ROUND WOOD STRUCTURE HOUSING

1. Abstract

The CONSTRUCTION aspect of WOOD-PERFECT comprises the realization of buildings with columns and ringbeam made of round wood, and walls made of compacted earth blocks.

The objective of such a system of construction is realizing strong and durable housings accessible to low-income population.

The building materials used have less environment impact: round wood and compacted earth blocks.

The advantages of those two materials are numerous:

- They are very competitive technically, economically and they preserve environment.
- They have very interesting parasismic characteristics.
- Specifically for wood: renewable resource, lightness, elasticity, etc.
  For regions which suffer from wood shortage, adjustments have to be done.
- Specifically for raw earth: quasi universal availability, practically unlimited resource, elasticity, good thermal mass, phonic insulation, favourable hygrometry, etc.

A number of problems have to be overcome in order to profit from the above listed advantages. Some recent innovations have helped to do so.

1° A good protection of raw earth walls against crumbling, shocks and weather.
2° A good protection of wood against biodegradation.
3° An effective column – ring beam joining.

A new technique of applying a cement render on surfaces of raw earth and wood plays an important role.
We apply an outer layer of cement, on a soft inside of wood and raw earth.

We can talk about an accurate marriage of wood, raw earth and cement for the shelter of low-income populations and the preservation of environment.

2. Description of the construction

2.1 The foundation

Simple foundation made of stones masonry.

2.2 Structure

The loadbearing structure is made of columns and chaining of round wood.
The columns are in one single piece and enter down to 1 m under the ground.

The upper ringbeam is posed at 3 meters from the ground. This leads to the use of lintels above openings. The struts are not necessary if the rafters are solidly fixed on the upper ringbeam. They may also be posed above the latter.

2.3 Walls

The walls are made of compacted earth blocks.

Joints are in earth mortar.
For the infill walls of up to 3 m high, the maximum pressure is about 0.5 bars at the base of the wall, and such mortar is convenient.

With the joint of earth mortar, be it that walls are of fired bricks or of compacted earth blocks, the resistance to compressive strength is comparable, since the later corresponds in the two cases, to that of the earth mortar.

Walls are rendered up to the doors level. Above, blocks are let apparent in order to help wall's "breathing".

The protection against the rise of humidity is done accordingly to the classical methods, notably by posing a plastic layer under the first row of blocks.
An additional precaution consists of using a high footing.

2.4 Roofing

The roof is made of treated round wood. As this wood is never exposed to humidity (biological class risk 1), it is not exposed to rot. Its treatment consists of a simple soaking in a borax solution.
We can also apply a layer of waste oil, slightly diluted in gas or petrol.

The cover is of galvanized iron sheets.

2.5 Particularities for multi storey constructions

a. A mixed floor

- Joists are made of round wood and rest completely upon the chaining.
- Planks of 5 cm thick are fixed on those joists and form a rigid floor.
- A cement layer of 3 cm thick is then fixed on the floor.
  This facilitates the daily entertainment, improves the rigidity, fights against fire, etc.

b. Triangulations

One of the main advantages of using loadbearing structure in multi storey buildings is the possibility of realizing an affordable triangulation as dense as necessary, as well in the vertical plan as in the horizontal one.

This results in a compact construction, with a good capacity of resistance notably against earthquakes. For regions particularly exposed to earthquakes, reinforced masonry is recommended.

c. Fire risks

As well inside as outside the building, columns and chaining are drowned in masonry and are not accessible to flames in case of fire.
The wooden floor is also covered by a layer of concrete. Only the ceiling may be attained by the flames, but this situation is not particular to this type of construction.

d. Walls in light materials

When an affordable, durable loadbearing structure (columns, ringbeam and struts) is available, walls can be made of light materials such as wood wool, particularly for interior walls.

3. Materials used

3.1 Round wood

Advantages of round wood

Using round wood has a triple advantage:

a) It is a raw wood, which has not required much energy for its transformation.

b) The quasi absence of transformation results in avoiding losses of material due to sawdust, chips, etc. that represent about 65% of the raw wood.

c) For the same mechanical performance one needs a less volume of round wood than of sawn wood.
Indeed, sectioning wood fibres during the sawing operation results in important drop of wood mechanical properties, especially it's bending strength.

Environmental aspect

While growing wood play an important role in uptake and storage of CO2 from atmosphere. This quantity of CO2 is returned in nature when the wood is burnt or decomposed by micro-organisms.

That is why the role of wood as carbon bin is as better as it is valorised in long lasting utilizations.

Of all utilizations, housing is the one with greater efficiency in terms of duration of storage of CO2: order of century.

3.2 Compacted earth blocks

Earth blocks are manually compacted, and have the following dimensions: 30 x 20 x 15 cm.
Such dimensions are necessary to make efficient inserting gravels on one face (see external walls).

The weight of one block is about 17 – 18 kg, but masons arrive to handle it correctly.

The ejection from the mould of a well compacted earth block of such dimensions is not easy. Indeed, due to elasticity of earth, the block exercises high pressure upon the mould walls and refuse to be ejected.
A particular mould construction allows overcoming this drawback.

The compaction (dynamical pressure applied) of successive small layers of earth, allows to attain easily the height of 15 or 20 cm, unlike usual compression presses.

3. The main challenges

Three recent innovations constitute the basis of these performances:

1° a good protection of raw earth walls against crumbling, shocks and weather;
2° a good protection of wood against biodegradation;
3° an effective column – ringbeam joining.

3.1 Protection of earth walls against crumbling, shocks and bad weather

The blocks used are not made of stabilised earth; only raw earth with sand.
However the two sides that will constitute the surface of the wall get a layer of stabilised earth (addition of 10% of cement).
The stabilised earth layers will allow the wall to fix the cement render as if it was made of fired bricks or any other classical material.
In this way, internal and external walls will be protected against bad weather, crumbling and shocks.

Comparatively to entirely stabilised earth blocks, there is an important saving of cement: about 80%!

The external stabilised earth layers may be replaced by a layer of gravels inserted into the block before starting compacting.
Compaction force used in manufacturing the blocks allows the gravels to be solidly fixed into the block.
It also results in a compressive strength of 10 bars minimum for the blocks, which is sufficient for the construction for infill masonry.

3.2 Wood protection

a) All the surface of the wood used in the construction (columns, ringbeam, and struts) will inherit of a mechanical protection: masonry and cement render aimed to straighten the edges. There won't be any wood surface in contact with air. The risk of rot for such a wood is nil: there is neither oxygen nor humidity. Indeed fungi, which are responsible of wood decay, need oxygen and water to develop.

However, all the wood will be impregnated with a solution of borax.

b) The risk of attack by insects is also inexistent thanks to the outer layer of render.

c) There subsists a risk of attack by termites in case of insufficient protection of the bottoms of the columns, if not enough protected.

That is why it is recommended to protect this important part of the construction using the technique of localized internal diffusion as developed by Wood-Perfect.

3.2.1 Mechanical protection

*** Protection against rain water**

For interior columns, protection against rain water is not needed.
For the exterior columns, the surface which is not drowned in masonry is rendered with cement by the way.

*** Protection against capillary rise**

A ribbon of plastic is rolled over the whole area of the columns which will be in contact with ground.

This doesn't constitute a chemical protection, but it is aimed to eliminating the exchanges of humidity and chemicals between the columns and surrounding soil. The latter has even very reduced humidity level, since it is under a sheltered area.

A supplemental measure of reduction of humidity consists of posing a plastic layer all around the building foundation.

3.2.2 Chemical protection

On the basis of the 2 preceding paragraphs, it is evident that the columns are not so exposed to rot, even if they are in permanent contact with ground.
The above mechanical protections reduce strongly the risk of rot, but not eliminate the risk of attack by termites.
However, those mechanical protections simplify very much the efforts made for chemical protection, since they eliminate practically the leaching of chemical by rain water and soil humidity.
Thus, a very lasting protection of the wood structure can be reached affordably.

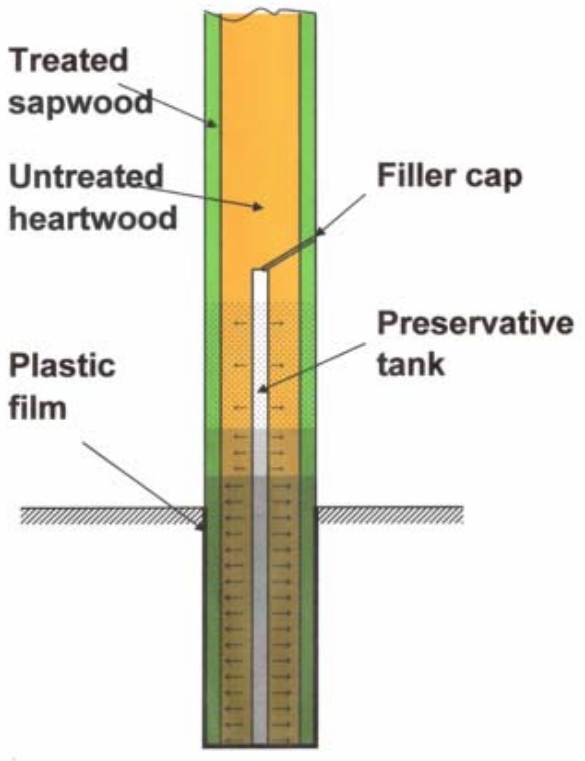
Recommend treatments:

- Impregnation with borax (by pressure or by axial injection of freshly cut wood), for the whole round wood that will be used: columns, ringbeam, struts, floor joists.

- Impregnation of the columns bottoms according to a new method for remedial treatment of utility poles, by injection or by **internal diffusion**.

Overview of the new process of preservation of round wood by internal diffusion

Wood column treated by internal diffusion: the sight of the internal tank.



3.3 An effective ringbeam joining

The column – ringbeam joining is realized at a level of a cut in the column.
The edges of the cut allow ringbeam to transfer vertical loads to columns and vice versa.

A threaded rod, which crosses the column and go axially into the chaining on a distance of 20 cm, insures the resistance of the structure to the traction strength.