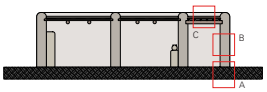
Simplicity and low-tech – one knot for all situations

An easy understandable low-tech construction system, which can be copied and further developed by the local artisans, was the precondition to build the school Tipu Sultan Merkez feasible and sustainable. Thus, a simple bamboo knot with a steel dowel and a string bond was taken as the main construction principal for the bamboo construction system of the porch and the top floor. All basic construction elements like posts, beams and ceiling are based on this or are a slightly modified joint. This requires just a small amount of tools like hammer, knife, drill machine and some kind of lashing straps. Most building parts like beams and posts can be preproduced on site in a little workshop. Assembled to wall elements flat on the ground they can be erected, fixed and finally filled with earth. To ensure a long life span of the building it was obligatory to treat the locally grown bamboo. This was done with a salt solution out of Borax/Boric Acid, which was filled into the punctured bamboo culms. While the top floor and the ceilings were constructed in a light-way bamboo construction system, the ground floor was built out of heavy cob walls, a mixture out of straw and earth. This earth construction technique builds on the locally applied earth building tradition, but is more durable due to the straw micro reinforcement, a waterproof foundation and a proper protection against water from the top. In combination the massive earth construction in the ground floor and the light bamboo frame structure in the top floor enable a two floor building, even in an earthquake area like the Punjab in Pakistan.

Research on traditional local building culture



A – Foundation: Missing a foundation as well as a horizontal damp proof the earth walls are exposed to harmful raising humidity from the ground

B – Walls: The monolithic earth walls are earth plastered and have to be replastered at least every two years. Due to a missing reinforcement and foundation the walls are in danger of getting cracks.

C – Roof: The flat roofs lack a proper water proofing and are built of rare untreated timber and partly expensive steel beams. In general they are constructed too weak.

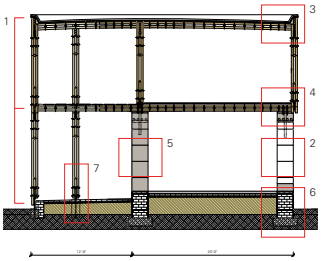
Construction details

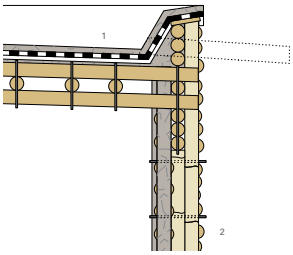
1. Double Story Building

In a dense populated country like Pakistan, where families have just limited space a double story building helps saving land.

2. Window Openings

Bigger window openings, which are not exposed to direct sun light provide better inside comfort and enable a proper air circulation to cool the building down especially at night.

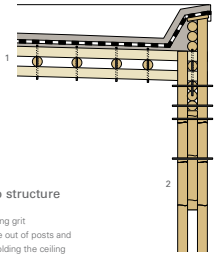




3. Connection roof to bamboo frame

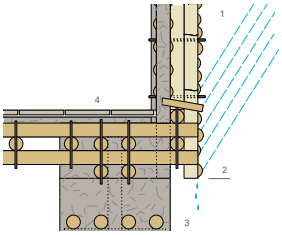
The bamboo roof rests on the earth filled bamboo frame structure. A damp proof course on top of the earth filling guarantees that no water comes in.

1 roof structure from top to bottom:
earth layer for sun protection
Bitumen membrane
lime coating
straw earth filling
3-layer bamboo ceiling
2 bamboo frame structure:
inside filled with straw earth
outside bamboo strip fassade



3. Bamboo structure

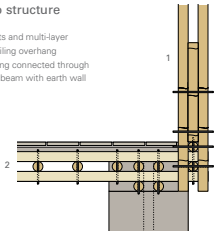
1 Bamboo ceiling grit
2 Bambo frame out of posts and multi-layer holding the ceiling



4. Connection bamboo frame to cob wall

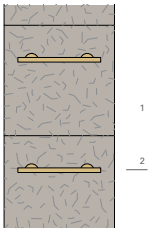
The facade of the light bamboo frame construction of the second floor has an overhang to the earth walls of the ground floor. Rain running down the bamboo facade can drop down in front of the earth wall.

1 bamboo frame structure:
inside filled with straw earth
outside bamboo strip fassade
2 overhang of wall
3 cob wall out of straw earth
4 3-layer bamboo ceiling with tiles



4. Bamboo structure

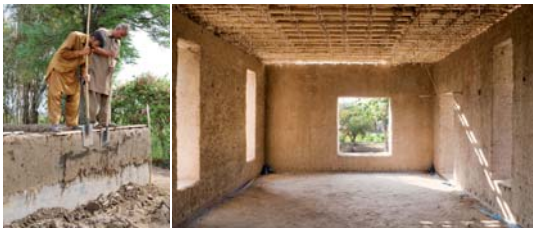
1 Bamboo posts and multi-layer resting on ceiling overhang
2 Bamboo ceiling connected through bamboo ring beam with earth wall

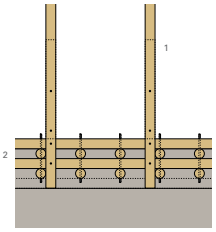


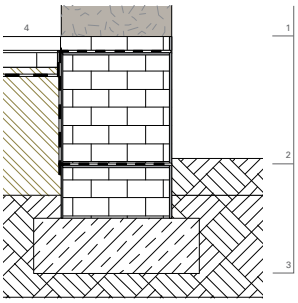
5. Cob wall

The addition of straw and a horizontal bracing in all corners improves the strength of the monolitic earth walls, especially in the case of an earthquake. Furthermore the straw makes the earth wall more rain resistant.

1 cob wall out of straw earth
2 horizontal bamboo reinforcement in corners







6. Waterproof foundation

Brickwork in combination with two moisture barrierers prevents damages caused by upraising humidity. Raised more than 60 cm from the ground the earth walls are protected in the case of a flood.

1 cob wall out of straw earth
2 over ground foundation:
one brick layer
bitumen membrane
brickwork (2 ft)
3 underground foundation:
bitumen membrane
brickwork (1 ft)
cement stabilized rammed earth (1 ft)
4 flooring:
bricks or tiles
rammed earth
moisture barrier
compacted earth

7. Column footing on Veranda

1 Bamboo post
2 Steel footing, connected to post through steel dowel and concrete filling
3 Concrete foundation