Cloud Matrix

Final Presentation

Earthy 4.0

Group 8

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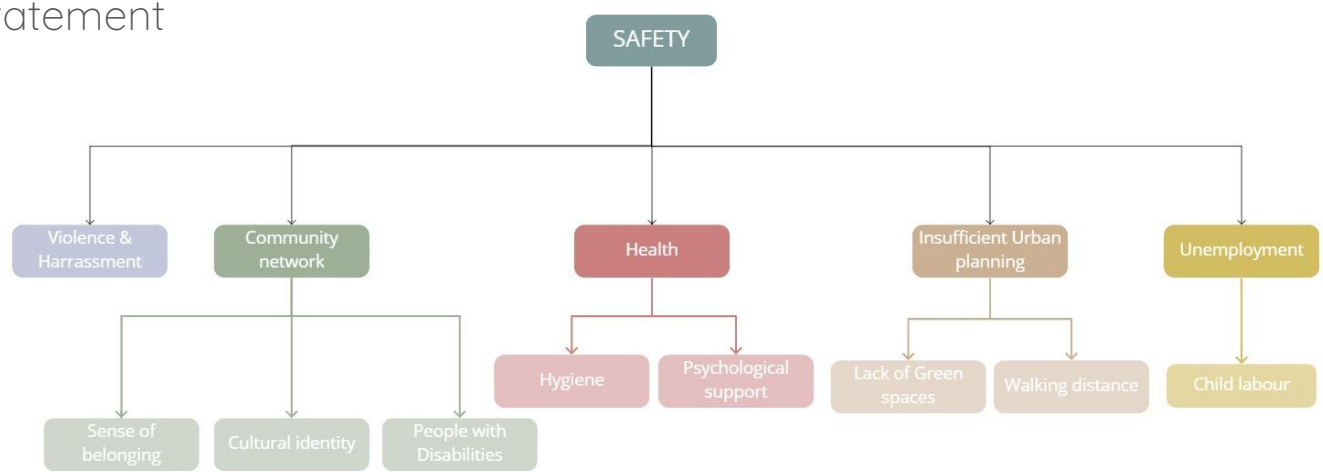
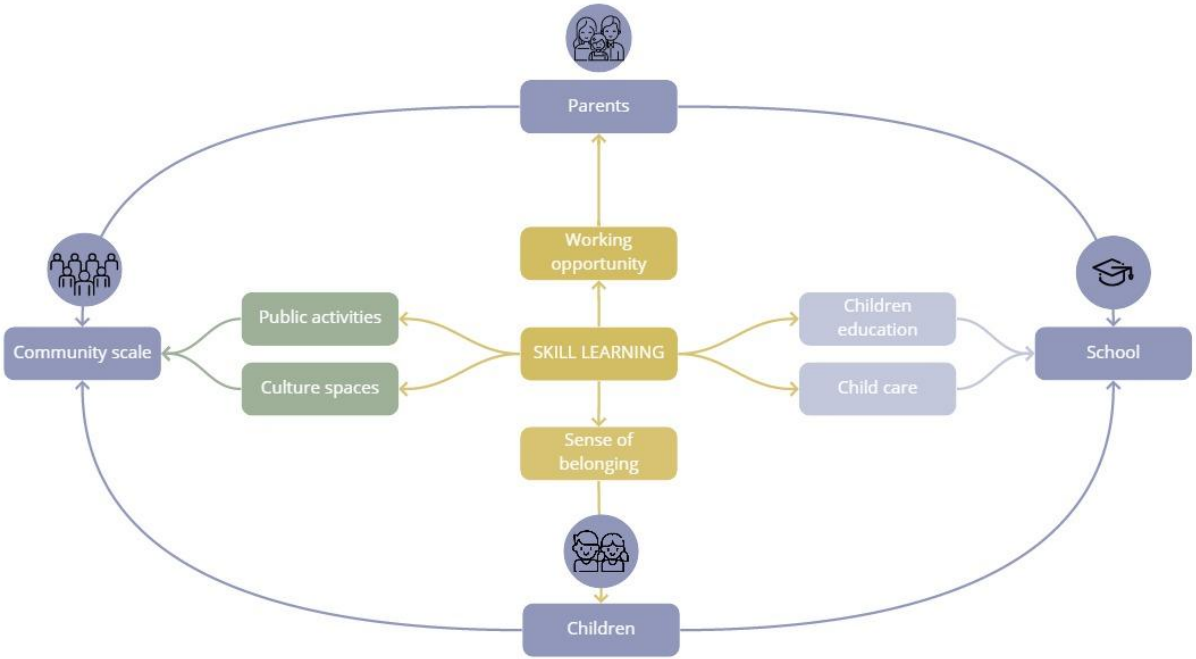
0.0 Initial Research

Facts

Problem Statement



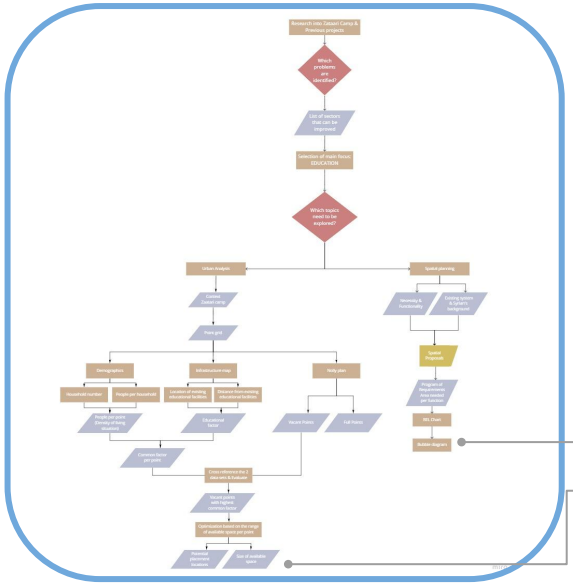
Design Vision



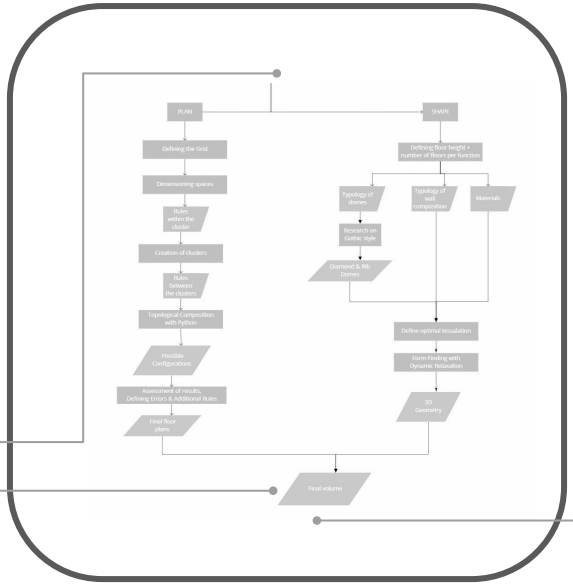
0.1 Configuration

Flowchart

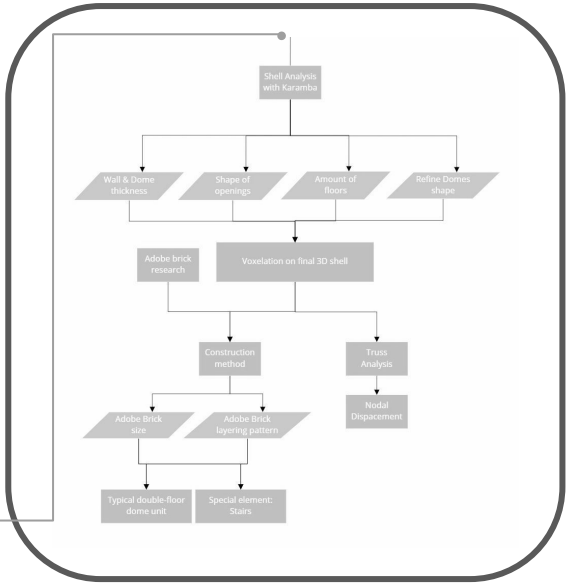
01. Configuration



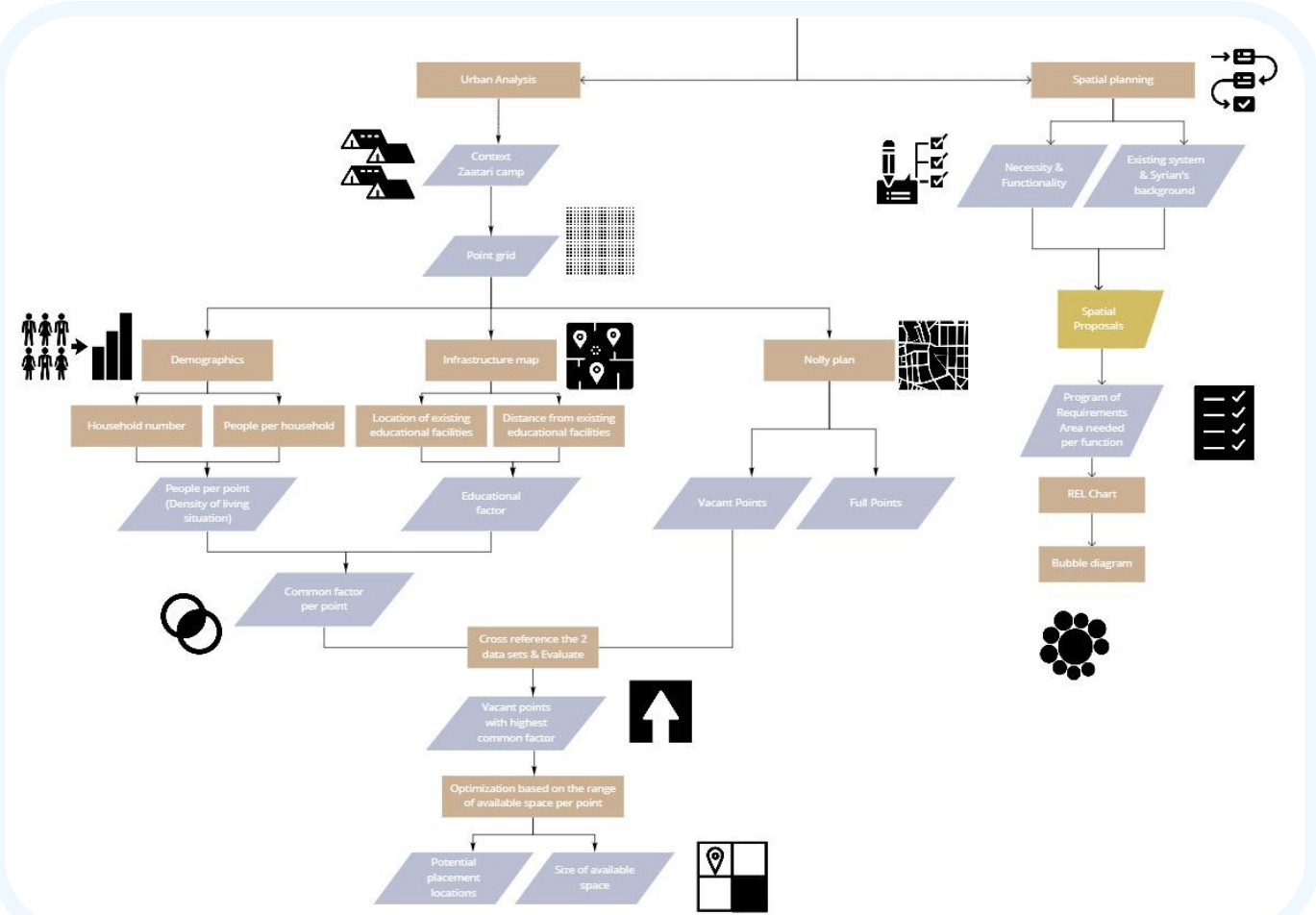
02. Forming



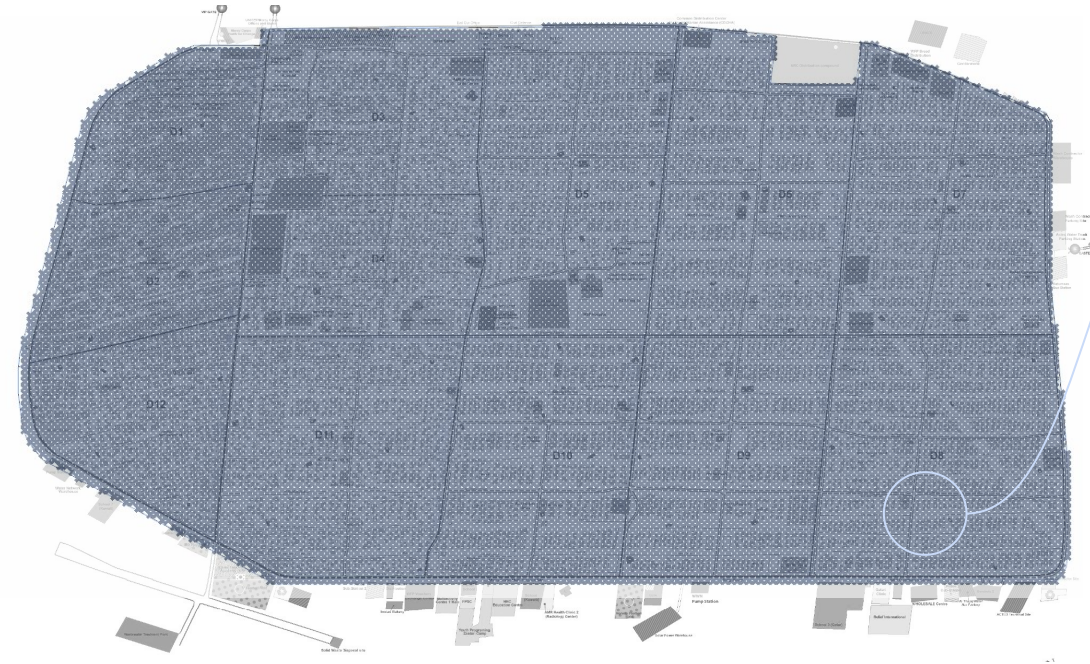
03. Structuring

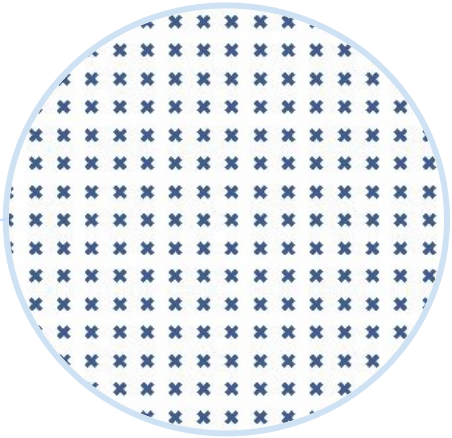


Flowchart


Urban Analysis
Spatial planning
Context Zaatari camp
Necessity & Functionality
Existing system & Syrian's background
Point grid
Spatial Proposals
Demographics
Infrastructure map
Nolly plan
Household number
People per household
Location of existing educational facilities
Distance from existing educational facilities
Program of Requirements Area needed per function
People per point (Density of living situation)
Educational factor
Vacant Points
Full Points
REL Chart
Bubble diagram
Common factor per point
Cross reference the 2 data sets & Evaluate
Vacant points with highest common factor
Optimization based on the range of available space per point
Potential placement locations
Size of available space

Point matrix in camp



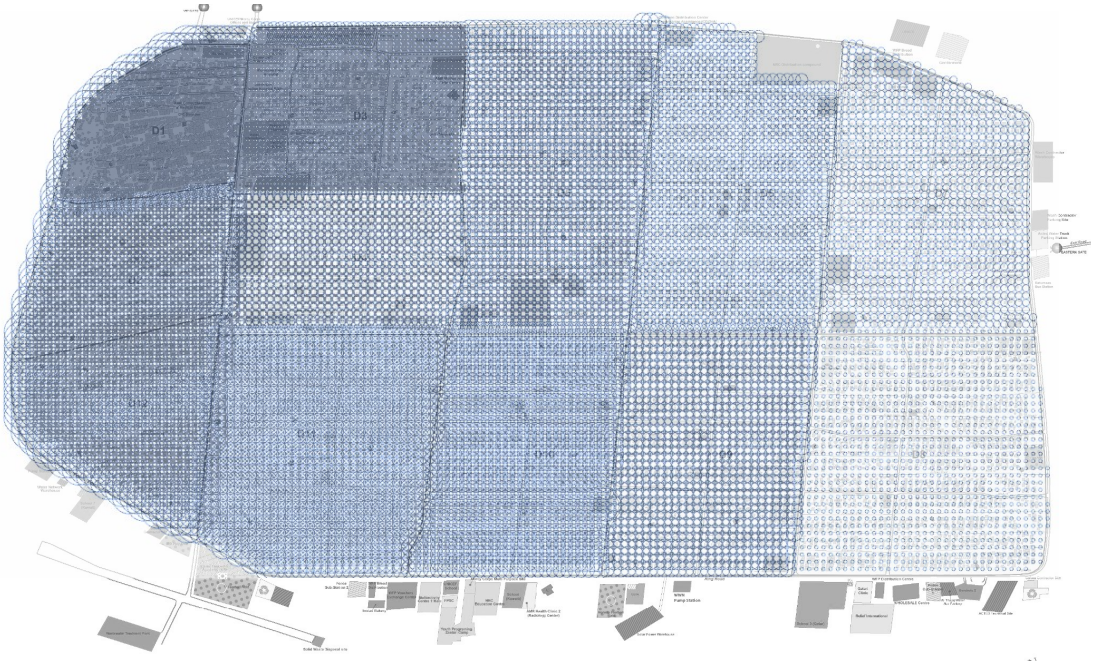


A Point Cloud is used in order to parameterize the process.

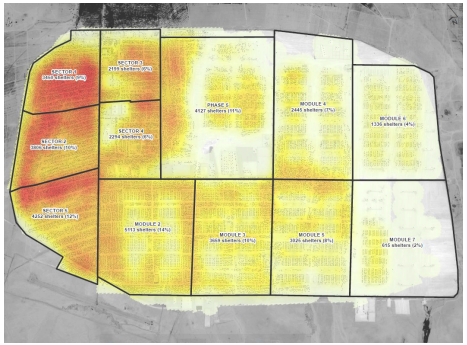
Point matrix = 2*2 m2 = **14548 points**

Population Factor

A1_Household Number



Point matrix = 2*2 m2 = **14548 points**



(source:https://reliefweb.int/map/jordan/al-zaatari-refugee-camp-shelter-locations-and-shelter-density-31-march-2013)

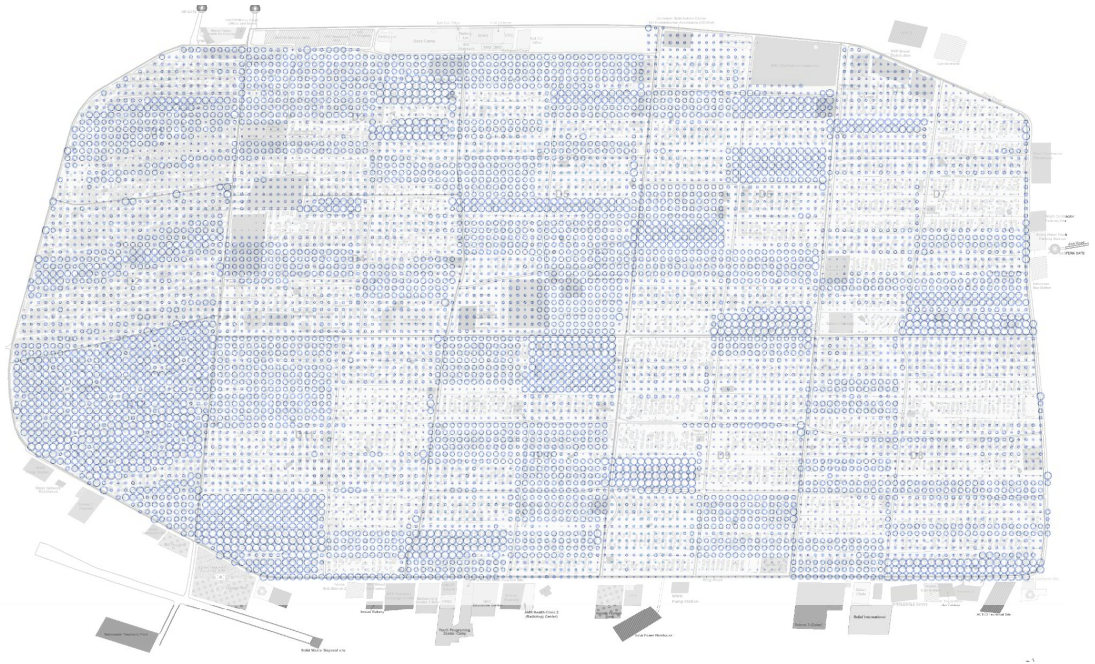
Sector	household	population	age range	people number
1	3450	18113	0 to 4	3568
			5 to 11	3894
			12 to 17	2608
			18 to 59	7426
			60-	689
2	3806	21276	0 to 4	4191
			5 to 11	4574
			12 to 17	3064
			18 to 59	8723
			60-	574
3	2199	12456	0 to 4	2454
			5 to 11	2678
			12 to 17	1794
			18 to 59	5107
			60-	336
4	2294	12407	0 to 4	2444
			5 to 11	2667
			12 to 17	1787
			18 to 59	5087
			60-	335
5	4127	23362	0 to 4	4602
			5 to 11	5023
			12 to 17	3364
			18 to 59	9579
			60-	631
6	2445	13643	0 to 4	2688
			5 to 11	2933
			12 to 17	1965
			18 to 59	5594
			60-	368

Sector	household	population	age range	people number
7	1336	7114	0 to 4	1401
			5 to 11	1530
			12 to 17	1024
			18 to 59	2917
			60-	192
8	615	3375	0 to 4	665
			5 to 11	726
			12 to 17	486
			18 to 59	1384
			60-	91
9	3025	16275	0 to 4	3206
			5 to 11	3499
			12 to 17	2344
			18 to 59	6673
			60-	439
10	3659	20971	0 to 4	4131
			5 to 11	4529
			12 to 17	3020
			18 to 59	8598
			60-	566
11	5113	28409	0 to 4	5597
			5 to 11	6108
			12 to 17	4091
			18 to 59	11648
			60-	767
12	4252	25767	0 to 4	5076
			5 to 11	5540
			12 to 17	3710
			18 to 59	10565
			60-	696

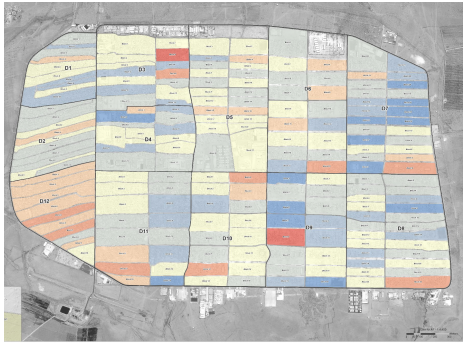
Hand Calculation

Population Factor

A2_People number per household



The bigger radius the more people in one household.



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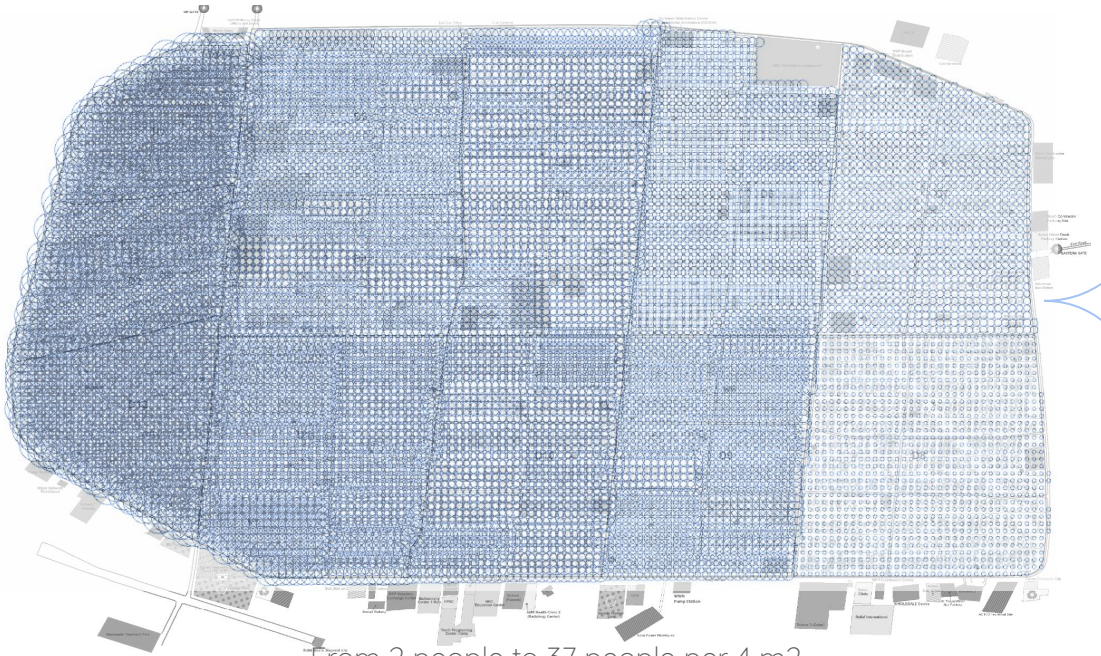
			5 to 11	5540
			12 to 17	3710
			18 to 59	10565
			60-	696

Hand Calculation

Population Factor (people per 4m2)

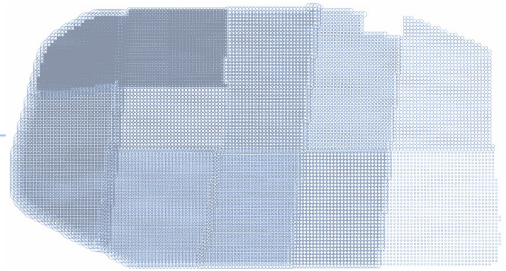
A=A1*A2



From 2 people to 37 people per 4 m2

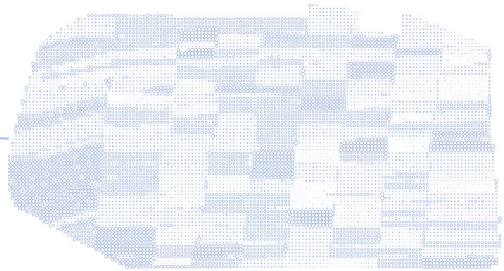
The darker blue the highest density.

A1



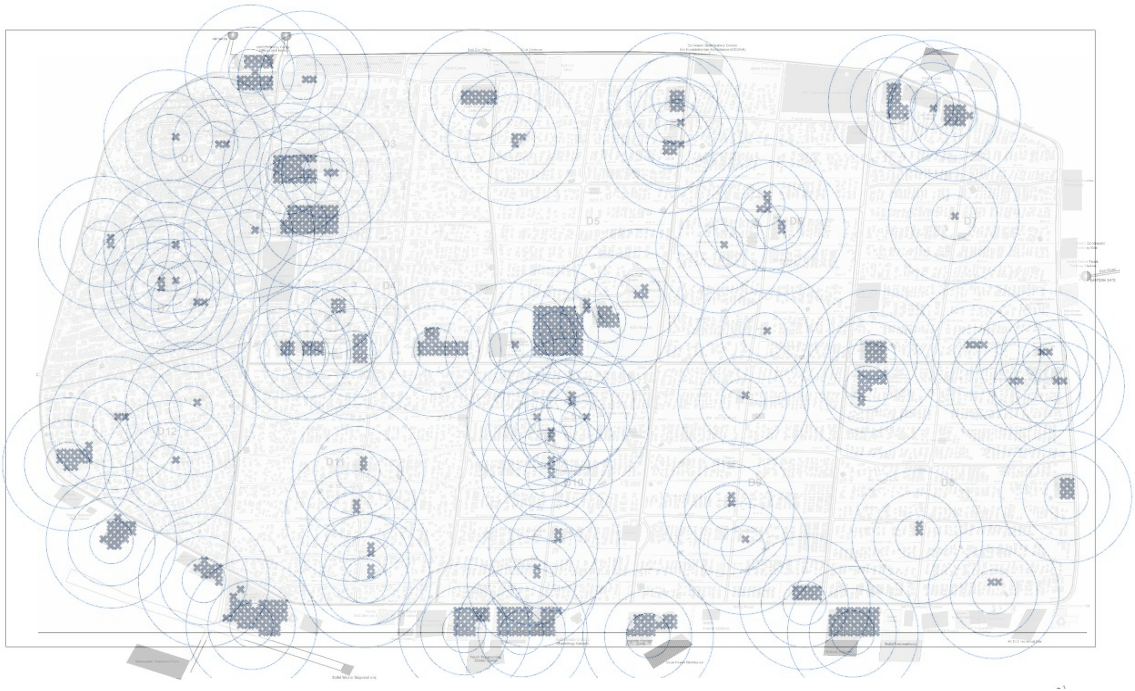
Household number

A2



People number per household

Educational facilities

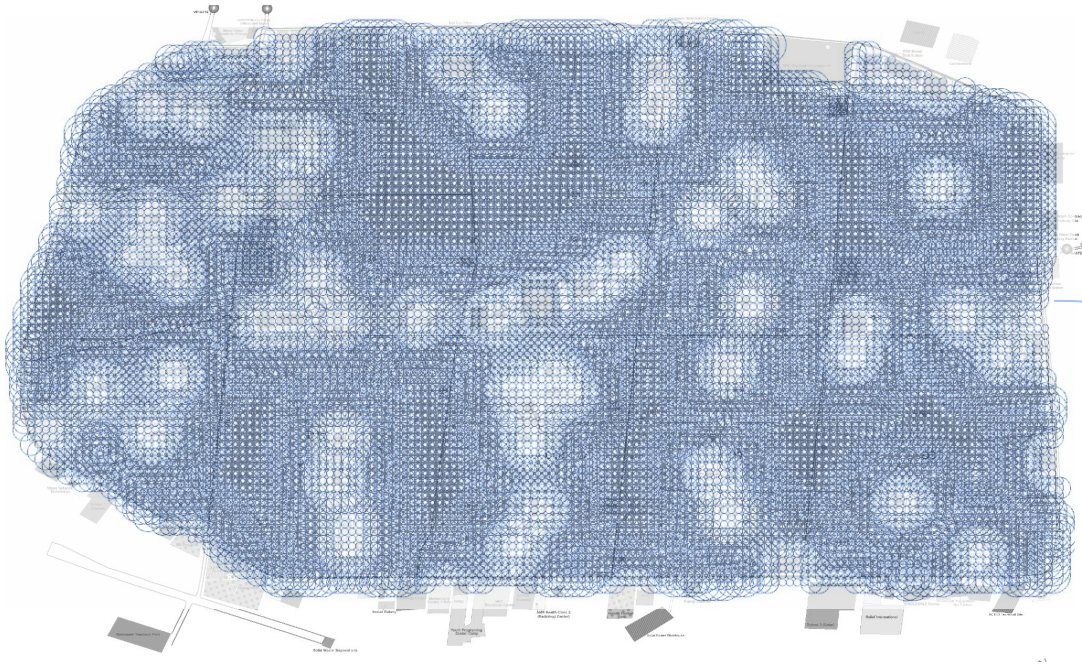


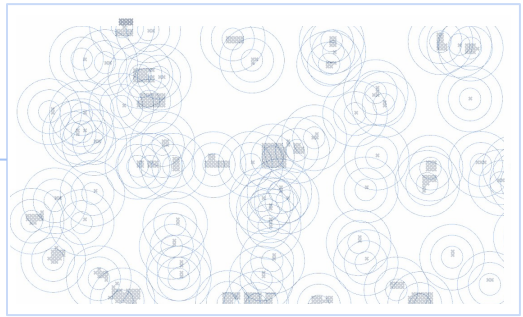
(source: UNHCR)

Homocentric circles show the distance from each educational facility.

Educational factor

B

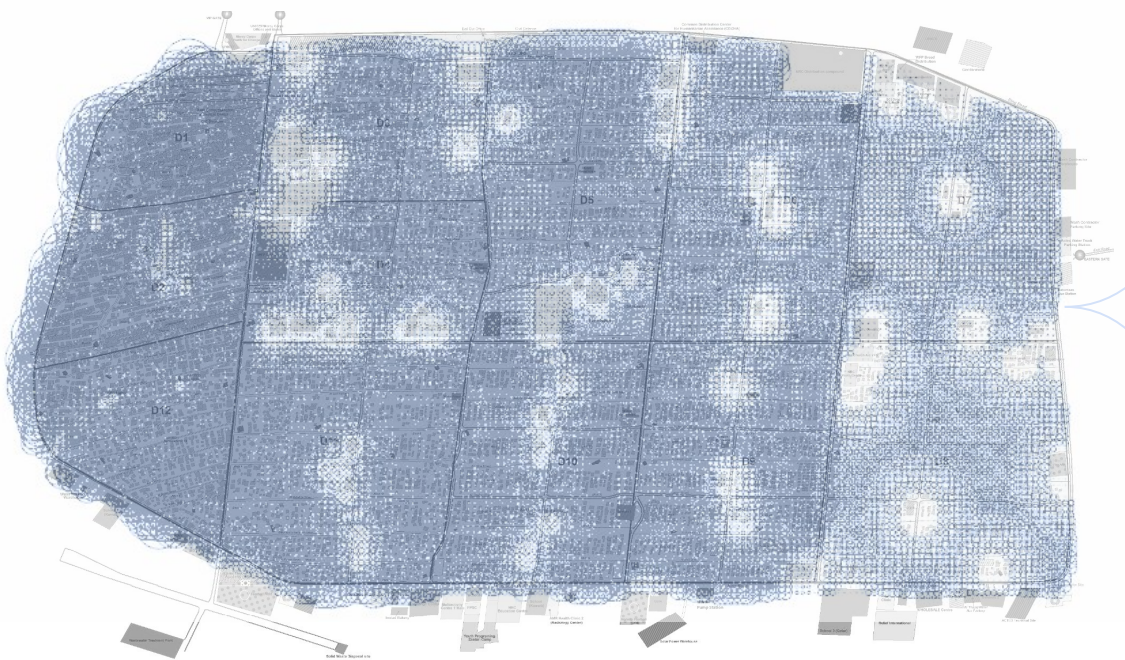




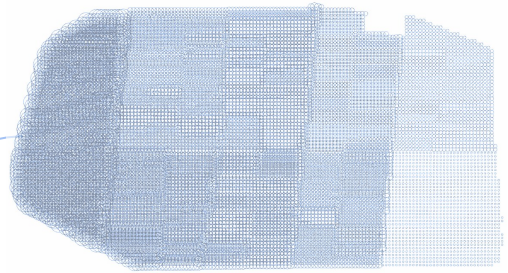
The darker blue the more distant from an educational center.

Common factor

$$C = A * B$$

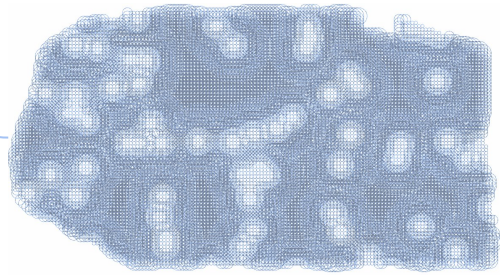


A



Population Factor

B



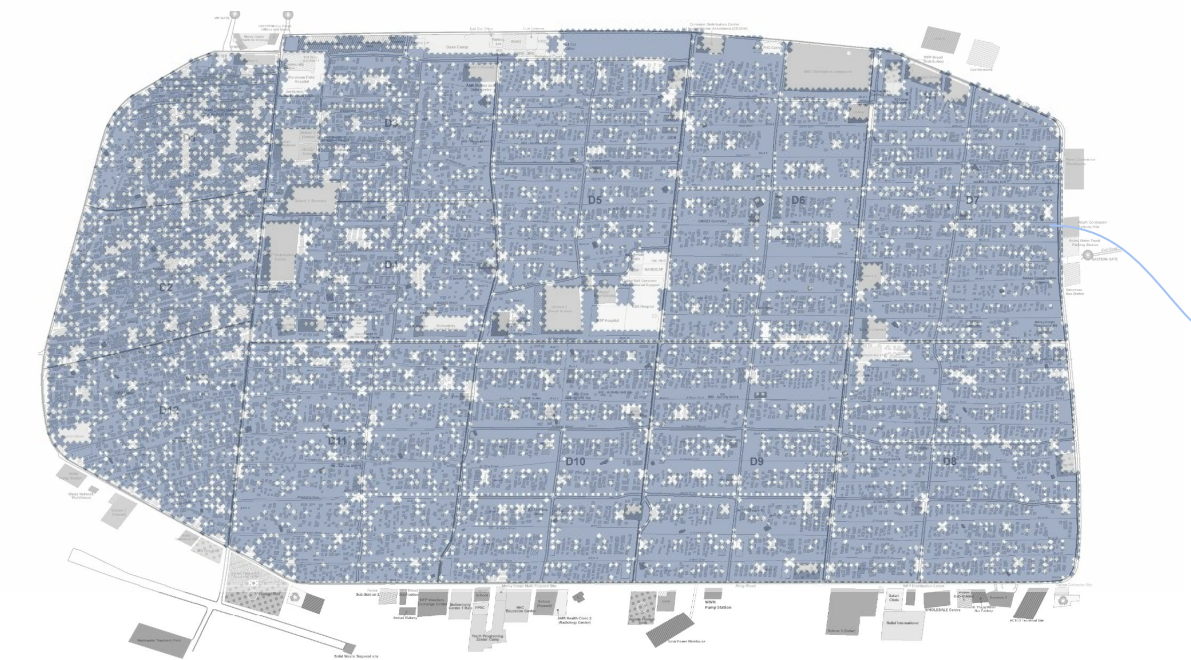
Educational factor

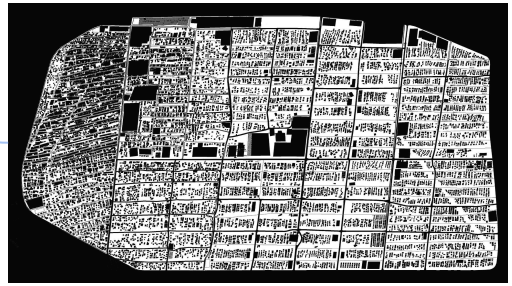
By cross referencing A and B, the darker blue the higher density <u>and</u> the longer distance from an educational center.

Highest Factor Points

We choose 2000 points with the highest values in order to find the most urgent area that has high population and a long distance from an educational center.

Vacant space

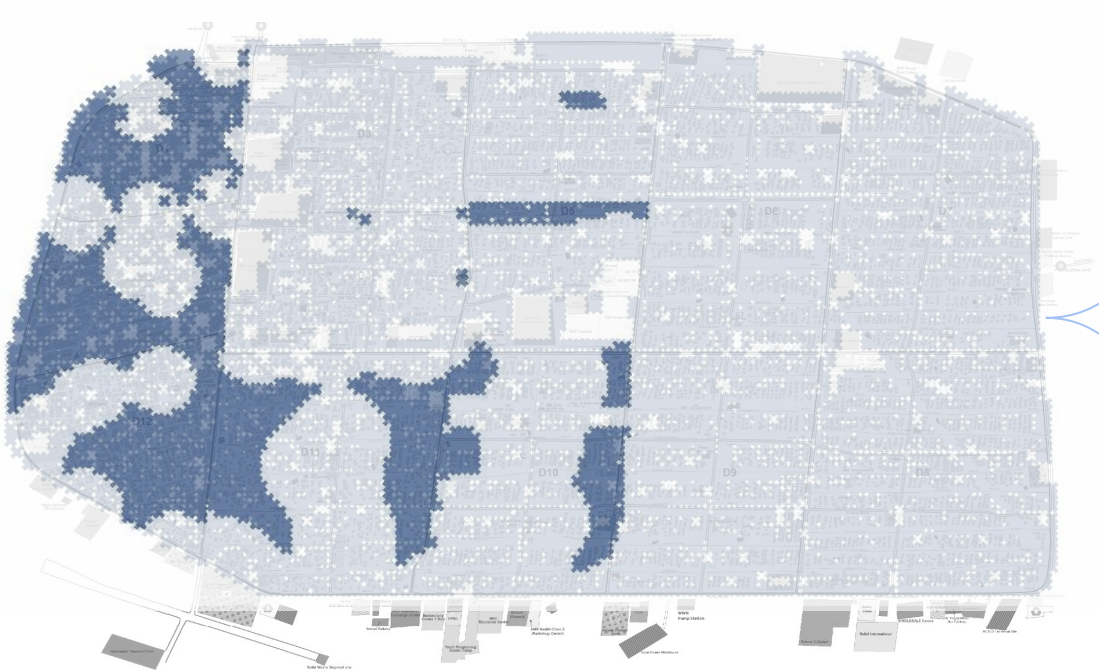


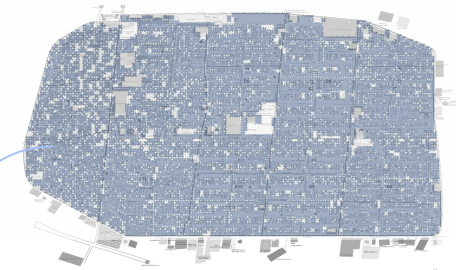


Nolli Plan

The vacant space is necessary to be found in order to evaluate if in the previous most urgent areas we have enough space to accommodate the selected program.

Cross Referencing Highest Factor Points and Vacant Spaces





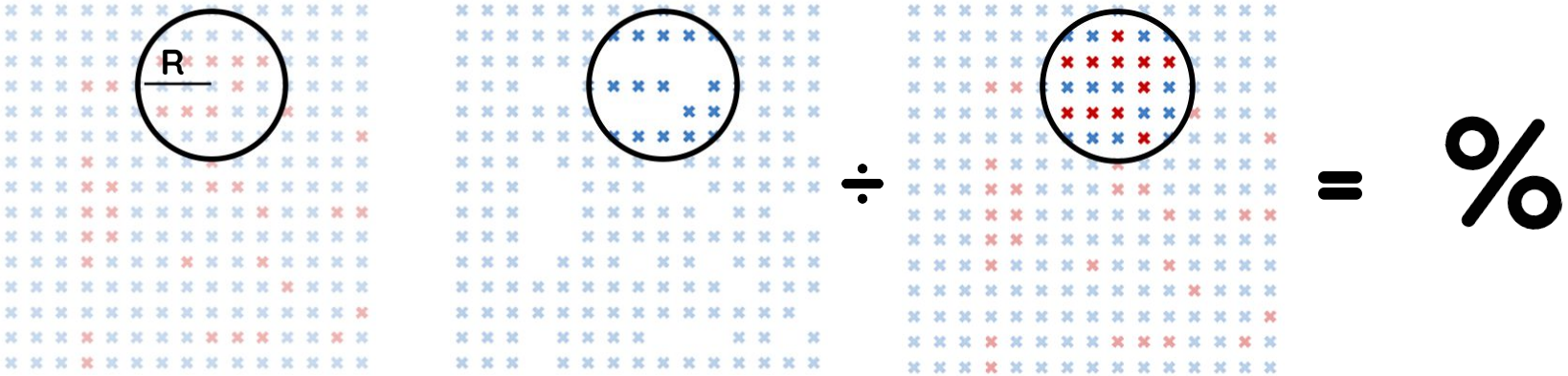
Vacant/Full Areas

Highest Factor Points

By linking these we have as a result full and vacant point the the areas with the most urgent need for educational center.

Potential placement locations methodology

Goal: Identify if the vacant space is continuous or scattered for a specific surface.



Step1:

Define the surface based on a radius.

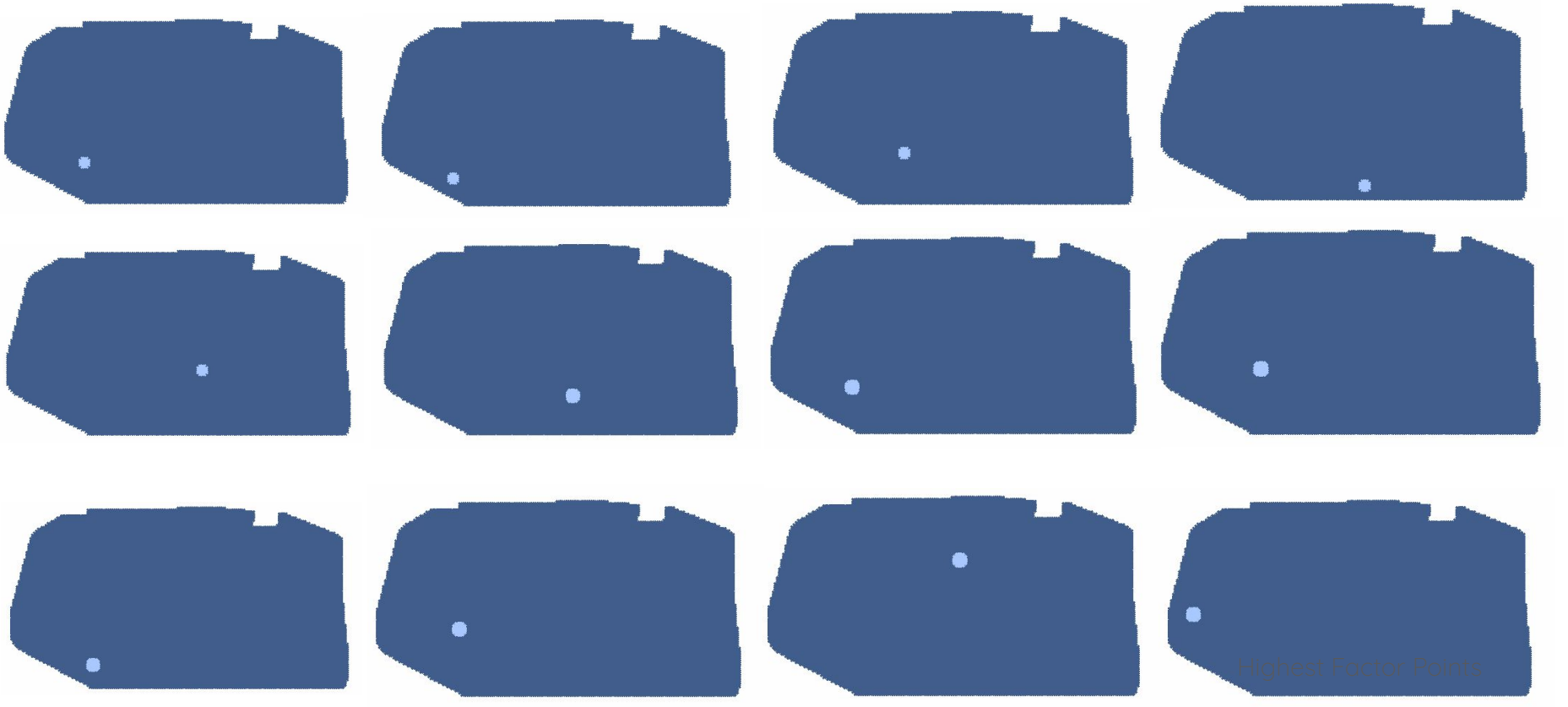
Step2:

Number of vacant points in the circle / Total points in the circle

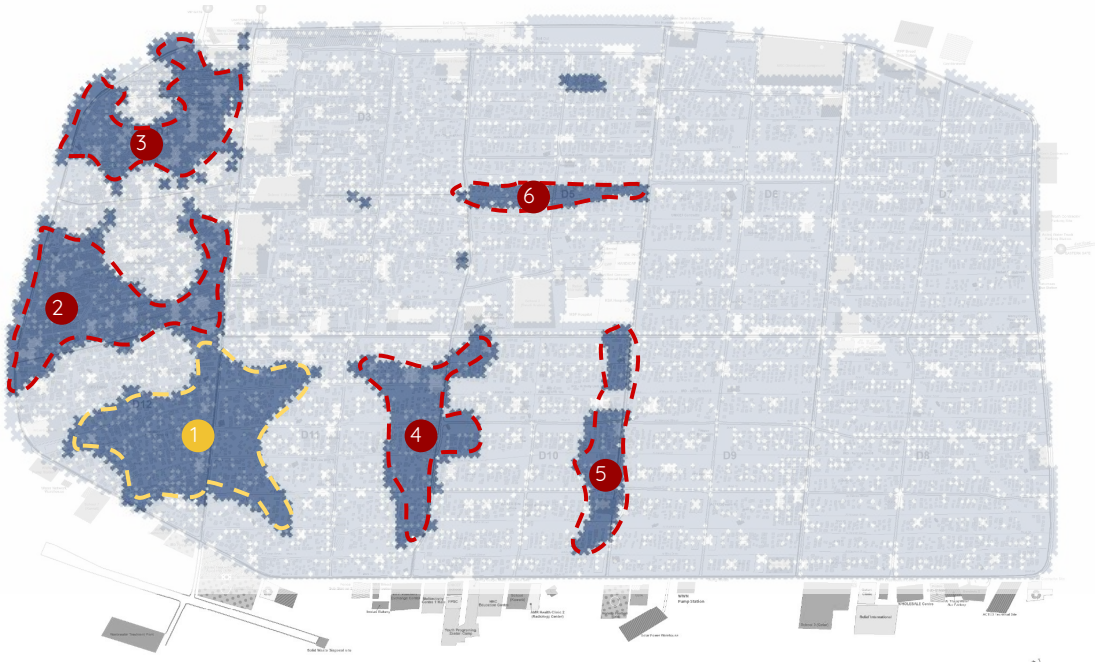
Step3:

Vacant space factor

Potential placement locations



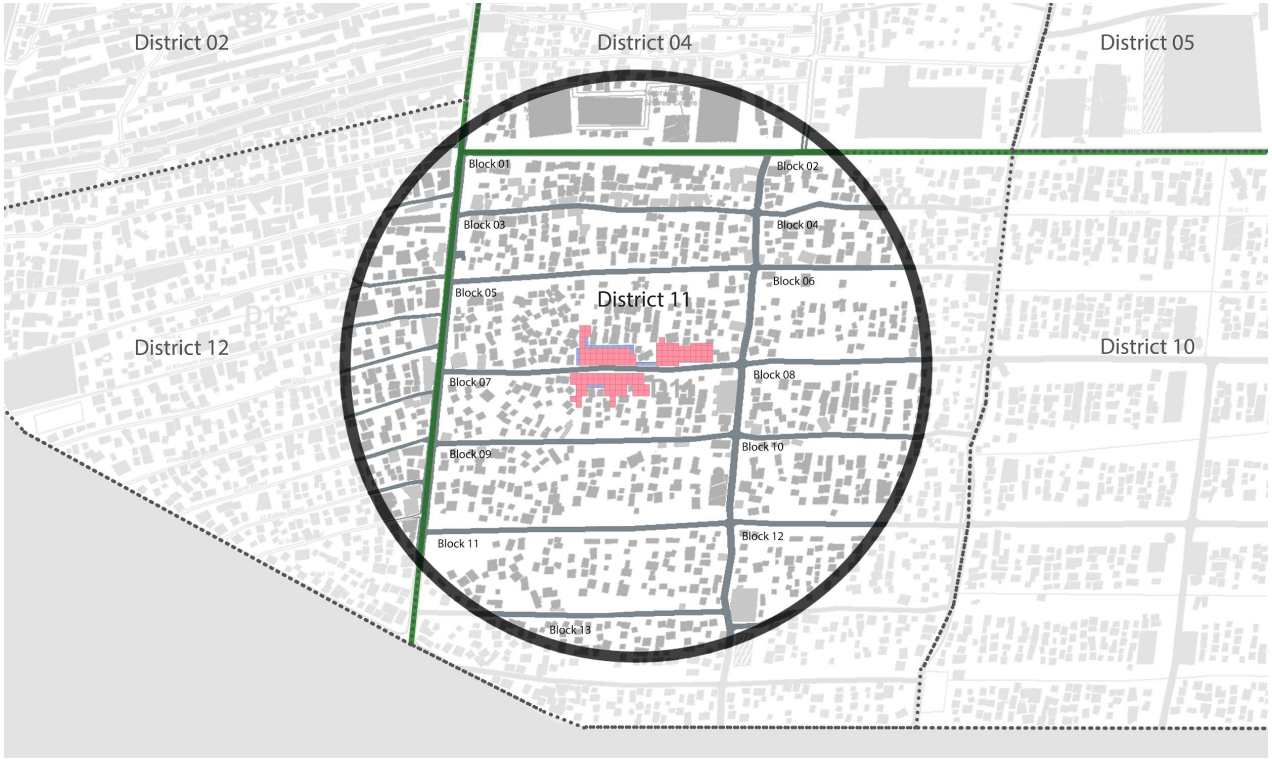
Final Building Location



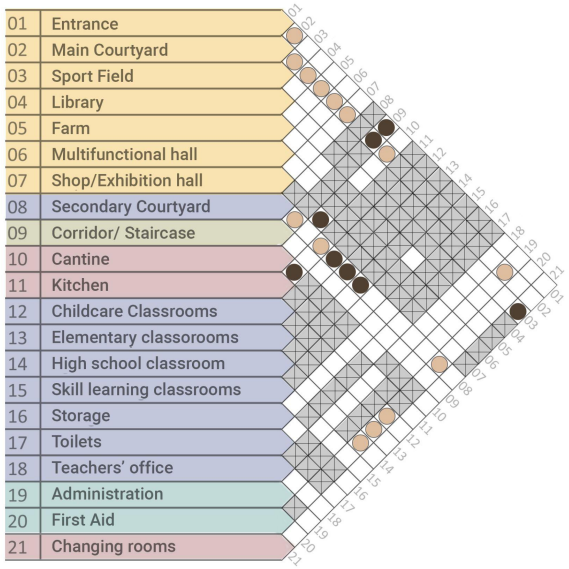
- Identifying six areas with biggest needs.
- Placing one educational center in each of them in order to create a network.
- Starting with the largest area because it corresponds to highest population with no access to education.

Site and surroundings

Final site location

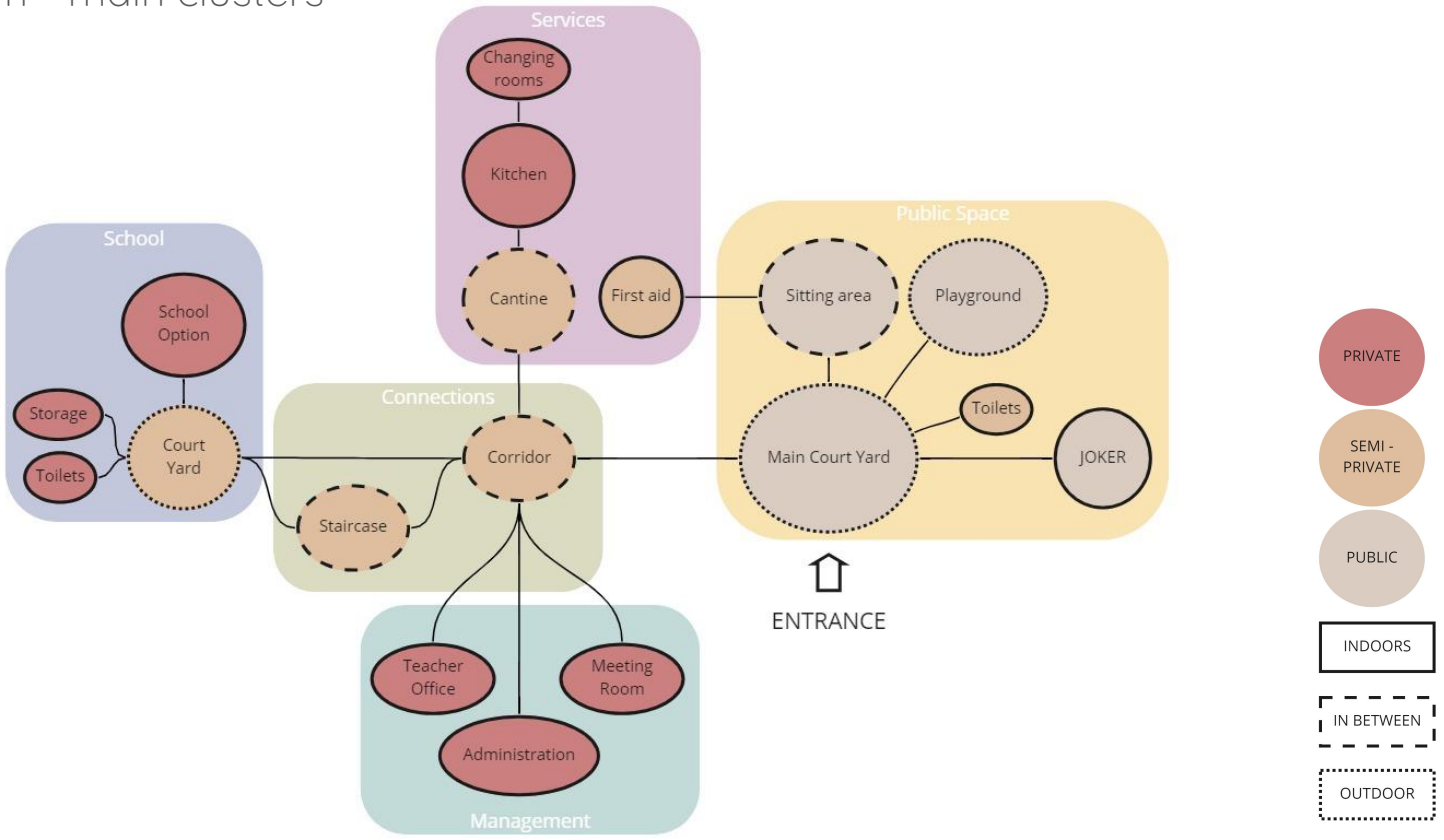


Program of requirements

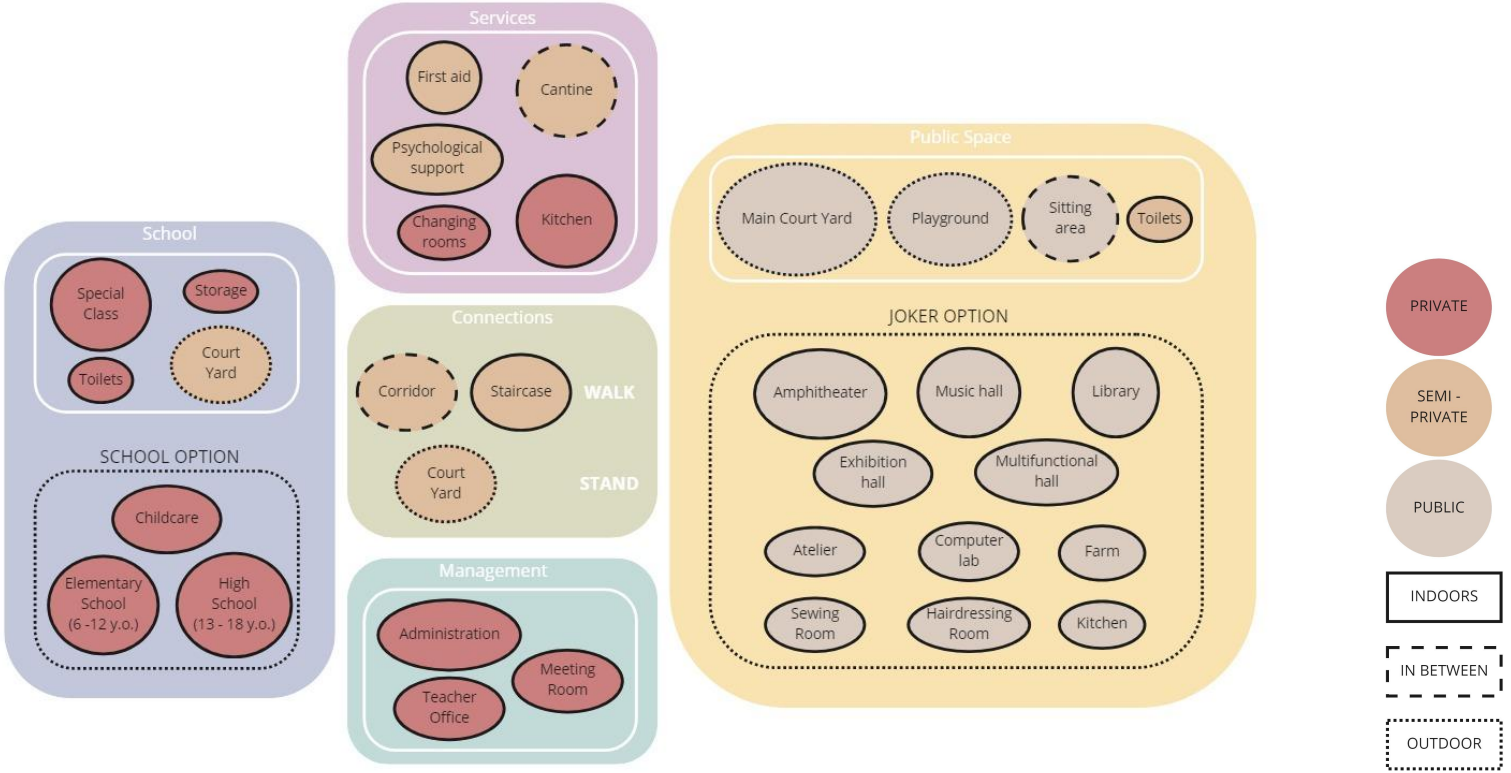


FUNCTION	LEVEL OF PRIVACY	INDOOR - OUTDOORS	AREA (m2)	NUMBER OF PEOPLE	HEIGHT REQUIREMENT	QUANTITY OF ROOMS	DAYLIGHT (LUX)
Main Court Yard	PUBLIC	OUTDOORS			-	1	-
Sport Field	PUBLIC	OUTDOORS	Football= (5p/team)= 36,5*27,5m (7p/team)= 55*36,5m (11p/team)= 105*68,5m Basketball= 28*15m		7,5 m	1	-
Library	PUBLIC	INDOORS	min. of 149 m2 and a max. of 372 m2		2,7 m	1	200 (book area) / 500 (reading area)
Farm	PUBLIC	INDOORS			-	1	-
Multifunctional hall	PUBLIC	INDOORS	one multipurpose space of 93 m2	for each 150 students	4,0 m	1	300
Shop/ Exhibition hall	PUBLIC	INDOORS			4,0 m	1	200
Court Yard	SEMI-PRIVATE	OUTDOORS			-	1 - 2	-
Corridor	SEMI-PRIVATE	IN BETWEEN	25% of the total net area		2,7 m	1 - 2	
Cantine	SEMI-PRIVATE	IN BETWEEN	*Check the graph		2,7 m	1 - 2	200
Kitchen	PRIVATE	INDOORS	*Check the graph		2,7 m	1	
CLASSROOMS: Childcare	PRIVATE	INDOORS	62 m2 per classroom	30 pupils each	2,7 m		300-500
CLASSROOMS: Elementary or High school	PRIVATE	INDOORS	55 m2 per classroom	30 pupils each	2,7 m		300-500
CLASSROOMS: Skill learning center	PRIVATE	INDOORS	83 m2 per classroom	30 pupils each	2,7 m		300-500
Storage	PRIVATE	INDOORS	20 m2		2,7 m	2 - 4	-
Toilets (M & F)	PRIVATE	INDOORS	4 m2 per toilet	1 for every 20 pupils 1 for every 25 staff	2,7 m	2 - 4	150
Teachers Office	PRIVATE	INDOORS	around 15m2	min. of 1.4 m2 of space per adult	2,7 m	1 - 2	500
Administration	PRIVATE	INDOORS	16 m2		2,7 m	1	500
First Aid	PRIVATE	INDOORS	10 m2		2,7 m	1 - 2	200
Changing rooms (M & F)	PRIVATE	INDOORS	15 - 20 m2		2,7 m	1 - 2	150

Bubble diagram - main clusters



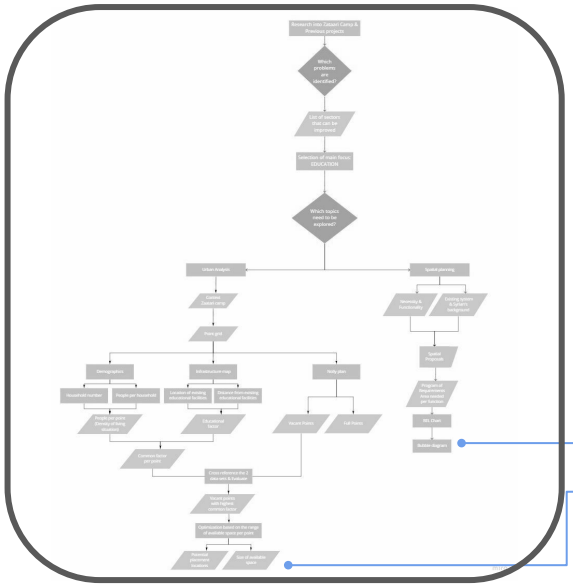
Bubble diagram



0.2 Forming

Flowchart

01. Configuration



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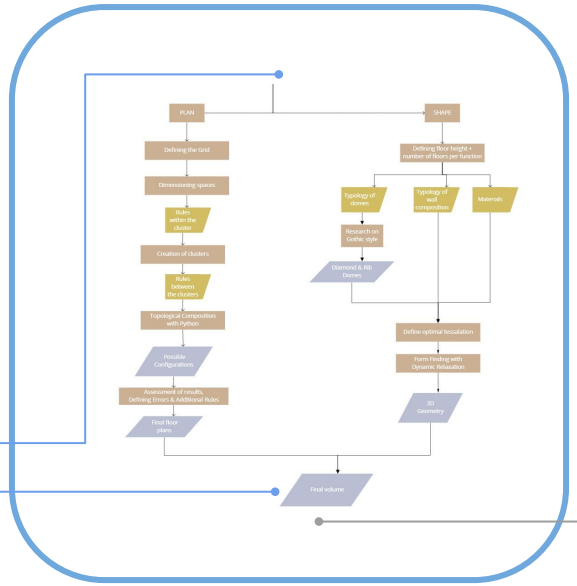
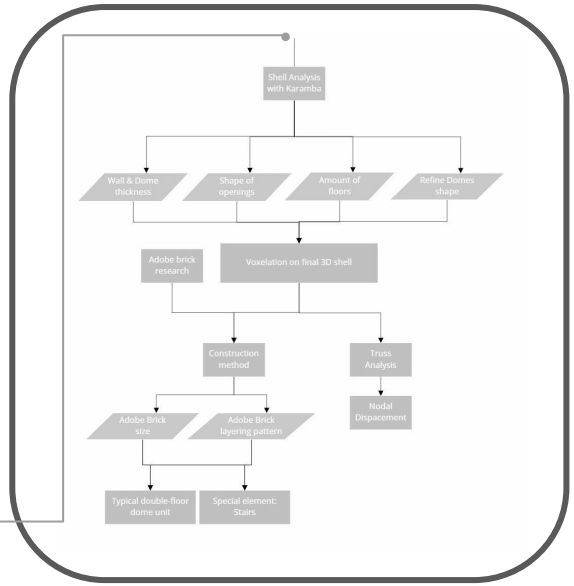
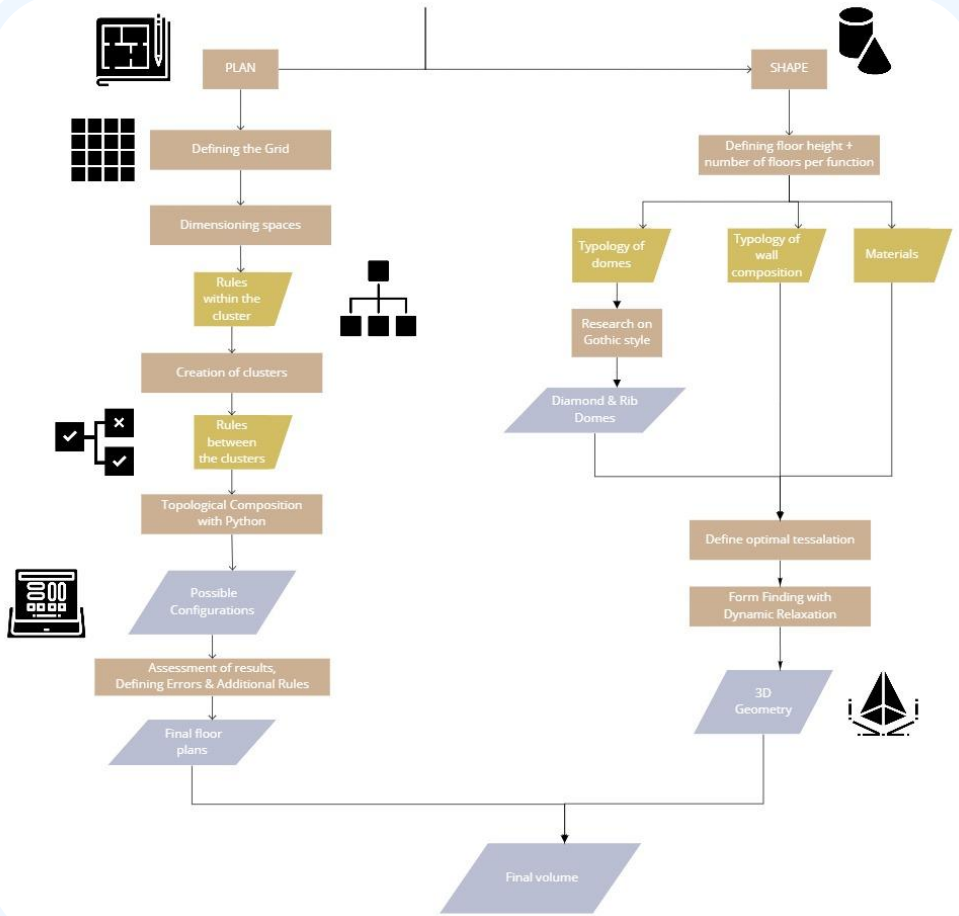


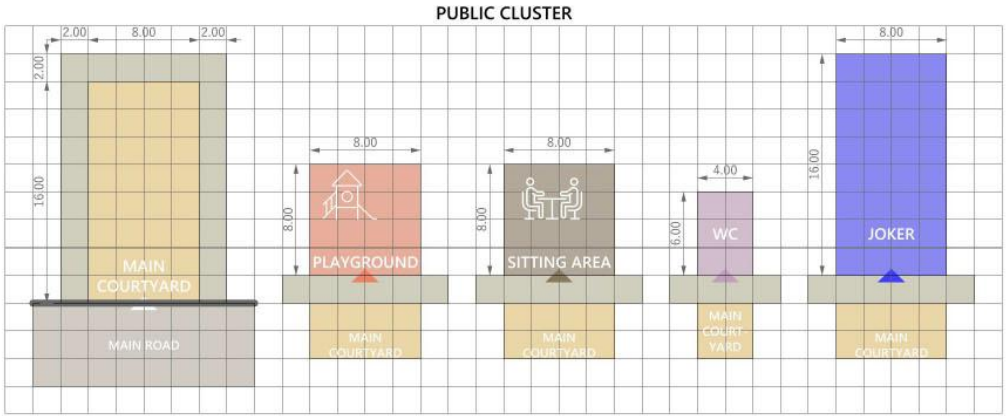
03. Structuring

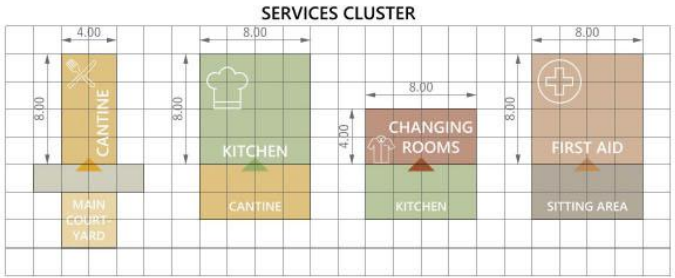


Flowchart

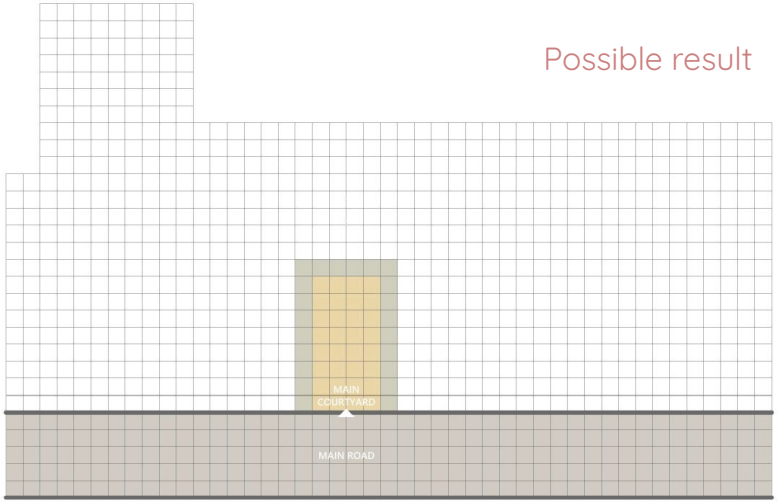

PLAN
Defining the Grid
Dimensioning spaces
Rules within the cluster
Creation of clusters
Rules between the clusters
Topological Composition with Python
Possible Configurations
Assessment of results, Defining Errors & Additional Rules
Final floor plans
SHAPE
Defining floor height + number of floors per function
Typology of domes
Typology of wall composition
Materials
Research on Gothic style
Diamond & Rib Domes
Define optimal tessalation
Form Finding with Dynamic Relaxation
3D Geometry
Final volume

Rules of the game

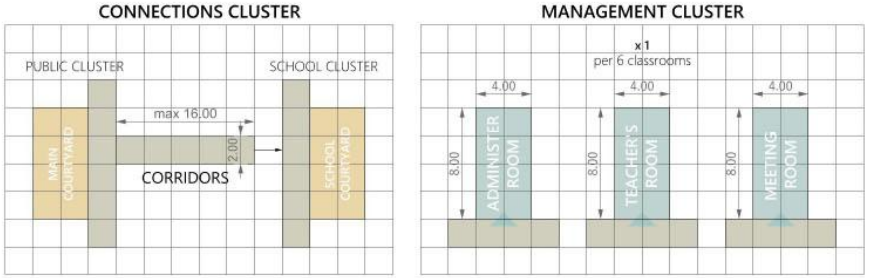


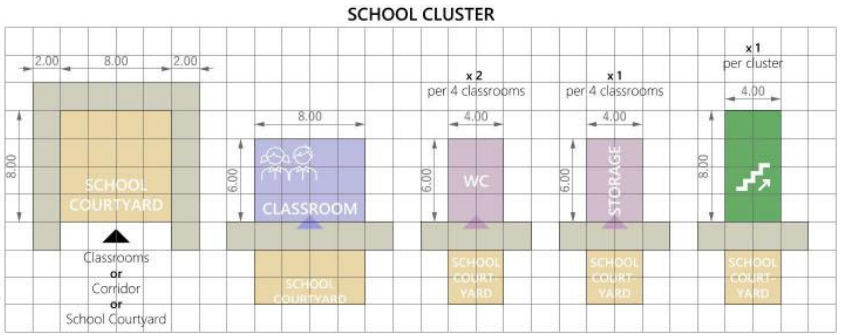


Possible result

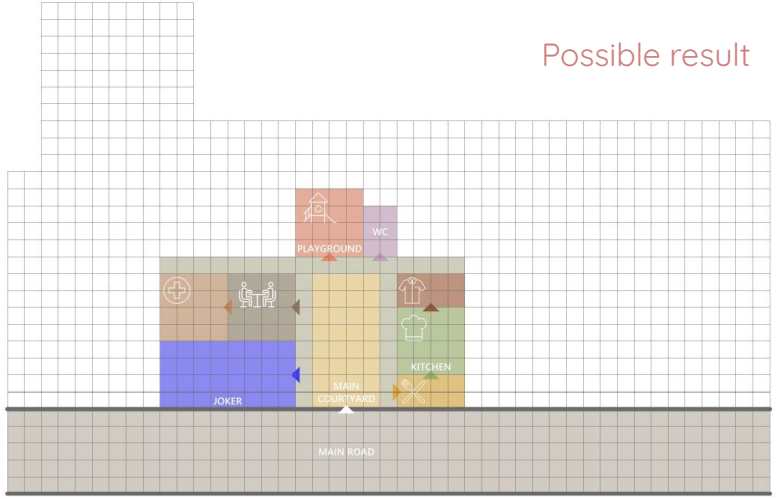


Rules of the game



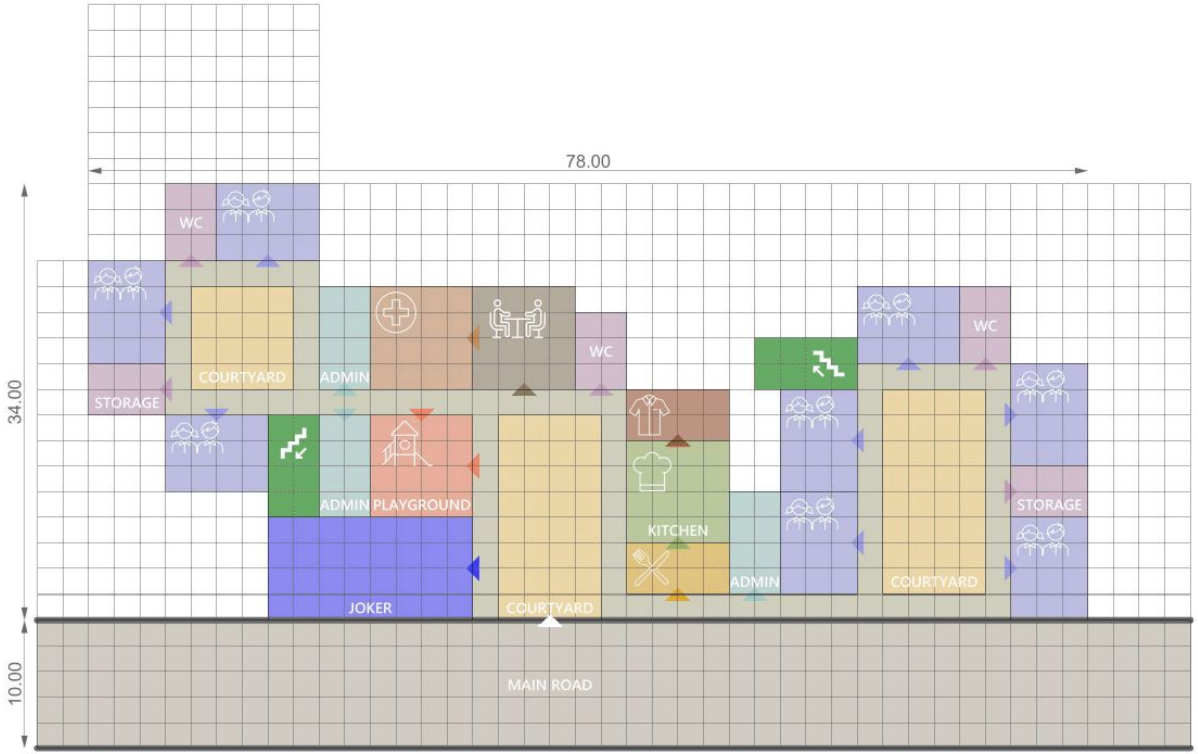


Possible result



Ground floor - Python

Generated alternatives



Evaluation criteria:

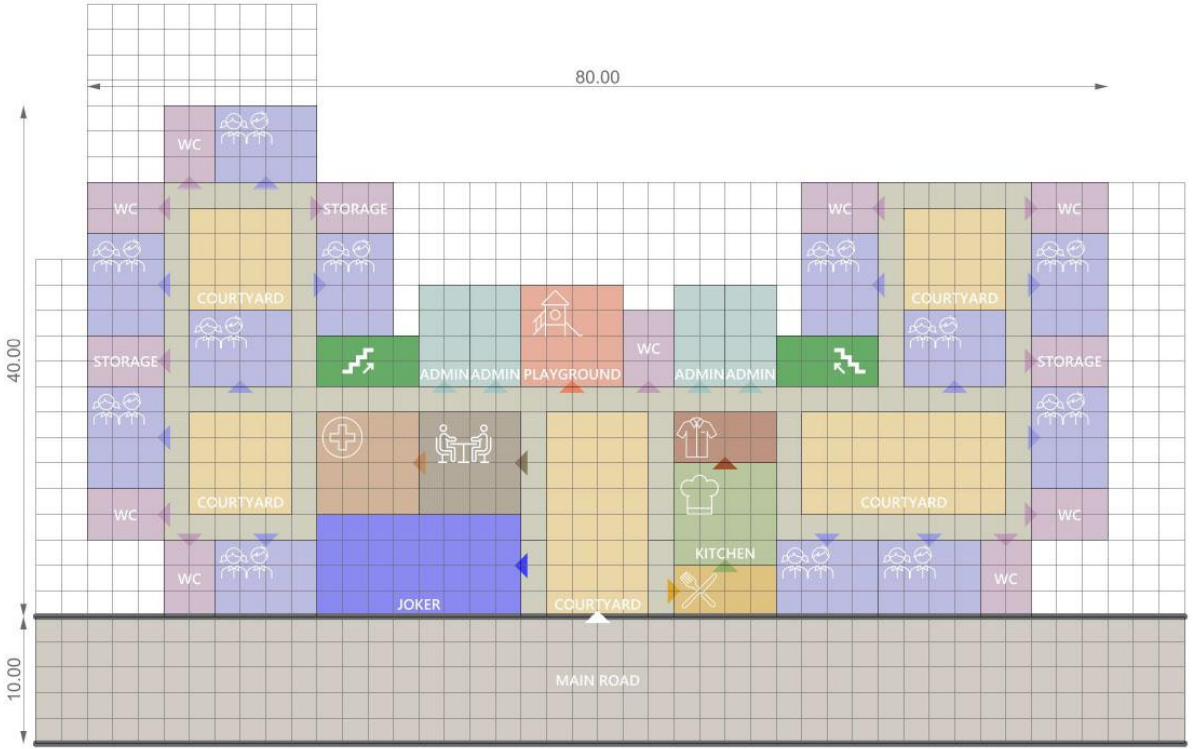
_ least amount of empty in-between space
_ no corridors next to the road
_ max amount of classrooms

Additional rules:

_ joker next to road
_ cantine next to road

Ground floor - Python

Chosen composition



Rules of the game

Function without Roofs	COURTYARD PLAYGROUND

Second floor - Python

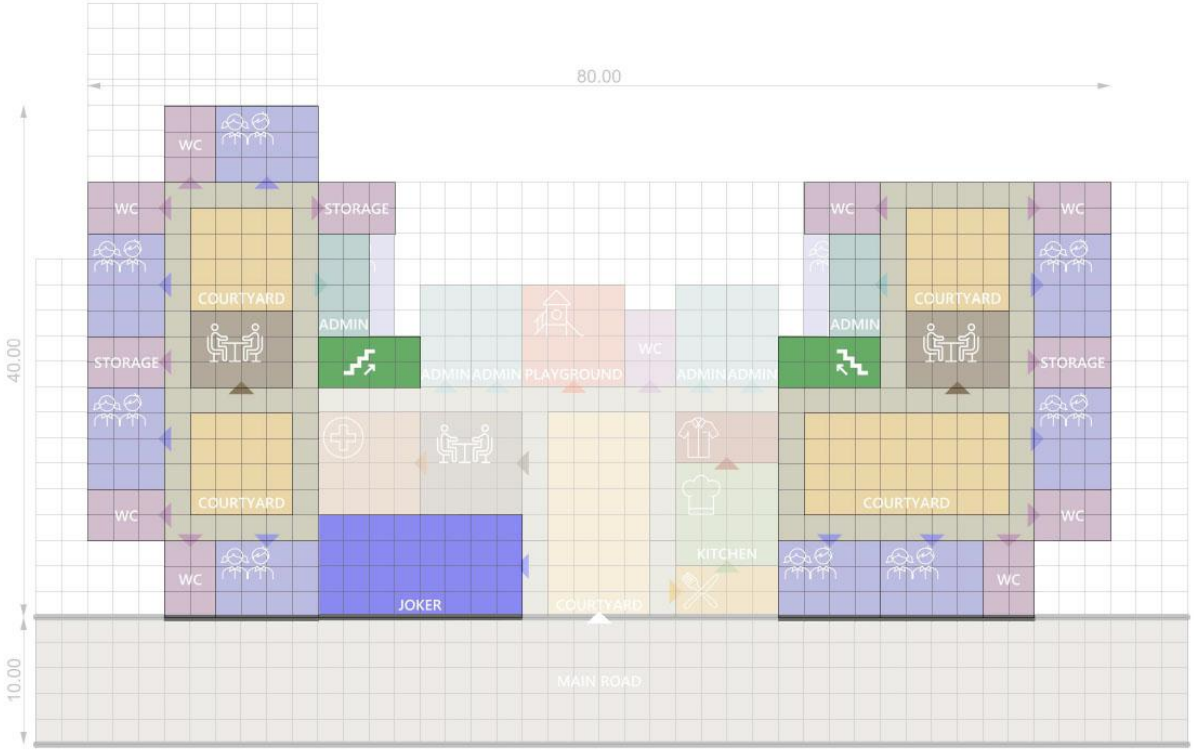
Chosen composition

Rules of the game

Function in 1st floor	CLASSROOM WC/ STORAGE SITTING AREA TEACHER'S ROOM

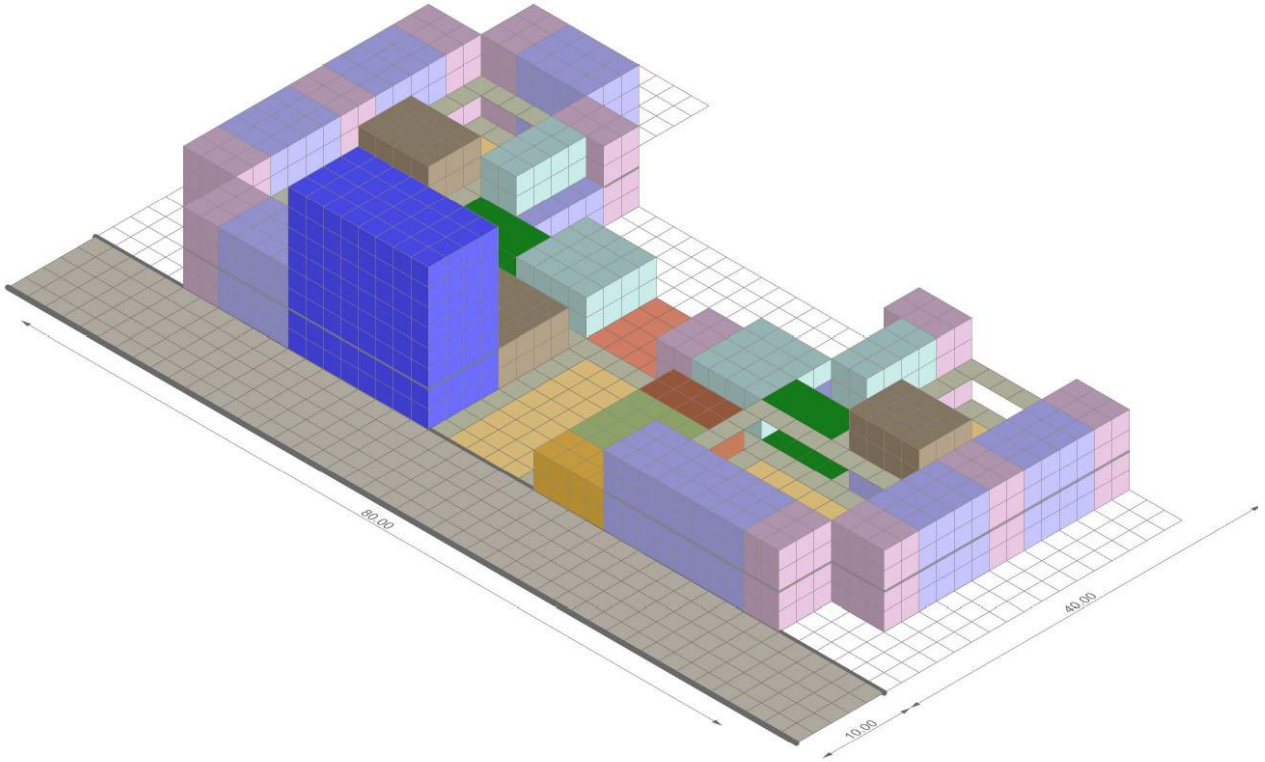
WHEN Classroom between Courtyard add sitting area

Every 6 classroom 1 teacher's room



Axonometric

Chosen composition



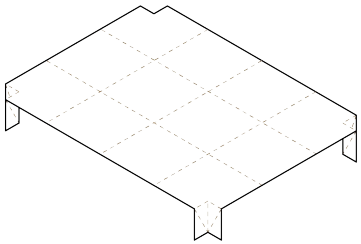
Rules of the game

HEIGHT based on importance of space

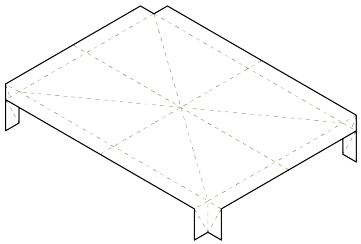
JOKER: higher than all the other functions

GROUND FLOOR all functions the same height

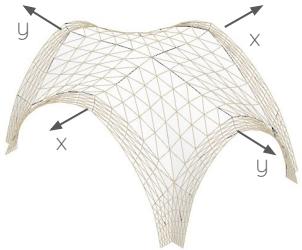
Form finding principles

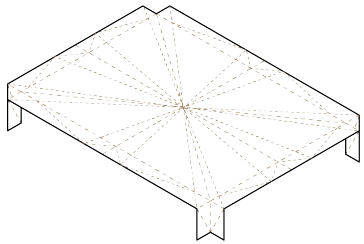


Identify room size
by functions
(Vault on the floor)

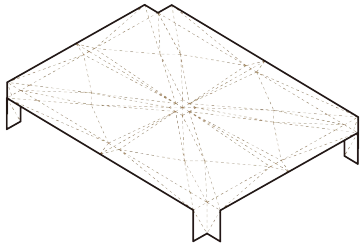


Basic tessellation
(fixed mesh edges)

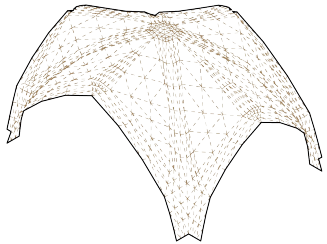




Finer division of
tessellation

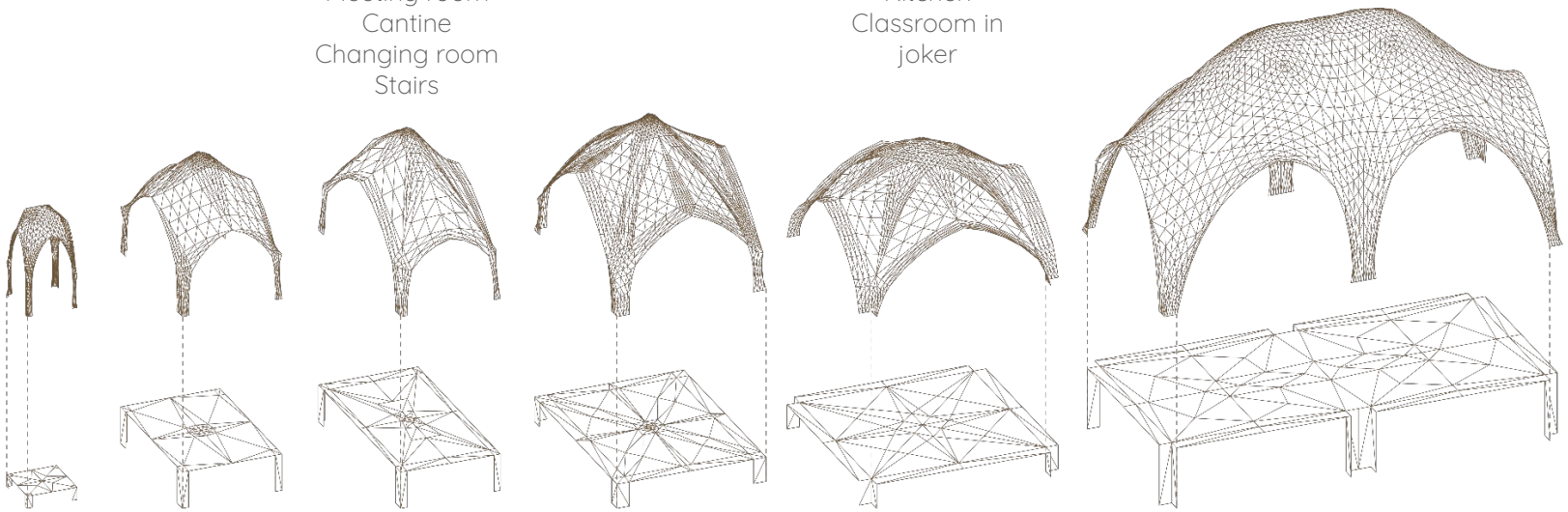


Final dynamic
relaxation form

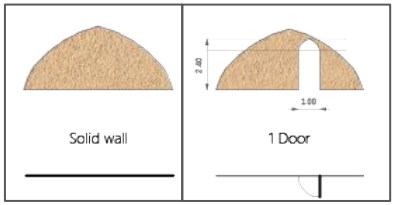


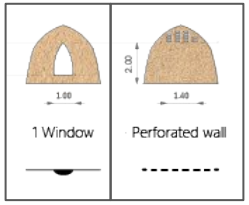
Form finding results and programs

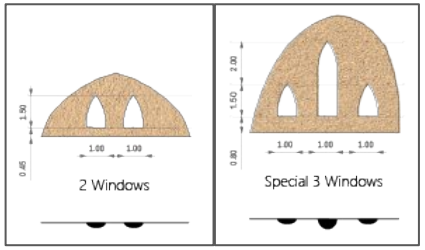
	2 x 2 m2	6 x 4 m2	8 x 4 m2	8 x 6 m2	8 x 8 m2	8 x 16 m2
Size						
Height	4 m	5 m	5 m	6 m	5m	8 m
Functions	Corridor	Toilet Storage	Admin. room Teacher room Meeting room Cantine Changing room Stairs	Classroom	Sitting area First aid Kitchen Classroom in joker	Joker

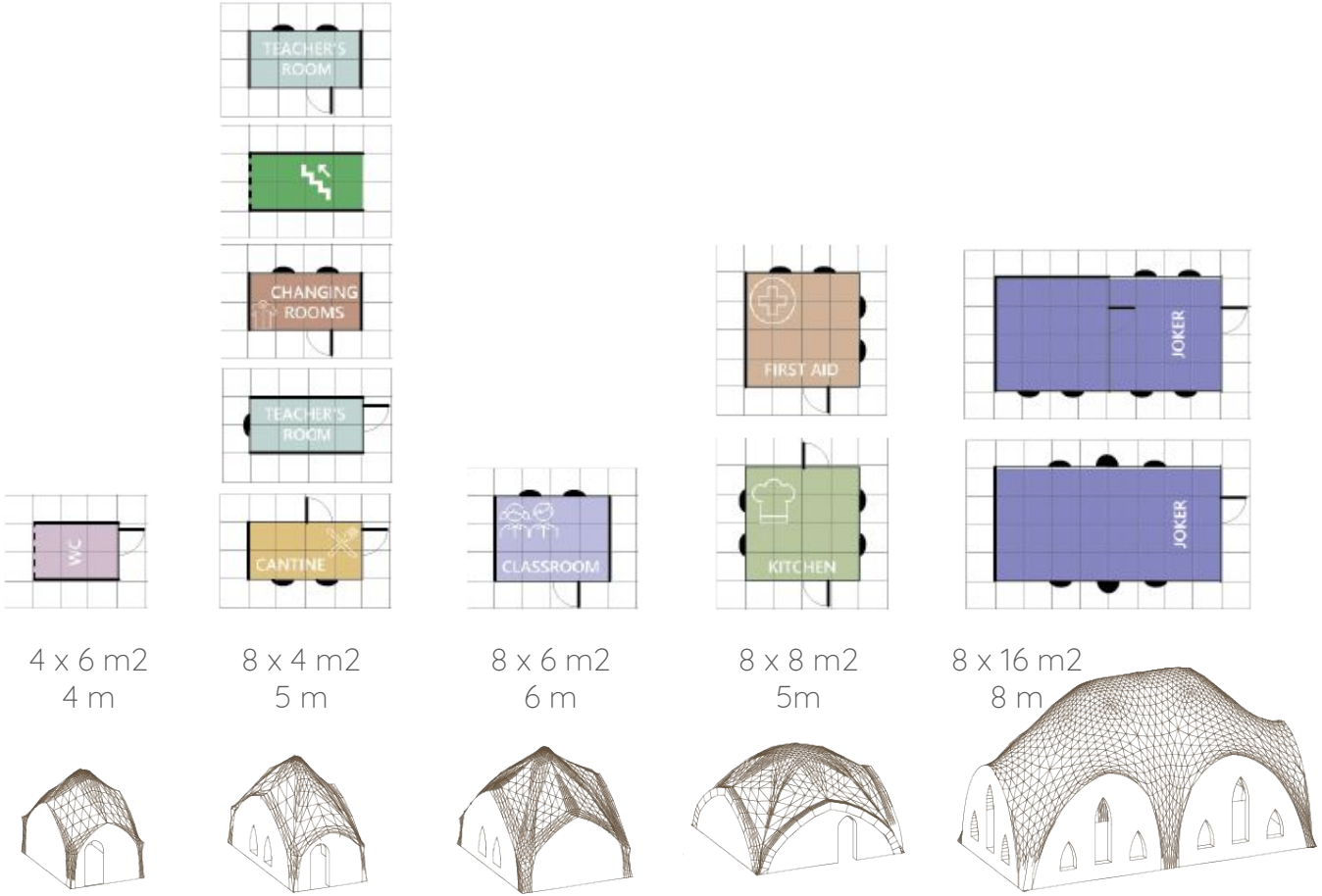


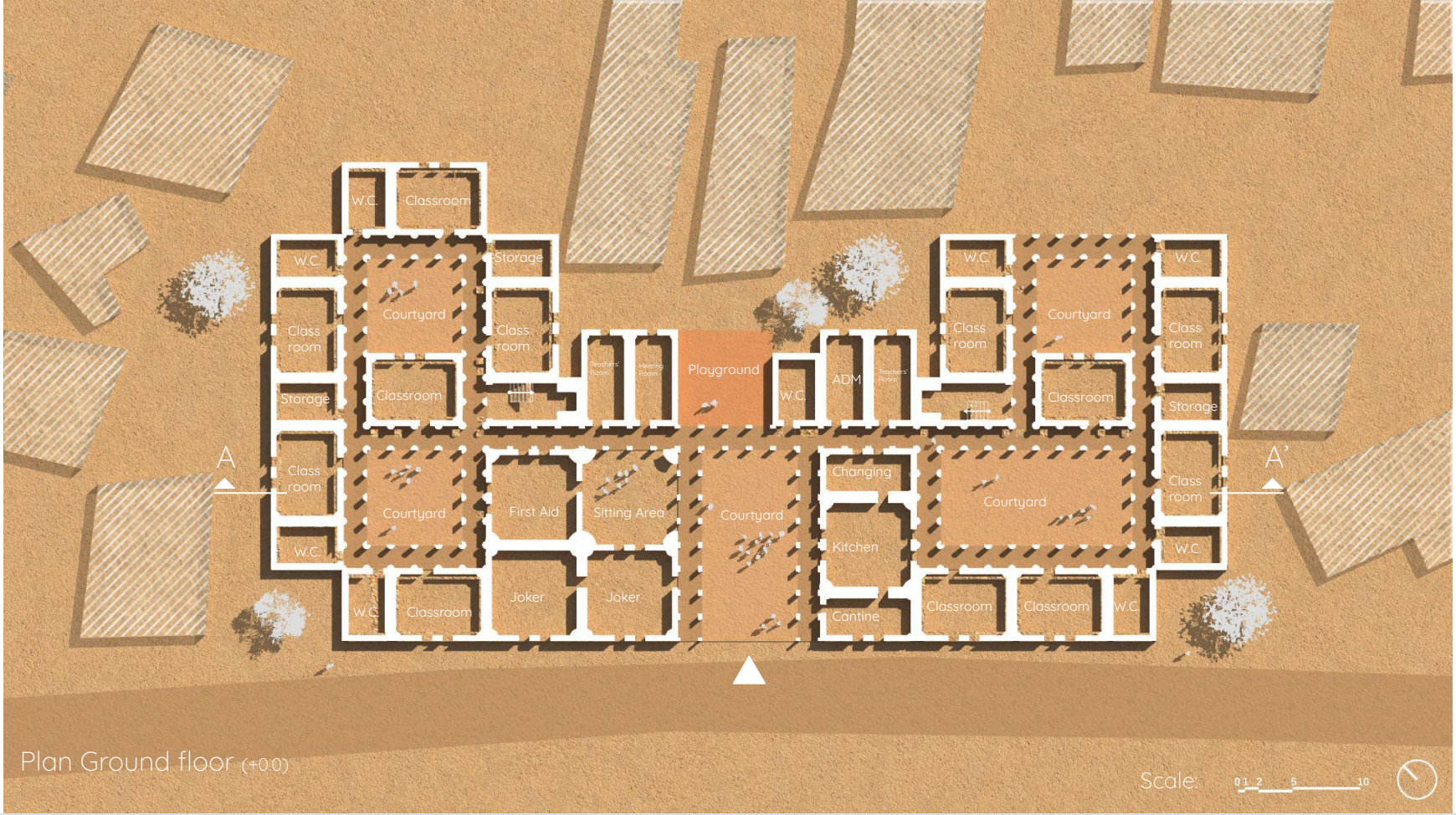
Wall Typologies





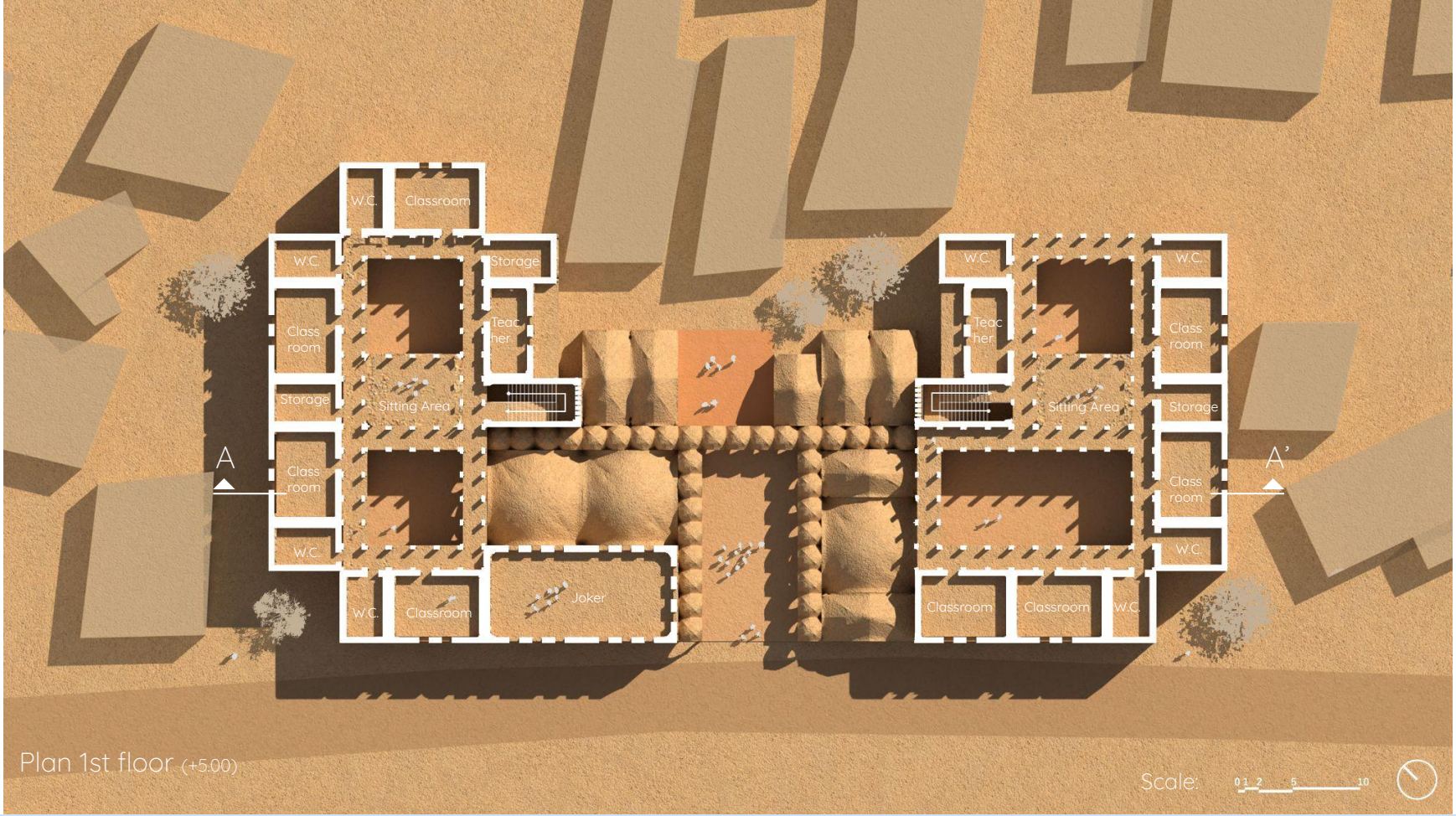






Plan Ground floor (+0.0)

Scale: 0 1 2 5 10



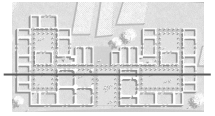
Plan 1st floor (+5.00)

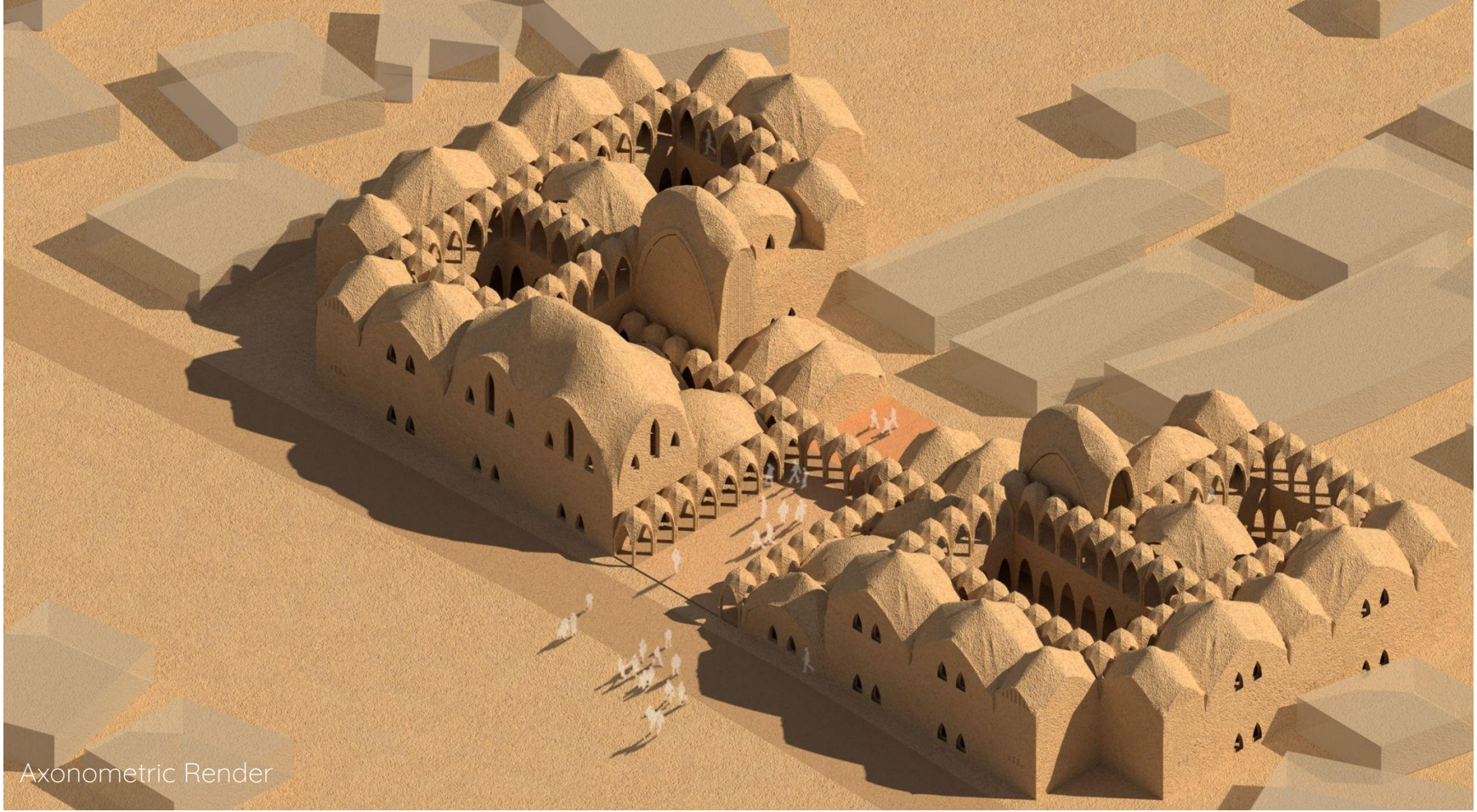
Scale: 0 1 2 5 10

Front View


Classroom
Classroom
Courtyard
First Aid
Sitting Area
Courtyard
Kitchen
Courtyard
Classroom
Classroom
6m
12m
8m
8m
12m
8m
20m
6m

Section A - A’

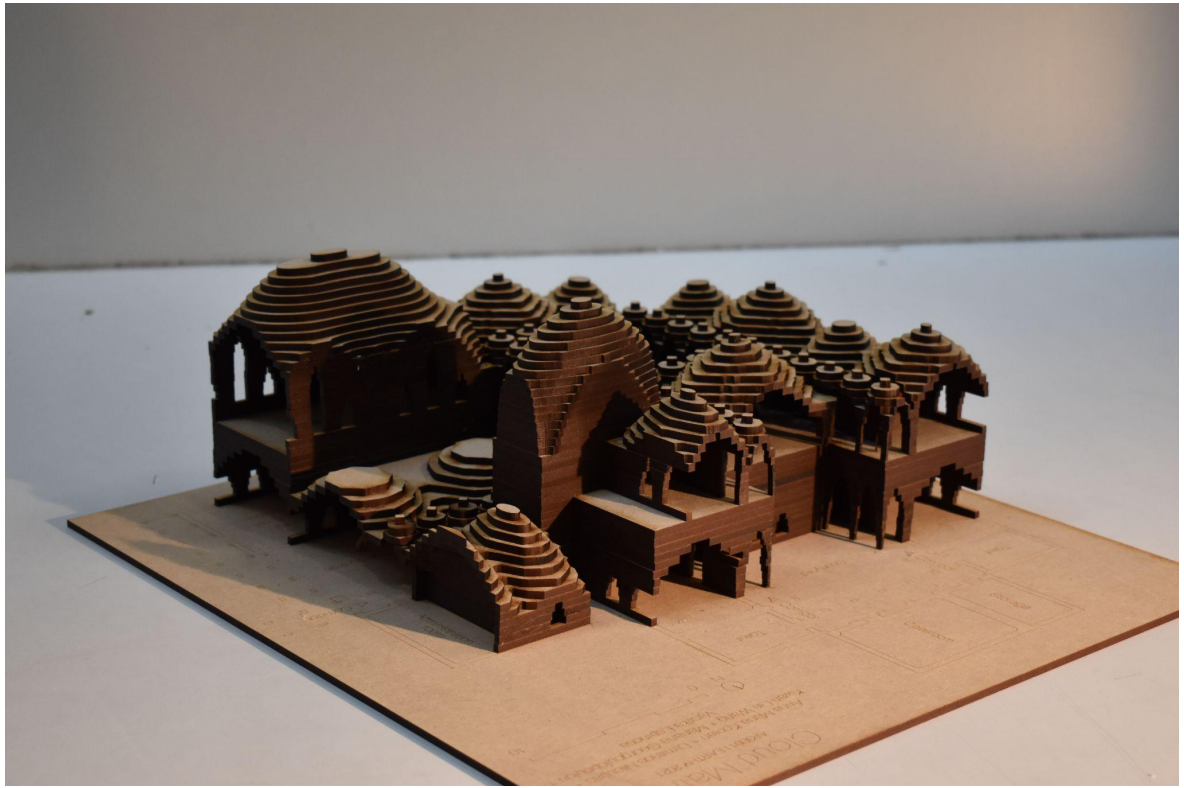


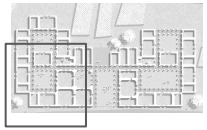


Axonometric Render

Physical model

Scale 1.100





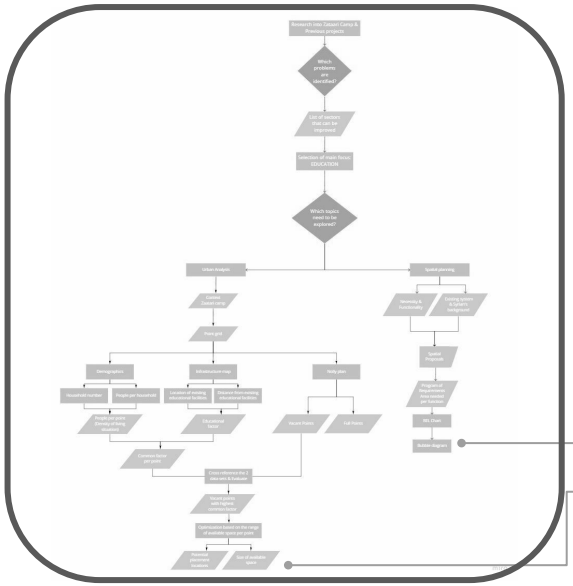
Physical model

Scale 1.100

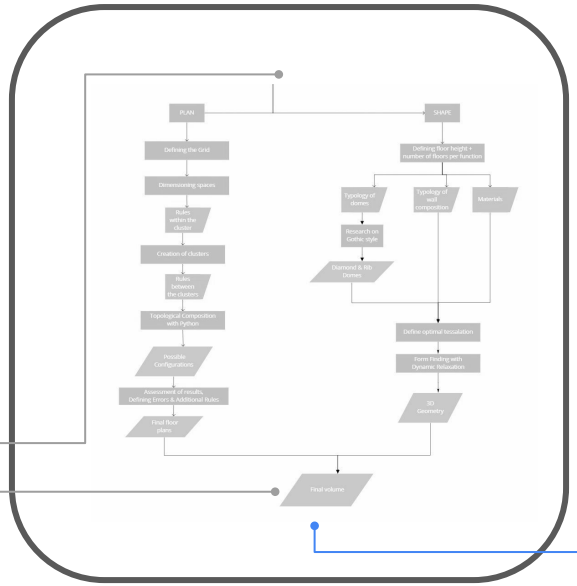
0.3 Structuring

Flowchart

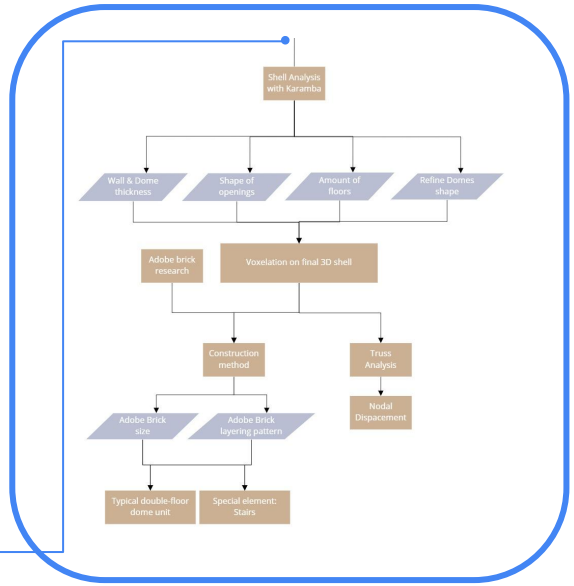
01. Configuration



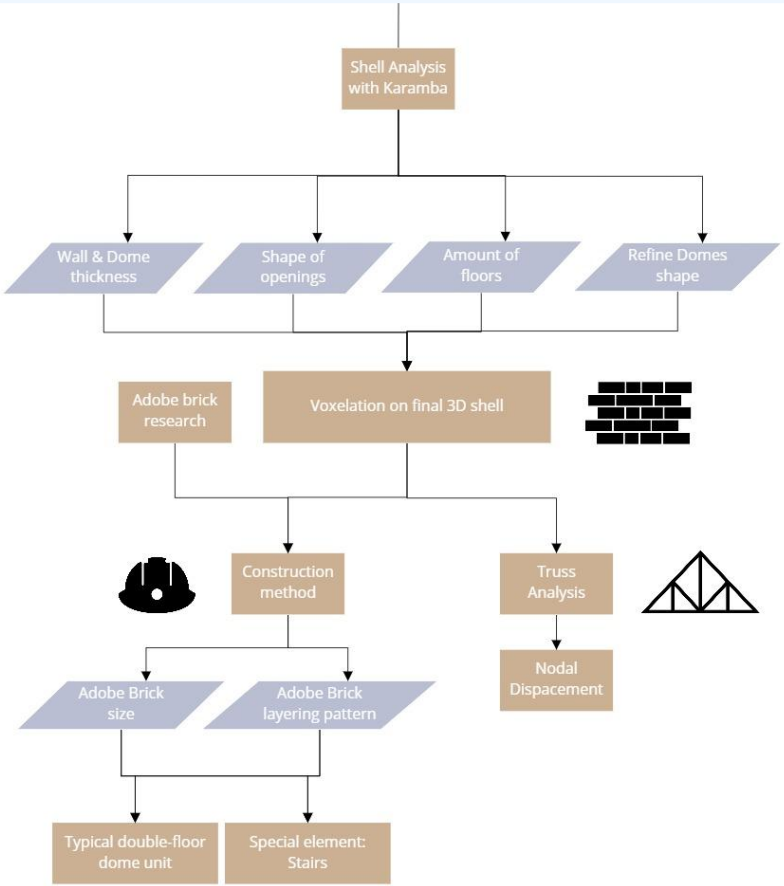
02. Forming



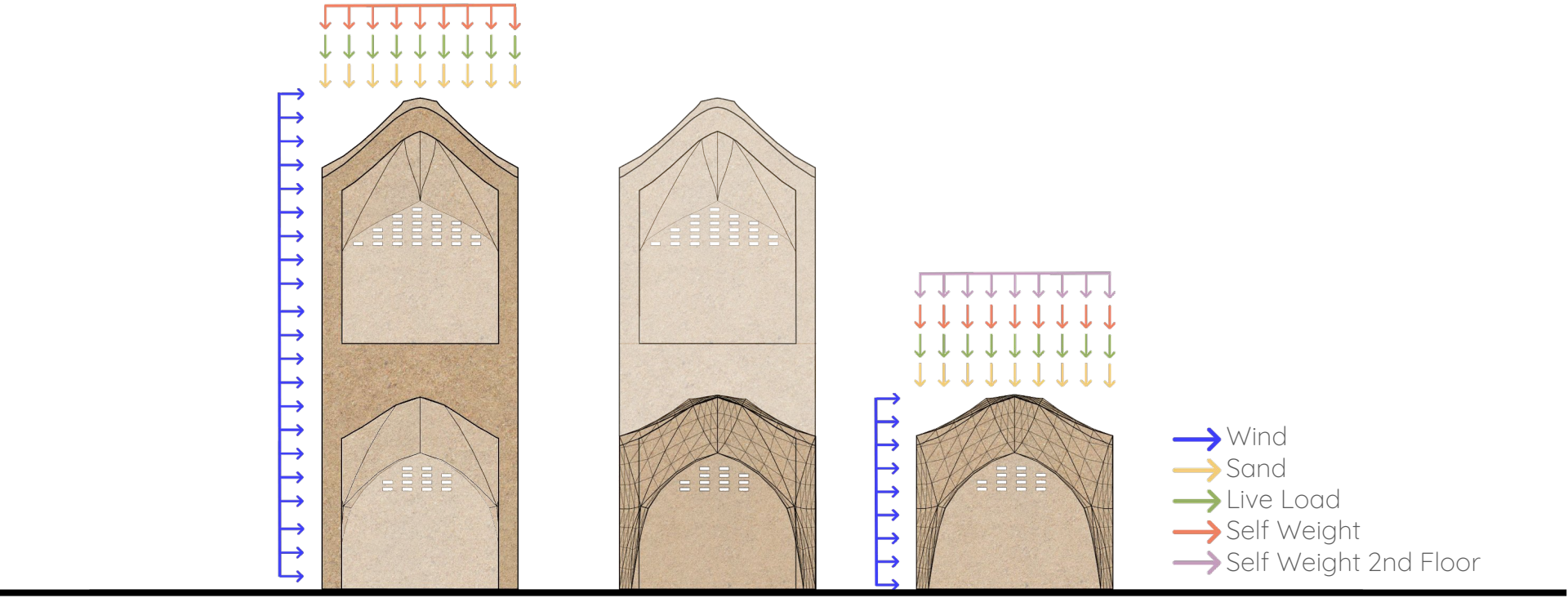
03. Structuring



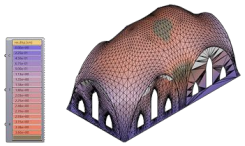
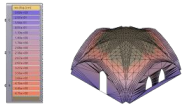
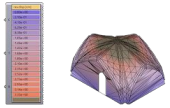
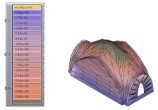
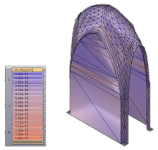
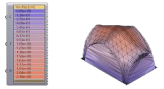
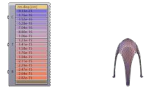
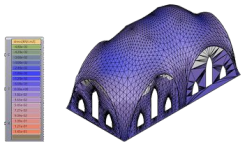
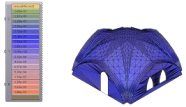
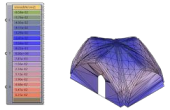
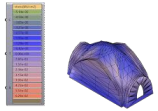
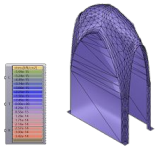
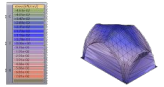
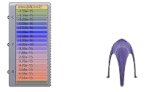
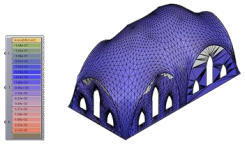
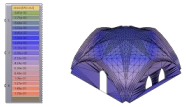
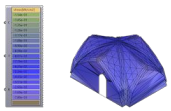
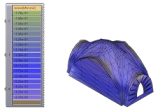
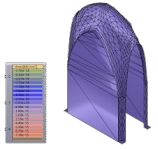
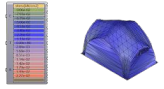
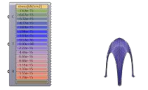
Flowchart


Shell Analysis with Karamba
Wall & Dome thickness
Shape of openings
Amount of floors
Refine Domes shape
Adobe brick research
Voxelation on final 3D shell
Construction method
Truss Analysis
Nodal Dispacement
Adobe Brick size
Adobe Brick layering pattern
Typical double-floor dome unit
Special element: Stairs

Methodology



Structural Analysis

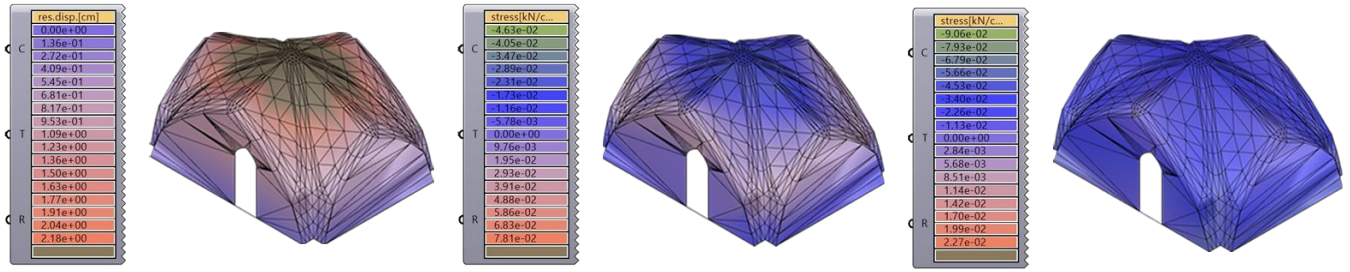
	8 x 16 m Joker	8 x 8 m Sitting Area, Kitchen, First Aid	6 x 8 m Classroom	4 x 8 m Administration, Cantine, Changing Teaching and Meeting Room	4 x 8 m Staircase	4 x 6 m W.C., Storage Room	2 x 2 m Corridor
Displacement							
Principle Stresses							
							

Example

Displacement

Principle Stresses

6 x 8m
Classroom



	Peak	Allowable
Compressive Stress	0.91 MPa	5 MPa
Tensile Stress	0.23 MPa	0.5 MPa
Displacement (<5%)	2,2 cm	40 cm

Young's Modulus	150 MPa
Cross Section Thickness	40 cm

Brick Material

	Proportion
Clay	30%
Fine Sand	30%
Coarse sand	40%
Water	10%
Straw	Additional 10% on the total paste

Material composition
source: Raha, Earthy 3.0, Strength of adobe bricks

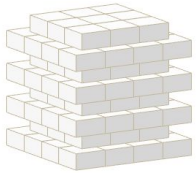
	Value
Density	1500 kg/m3
Young's modulus	150 MPa
Tensile stress	Max 0.5 MPa
Compressive stress	Max 5 MPa
Yield strength	1.3 MPa

Material properties
source: Raha, Earthy 3.0, Strength of adobe bricks

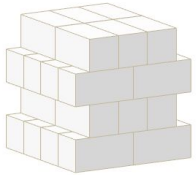



Method of making bricks with moulds
source: Minke G. (2006), Building with Earth, Design and Technology of a Sustainable Architecture, *Birkhauser*

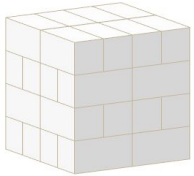
Brick types



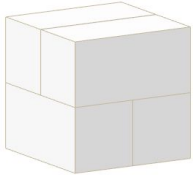
Brick type 01:
10 x10 x 5 cm



Brick type 02:
10 x 20 x 10 cm

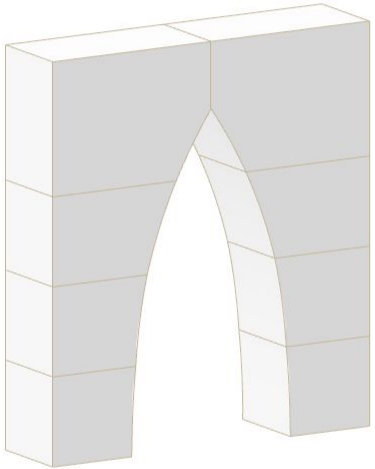


Brick type 02:
10 x 20 x 10 cm

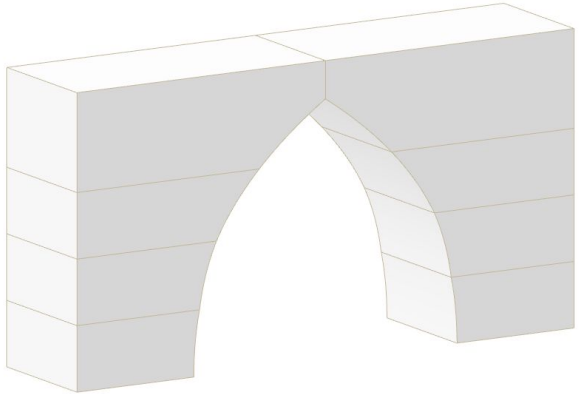


Brick type 03:
20 x 40 x 20 cm

Wall and shell thickness: 40 cm
Brick size is the common divisor of wall thickness

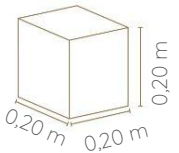


Window opening:
80 x 40 x 90 cm



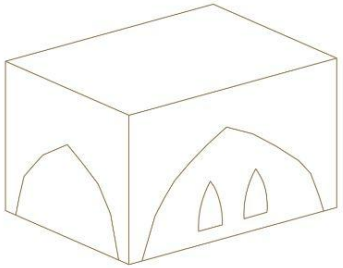
Door opening:
180 x 40 x 90 cm

Voxelation

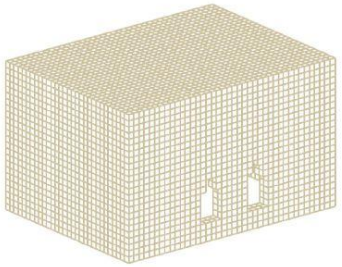


Voxel size based on wall thickness

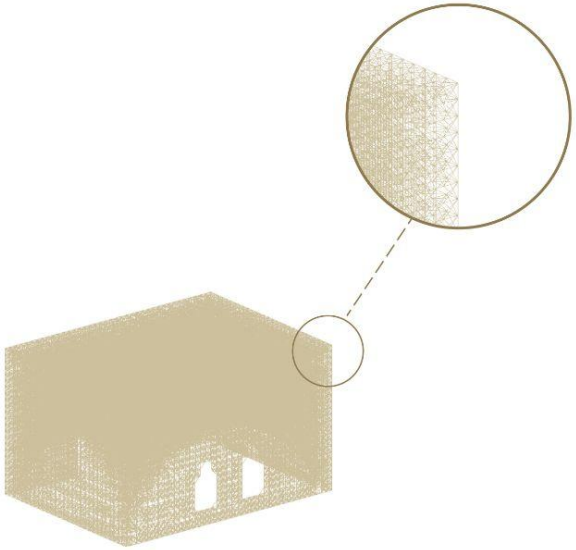
Length: 0,20 m
Width: 0,20 m
Height: 0,2 m



Application on the classroom mesh (shell + walls)

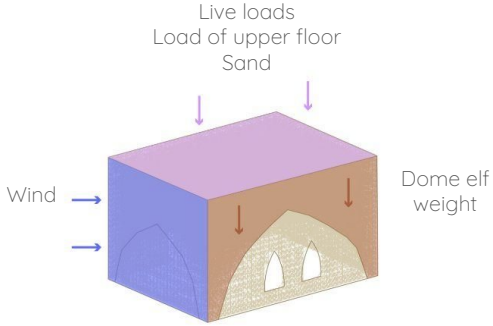


Voxelated geometry

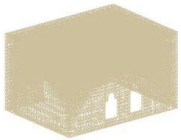


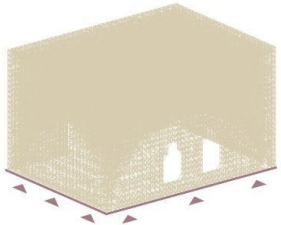
Lattice interconnecting the centers of gravity between neighbouring points

Truss analysis



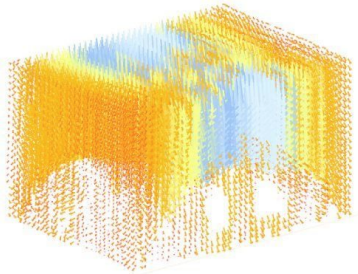
Loads



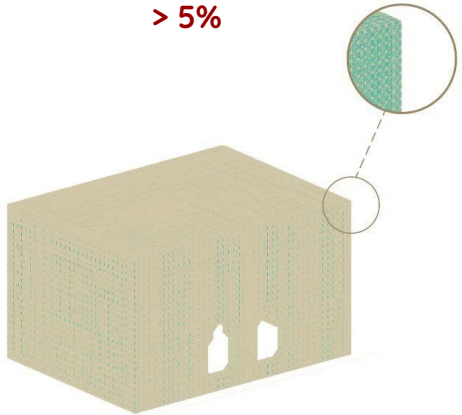


Supports

Truss cross section
(Deformation comparison)



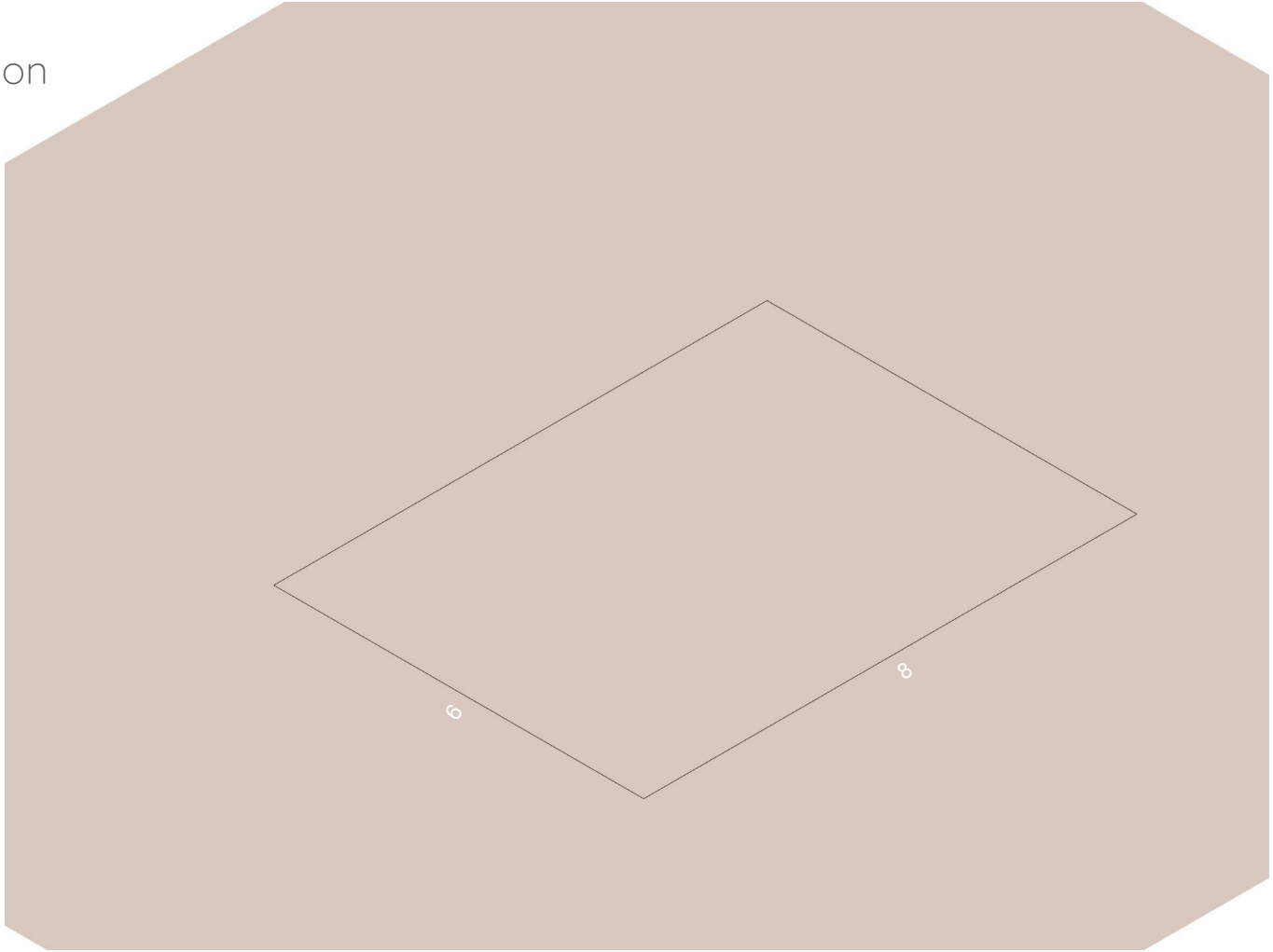
Nodal displacement
> 5%



Principal stresses
> 5 MPa

Construction Sequence

Construction Sequence



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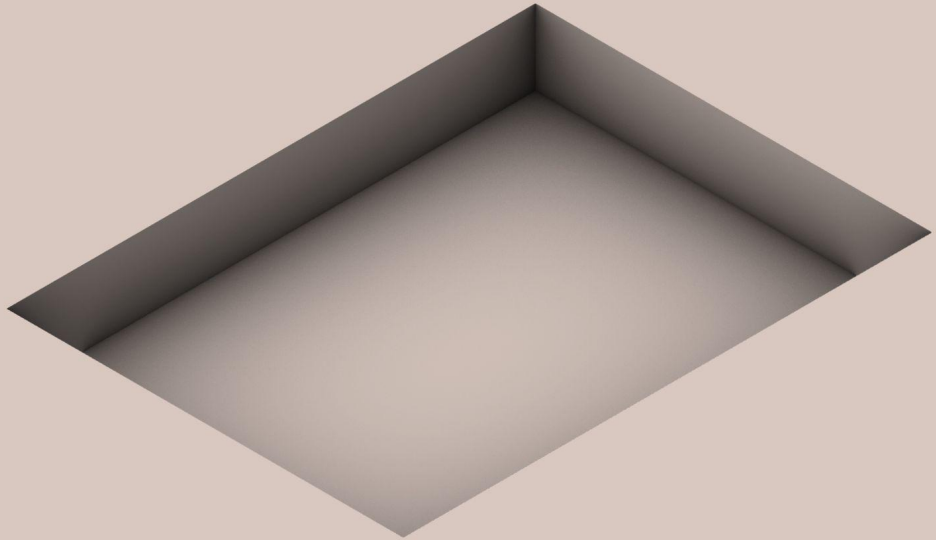

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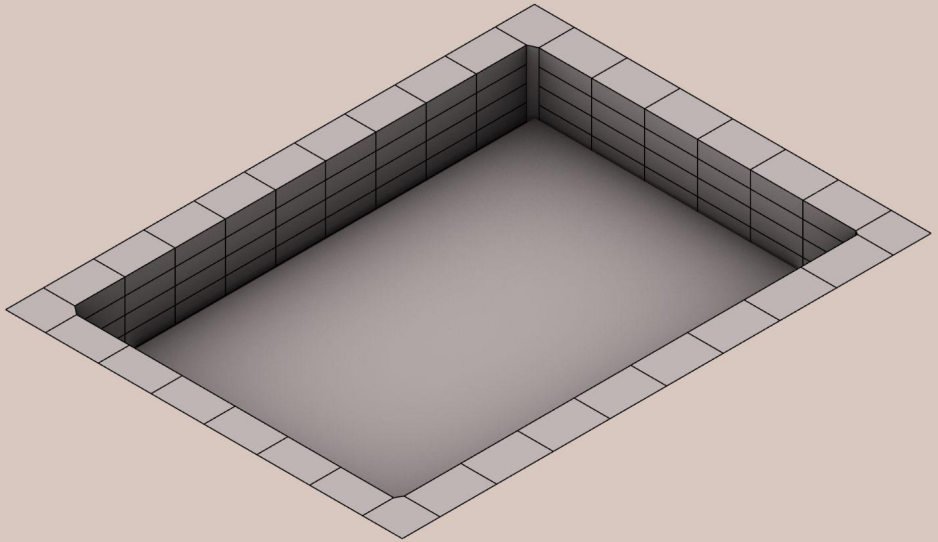

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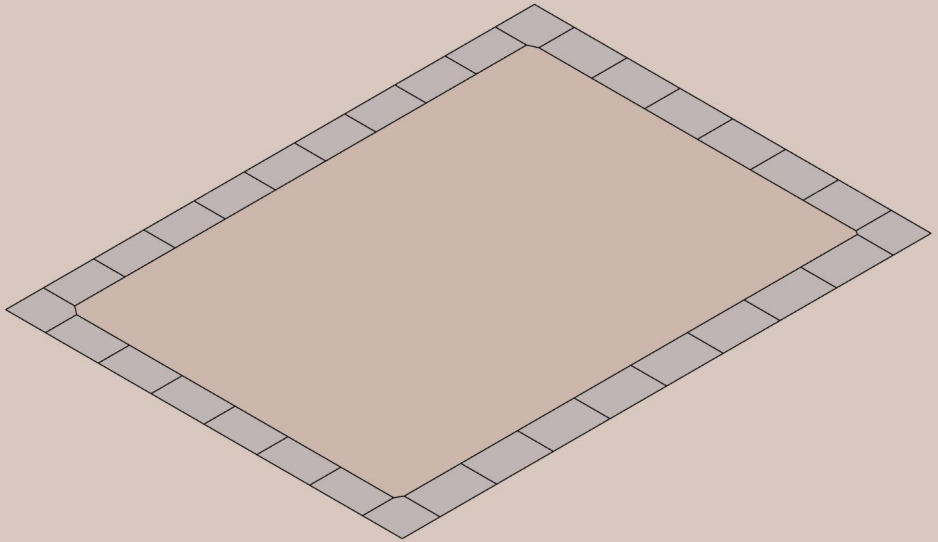

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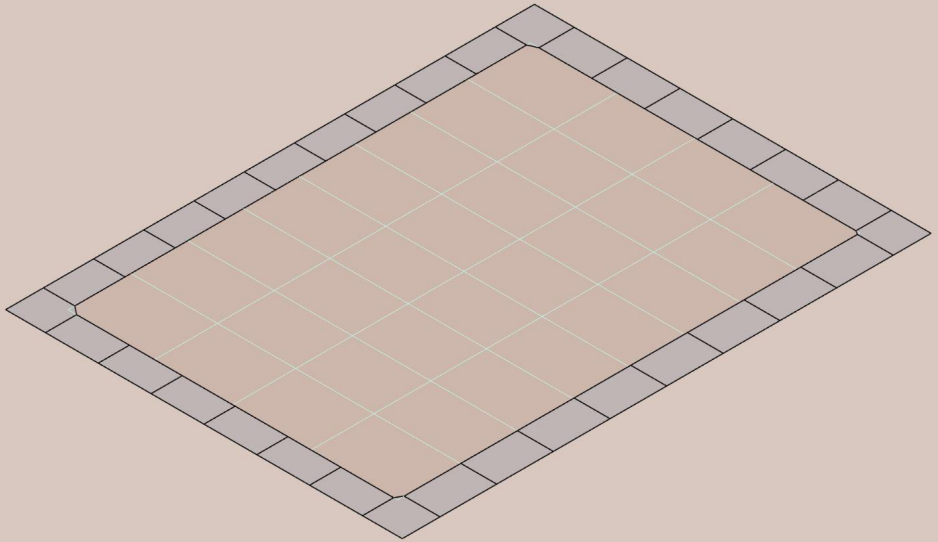

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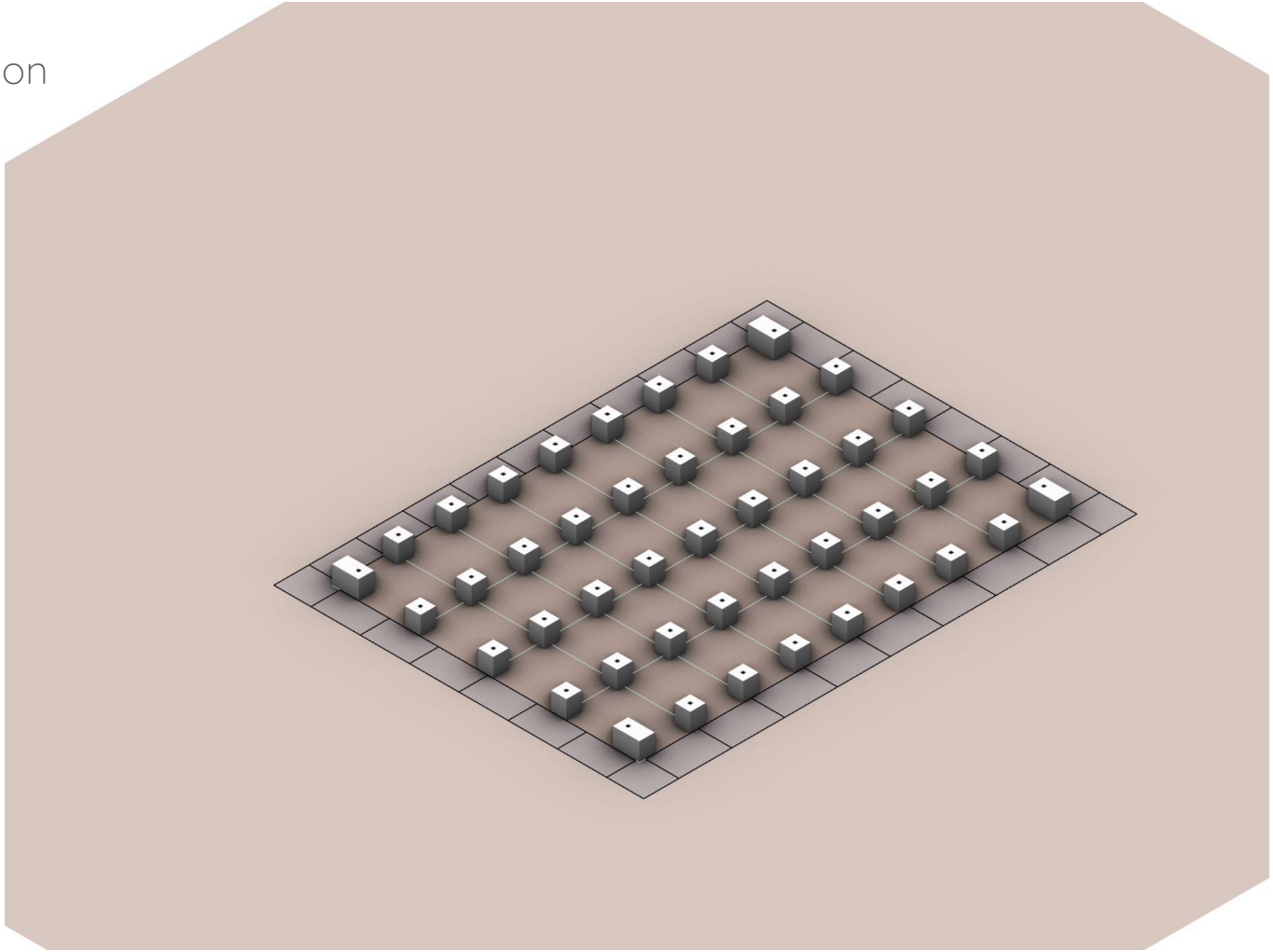

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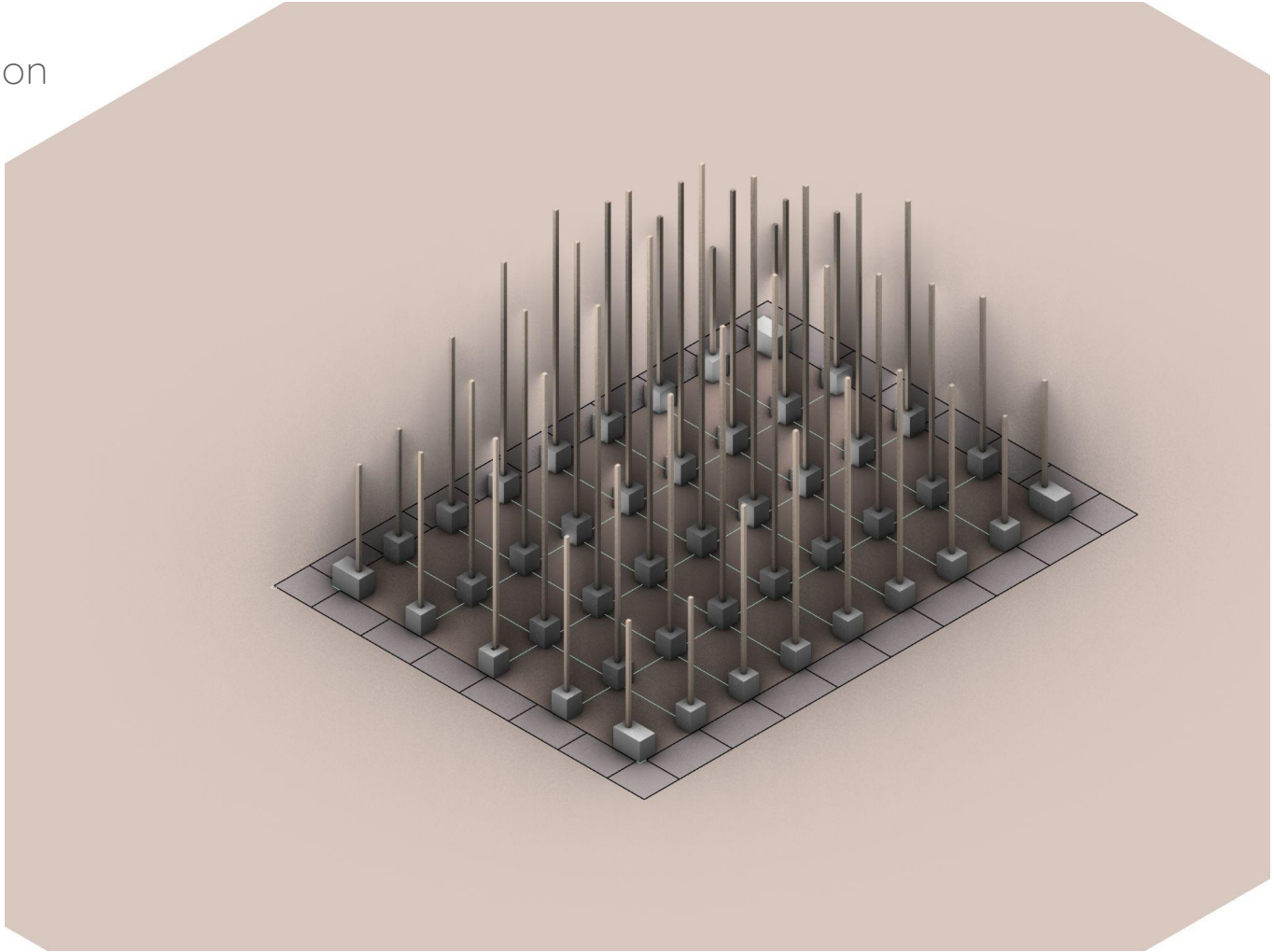

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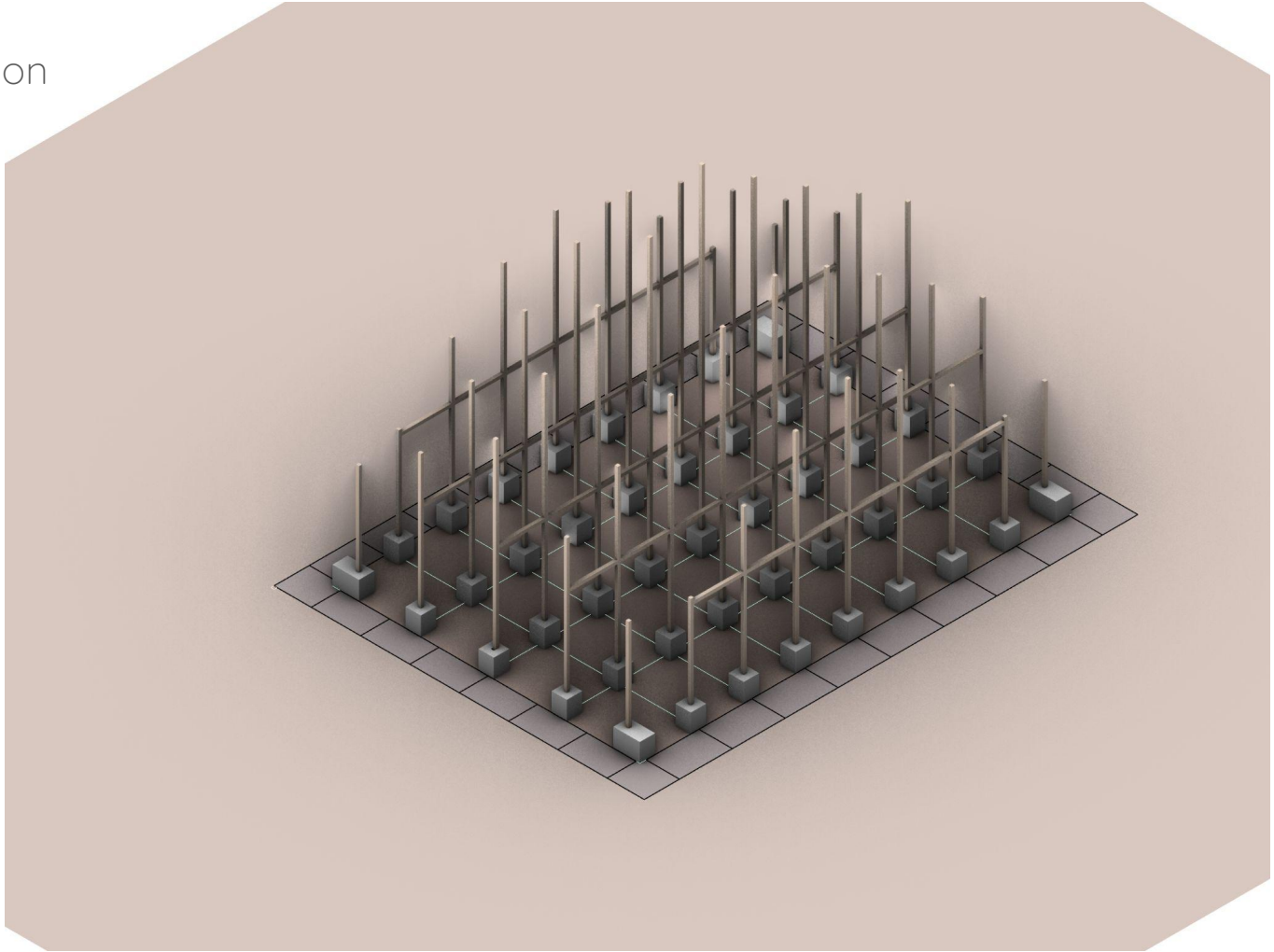

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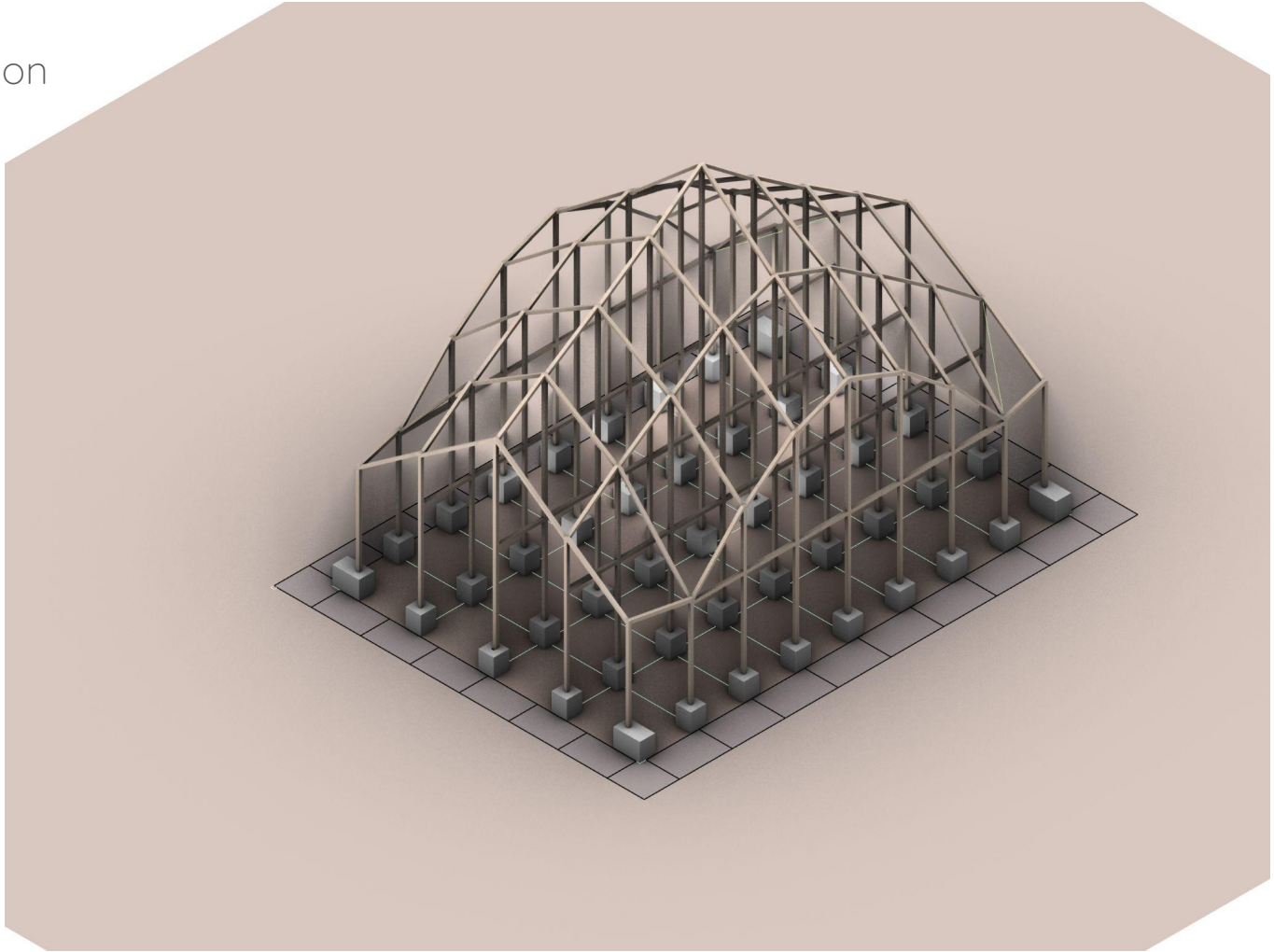

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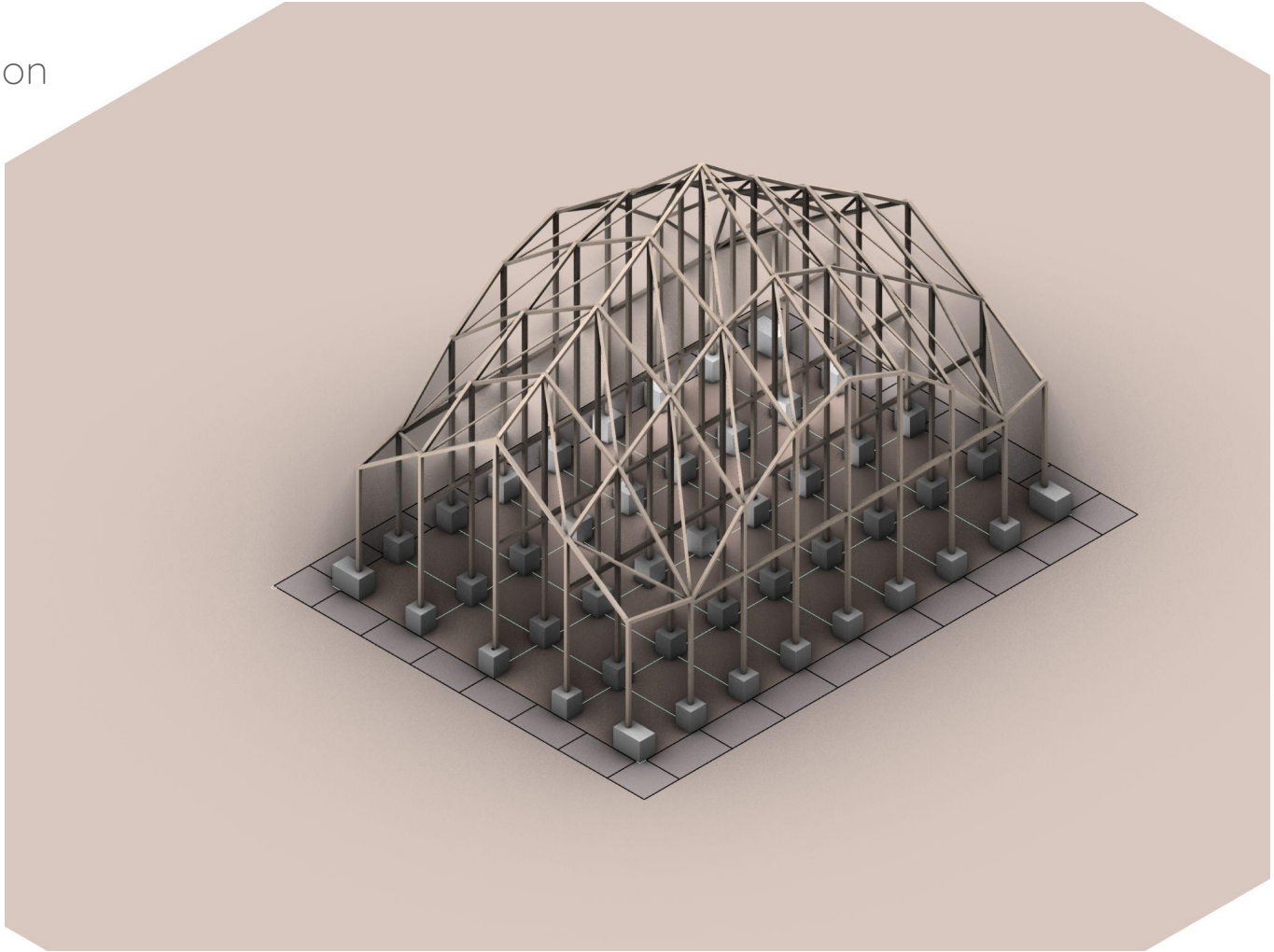

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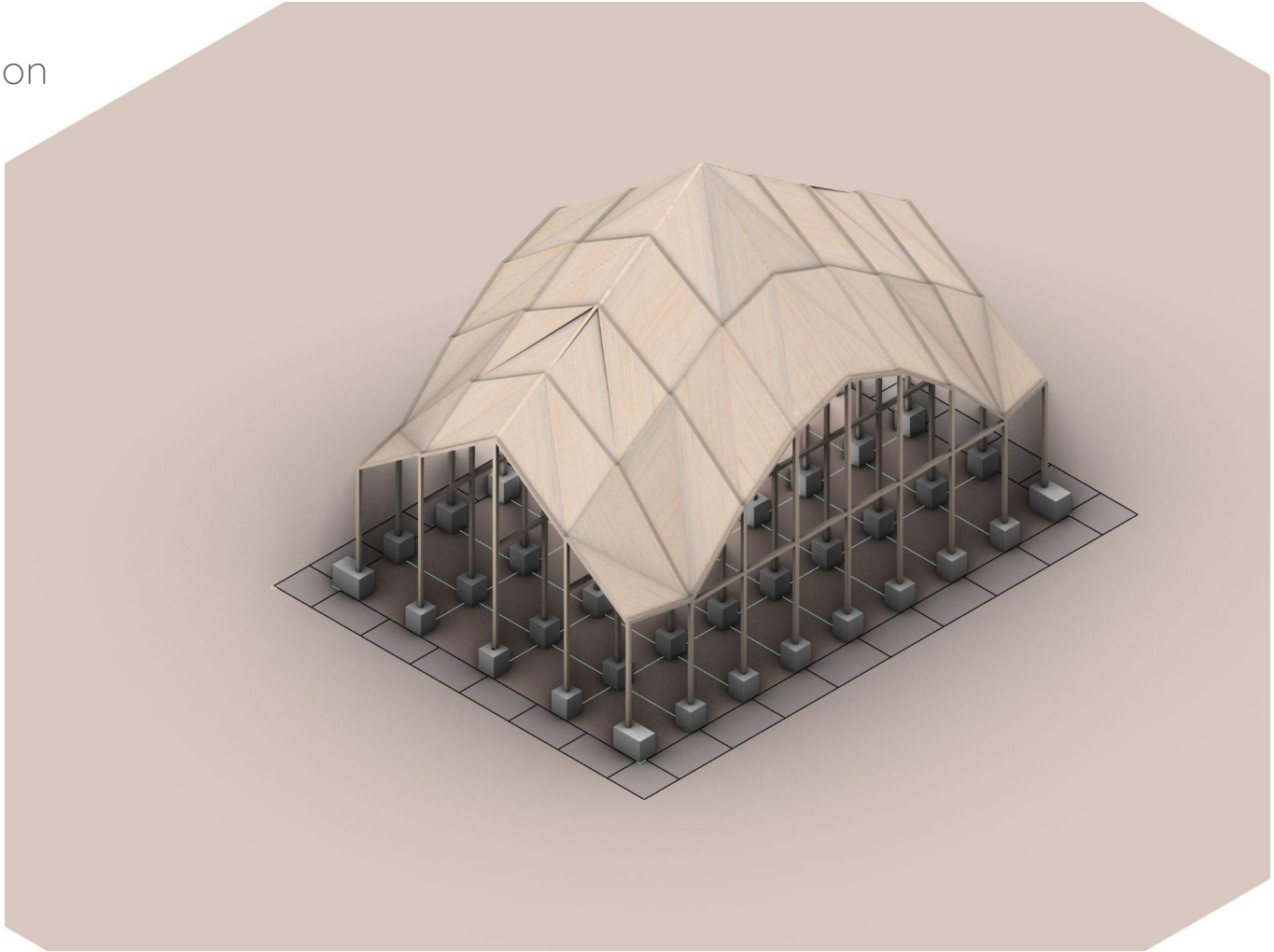

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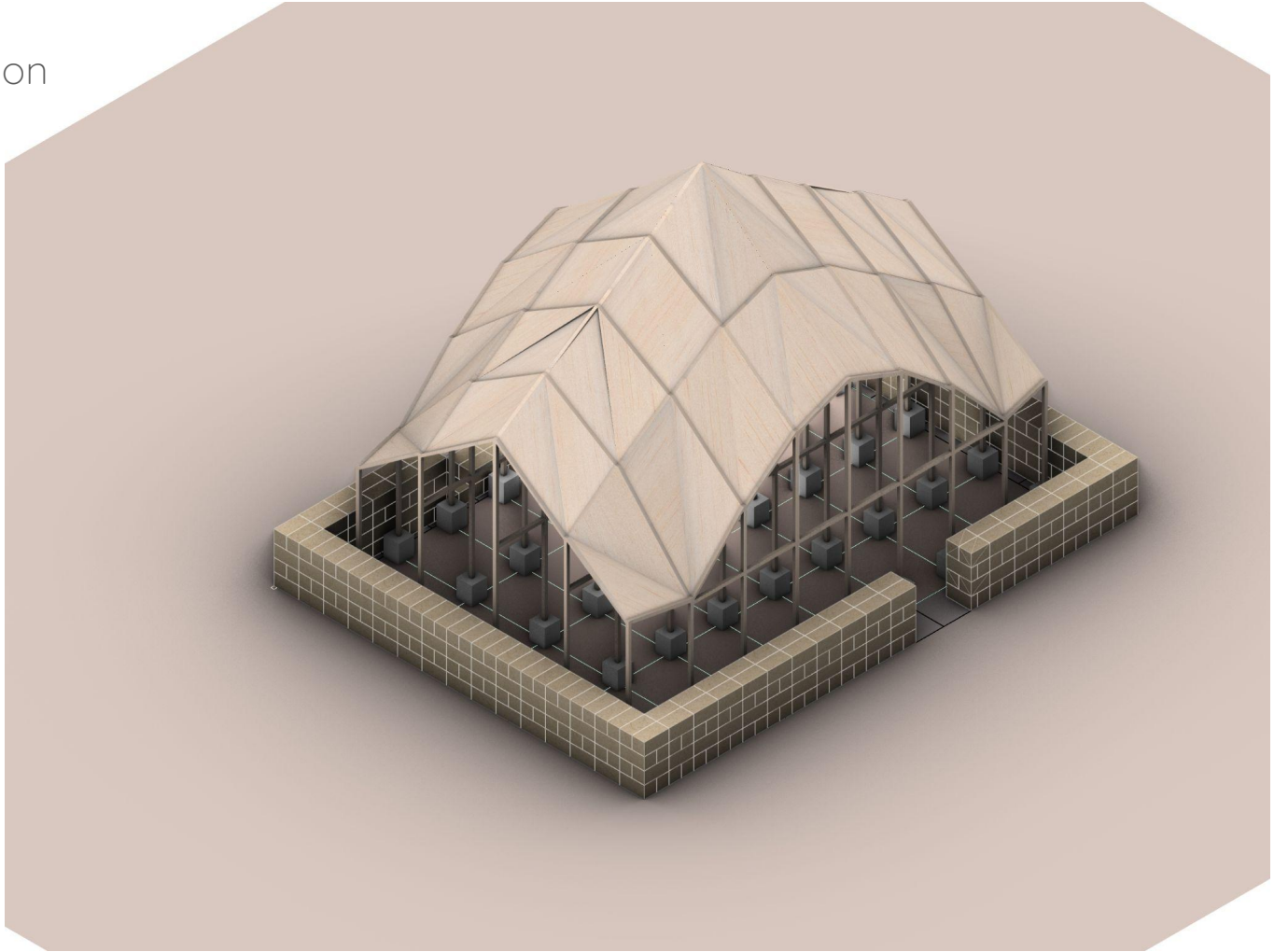

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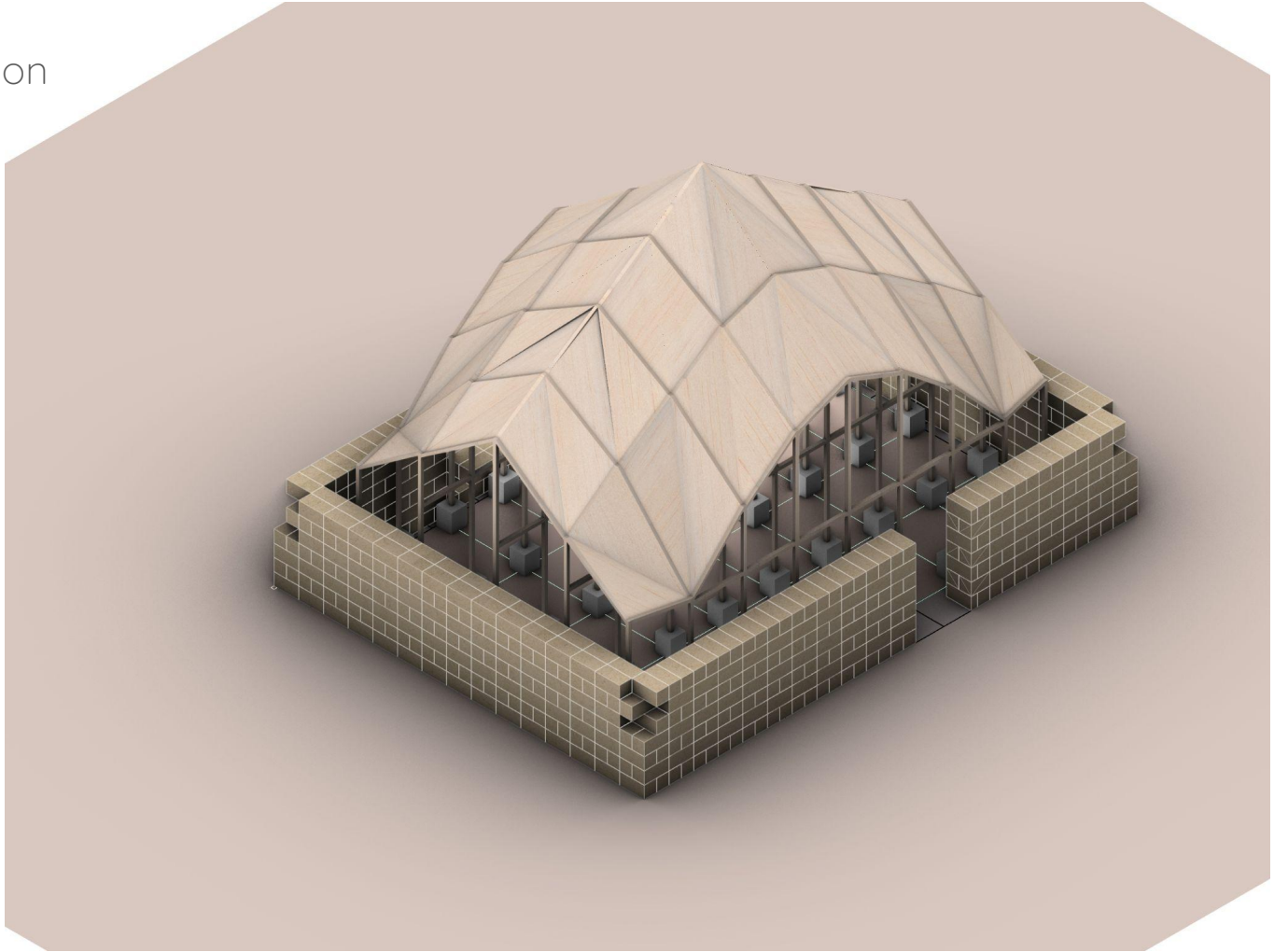

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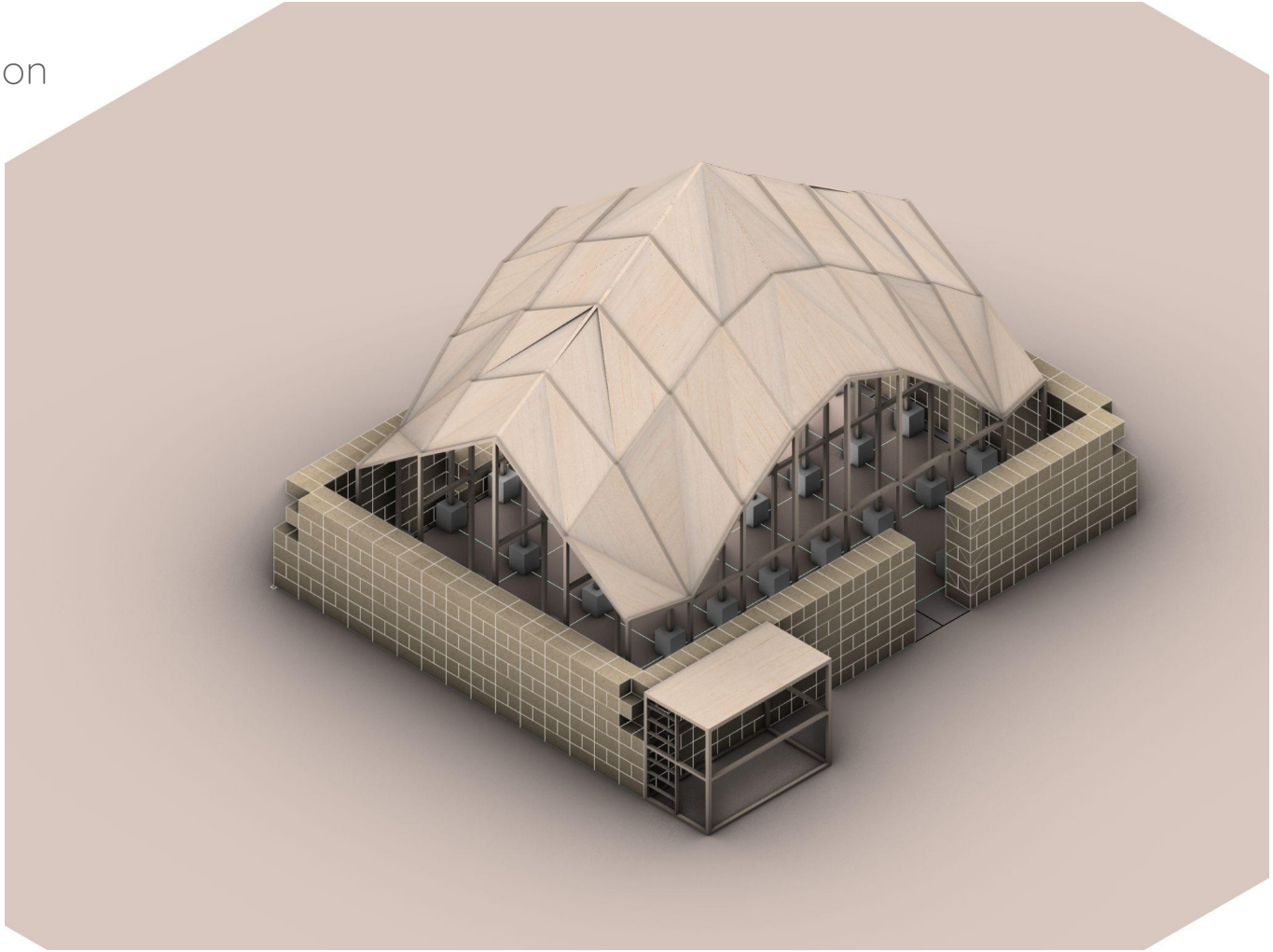

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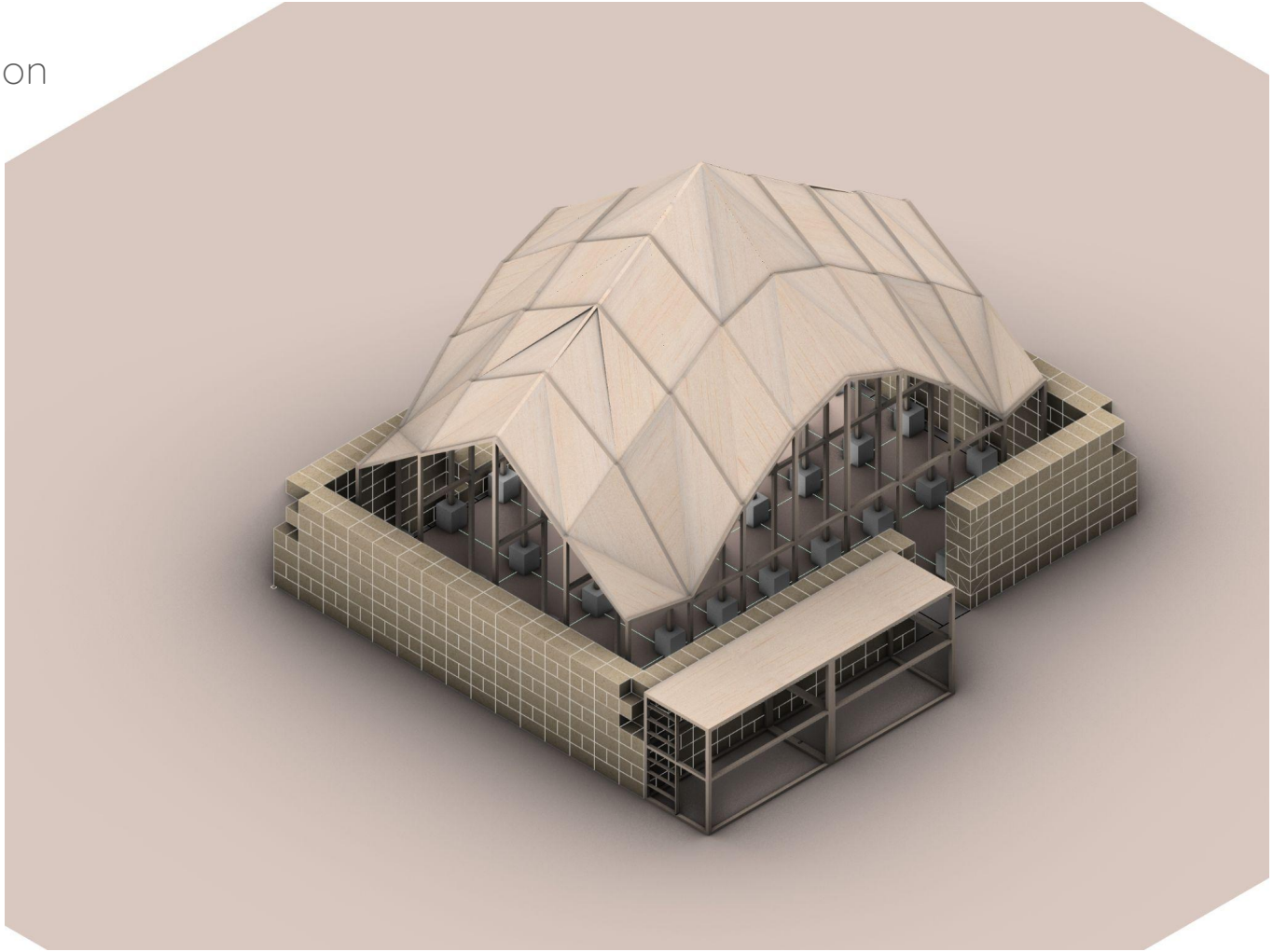

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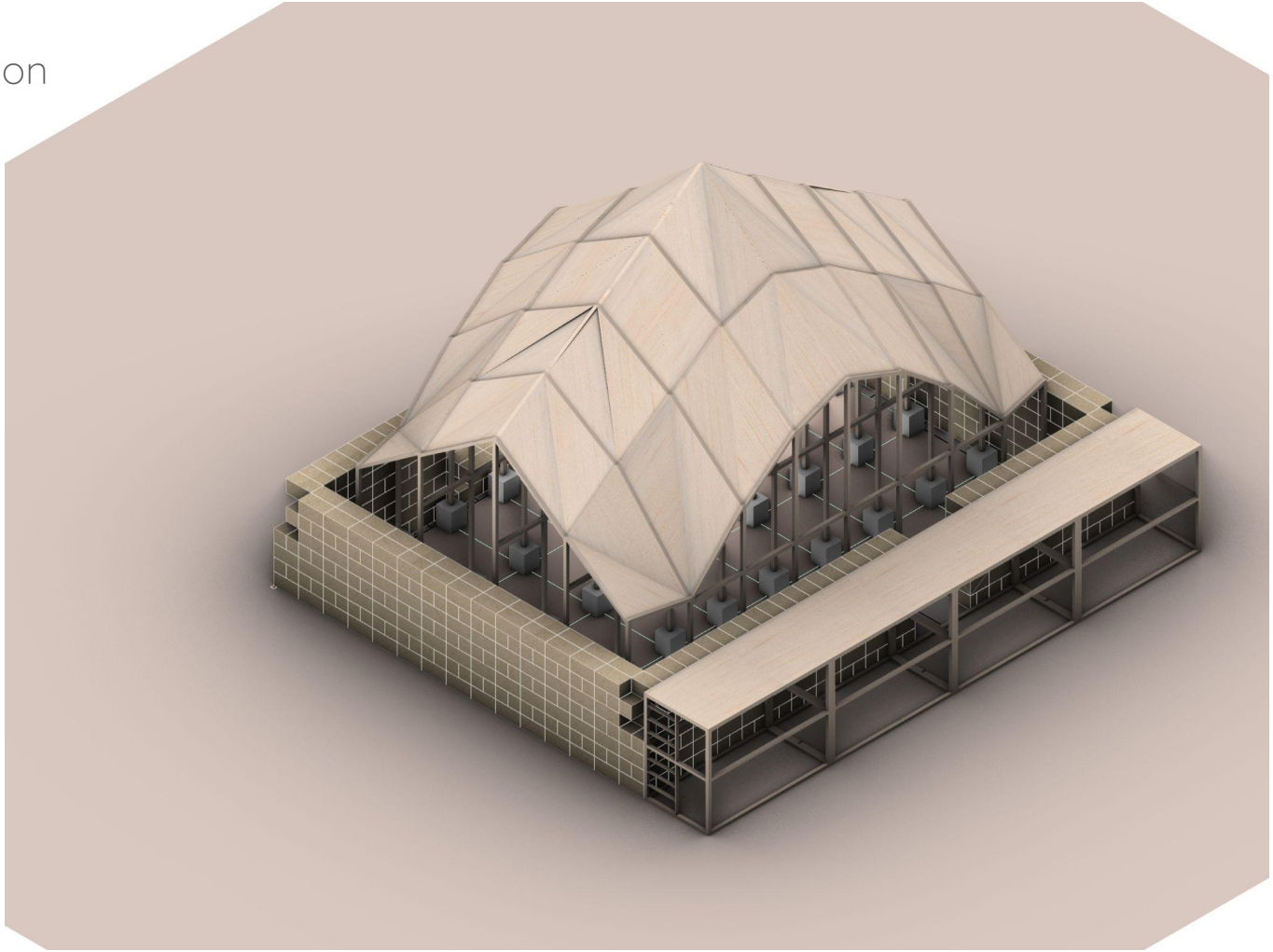

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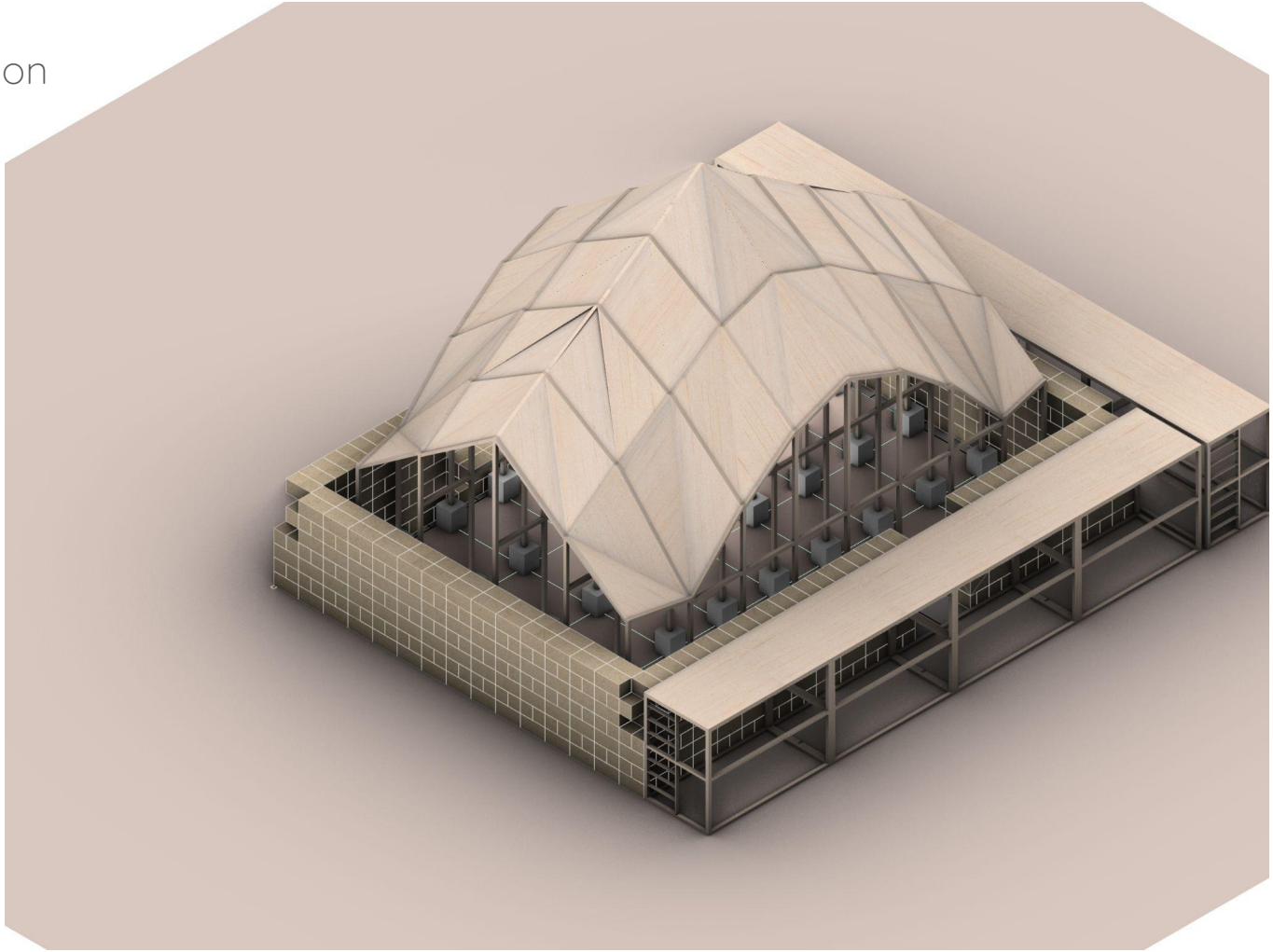

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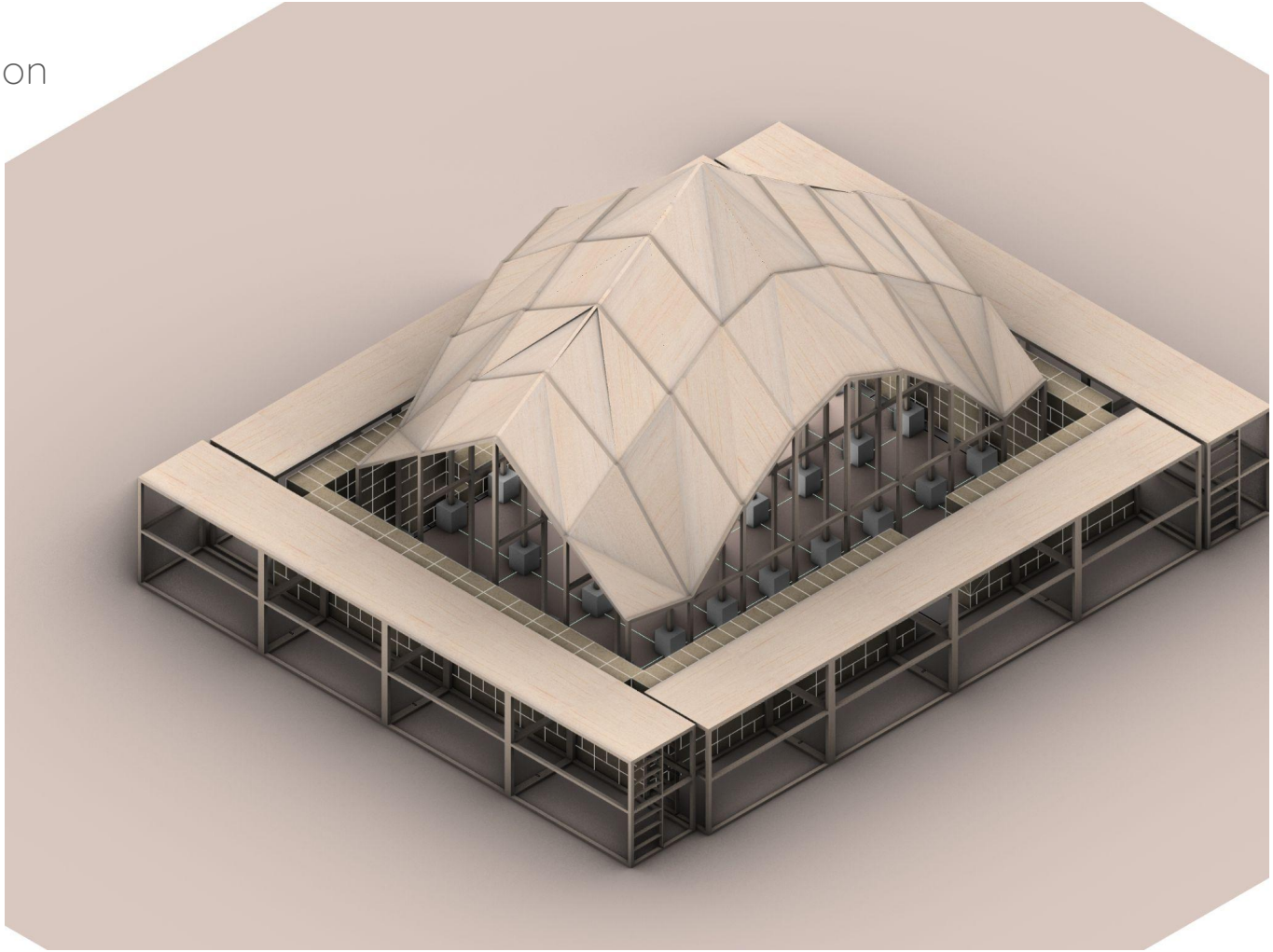

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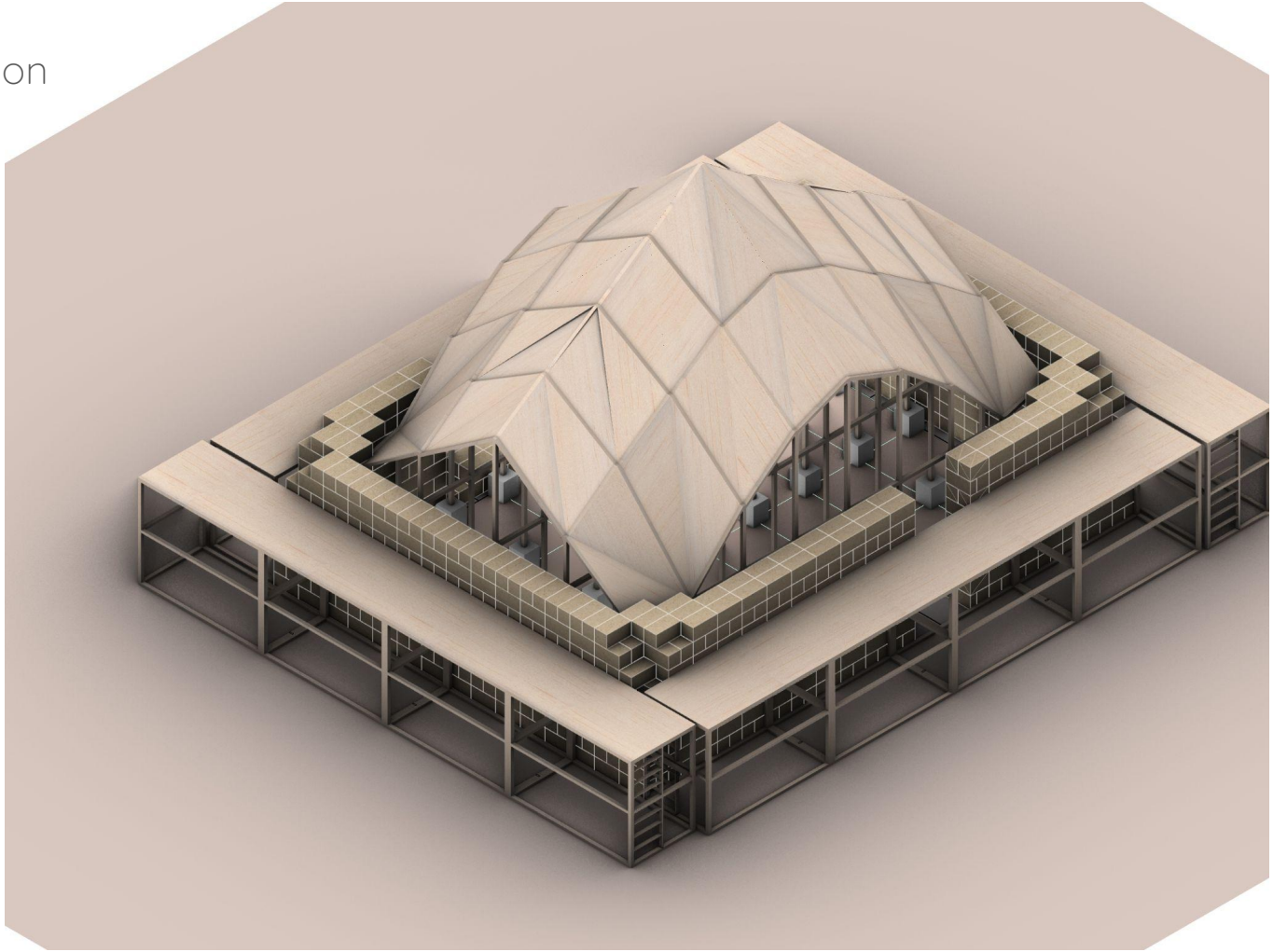

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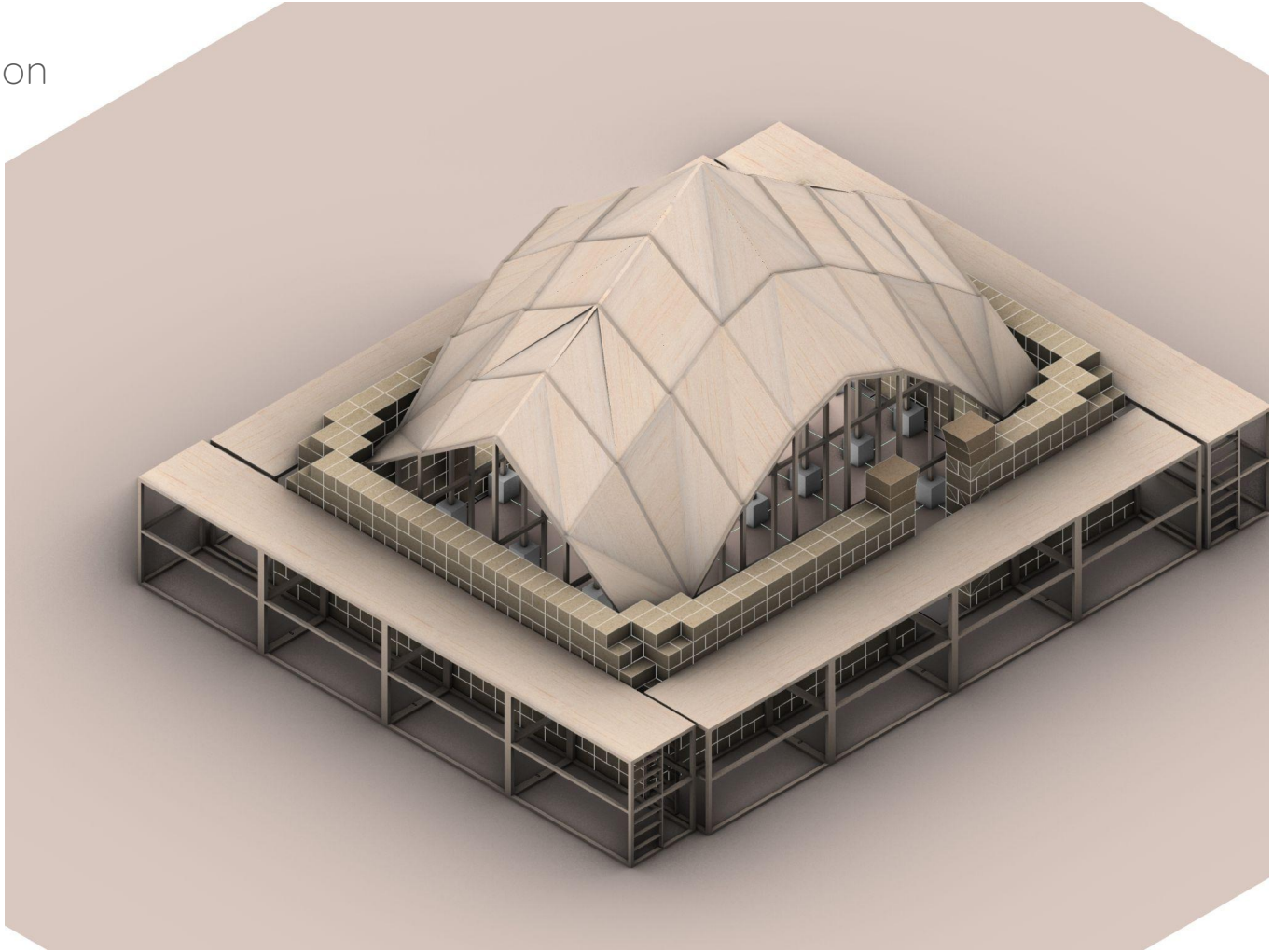

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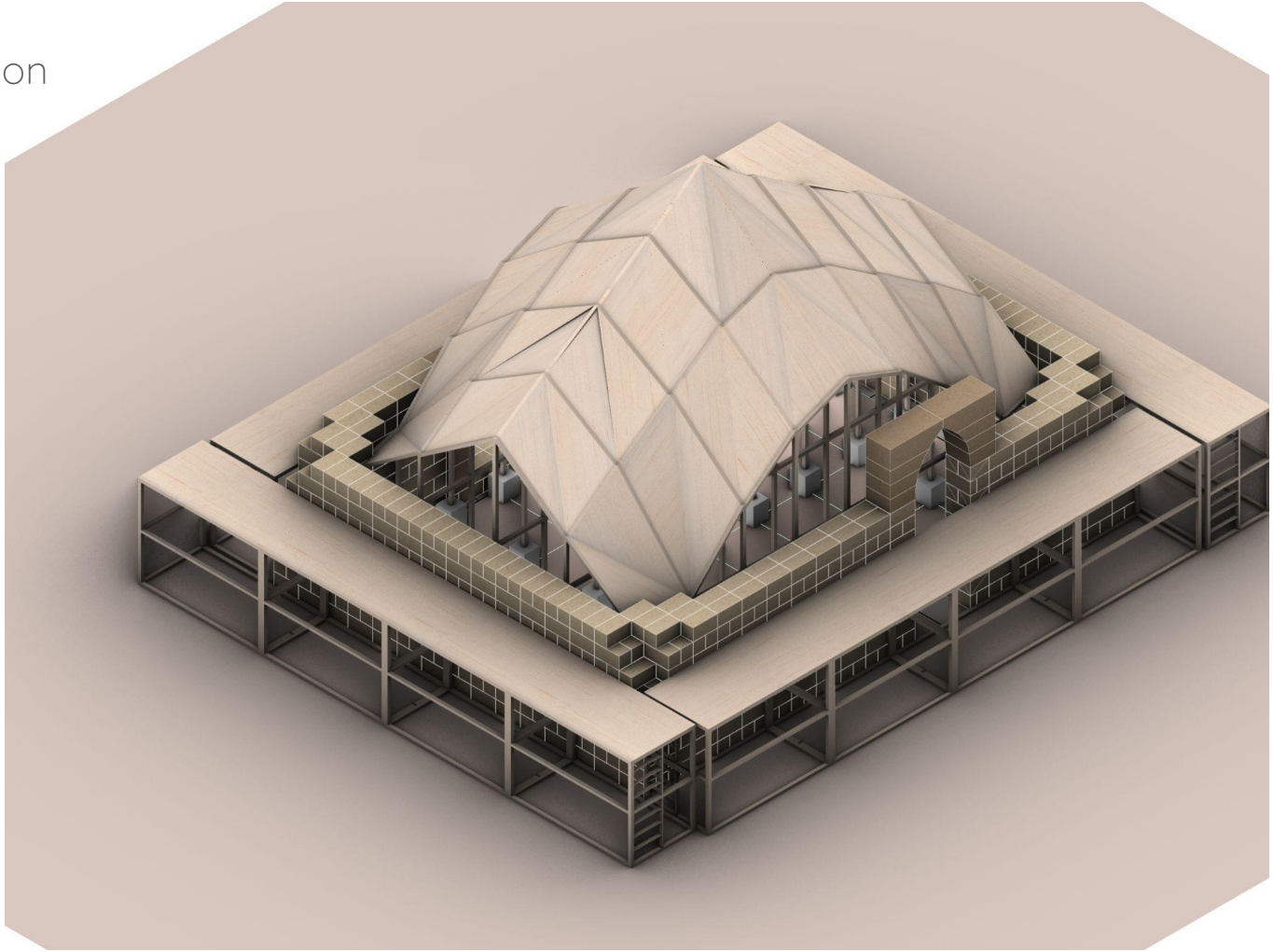

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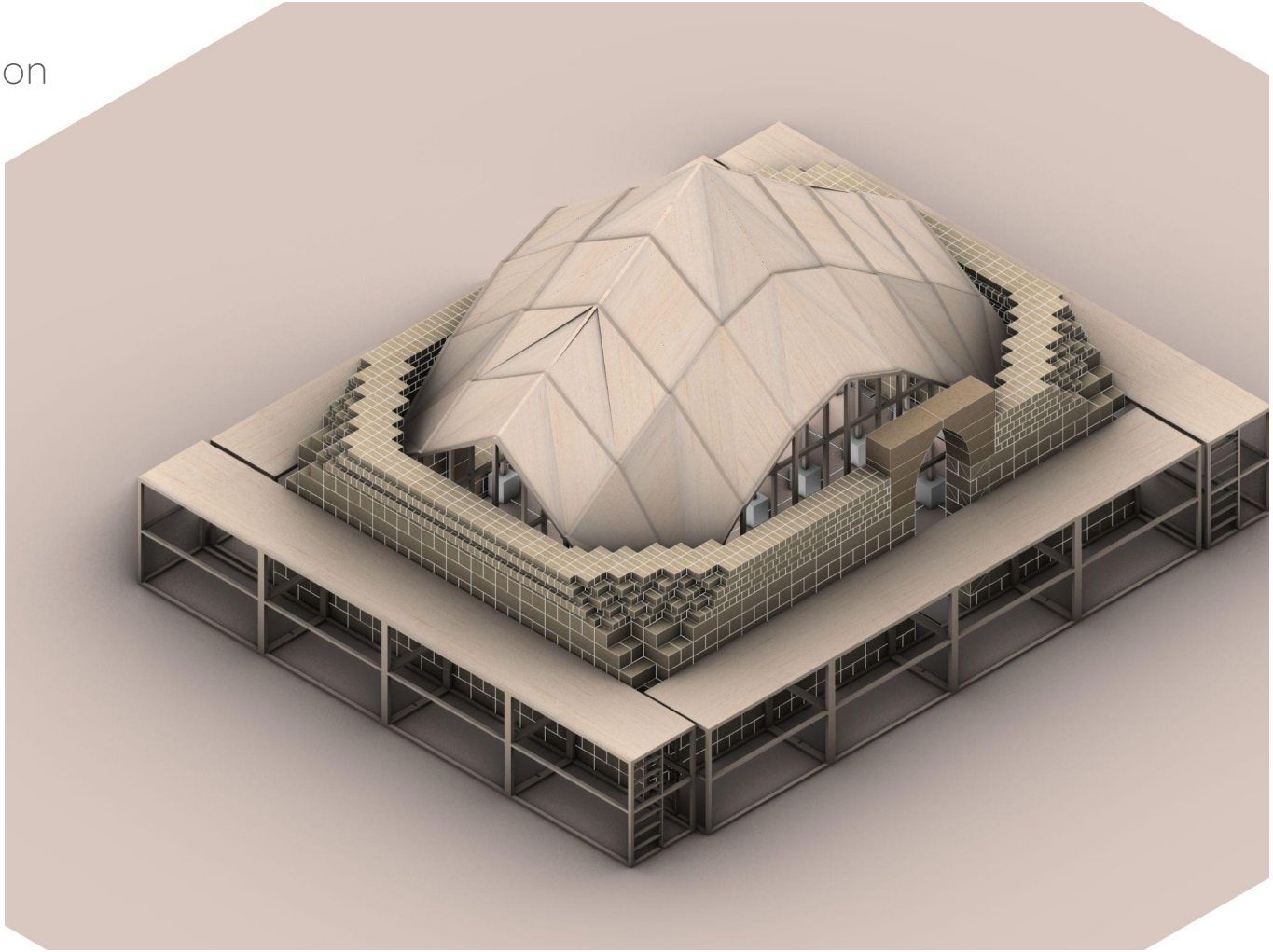

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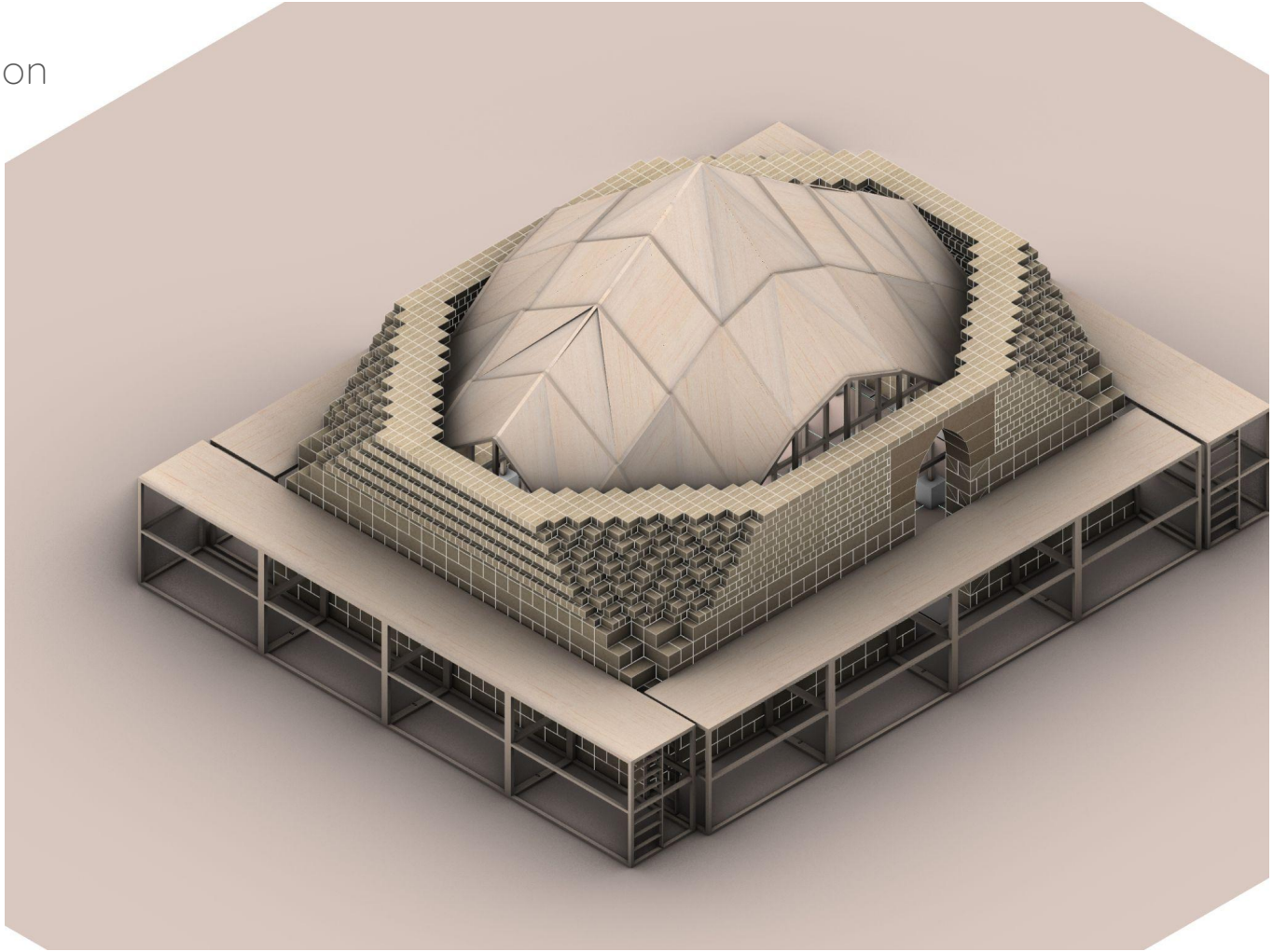

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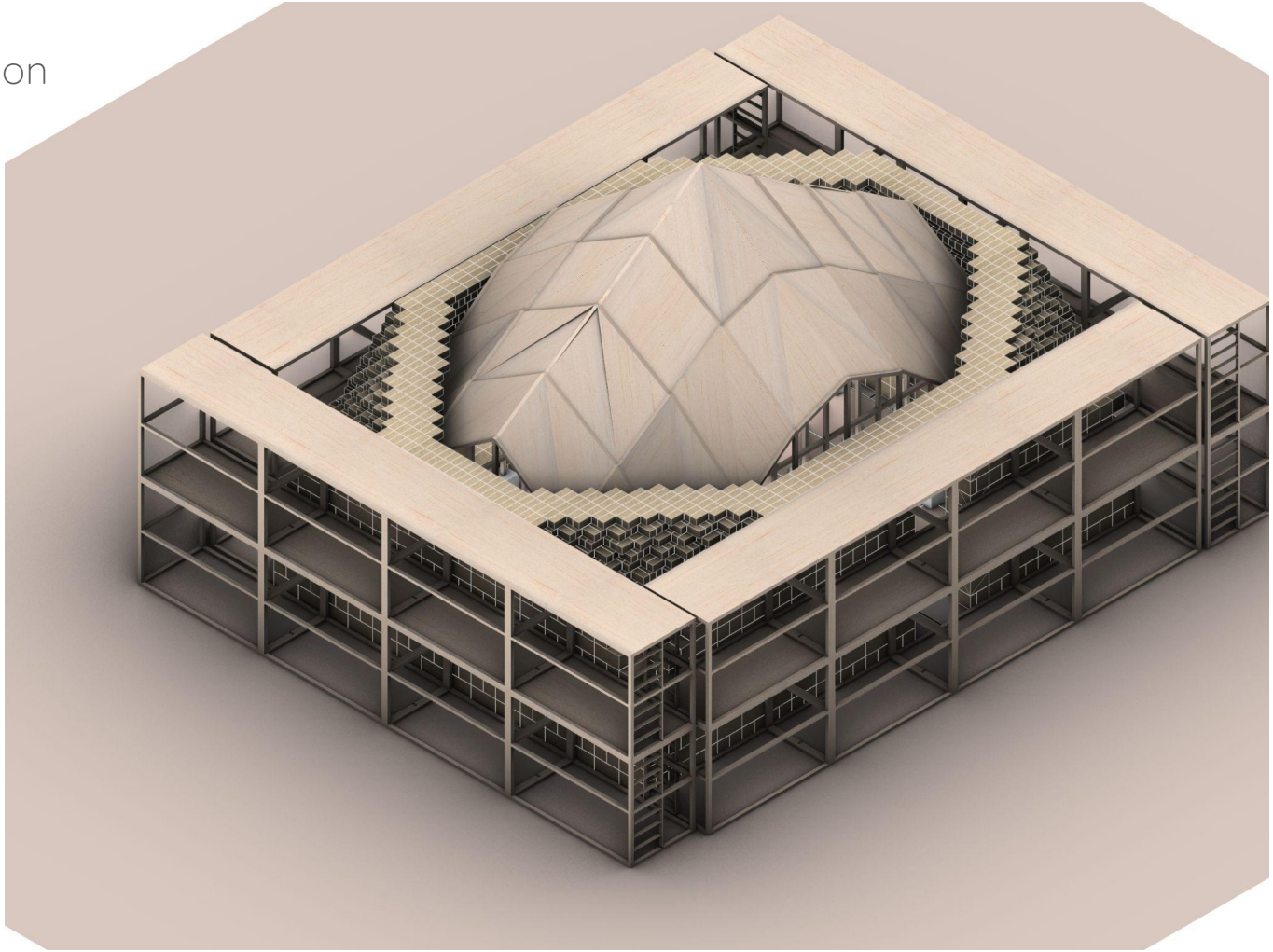

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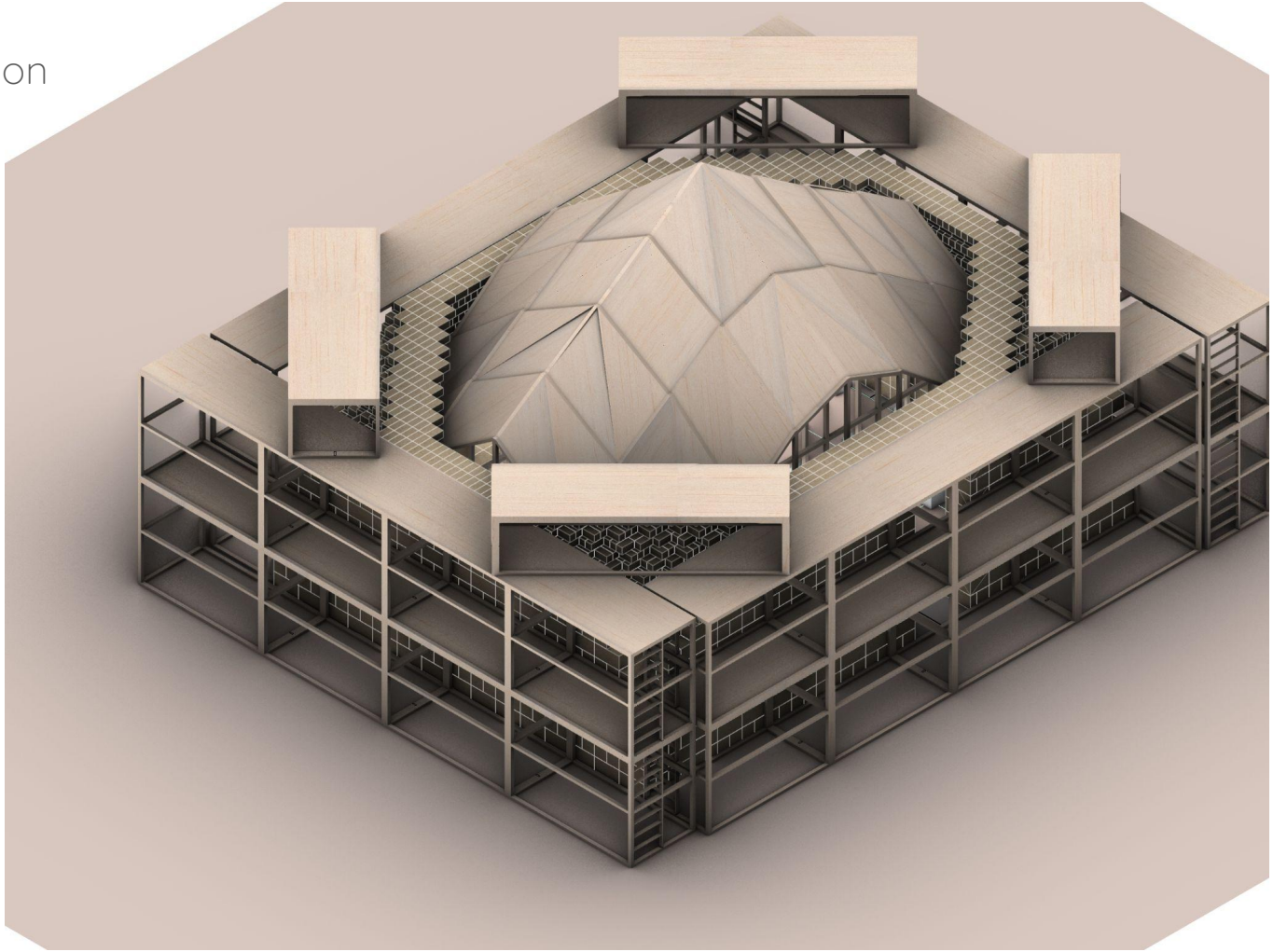

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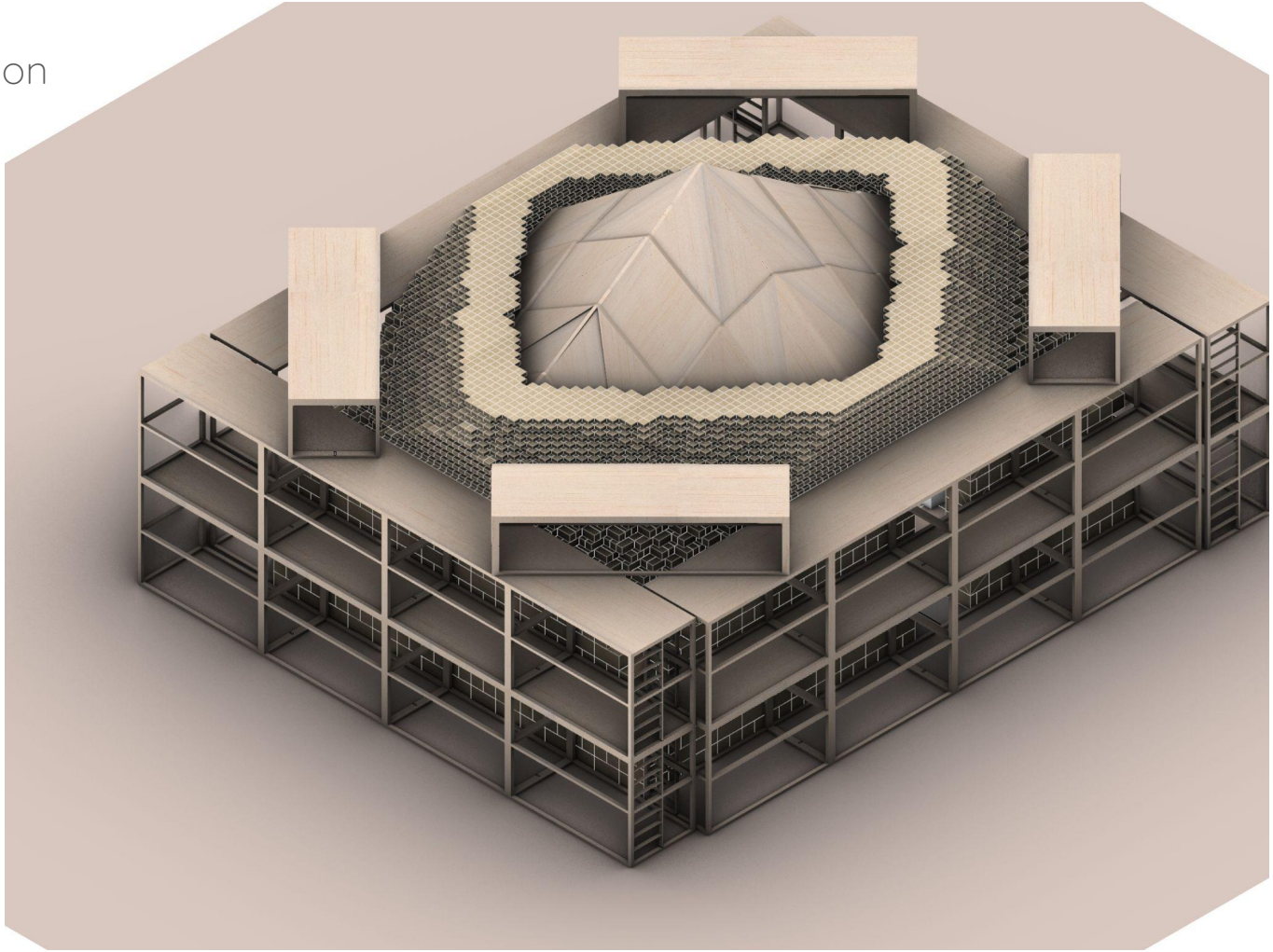

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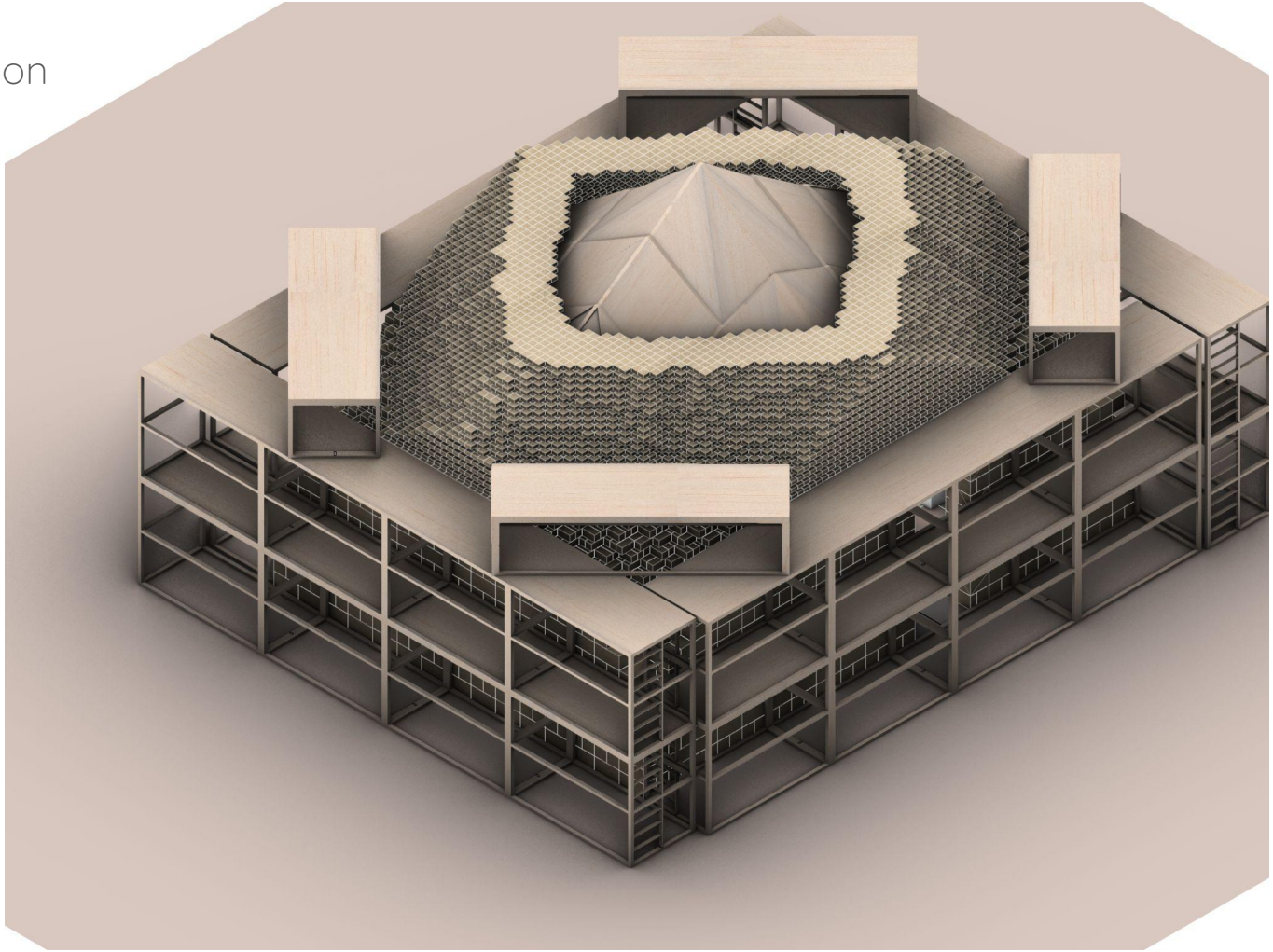

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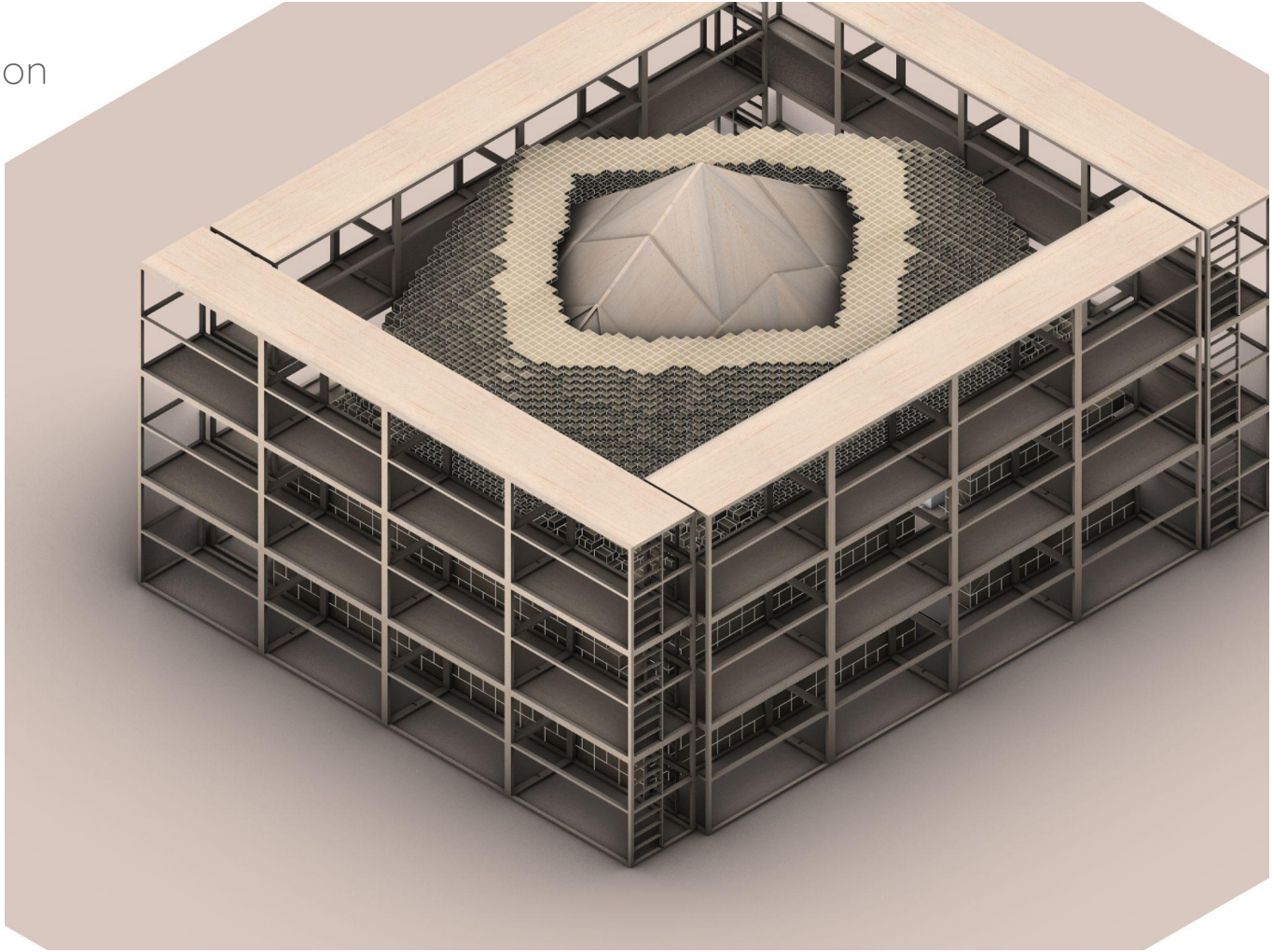

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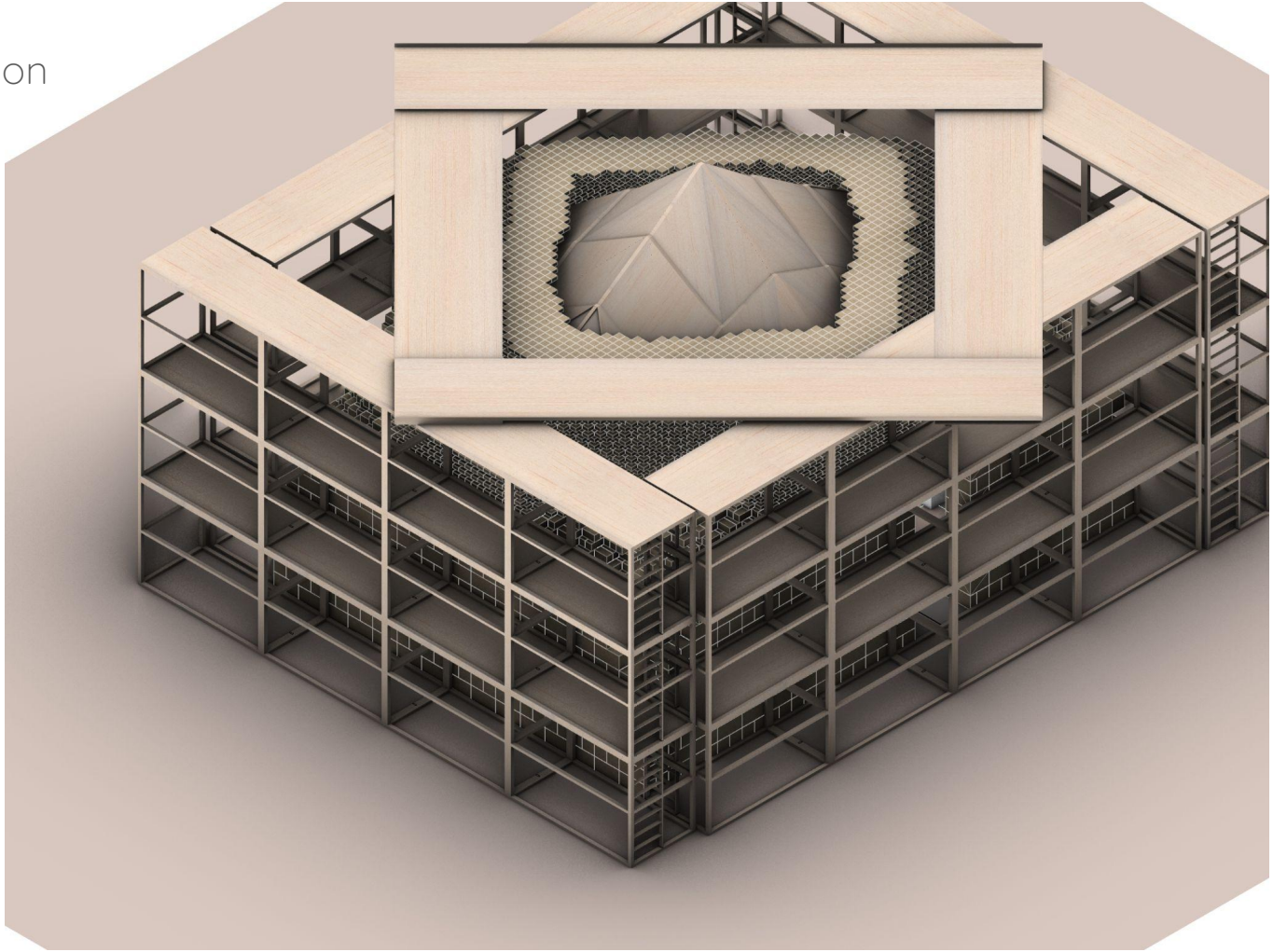

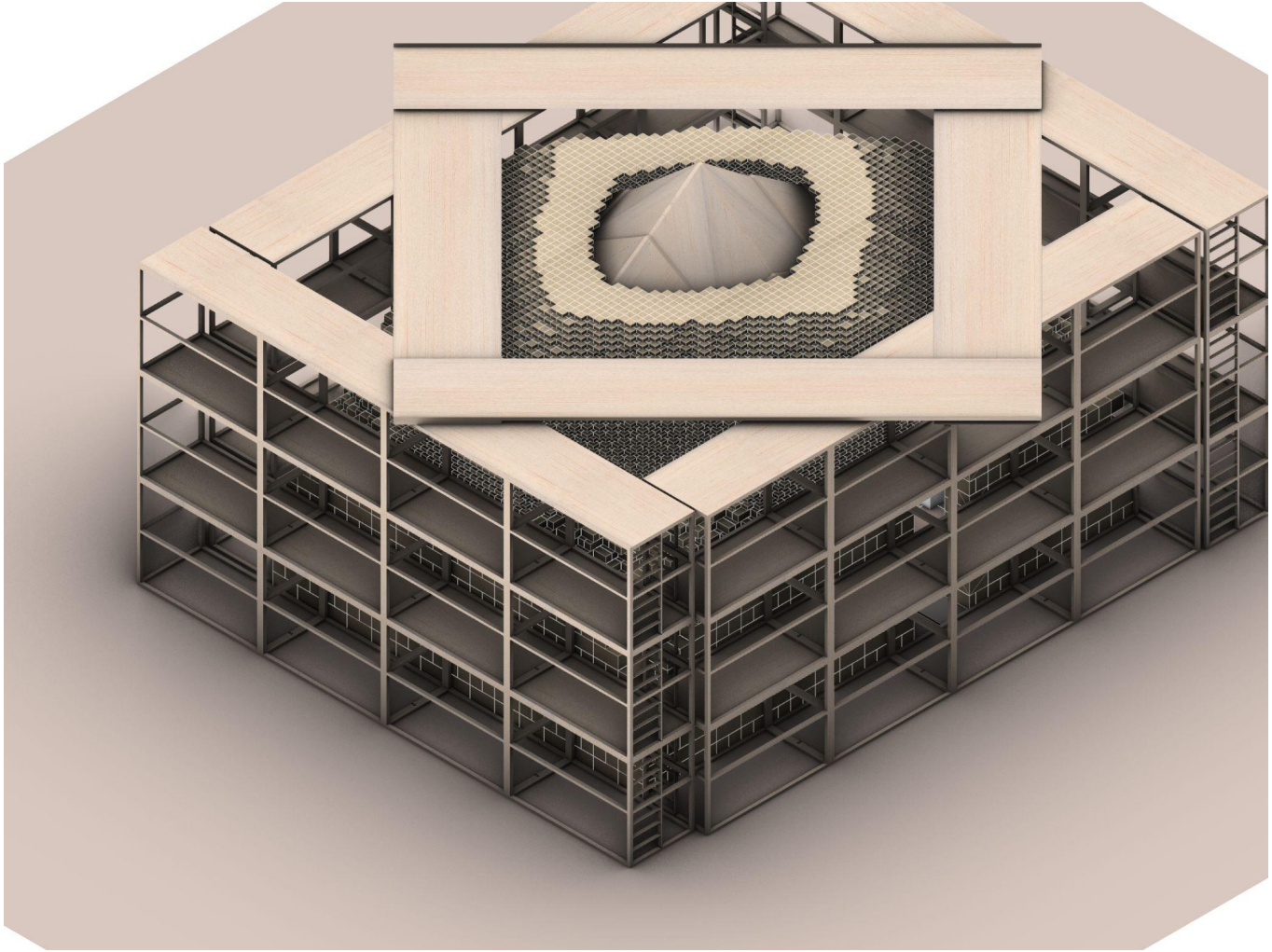

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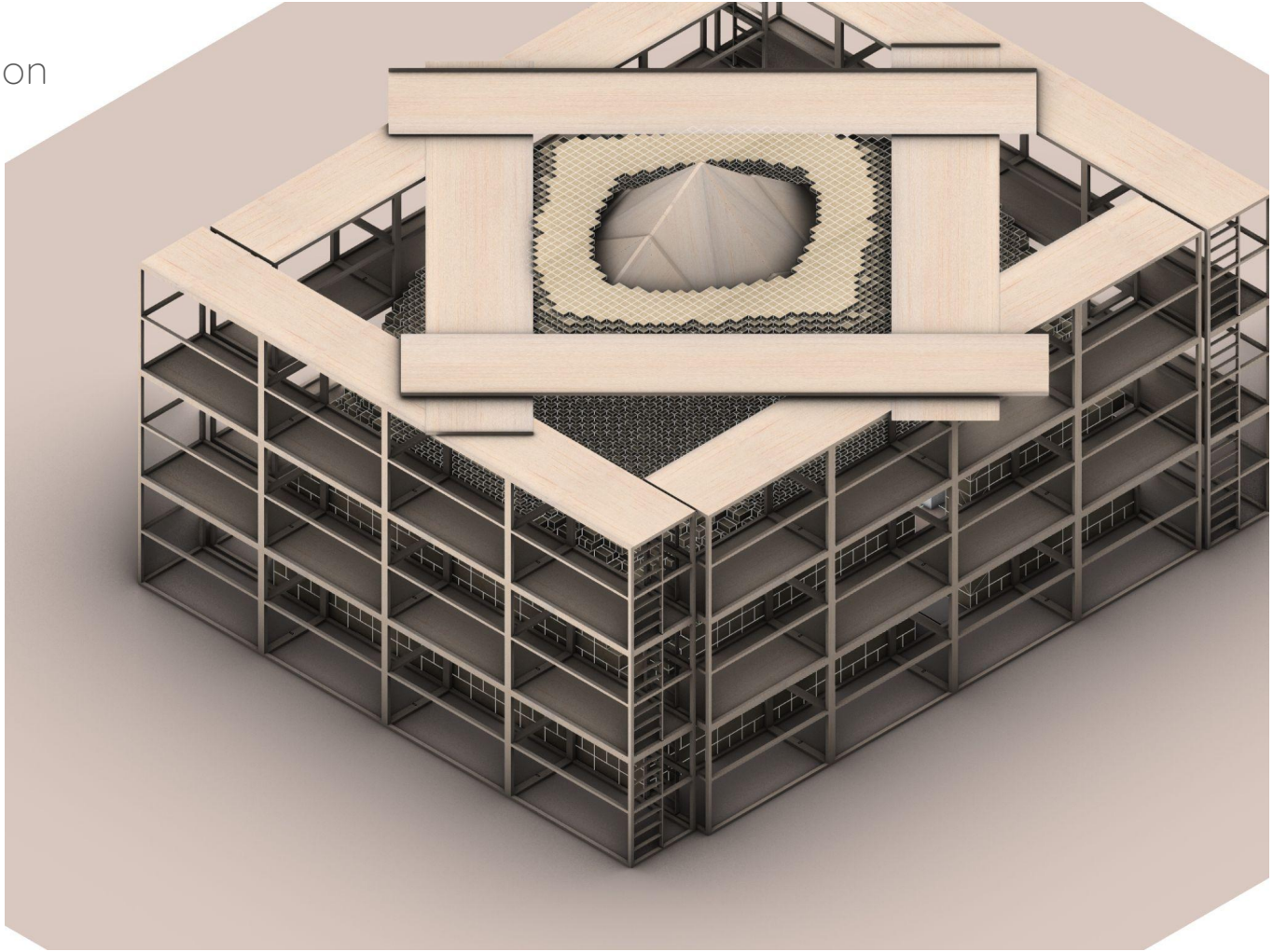

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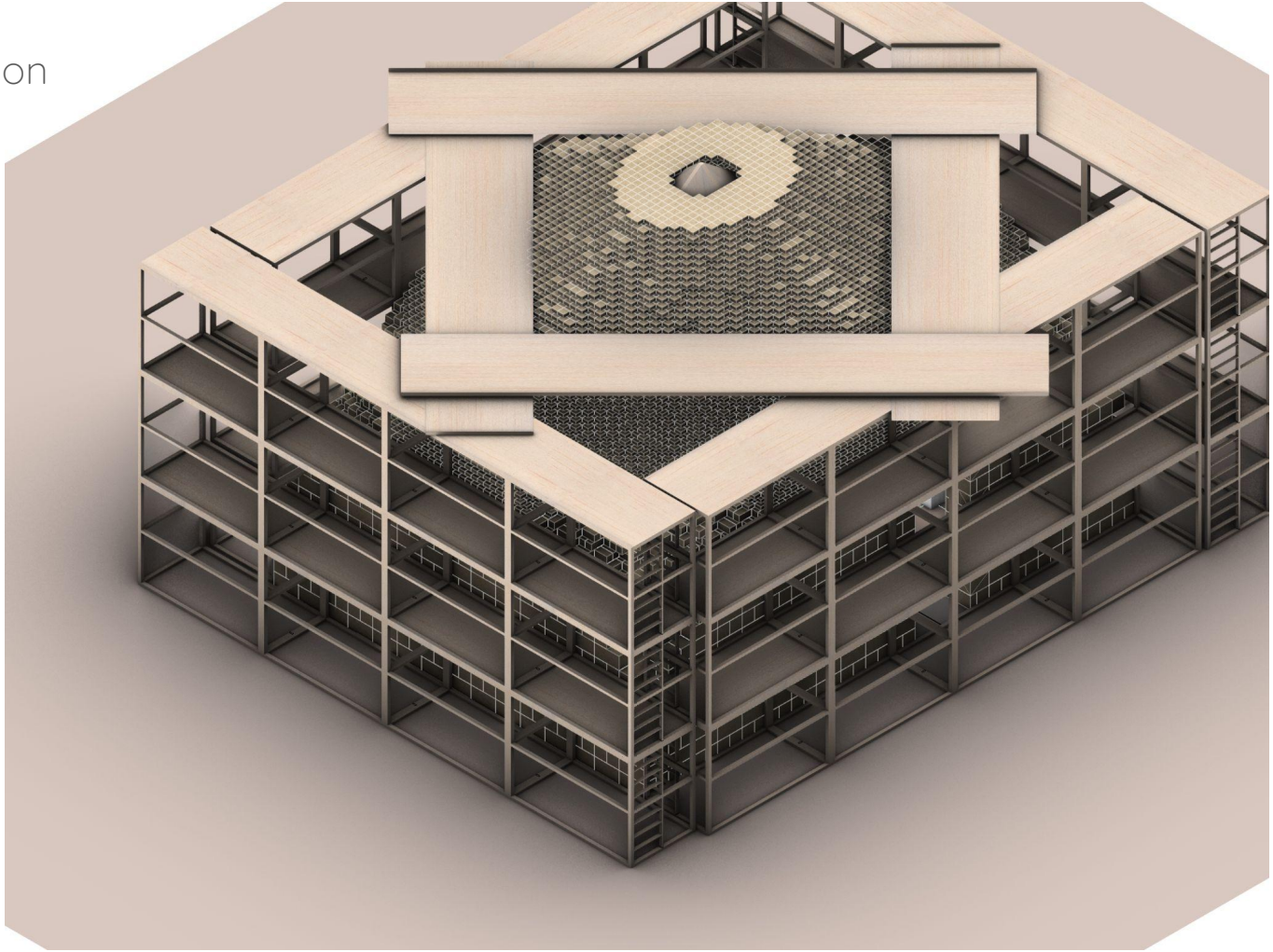

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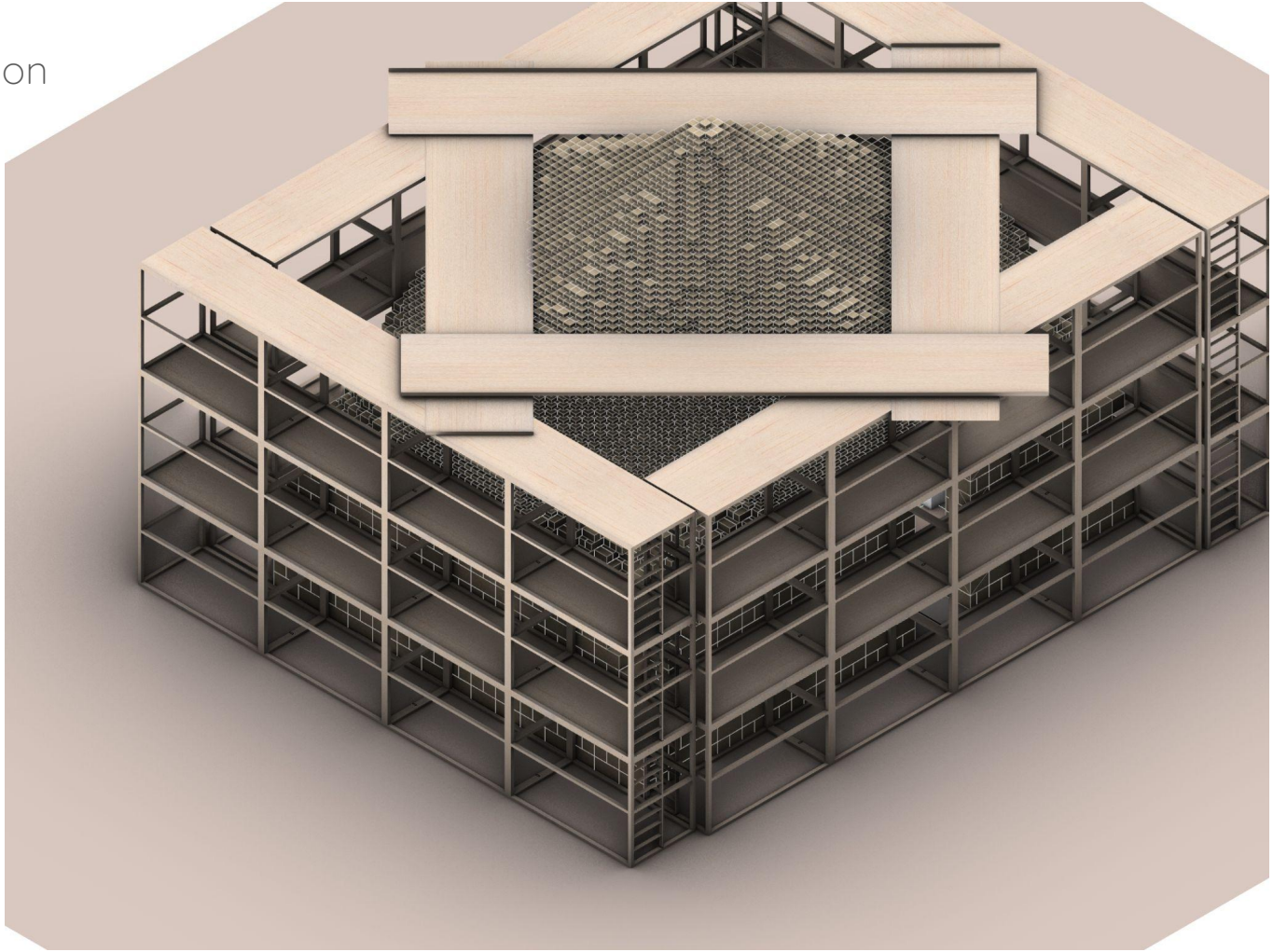

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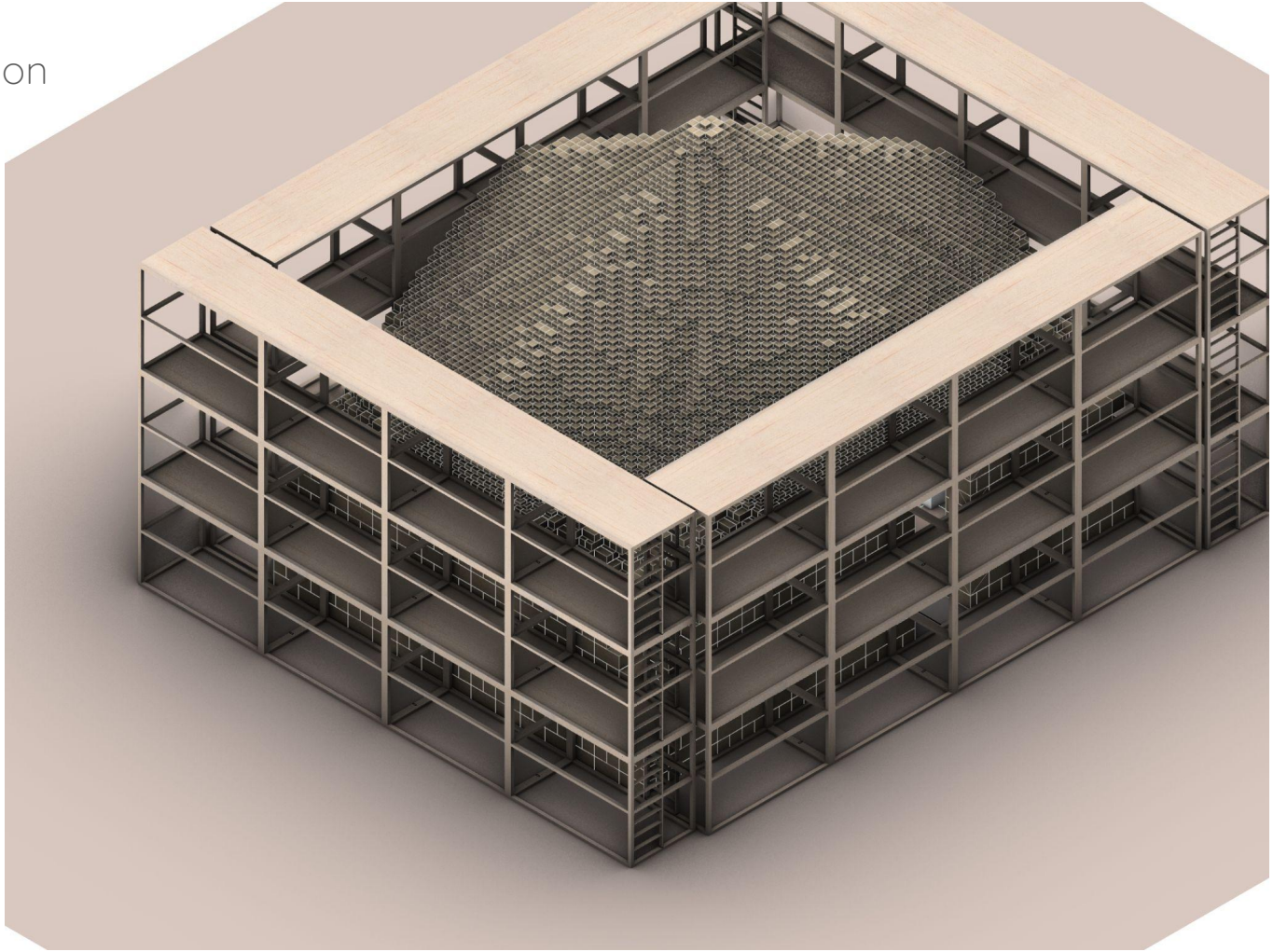

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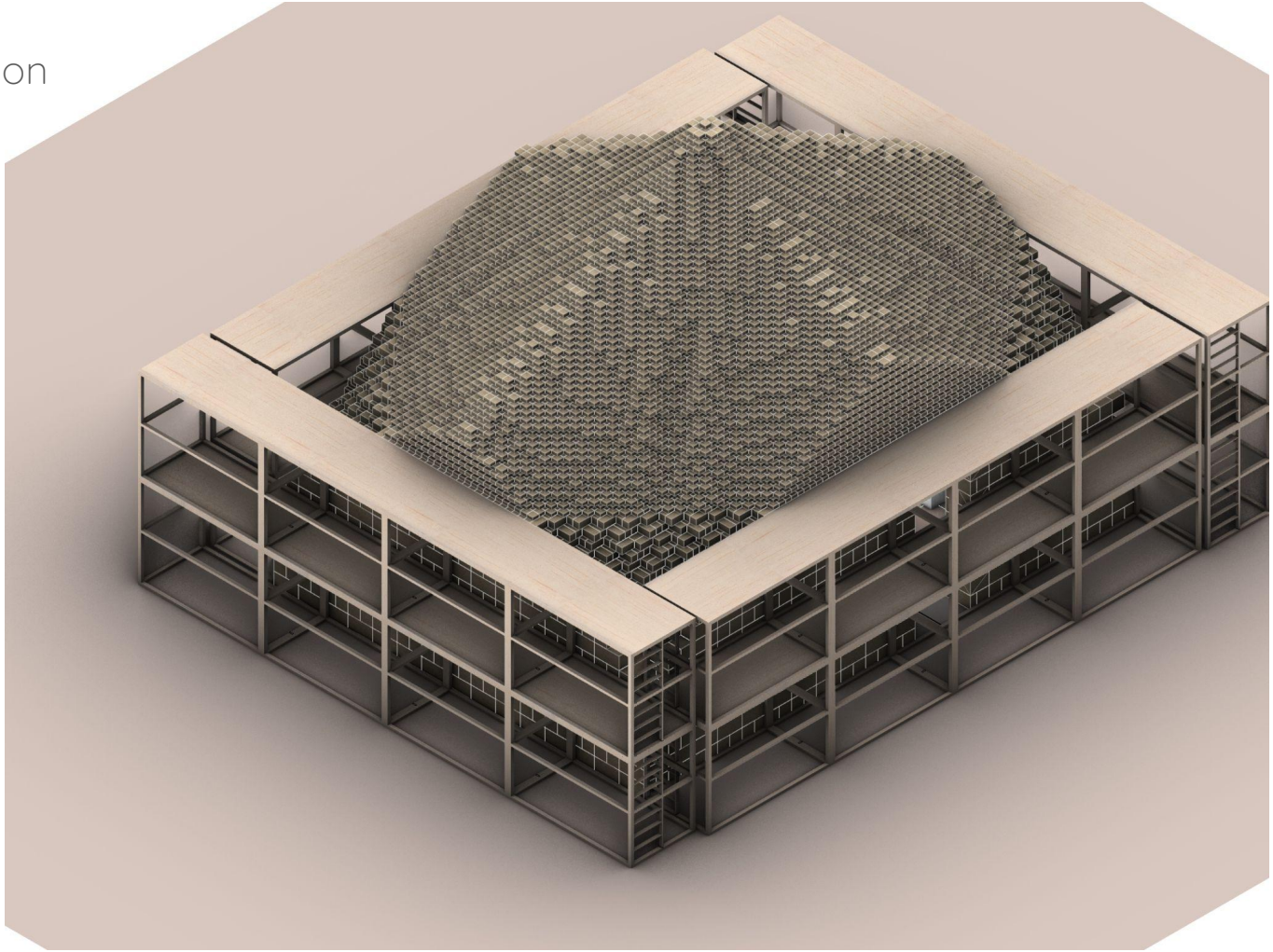
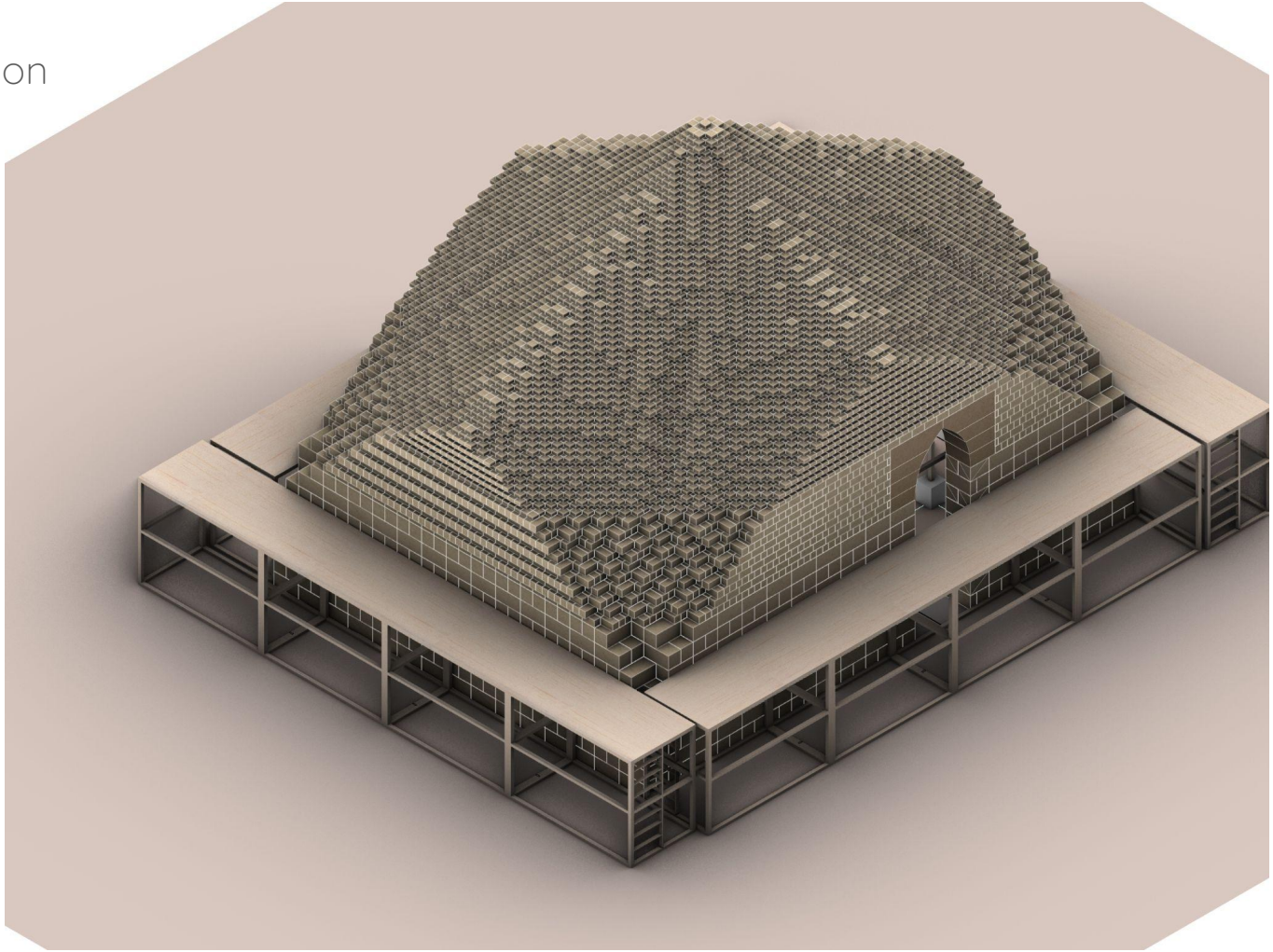
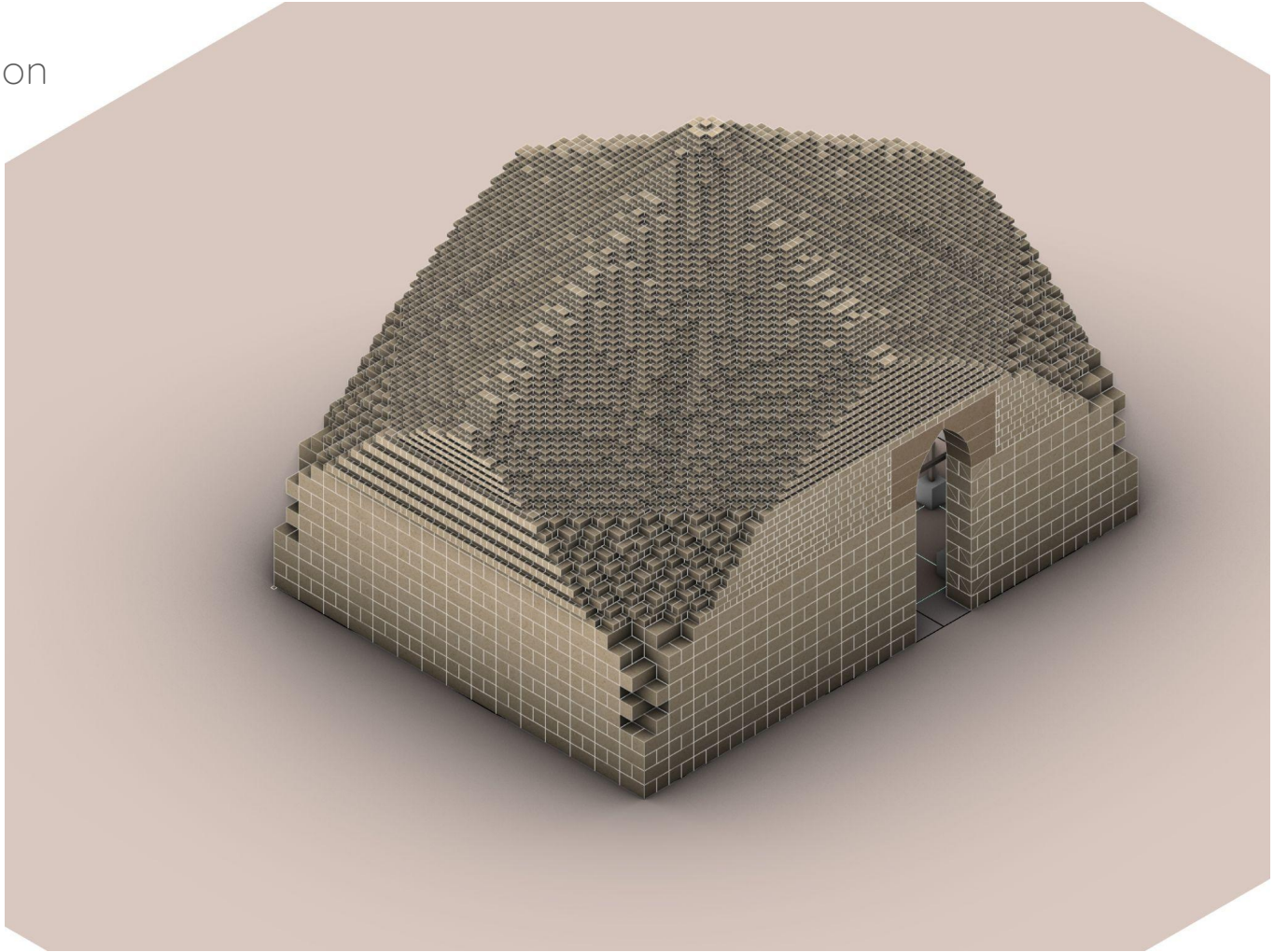


Construction Sequence



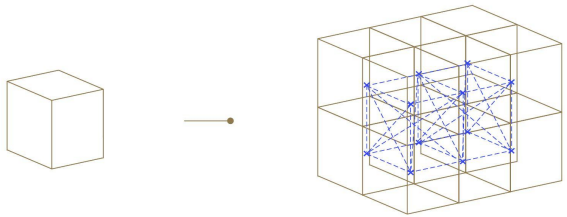
Construction Sequence



0.4 Reflection

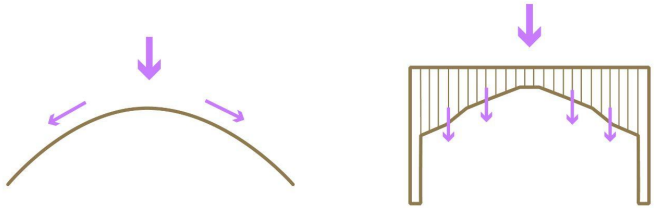
04. Reflection

Ways of Improvement



Simulation for cross section definition is not considering reactions between bricks

→ Simulate with a bigger set of voxels

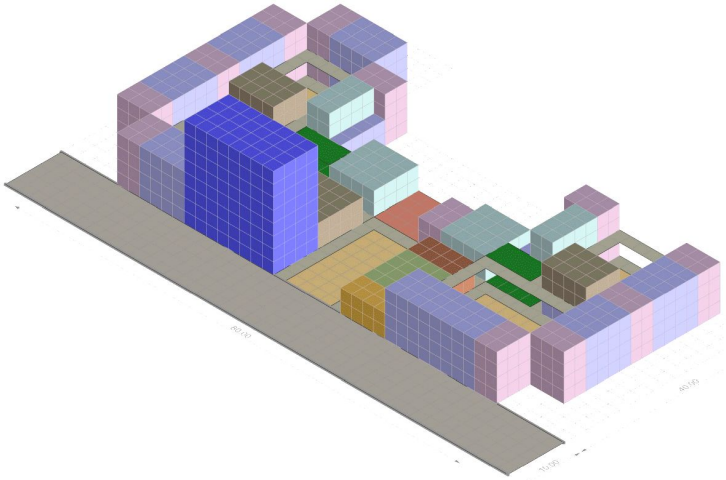


Different way of force transmission for shell - lattice

→ Higher weight factor on the diagonal direction of the lattice

04. Reflection

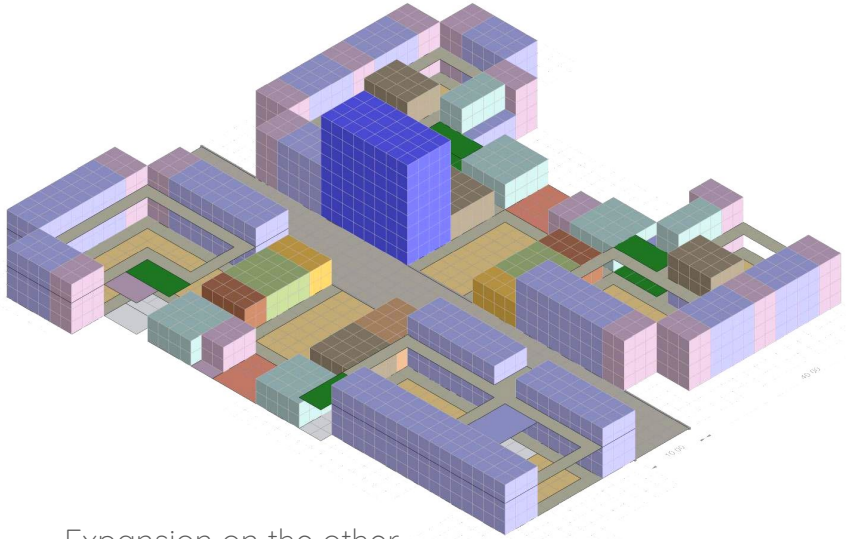
Ways of Improvement



Expansion in height

_not structurally feasible with our dome structure

_additional rules are required for functions' distribution



Expansion on the other side of the road

_possibility of connection with skybridge (structurally challenging)

Thank you!

Questions?