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URBAN VERTICAL CEMETERY

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A New Type of Burial in Cities of High Density

MASTER´S THESIS ARCHITECTURE 2017

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Chalmers School of Architecture
Examiner: Jonas Lundberg
Tutor: Kengo Skorick

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Master Program of Architecture and Urban Design (MPARC)

Material Turn Studio

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Thanks to:

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Thanks for your company.

CONTENTS

INTRODUCTION
Abstract ····1
Urban cemetery····3
Vertical cemetery····5
Practical problem····7

RESEARCH
Scale of the columbarium····9
Overall arrangement····13
Vertical structure····16

PROTOTYPE
Inspiration····21
Reference····23
Tube & Plate····25
Context····32
Formation····37

PROPOSAL
Inspiration····45
Reference····47
Internode & Branch····49
Organization····51
Formation····53

SUPPLEMENT
Index of images····63
Bibliography····64

INTRODUCTION

Abstract

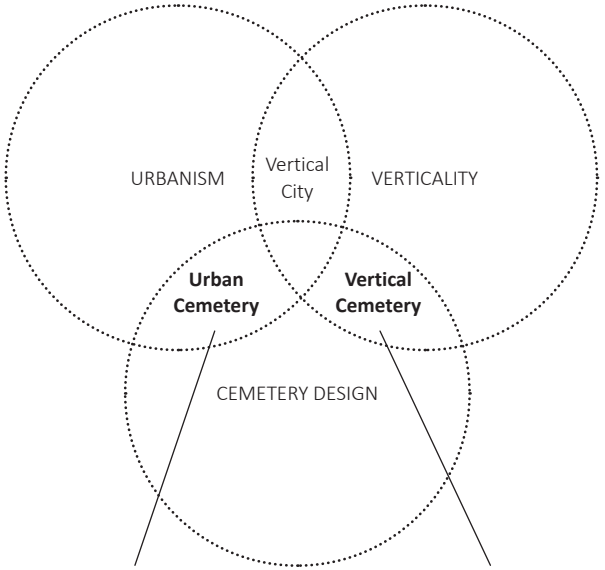
Facing the rapidly aging problem, cities of high density find it difficult to spare enough land for burials. Establishment of new burial has expanded to the outskirts, and the sepultures become really expensive. Even though verticality has been applied to most building typologies since it could help to solve the spatial and economic problem, vertical cemetery might cause controversy.

The purpose of the project is to apply verticality into cemetery typology. Verticality provides opportunities to bring cemeteries back to the urban district. While urban cemetery makes it possible to mix city functions and encourage daily visits to the burial, which benefits people's attitude towards life and death.

The project is developed with the periods of research and design. In the period of research, the proper scale of the columbarium room is discussed according to the field of view of human eyes. While the vertical structure is also developed, creating different space for various activities within the same structure system.

During the design period, the construction system (internode & branch) is based on the regulation of how bamboo grows. And the organization of vertical cemetery is supposed to be more organic and natural. It seems like a very open and public bamboo forest, where people can see the blue sky, enjoying the sunlight and fresh air.

The final design result is a proposal of urban vertical cemetery, providing enough memorial space for the citizens with a fair price and kind atmosphere. It is not only a place for the dead, but also a vertical park where daily life could happen.



Discourse diagram | 2

Urban cemetery

These two maps compare the current cemeteries in Paris and Shanghai.

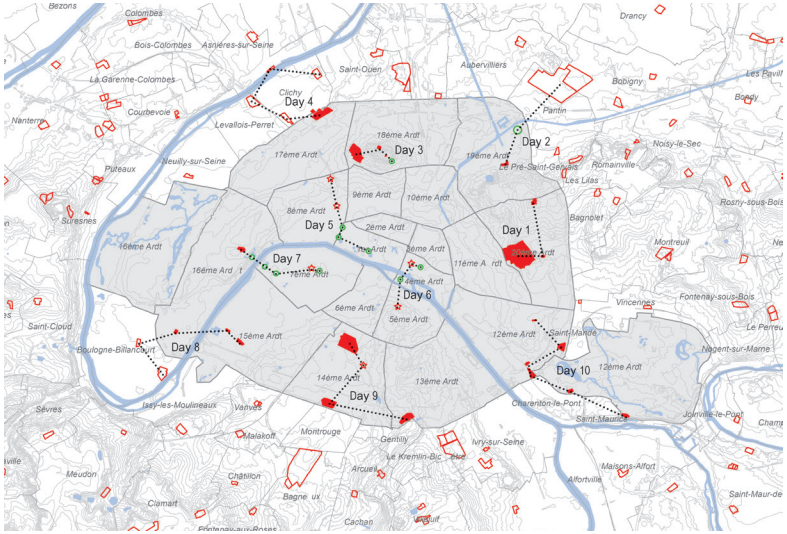


Figure 01. Cemeteries in Paris

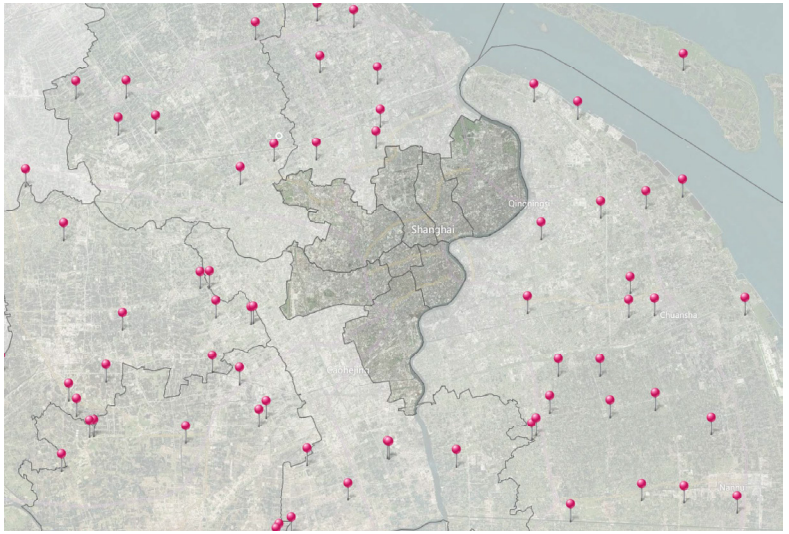


Figure 02. Cemeteries in Shanghai

In Paris, we can find more than 20 cemeteries inside the central districts. These cemeteries belong to the ***artificial public space***, they play an important role in the city like public parks, where daily life could happen.

However in Shanghai, the cemeteries are always far from the city center. These cemeteries belong to the ***municipal utilities*** and embrace the whole city, which reflects the lack of consideration in the aspect of urban planning

Vertical cemetery

There are already some design proposed and some vertical cemeteries built.

Figure 03. Skyscraper Cemetery for Norway, by Andrew McSherry

Figure 04. Vertical Cemetery for Paris, by Fillette Romaric & Chandrasegar Velmourougane

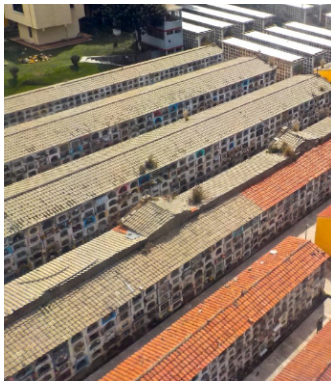


Figure 05. La Paz cemetery, Bolivia

Figure 06. Yarkon Cemetery, Israel

Figure 07. Memorial Necropole Ecumenica, Brazil

Currently the world's tallest cemetery is in Brazil. It measures **108 meters tall** with **32 stories** and **25,000 storing units**. And the building also contains a restaurant, a chapel, a snack bar and even a peacock garden, which makes the cemetery became a tourist attraction.

Practical problem

Although verticality has been applied to most building typologies since it could help to solve the **spatial** and **economic** problem, vertical cemetery might still cause controversy.

In San Cataldo Cemetery designed by Aldo Rossi in Bologna, Only the niches in the first layer were sold out.

The same situation happens in Fuleshan Cemetery in Shanghai, the 4-story building is totally out of use.

According to these references, the problem must be avoid is that vertical burials are usually **out of use** especially when they are far from the city and is **not convenient to access**.

So The purpose of the project is to apply verticality into cemetery typology. Verticality makes it possible to bring cemeteries back to the urban district. While urban cemetery makes it possible to **mix city functions** and **encourage daily visits** to the burial, which benefits people's attitude towards life and death.

Figure 08. San Cataldo Cemetery, Bologna

Figure 09. Fuleshan Cemetery, Shanghai

RESEARCH

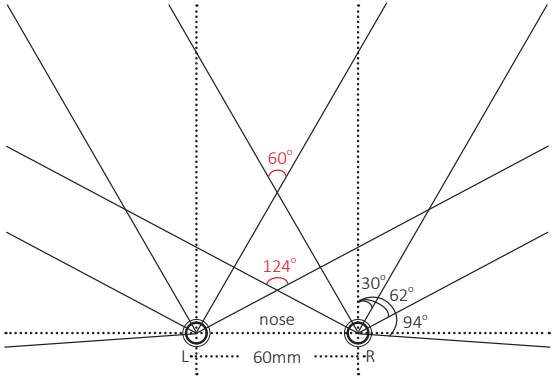
Scale of the columbarium

How to balance the density and quality of the space?

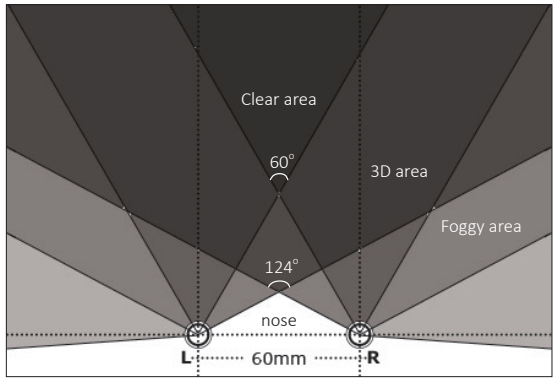
Figure 10. General types

Figure 11. Vertical types

Since people don't like to be surrounded by too much niches, especially when they belong to people you don't know. So the **proper distance** to the cremation niches and **proper diameter** of the memorial space could be evaluated according to the study of **field of view of human eyes**.



60° - Comfortable range for single eye, where the object could be focused on



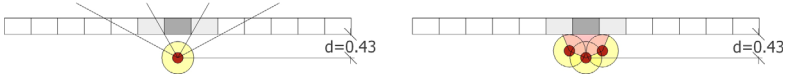
124° - Object in this area could be seen by both eyes, resulting in a 3D image

Clear area
3D area
Foggy area
Bland area

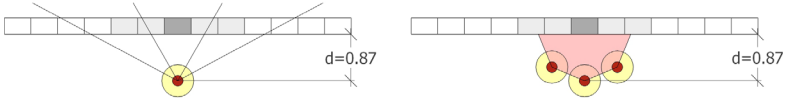
Proper distance to the columbarium wall

Suppose that you are in front of a columbarium wall, what you want is to worship towards your relative rather than be influenced by others.

N=1 n=3 d=0.43m S=0.27m^2

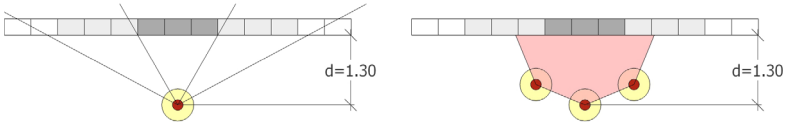


N=1 n=5 d=0.87m S=1.06m^2



proper range: 0.87< d <1.30

N=3 n=9 d=1.30m S=2.39m^2



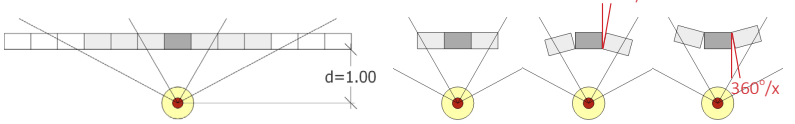
w = 500mm = width of a single niche
r = 300mm = range of a single person
n = number of niches that is in your eyesight

N = number of niches that you are focused on
d = distance between the person and the wall
S = memorial area for a certain niche

Proper diameter of the memorial spacel

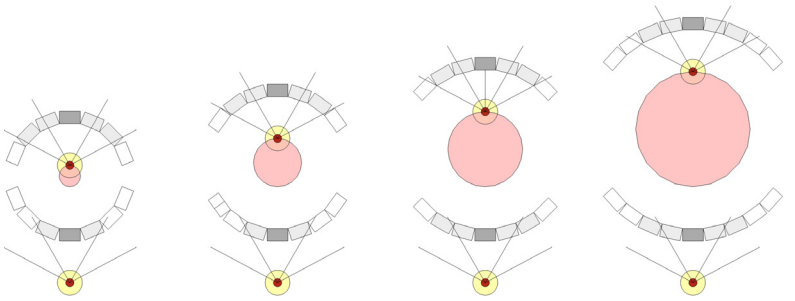
Define d = 1.00m

N=1 n=7 **d=1.00m** S=1.41m2



x = 16,17,18,19... = number of the side
a = area of the public space created
A = area of the total space inside

K1 = 1000*(a/A/x) = quality of the space
K2 = x/A = density of the space
K = K1*K2 = cretia of the evaluation



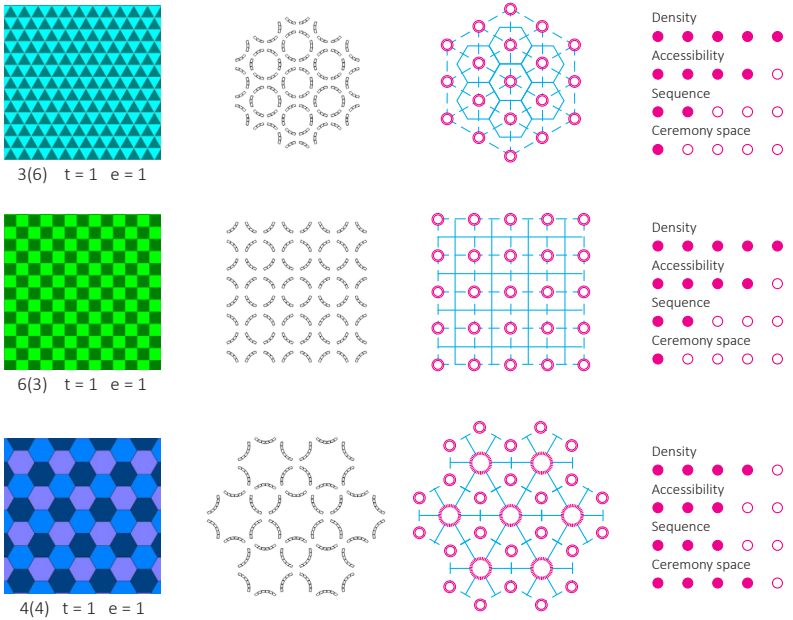
x = 16	x = 20	x = 24	x = 30
a = 0.20m^2	a = 1.03m2	a = 2.51m2	a = 5.87m2
A = 5.03m^2	A = 7.64m2	A = 11.39m2	A = 17.84m2
K_1 = 2.49	K1 = 6.74	K1 = 9.18	K1 = 10.97
K_2 = 3.18	K2 = 2.62	K2 = 2.11	K2 = 1.68
K = 7.92	K = 17.66	K = 19.37	K = 18.43
D = 3100mm	D = 3800mm	D = 4400mm	D = 5400mm

proper range: 4000mm < D <6000mm

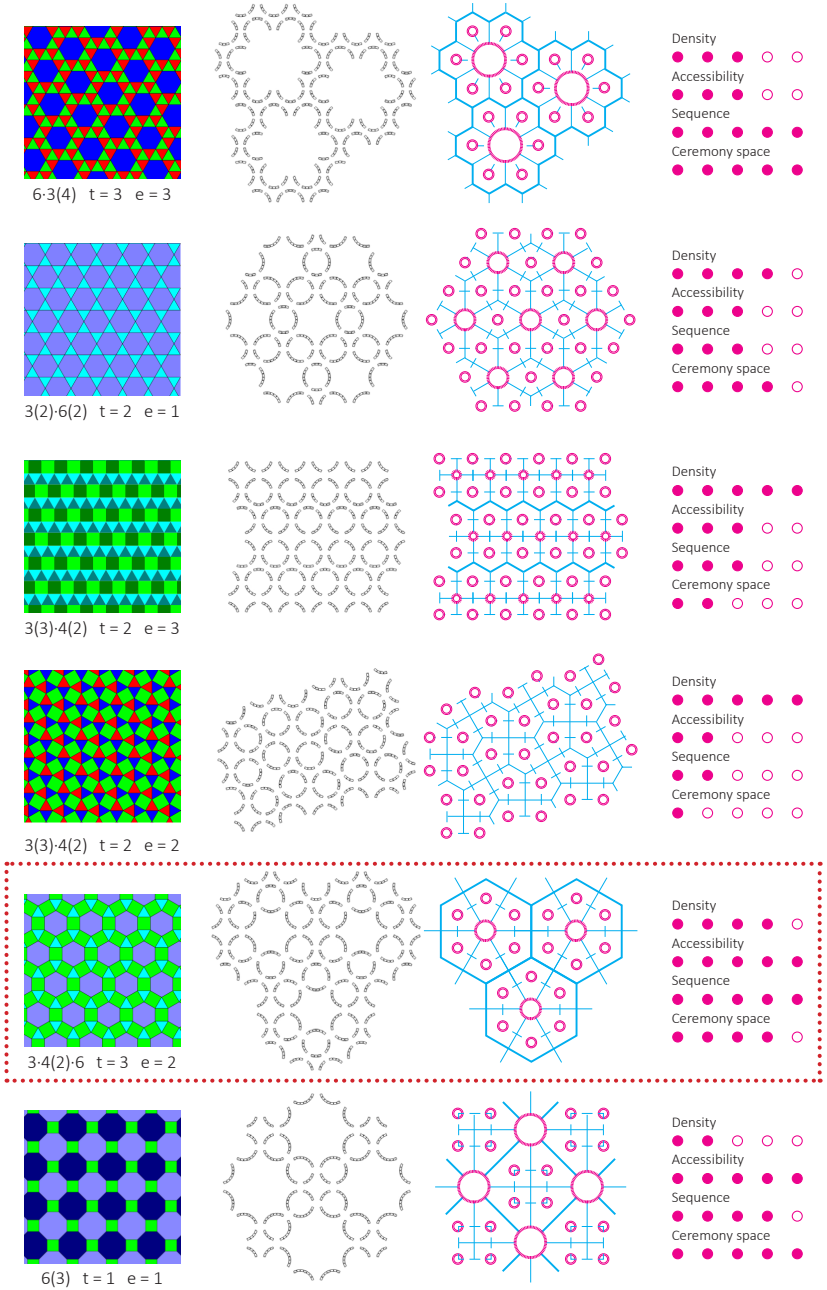
Overall arrangement

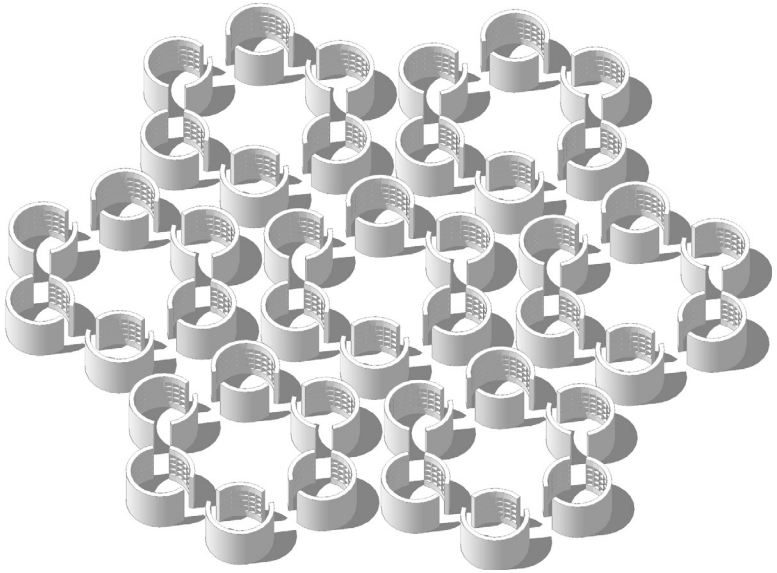
Evaluate each type in the aspect of **density**, **accessibility**, **sequence** and **ceremony space**.

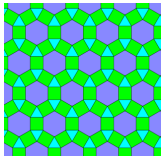
Regular tilings (3)
by single type of regular polygons



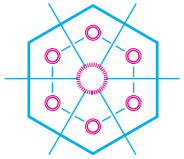
Uniform tilings (8)
by multipul types of regular polygons

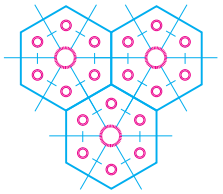






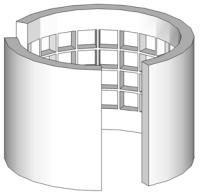
3·4(2)·6 t = 3 e = 2

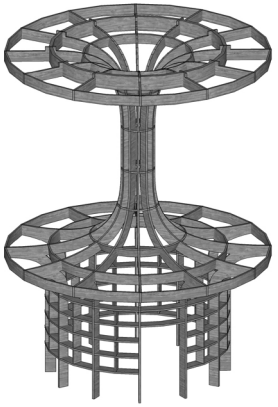




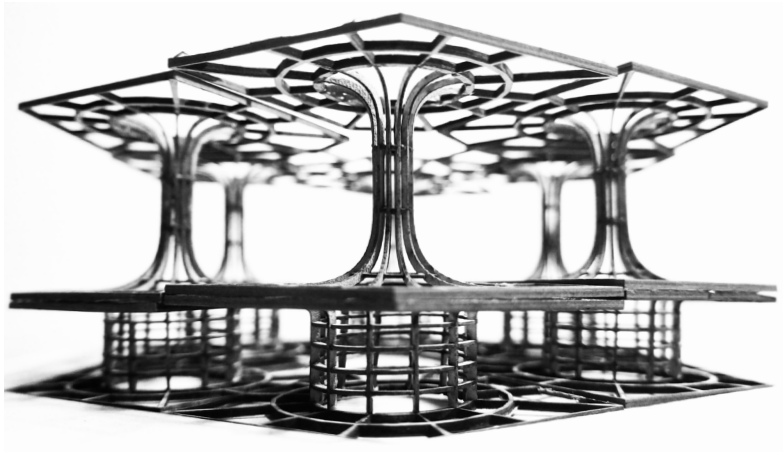
Density
Accessibility
Sequence
Ceremony space

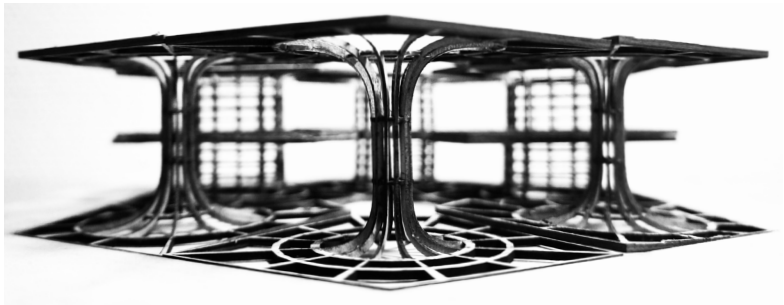
Vertical structure





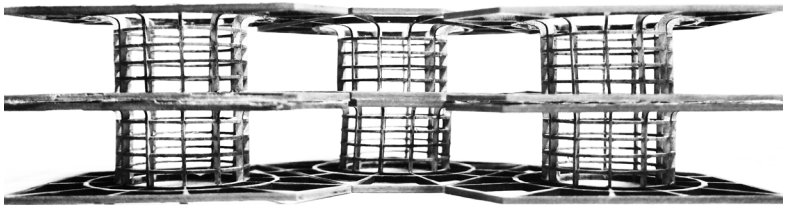
Structure system is really important for a vertical cemetery.
The **burial wall** could be designed as the origin of the vertical structure.
It will be boring if each floor copies the same type. So the unit tried to create totally **different space** for different activities **within the same structure system**.





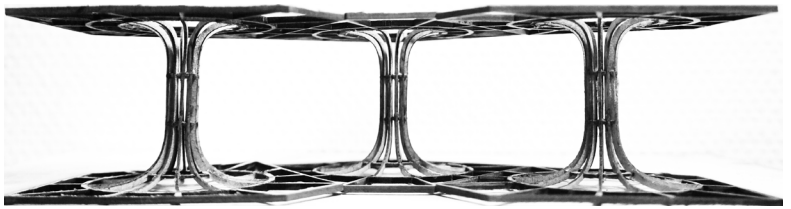
Space for **privite ceremony**

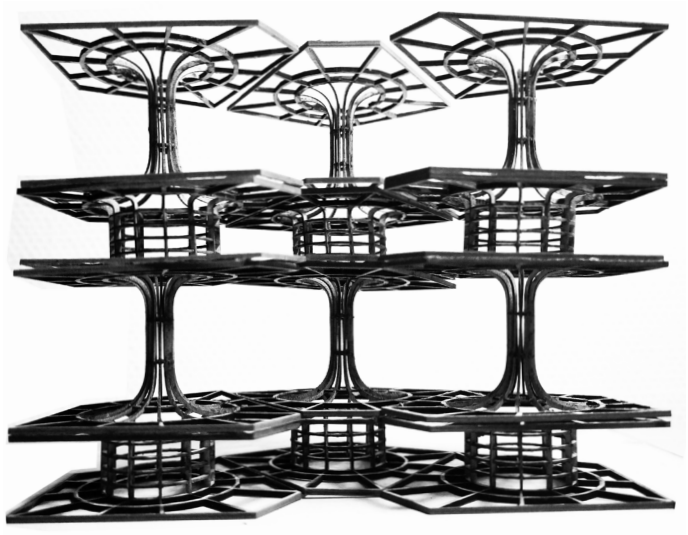
The structure based on the burial walls, creating more intimate and privite space.

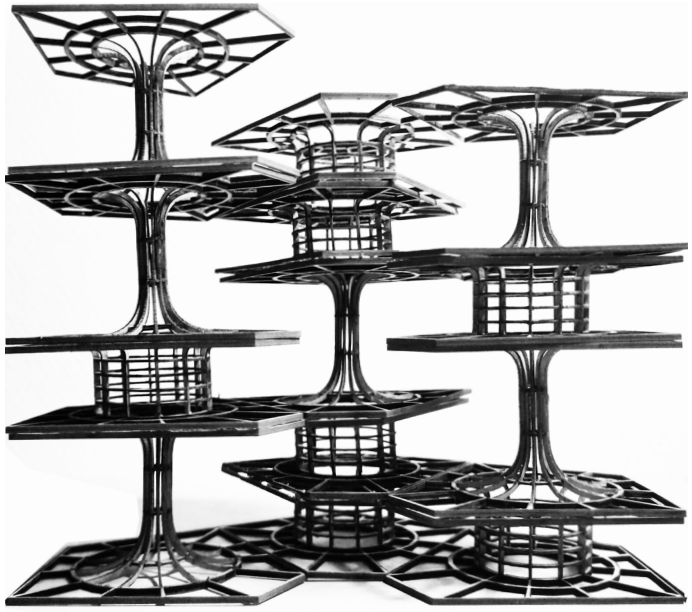


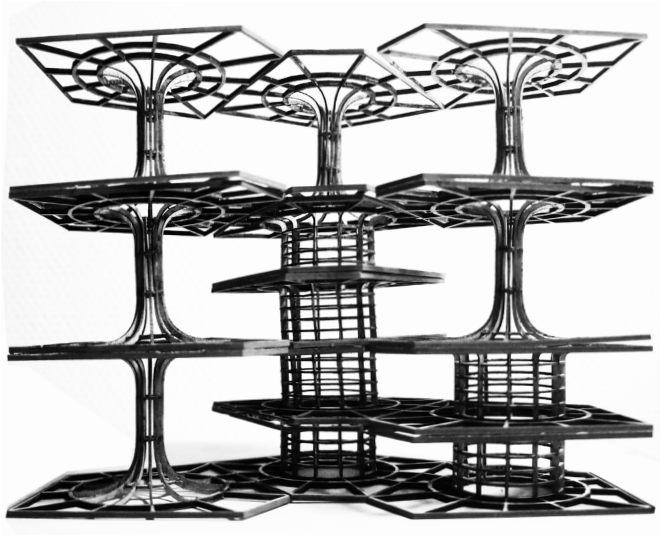
Space for **open ceremony**

The structure is in the form of columns, creating more bright and open space.









Reflection

The structure is not flexible enough since there are only two basic types of the units. Could we improve the construction system and create a more **natural experience** in the vertical cemetery?

PROTOTYPE

Inspiration

Figure 12. Woodland cemetery, Stockholm

The inspiration comes from the Woodland cemetery in Stockholm. What impressed me most was the **scale of the trees**. They are really tall and strongly attract your attention, so the graves are hidden in the forest. The experience is like you are surrounded by forest rather than only graves.

Reference

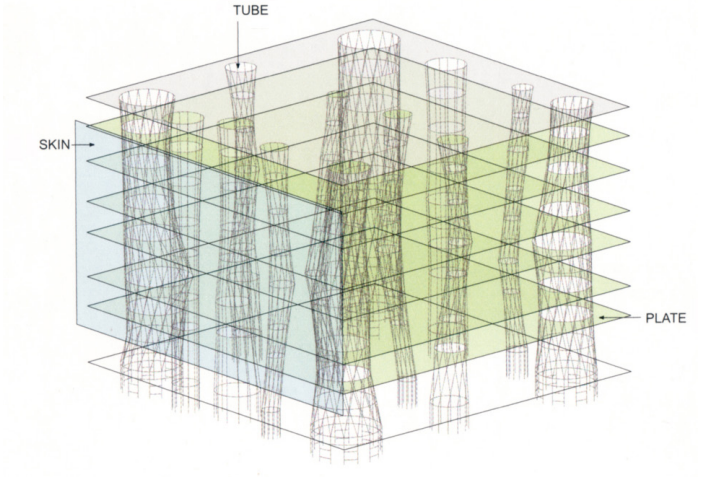
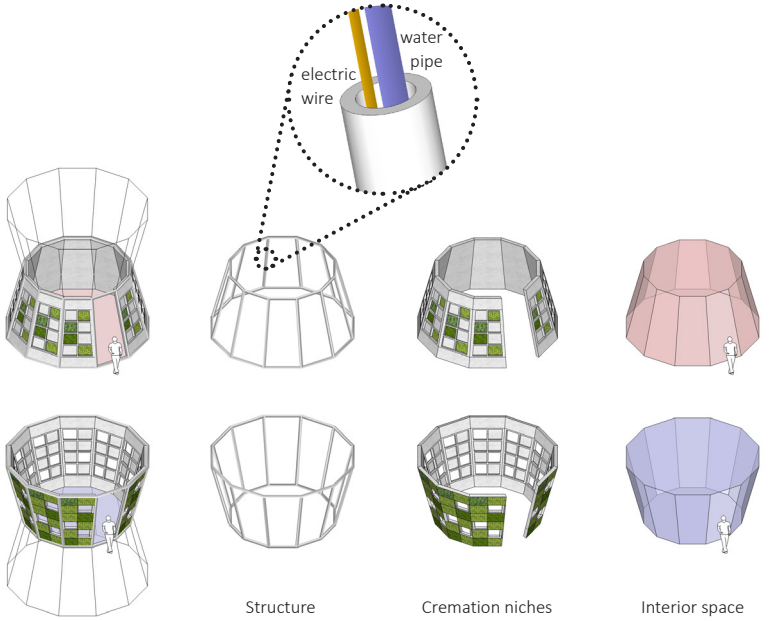


Figure 13. Construction system of Sendai Mediatheque

In Sendai Mediatheque designed by Toyo Ito, **structure as the highlight** of the space, strongly attracts people's attention and also creates a special experience of the interior space like forest.

The construction system of Sendai Mediatheque consists of three elements: **tube**, **plate** and **skin**.

The tube is not only a part of vertical structure but also provides space for stairs, elevators, electric and water pipes, sunlights and so on.



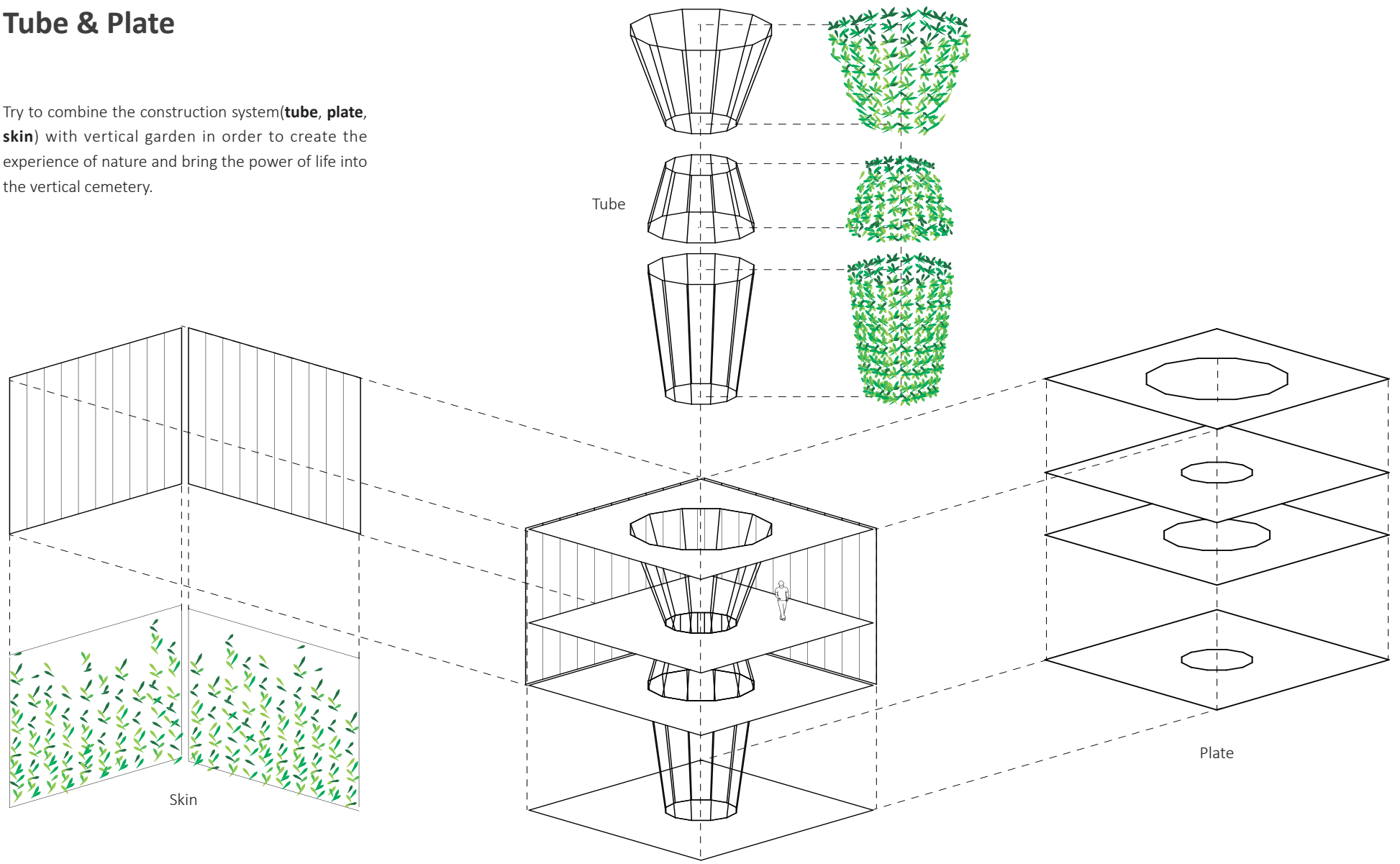
Structure
Water pipes and electric wires are put inside the structure.

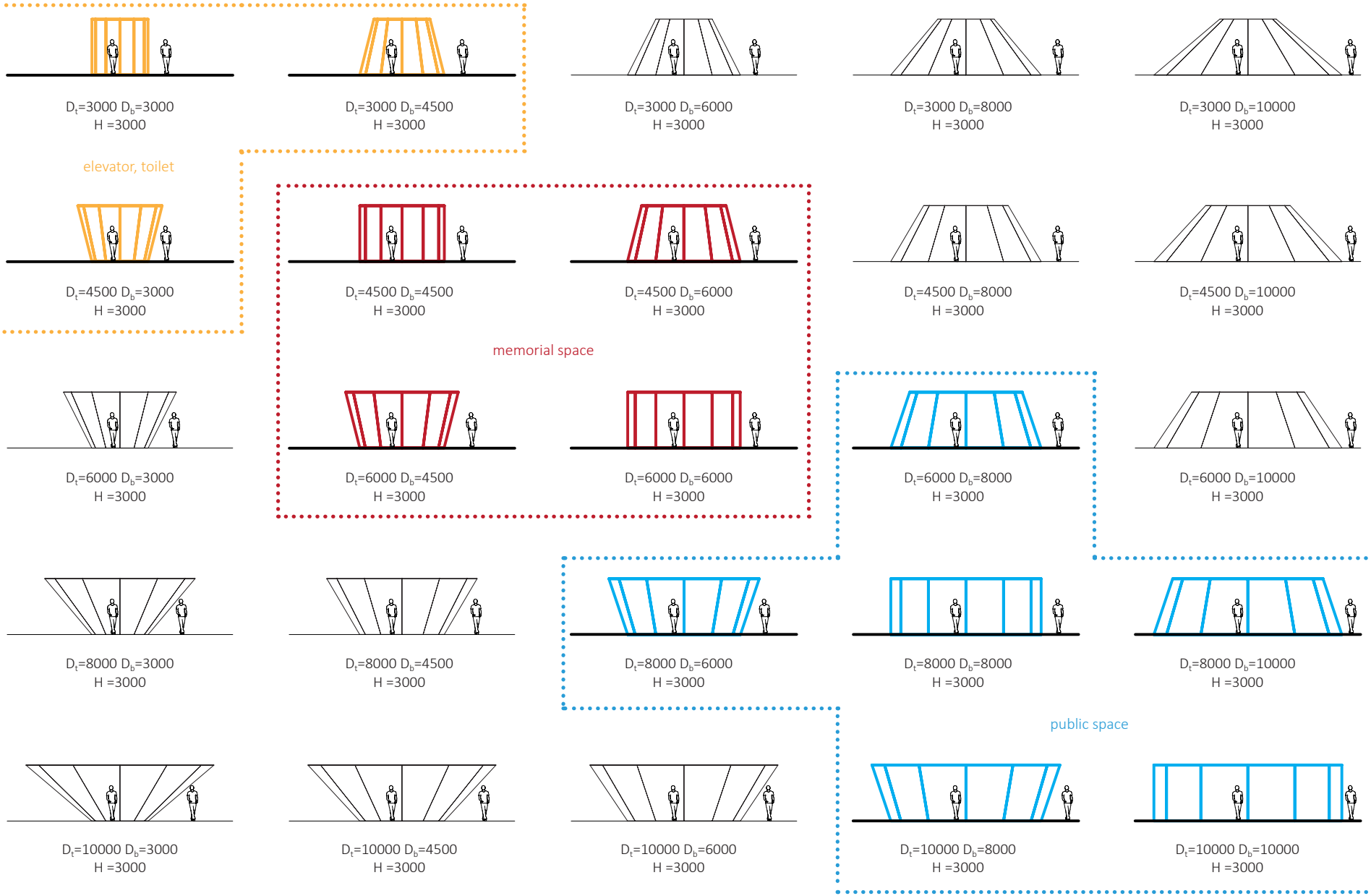
Cremation niches
Cremation niches are combined with the plant walls .

Interior space
The space inside the structre could be designed for various functions according to the shape of the tubes.

Tube & Plate

Try to combine the construction system(**tube**, **plate**, **skin**) with vertical garden in order to create the experience of nature and bring the power of life into the vertical cemetery.





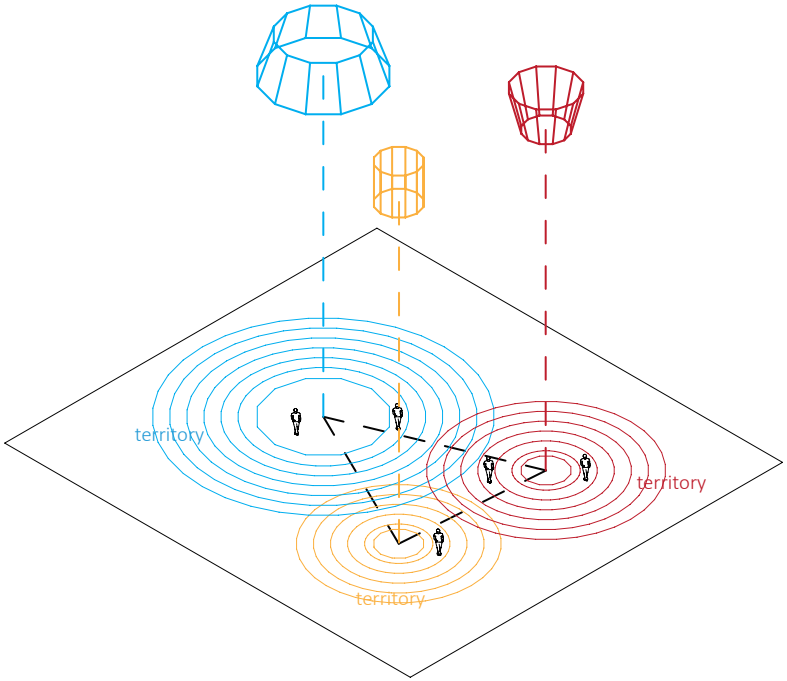
D_t=diameter of top circle, D_b=diameter of bottom circle, H=height of the tube

Occupation and connection

Each tube will be the center of its own territory. So the structure system of the plate could reflect the **occupation** and **connection** of the tubes.

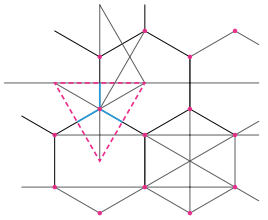
There are three kinds of regular tilings: **triangular**, **rectangular** and **hexagonal**.

Suppose each of them occupies same regional area, we could get a serious of parameters to evaluate each system.

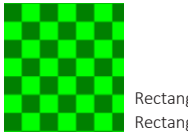


Tpye	Territory	Basic Net	S regional area	L length of structure	k the ratio of 'L' to 'S'	D distance between two center points
△	Triangular	Hexagonal	42.4	8.6	0.20	10.7
□	Rectangular	Rectangular	42.4	13	0.31	13
⬡	Hexagonal	Triangular	42.4	21	0.50	14

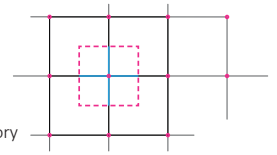
Hexagonal net
Triangular territory



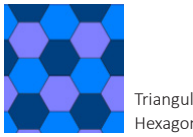
d = 5.7 S = 42.4
L = 3x5.7/2 = 8.6
k = 8.6/42.4 = 0.20
d1 = 5.7
d2 = 2x5.7 = 11.4
d2'= 2x5.7xCos30o = 9.9
e = (11.4-9.9)/9.9= 15.1%
D = 5.7+9.9/2 = 10.7



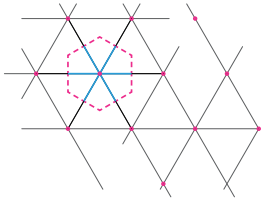
Rectangular net
Rectangular territory



d = 6.5 S = 42.4
L = 4x6.5/2 = 13
k = 13/42.4 = 0.31
d1 = 6.5
d2 = 2x6.5 = 13
d2'= 2x6.5xCos45o = 9.2
e = (13-9.2)/9.2 = 41.3%
D = 6.5+13/2 = 13

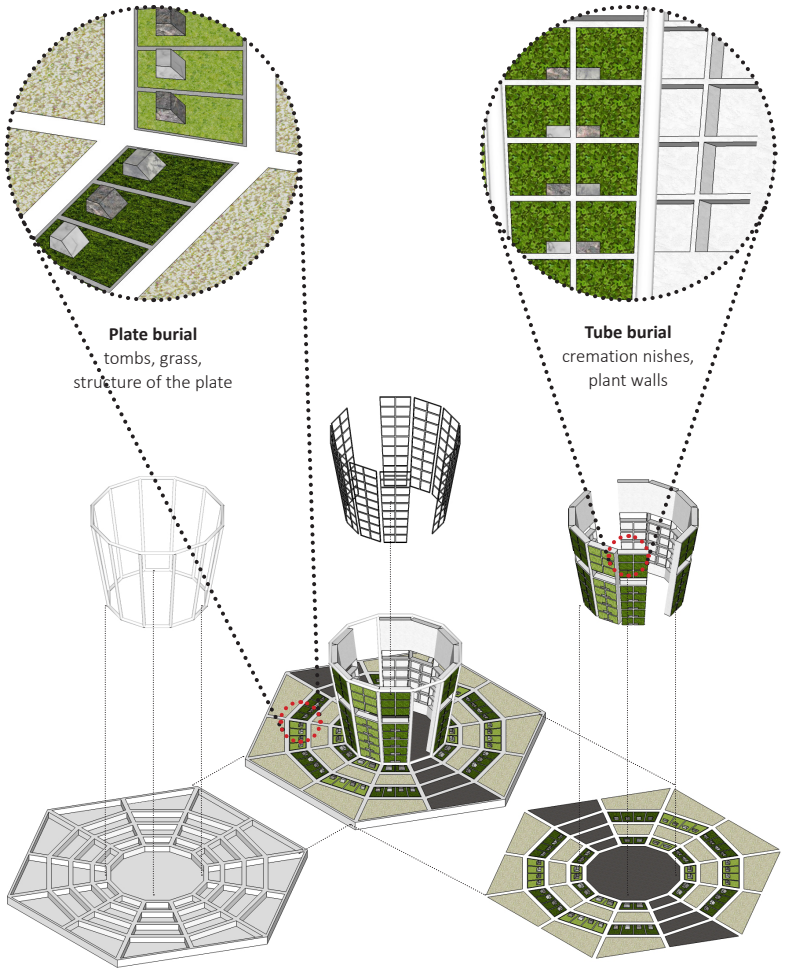


Triangular net
Hexagonal territory



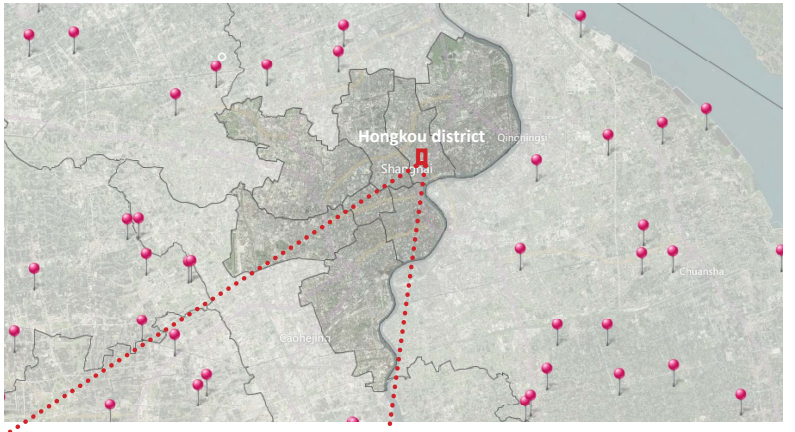
d = 7 S = 42.4
L = 6x3.5 = 21
k = 21/42.4 = 0.50
d1 = 7
d2 = 2x7 = 14
d2'= 2x7xCos30o = 12.2
e = (14-12.2)/12.2 = 14.7%
D = 7+14/2 = 14

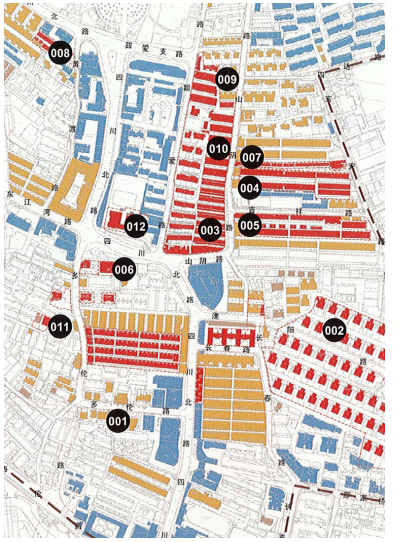
From the perspective of structure, **hexagonal territory** is the best choice.



Context

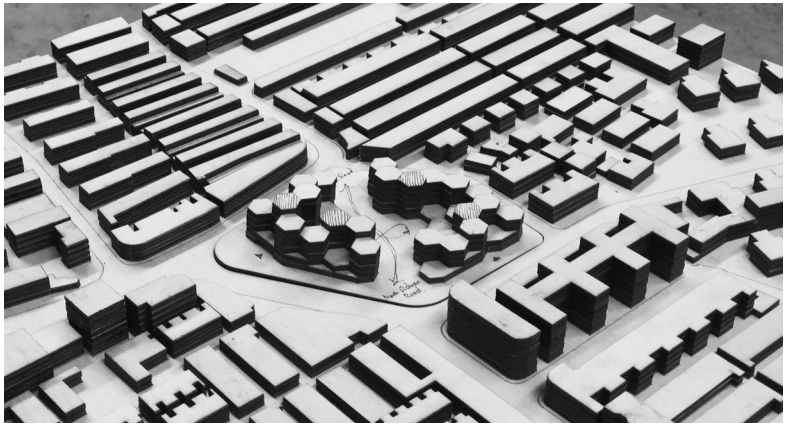
The site locates in a very central district in Shanghai





Shanyin Road- A famous **residential** area. There are many historic buildings, former residence of many famous persons. It's very quiet and peaceful.

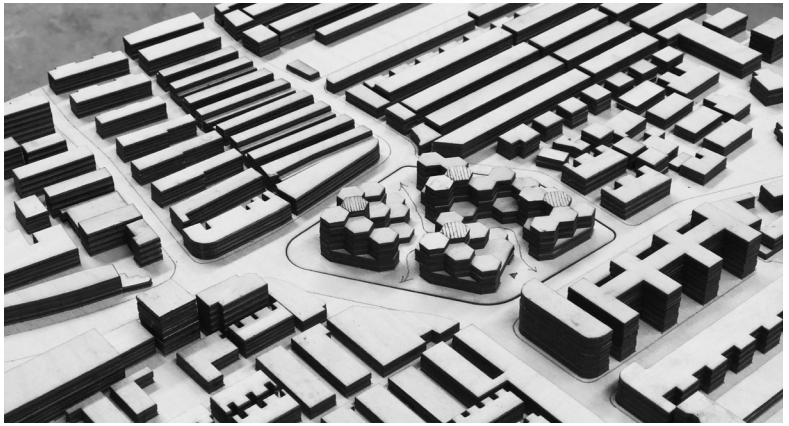
North Sichuan Road- One of the most important **commercial** street in Shanghai. There are many commercial buildings and office buildings. It's always crowded and energetic.

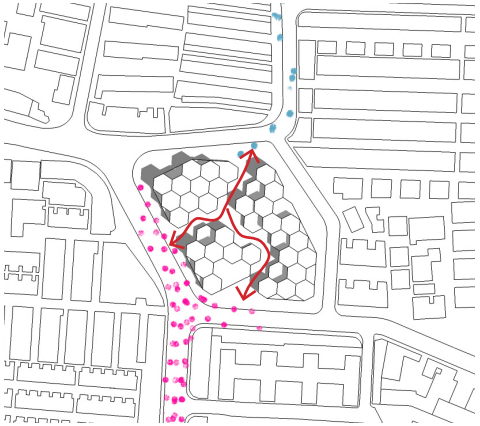


Strategy A

Strategy A creates a valley between two clusters, which directly connects two streets.

The problem is that the crowds in North Sichuan road could easily flood into the Shanyin road and damage the original atmosphere.



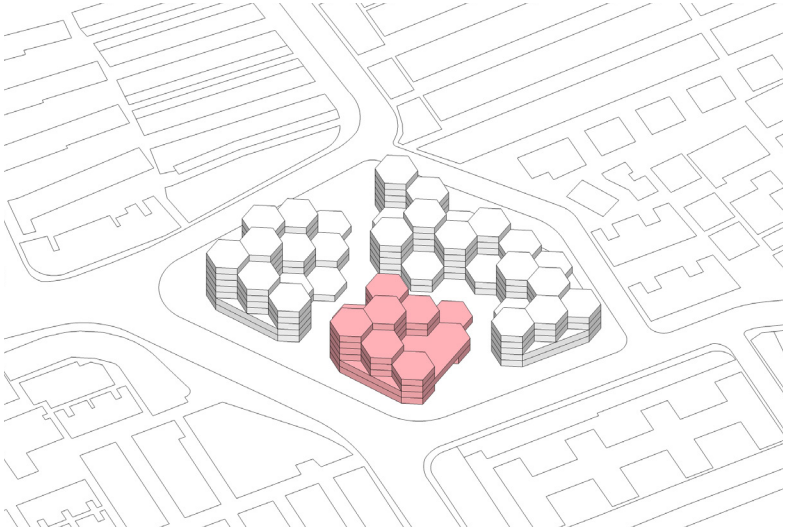


Strategy B (selected)

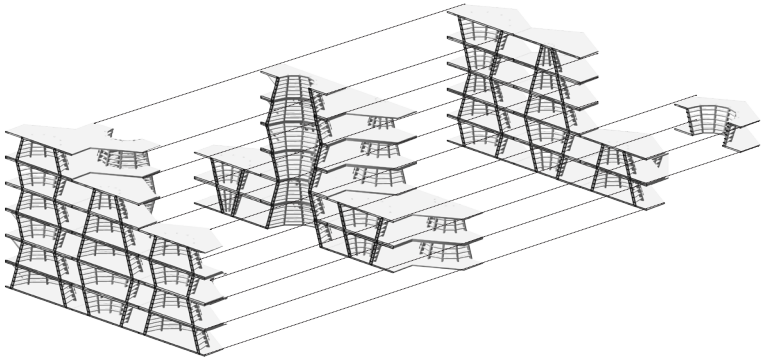
In strategy B there are three clusters divided by two valleys.

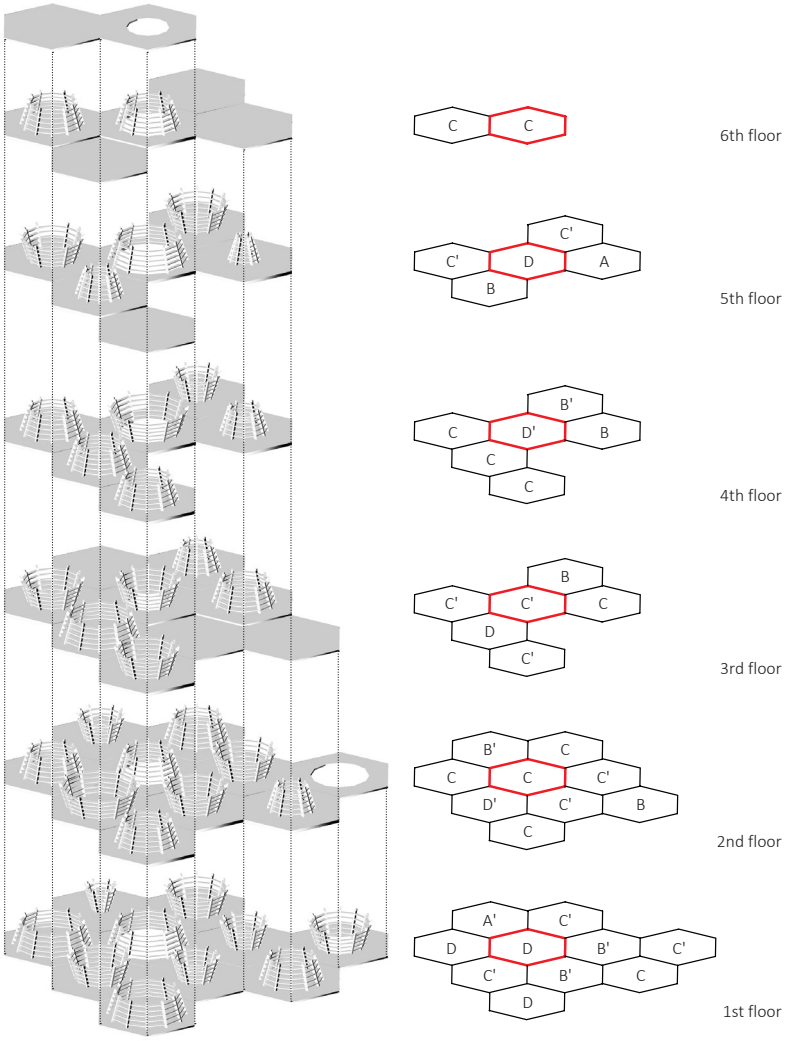
The surface towards the street is increased, which benefits commercial activities.

Formation

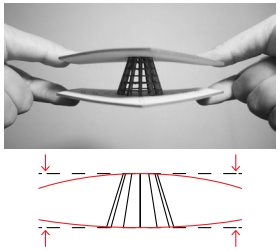


Based on the discussion of context and structure, an individual cluster is chosen to develop further.

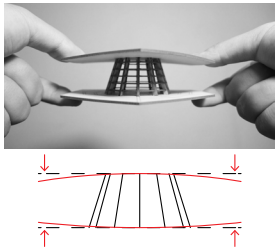


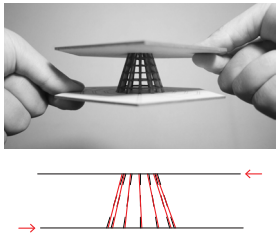


The structure analysis evaluates each unit in the aspect of **compressive strength**, **shear strength** and **torsional strength**.

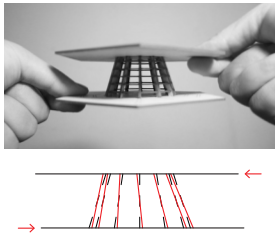


Compressive strength

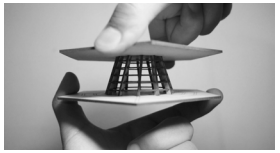


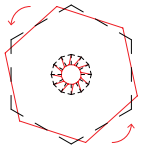


Shear strength



Torsional strength





Unit A

Compressive strength

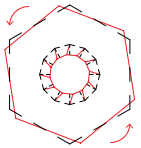
●○○○

Shear strength

●●●●

Torsional strength

●○○○



Unit B

Compressive strength

●●○○

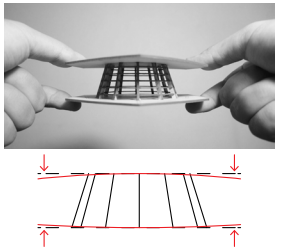
Shear strength

●●●○

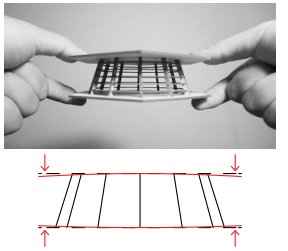
Torsional strength

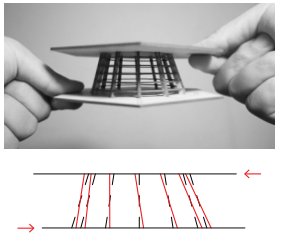
●●○○

The result shows the **combination rules** of how to organize them together.

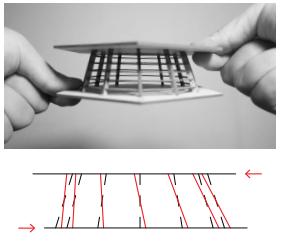


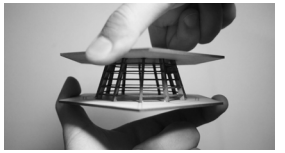
Compressive strength



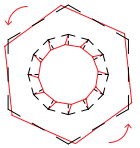


Shear strength





Torsional strength



Unit C

Compressive strength

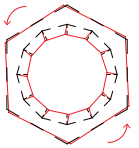
●●●○

Shear strength

●●○○

Torsional strength

●●●○



Unit D

Compressive strength

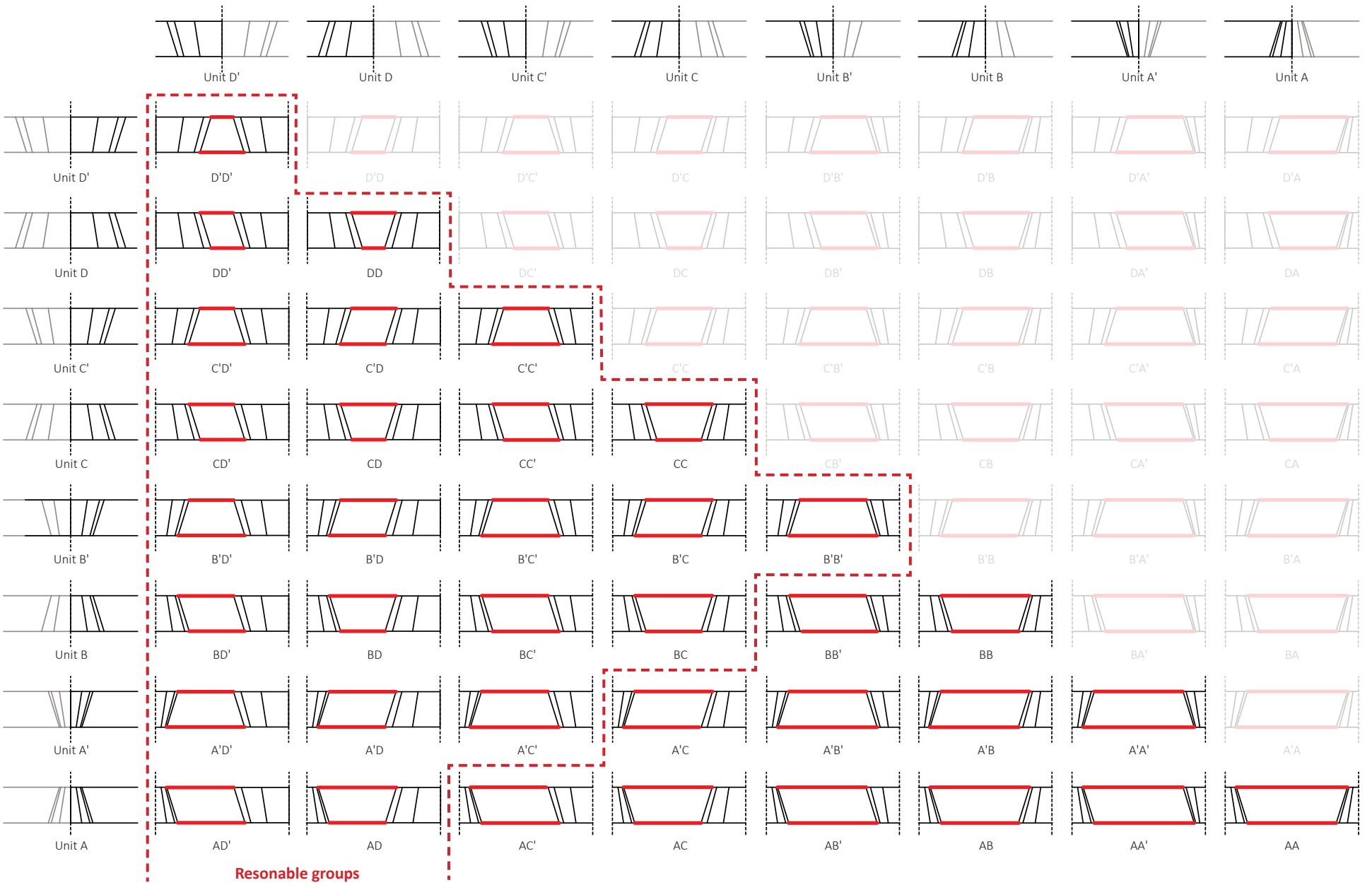
●●●●

Shear strength

●○○○

Torsional strength

●●●●


Unit D'
Unit D
Unit C'
Unit C
Unit B'
Unit B
Unit A'
Unit A
Unit D'
D'D'
D'D
D'C'
D'C
D'B'
D'B
D'A'
D'A
Unit D
DD'
DD
DC'
DC
DB'
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DA'
DA
Unit C'
C'D'
C'D
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Unit C
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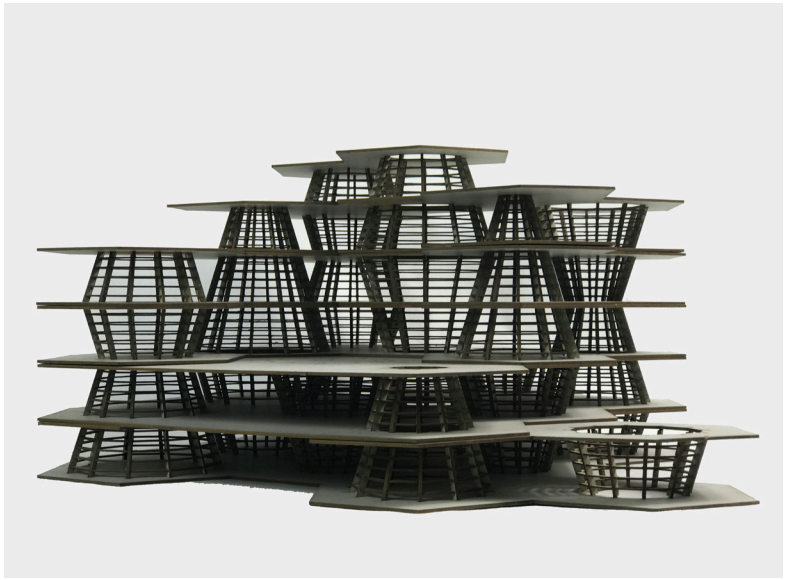
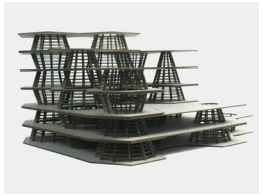
A'A
Unit A
AD'
AD
AC'
AC
AB'
AB
AA'
AA
Resonable groups

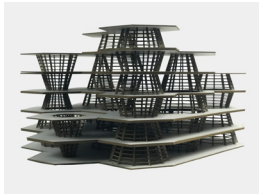
Reflection

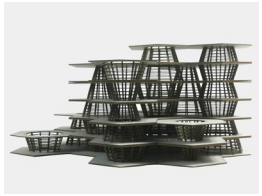
However, when I finish the model, I'm not satisfied with the space inside.

I realized that the quality of the natural space depends on the fact that there should be **no ground in the air**.

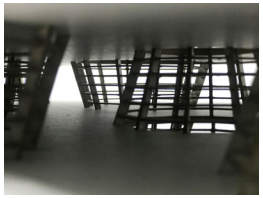








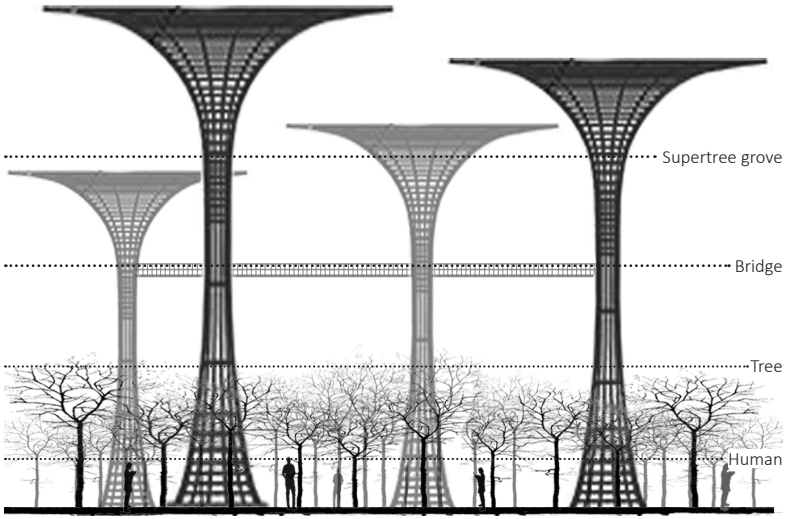
Urban vertical cemetery should not be a stacked volume and only increase the density of burial. It's also supposed to be more **open** to the public and provide a charming place inside the city, where people can see the **blue sky**, enjoying the **sunlight** and **fresh air**.



PROPOSAL

Inspiration

Figure 14. Gardens by the bay, Singapore

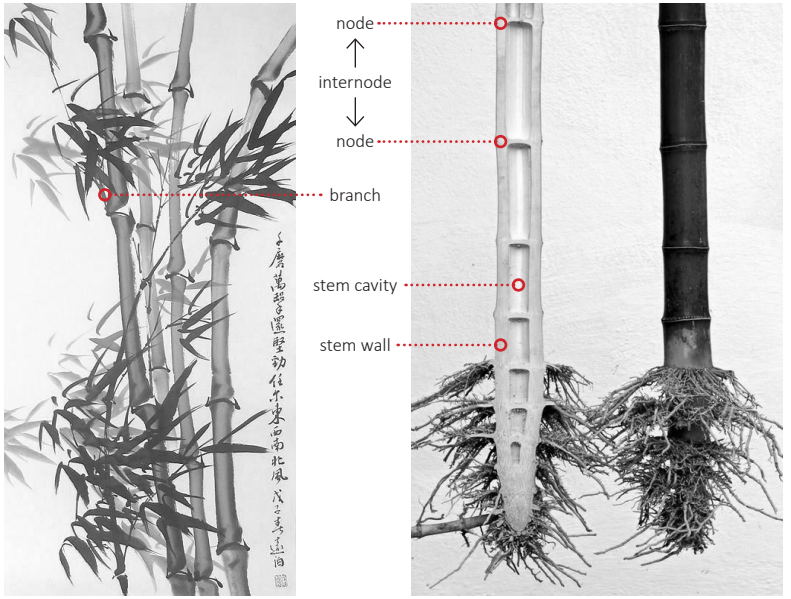


There are several super-tree groves scattered in the park.

The structure is really huge and organic, with varies kinds of plants climbing on. And the bridge connecting the neighboring groves provides a special experience of walking in the sky, which makes it an interesting place of tourist attraction.

Reference

Figure 15. Bamboo forest

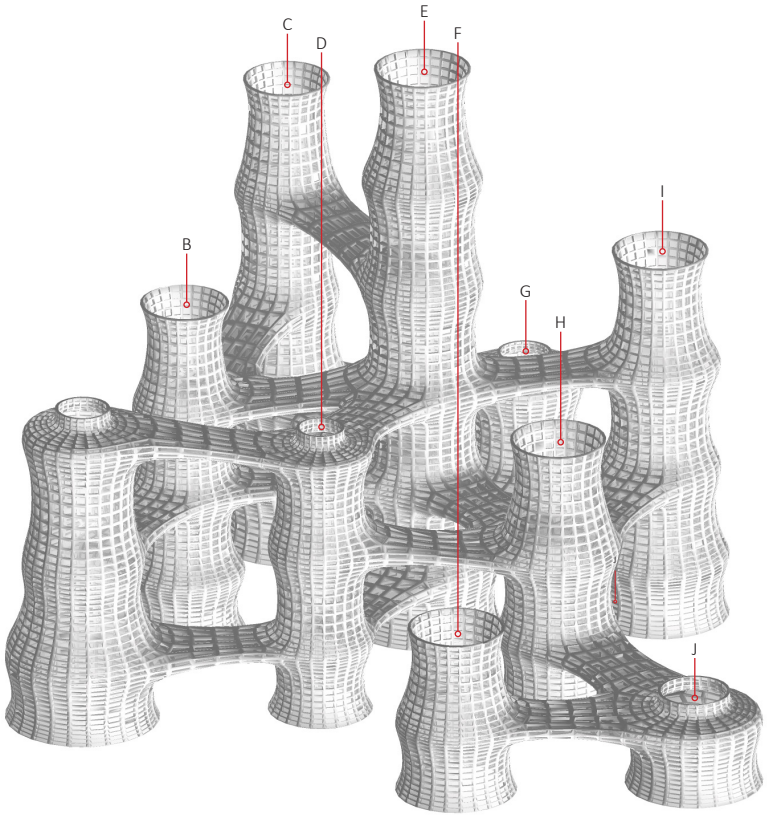


It happens that bamboo is very **popular** and enjoys really good reputation in Chinese culture, which symbolizes nobility and good personality of a person.

And the section of bamboo is also very interesting and we can learn a lot from it. The branch is always growing from the node. The height of the internode **increases** and the diameter of the internode **decreases** as it grow up, which is also reasonable from the perspective of structure.

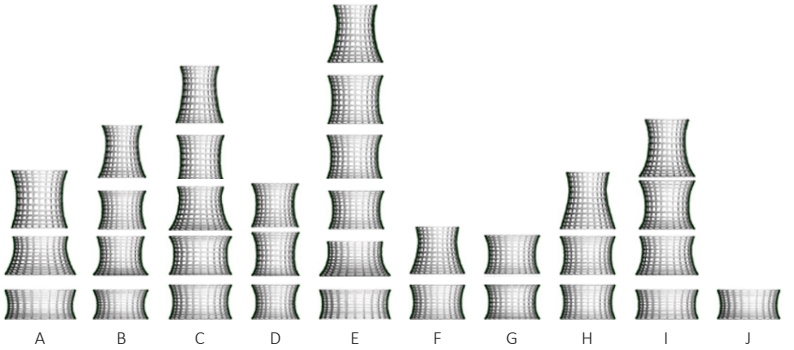
Internode & Branch

There is an evolution from **Tube & Plate** to **Internode & Branch**.



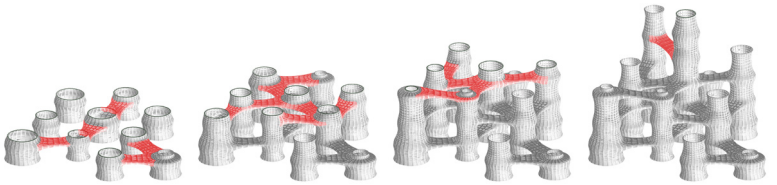
Internode

The internode unit varies in height and diameter, and the organization of them follows **the regulation of how bamboo grows**.
The internodes in up layers will be taller and narrower, while the internodes in low layers will be shorter and wider.



Branch

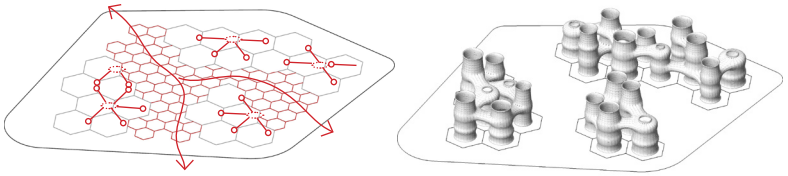
The branch growing from the node is not only a **transportation connection** between neighboring internodes but also a **structural element** that the internodes could support each other.



Organization

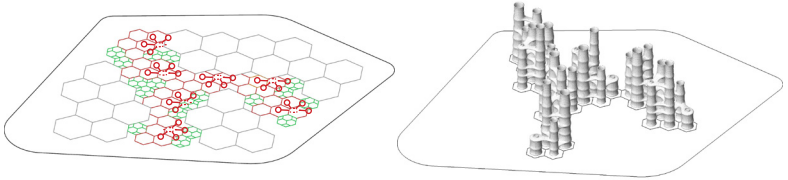
city program

the scale of the space inside is normal for city programs, such as museum, market, cafe, restaurant and so on.



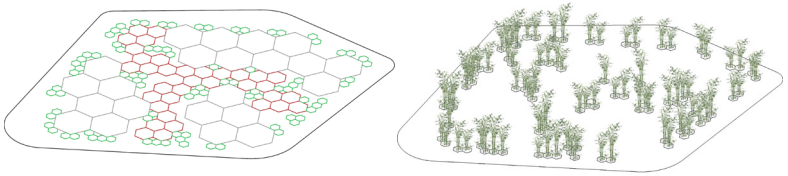
Cemetery

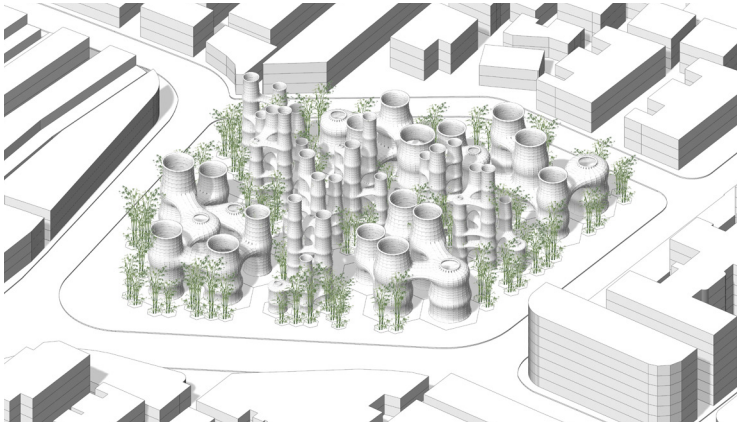
The scale of the space inside is more sacred, there will be columbarium room, chapel, memorial hall and so on.

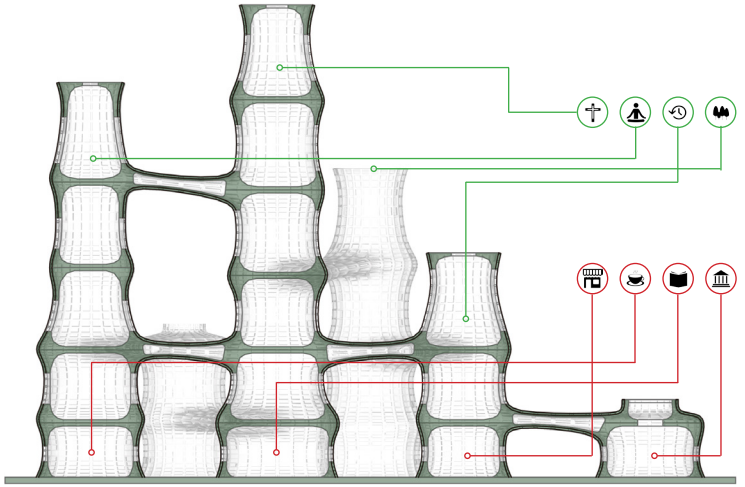


Landscape

Bamboo will be planted everywhere as the main natural landscape in the vertical cemetery.







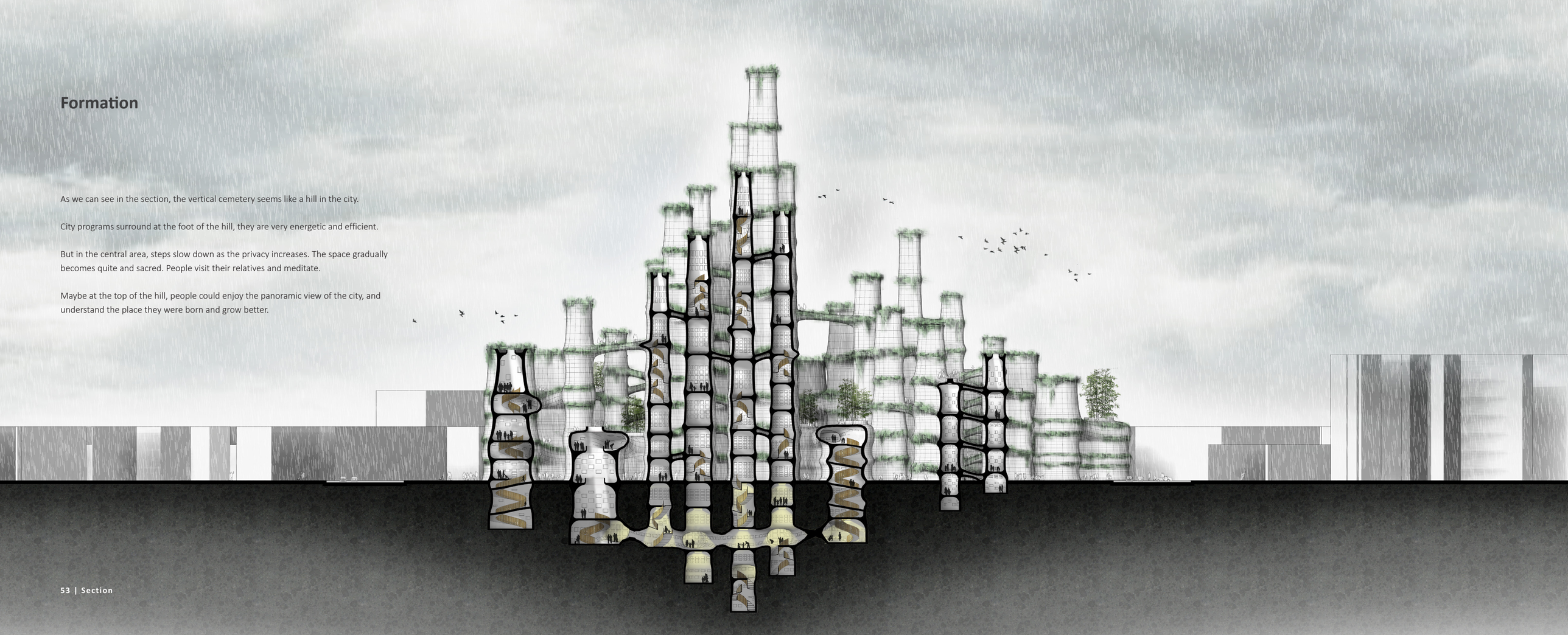
Formation

As we can see in the section, the vertical cemetery seems like a hill in the city.

City programs surround at the foot of the hill, they are very energetic and efficient.

But in the central area, steps slow down as the privacy increases. The space gradually becomes quite and sacred. People visit their relatives and meditate.

Maybe at the top of the hill, people could enjoy the panoramic view of the city, and understand the place they were born and grow better.

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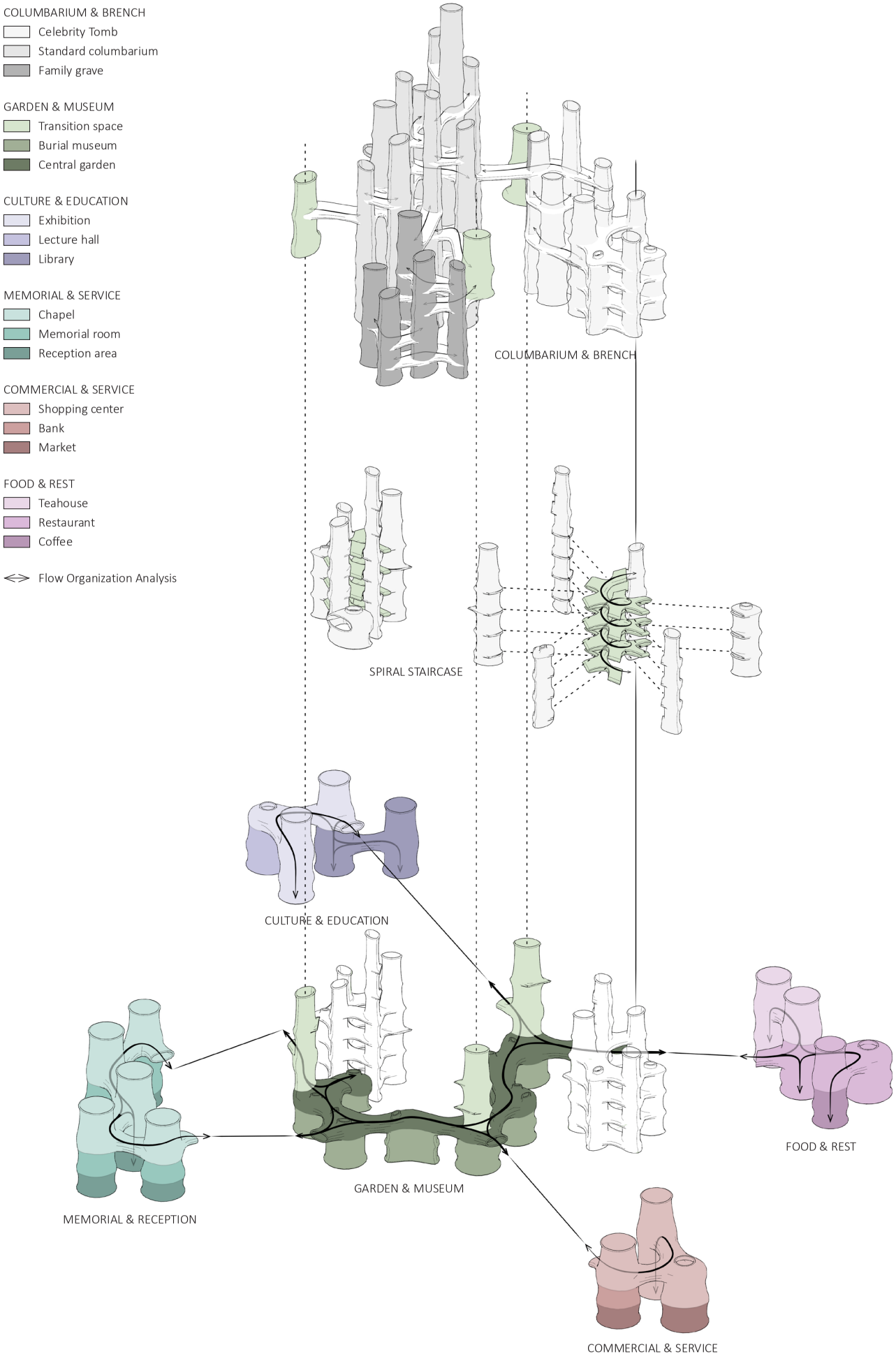
COLUMBARIUM & BRENCH
Celebrity Tomb
Standard columbarium
Family grave
GARDEN & MUSEUM
Transition space
Burial museum
Central garden
CULTURE & EDUCATION
Exhibition
Lecture hall
Library
MEMORIAL & SERVICE
Chapel
Memorial room
Reception area
COMMERCIAL & SERVICE
Shopping center
Bank
Market
FOOD & REST
Teahouse
Restaurant
Coffee
Flow Organization Analysis
COLUMBARIUM & BRENCH
SPIRAL STAIRCASE
CULTURE & EDUCATION
GARDEN & MUSEUM
FOOD & REST
MEMORIAL & RECEPTION
COMMERCIAL & SERVICE

SUPPLEMENT

Index of images

Figure 03. http://www.equipmentworld.com/as-land-for-graves-becomes-scarce-this-design-for-a-skyscraper-cemetery-could-be-the-resting-place-of-the-future/

Figure 04. http://www.evolo.us/architecture/vertical-cemetery-for-paris/

Figure 05. http://www.atlasandboots.com/la-paz-walking-tour/

Figure 06. http://www.haaretz.com/jewish/news/1.621256

Figure 07. http://dip9.aaschool.ac.uk/author/MANON_MOLLARD/

Figure 08. http://www.archdaily.com/95400/ad-classics-san-cataldo-cemetery-aldo-rossi

Figure 13. https://kmckitrick.wordpress.com/sendai-mediatheque-toyo-ito-kevin-mckitrick/

Figure 14. https://en.wikipedia.org/wiki/Gardens_by_the_Bay

Figure 15. http://ssl.panoramio.com/photo/126942683

All the other images were taken by the author.

All the schemes, drawings and visualisations were made by the author.

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