



Future with Nature

Innovative coastal pre-fab architecture to handle cyclones and CRZ regulations

Indian regulations make it very challenging to build dwellings or structures on the ocean and river front. The Coastal Regulation Zone (CRZ) rules are stringent and a huge deterrent for serious investments in the tourism and wellness space. Even though India has idyllic locations on its coast, estuaries, rivers and lakes, we have never seen daring, innovative and stunning tourism or real estate projects as seen in Maldives, Bali, Thailand and the UAE. Building onto the sea or close to the sea can be spectacular and deliver unforgettable guest experiences.

India has been on the backseat of coastal experiential tourism. That is about to change. Government of India made huge concessions in the 2019 CRZ policy. New guidelines allow temporary structures or shacks to be built on the shoreline; just behind 10 meters from High Tide Line. What is the definition of a temporary shack? That which can be assembled on site and disassembled with equal ease without leaving a scar on the ground. If need be, these structures need to be dismantled before the monsoons, cyclones and the hurricanes. Design and innovation in pre-fab is the available way forward.

The Panchabhuta Conservation Foundation based in Kagala, Karnataka; strives to be the catalyst for big change in responsible and regenerative tourism in the Uttar Kannada region. With various sea-front projects to be developed, the foundation has created a strong ecosystem of researchers, experts, architects and local craftsmen to innovate designs for luxury accommodations that can be easily assembled, dismantled and leave no footprint on the natural surroundings. Located within a delicate ecosystem of the Aghanashini estuary, the designs had to be extending enough to experience the natural elements of the land, but also retract quickly into a protected cocoon in case of extreme weather during monsoons and occasional cyclones.

Ecological pre-fab architecture for coastal development

Panchabhuta's aim is to generate responsible tourism that empowers local communities, has no adverse impact on the surroundings and redefine living with nature. In order to create these responsible coastal developments, the foundation has been studying and innovating various typologies of luxury accommodations in bamboo and timber; with the following criteria in the forefront of the design approach.

1. Temporary architecture and modular assembly
2. Climate responsive design
3. Integrated Services
4. Sustainable waste management systems
5. Community inclusion and empowerment

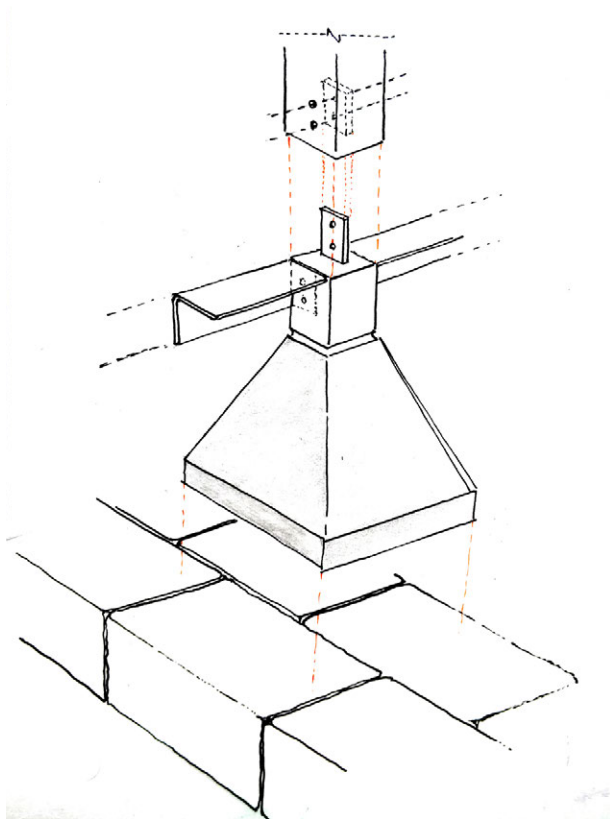
Temporary architecture and modular assembly

To build in accordance with the guidelines of the 2019 CRZ policy, it is imperative to develop structures that are retractable, movable and have no detrimental effect on the land. To build a luxurious, yet temporary product, the pre-fab design approach unfolds various opportunities to innovate and learn.

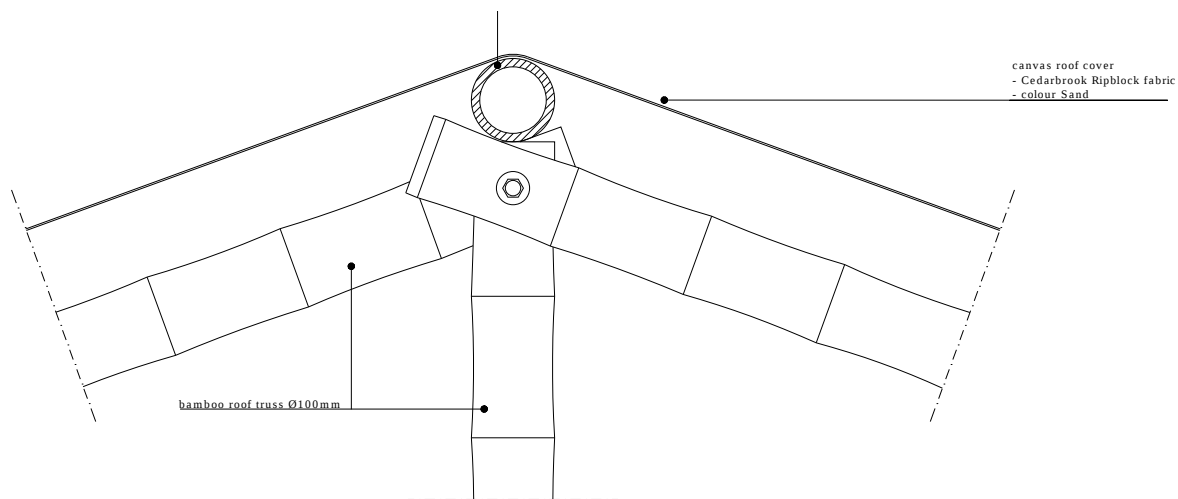
- (a) The foundation structures comprise of pre-fab metal rafts resting on pre-cast RCC footings. These footings are anchored onto a compact bed of laterite stone to assure uniform load distribution and avoid settling of footings on sandy beach soil.
- (b) The structural members are fabricated off-site and assembled on-site using dry-stack construction techniques, basic carpentry joineries and nut-bolting systems, thus eliminating any permanent impact on the ground and the surroundings.
- (c) Since the members are joined using nut-bolt fastening systems, they can be easily dismantled, stored and re-assembled as per seasons and requirements.
- (d) Usage of modular structural members and mortar-less construction allows easy transportation and handling of materials



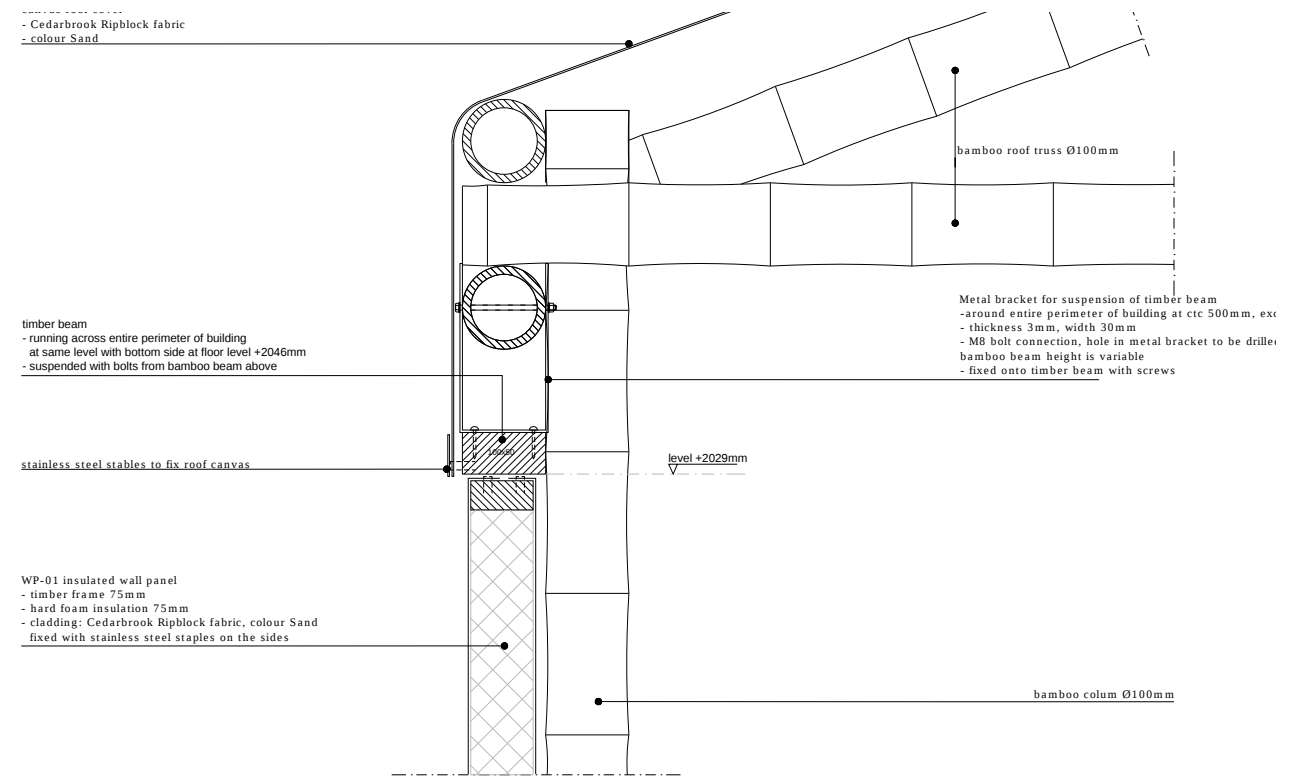
top : dry Assembly of wall panels covered with Rip-stock fabric in progress



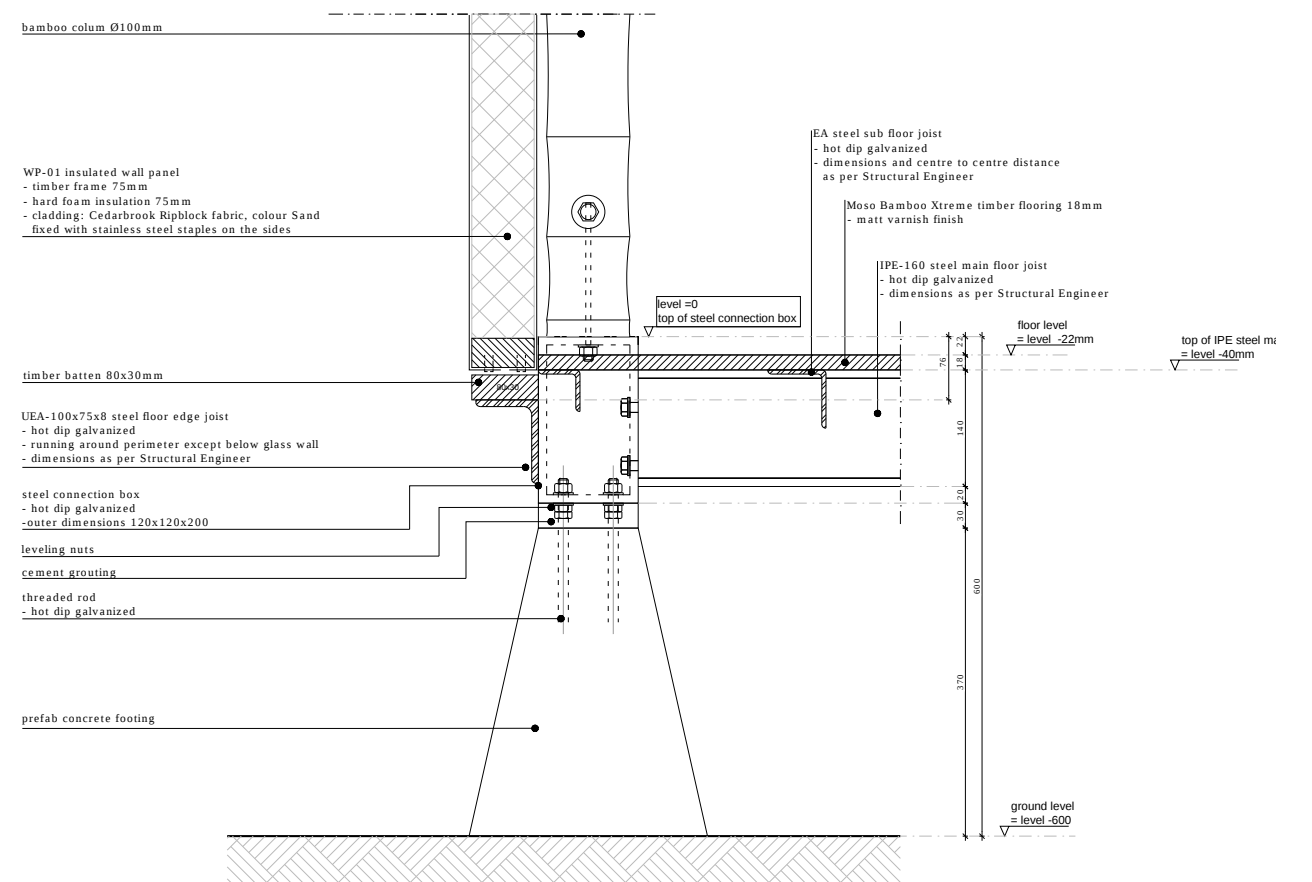
top : Dry stack assembly of structural members
bottom : Assembly of wall panels covered with Rip-stock fabric in progress



Bamboo roof truss joinery detail



Joinery detail - Bamboo roof truss, Column & Wall panels

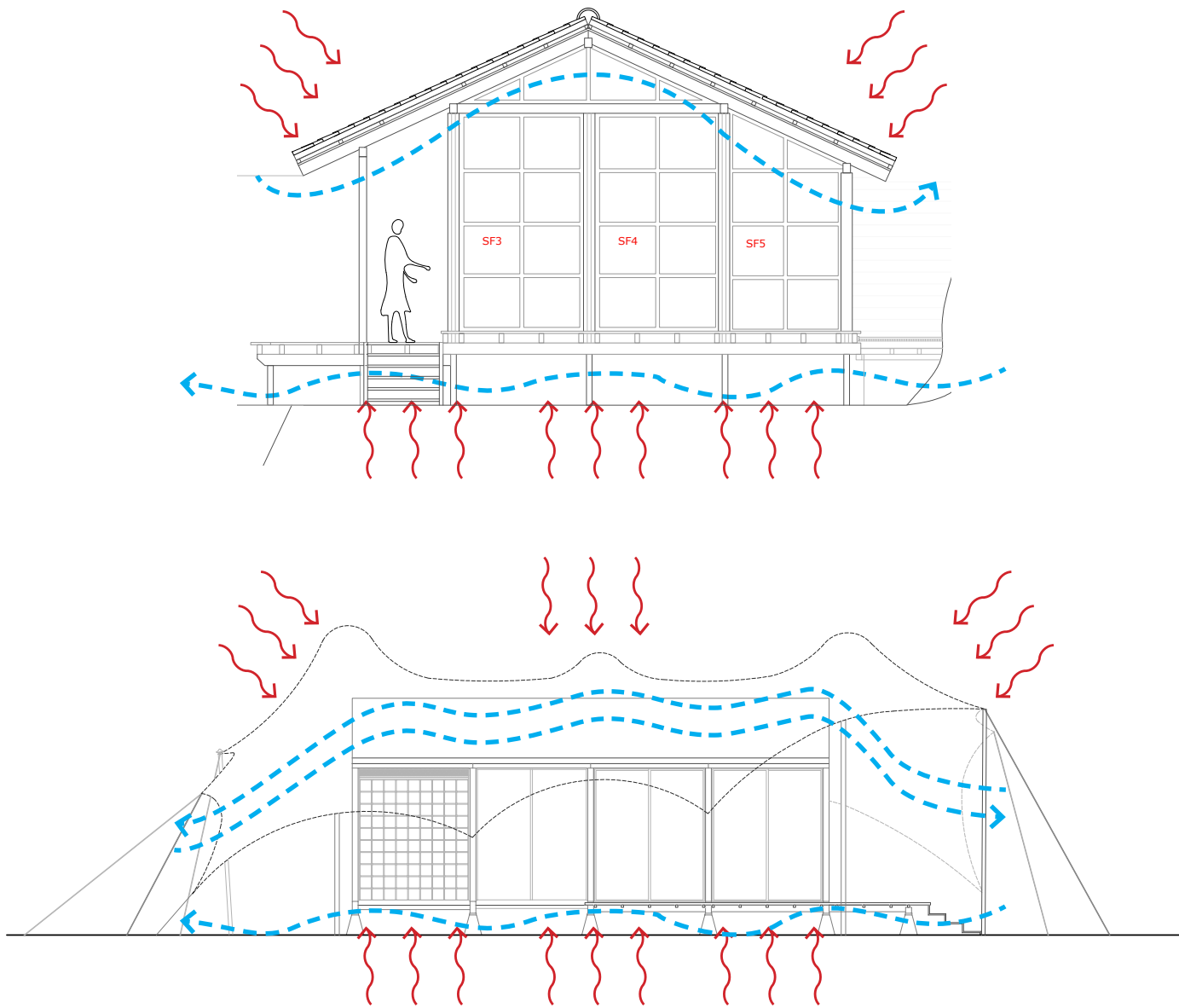


Joinery detail - Precast footing, Steel raft & Bamboo columns

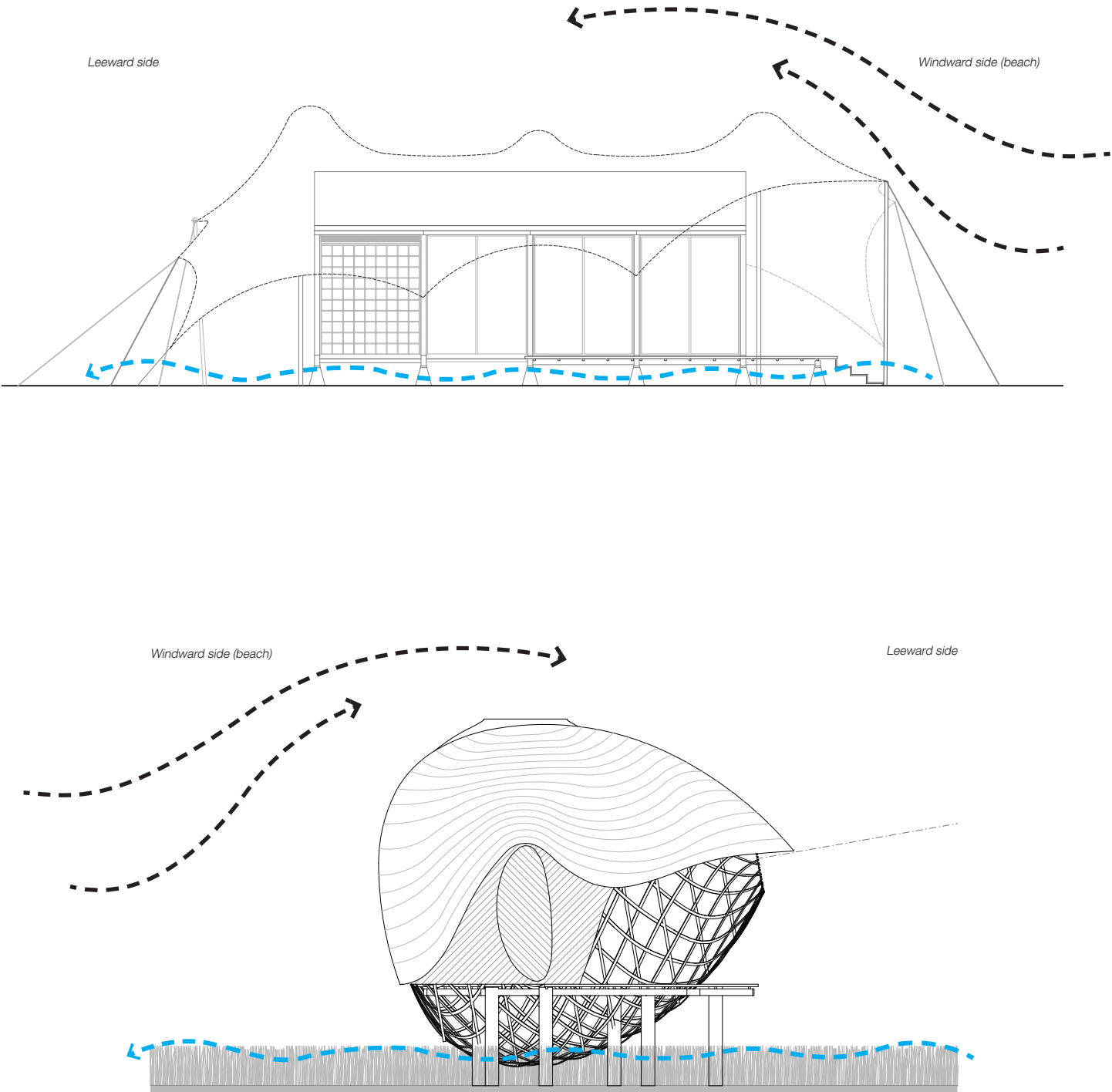
Climate responsive design

Located on the sea front of the Aghanashini estuary, the land is often prone to flooding during peak monsoons and cyclones. In order to allow free flow of water, the structures are raised on a pre-fab metal raft over one meter high from the ground, well protected from floods and ground water seepage.

Each of the designs is configured to be protected by extended roof overhangs or external weather sheds, securing the interiors from extreme monsoons and high velocity coastal winds. The air gap created between these external sheds and internal structures provide natural insulation from the heat and work as passive cooling devices during the harsh summers. This keeps the interior temperature comfortably lower than the surrounding heat.



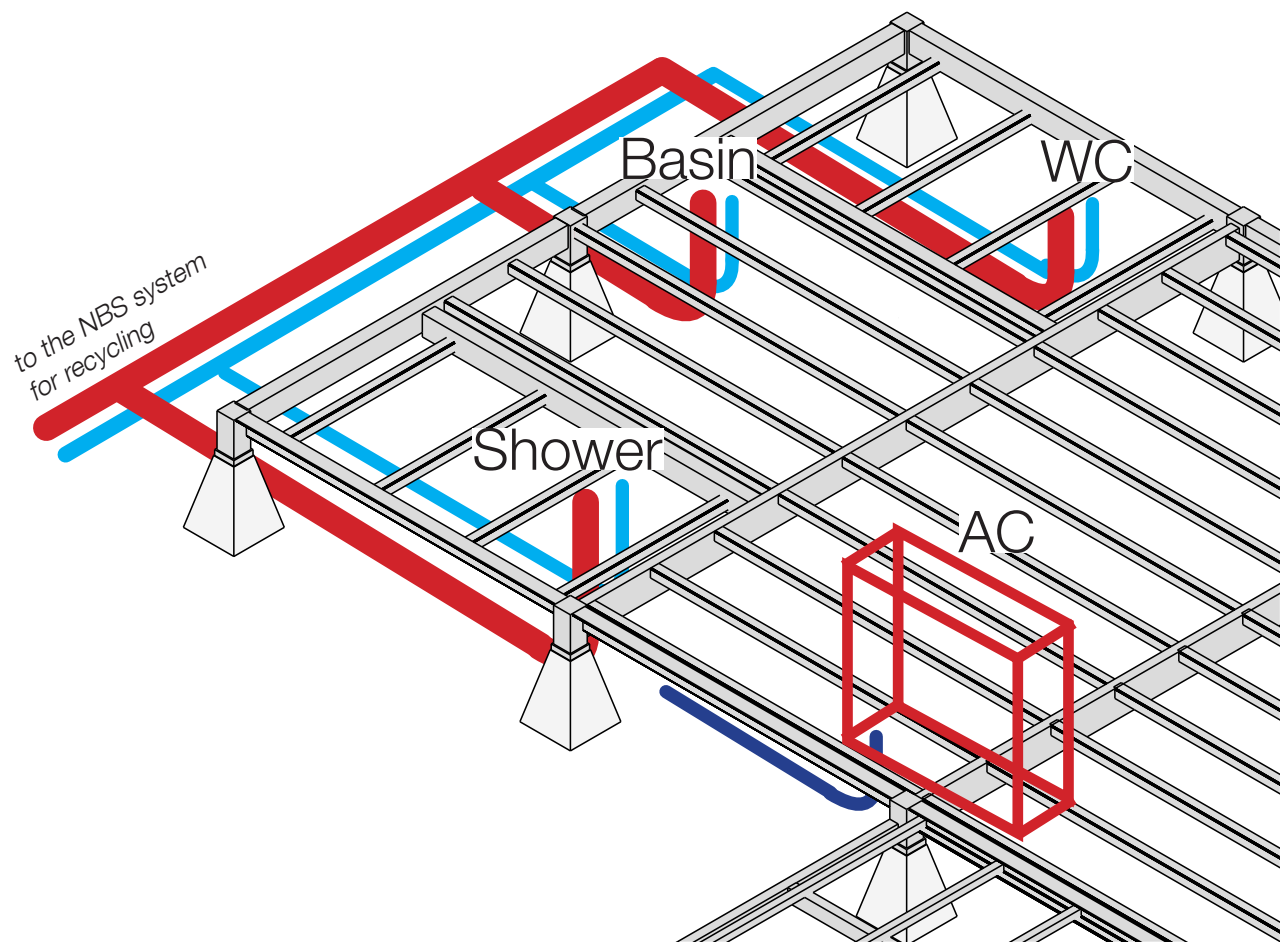
Circulation in the air gaps above and below (blue)
reduces the effects of Radiated heat (red)



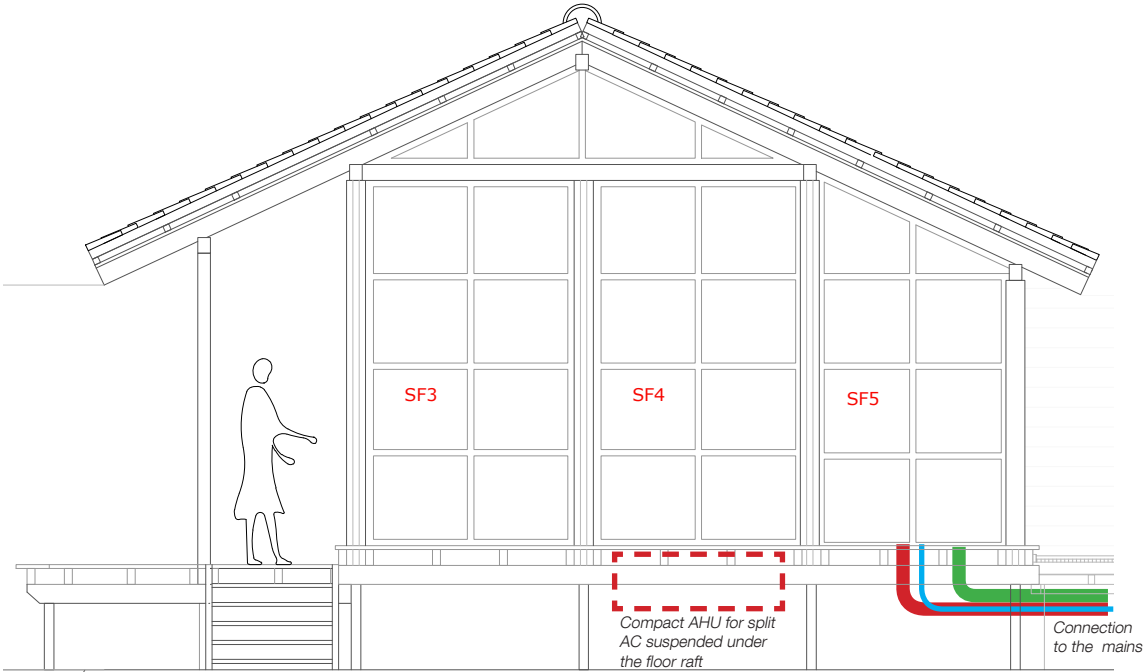
Wind movement diagram above the external layer (black)
Surface water run off from under the units (blue)

Integrated Services

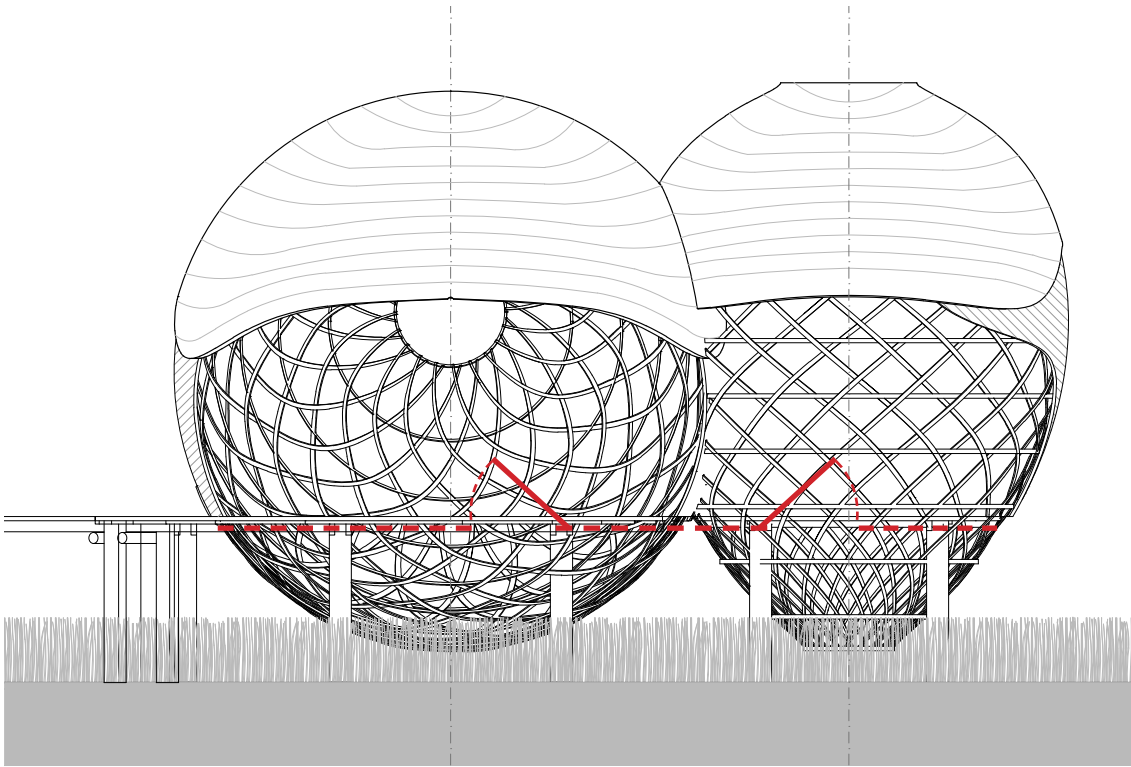
- (a) The running and maintenance of services in temporary architecture make it imperative for the systems to be designed as decentralized, independent and self sustaining plug and play units of the structure. This component-based arrangement allows these systems to be easily retractable.
- (b) Coastal climates and salty winds demand frequent maintenance and upkeep of appliances. This makes it very important for the systems to be easily accessible and within its independent loop of input and output.
- (c) The raised metal rafts allow for easy integration of the services under the structure, easily accessible and well protected from floods. To accommodate and access these conduits and service lines, the flooring must be laid as removable planks/boards mounted onto metal/timber frameworks as compared to RCC / pre-cast slabs.



example 1 : Water supply and Drainage lines suspended under the floor raft and passing through the spaces in floor joists



example 2 : Integrated Services lines suspended under the floor raft

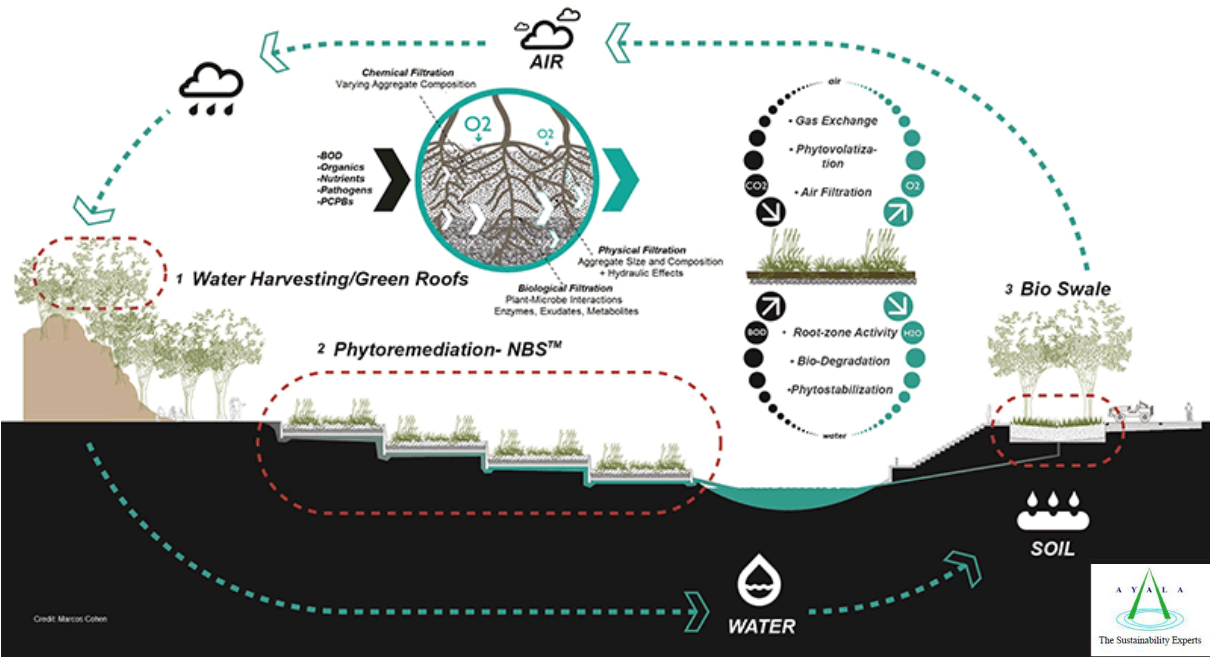


example 3 : Equipments that need regular servicing can be accessed through floor trapdoors.

Sustainable waste management systems

As forerunners in promoting ecological tourism, Panchabhuta has engaged with Israel based sustainability experts – Ayala, to create portable systems of sewage and wastewater treatment. These systems can be easily annexed to the pre-fab luxury accommodations, discreetly integrated within the surrounding landscape.

- (a) These sewage treatment systems work on the concept of phytotechnology, which provides solutions to scientific and engineering problems using plants. It is mainly focused on contaminant removal and the ability of plants to sequester certain impurities and adulterants within their root systems.
- (b) The innovation being worked on is called the Natural Biological System. It is a completely self-sustaining, eco-friendly and portable system for treatment and reuse of sewage and wastewater.
- (c) The treatment system is modular and can be scaled up based on requirements, future expansion and site conditions. It requires minimal maintenance and does not utilize any external energy or chemicals to operate.
- (d) With a compact footprint of about 1.4m in diameter, the Ayala innovated system can be concealed as an underground tank, or discreetly placed within the surrounding landscape.

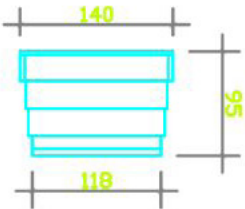


NBS™ TECHNOLOGY

- Sustainable engineered wetland technology, gravity powered, resistant to human and environmental impacts
- Effluent parameters: as desired; COD <80 mg/L; BOD <20 mg/L; minimal to zero detectable fecal coliforms. The only peer-reviewed home treatment system capable of meeting strict regulatory targets for unrestricted irrigation including elimination of pathogens. Azaizeh et al, *Water Science and Technology* (2013).
- Minimal maintenance schedule performed by the homeowner- no technicians needed
- Designed by the global leader in applied phytotechnology for sewage treatment

AYALA-ECO 1

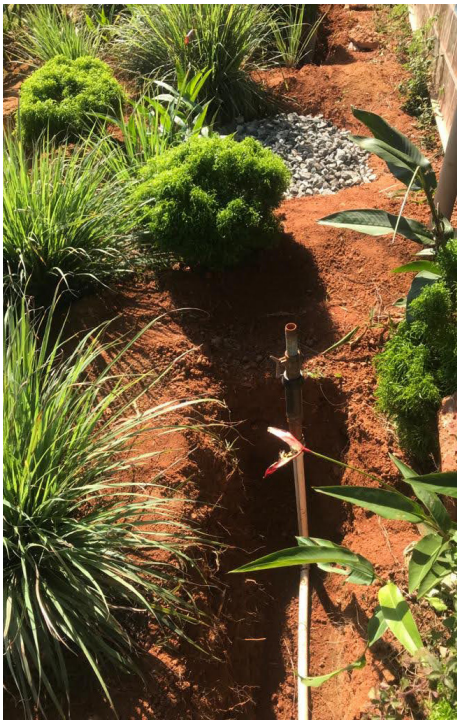
- High flexibility in installation- small footprint
- 1-2 m³ of black water/day, 1-3 m³ of grey water/day
- Onsite treatment and reuse for irrigation
- Minimal maintenance
- Modular- easily scaled up
- Application: domestic; small households
- Dimensions: Length 2.24 mt Width 1.4 mt (approx.)



1-4 Person



5-7 Person



Community inclusion and empowerment

In coastal development projects in such delicate ecosystems, pre-fab innovations and technologies provide great opportunities for local communities through skill development, employment, training, resource management, etc. Each of the structures is made using locally available materials and indigenous techniques of the region. Panchabahuta has been trying to involve the local communities in the planning and execution of these prototypes through various model building workshops, on-site permaculture seminars and training via international experts in sustainable design.



Local farmer sorting seasons harvest from Panchabhuta foodscapes



Local farmers involved in Permaculture training and landscaping



top left & bottom : Local craftsmen raising the tensile structure in collaboration with engineers from South Africa

top right : Local boatmaker and his son sharing their expertise in woodwork



Local masons involved in sustainable design and construction techniques using local materials

Pre-fab prototypes and typologies being explored

With an aim to promote regenerative coastal tourism, the foundation engaged with ‘temporary architecture’ experts – Nomadic Resorts and Amsterdam based Studio Oana Tudose to explore and develop coastal pre-fab luxurious accommodations that can be easily assembled and dismantled, and can be used throughout the year. With a strong ecosystem of experts and designers, the foundation has made great progress in innovating and experimenting with various typologies and materials.

- 1. Tented Suite (Bamboo)
- 2. Tented Suite (Timber)
- 3. Wooden Cabins
- 4. Bamboo Rice Pods



1. Tented Suite – Bamboo

With the expertise of Nomadic resorts in temporary and tropical architecture, combined with locally available skill, knowledge and materials, the design was conceptualized as a bamboo framed structure with three major parts; an inner tent, outdoor decking and an outer tent, all measuring to about 800 sq.ft. The footprint can be extended to approximately 3000 sq.ft. with specially curated landscapes; including sustainable methods of waste treatment, solar energy and rainwater harvesting.



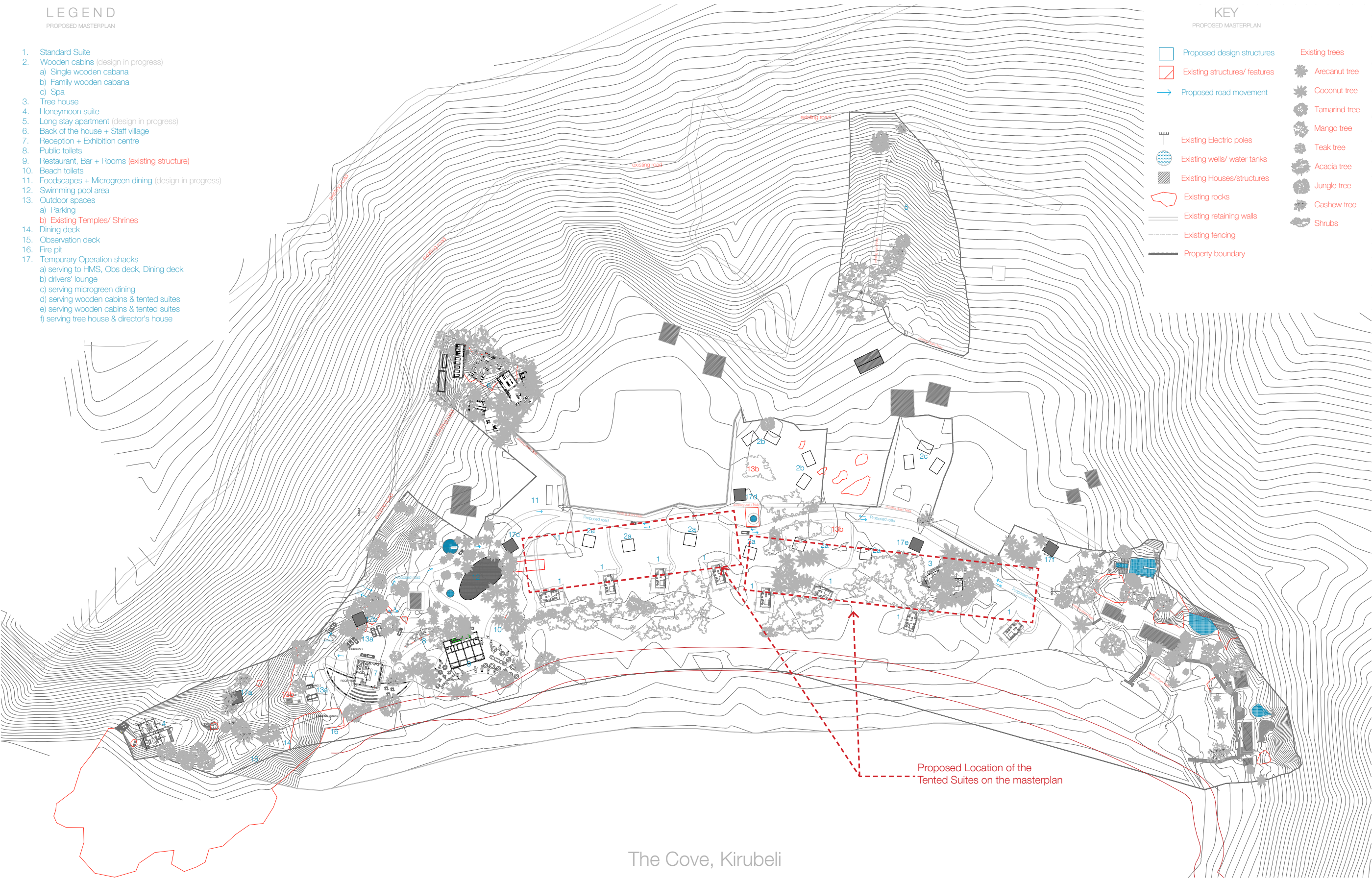
The Kirubeli Cove, Kirubeli
PROPOSED MASTER PLAN

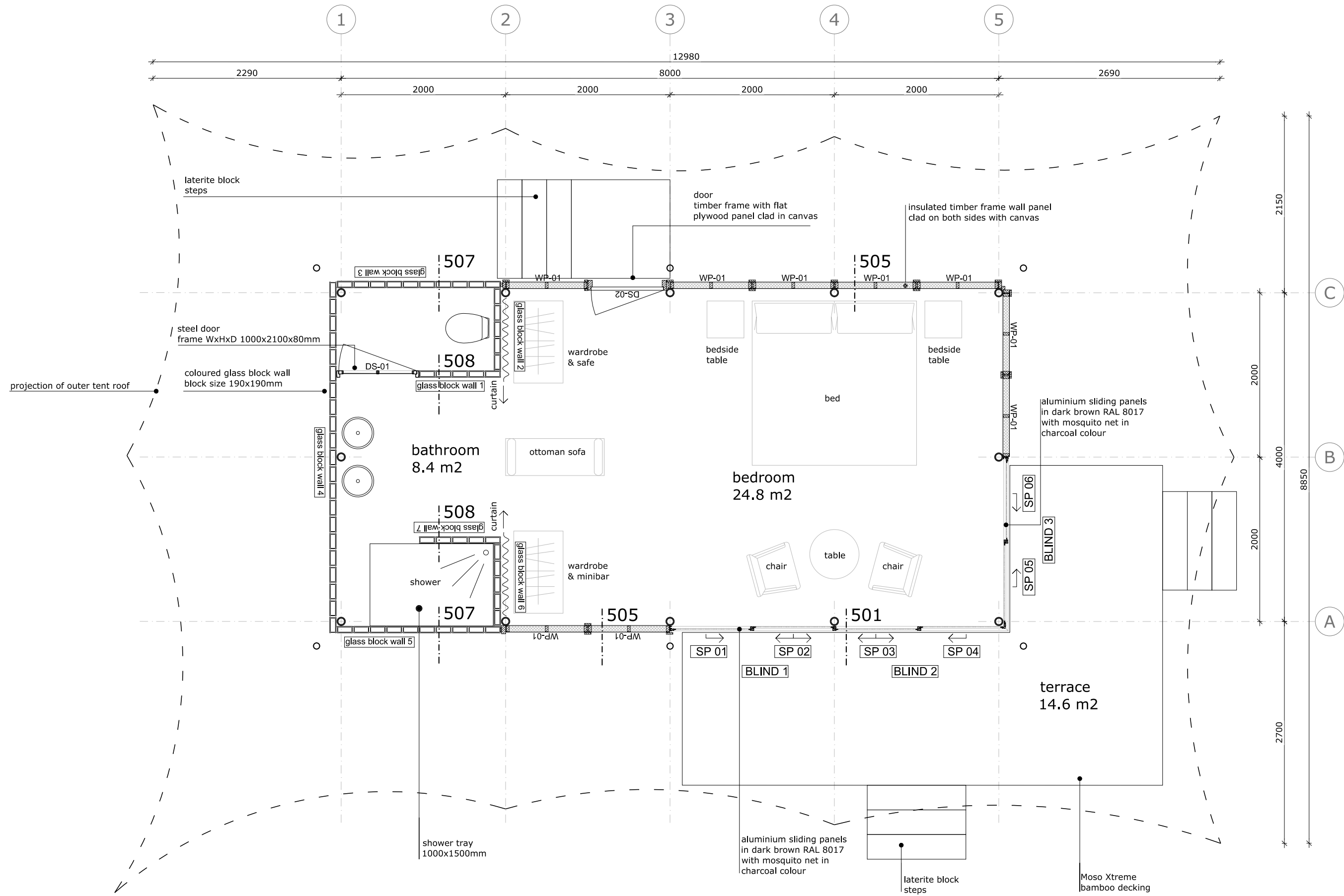
LEGEND
PROPOSED MASTERPLAN

- 1. Standard Suite
- 2. Wooden cabins (design in progress)
 - a) Single wooden cabana
 - b) Family wooden cabana
 - c) Spa
- 3. Tree house
- 4. Honeymoon suite
- 5. Long stay apartment (design in progress)
- 6. Back of the house + Staff village
- 7. Reception + Exhibition centre
- 8. Public toilets
- 9. Restaurant, Bar + Rooms (existing structure)
- 10. Beach toilets
- 11. Foodscapes + Microgreen dining (design in progress)
- 12. Swimming pool area
- 13. Outdoor spaces
 - a) Parking
 - b) Existing Temples/ Shrines
- 14. Dining deck
- 15. Observation deck
- 16. Fire pit
- 17. Temporary Operation shacks
 - a) serving to HMS, Obs deck, Dining deck
 - b) drivers' lounge
 - c) serving microgreen dining
 - d) serving wooden cabins & tented suites
 - e) serving wooden cabins & tented suites
 - f) serving tree house & director's house

KEY
PROPOSED MASTERPLAN

- Proposed design structures
- Existing structures/ features
- Proposed road movement
- Existing Electric poles
- Existing wells/ water tanks
- Existing Houses/structures
- Existing rocks
- Existing retaining walls
- Existing fencing
- Property boundary
- Existing trees
 - Arecanut tree
 - Coconut tree
 - Tamarind tree
 - Mango tree
 - Teak tree
 - Acacia tree
 - Jungle tree
 - Cashew tree
 - Shrubs

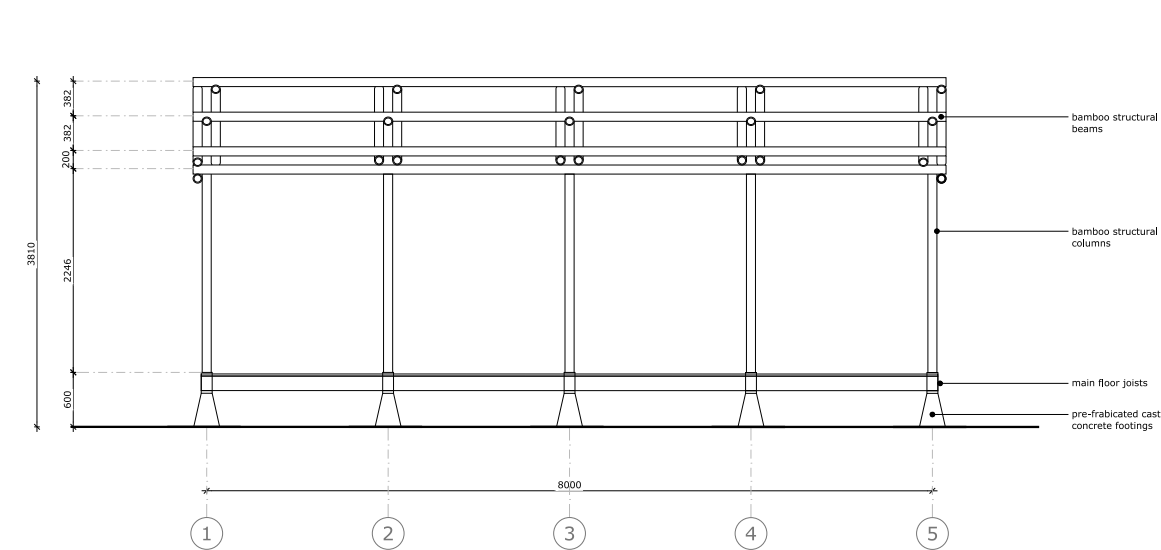




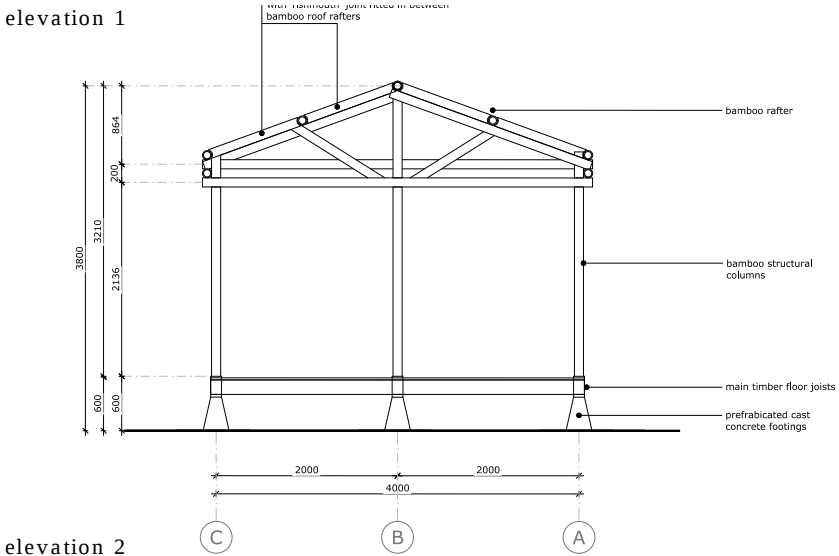
PLAN : Bamboo frame structure

Inner tent : With the help of Bangalore based designers – Bamboopecker, the inner tent has been designed as a modular bamboo-framed structure, with each of the components sized, treated and finished off site and then assembled together on site. The design is raised on a pre-fab metal raft over one meter high, well protected from flooding waters during monsoons and cyclones. The metal raft is anchored into the ground with pre-cast concrete pedestals, placed on a compacted laterite bed.

The bamboo frames are empaneled with rip-stock fabric mounted on timber frames and lined with rock wool insulation, protecting the interiors from the harsh summers. The ceiling is covered using the same rip-stock fabric, stretched tightly above the bamboo trusses with insulated panels of canvas lined on the interior. Thermally treated bamboo strips are compressed into boards and used for the flooring, extending onto a deck facing the beach. Secure, large spanned Aluminum sliding doors allow for quick 'open and close' options, with expansive views of the ocean and the surroundings. All the mechanical, electrical and plumbing services are deigned as plug and play components, strategically concealed using customized aluminum angles mounted under the raised steel raft - free of flooding and rodents.

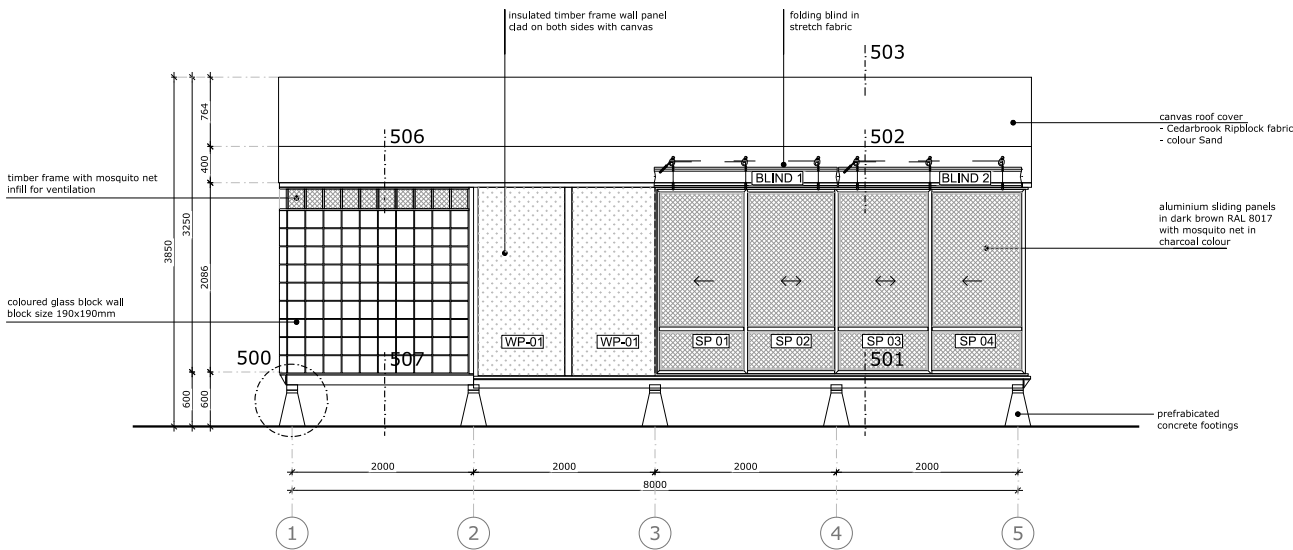


elevation 1

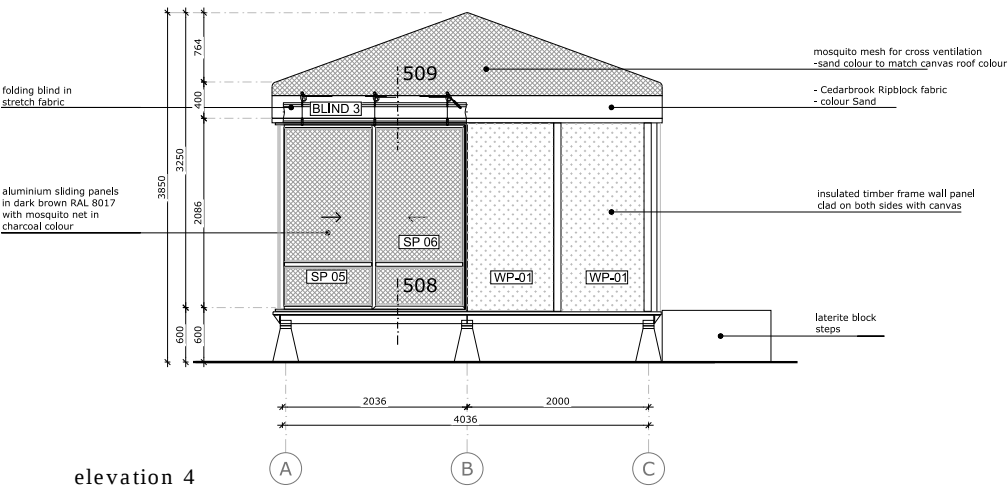


elevation 2

Bamboo frame structure



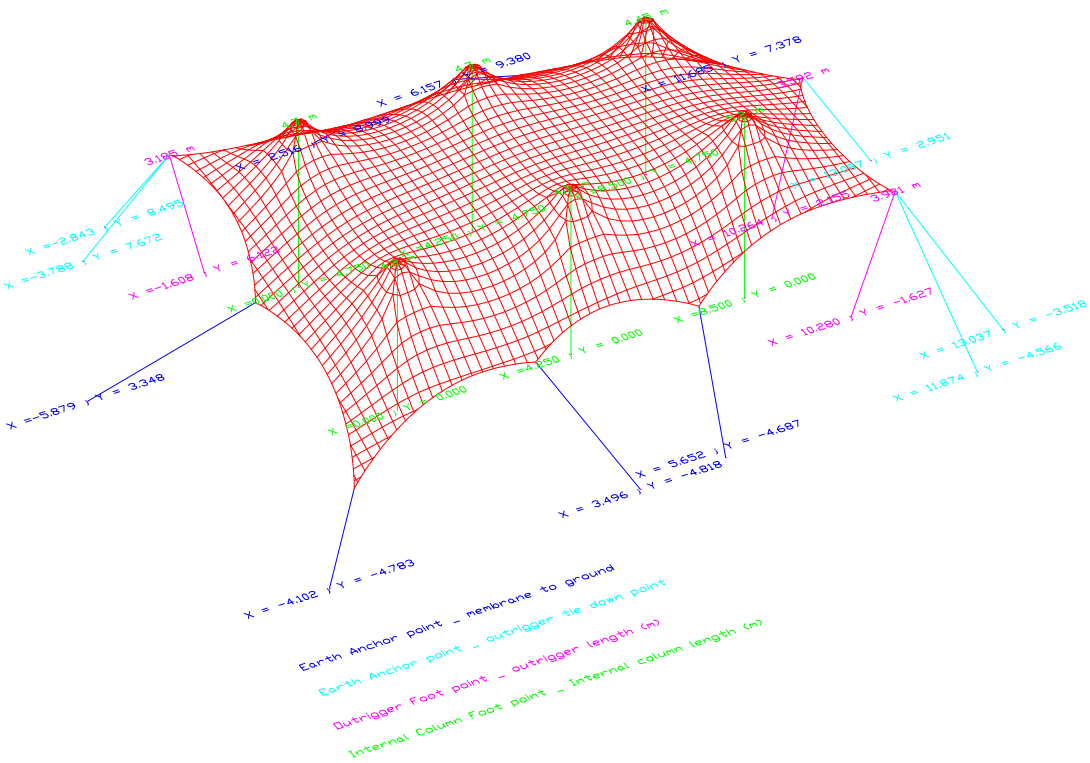
elevation 1



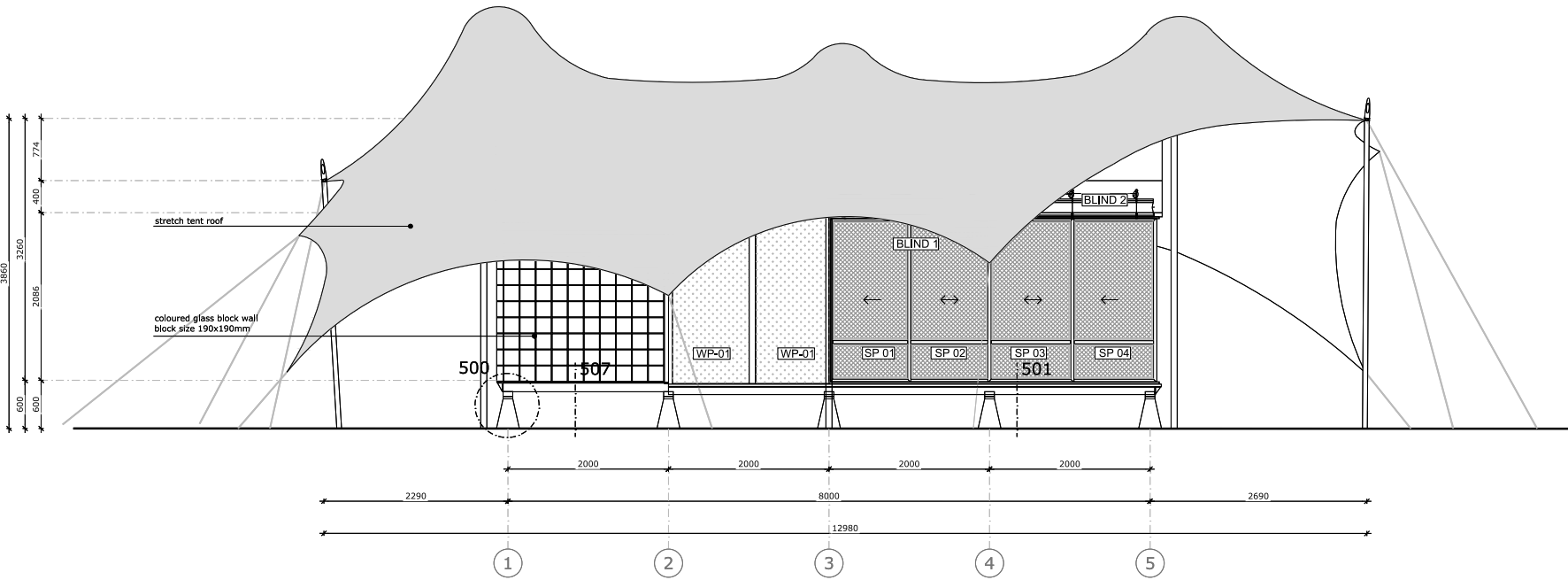
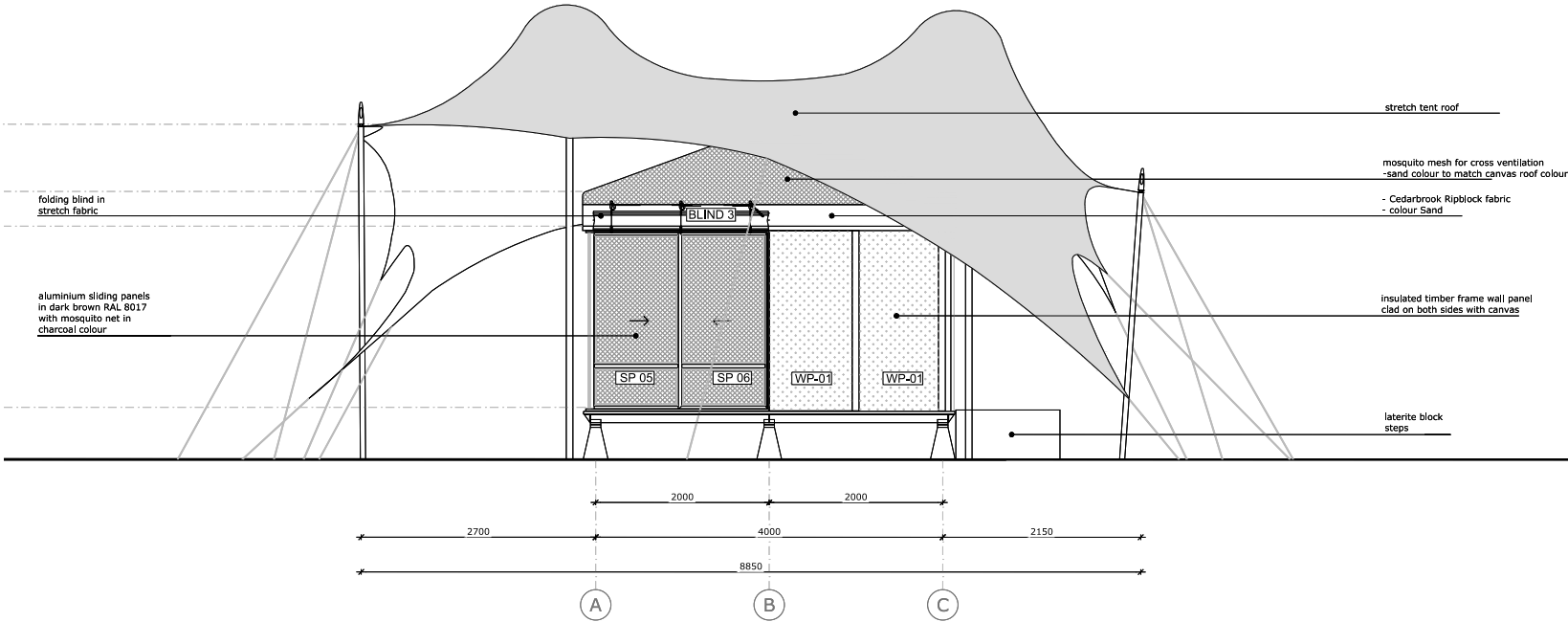
elevation 4

Bamboo frame structure
with Ripblock fabric panels

Outer tent : The outer tent is an external layer acting as a weather-shed, hovering above the bamboo structure. It is a waterproof canvas made of Elastomeric PVC coated Polyester. As the outermost layer protecting the inner tent from high velocity coastal winds and rain, the membrane is separately anchored to the ground, specific to the position of the structure, direction of winds and points of high impact due to climatic conditions.



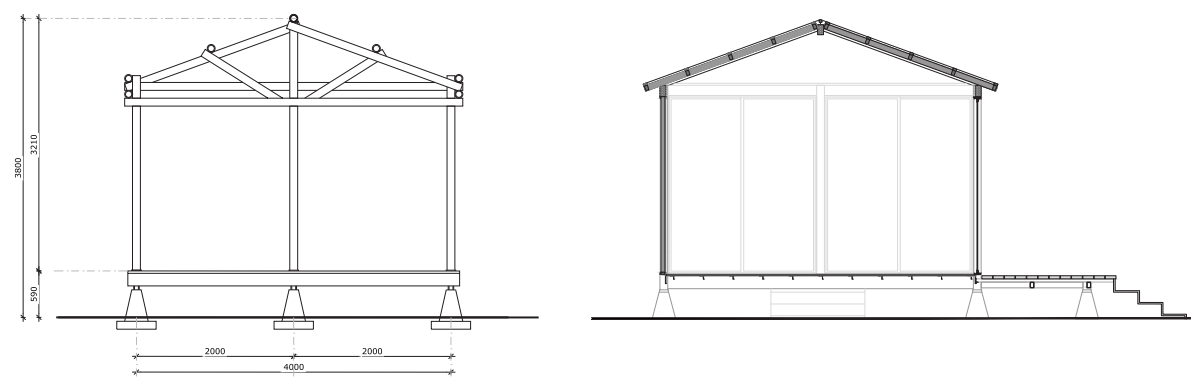
Anchor and columns positioning and design based on wind loads



2. Tented Suite – Timber

The bamboo tent innovation has been tested against two harsh monsoons and recent cyclones such as Nisarga and Tauktae; and the design remains firmly anchored and braced, with the flexibility to dismantle and re-assemble with ease.

Based on the learning and experience gained from the bamboo prototype, and the abundance of skill and knowledge for timber within the region, Panchabhuta has engaged Mumbai based architecture and design studio OTLA to fine-tune and develop the luxury tent prototype with timber frames.

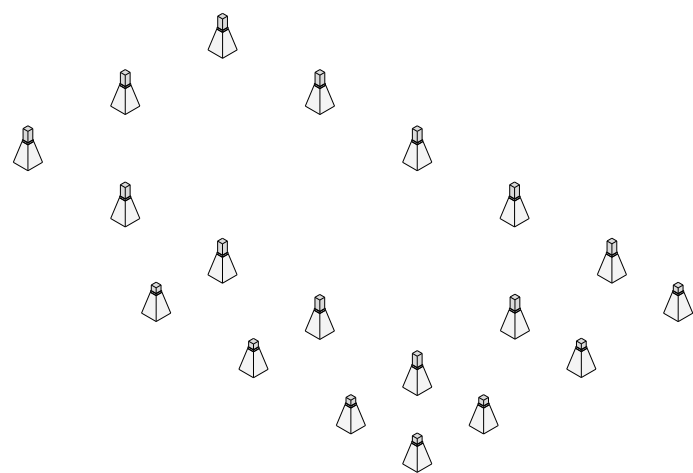


top left : Tent with Bamboo frame structure
top : Tent with Timber frame structure

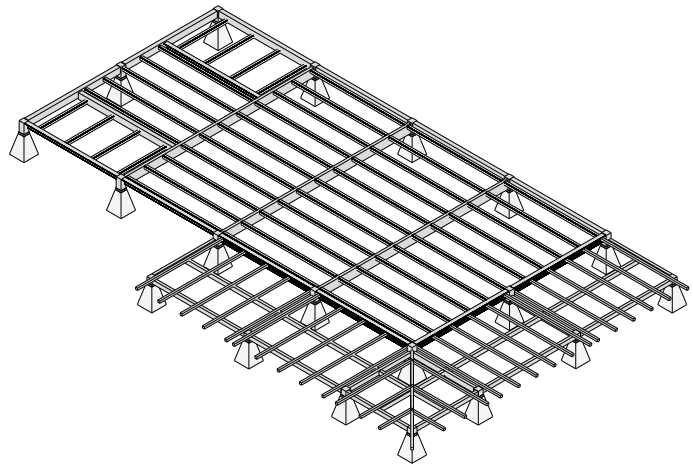


top : Timber Tent with hardwood infill + bamboo shingles roofing
bottom : Timber Tent with bison board infill + bamboo shingles roofing

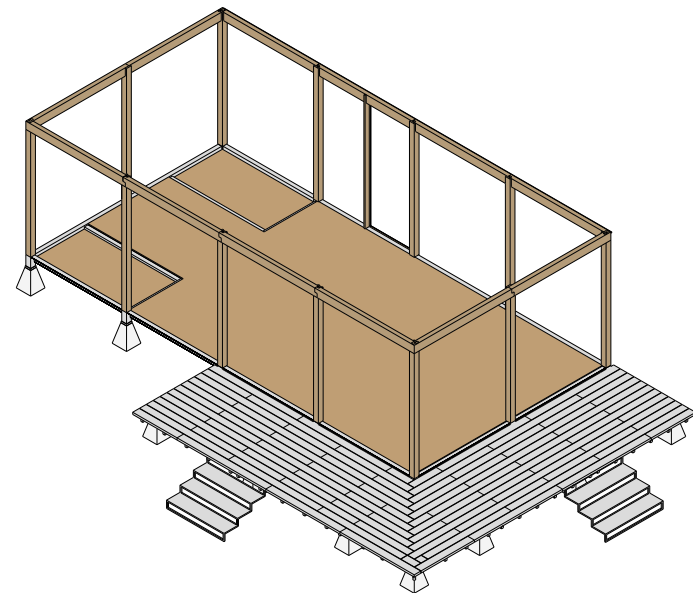
Construction stages : Timber structure with Ripblock fabric panel infills



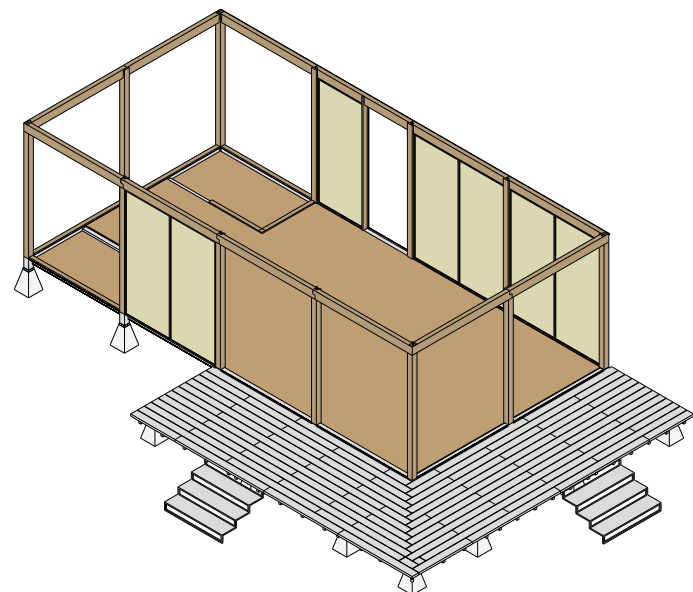
Precast RCC footings



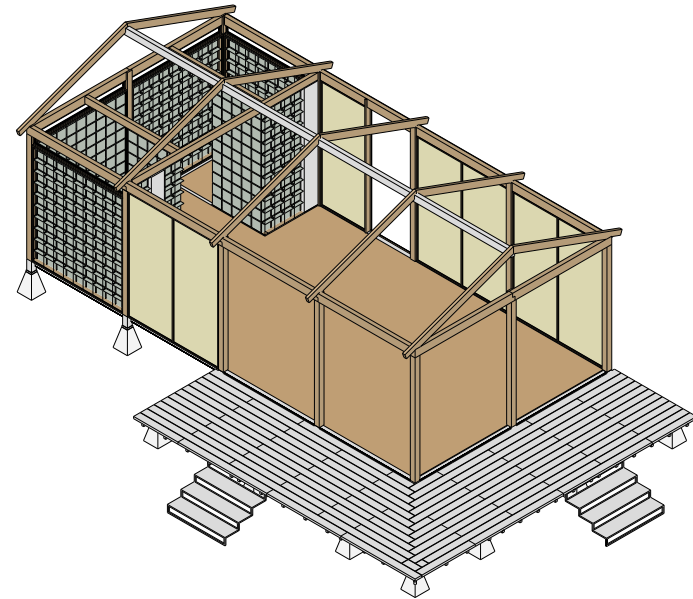
Steel Raft/ floor substructure



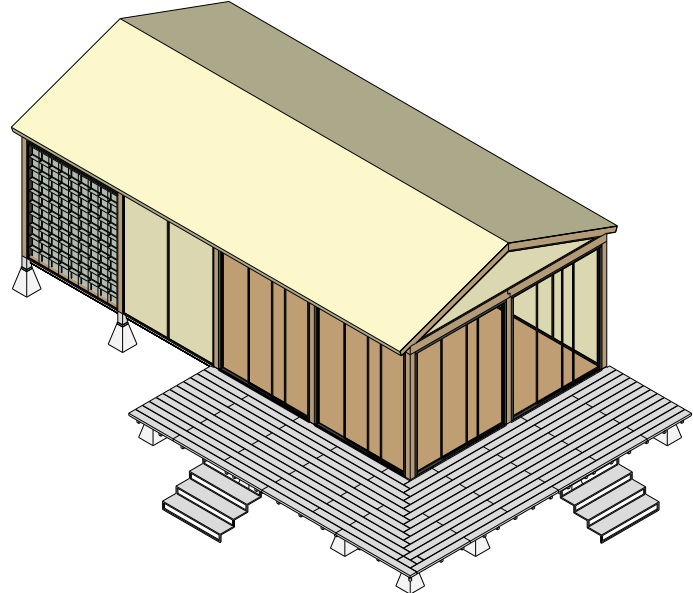
Timber columns-beams and hardwood flooring



Ripblock fabric insulated wall panels



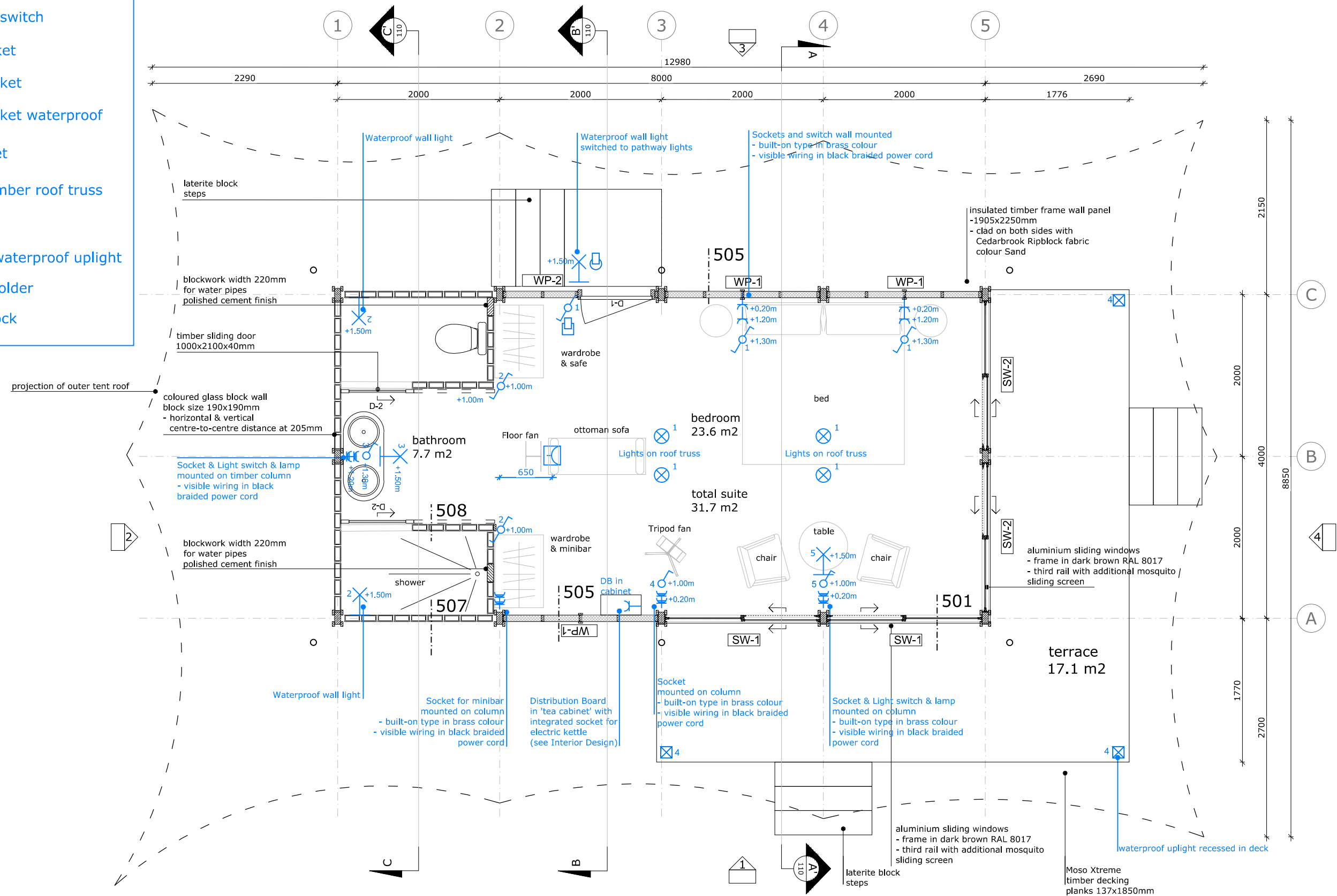
Timber roof truss



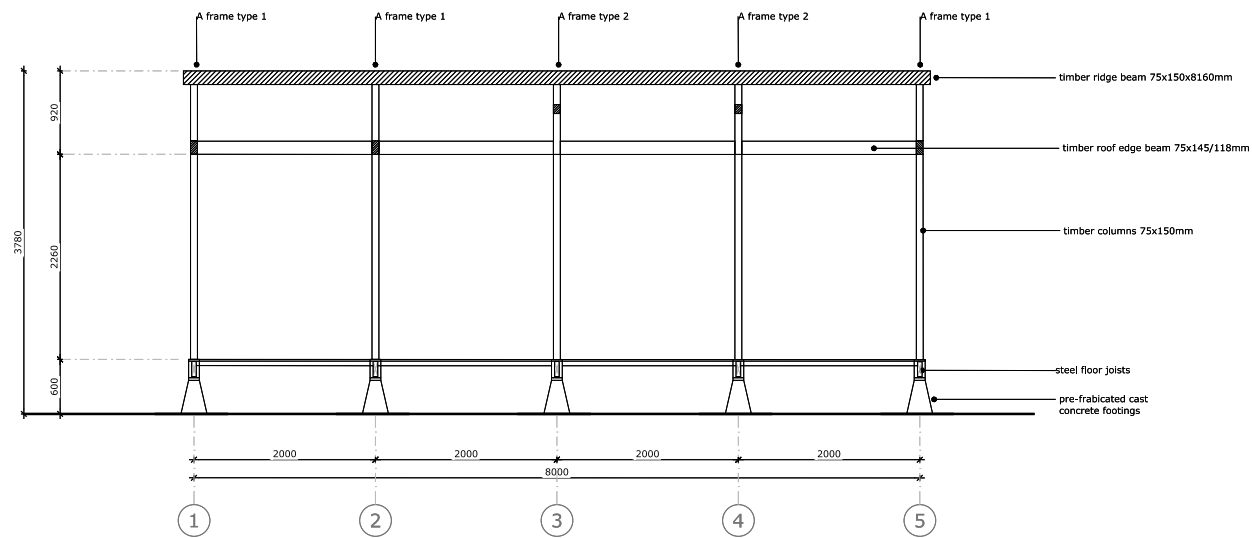
Ripblock fabric roofing and sliding shutter

LEGEND

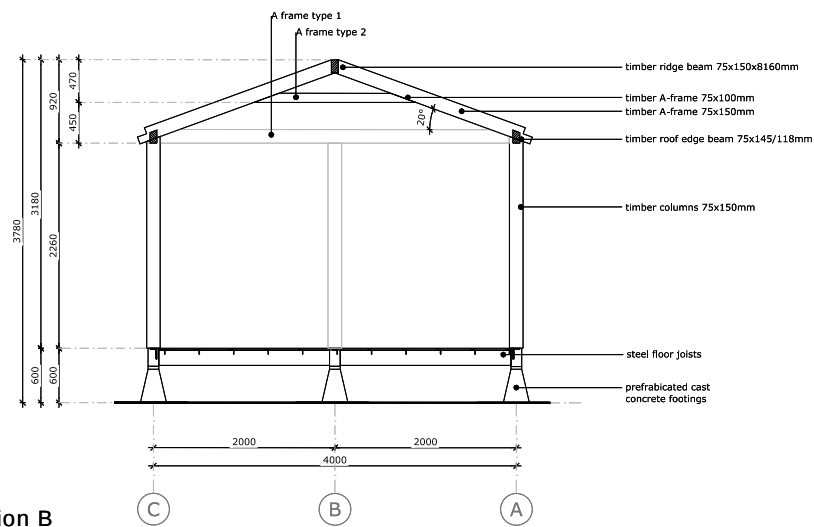
-  Light switch
-  Hotel light switch
-  Single socket
-  Double socket
-  Double socket waterproof
-  Floor socket
-  Light on timber roof truss
-  Wall light
-  Recessed waterproof uplight
-  Key card holder
-  Key card lock



PLAN : Timber frame structure

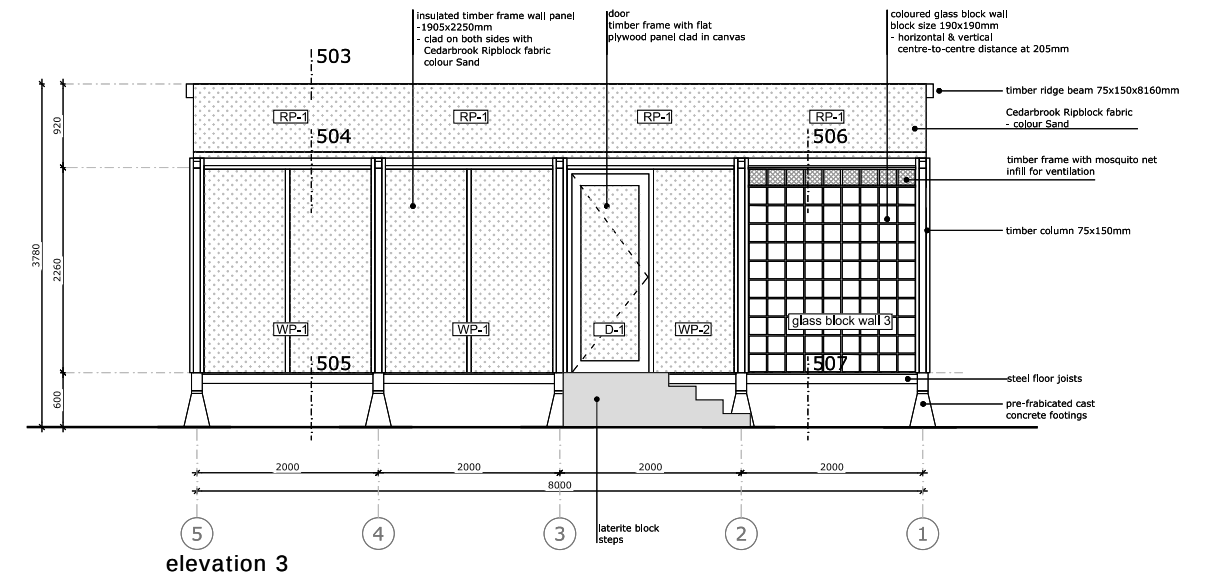


section A

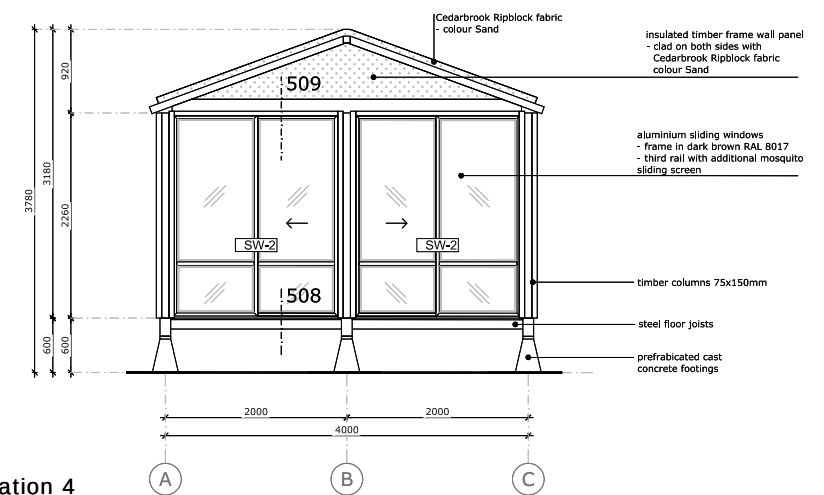


section B

Timber frame structure

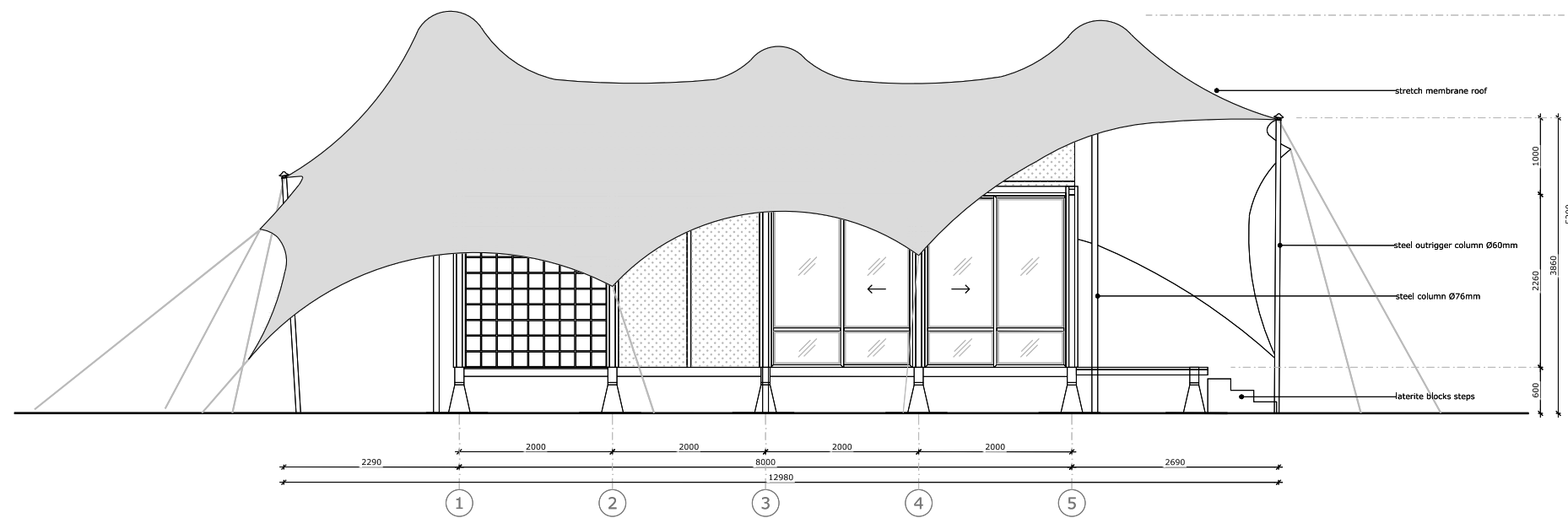
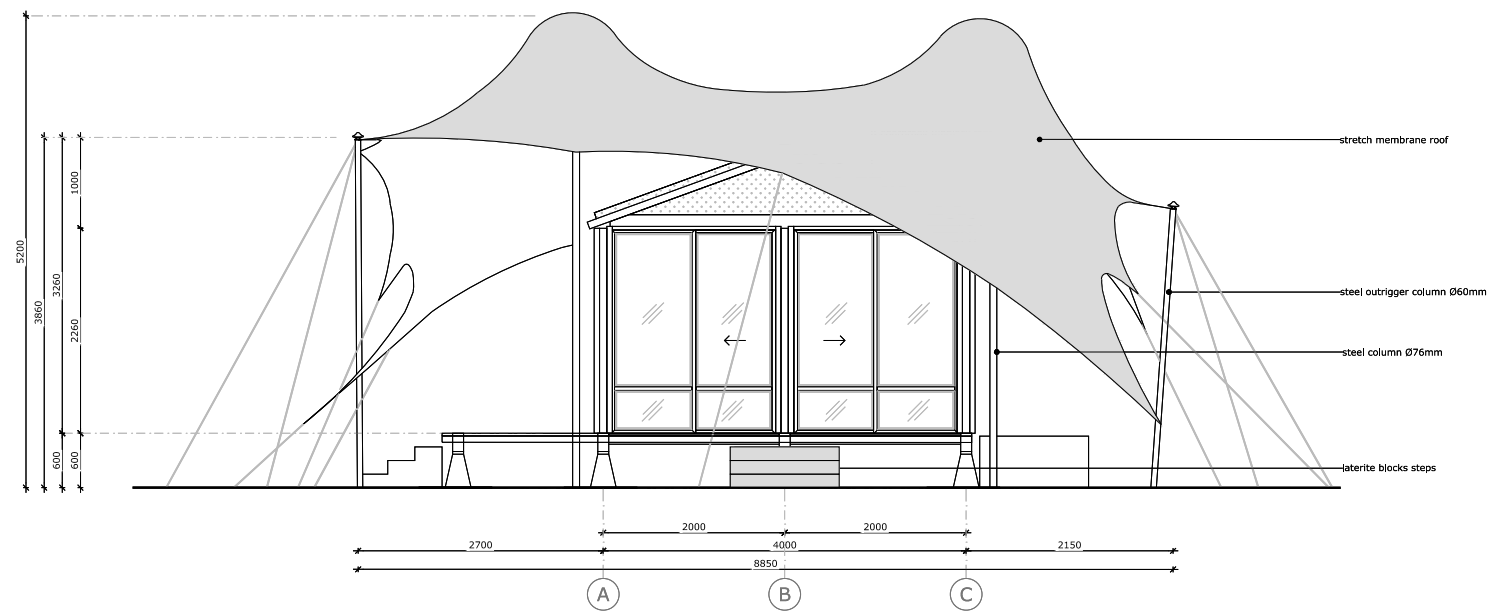


elevation 3



elevation 4

Timber frame structure
with Ripblock fabric panels



Timber frame structure
with Outer tent

3. **Wooden Cabin**

The Wooden Cabin is a luxurious Pre-fabricated bedroom design that accommodates a kitchenette, wardrobe, washroom and an outdoor shower area. The structure is mounted onto a wooden raft that is raised above ground using thin mild steel box sections anchored into the ground. The carpentry of the structure and fenestrations are done in local seasoned hardwood (Jalli and Kalam Bogi) with all the joineries relying on self weight and bolting systems. All the carpentry detailing is completed off-site and then transported and assembled on site.



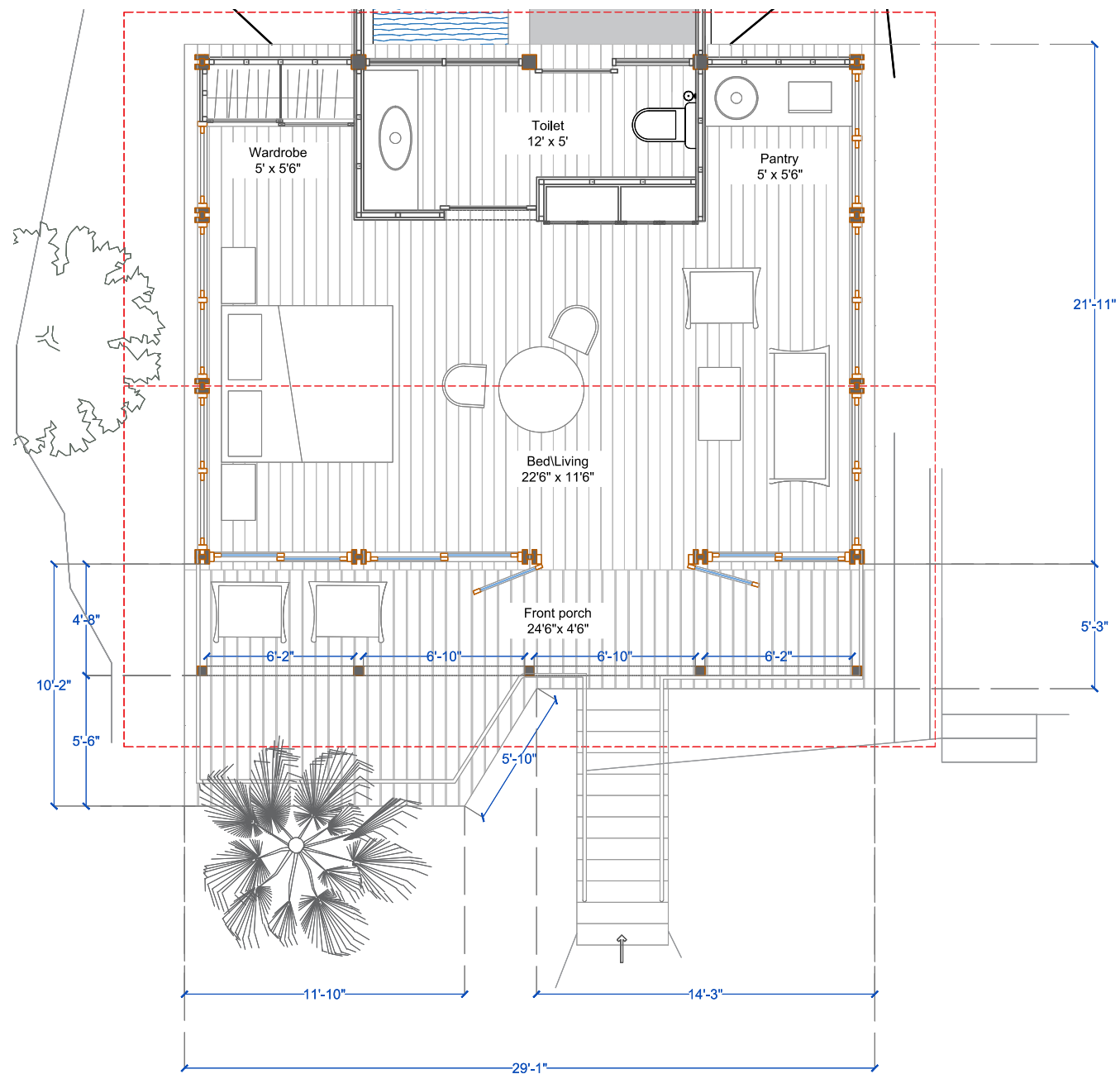
3D views of Wooden cabin design



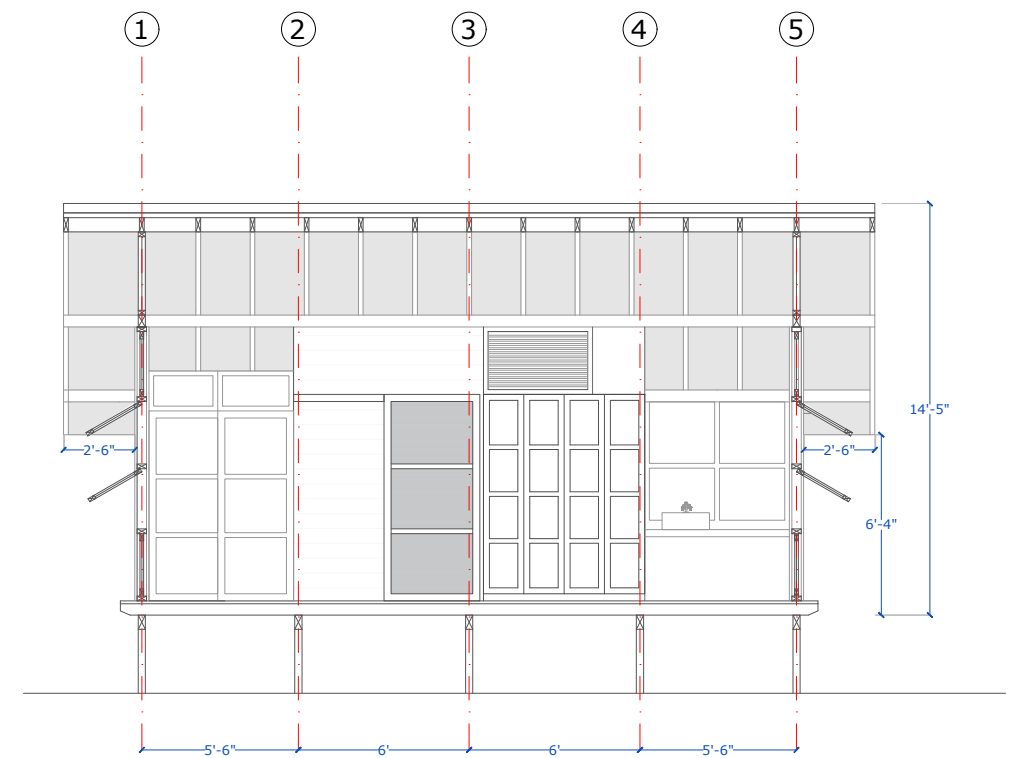
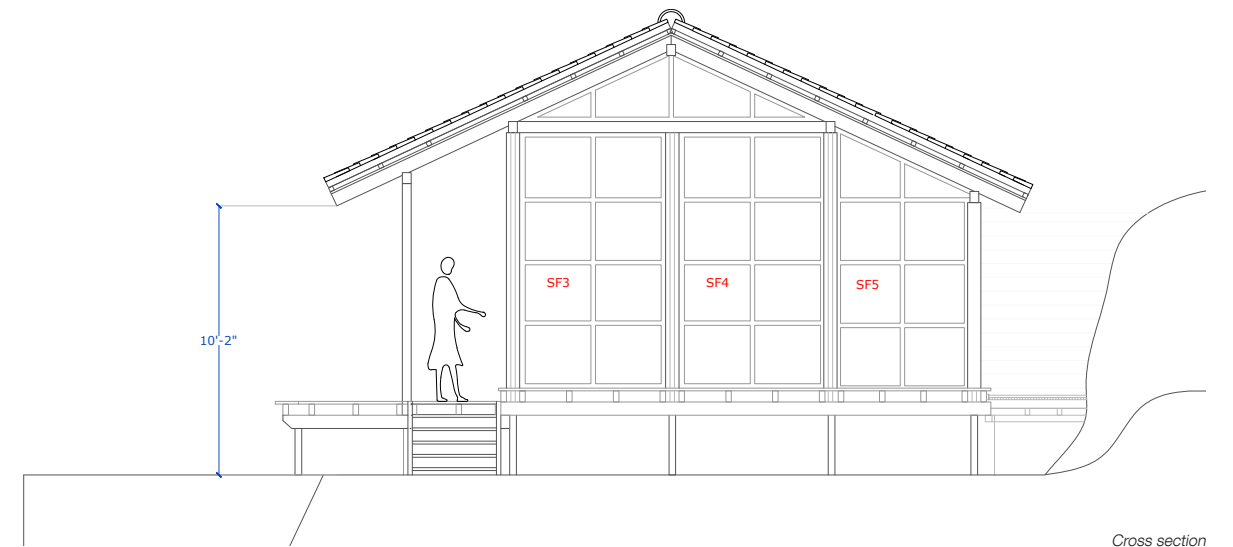
top : Local boatmaker wood working with his indegenous tools and techniques
bottom : Wooden cabin protoype raised on Mild steel legs



Rainwater harvesting system
for watering landscape



PLAN : Wooden Cabin



4. Bamboo Rice Pods

The Rice pod design is a lightweight bamboo skeleton designed and raised on Palmyra wood logs and covered with wire mesh and Bamboo shingles. The main bamboo skeleton has been divided into 3 segments that can be woven offsite and easily transported, assembled in-situ and mounted onto the wooden footings. The joineries and weave of Bamboo and timber have been developed in collaboration with local artisans thus making it a quick and inclusive process.

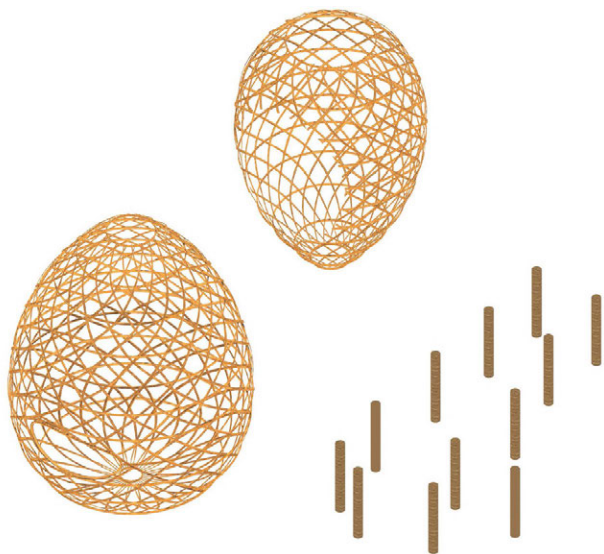


Nirvana Beach, Kagal

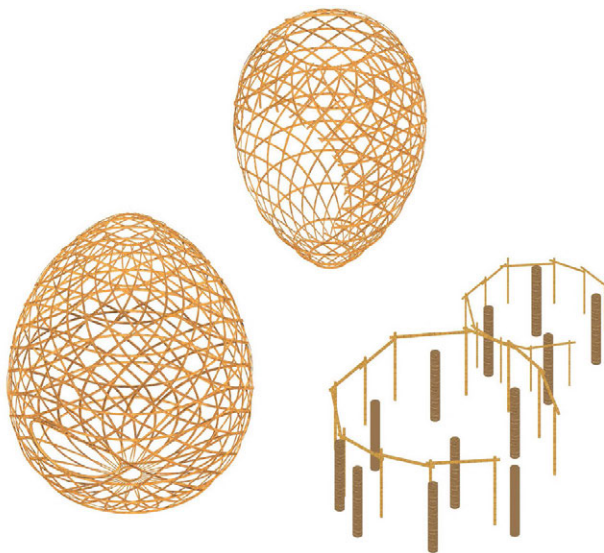


Conceptual visualisations

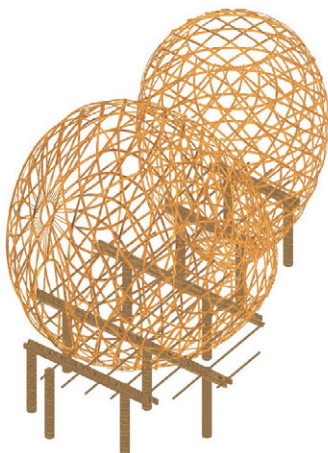
Construction stages : Bamboo rice pods



Palmyra wood footings
Split bamboo for pod structure



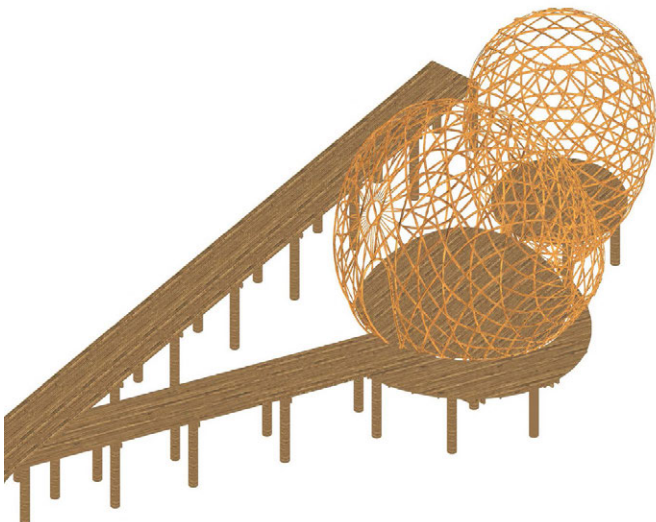
Temporary bamboo scaffolding
to hold pods in position



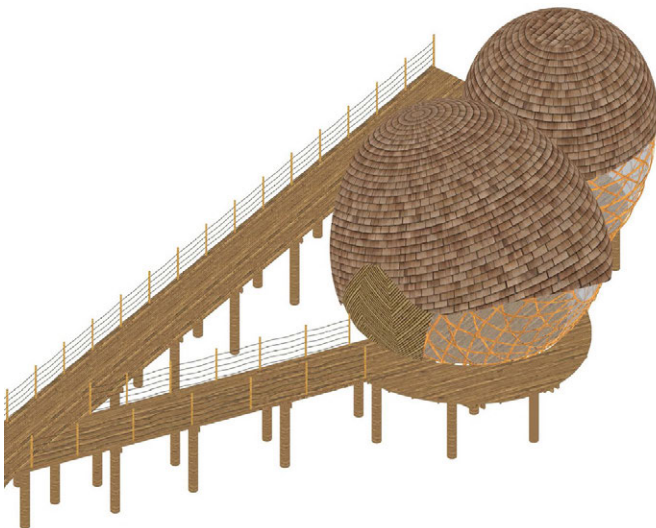
Floor beams and joists laid
after structures are positioned



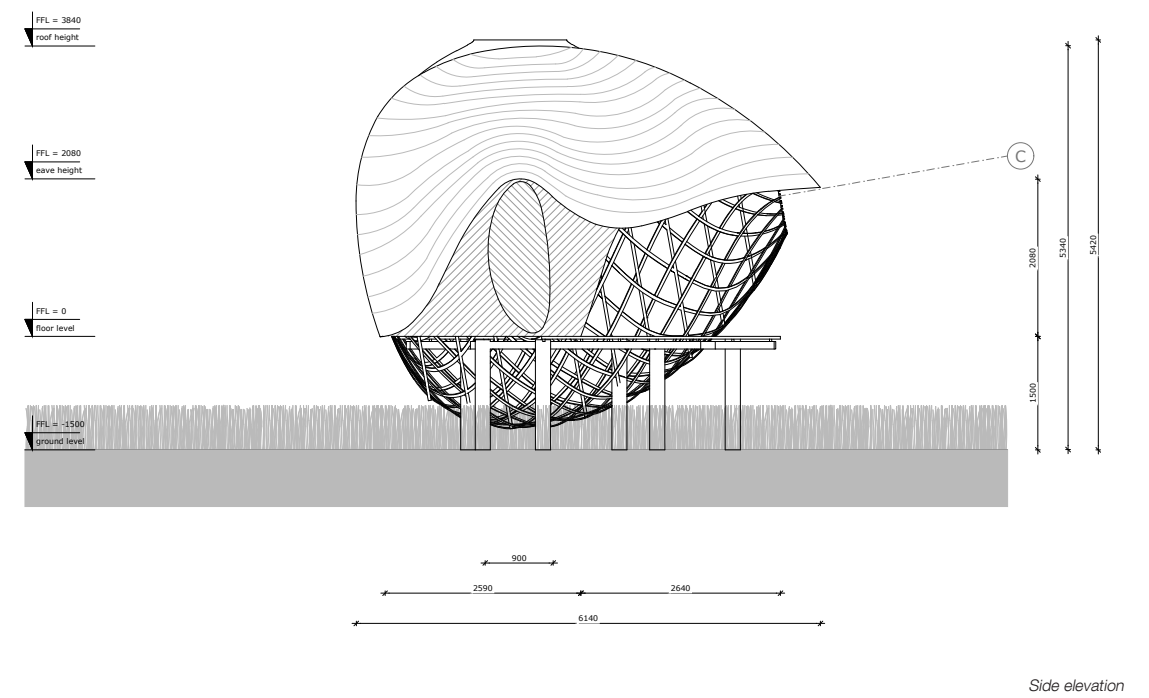
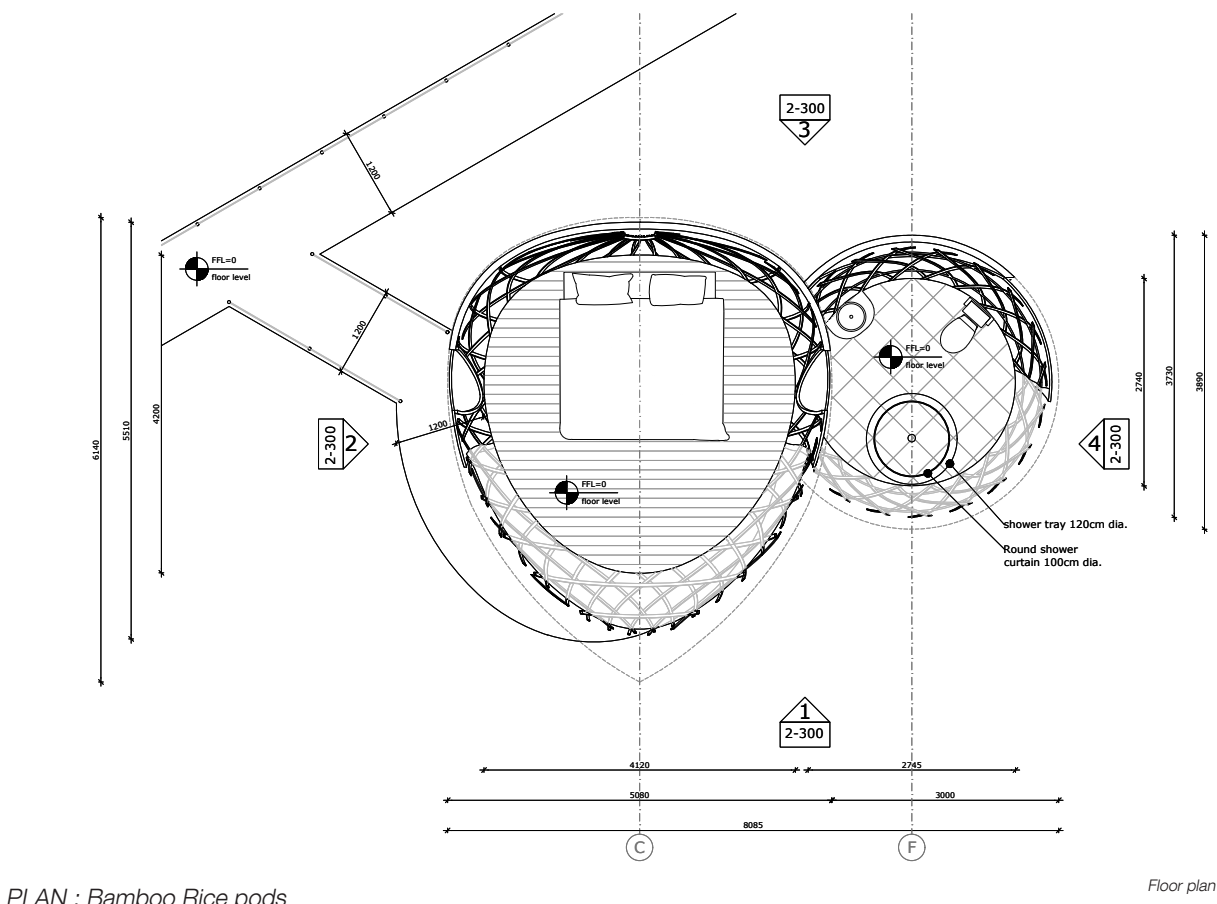
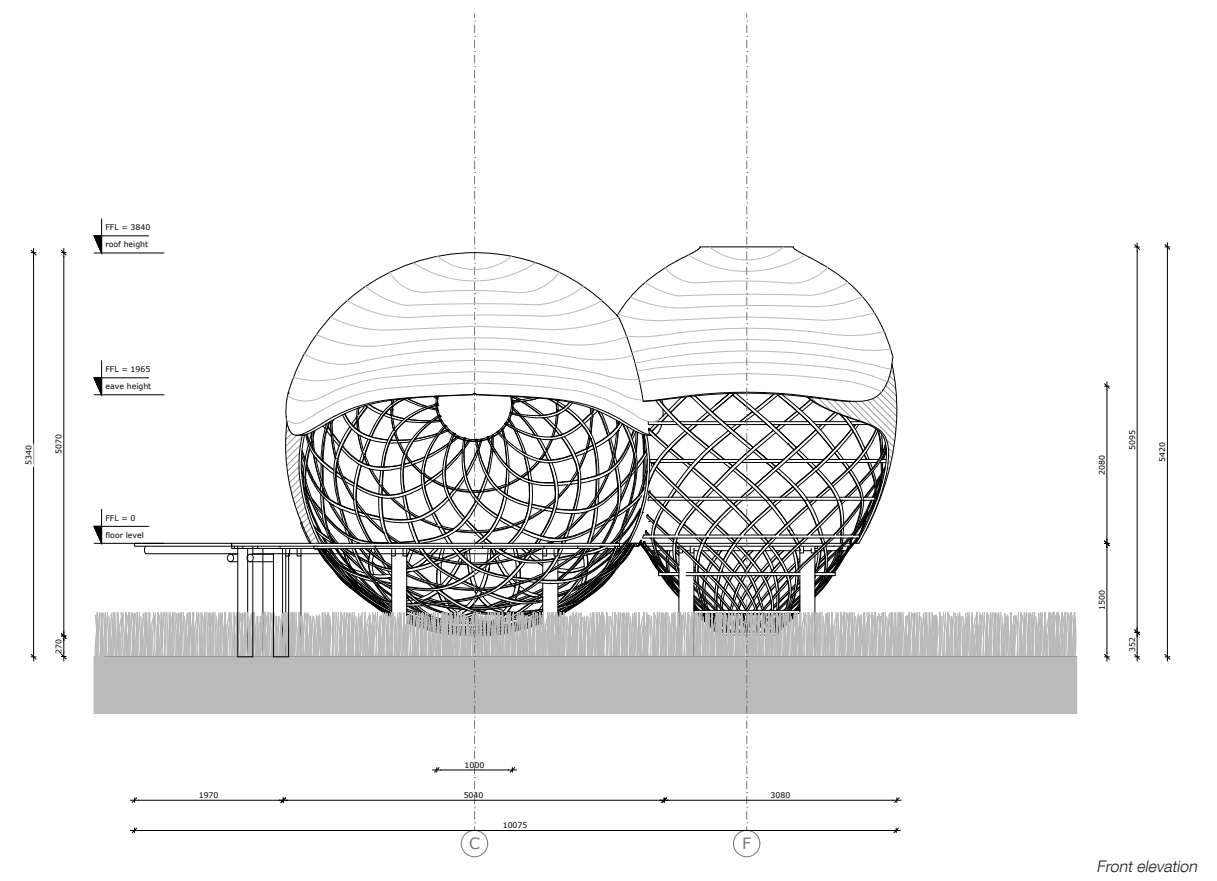
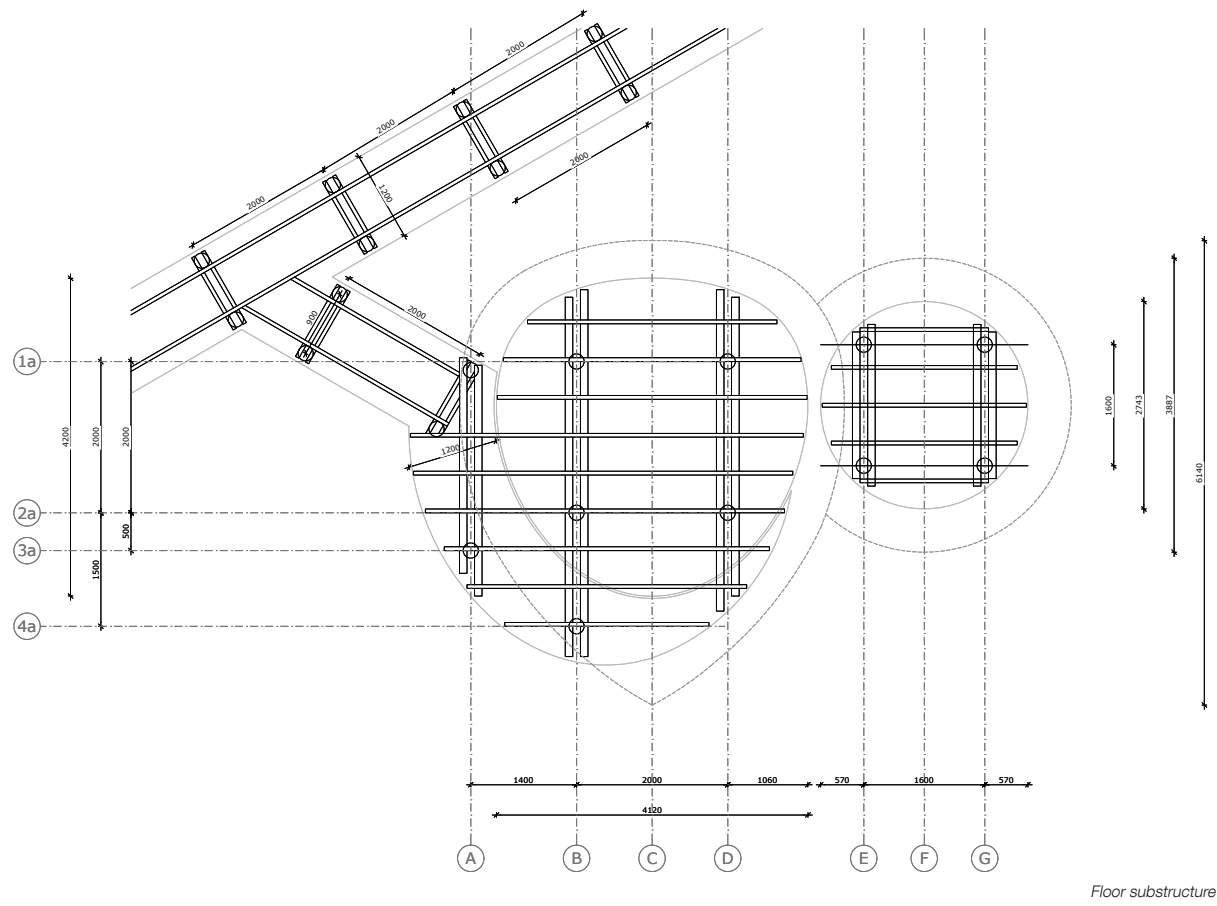
Hardwood floor boards laid
over joists



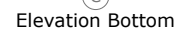
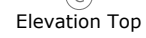
Broadwalk structure and
boards are connected



Wire mesh in the bamboo skeleton and
bamboo shingles roofing layer



PLAN : Bamboo Rice pods



Bamboo skeleton weave details

