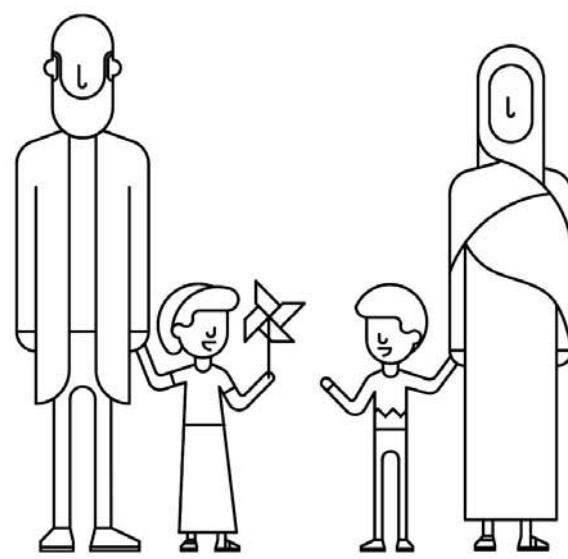
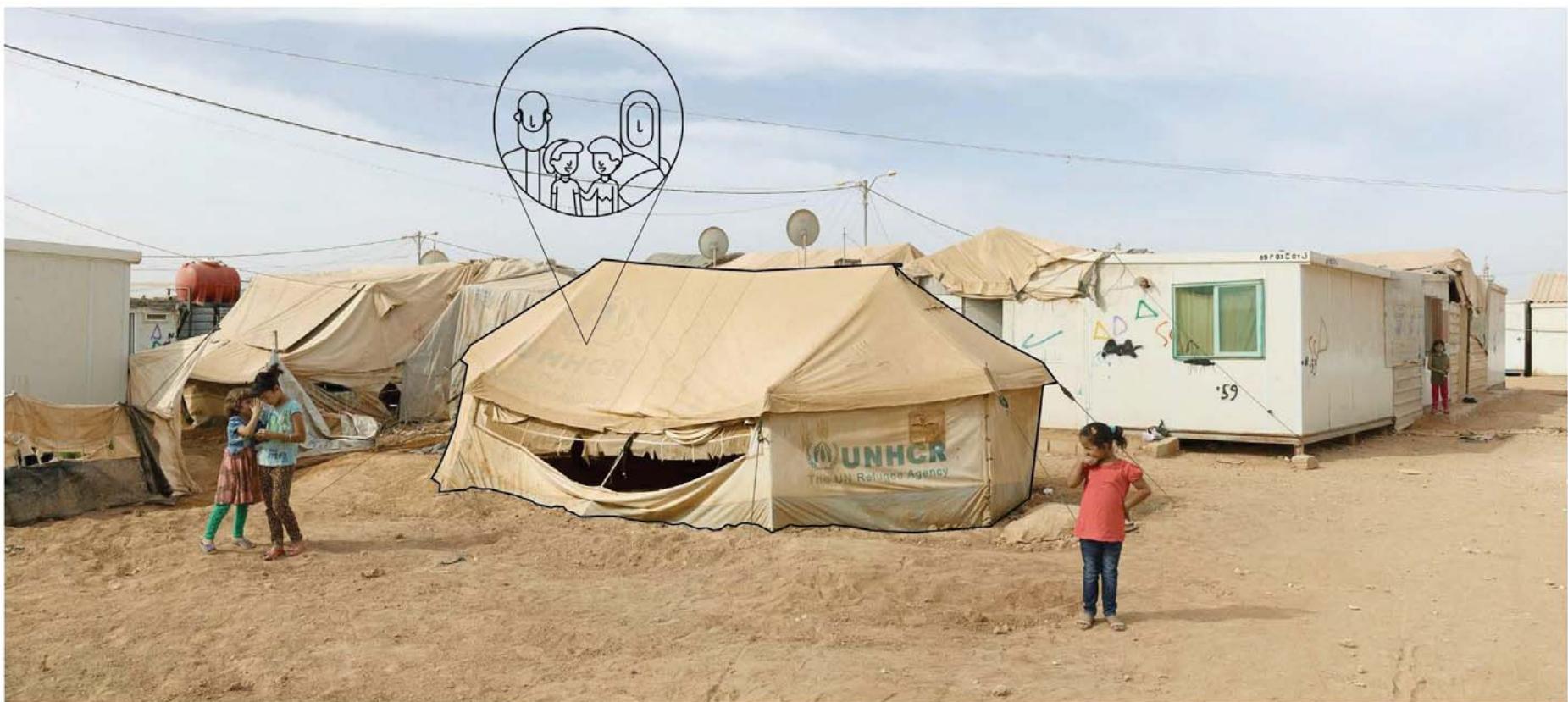


TERRABAYT

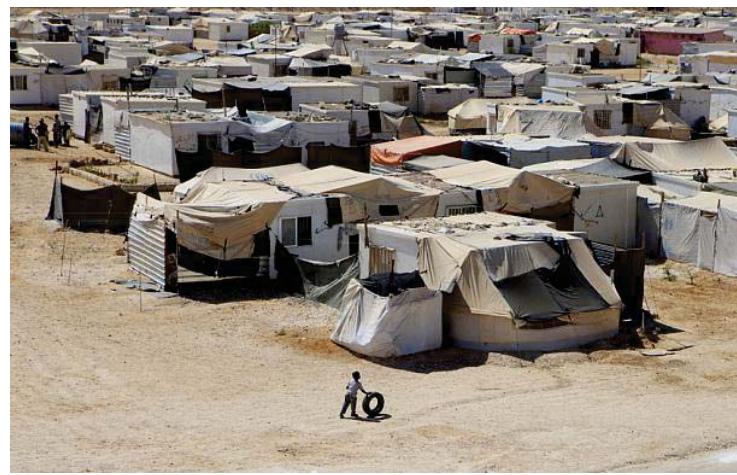
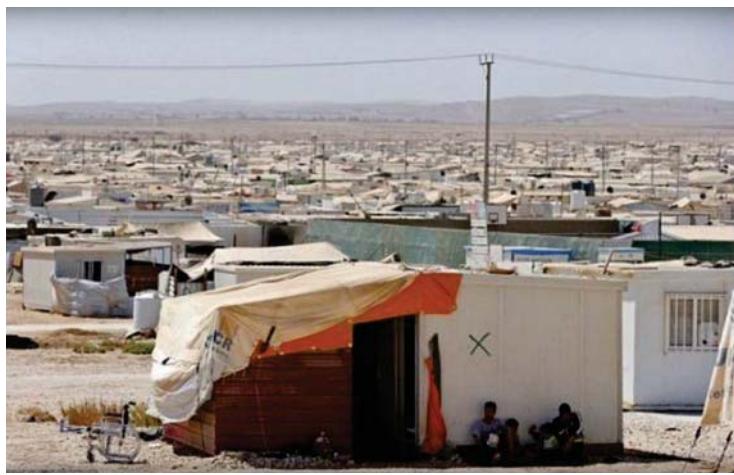
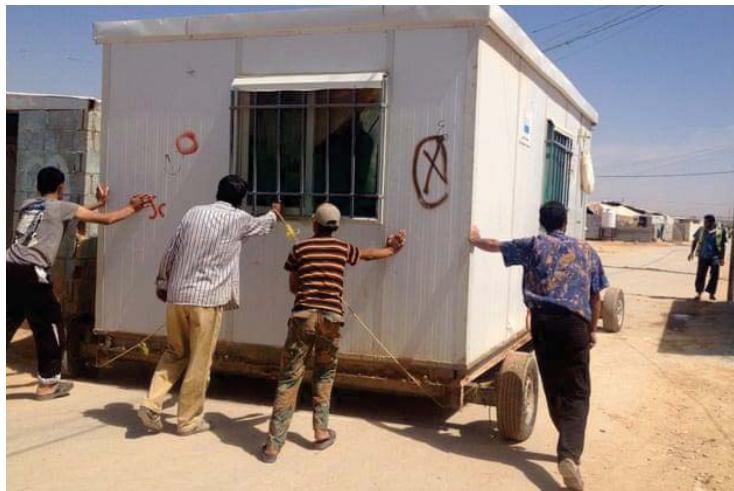
Anna Tsagkalou | Andri Lysandrou | Ginevra Nazzarri
Ivan Avdić | Momir Nikolić | Okan Turkcan



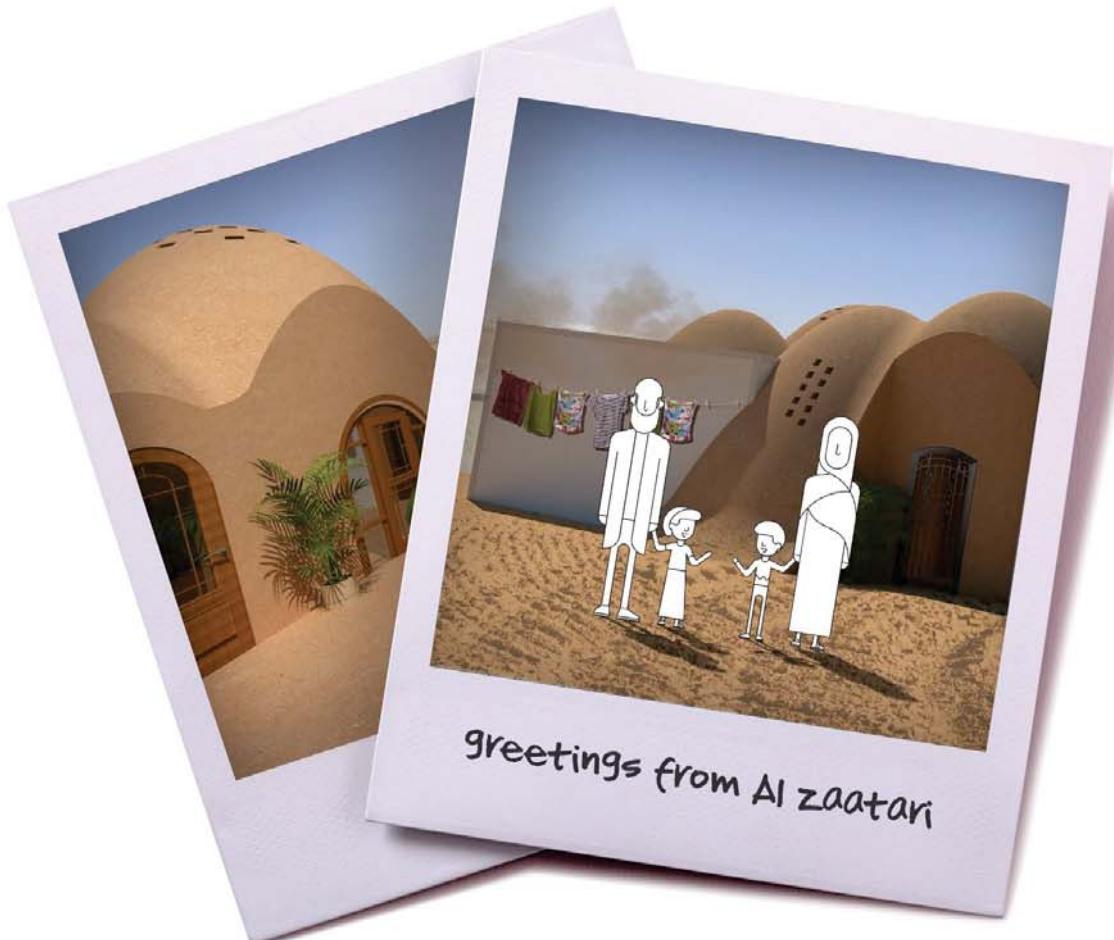










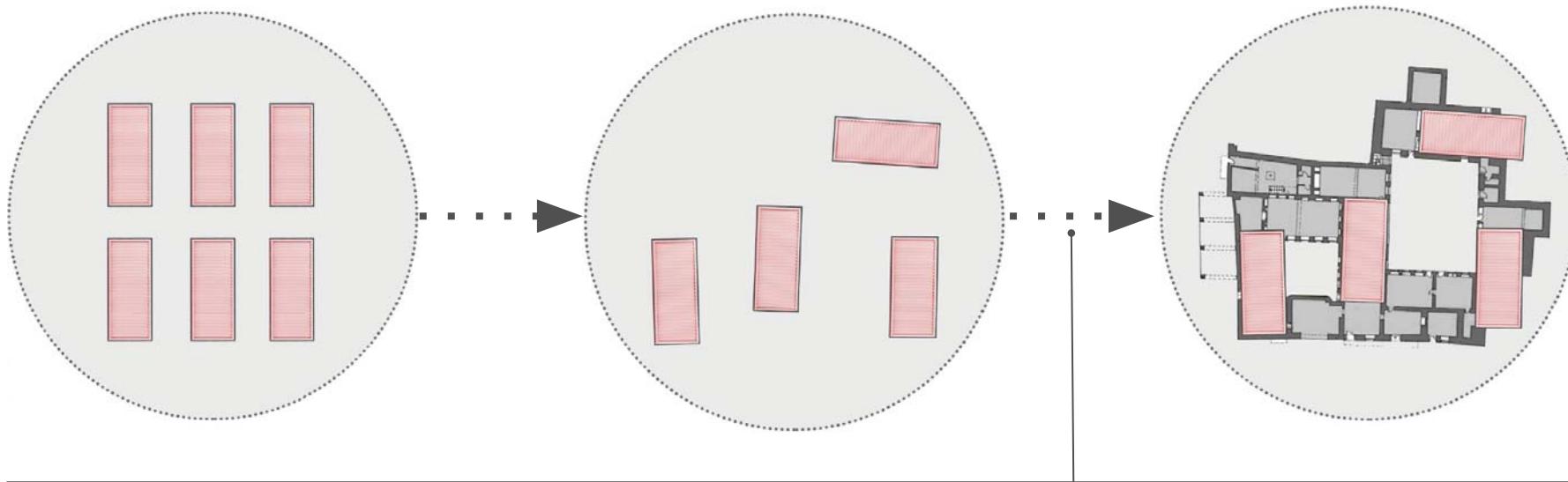


TERRABAYT

terra /'tɛrə/ - lat. **earth**

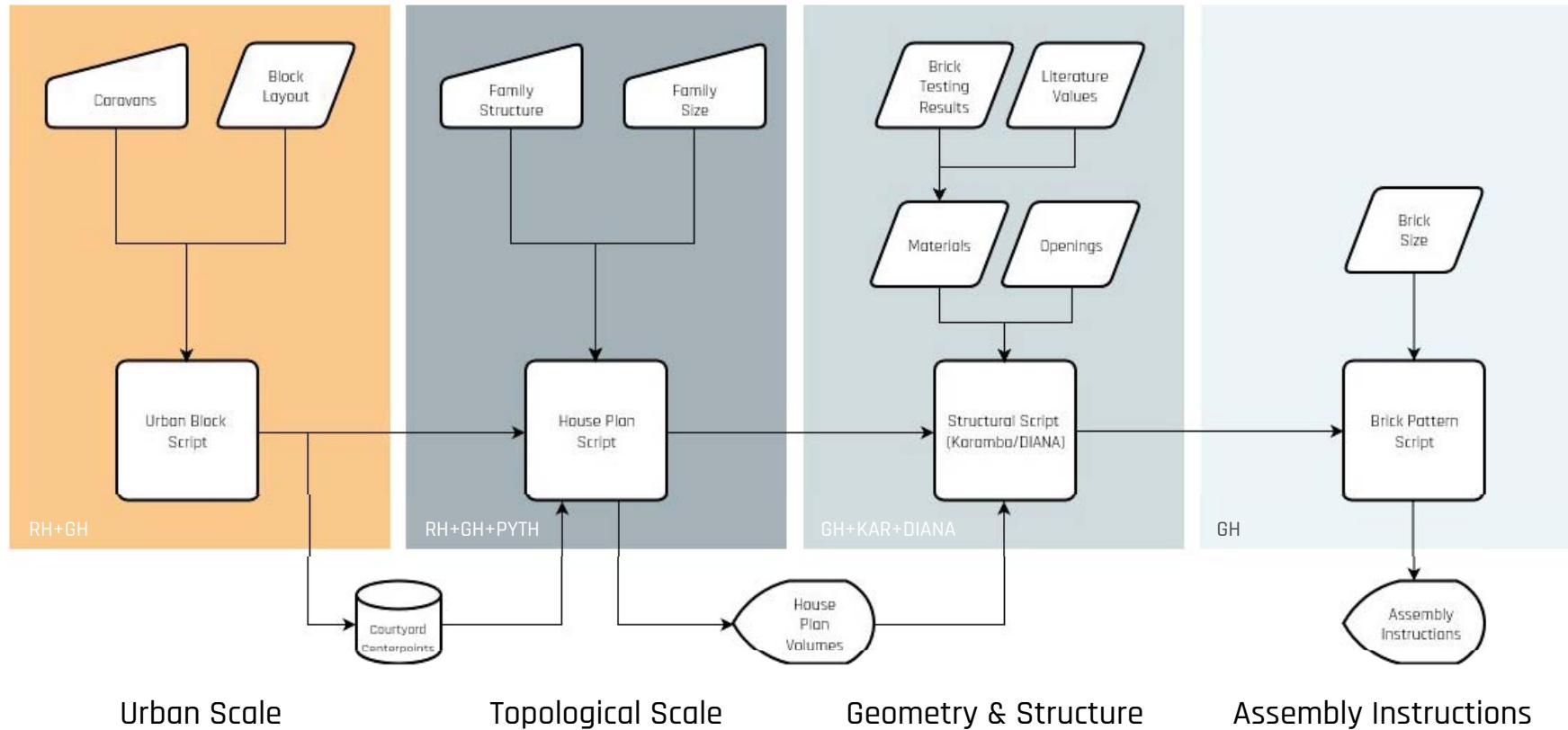
bayt /bajt/ - ar. **house**

Terrabayt

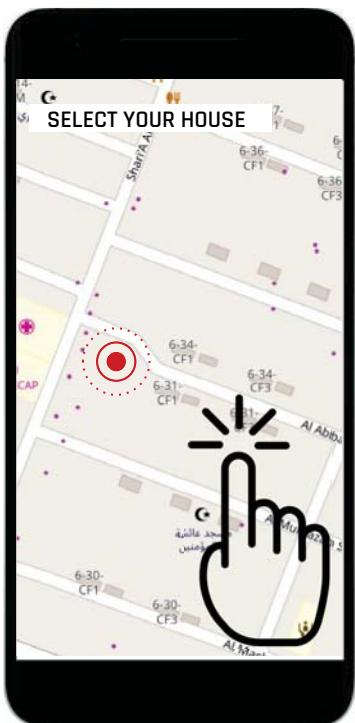


"a computational tool that generates housing typologies more in line with the needs of its inhabitants, whose topological and geometrical characteristics are based on traditional Syrian ones"

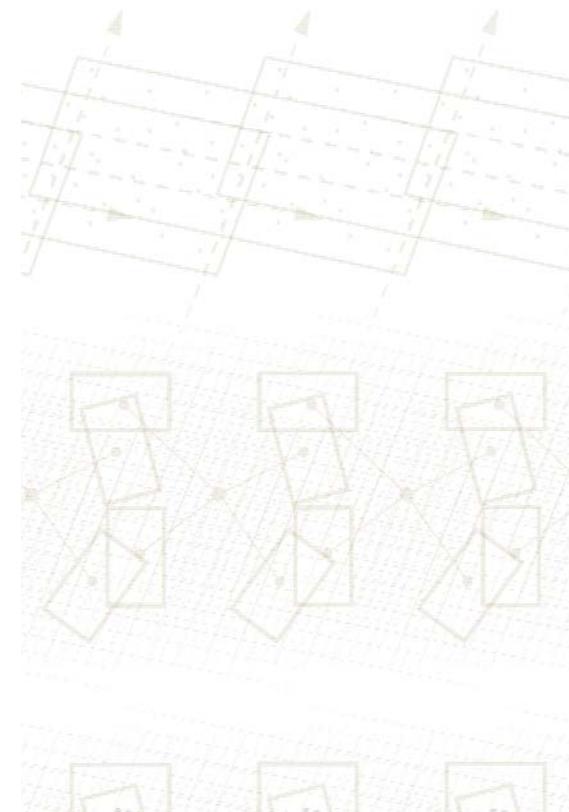
Flowchart

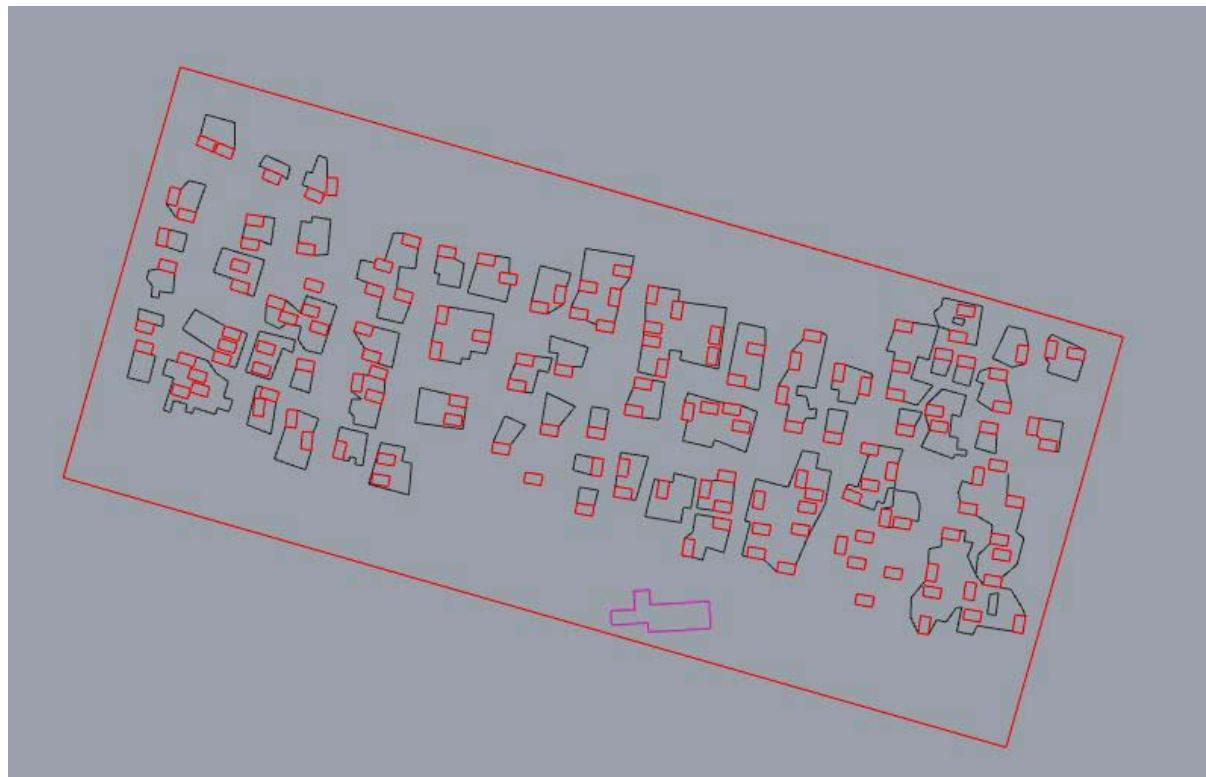


Urban Script

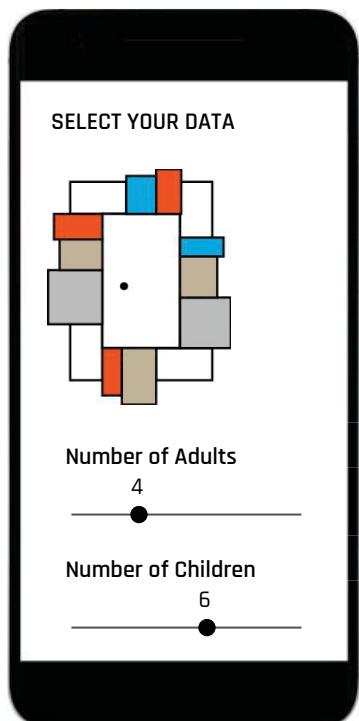


- Caravan grouping as input
- Urban 1x1m grid from principle vectors
- Courtyard centerpoints determined
- New courtyard centers pulled to grid





Topology Script



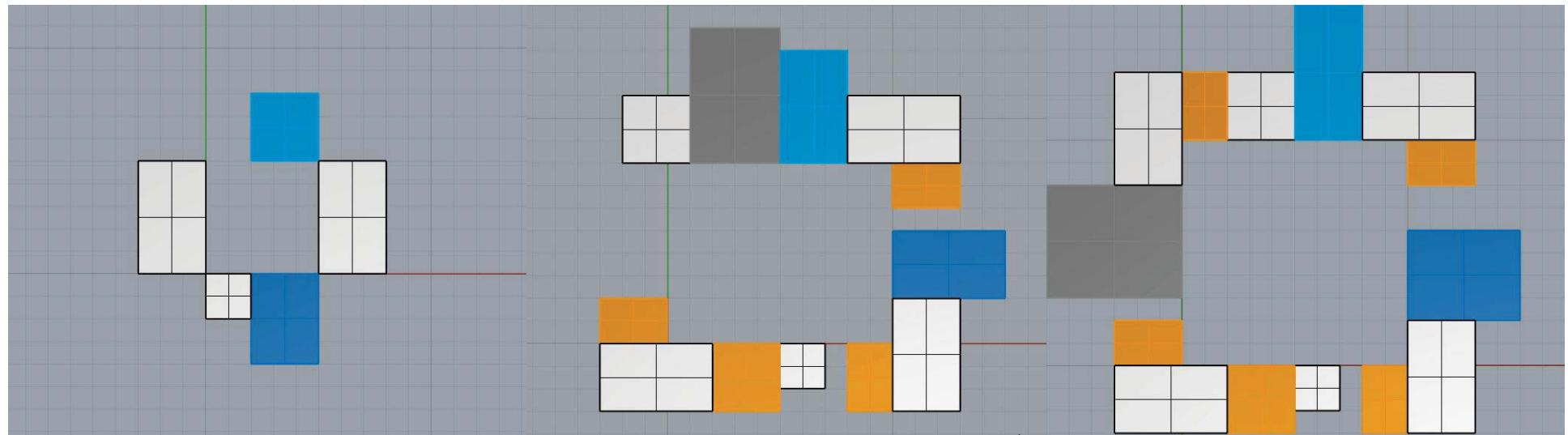
- Family size as input
- Space sizes generated from factors
- Spaces placed in priority starting from one corner
- Looped script until all spaces are placed

```
# Formulas to calculate the room areas based on the inputs
areas = {
    ... "courtyard": No_caravans*25,
    ... "kitchen": 6 + 0.5*No_persons,
    ... "bathroom": 4 + 0.5*No_persons,
    ... "winter living room": 6 + 1*No_persons
}

# The heights of the rooms
heights = {
    ... 'courtyard': 0,
    ... 'kitchen': 3.5,
    ... 'bathroom': 3,
    ... 'entrance': 3.6,
    ... 'winter living room': 3.5,
    ... 'added bedroom': 3.5
}

# courtyard corners along with info about their overflow
corners = [
    ... {'name': 'WS', 'index': 0, 'overflow': False},
    ... {'name': 'SE', 'index': length, 'overflow': False},
    ... {'name': 'EN', 'index': length+width, 'overflow': False},
    ... {'name': 'NW', 'index': 2*length+width, 'overflow': False},
]

corner_indexes = map(lambda c: c['index'], corners)
```

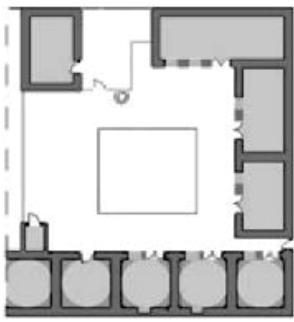


2 Caravans
2 Couples
6 Children

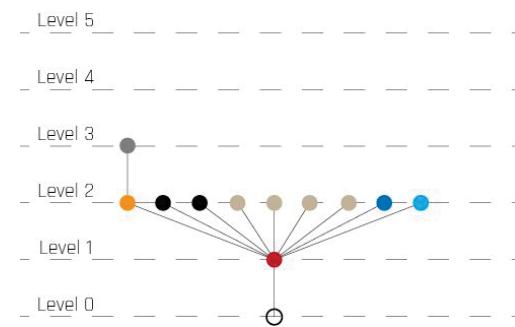
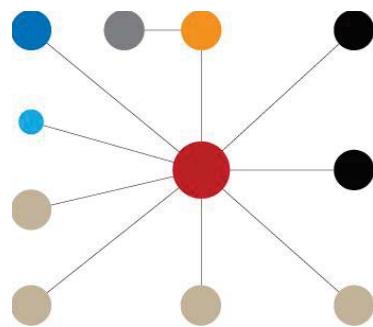
3 Caravans
3 Couples
11 Children

4 Caravans
3 Couples
17 Children

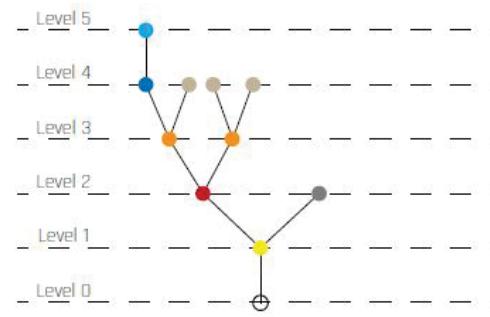
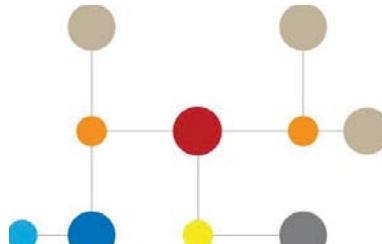
Topology Analysis



Traditional rural Syrian house



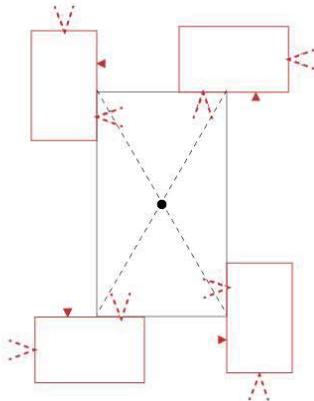
Al Za'atari house with courtyard



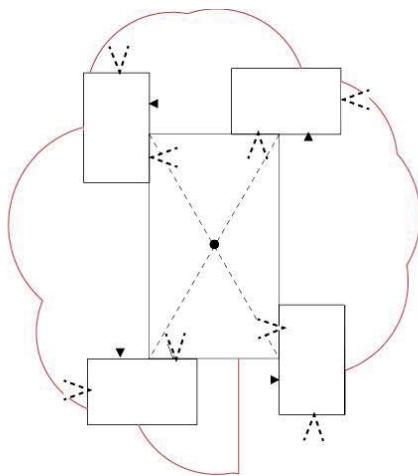
Geometry



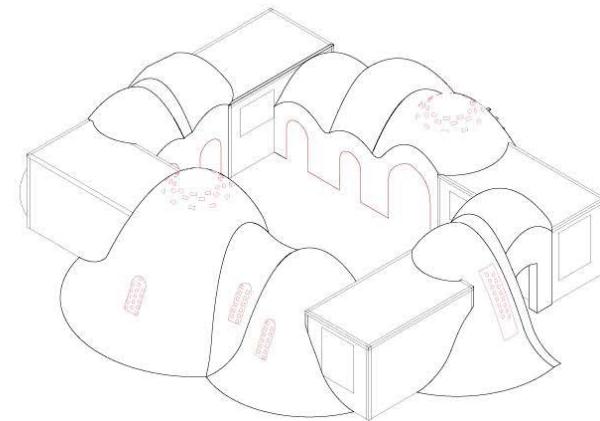
Keeping the
courtyard



Place the
caravans in
the corner
points

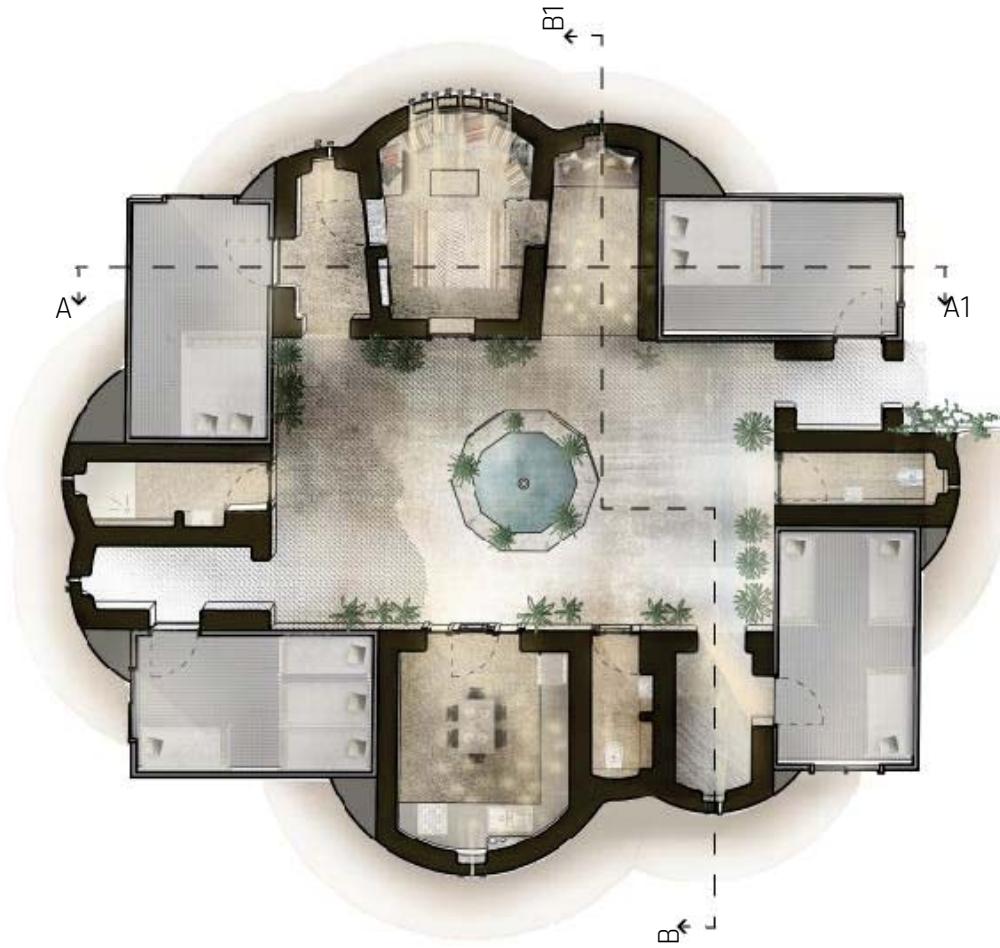


Earthy
connections
integrated
into the
landscape

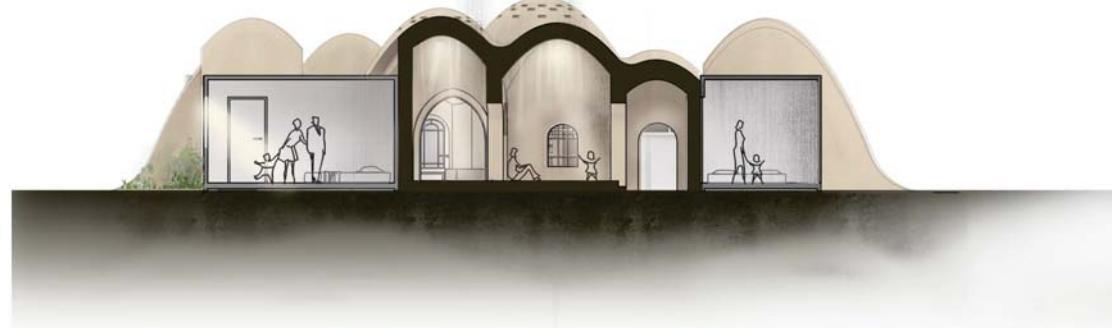


Keeping
traditional
vocabulary
through the
openings

Floor Plan

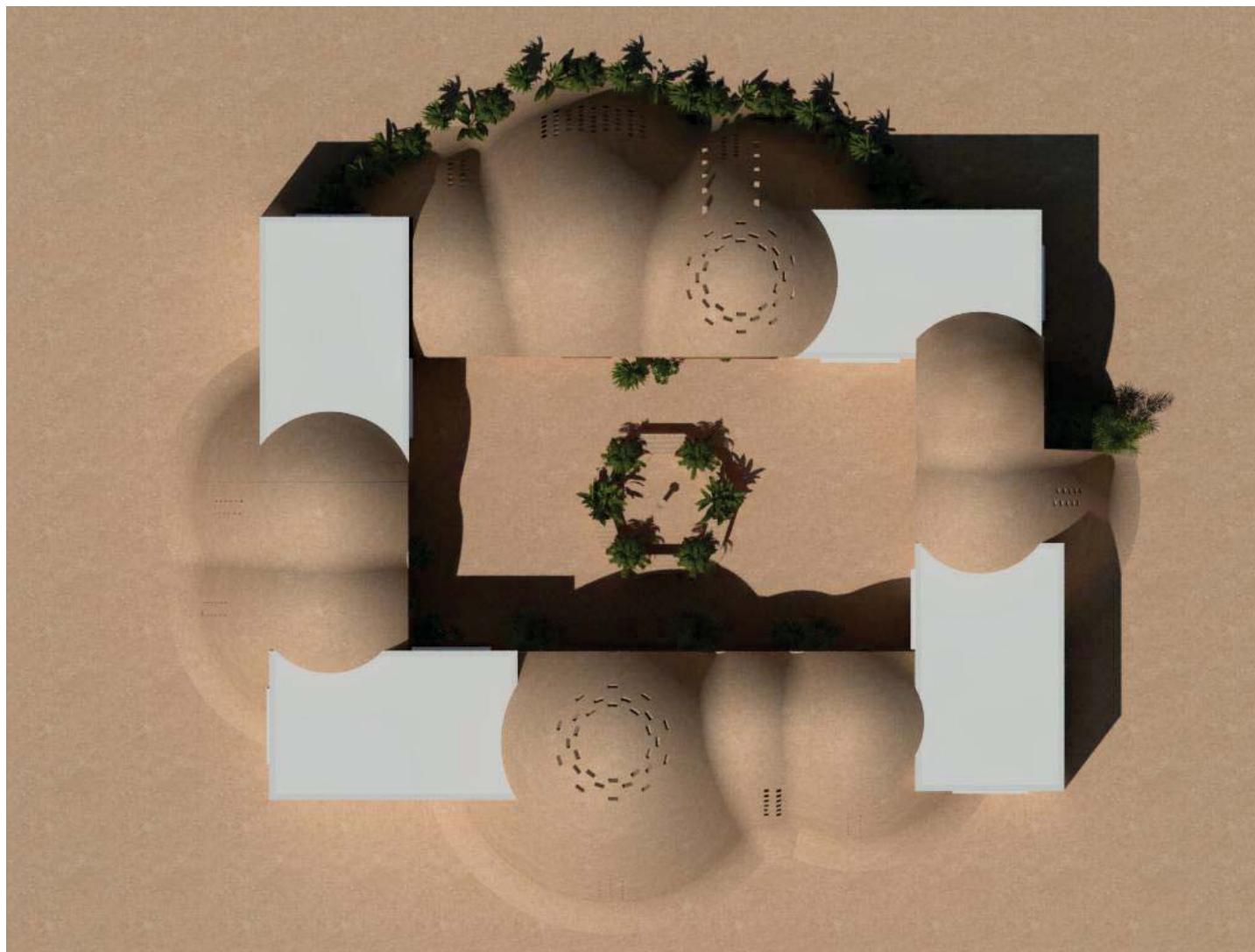


SECTION A-A1



SECTION B-B1





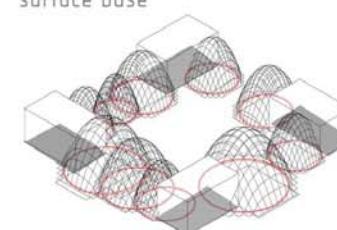
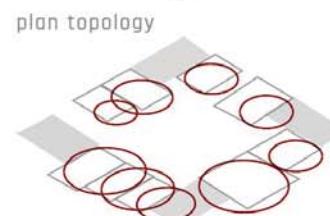
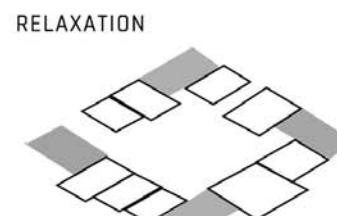
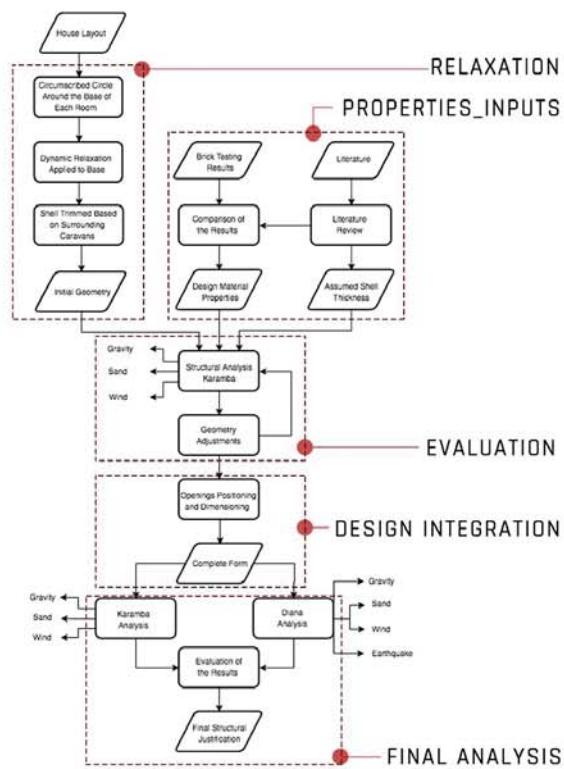




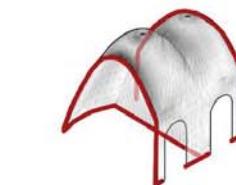
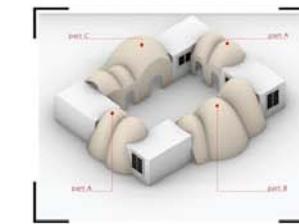




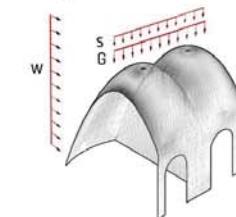
Structural Design



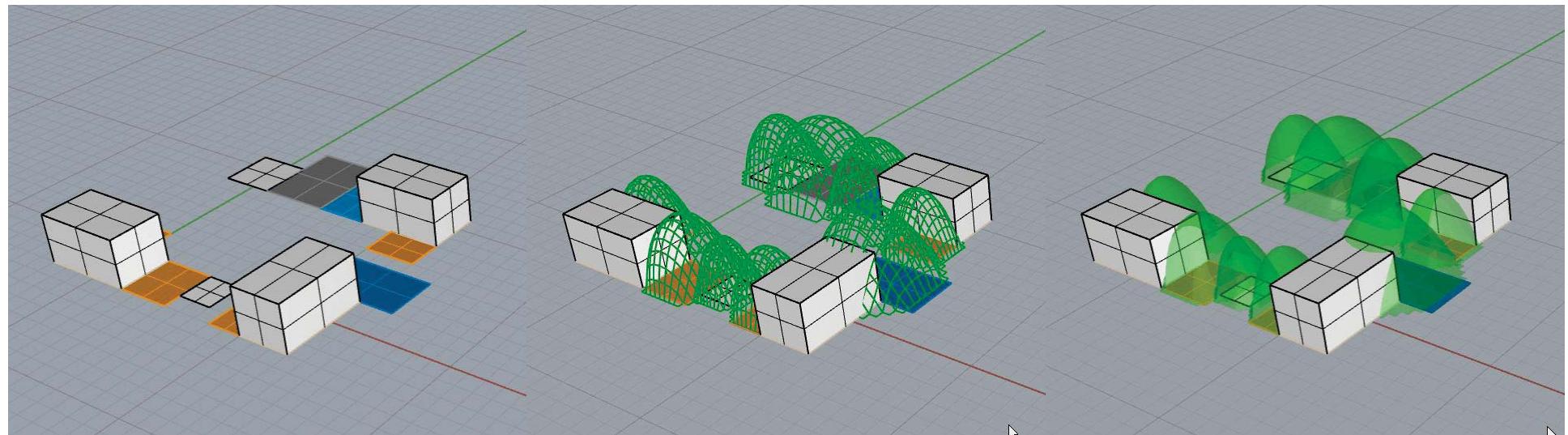
STRUCTURAL MODEL



supports



loads



House Plan Script

Mesh Relaxation

Mesh Intersection

Force Flow



RESULTS
principal stress result

CARAMBA

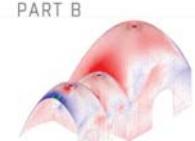


PART A

DIANA



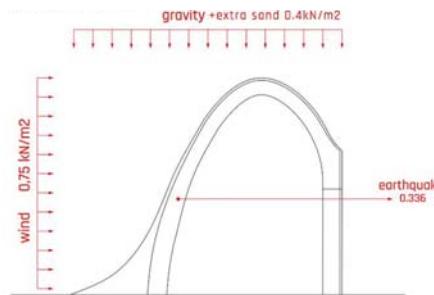
PART B



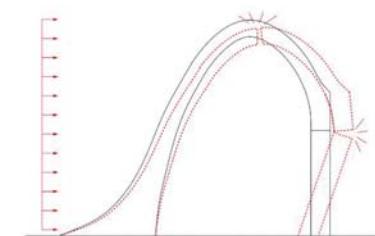
PART C



Load Values & Unity Checks



Possible Stability Issues



House Part	Load Case	Principle Stress 1 [C]	Principle Stress 1 [T]
A	GS	-0.000119	0.0368000
	UC	0.000261	-1.251618
	GS + Wind X	-0.000093	0.0390000
	UC	0.000364	1.250655
	GS + Wind Y	-0.000062	0.0384000
	UC	0.000196	1.238710
	GS + EQ X	-0.000078	0.0495000
	UC	0.000254	1.596714
	GS + EQ Y	-0.000057	0.0596500
	UC	0.000193	1.890323
B	GS	-0.000031	0.0478000
	UC	0.000169	1.541925
	GS + Wind X	-0.000026	0.0396000
	UC	0.000095	1.283871
	GS + Wind Y	-0.000024	0.0347000
	UC	0.000079	1.175855
	GS + EQ X	-0.000028	0.0578000
	UC	0.000073	1.964391
	GS + EQ Y	-0.000044	0.0549000
	UC	0.000062	1.707688
C	GS	-0.000059	0.0765000
	UC	0.000190	2.503226
	GS + Wind X	-0.000066	0.0594000
	UC	0.000112	3.206450
	GS + Wind Y	-0.000077	0.0762000
	UC	0.000224	2.476865
	GS + EQ X	-0.000000	-0.1500000
	UC	0.003226	4.838710
	GS + EQ Y	-0.000067	0.0957000
	UC	0.000215	2.764516

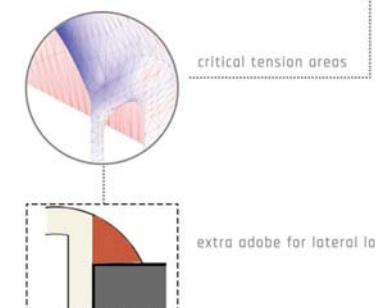
	0t2 - A	0t2 - B	0t2 - C	
Karamba	-1.37	-0.61	-1.23	
DIANA FEA	-1.2	-0.73	-1.05	
Δ	14%	16%	17%	16%

Allowable compressive stress: **0.03 kN/cm²**

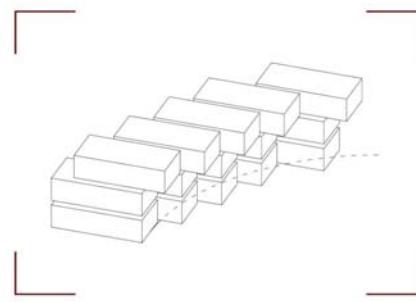
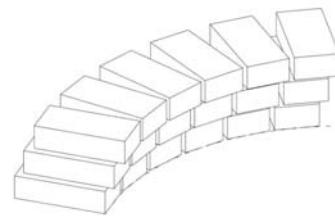
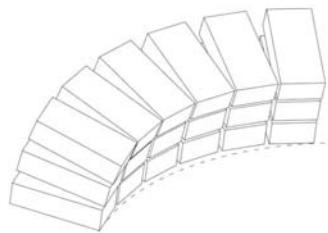
Allowable tensile stress: **0.003 kN/cm²**

Max deflection:

14mm



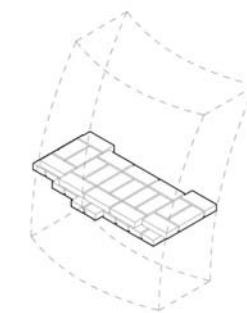
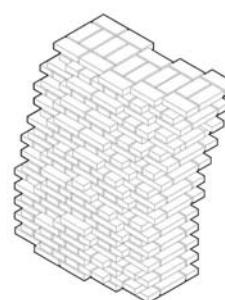
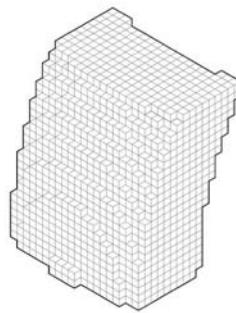
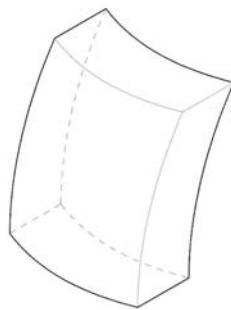
Brick pattern exploration



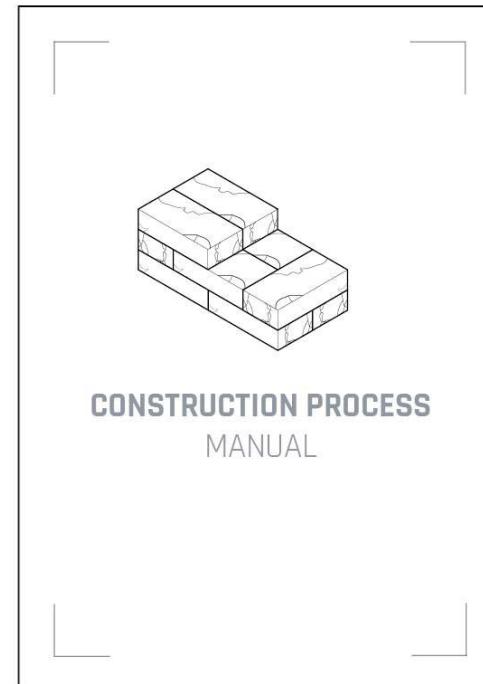
easier instructions

- constuction time reduction
- avoidance of flasses

VOXELIZATION



Construction Process



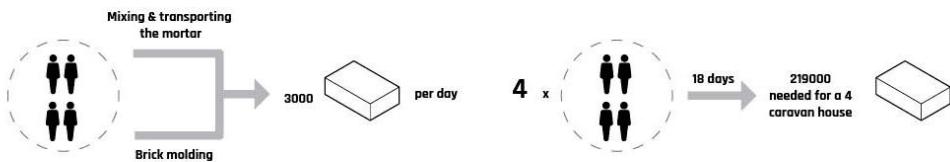
Site preparation

Materials and tools

- Task division
- Material collection and transportation
- Tools preparation

	Sand	Clay	Straw	UNHCR tents <small>(poly-cotton canvas; Polyethylene tarpaulin)</small>	Ropes	Cardboard	Metal sheets	Aluminium poles	Scrap wood poles
Application	Foundations Flooring Bricks Mortar Coating	Foundations Flooring Bricks Mortar Coating	Flooring Bricks	Shading	Measurement tool	Form-work	Supports/ Form work	Supports	Brick molds
Source	On site	Creek 1km west of the camp site	Creek 1km west of the camp site	On site	On site	Waste on site	From old caravans and other infrastructures	(Already) Taken from the fences surrounding the camp	Waste on site
Re-usability	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes

Brick making



1 Collect the right quantities on site

recipe:
Dry mixture: 80% sand, 20%clay
Add 10% (of the dry mass) water
Add 1% (of the total volume) straw

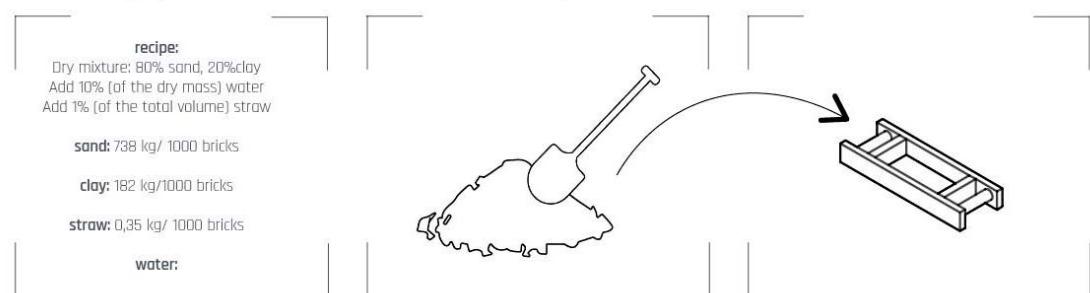
sand: 738 kg/ 1000 bricks

clay: 182 kg/1000 bricks

straw: 0,35 kg/ 1000 bricks

water:

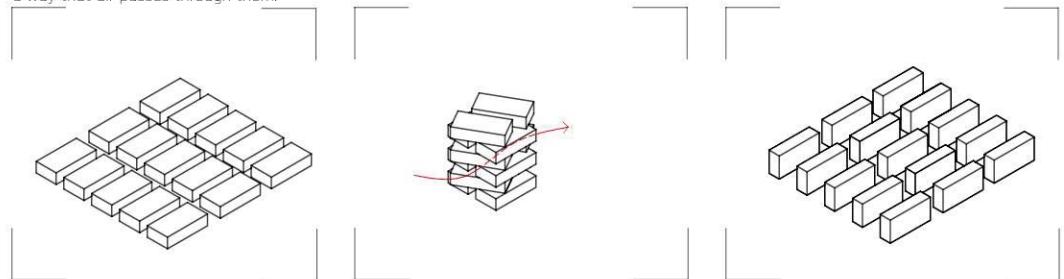
2 Mix the mortar uniformly



3 Put the mortar in the molds

Brick drying

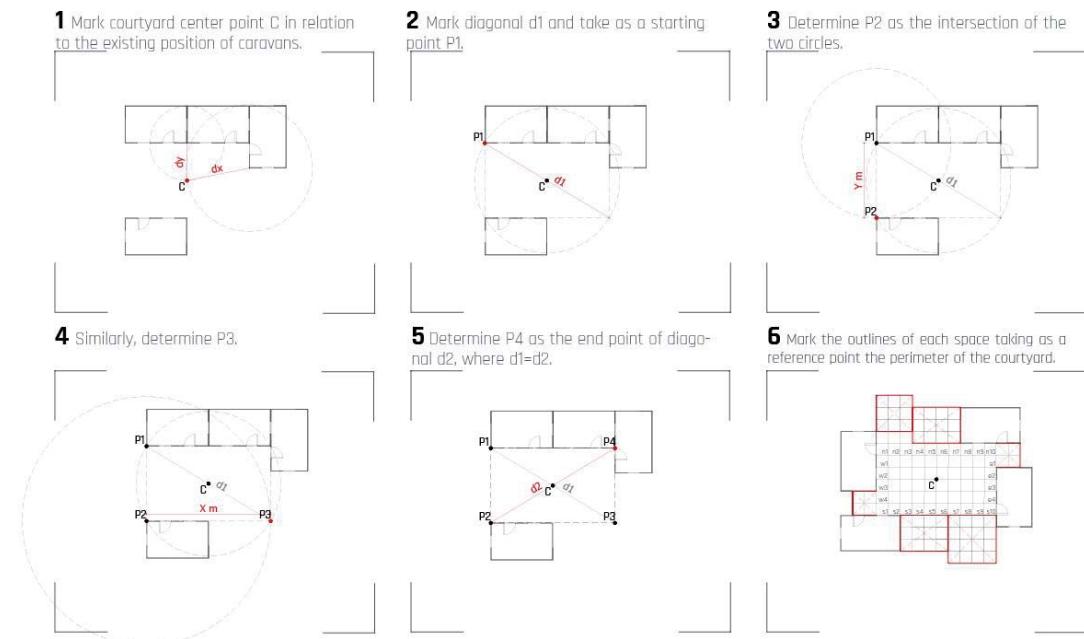
1 Lay the bricks in rows on ground. If there is limited space, arrange them in columns in such a way that air passes through them.



2 On the 3rd day, put them on their edge

Mark house's outline

- Courtyard center is given in relation to the existing caravan
- Space sizes are given in relation to the courtyard
- Ropes are used as measurements tools (with knots division every of 1m)



Foundations

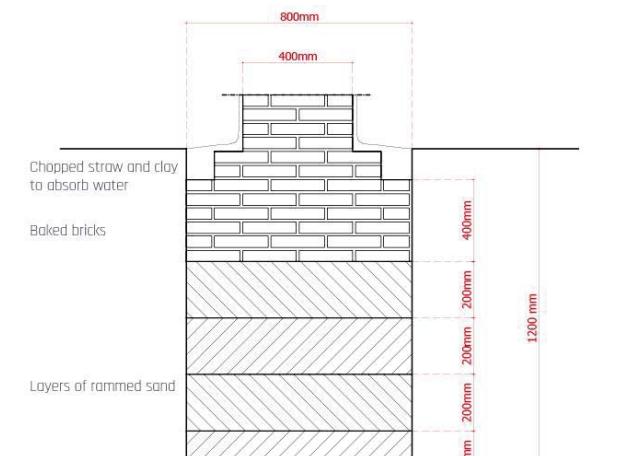
1 Move the caravans aside



2 Dig trenches of 800mm width around the outlines.

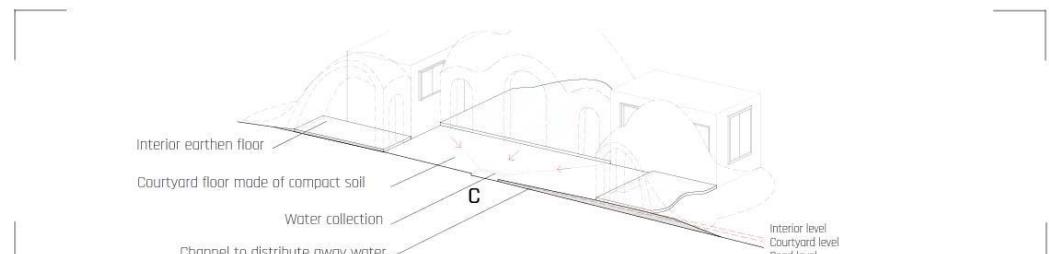


3 Fill the trenches of layers of compact sand and baked bricks.

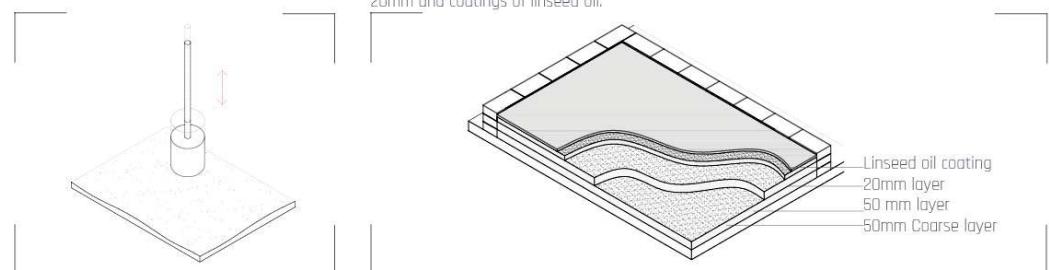


Flooring

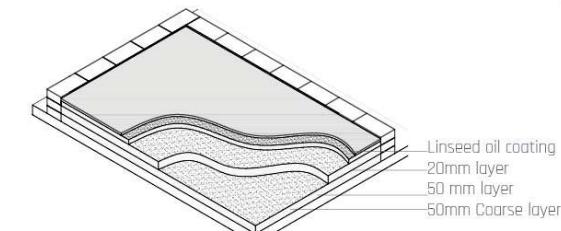
1 Level the courtyard flooring so as to direct water to the center of the courtyard. Create a channel to distribute water to the road.



2 Compact soil



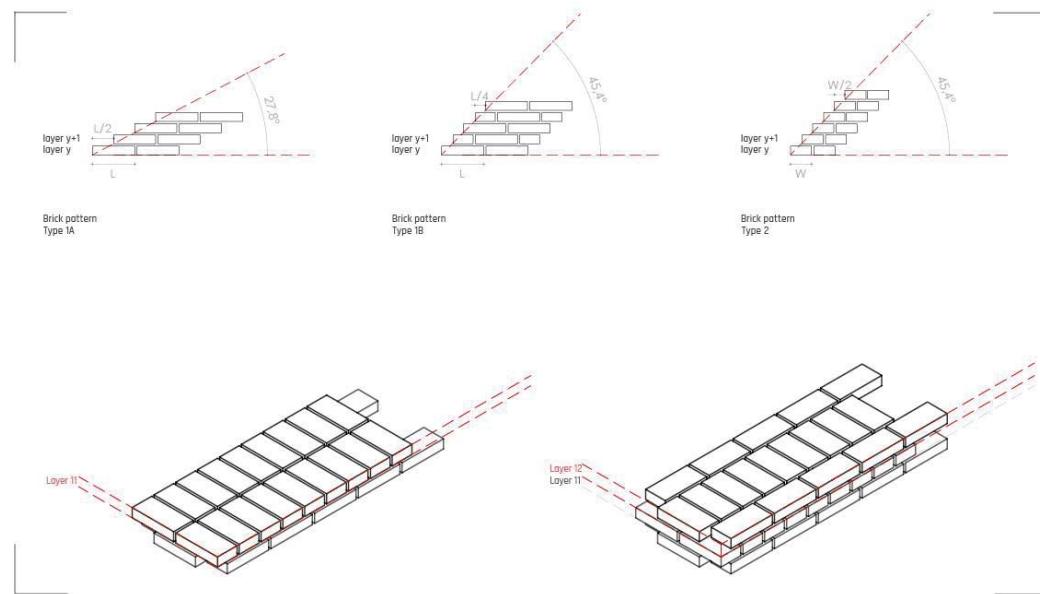
3 Apply layer of 50mm and let it dry. Lay second layer same as the first one. Apply a final layer of 20mm and coatings of linseed oil.



Walls/Roofs

- To make the construction process easier, all the rooms are built layer by layer, in courses.
- Each brick layer can be visualized in relation the previous one, thus assisting those building the wall in applying the correct brick pattern.

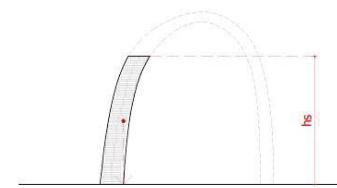
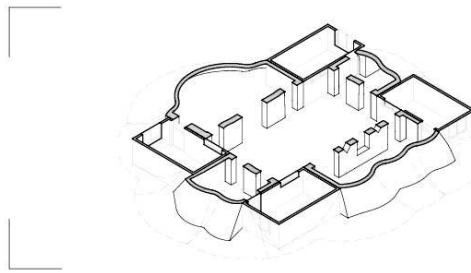
1 Different brick patterns



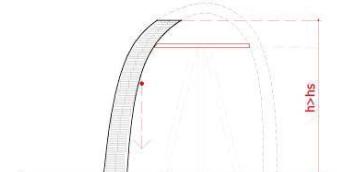
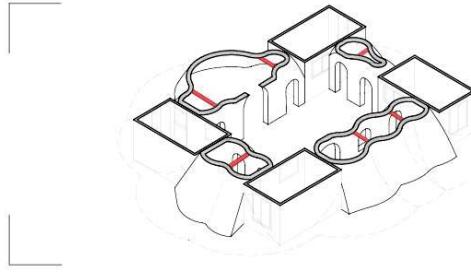
Walls/Roofs

- The height after which supports are needed is pre-defined.

2 Laying of the brick courses before the maximum height of horizontal forces



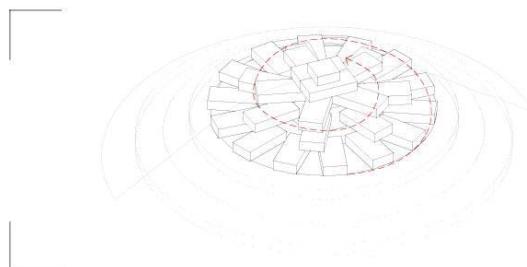
3 Laying of the brick courses aided with supports after the maximum height of horizontal forces



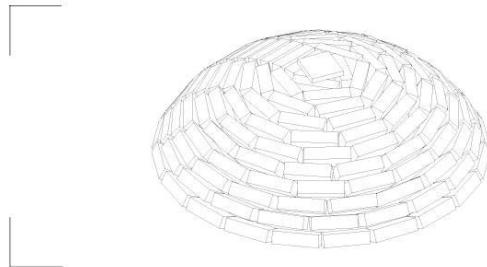
Roofs

- Depending on the inclination, different brick layerings are provided.
- Use of lighter bricks is suggested for the roof (with higher percentage of straw)

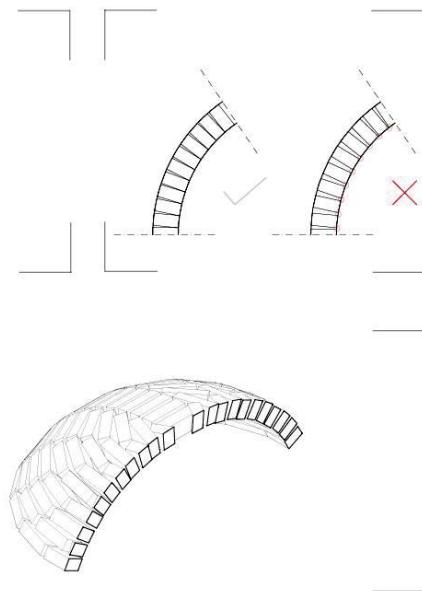
1 Roof top with horizontal layers



2 Roof top with inclined layers



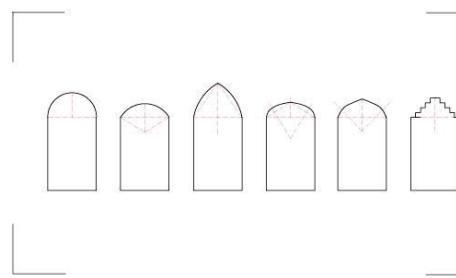
3 Mortar in between inclined bricks



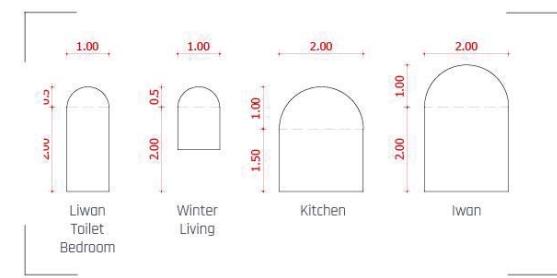
Openings

- Interior#Exterior openings
- Modular sizes depending on the space function
- Restrictions regarding wall to openings ratio.

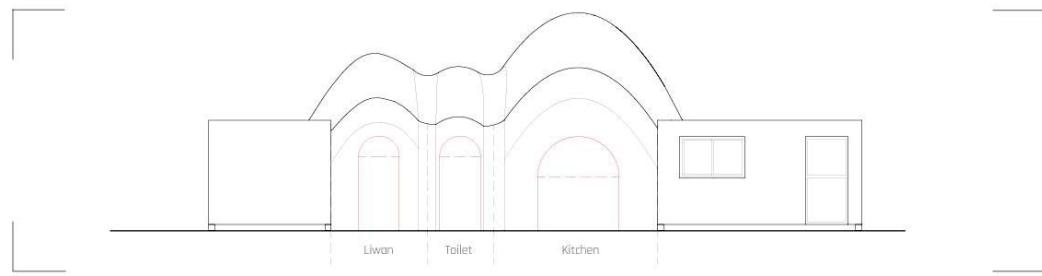
1 Arch vocabulary



2 Modular sizes of openings depending on the space function

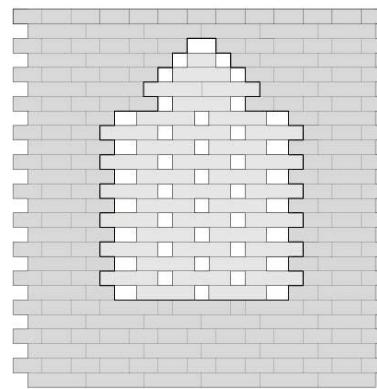
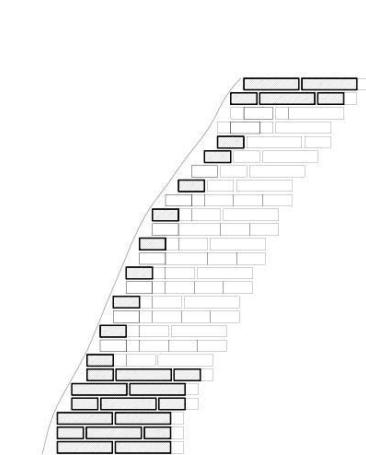


2 Example of a final facade towards the courtyard



Openings

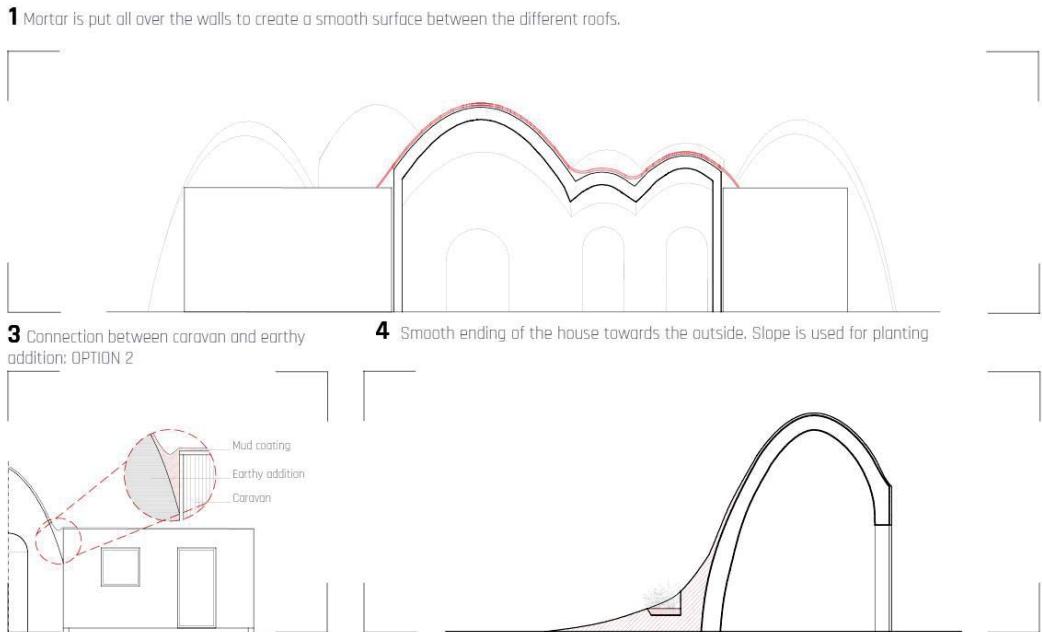
2 "Mashrabiya" type opening in the outdoor walls.



Coating

- Critical parts: Connection between caravans and earthy additions
- Maintenance info

...Field tests will give more detailed insight into the construction process





Further Development

- Improvement of layout generation
- Further exploration of openings
- Pay more attention to the urban space
- Develop construction instructions communication

Reflection

- Back to the drawing board for Meshing
- Allow for changing thickness in the shell
- Rethink voxelization script
- Allow the scripts to run

