distance and direction on the wall using advanced computational design to achieve a geometric pattern that is not only beautiful but serves the purpose of radiation optimization.
The designing wall is physically fabricated using sculpting techniques, then arranged by cutting and combining to get the geometry with the triple point.

Scan !!!

Animations and blog post

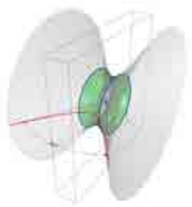
Understanding hyperboloid

The curve obtained by rotating one of the two circles or ellipse connected together is called hyperbola. By revolving this curve, we get a shape called a hyperboloid. Hyperboloid structures are double curved and are simultaneously curved in opposite directions. They are very resistant to buckling. By intersecting these hyperboloids and carving the space inside, we get interesting patterns that can be used architecturally. By understanding its ruled surface properties, we carve the hyperboloid to fit together to make a facade.

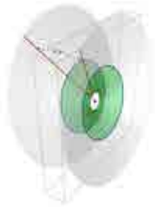


Hyperbola

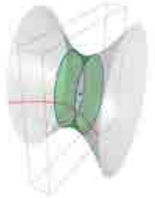
Intersection possibilities of hyperboloid with wall



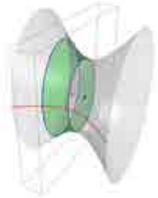
Same center and radius



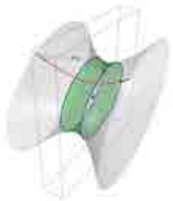
Small center raduis



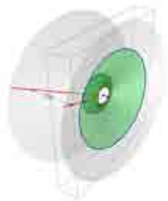
Raduis a > b



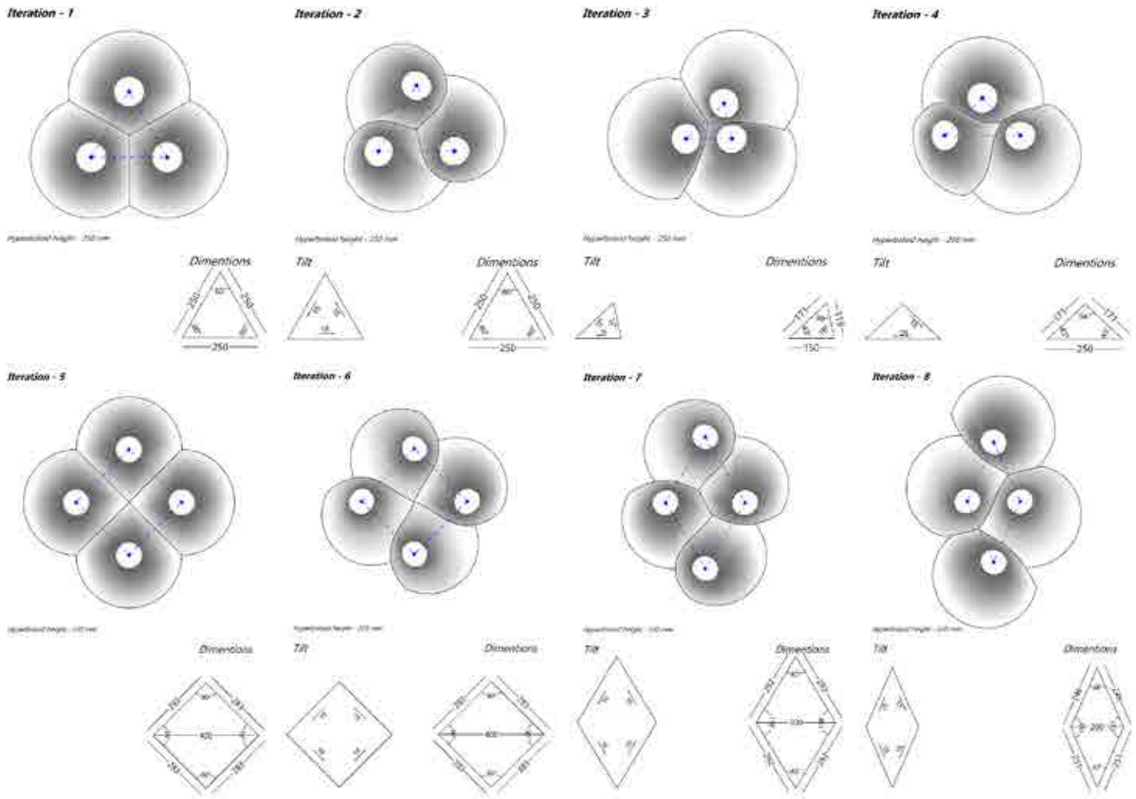
Offcenter Raduis a > b



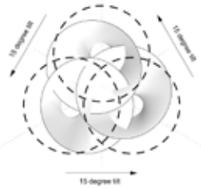
Rotation of hyperboliod



Offcenter Rotation of hyperboliod



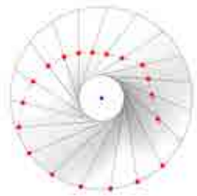
Intersect hyperboloids in an equilateral triangle



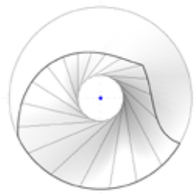
Tilt 15 degree inside

Trim intersecting surfaces

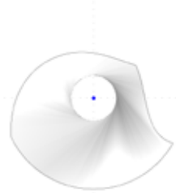
FInal geometry



Marking points on ruled surface lines



Cut the projected curve



Cut piece

FInal geometry

Hyperboloid shape crafted in CNC machine.

Rotate the form to prepare the mould.

Apply oil to mould to reduce friction.

Pour plaster to get the shell for hyperboloid.

Remove excess to reduce weight and for clean finish.

Remove the shell to get hyperboloids.

Get the rulled surface lines.

Measure and mark points. Connect the poinys to get the curve.

Cut to get the shape.

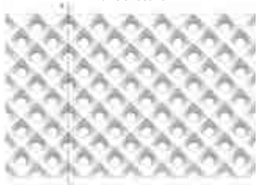
Crafting board with movable base for perfect attachment.

Get the perfect triple point and apply plaster for finishing.

Iteration - 1

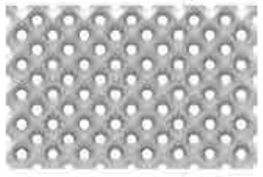
Grid

Hyperbola parameters
R1 - 3800, R2 - 5755, R3 - 200
Hyperbola angle - 0
Plane offset - 0

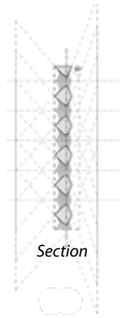


Front elevation

Wall parameters
Wall angle - 0
Wall thickness - 1200

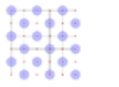


Back elevation



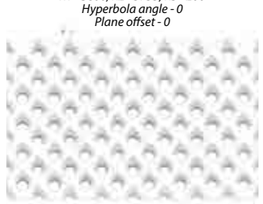
Section

Iteration - 2



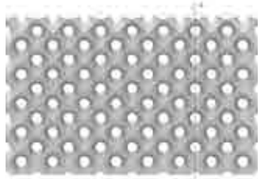
Grid

Hyperbola parameters
R1 - 3800, R2 - 5755, R3 - 200
Hyperbola angle - 0
Plane offset - 0

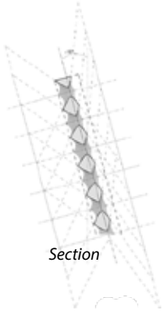


Front elevation

Wall parameters
Wall angle - 15
Wall thickness - 1200



Back elevation

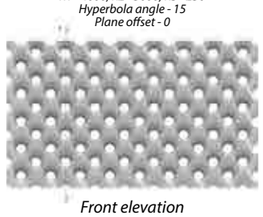


Section

Iteration - 3

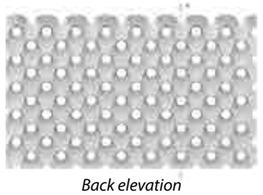
Grid

Hyperbola parameters
R1 - 4000, R2 - 5000, R3 - 250
Hyperbola angle - 15
Plane offset - 0

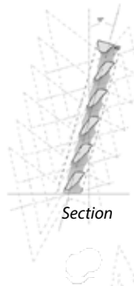


Front elevation

Wall parameters
Wall angle - 15
Wall thickness - 1200

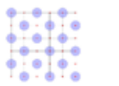


Back elevation



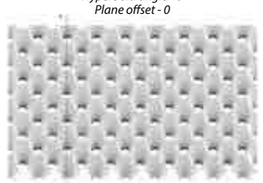
Section

Iteration - 4



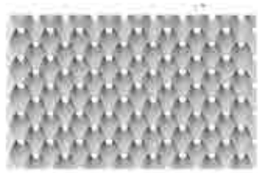
Grid

Hyperbola parameters
R1 - 4000, R2 - 5000, R3 - 200
Hyperbola angle - 0
Plane offset - 0

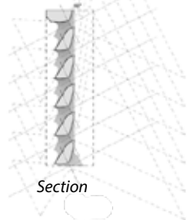


Front elevation

Wall parameters
Wall angle - 0
Wall thickness - 2400



Back elevation

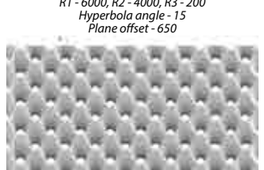


Section

Iteration - 5

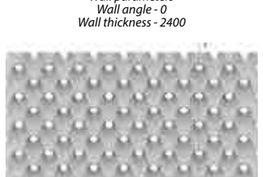
Grid

Hyperbola parameters
R1 - 6000, R2 - 4000, R3 - 200
Hyperbola angle - 15
Plane offset - 650

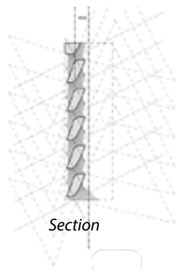


Front elevation

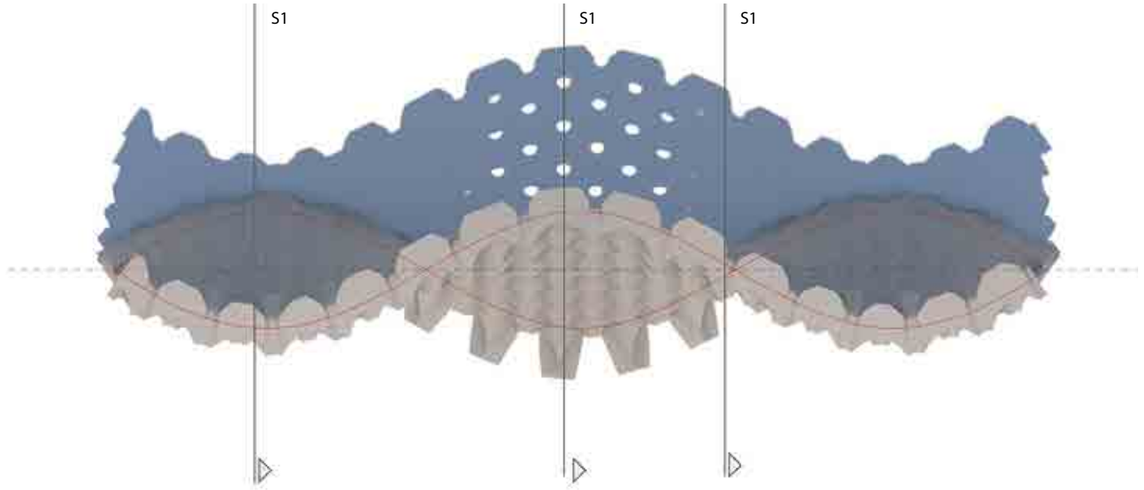
Wall parameters
Wall angle - 0
Wall thickness - 2400



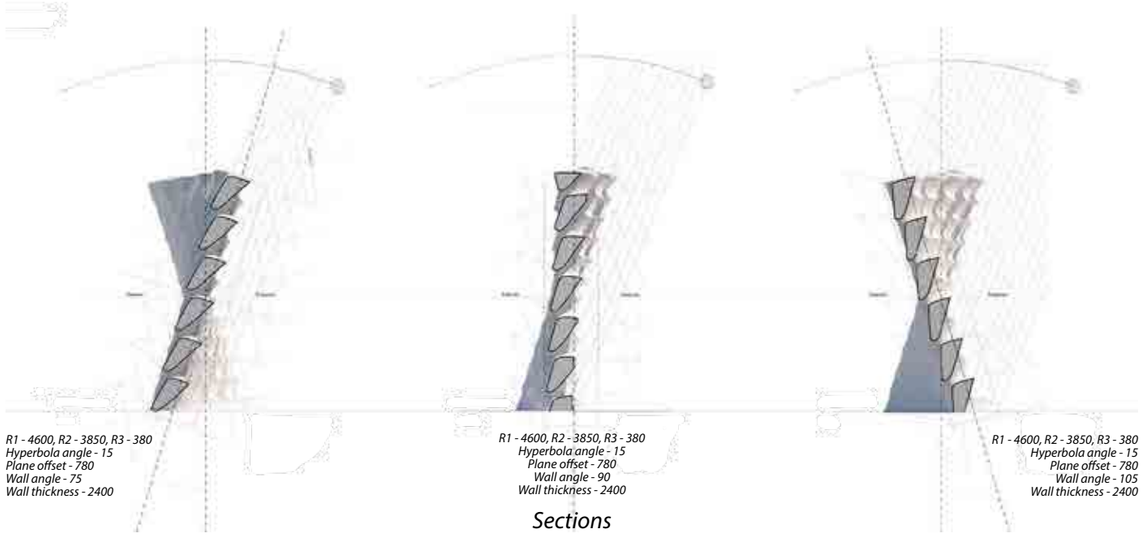
Back elevation



Section



Plan

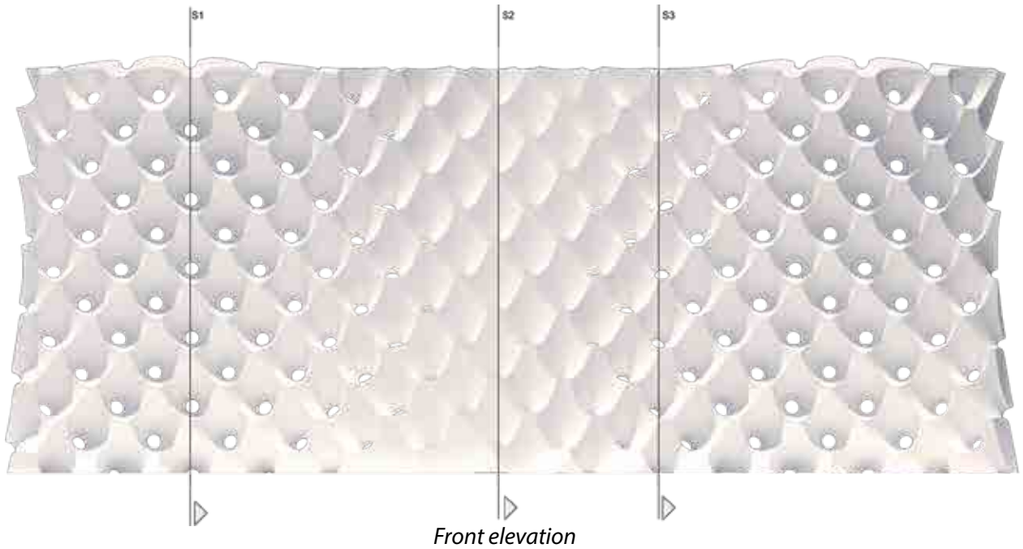


R1 - 4600, R2 - 3850, R3 - 380
Hyperbola angle - 15
Plane offset - 780
Wall angle - 75
Wall thickness - 2400

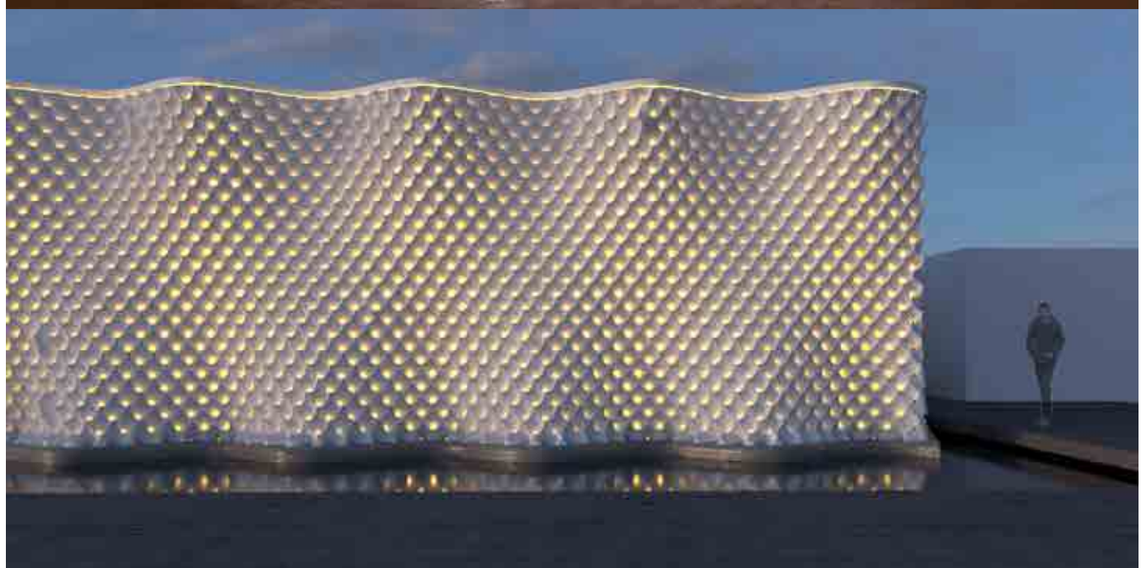
R1 - 4600, R2 - 3850, R3 - 380
Hyperbola angle - 15
Plane offset - 780
Wall angle - 90
Wall thickness - 2400

R1 - 4600, R2 - 3850, R3 - 380
Hyperbola angle - 15
Plane offset - 780
Wall angle - 105
Wall thickness - 2400

Sections



Front elevation



2.3 FALLING WATER - 2021

Self Sufficient Buildings - One^3 house

Project discription

Studio project - Iaac
Objective is to design and make working model of a house using a scientific phenomennon.
Softwares - Rhino, Grasshopper, Arduino
Digital fabrication - CNC milling and Physical programming
Materials - Burch Plywood and acrellic

Abstract

Falling water 2021 - Slef sufficient buildings

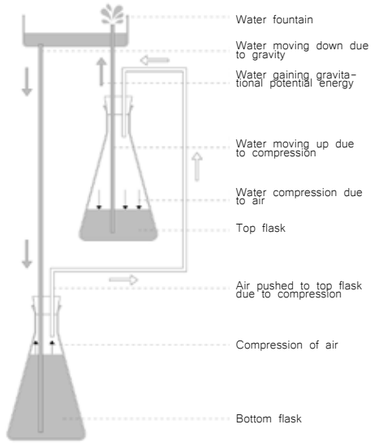
Falling Water 2021 is a group project done in the design studio of self-sufficient buildings in which the objective was to design a house for a man for a year by understanding a scientific phenomenon to implement in the building to make it self-sufficient in a way.
With water making up 70% of both planet earth and the human body, we dive into the relationship between human, architecture and water to explore the extent to which water can define the spaces we inhabit and our lifestyle in relation to it. Energy, being intangible, is difficult to visualize, but water holds the ability to carve, move, reflect, and respond, and its power is a medium with which we can make this energy evident. We explored the phenomenon of gravitational potential energy in order to circulate water and to shape a new way of living in response to the environment.

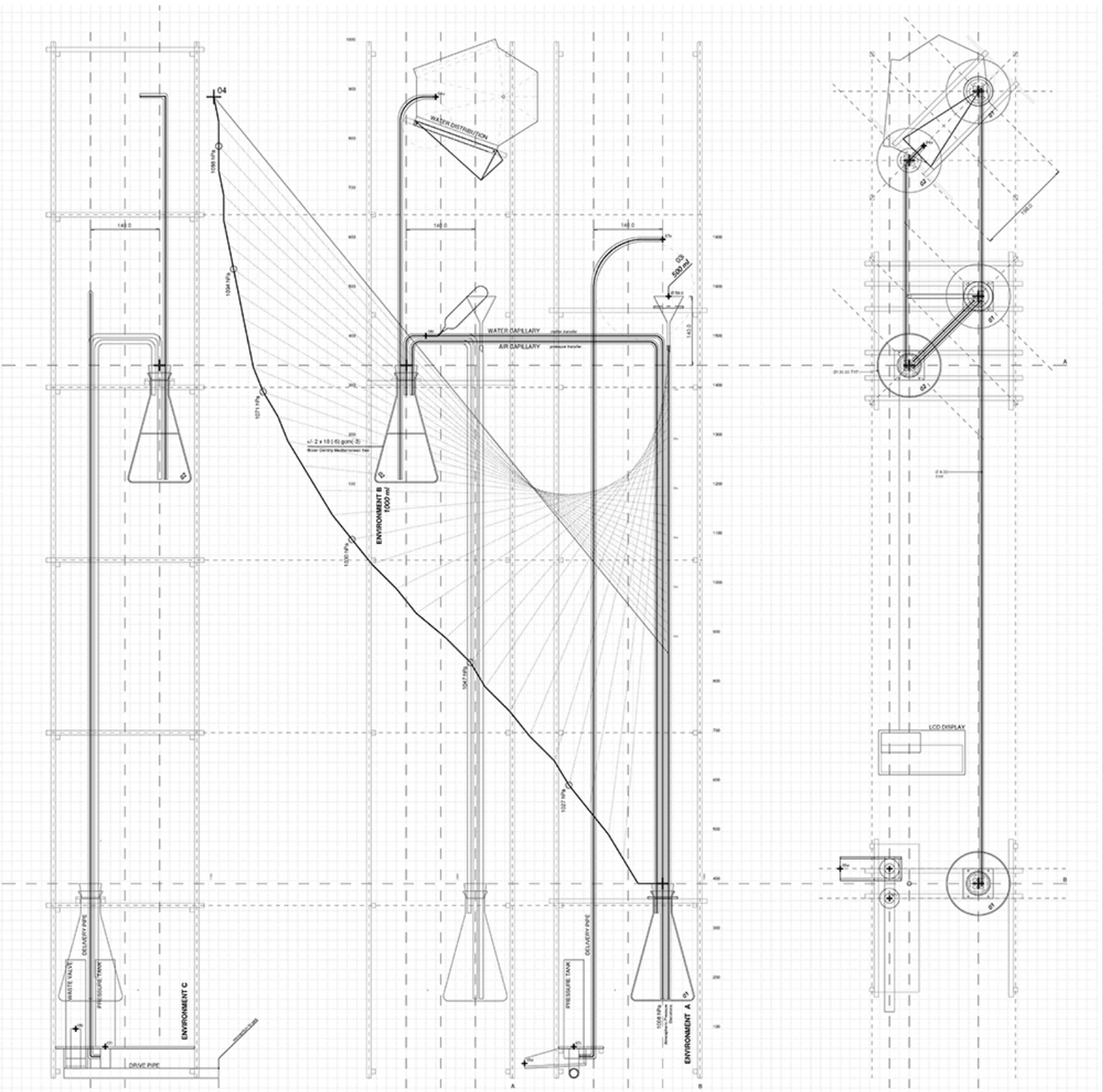
Scan !!!

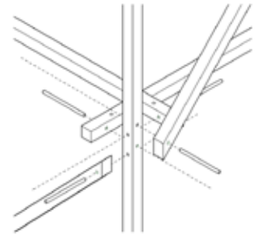
Animations and blog post

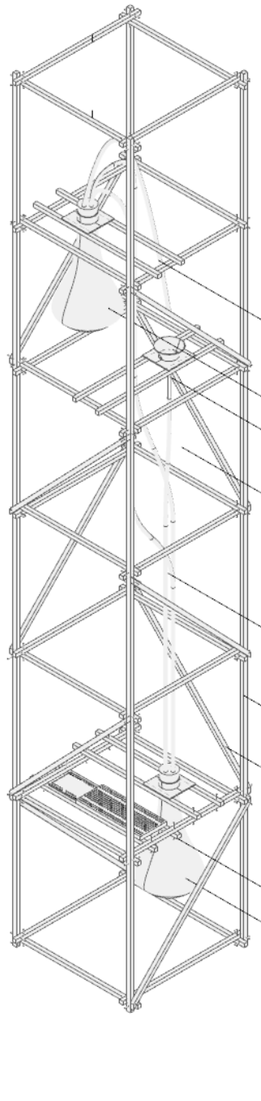
Working drawing of experiment

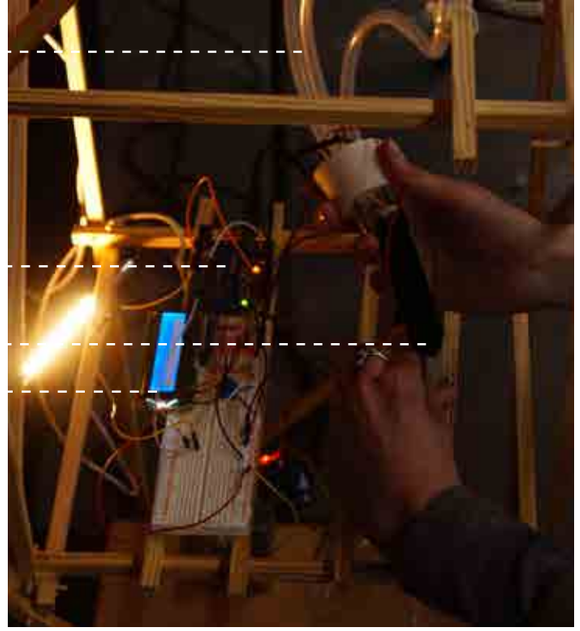
Gravitational potential energy is the energy stored as a result of its vertical position or height. Hence, the greater the height, the higher the energy. We explored the potential of this phenomenon through a hydropneumatic water system. With this system, we are able to circulate water vertically while optimising the distance and speed at which the water can travel.





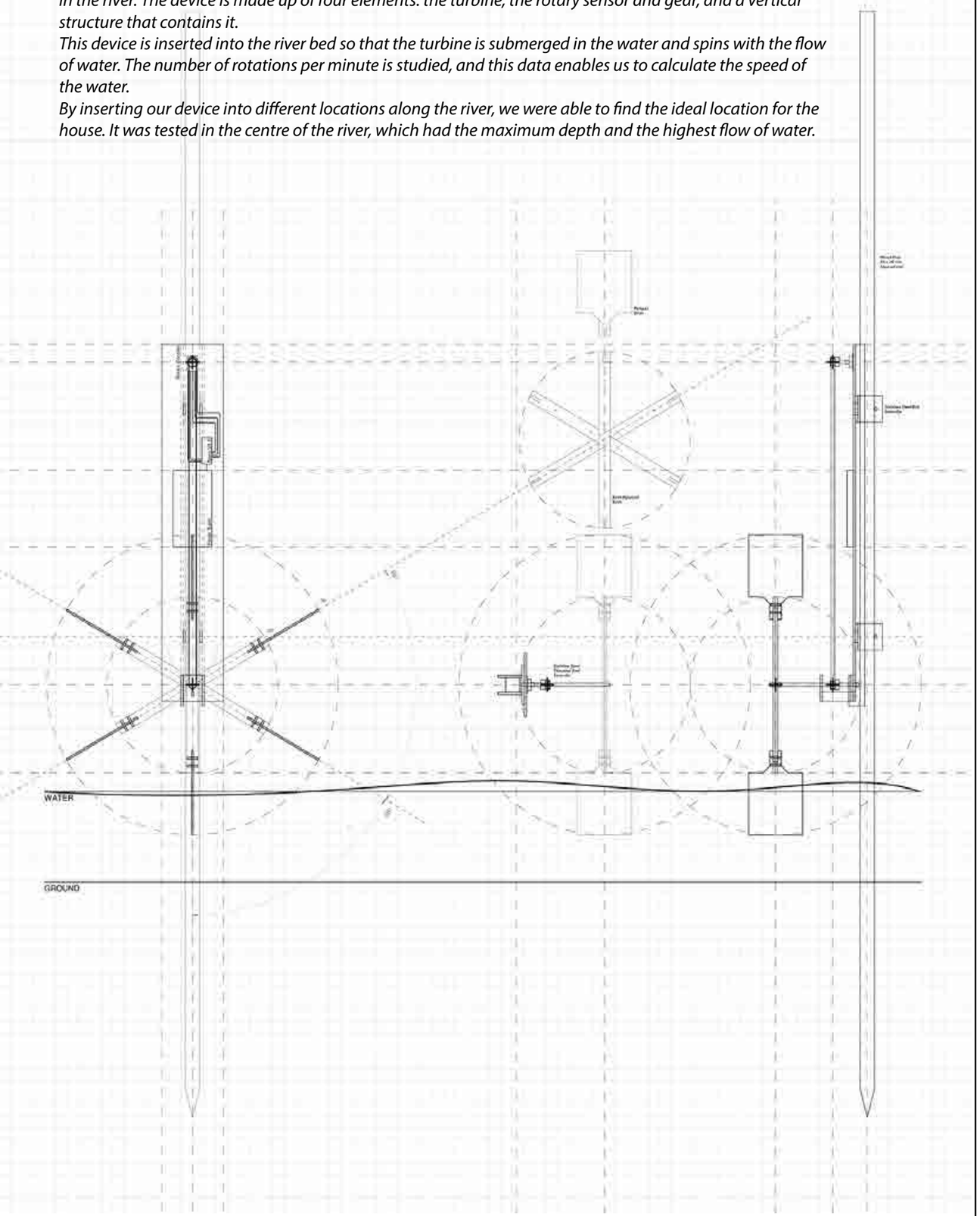


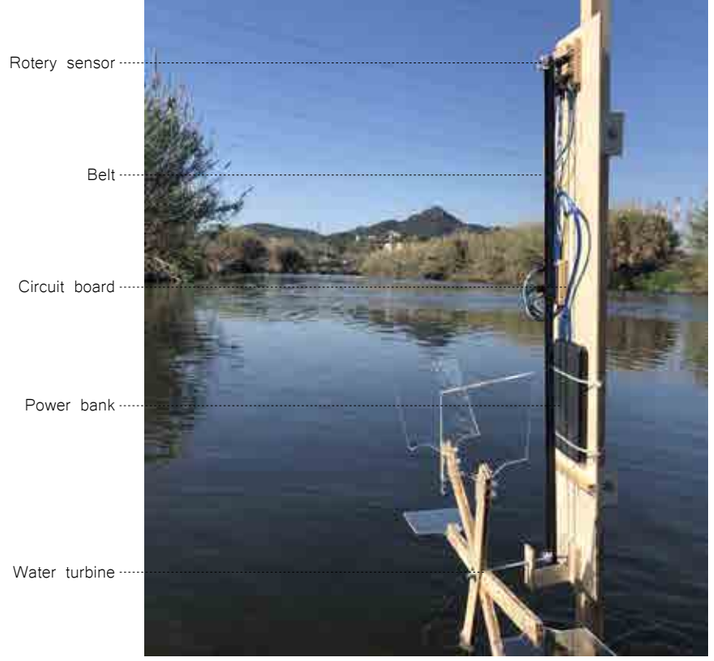


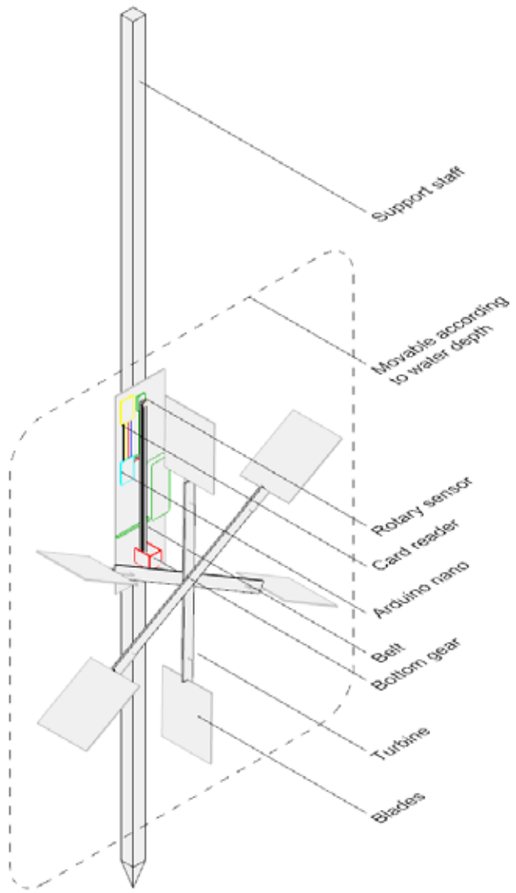


Working drawing of turbine

To literally 'test the waters' we were stepping into, we designed a device to calculate the speed of water in the river. The device is made up of four elements: the turbine, the rotary sensor and gear, and a vertical structure that contains it.
This device is inserted into the river bed so that the turbine is submerged in the water and spins with the flow of water. The number of rotations per minute is studied, and this data enables us to calculate the speed of the water.
By inserting our device into different locations along the river, we were able to find the ideal location for the house. It was tested in the centre of the river, which had the maximum depth and the highest flow of water.





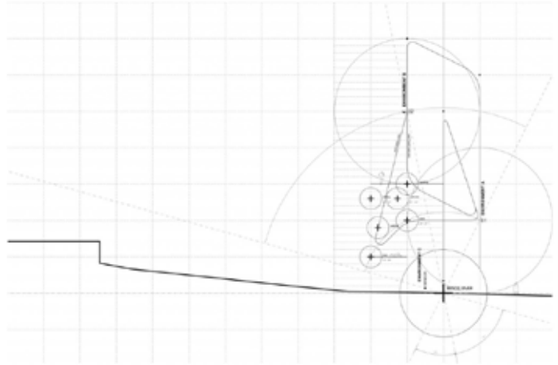


Design iteration 1 - One ³ house

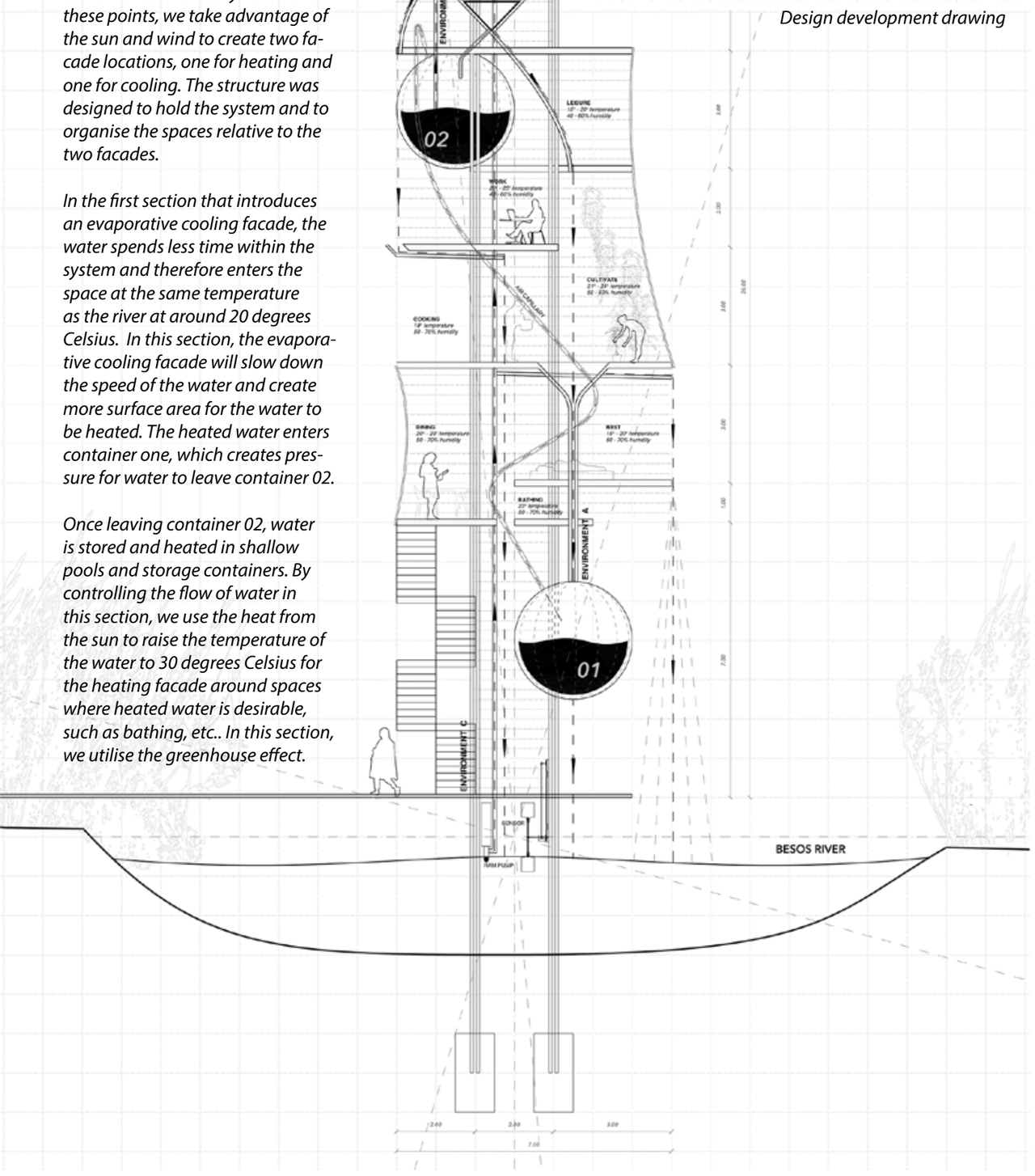
At two points within the cycle, the water leaves the airtight containers and interacts with the surrounding environment and climatic conditions. These two areas, therefore, have the greatest impact on the internal spaces and how long the water remains in the system. At these points, we take advantage of the sun and wind to create two facade locations, one for heating and one for cooling. The structure was designed to hold the system and to organise the spaces relative to the two facades.

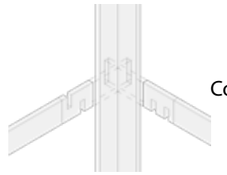
In the first section that introduces an evaporative cooling facade, the water spends less time within the system and therefore enters the space at the same temperature as the river at around 20 degrees Celsius. In this section, the evaporative cooling facade will slow down the speed of the water and create more surface area for the water to be heated. The heated water enters container one, which creates pressure for water to leave container 02.

Once leaving container 02, water is stored and heated in shallow pools and storage containers. By controlling the flow of water in this section, we use the heat from the sun to raise the temperature of the water to 30 degrees Celsius for the heating facade around spaces where heated water is desirable, such as bathing, etc.. In this section, we utilise the greenhouse effect.

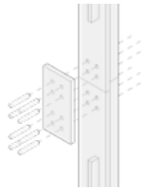


Design development drawing



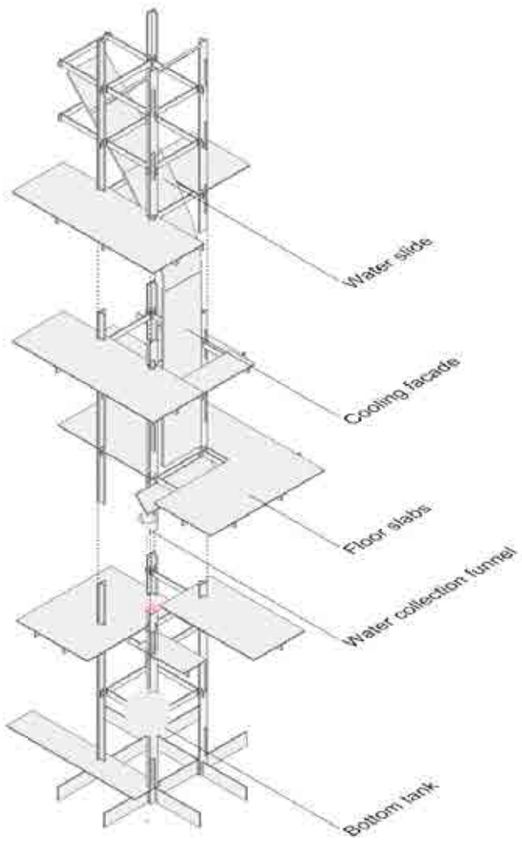


Column to beam connection



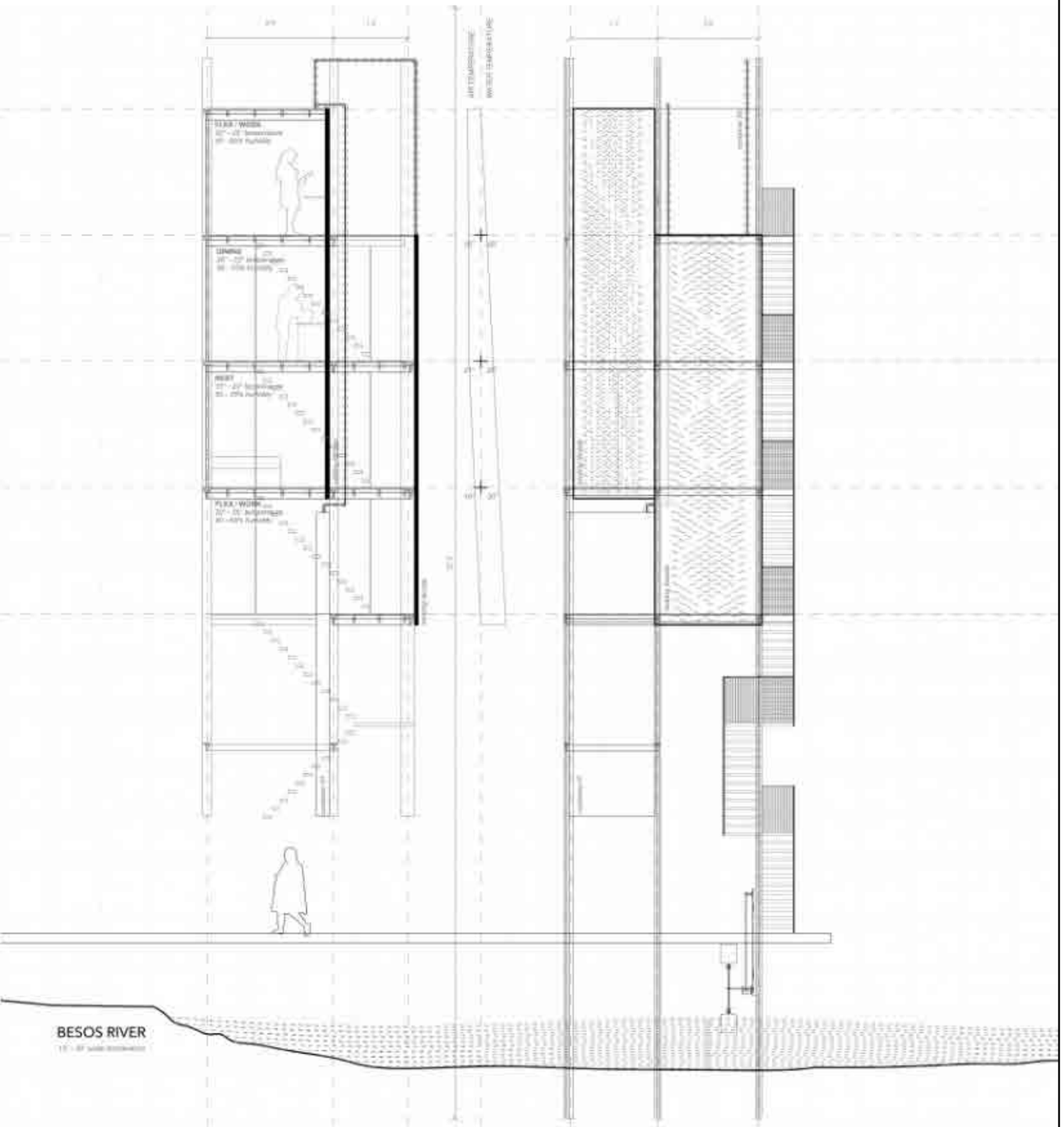
Column to column connection

Model to base connection

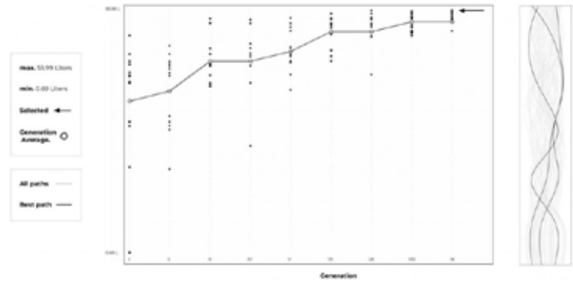


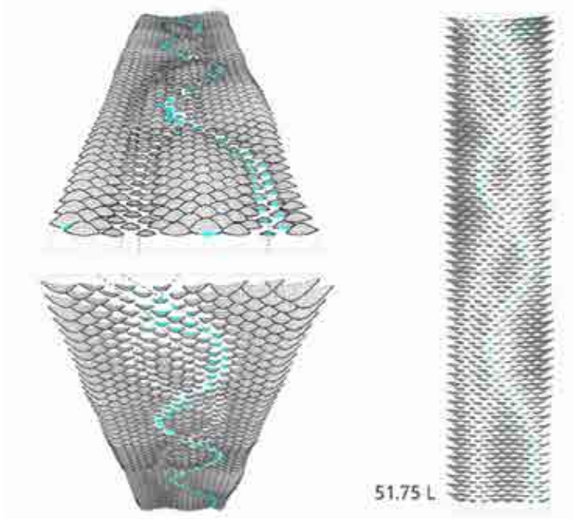
Fallign water 2021 - One³ house

We designed our own evaporative cooling facade to reduce the speed at which water flows through it and to control the path of flow to the desired locations. By testing the same quantity of water against time, we derived the shape of the pattern within the facade.
The facade was designed parametrically to relate to the spaces within the house. The spaces, which need to be cooled more, have a denser pattern to hold more water. The Genetic Solver evaluates thousands of iterations to find the maximum amount of water that the facade can hold while falling. The graph indicates all the different possible solutions of the genetic solver.



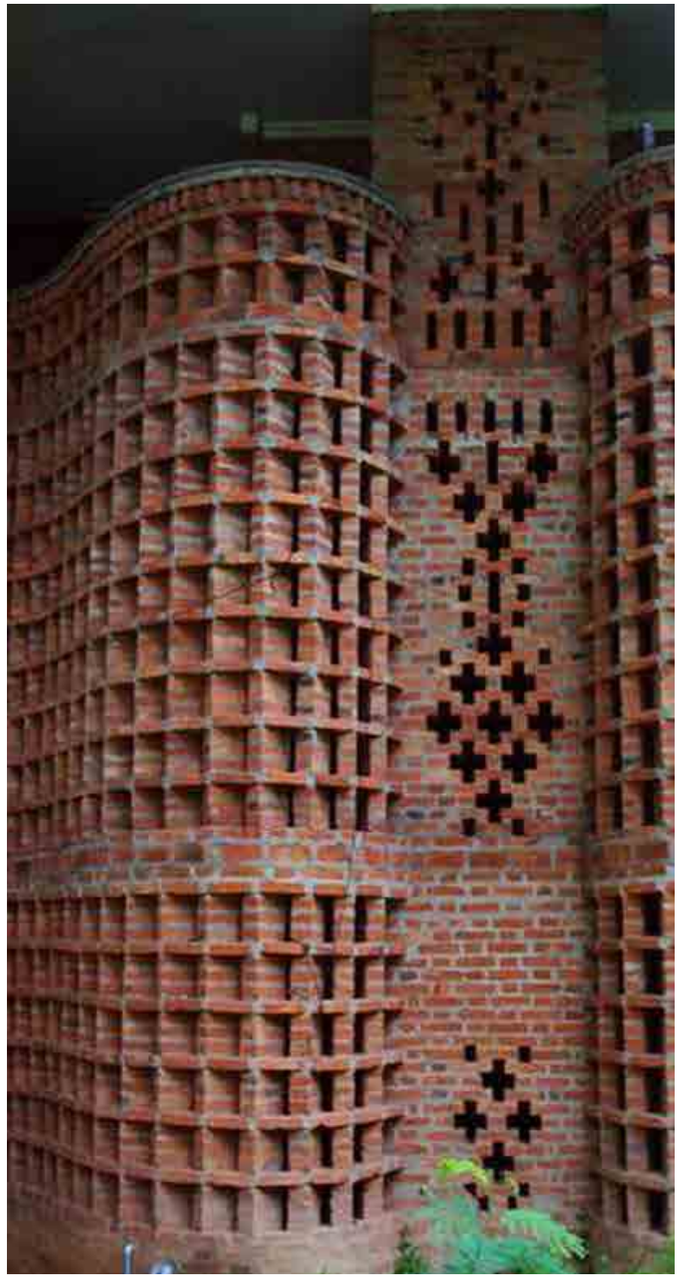
To what extent can water define the space we inhabit and can our lifestyle revolve around changes in water relative to the environment?





2.4 Climb

Thesis project - B Arch



Project discription

Thesis project - B Arch

Objective is to design a sustainable and low cost mountaineering institute .

Softwares - Auto Cad, Sketch Up, Lumion

Abstract

Climb

Adventure sports has interested many people and is current doing so. Adventure sports are dangerous, so one must acquire professional training to pursue them as a sport. Currently, there are four mountaineering institutes in India. All of these institutes being in the Himalayas, in the south of India, there is scope for such an institute in sahayadries. With the Sahayadris and Nilgiris being equally challenging as the Himalayas, it could be an ideal space for a mountaineering institute.

Climb as a project aims to design an institute for mountaineering and allied sports in Sahayadris. (western ghats)

This institute will create an opportunity and introduce men, women, and children to the mountains and nature through its various mountaineering and adventure courses. The courses are designed to develop a person physically and mentally so as to sustain them in nature.

The project is designed using the guidelines of sustainable and low-cost development inspired by architect Laurie Baker, using exposed concrete and brickwork to enhance its connection with nature around it.

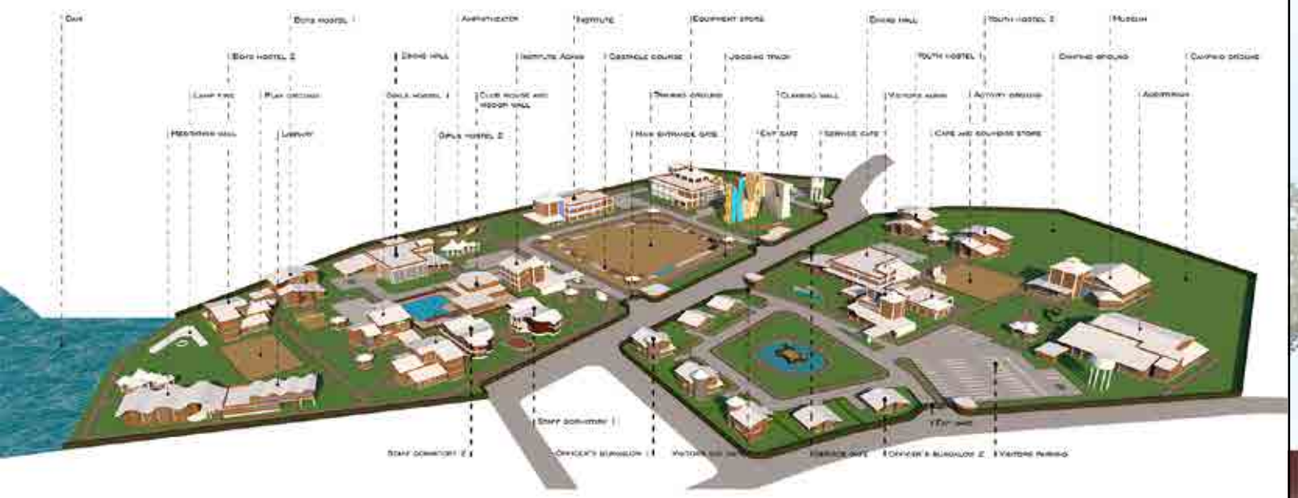
Site

Adventure sports have interested many people and are currently doing so. Adventure sports are dangerous, so one must acquire professional training to pursue them as a sport. Currently, there are four mountaineering institutes in India: Himalayan Mountaineering Institute (Darjeeling).
-Nehru Institute of Mountaineering (Uttarkashi).
-Atal Bihari Vajpayee Institute of Mountaineering and Allied Sports (Manali).
-Jawahar Institute of Mountaineering (Pahalgam).
All of these institutes being in the Himalayas, in the south of India, there is scope for such an institute in sahayadries. Because the Sahayadris and Nilgiris are both as difficult as the Himalayas, it could be an ideal location for a mountaineering institute.The adventure seekers in the south have to go all the way to the north for this training. This institute will provide an opportunity for mountain lovers to gain knowledge about the mountains, rivers, and skies.

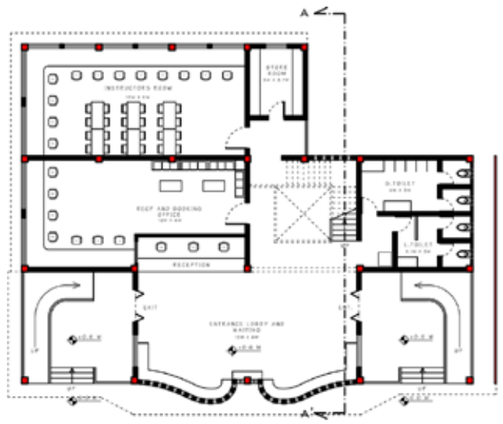
The aim is to design an institute for mountaineering ar allied sports in Sahayadris.
This institute will create an opportunity and introduce men, women, and children to the mountains and natu through its various mountaineering and adventure courses. The courses are designed to develop a person physically and mentally to be self-sustaining in nature.

Location plan

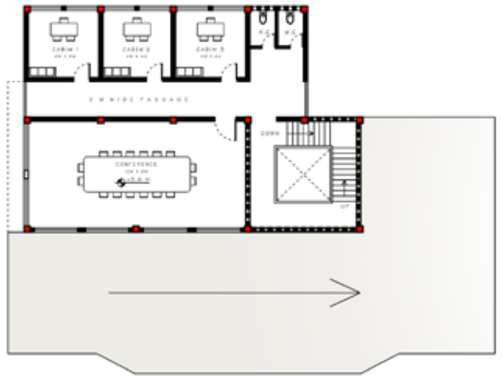
Site planning



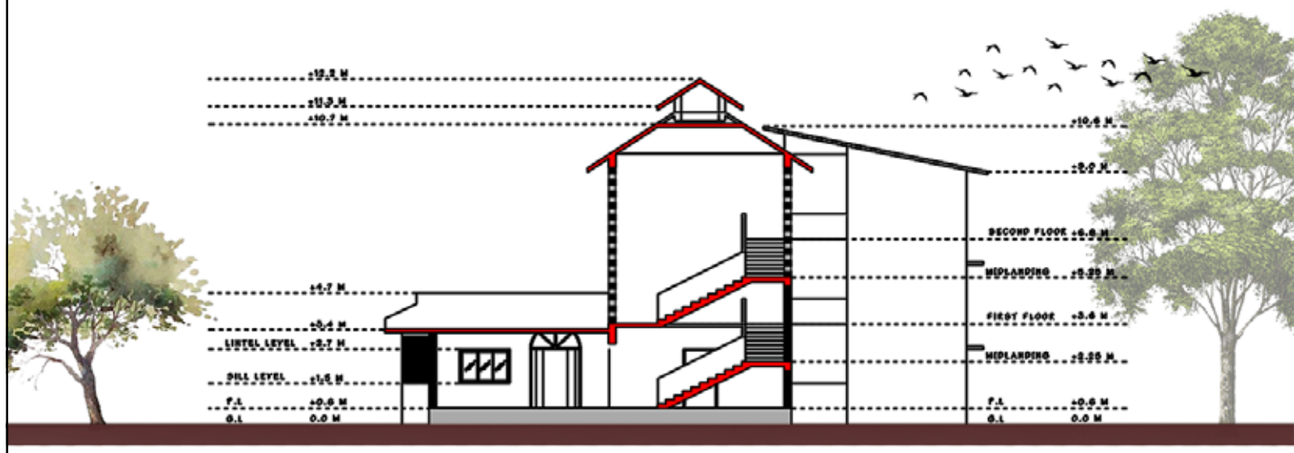
Master plan



Plan - Ground floor



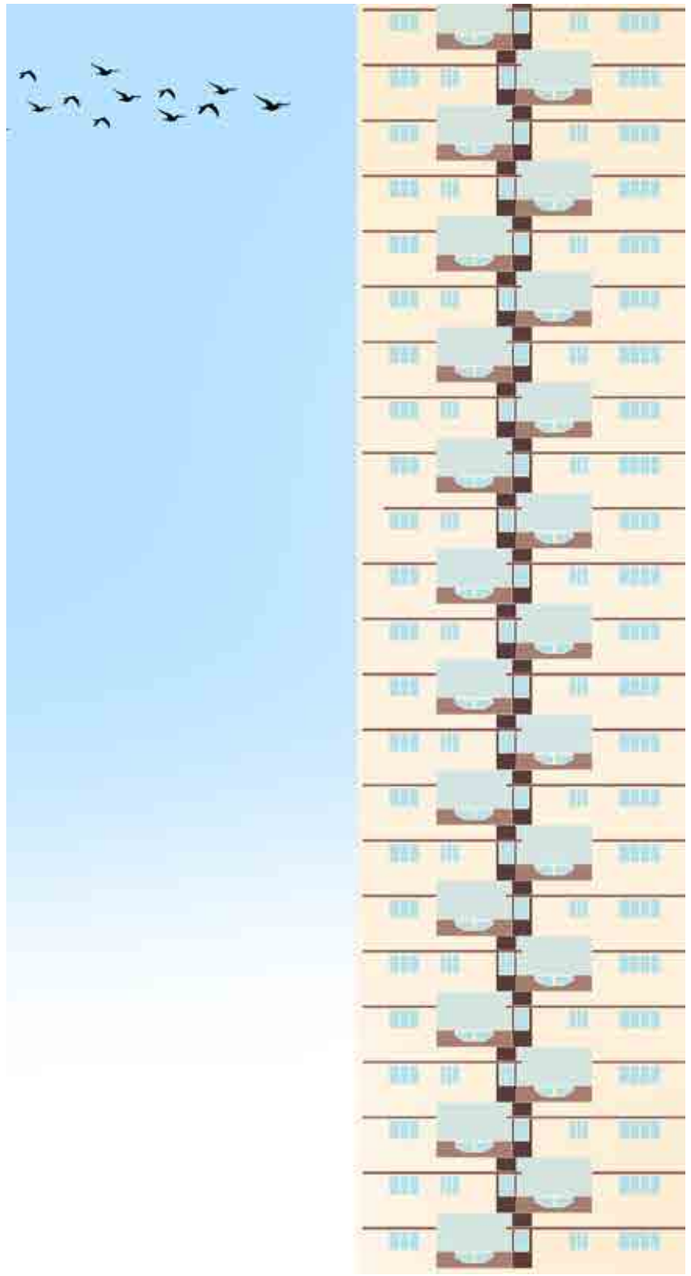
Plan - First floor



Section

2.5 URBAN HOUSING

Professional work



Project discription

Professional project
Objective is to design a rehabilitation housing project
Softwares - Auto Cad, Sketch Up, V Ray

Abstract

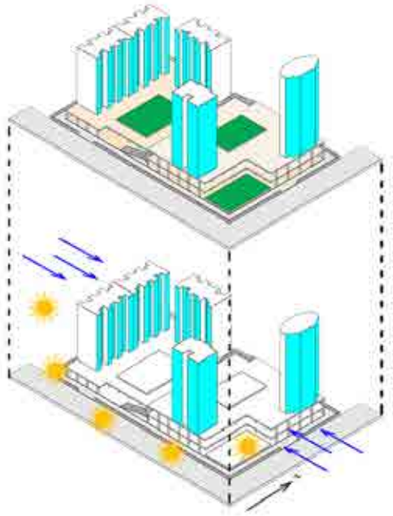
Urban Housing

"Mumbai", a metropolitan city and the economic capital of India, holds a lot of scope for urban development. People all around India and the world are attracted to this city because of its amazing job and business opportunities. The current population of Mumbai is 22.5 million and is growing at a rate of 17–20% per decade. Around 41.5% of people in the city are living in slums, and there is a huge need for the basic commodity of life, "housing".

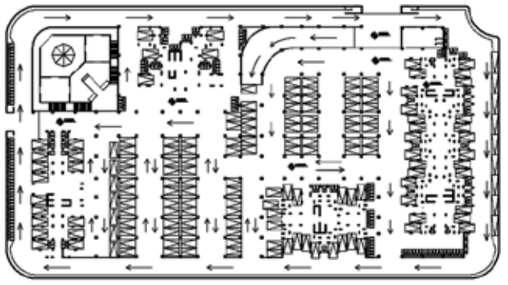
The project urban housing is to develop housing complexes (towers) with both affordable and luxurious apartments in Mumbai. The objective is to design high-rise towers for LIG (low income group), MIG (middle income group), and HIG. (high income group). Catering to a high population of people, there is a need to think about open recreation space and social interaction between people.

Redevelopment project Mumbai - sub

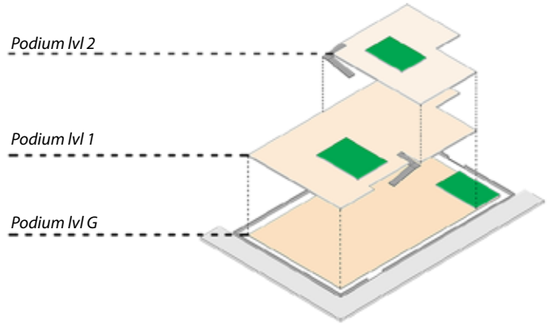
This housing project consists of five residential towers of different categories of apartments. The complex has 650 apartments, so vehicular parking is most needed. There are 3 levels of podium for vehicular parking, which are easily accessible via two, two-way ramps which are designed for smooth vehicular circulation. The level difference subtly divides the site from rehabilitation building to sale building. There are 3 recreation grounds, one on each podium level. There is a senior citizen garden on ground level, as most Indian families are joint families. This helps them relax and spend quality time with fellow senior citizens. The other two RGs are for children and teenagers for their much faster sports.
The towers are placed so that each house gets direct natural light and ventilation. No two buildings directly face each other, and in a complex of 650 apartments, each one has its own complete privacy. The central open space allows the wind to flow in its natural way and creates enough space for good vehicular circulation.



Climate analysis

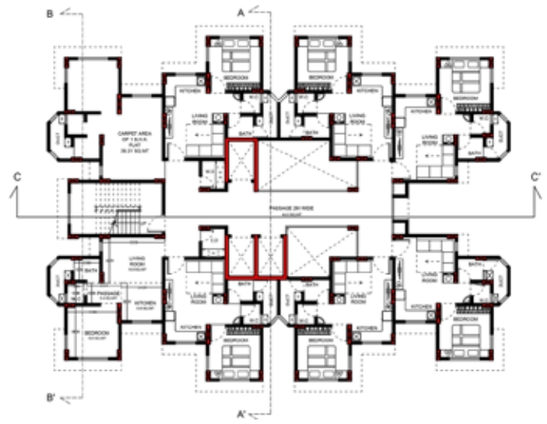


Parking layout and vehicular movement



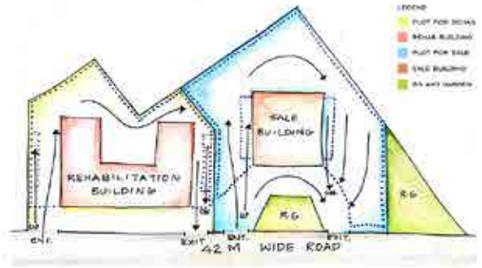
Three bedroom appartment building

One bedroom appartment building

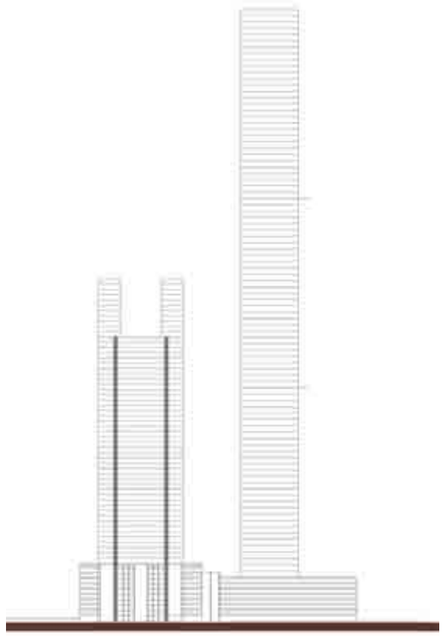


Redevelopment project Mumbai - Town

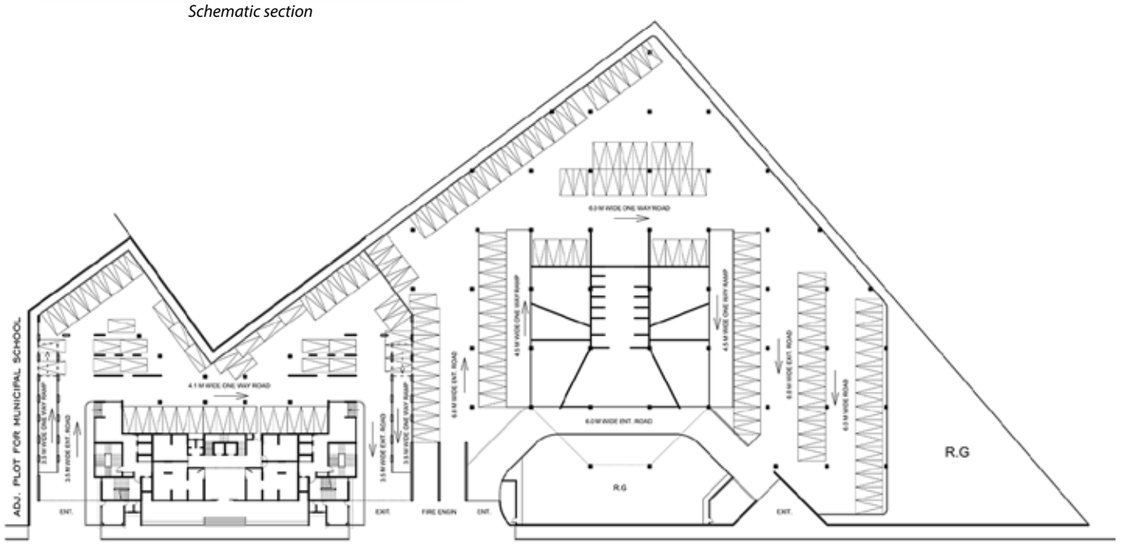
This skyscraper design is highly inspired by the Kanchan-junga apartment building in Mahalaxmi, Mumbai. The building is designed in a 33 x 33 m square, with flat sizes increasing as we go up. The R.C.C column layout chang-es as we go up, and the transition of changes takes place at the 2 levels of service floors each after 25 floors, which divides the elevation of the tower into 3 sections, giving it a well-designed and contemporary elevation both in front and on the sides.
The rehab tower consists of smaller 1 bhk and 2 bhk flats designed to fit well on the site.



Site planning



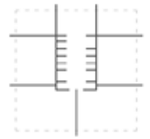
Schematic section



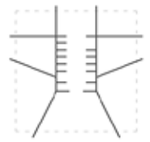
Site plan

Floor plan - Building 1

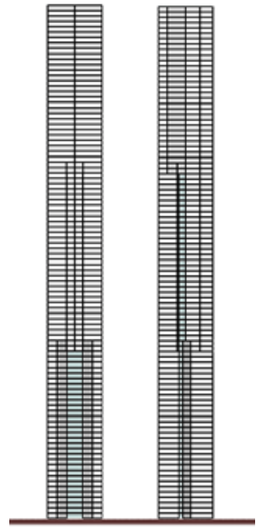
RCC grid till 75 floor



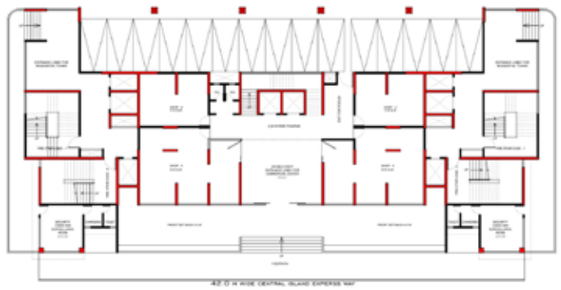
RCC grid till 50 floor



RCC grid till 25 floor

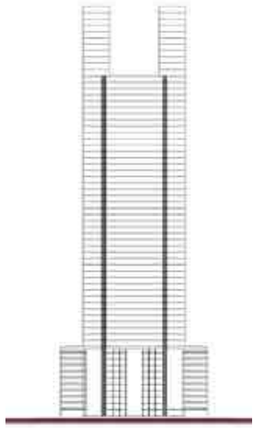


Schematic section



Floor plan - Commercial lobby

Floor plan - Building 2



Schematic section

3.1

TIME

Robotic tufting

Project discription

Group project
Objective is to design a rug and fabricate using a robotic arm
Softwares - Rhino, Grasshopper, Robots(Gh Plugin)
Machines used - Robotic Arm
Technique - Robotic tuffting
Material used - Canvas, Yarn

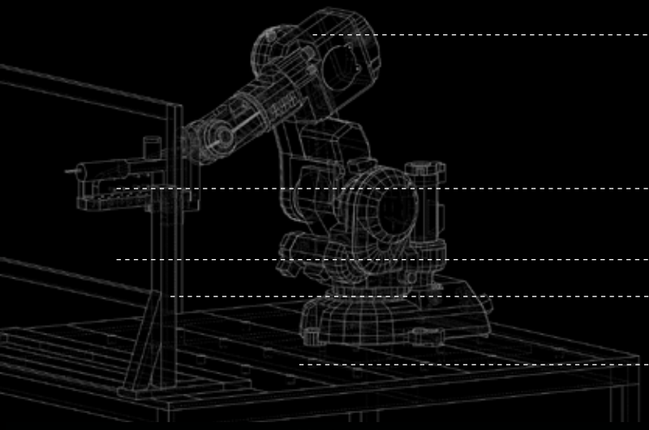
Abstract

Time

Time is a group project that explores the art of tufting using a robotic arm. The objective is to design a rug and fabricate it using a tufting gun mounted on the robot.
The system comprises a canvas board mounted vertically on the table, with a tufting gun used as the tool. The design of the rug is a prism representing illusion, and the drawing for the rug is developed keeping in mind the constraints of tufting, such as the direction of curves, distance between them, and the pressure needed to be applied on the canvas to get the desirable output.

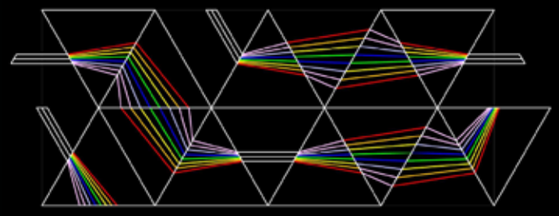
Scan !!!

Animations and blog post

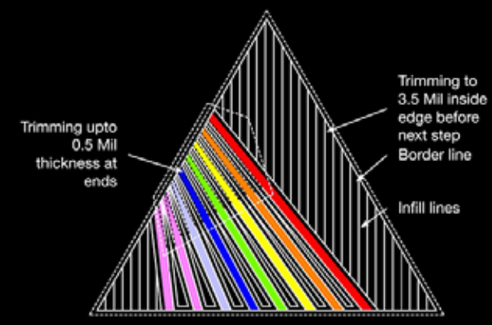


Module -2

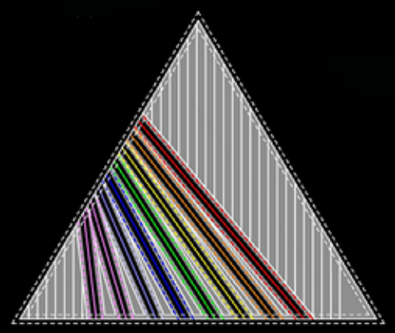
Module -1 Module -3



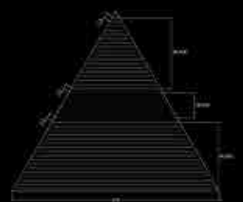
Aggrigation



Design consideration for fabrication

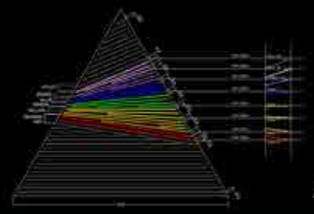


Design consideration for fabrication



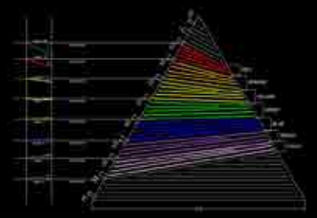
Curves for robot

Desired output



Curves for robot

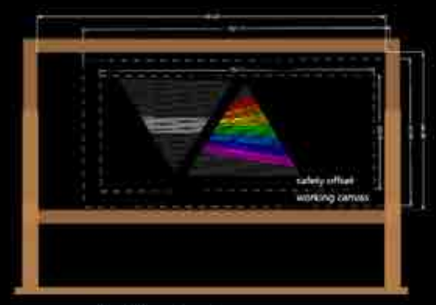
Desired output



Curves for robot

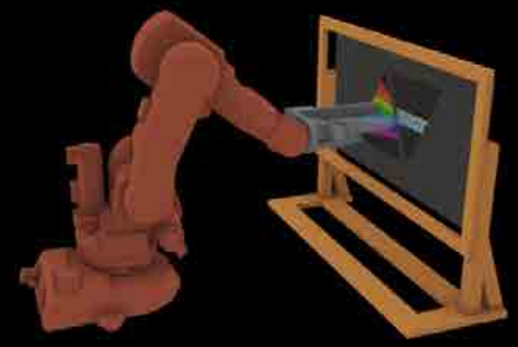
Desired output

Red Orange Yellow Green Blue Indigo Violet



Fabrication frame 2

Vector direction

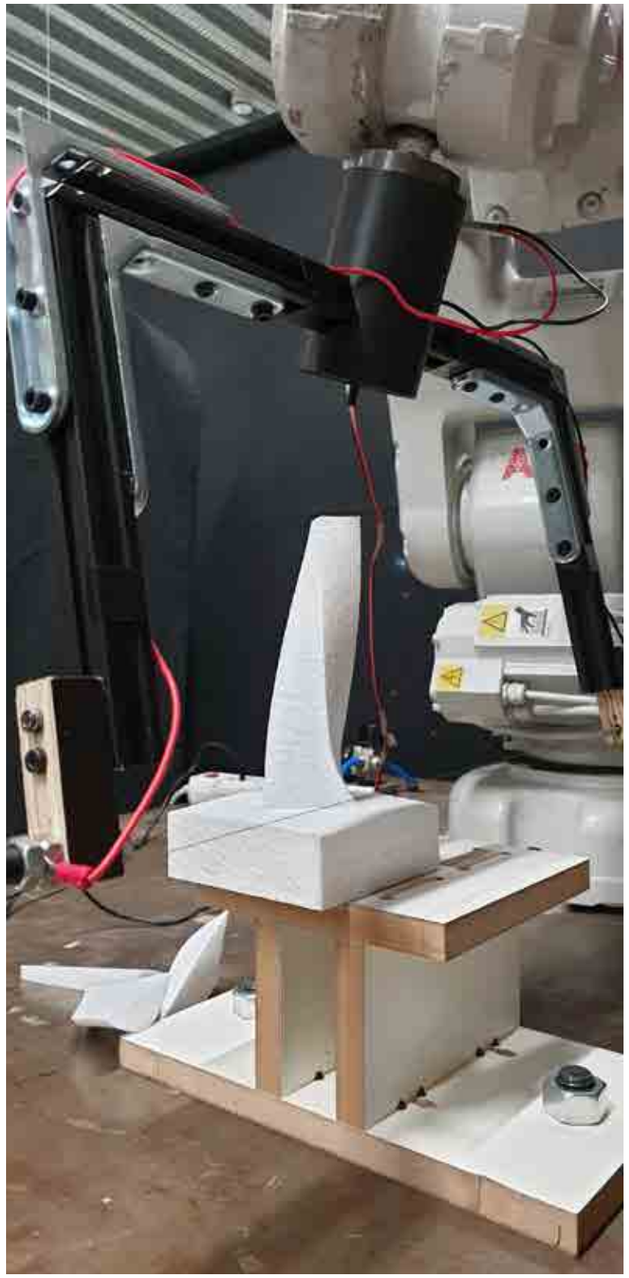


Tufting Strategy

Final output

3.2 ROBOTIC STEREOTOMY

Advanced robotic fabrication - Hot wire cutting



ROBOTIC STEREOTOMY

Advanced robotic fabrication - Hot wire cutting

Project discription

Group project - Me and Lekha Gajbhiye
Objective is to desing a facade by using robotic stereotomy using the princpal of ruled surfaces
Softwares - Rhino, Grasshopper, Robots(Gh Plugin)
Machines used - Robotic Arm
Technique - Hot wire cutting
Material used - EPS foam blocks

Abstract

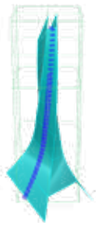
Robotic stereotomy - Hot wire cutting

Robotic stereotomy is a group project developed by me and Lekha Gajbhiye. This project aims to understand the stereotomy of blocks using a robotic arm. The blocks used are EPS foam blocks and are cut using a hot chromium wire which is guided by the robotic arm. By modelling the block in rhino and grasshopper, the toolpath is generated by using planes as targets for the robot, which follows them according to their orientation and order. For modelling the blocks, certain constraints were taken into consideration, such as
Avoid the singularity and make comfortable movements for the robot.
Make sure that the tool doesn't touch the robot.
The toolpath should avoid cutting the model
The project objective is to design an aggregating piece using the concept of ruled surfaces and create an effective facade system for the Barcelona Pavilion to enhance the radiation performance of the building as well as enhance the dramatic play of light in and out of the building.

Scan !!!

Animations and blog post

Face - 1



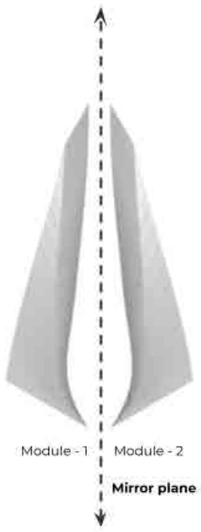
Face - 2

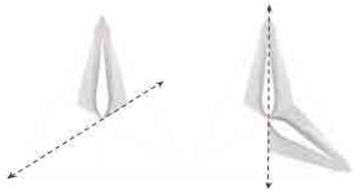
Face - 3

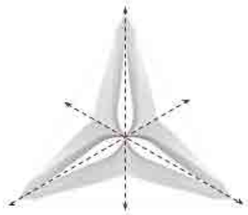
Face - 4

Face - 5

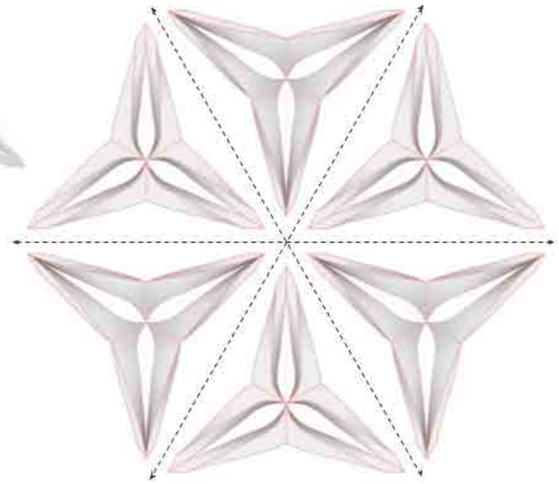
Face - 6



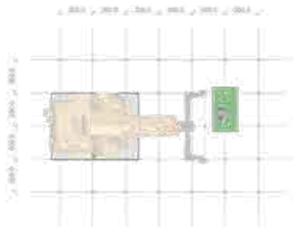




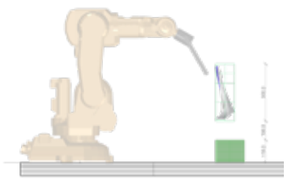
Aggregation Triangle



Aggregation Hexagon



Base Placement



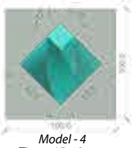
Block location

Cut simulation

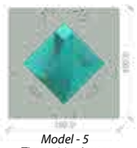
Model - 1
Time - 12 minutes
Speed - 5% of 100
Voltage - 9.2 V
Rotation - 90° clockwise

Model - 2
Time - 15 minutes
Speed - 5% of 100
Voltage - 9.2 V
Rotation - 180° clockwise

Model - 3
Time - 15 minutes
Speed - 5% of 100.
Voltage - 9.2 V
Rotation - 90° clockwise

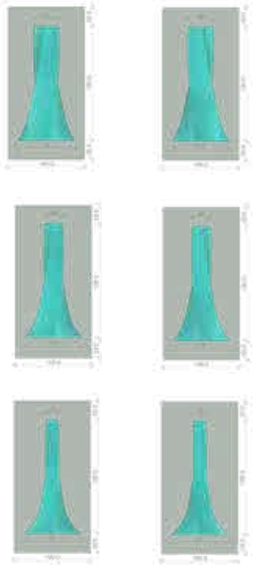


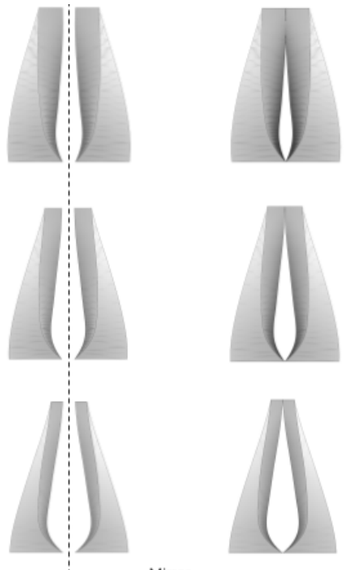
Model - 4
Time - 15 minutes
Speed - 5% of 100
Voltage - 9.2 V
Rotation - 90° anti -clockwise

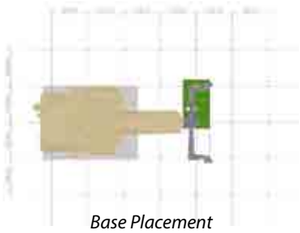


Model - 5
Time - 11 minutes
Speed - 5% of 100
Voltage - 9.2 V
Rotation - 90° clockwise

Model - 6
Time - 12 minutes
Speed - 5% of 100
Voltage - 9.2 V
Rotation - 90° clockwise







Base Placement

Block location

Cut simulation

3.3 PRINT N PLACE

Thesis project - MAA 02

Project discription

Thesis project - MAA 02
Objective is to derive a solution to 3D printinterlocking blocks for compressive forms
Softwares - Rhino, Grasshopper, Robots(Gh Plugin)
Machines used - Robotic arm
Technique - Robotic 3D printing
Materials - Clay

Abstract

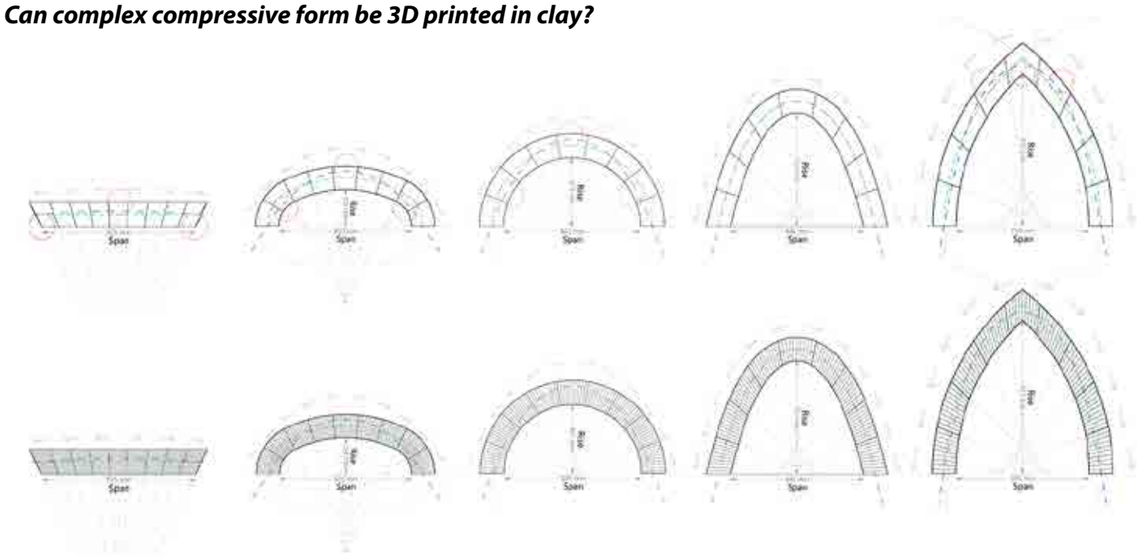
Print N Place

Historically, arches, domes, and vaults have been the backbone of structural technology for constructing buildings. All of these forms are compressive forms, i.e., They work best in compression. These forms were explored to maximise their load bearing capacity and were developed from shapes like arches, domes, and vaults to pure compressive forms, which are funicular structures.
The rise of computer-aided design and modelling techniques and computational tools have enabled the language of doubly curved surfaces in architecture, and structural concepts are being integrated as organising principles of form, material, and structure. The new digital fabrication methods have furthermore made the realisation of complex forms technically and economically feasible.
The major drawback for constructing generated funicular structures is that they need precise and unique formwork to build, which is only true to the designed shape.
The thesis, Printing Masonry, analyses the forces in pure compressive forms to then discretize them into interlocking blocks, which are then 3D printed using locally available material and assembled using minimum formwork. The research concentrates on studying the forces experienced by the structure to develop a mortarless construction system for funicular structures using topological assemblies. Topological assemblies interlock with their contact surfaces. Further, these force-locked elements are kinematically constrained under their own compressive load, which helps the addition of new blocks without the need for supports, hence minimising formwork.

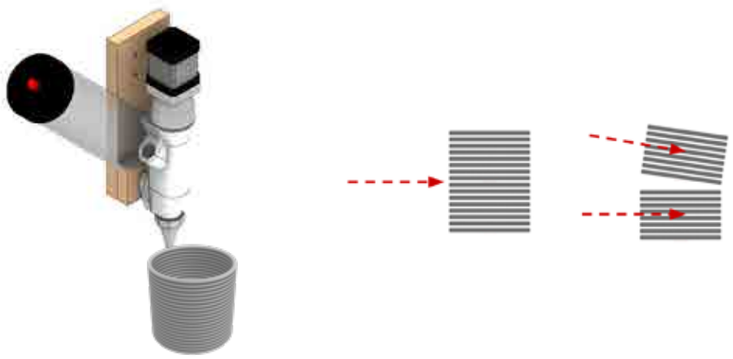
Scan !!!

Animations and blog post

Can complex compressive form be 3D printed in clay?



Changing printing principle



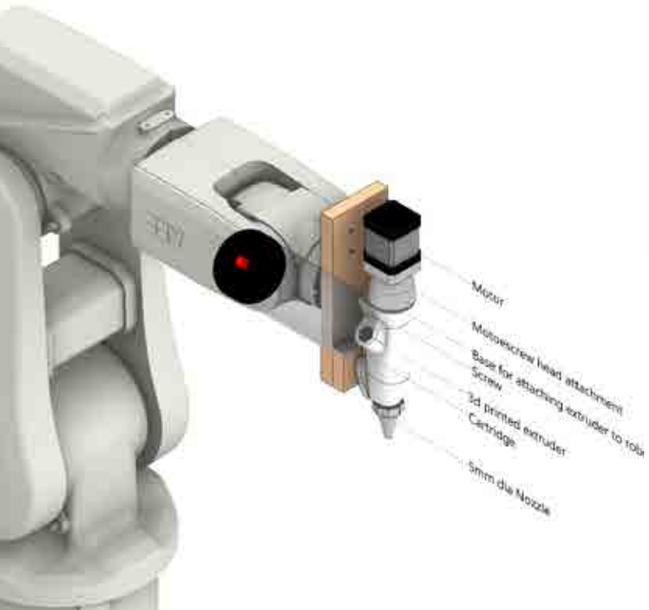
Working principle for 3D printing

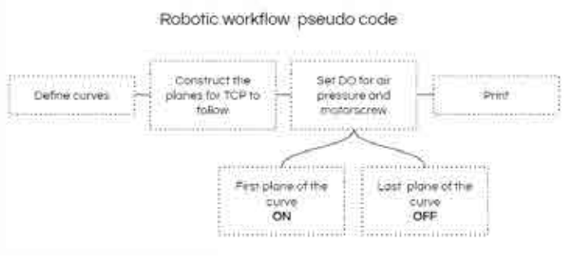
Load applied

Split in formation

Angled printing to print perpendicular to forces

Setting up the system.

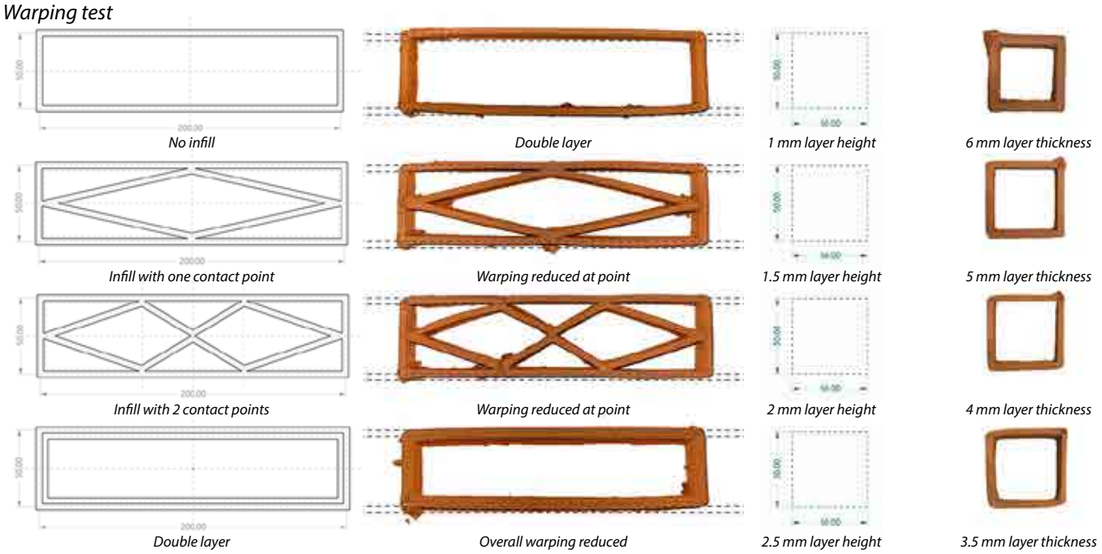




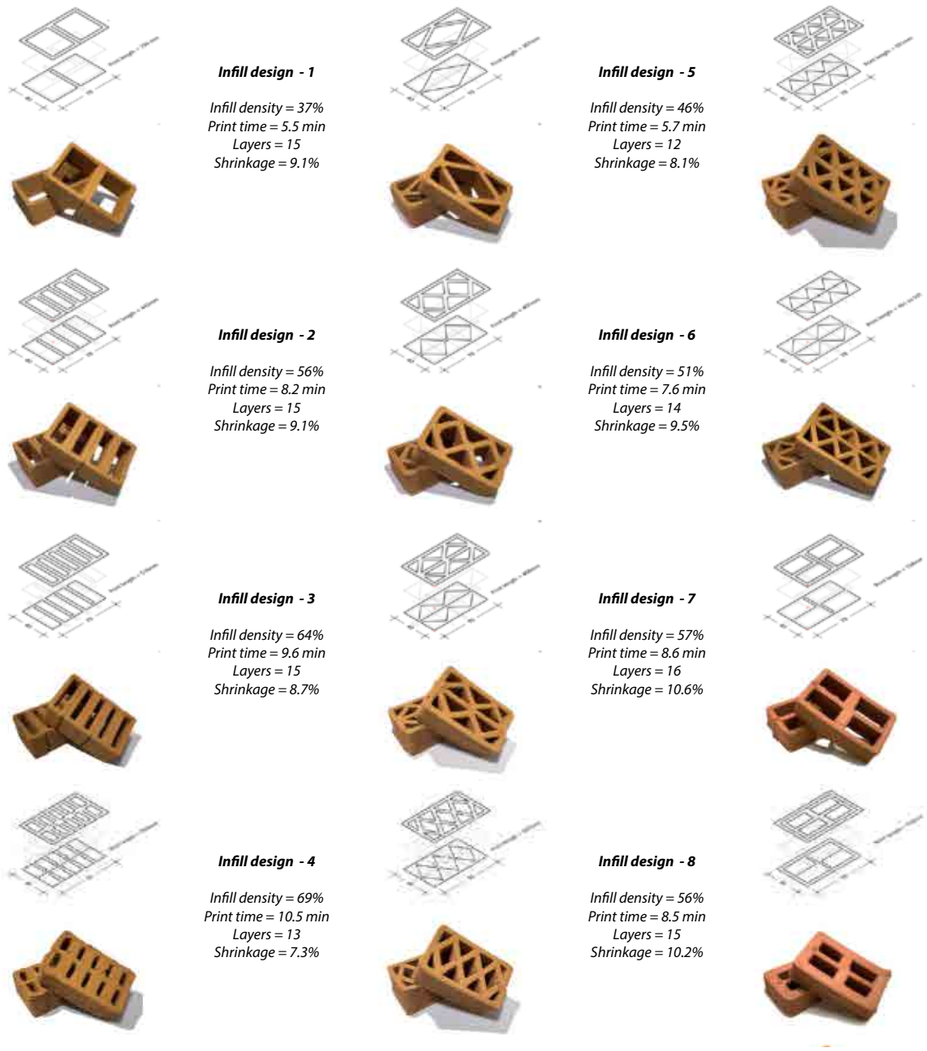
Print speed - 15 mm /sec
Zone interpolation - 0
Air pressure - 2 to 2.5 Bars
Nozzle diameter - 5 mm
Layer height - 2mm
Material consistency - 7% to 8% water in clay

Understanding material properties, strengths and weaknesses.

Warping test



Shrinkage test



Infill design - 1
Infill density = 37%
Print time = 5.5 min
Layers = 15
Shrinkage = 9.1%

Infill design - 5
Infill density = 46%
Print time = 5.7 min
Layers = 12
Shrinkage = 8.1%

Infill design - 9
Infill density = 62%
Print time =9.4 min
Layers = 15
Shrinkage = 9.8%

Infill design - 2
Infill density = 56%
Print time = 8.2 min
Layers = 15
Shrinkage = 9.1%

Infill design - 6
Infill density = 51%
Print time = 7.6 min
Layers = 14
Shrinkage = 9.5%

Infill design - 10
Infill density = 60%
Print time = 7.8 min
Layers = 14
Shrinkage = 9.4%

Infill design - 3
Infill density = 64%
Print time = 9.6 min
Layers = 15
Shrinkage = 8.7%

Infill design - 7
Infill density = 57%
Print time = 8.6 min
Layers = 16
Shrinkage = 10.6%

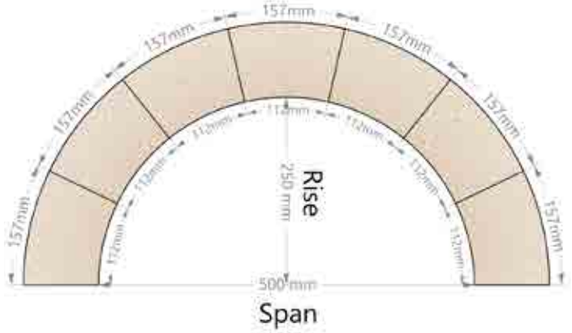
Infill design - 11
Infill density = 57%
Print time = 6.6 min
Layers = 10
Shrinkage = 11.3%

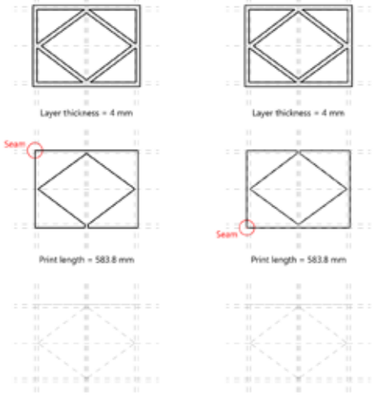
Infill design - 4
Infill density = 69%
Print time = 10.5 min
Layers = 13
Shrinkage = 7.3%

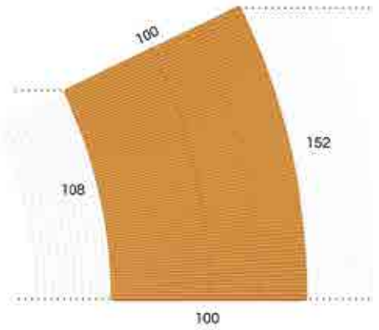
Infill design - 8
Infill density = 56%
Print time = 8.5 min
Layers = 15
Shrinkage = 10.2%

Infill design - 12
Infill density = 71%
Print time = 9.5 min
Layers = 10
Shrinkage = 11.3%

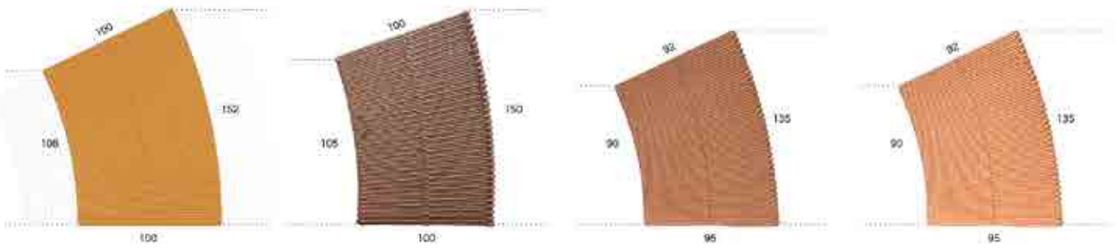
Fabrication of a round arch







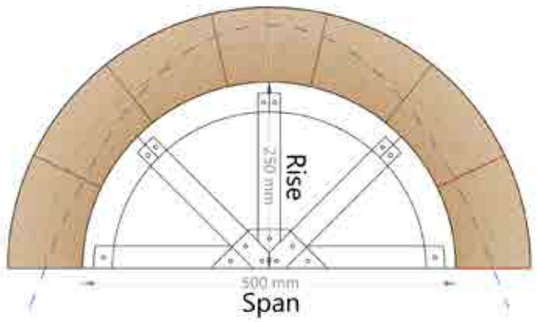
Layer height = 1.6 mm
Layer height = 2.2 mm
No. of layers = 71
Print time = 50 mins
Print length = 41450 mm
Print speed = 15mm/sec

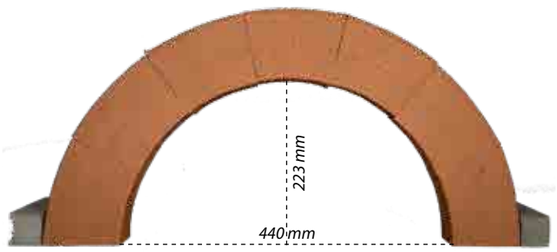


Drawing ***Print wet*** ***Print dry*** ***Print bake***

a = 100	*9.5% shrinkage*	*a = 95*	*No shrinkage*	*a = 95*
b = 105	*13.5% shrinkage*	*b = 90*		*b = 90*
c = 100	*10% shrinkage*	*c = 92*		*c = 92*
d = 150	*12.3% shrinkage*	*d = 135*		*d = 135*

Average shrinkage = 11.3 %

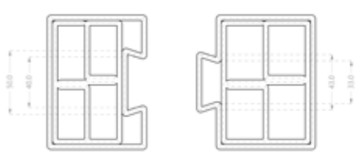




Average shrinkage = 11.5 % for assembled arch

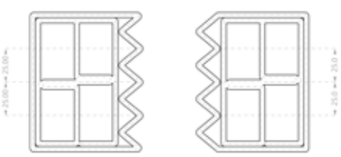
Interlocking tests

Tongue and groove interlocking



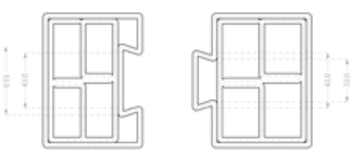
6mm groove offset

Interlock - NO



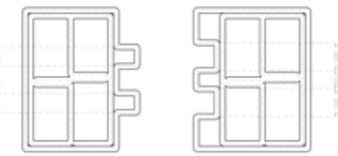
6mm groove offset

Interlock - YES



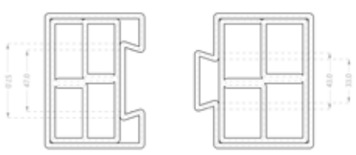
10mm groove offset

Interlock - YES



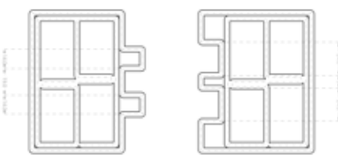
6mm groove offset

Interlock - NO



14mm groove offset

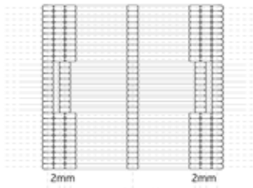
Interlock - YES but loose



10mm groove offset

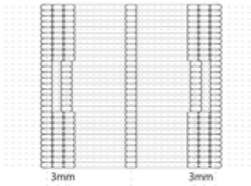
Interlock - YES

Infill interlocking



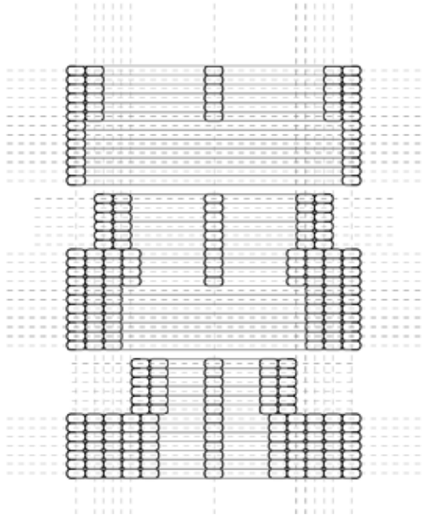
2mm infill offset

Interlocks - YES High tolerance

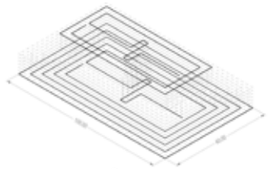


3mm infill offset

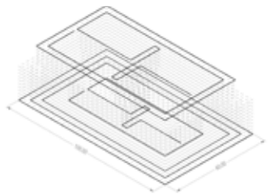
Interlocks - YES Low tolerance



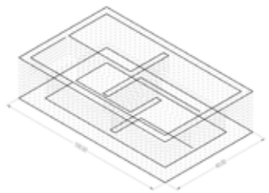
Interlocked stacking



Bottom

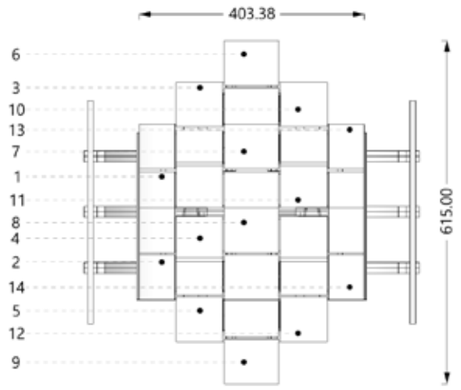


Middle

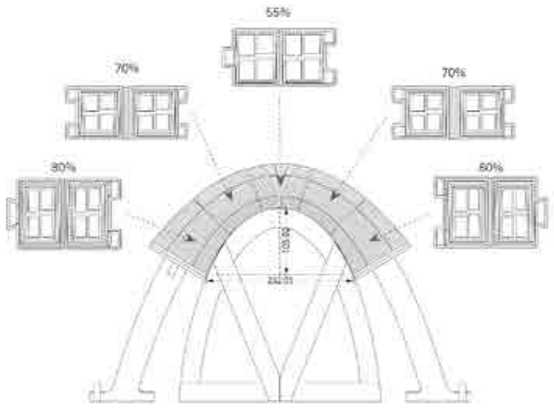


Top

Fabrication of catanary barrel vault with interlocking blocks.



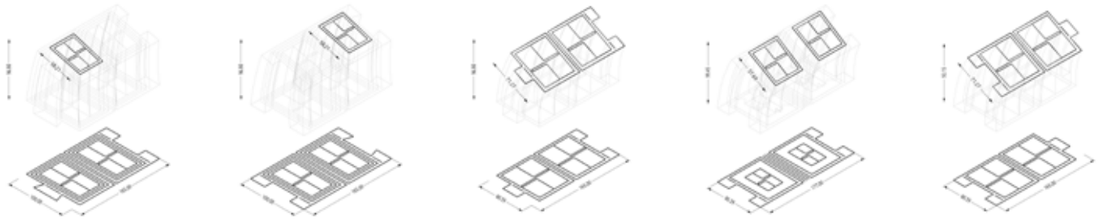
Plan



Changind infill density as per load distribtion

Arrangement and interlocking of blocks

Isometric view of the model



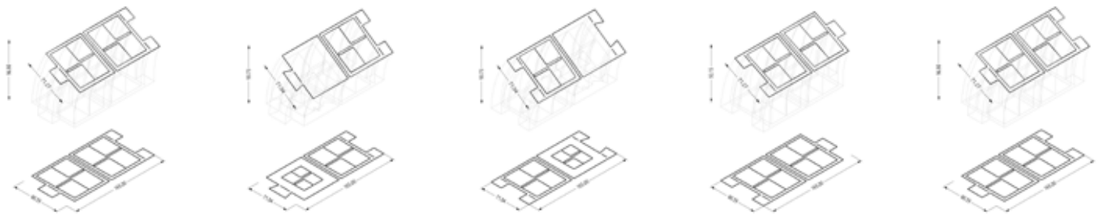
Block - 1
Layers - 45
Infill layers - 4
Infill density = 65%

Block - 2
Layers - 45
Infill layers - 4
Infill density = 65%

Block - 3
Layers - 40
Infill layers - 2
Infill density = 45%

Block - 4
Layers - 44
Infill layers - 3
Infill density = 55%

Block - 5
Layers - 40
Infill layers - 2
Infill density = 45%



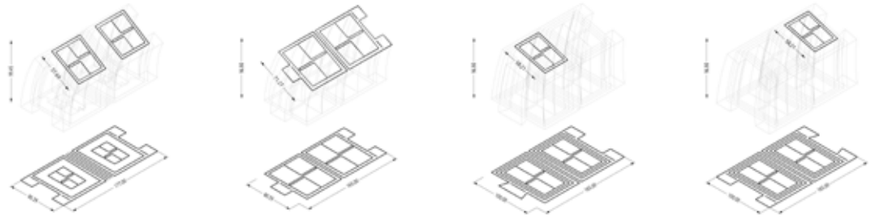
Block - 6
Layers - 39
Infill layers - 2
Infill density = 45%

Block - 7
Layers - 39
Infill layers - 2
Infill density = 45%

Block - 8
Layers - 39
Infill layers - 2
Infill density = 45%

Block - 9
Layers - 39
Infill layers - 2
Infill density = 45%

Block - 10
Layers - 40
Infill layers - 2
Infill density = 45%

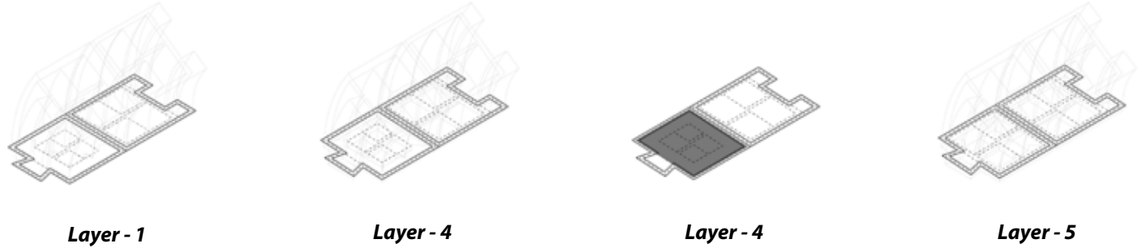


Block - 11
Layers - 44
Infill layers - 3
Infill density = 55%

Block - 12
Layers - 40
Infill layers - 2
Infill density = 45%

Block - 13
Layers - 45
Infill layers - 4
Infill density = 65%

Block - 14
Layers - 45
Infill layers - 4
Infill density = 65%

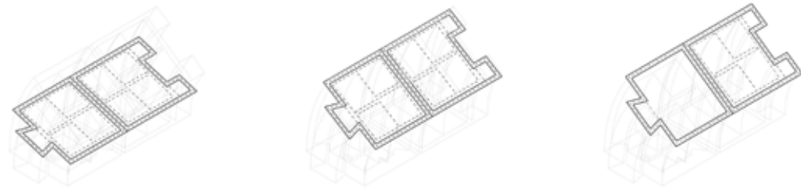


Layer - 1

Layer - 4

Layer - 4

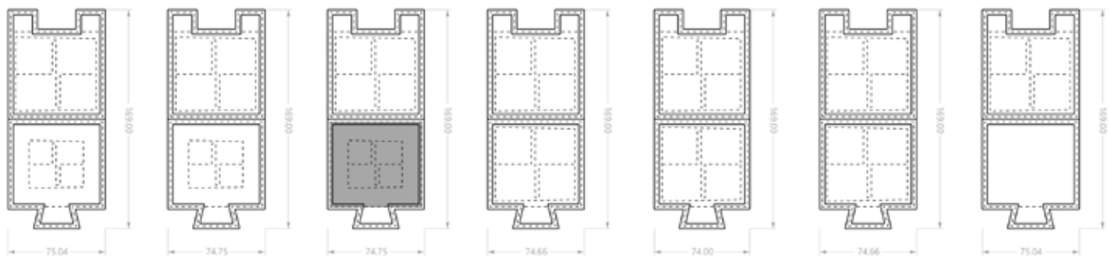
Layer - 5



Layer - 20

Layer - 35

Layer - 39



Layer - 1
Print infill support

Layer - 4
Infill support end

Layer - 4
Paper for support-ing above layers

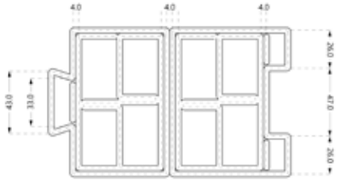
Layer - 5
Layer above the support

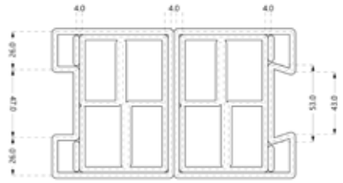
Layer - 20
Halfway layer

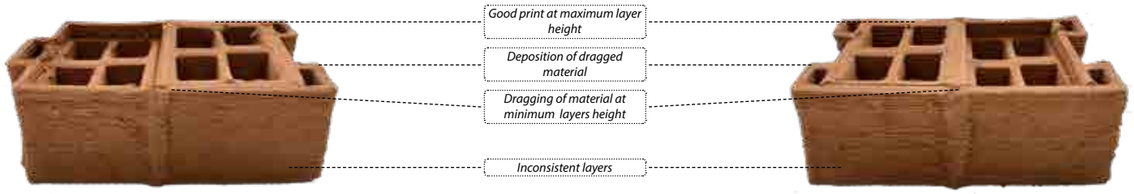
Layer - 35
Layer before infill interlocking

Layer - 39
Cavity for infill interlocking for next block

Printing challenges

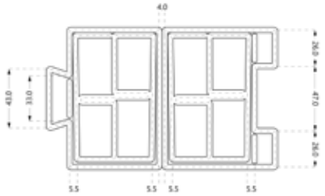


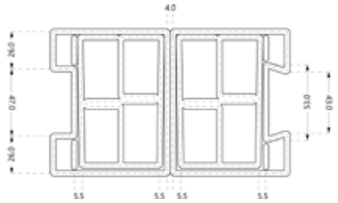


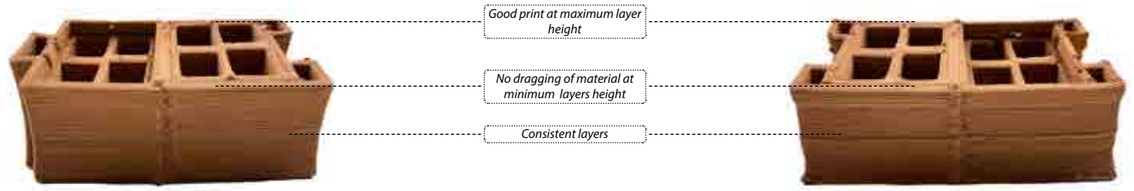


Printing solution

Changing the infill shape to trapeziod solves the problem as there is more space for compressed latyers.

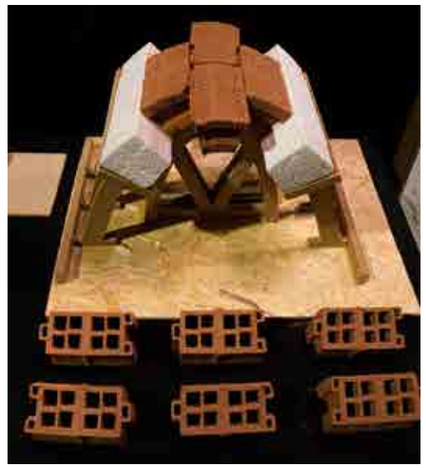
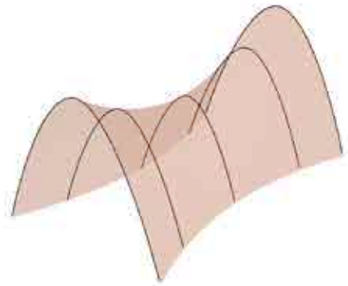






Conclusions

Shrinkage causing tolerance problem.
Needs sanding.
Base of the print shrinks less due to resistance from base.
Layer is thin and breaks easily.
Cannot be aggregate due to low tolerance in interlocking

Probable solutions

Thicker layers.
Less resistive base for homogeneous shrinkage.
Minimum 2 layers thickness at interlocking.
Cleaner prints will solve tolerance problem