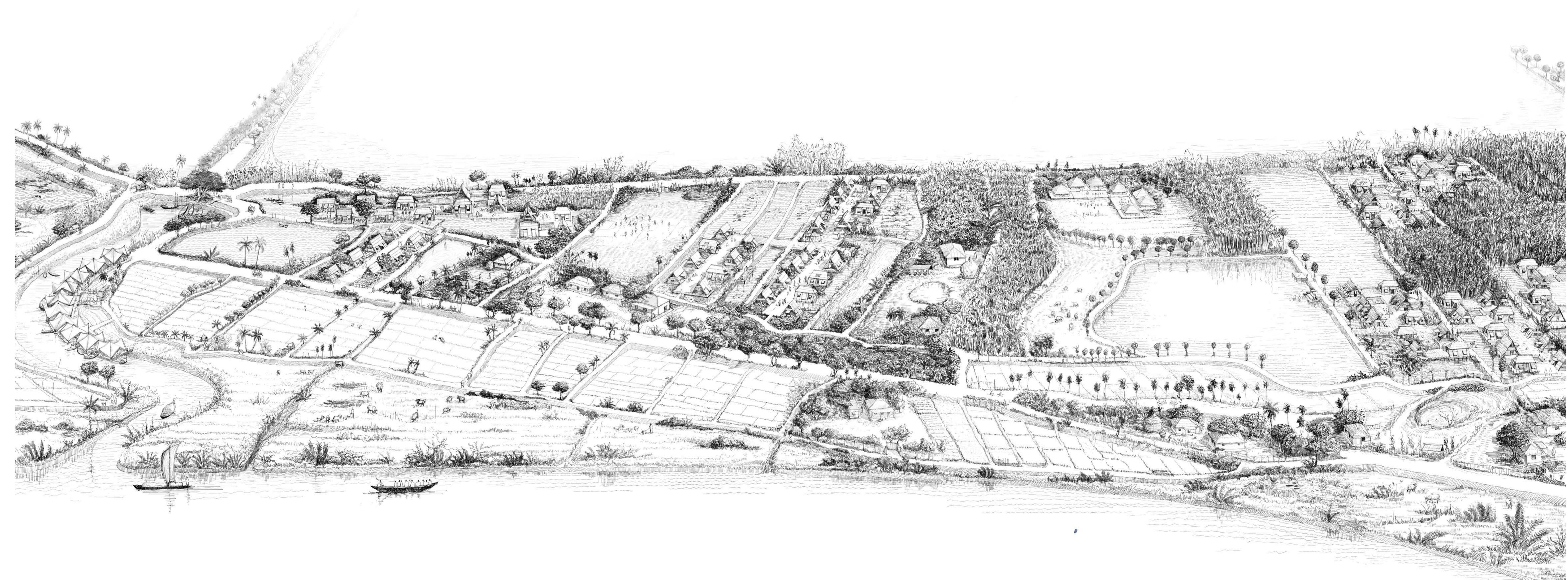


# RETHINKING LOW-COST HOUSING IN TROPICAL MANGROVE FOREST

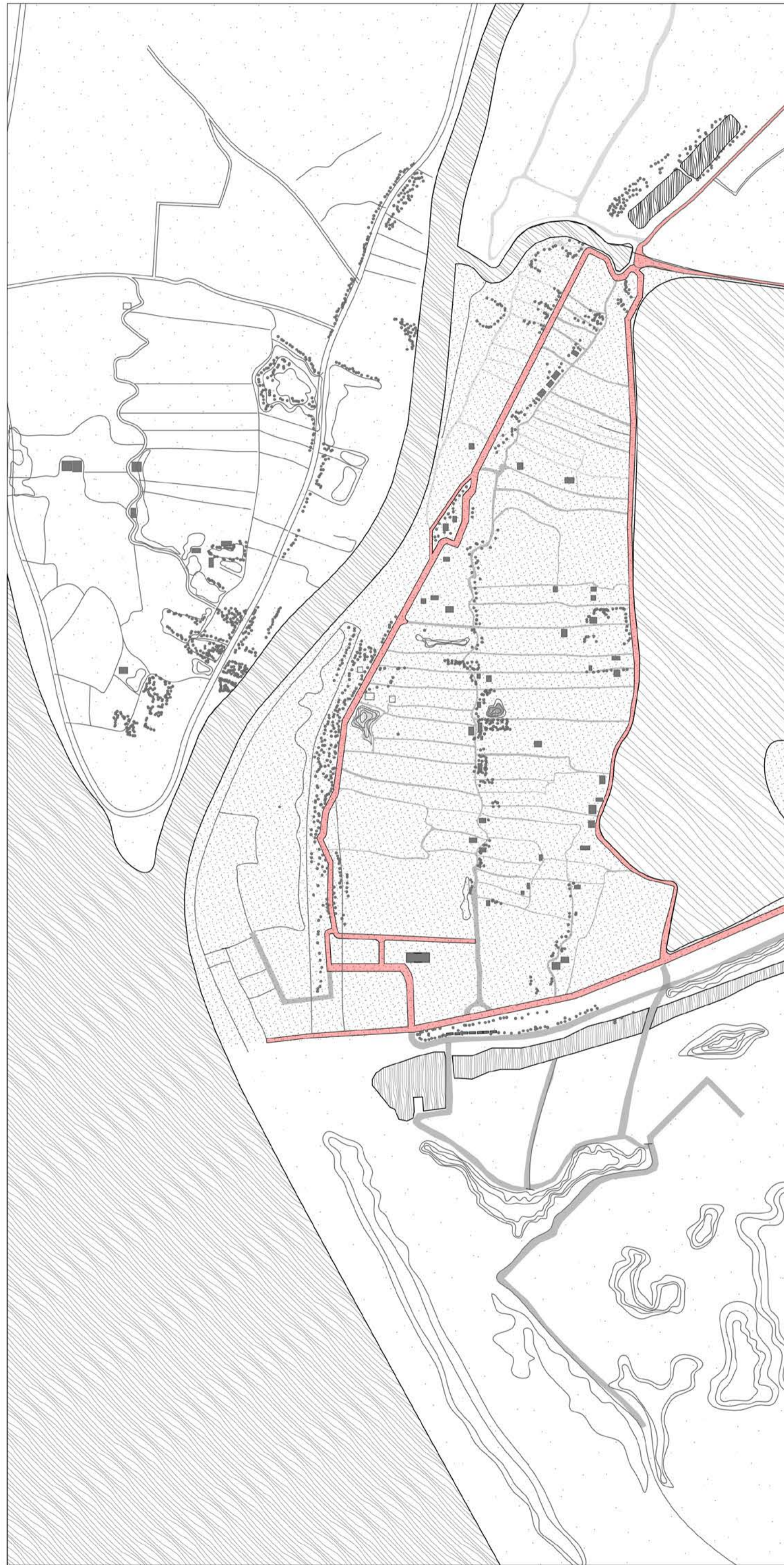
This project aims to provide affordable housing facilities for disaster-distressed families in the coastal region in Bangladesh; a country situated between the Bay of Bengal and the Himalayan mountain range, experiences several natural disasters causing a lot of destruction of properties and livestock every year.

The government allocated site of this project is a tidal plane land on the bank of the river "Pashur", 10 kilometers north to the Mongla Sea Port and 5 kilometers West to the Rampal municipality. Most of the land is inundated during monsoon season. Besides, high tide floods part of the site twice a day.

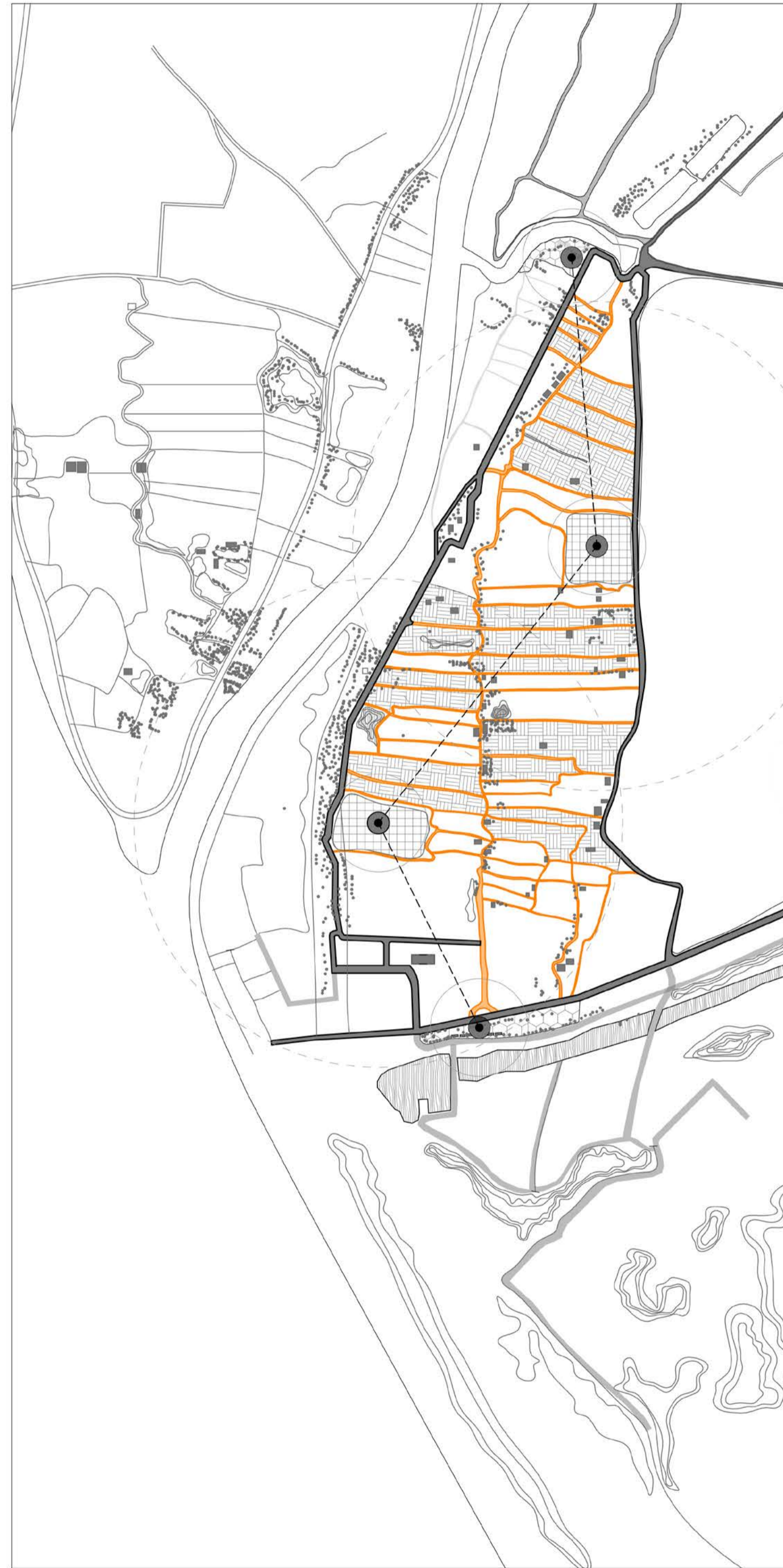
Government lead housing projects follow a common method of construction for such kind of community housing which are generally not quite responsive to the specific needs of the site and users. The main objective of this project is to improve upon or provide alternative, site specific and most importantly sustainable solutions to the given government scheme.



### Site Information







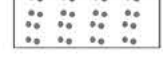
### Urban Analysis

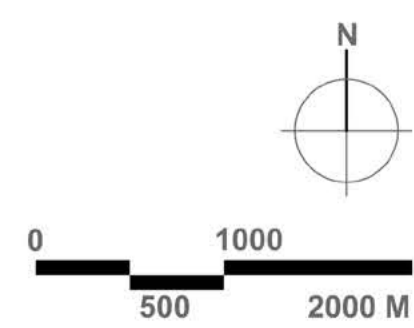




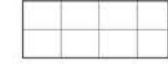


### Proposed Intervention

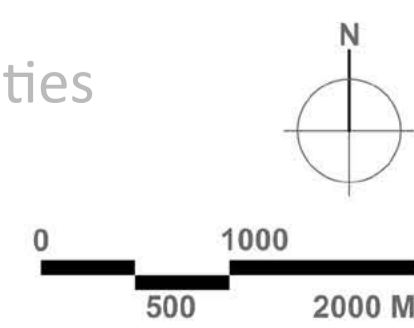


#### Legends

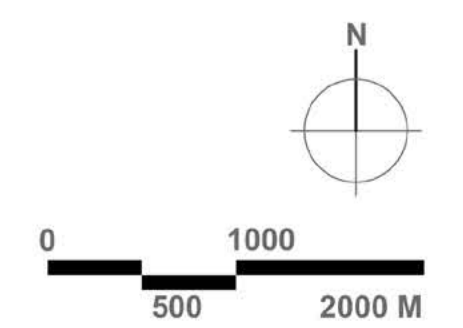
-  Waterbody
-  Site Area
-  Vehicular Road
-  Existing Buildings
-  Vegetation



-  Potential access road
-  Potential site for Commercial Activities
-  Potential site for Community Facilities
-  Potential site for residential units
-  Focal Elements



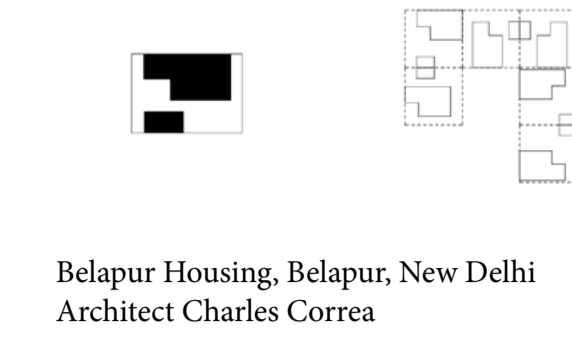
- 1 Residential facilities
- 2 Floating Market
- 3 Elementary School



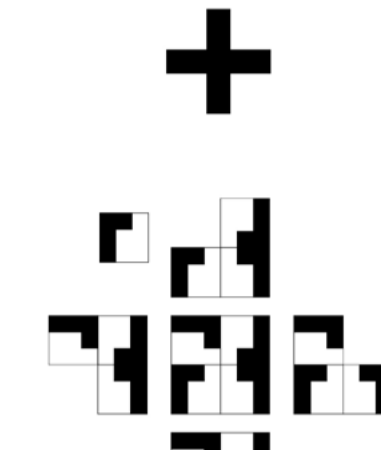
## Housing Facilities: Neighborhood Plan

A neighborhood consists of 50-60 houses placed following 2 types of cluster pattern. The clusters are placed strategically respecting the terrain and the existing pathways. They are placed in conjunction with open spaces, ponds, gardens, and crop fields so that the houses are protected by the natural wind barriers.

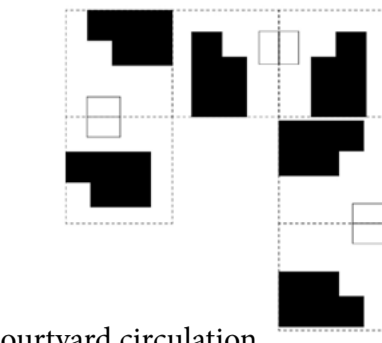
Each cluster can be accessed by one or two access ramps which are fixed with the pedestrian roads which can pivot at a fixed point in case of raising water-level.



Belapur Housing, Belapur, New Delhi  
Architect Charles Correa



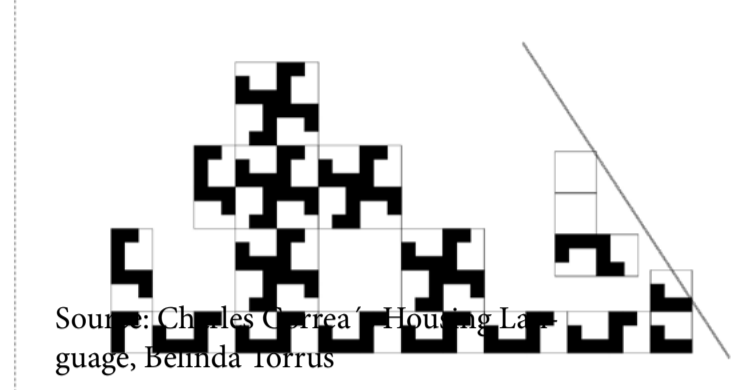
HUDCO housing, Ludhiana  
Architect Charles Correa



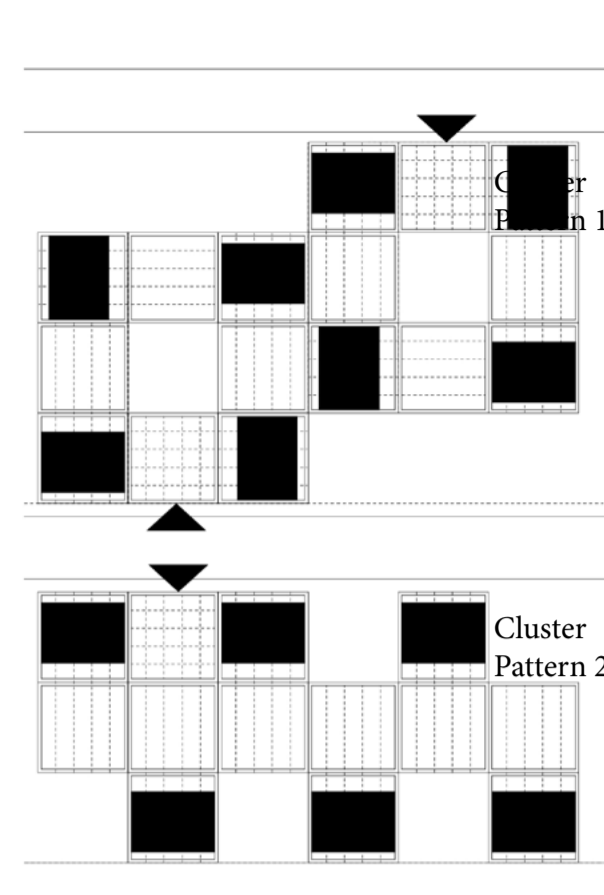
Courtyard circulation



Cluster Pattern Formation



Source: Charles Correa, Housing in Ludhiana, Ludhiana, Punjab, India

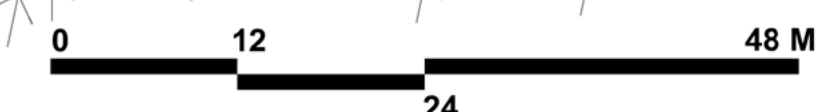


Cluster Pattern 1

Cluster Pattern 2

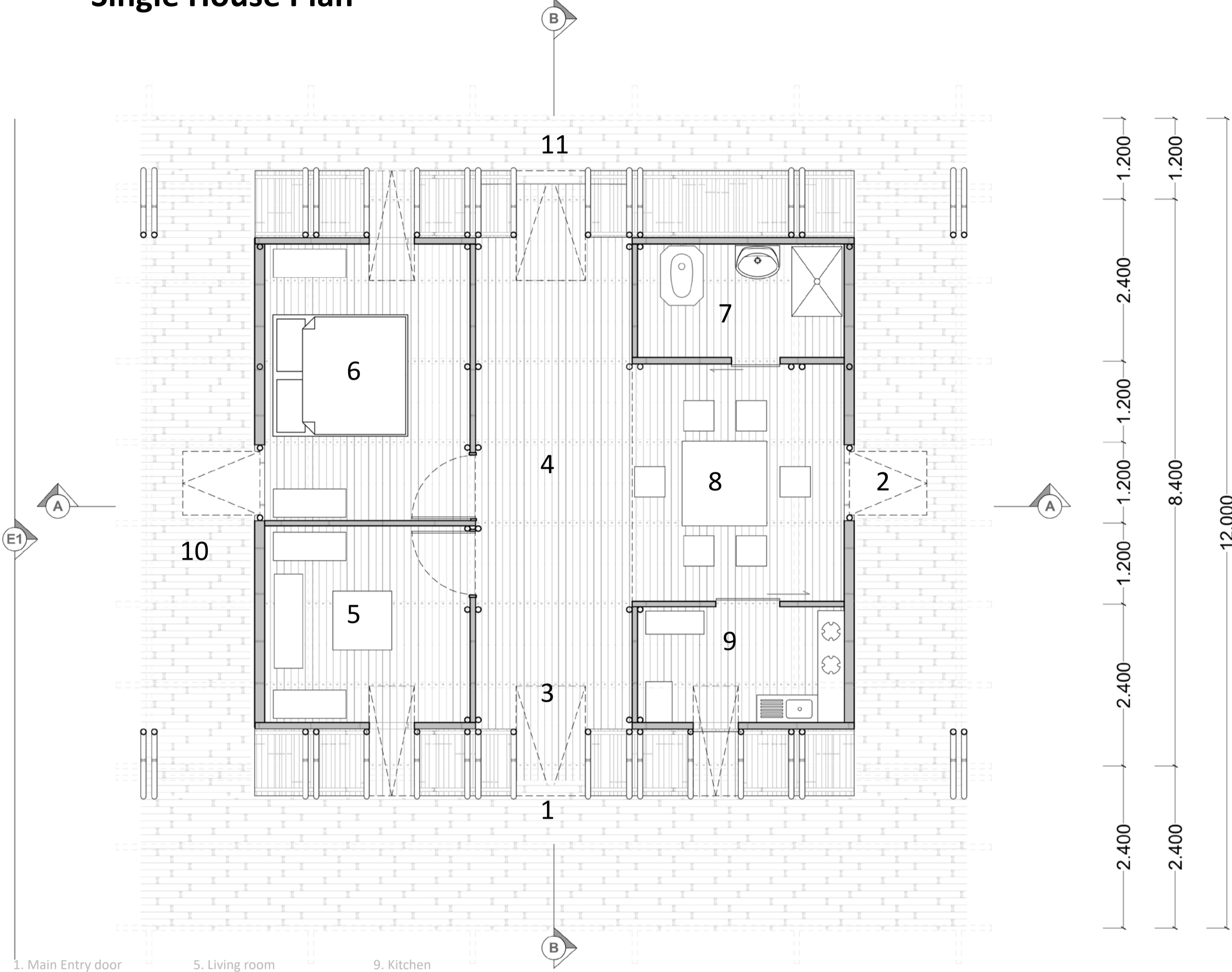


Neighborhood Plan: (Top View)  
Scale: 1: 500



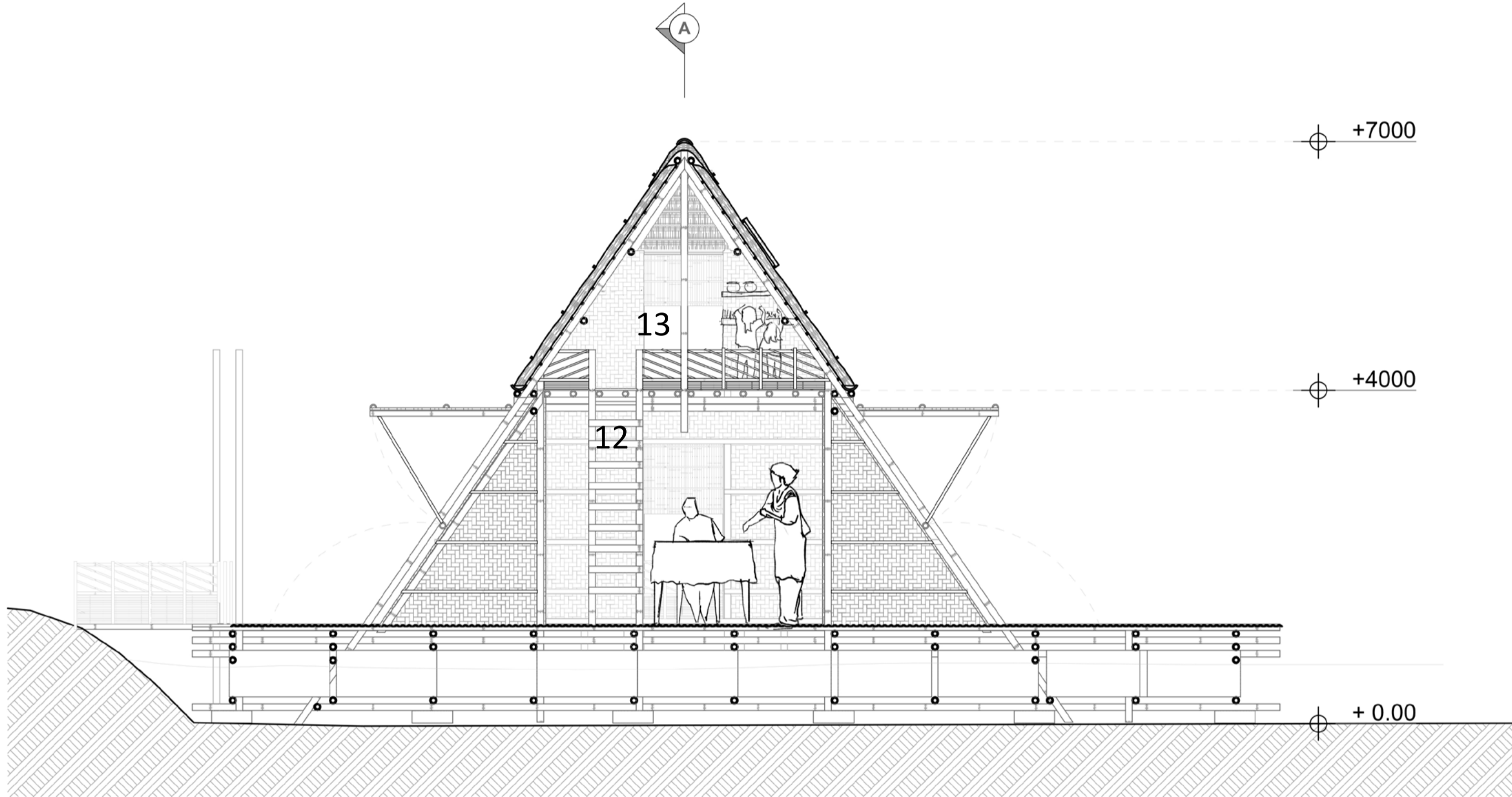


**Single House Plan**



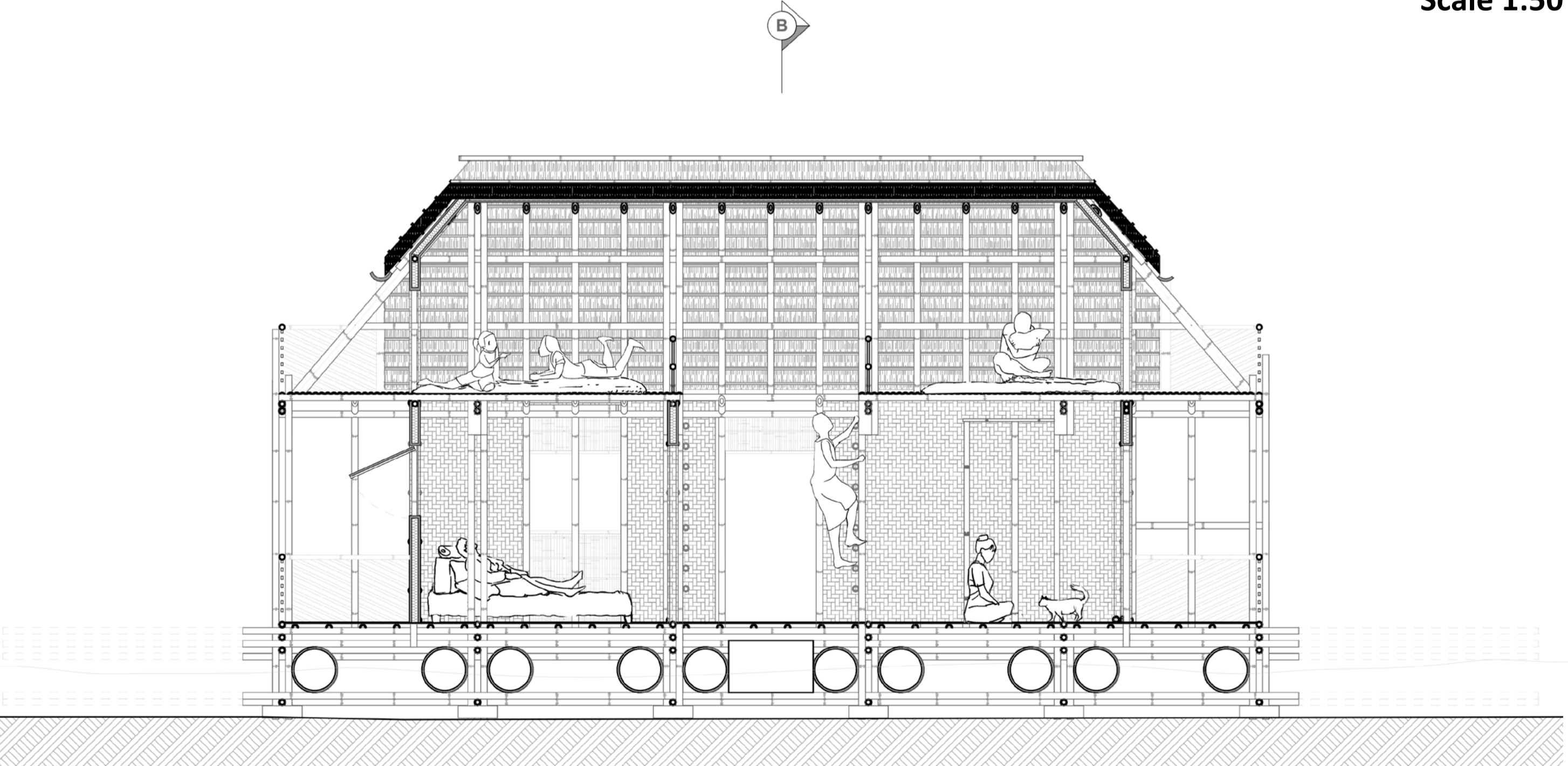
- 1. Main Entry door
- 2. Secondary Entry (Service)
- 3. Foyer
- 4. Circulation space
- 5. Living room
- 6. Sleeping space
- 7. Restroom and shower
- 8. Dining
- 9. Kitchen
- 10. Terrace
- 11. Fishing Deck

**Ground Floor Plan**  
Scale 1:50

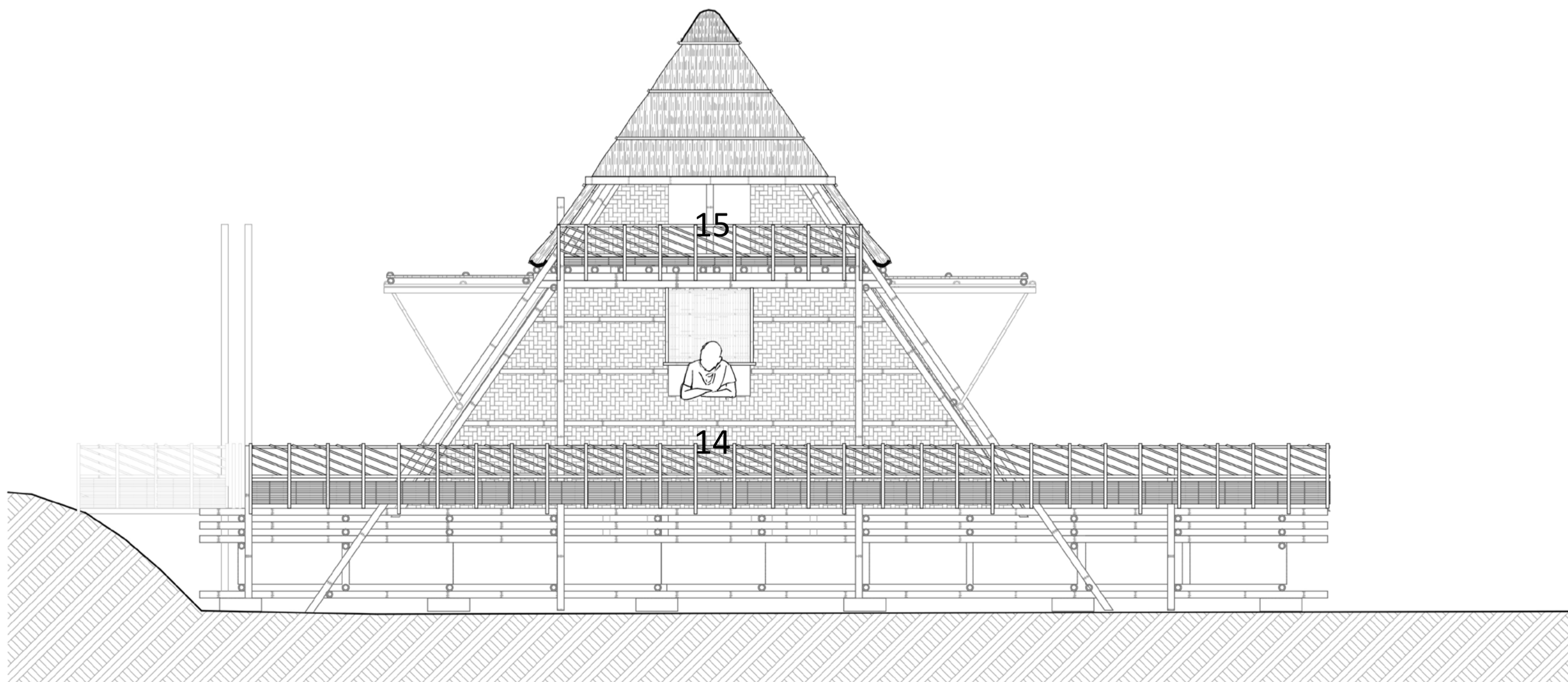


- 12. Vertical circulation (Ladder)
- 13. Additional Sleeping Space

**Section BB'**



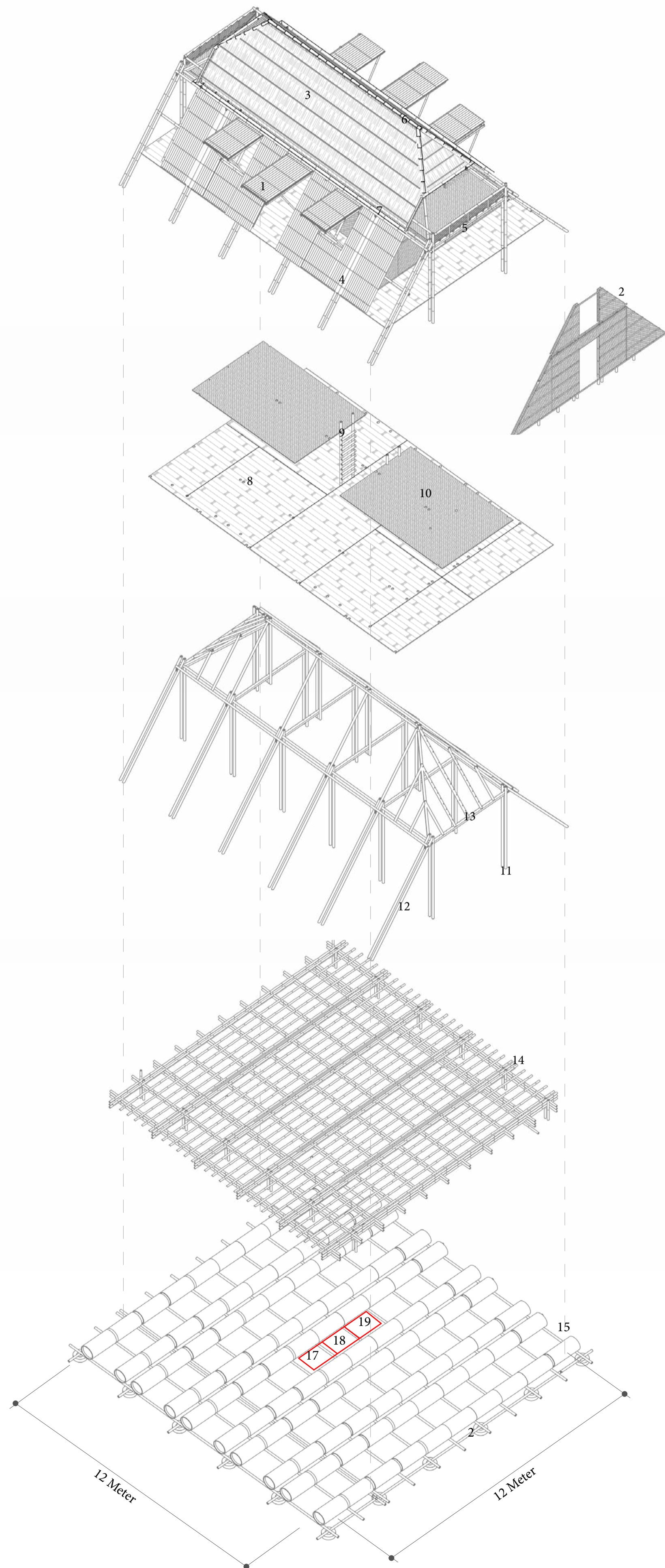
**Section AA'**



- 14. Covered balcony
- 15. Open balcony

**Elevation E1**

# Construction Details



## Envelope

1. Window with shingle layer of long bamboo shingle laid in Roman tile fashion. Approximately 20 shingles per meter
2. Double layered woven wall consisted of thin walled bamboo canes of small diameter.
3. Gable roof with Palm leave covering ca. 1.2 meter and 6 cm diameter
4. Long shingle roof with halved bamboo canes in Roman tile fashion
5. Thomas fence with bamboo slices 15-20 mm, 90-100 cm in height
6. Half of a large diameter bamboo cane is placed on the ridge joint with the convex side up
7. Roof gutter with long halved bamboo

## Floor Slabs

8. Ground Floor slab with Bamboo batten slice boards nailed on bamboo platform, ca. 35-40 mm wide. This type of floor is very strong for dead and live loads. Top surface is carefully polished to avoid injuries and to provide a suitable walking surface.
9. Vertical circulation with ladder at 90° with ground. Round bamboo tread, 40 mm diameter, placed at 20 cm elevated from each other. Treads are attached to the vertical rail by making holes in it. The vertical rail also works as handrail
10. First floor with woven mat made from bamboo strips. This kind of floor is very pleasant and slightly springy flooring which, like an orthopedic bed, is ideal as a sleeping surface.

## Building Structure

11. Vertical Load bearing member: Bamboo couple posts with 35-40 mm diameter and 3.5-4.0 meter long, fastened together with jute ropes and strengthened by part of bamboo in the middle.
12. Diagonal supporting member for roof and floor deals with lateral loads (wind) and transfer it to the foundation base.
13. Horizontal Members (Couple beam), supporting the upper floor and also strengthen the roof.

## Plinth

14. Solid Core Bamboo platform: Diameter 40-45mm, 3 Meter and 6 Meter long laid as battens and counter-battens, 5 layers on top of the oil cans. The bamboo is laid in a grid of 1.2 X 2.4 meter to contain the oil drums as flotation device. The bottom layer of bamboo contains a rubber based material fastened at the junctions to provide soft surface for the flotation device. The battens are covered with a black organic glue to protect them from rotting in the water.

## Floating Base

15. Plastic drum reuse ( Length 120 cm, Diameter 60 cm)
16. Bamboo Platform laid on Recycled vehicle Tire ( Diameter 35-40 mm) to provide the structure with a suitable landing surface
17. Septic Tank
18. Filter Tank
19. Water tank, are placed under the common living area so that it can be easily maintained regularly.

## 1. Roof and wall

From outside, Roof covering with Nipa palm leaves bent around a thin bamboo batten after the stiff leaf spine has been removed at the fold over a distance of 7 cm. These leaf shingles are tied to rafters forming three layers, 50-60 mm thick roof covering. Another batten is placed on top to secure the leaves from being blown away.

Rafters and purlins are fastened with jute ropes. An additional bamboo branch with smaller diameter (tourniquet) is fastened with each purlin to provide more friction.

Insulation layer of 4 cm, mostly composed of rice straw filling placed between purlin and installation layer. Small bamboo supporting members are placed along the length of purlin at a distance of 90-100 cm

Installation layer 20-25 cm, halved bamboo battens are nailed or fastened with the purlins by jute ropes, convex side down to provide fixation surface for interior cladding

Inner cladding is a thin layer of cross-woven bamboo mat with thickness of 5-10 mm

## 2. Window

From top, Hard bamboo canes are placed loosely into one another alternating between a convex and concave half (radius 20 mm). Battens 20 mm half bamboo battens. Insulation materials can be used or kept vacant for air space. Window frame with hinge attached to the main structure 40 mm. Bamboo lashes with half bamboo canes 20 mm

## 3. Floor

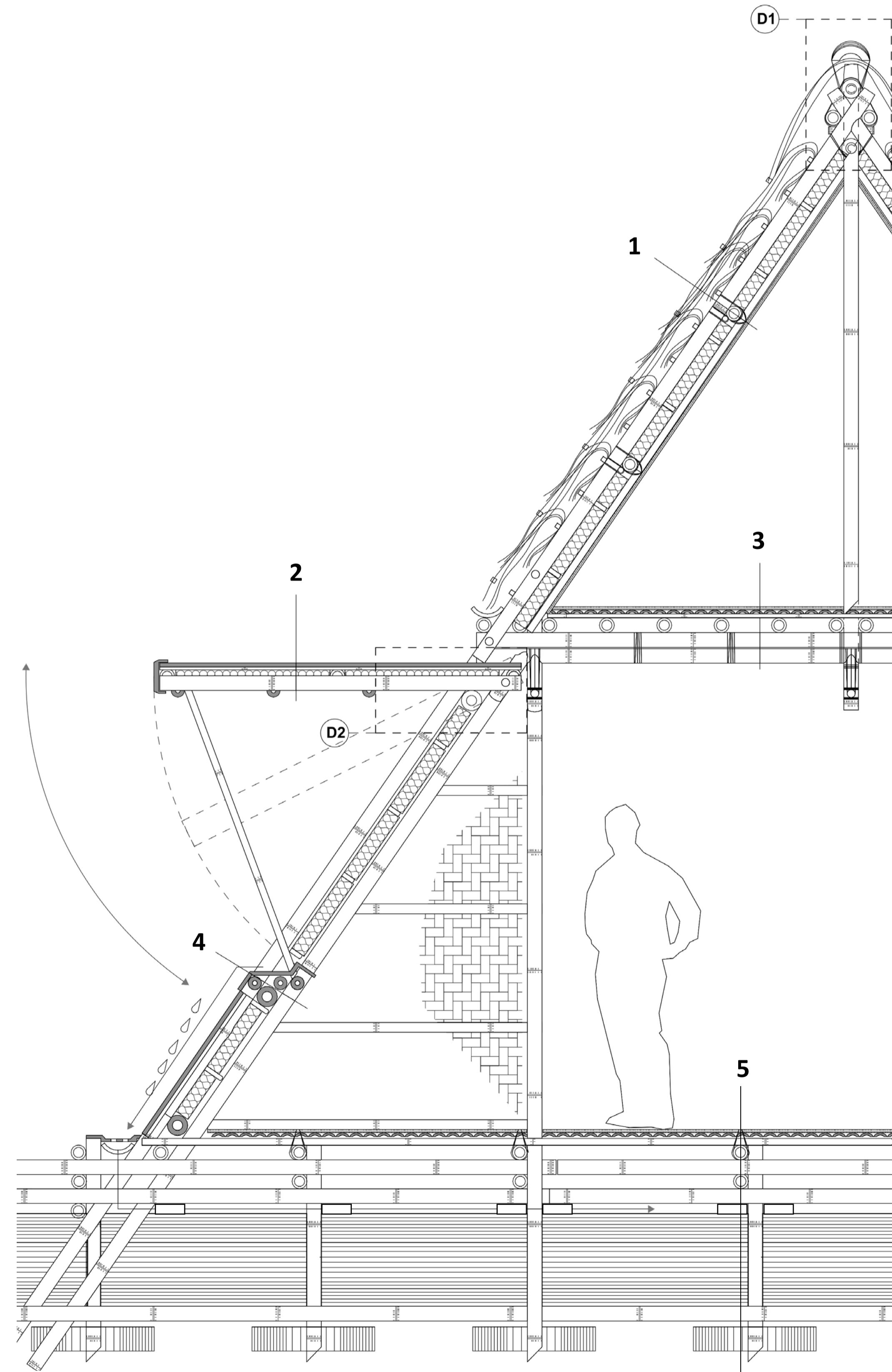
From top, Flooring material, thin layer of cross-woven bamboo mat with thickness of 5-10 mm. Floor structure, long bamboo canes cut into one fourth of its cross section laid side by side and nailed with the layer below (20 mm). Hard bamboo canes with 35-40 mm diameter placed 30 cm apart, nailed or fastened with building structure. Tension member, two 40 mm full bamboo canes are fastened with each other rested on posts on both side and a central support from the roof (80 mm)

## 4. Window sill

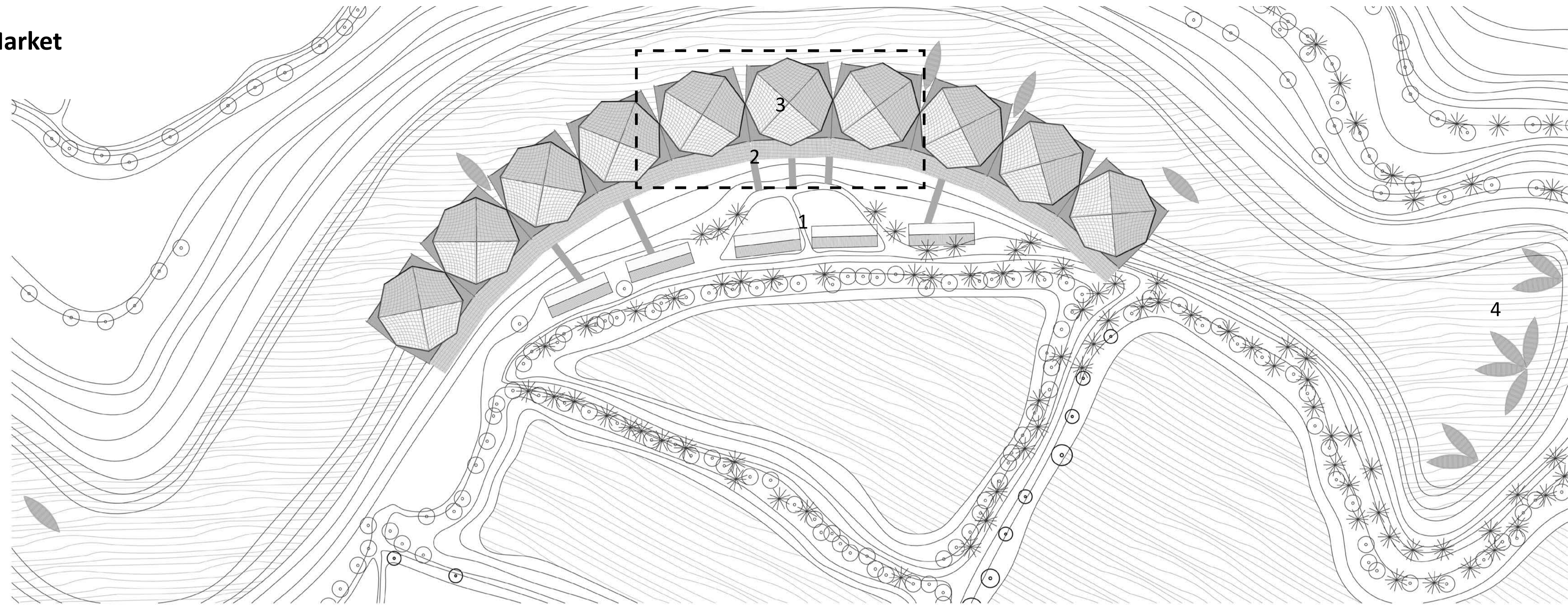
From outside, Waterproof material made with rubber on top of industrial sheet, bent in places to provide resting surface for window frame when closed. Bamboo canes with smaller diameter 20 cm placed to produce an outward slope in order to drain the rain water. Structural member 40 mm dia bamboo.

## 5. Plinth

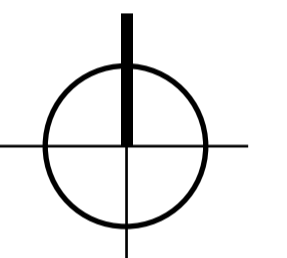
From top, Flooring material, thin layer of cross-woven bamboo mat with thickness of 5-10 mm. Floor structure, long bamboo canes cut into one fourth of its cross section laid side by side and nailed with the layer below (20 mm). Diameter 40-45mm, 3 Meter and 6 Meter long laid as battens and counter-battens, 5 layers on top of the oil cans. The bamboo is laid in a grid of 1.2 X 2.4 meter to contain the oil drums as flotation device. The bottom layer of bamboo contains a rubber based material fastened at the junctions to provide soft surface for the flotation device. The battens are covered with a black organic glue to protect them from rotting in the water. Plastic drum reuse ( Length 120 cm, Diameter 60 cm) as flotation device. Under the common living area three of them are used as septic tank, filter tank, and water tank respectively. Bamboo Platform laid on Recycled vehicle Tire ( Diameter 35-40 mm) to provide the structure with a suitable landing surface.



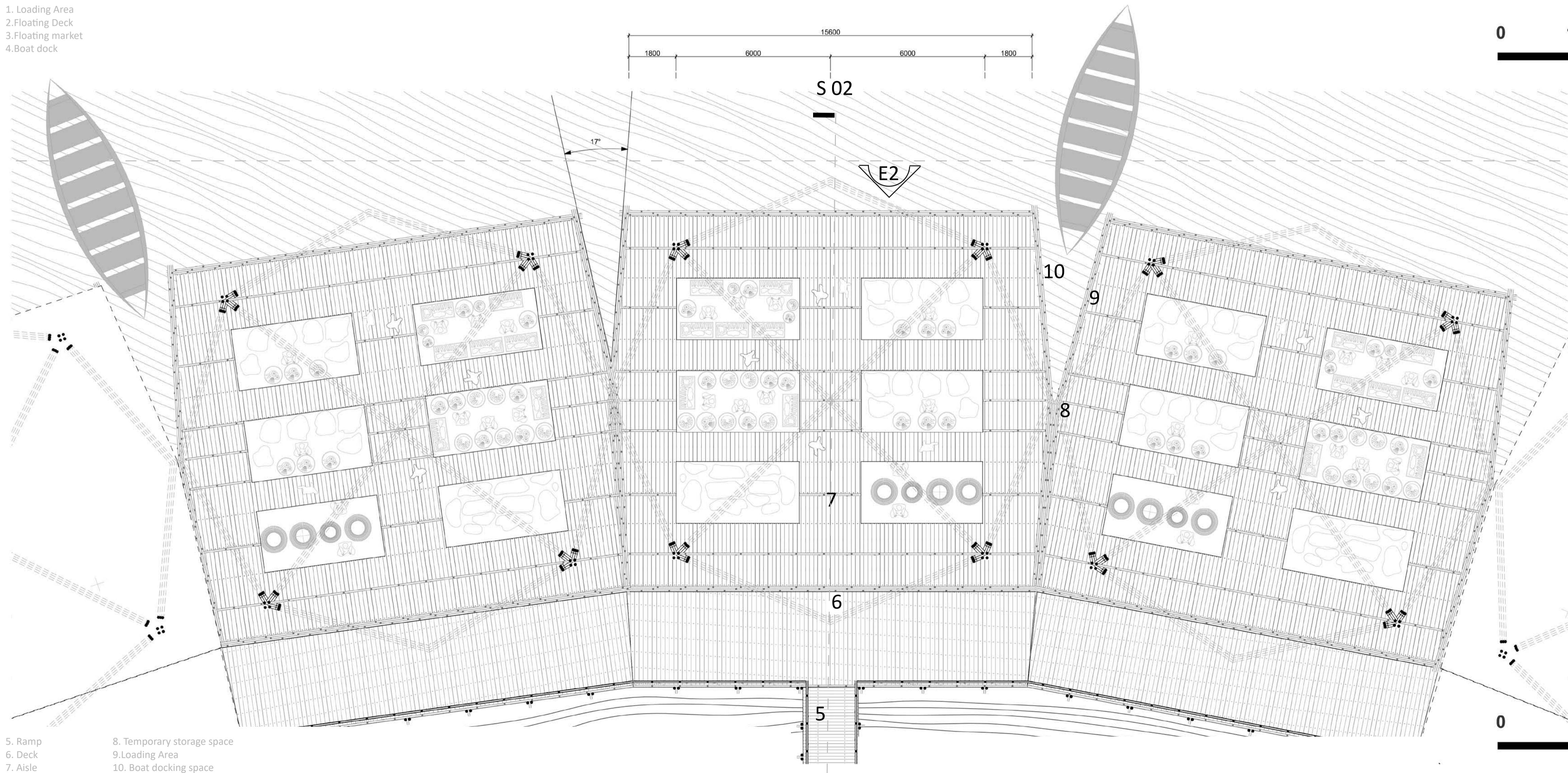
# Floating Market



- 1. Loading Area
- 2. Floating Deck
- 3. Floating market
- 4. Boat dock



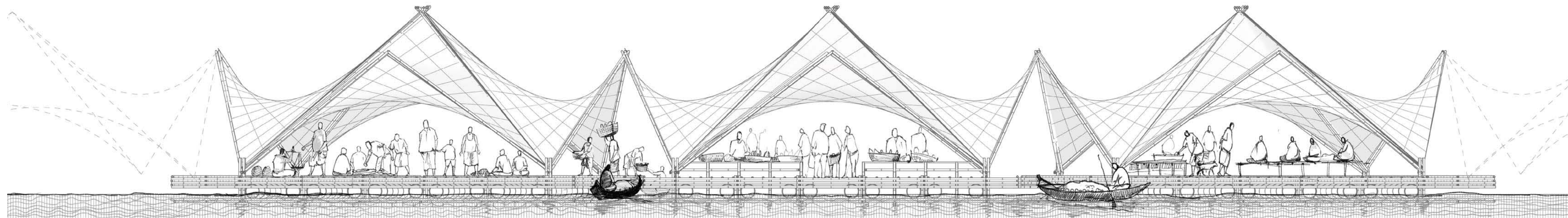
Top View  
Scale 1: 500



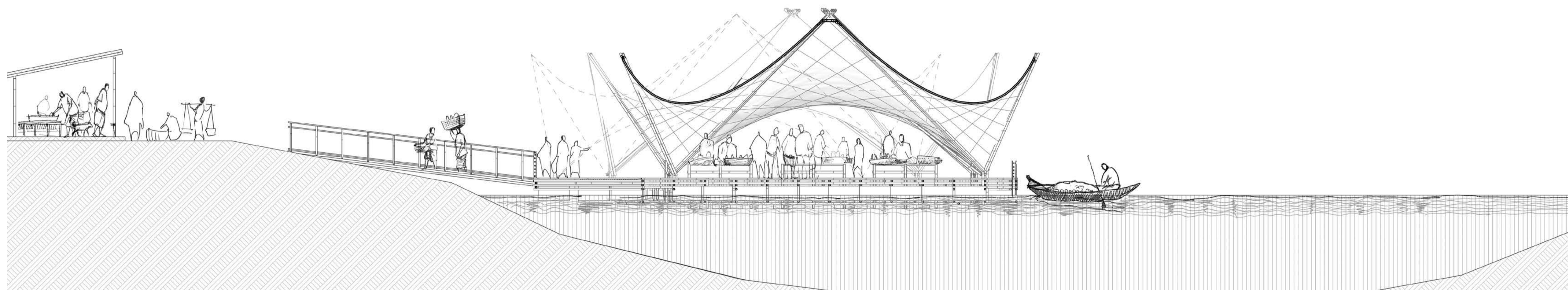
- 5. Ramp
- 6. Deck
- 7. Aisle
- 8. Temporary storage space
- 9. Loading Area
- 10. Boat docking space

Ground Floor Plan (Part)  
Scale 1:100





Elevation E2 (Part)  
Scale 1:100

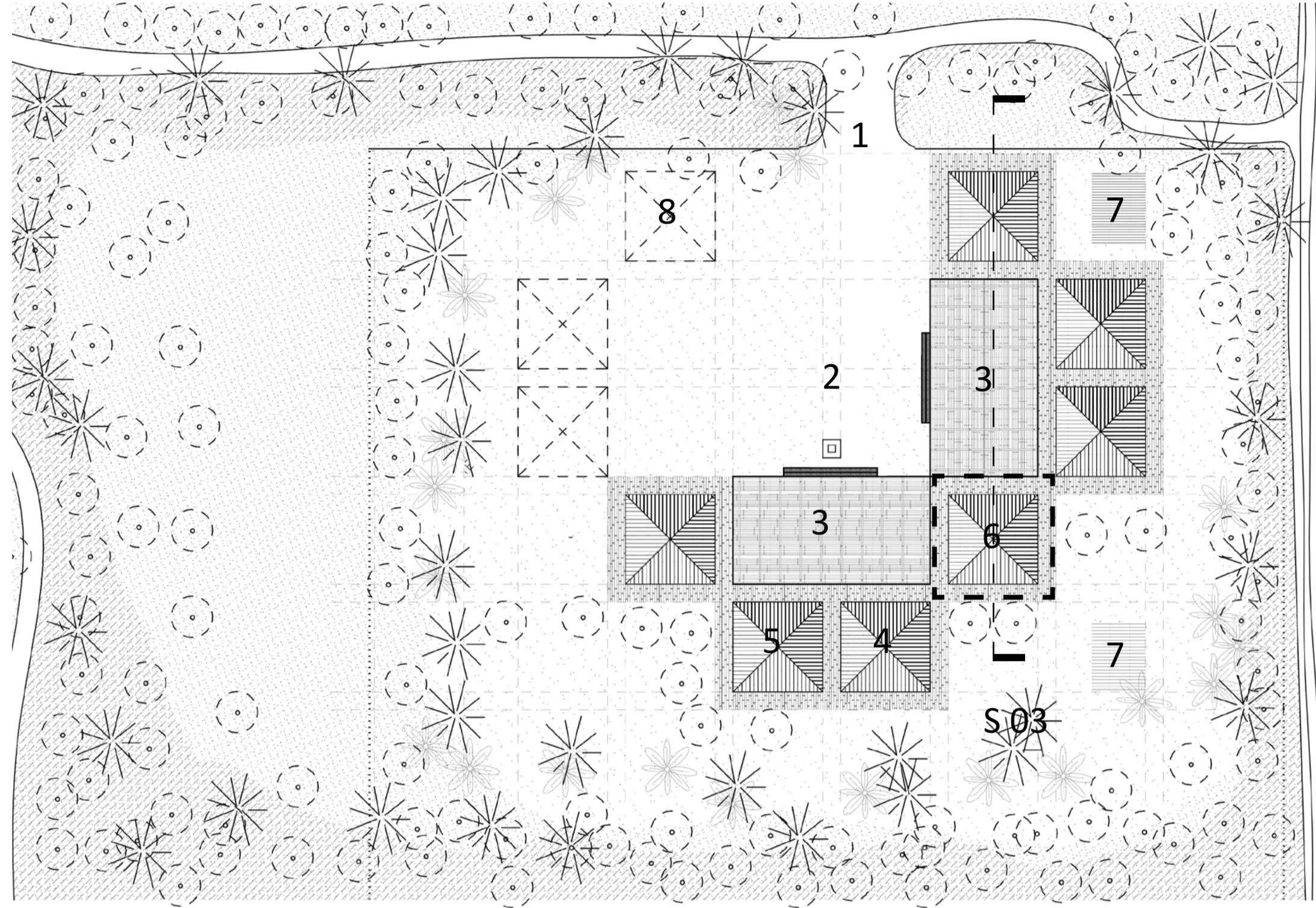


Section S2  
Scale 1:100

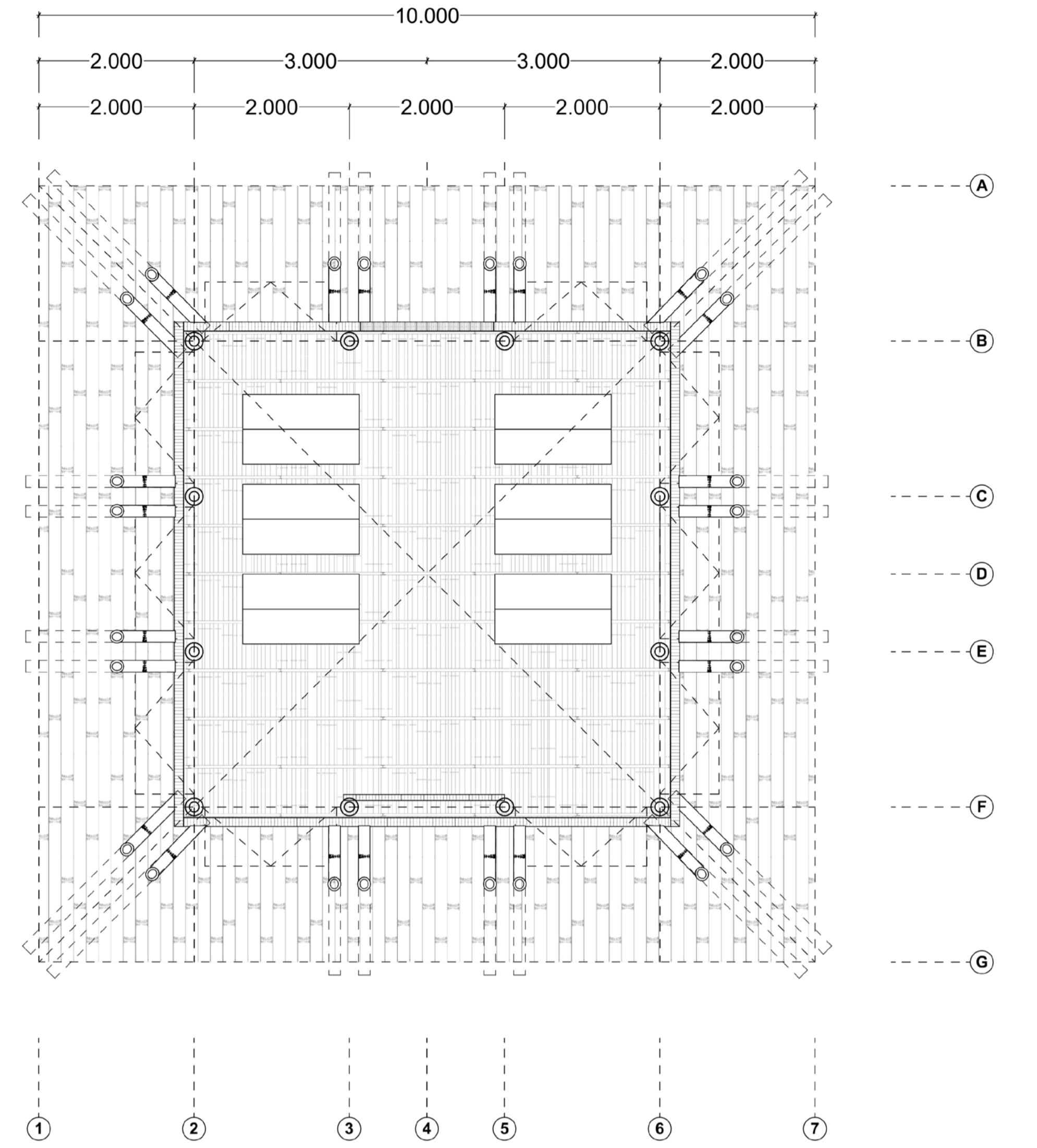
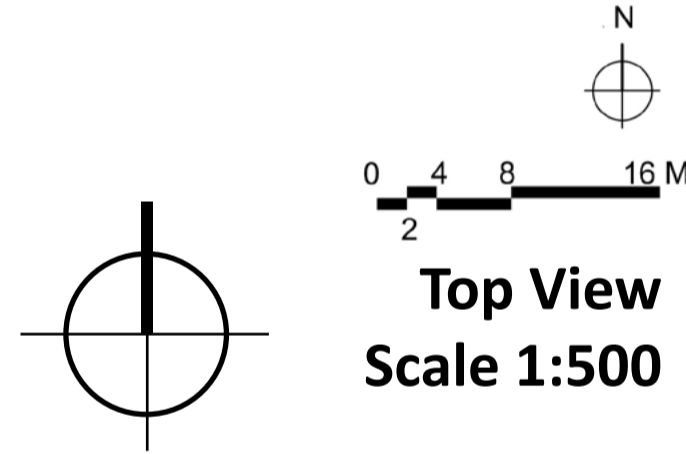




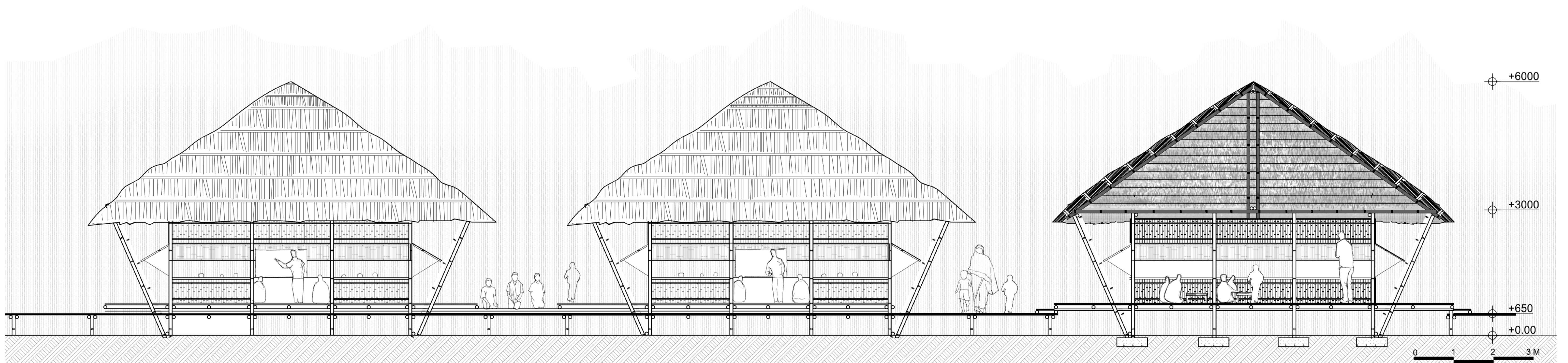
# Elementary School



- 1. School gate
- 2. Playground and Assembly Space
- 3. Open Classroom and play area
- 4. Teachers' room
- 5. Library and equipment room
- 6. Typical Classroom
- 7. Toilets and space for Tubewell
- 8. Playscape

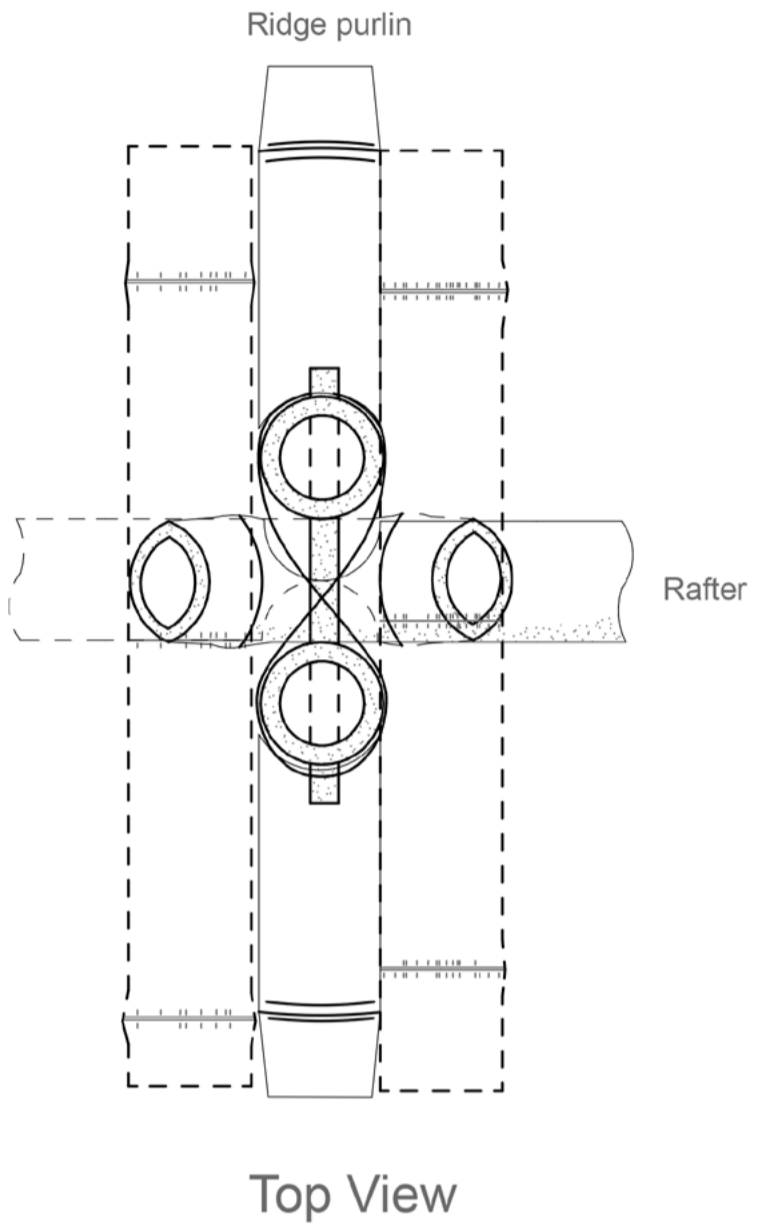
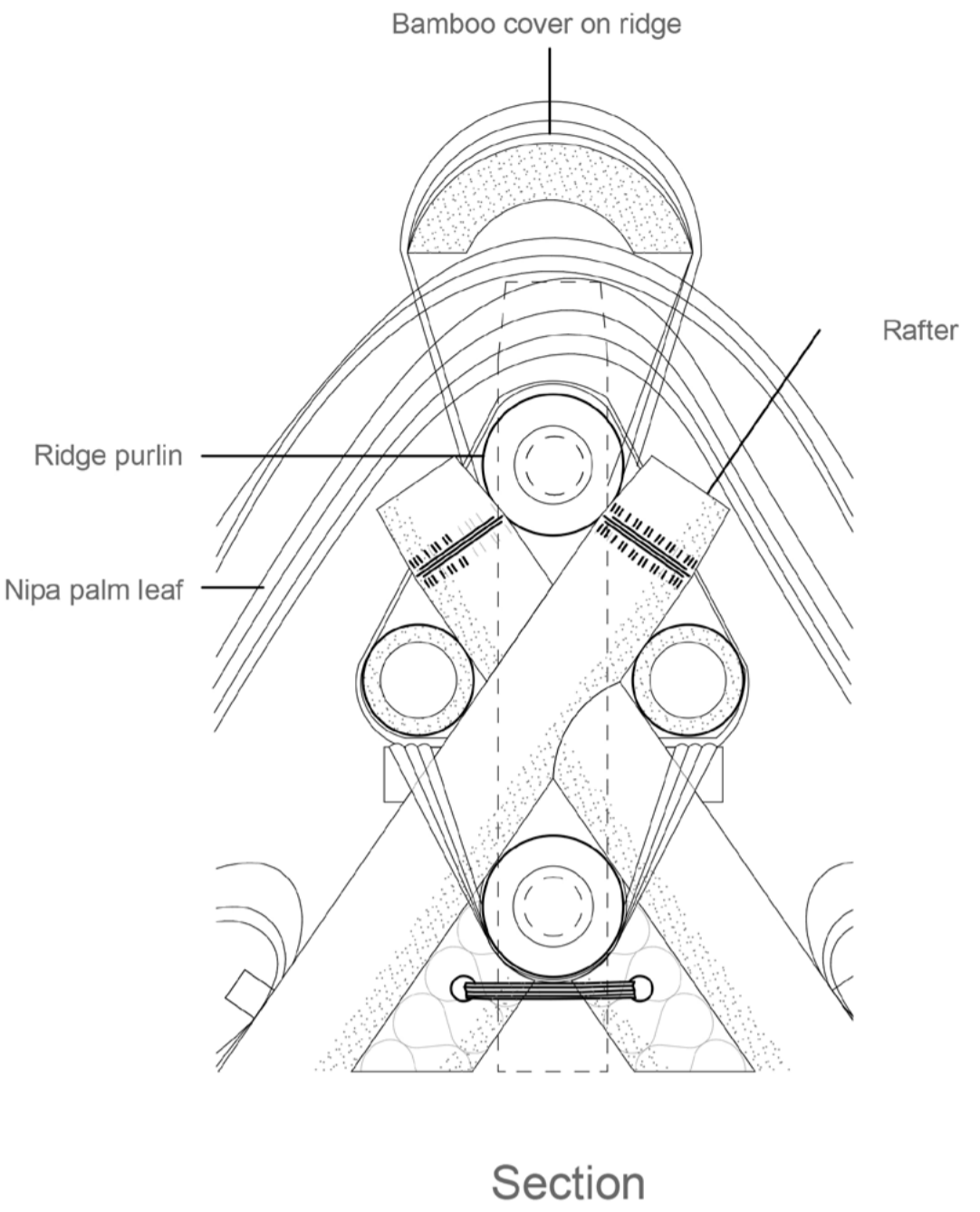


**Ground Floor Plan (Part)**  
Scale 1:50

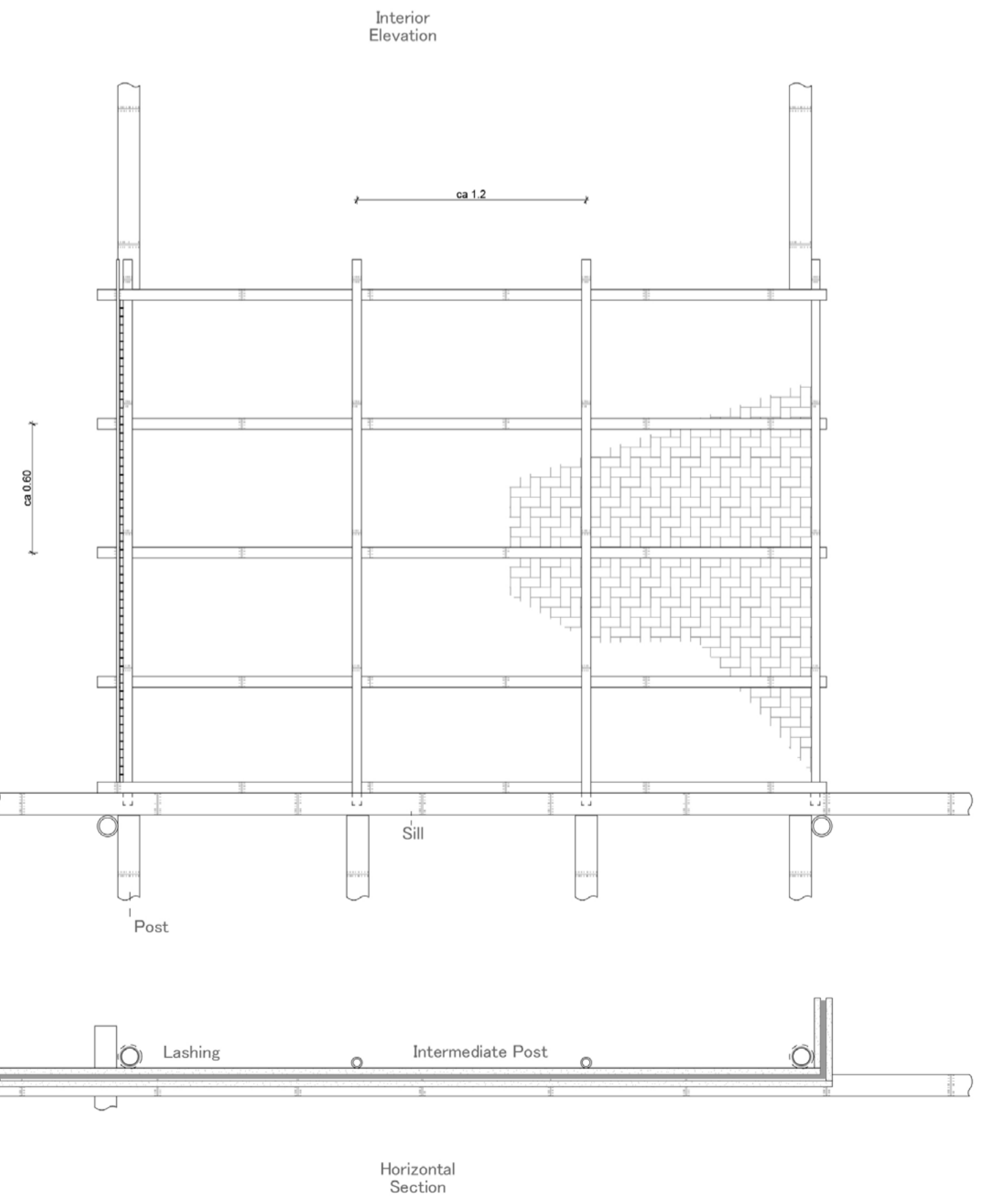
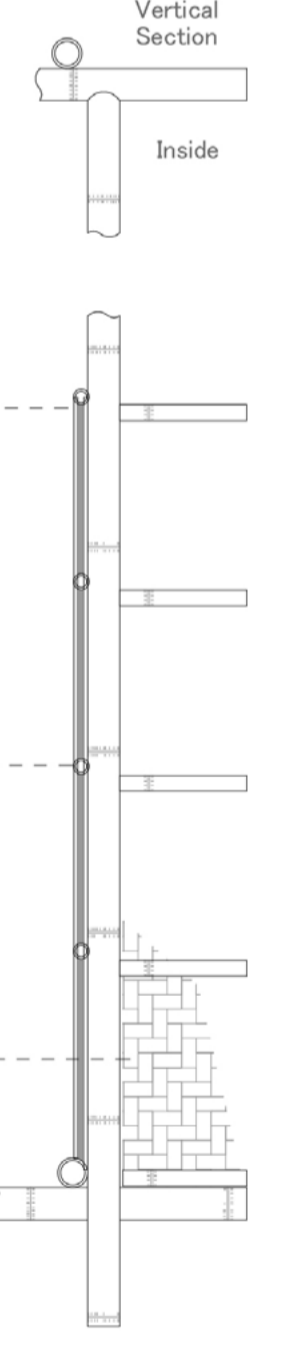
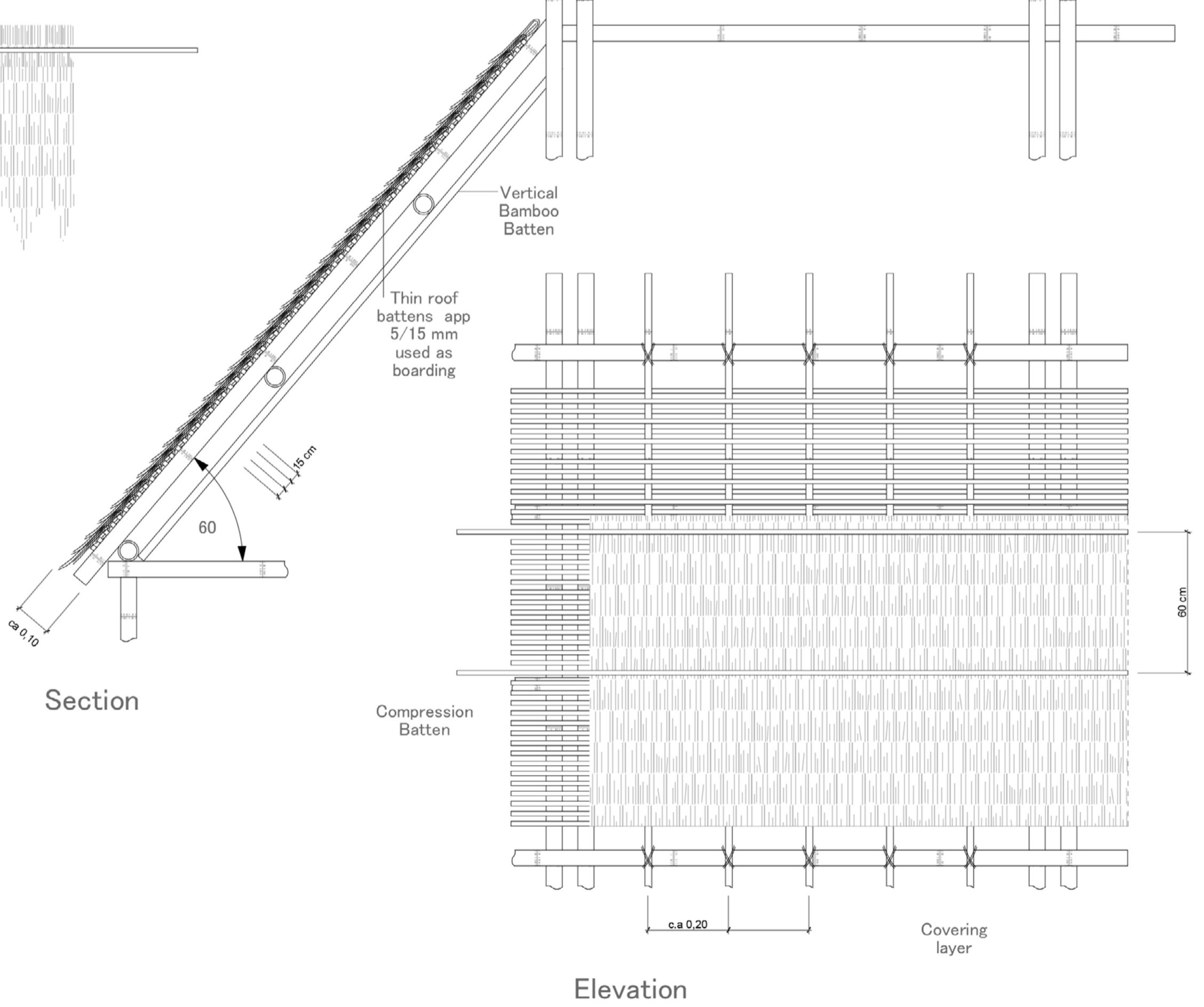
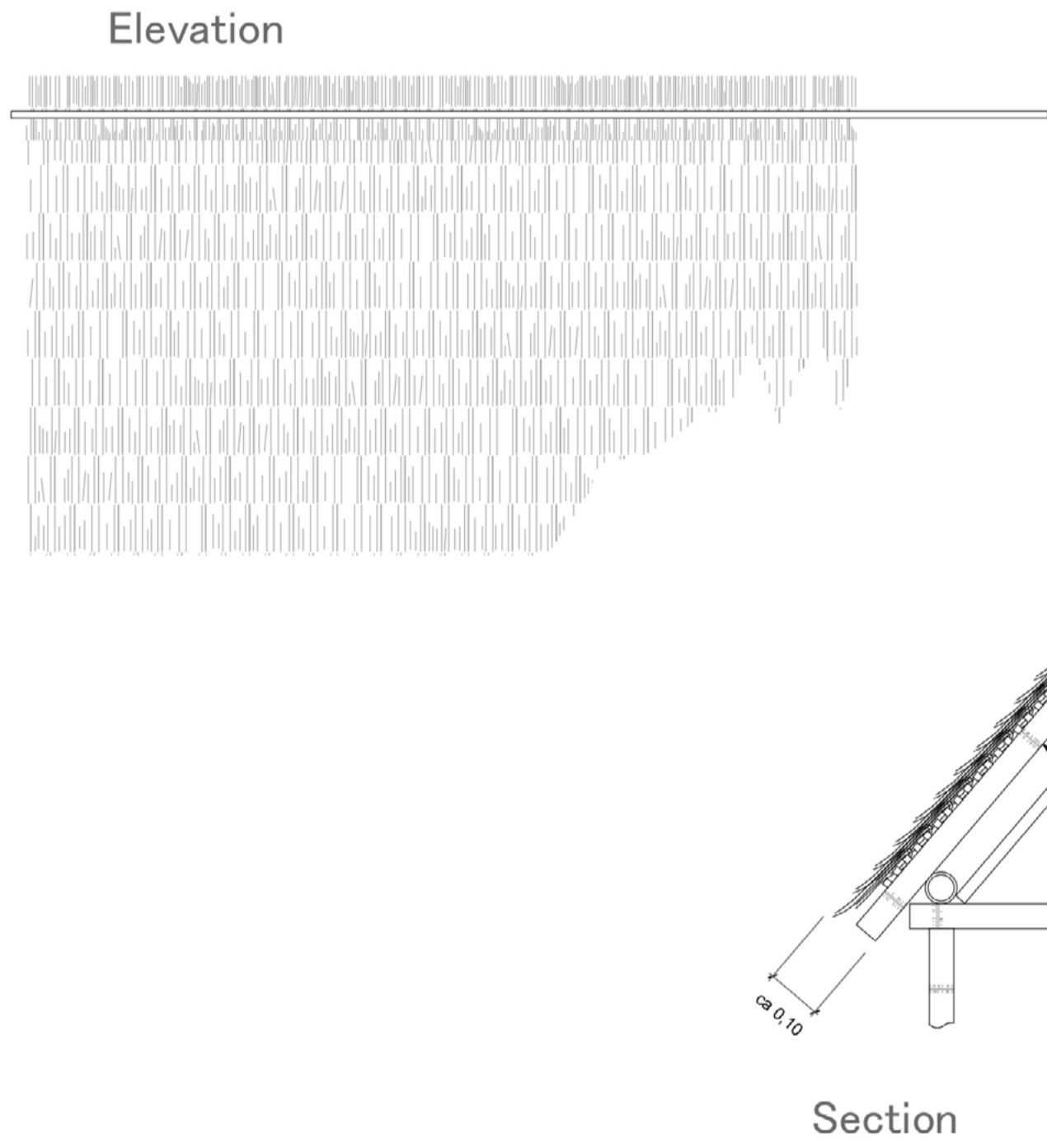


**Section S3**

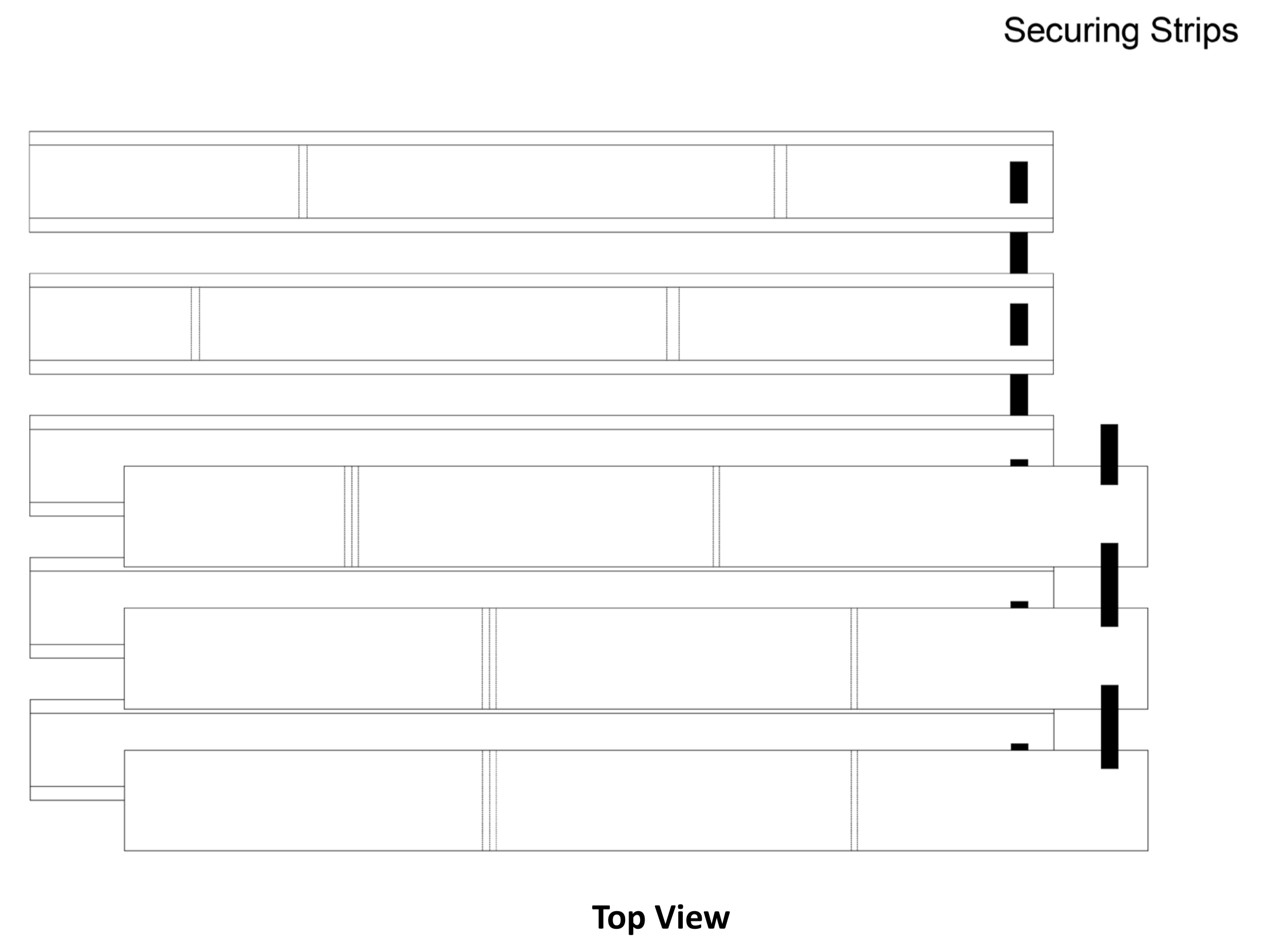
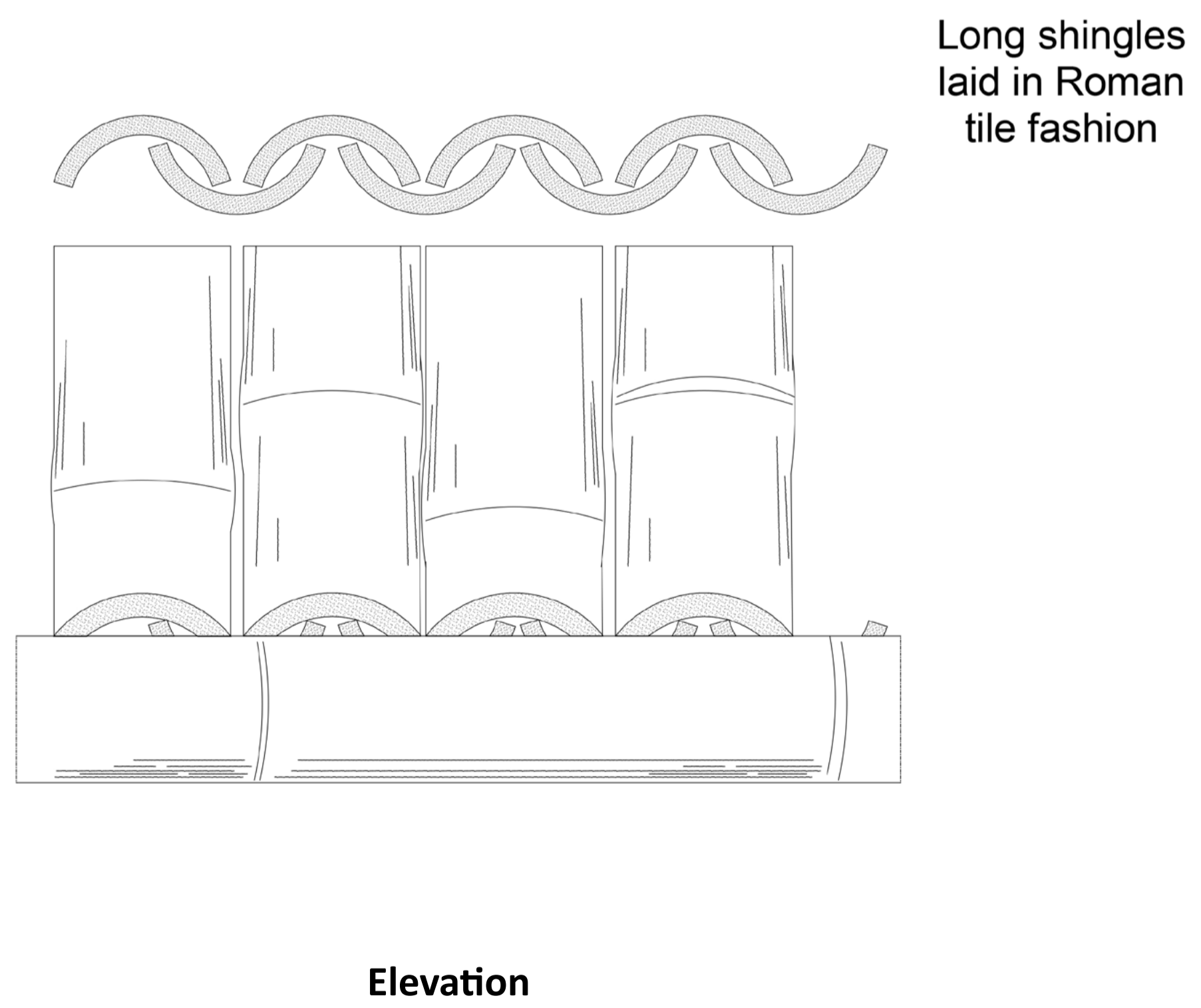
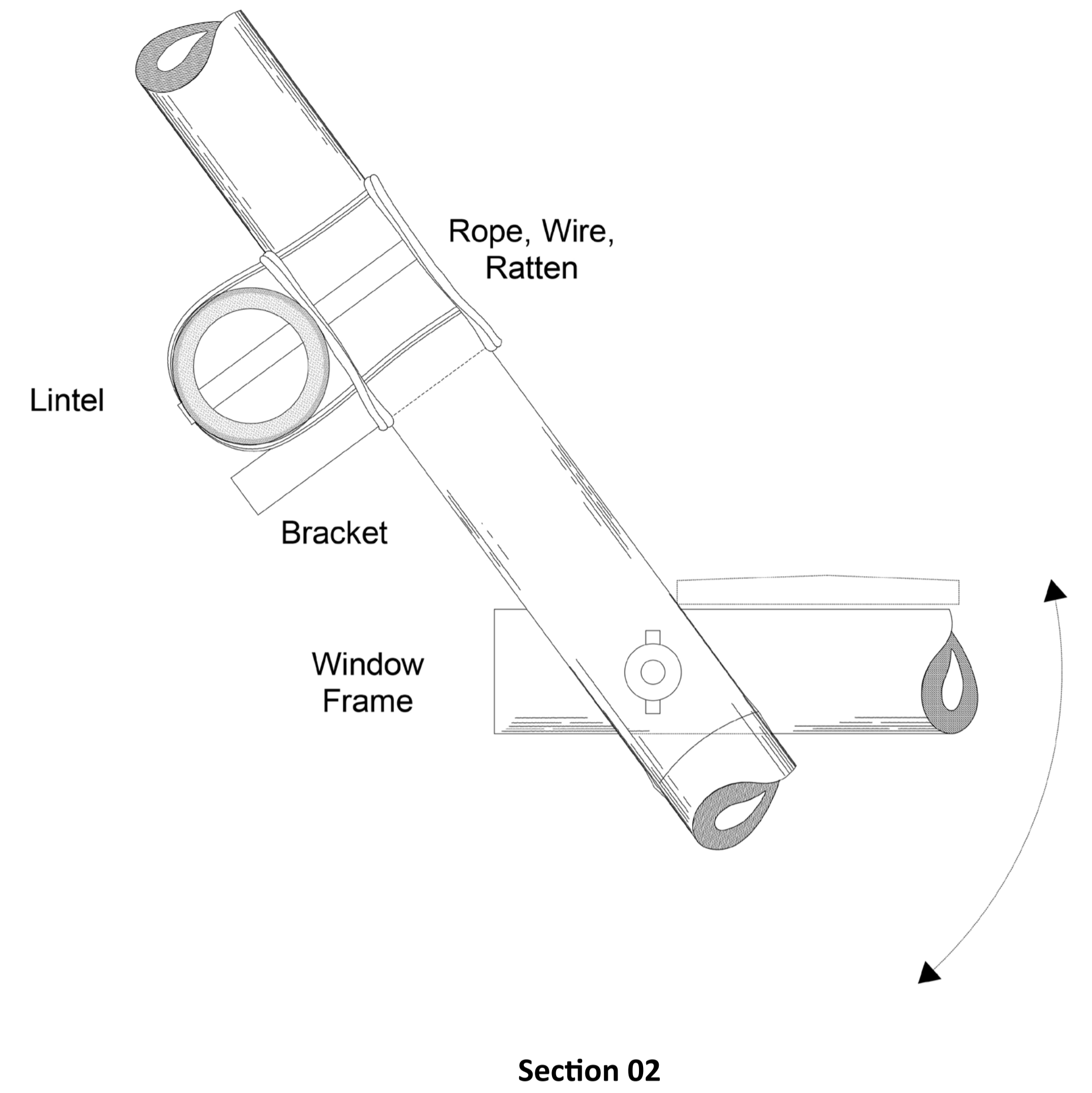
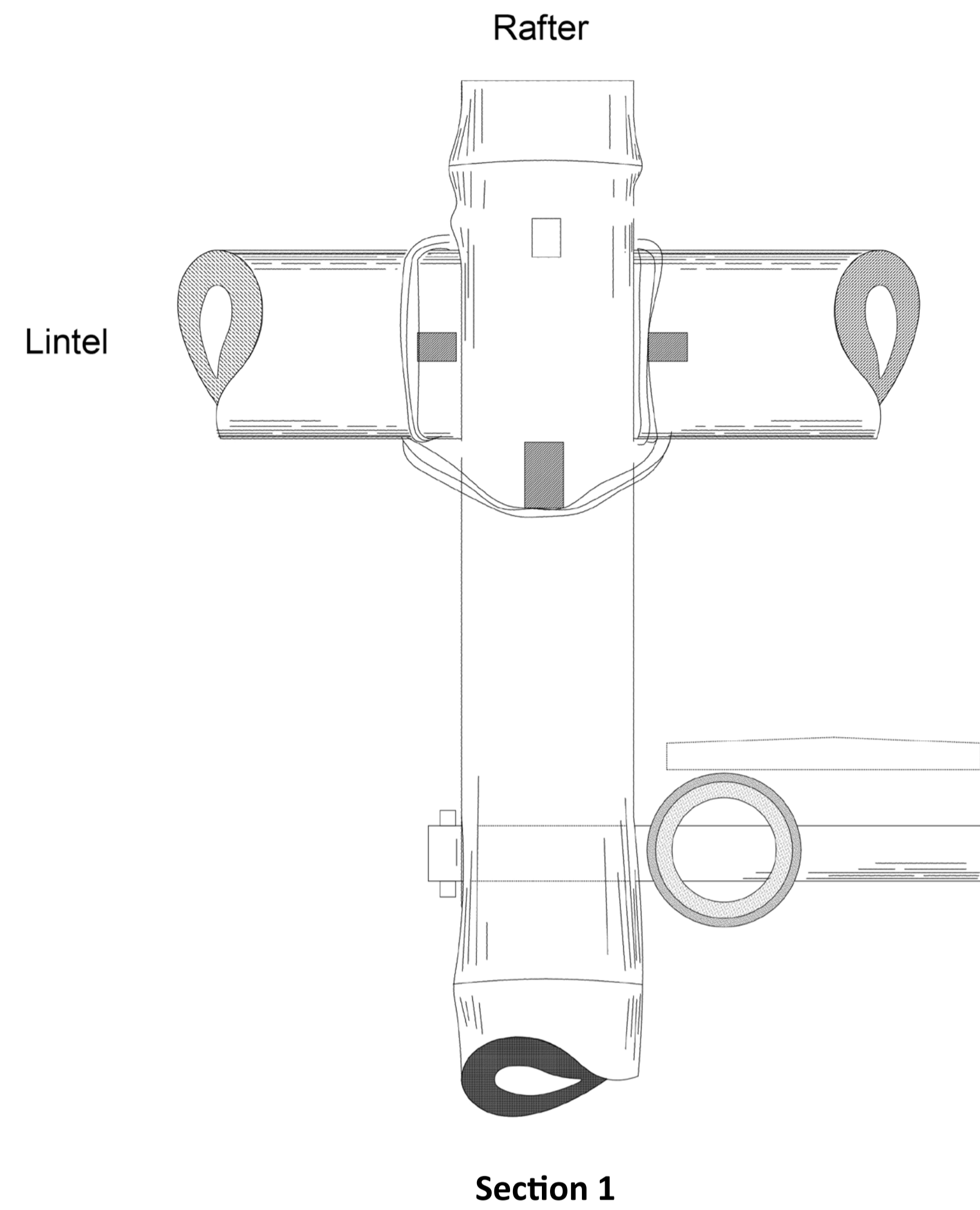
**Construction Details**



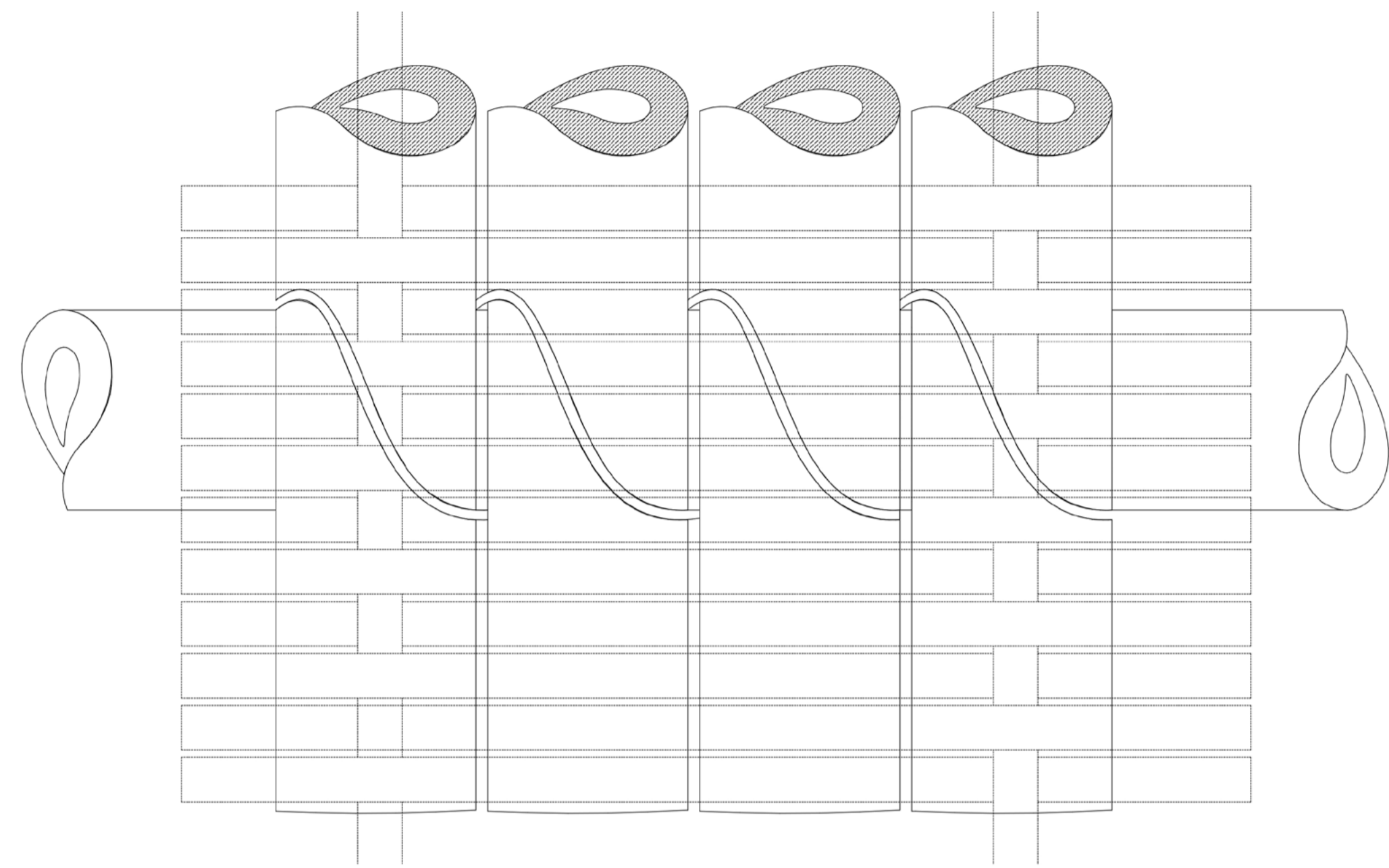
**Detail 01: Roof ridge joint detail**



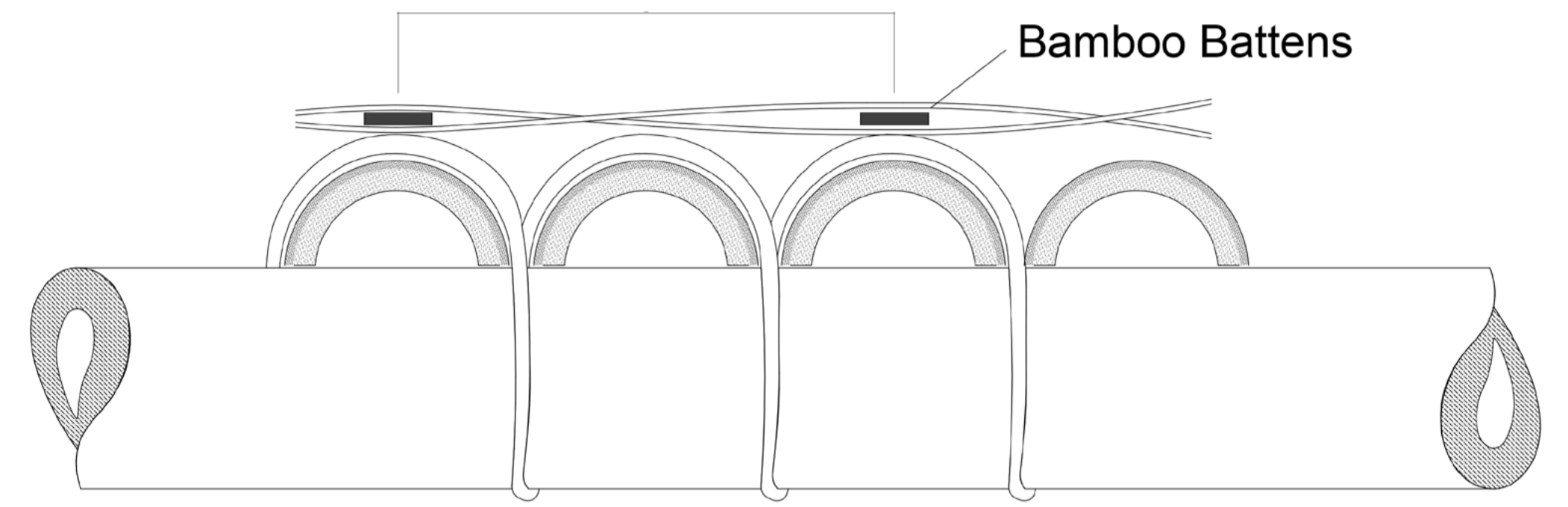
**Roof and wall construction details**



Detail 02: Bamboo Shingle Window details

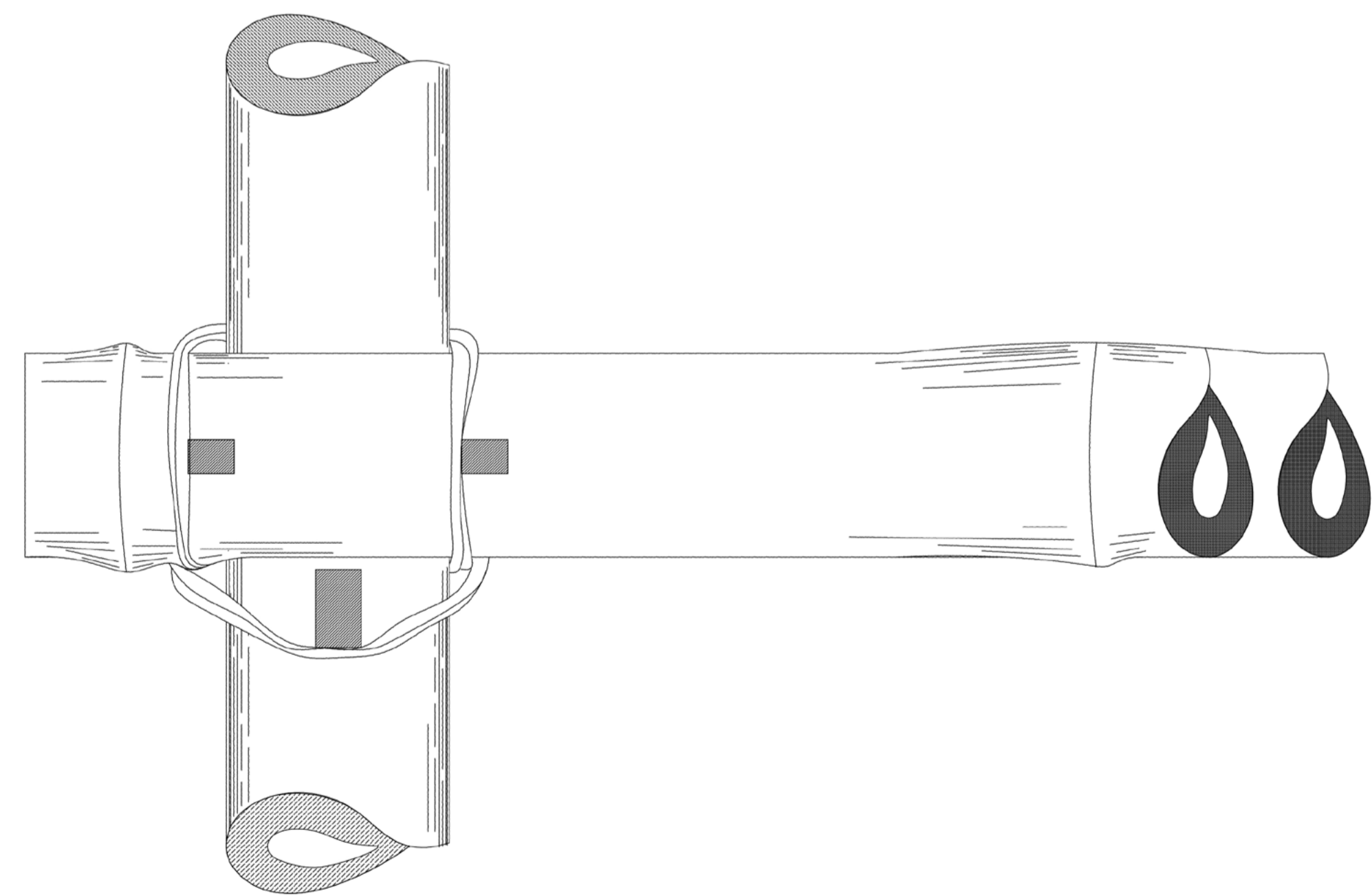


Plan

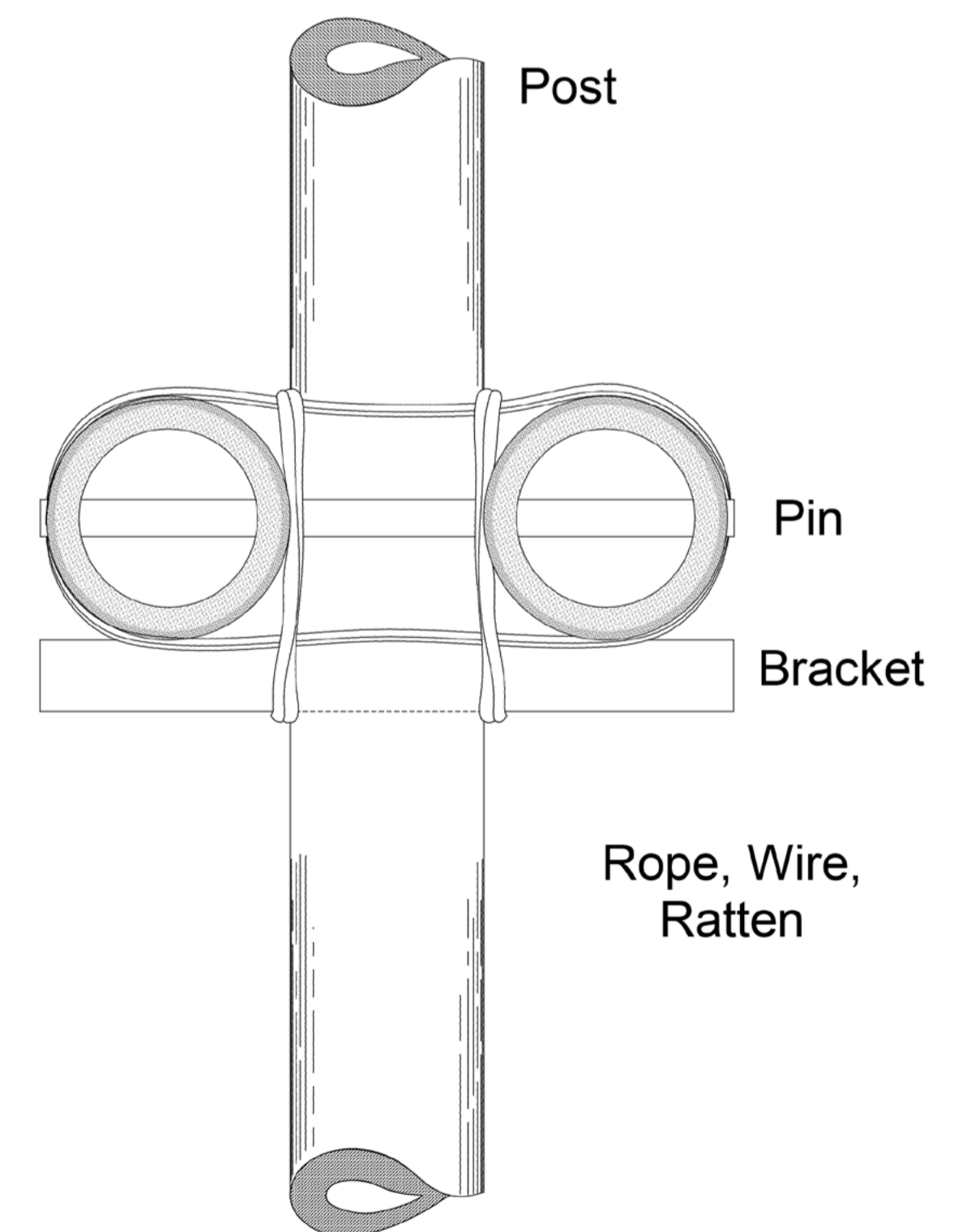


Section

Detail 03: Floor Details



Post



Detail 04: Post and beam joining details