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REEDCOB - Recover and innovation Strategy of earth walls with reed and lime

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THÈME 4 - 4.2. ENGINEERING, BUILDING TECHNIQUES AND STRUCTURES, SEISMIC RESISTANCE

Summary
In recent years it has been noticed the progressive disappearance of vernacular building technologies all over the world mainly due to a strong urban rehabilitation process with modern technologies not compatible with ancient knowledge. Simultaneously new dwellings are needed worlwide and in this sense it was decided to study an ecological and cost-controlled building technology of monolithic walls that can combine the use of low carbon footprint materials, such as earth, fibres and air lime using an invasive species: giant reed cane (Arundo Donax).

Introduction
After the Second World War there was a massive need for reconstruction and new housing in Europe. For this it was fundamental the development of fast setting cement-based technology to respond to these urgent housing needs.
Because of its low cost and apparent durability modern technology has been replacing ancient technology and causing a loss in the vernacular knowledge still established in developing countries.


Fig.1

Trying to present alternatives to the previously mentioned status, it was decided to study an ecological and cost-controlled building technology that can combine the use of materials that have been used in old buildings in Portugal, such as air lime and earth, with others with low carbon footprint, as giant reeds in the form of cane and its fibres. Giant reed cane (Arundo Donax) is an invasive species in southern Europe and North of Africa.
The aim is to develop a building technology capable of improving ancient vernacular knowledge but adapted to present time constraints and comfort needs.
This technology called «reedcob» has been characterized and mainly consists on building monolithic walls with successive layers of a mix of earth and reed fibres, and layers of reeds. As an internal bracing structure and for plum work there were used vertical wooden pieces.

Methodology
To recover and improve ancient knowledge on earth building, as well as creating a new technology applicable for the construction of new dwellings, several experiments were made related to constructive feasibility, hygrothermal and mechanical characteristics. The technology was developed through several prototypes: a first linear wall (prototype 1, Fig.1), a second wall forming a corner (prototype 2, Fig.2), several small samples (Fig.3), wallets and a small building (prototype 3, Fig.4 and 5) were built to assess and analyze constructive feasibility, mechanical behavior and anti-seismic performance.
In the conception, production and analysis of the prototypes two architects, three engineers and five engineering students were involved.


Fig.2

Results
In terms of mechanical behavior it can be observed that the addition of a drying additive (calcium oxyde and metakaolin) in the mortar increases the compressive strength while the addition of fibers seems to decrease it, as well as the dynamic modulus of elasticity (Fig.6 and 7).
Relating bulk density and thermal conductivity it can be noticed that bulk density varies, of course, directly with the amount of reeds inside the samples (Fig.8).


Fig.3

In terms of temperature it can be seen (Fig.9) that the amplitude indoors is reduced in comparison with outdoors even with only a heater connected during the night in the end of the winter season (since the first day of measured).
The amplitude inside seems to stabilize around 3-4ºC while outdoors is at least the double, and the indoor temperature seems to stabilize over 18ºC.
The same happens in terms of relative humidity for the reduction of amplitude and stabilizing between 75-85%. The high values may be related to the building moisture during construction and that the cellule is not rendered and plastered.
These results validate a technology that have a low carbon footprint made with natural materials and have both efficient mechanical properties in terms of flexural and compression strength and thermal resistance.
Comparing with other monolithic technologies this technology it is very easy of implementing:
The production and applicability is light weight, made with thin layers of mortar and reed canes.
It does not envolve the use of complex and heavy machinery or tools in its process.
Also, for people without previous experience in construction, the technology it is easy to learn.

Conclusion
Compared to other earth walls solutions, this technology generally presents a lower density and higher thermal resistance and high mechanical flexural strength.
Its easy implementation has a very high potential to be use for building in developing countries, because of its low cost natural materials (earth and reed) and because of its mechnical behaviour can result in an high resistance quality for seismic hazard areas.

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Fig.4.


Fig.5


Fig.6

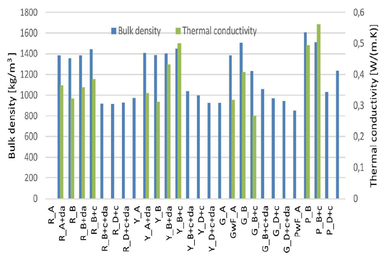

Fig.8

Fig.1. Prototype 1. Rendering test
Fig.2. Prototype 2. Corner wall
Fig.3. Samples for mechanical tests
Fig.4 and 5. Prototype 3 (cellulle) under construction and detail of wall layers
Fig.6. Three points flexural strength test
Fig.7. Dynamic modulus of elasticity, flexural and compressive strength of samples
Fig.8. Bulk density and thermal conductivity of samples
Fig.9. Indoor and outdoor temperature and relative humidity in the cellule

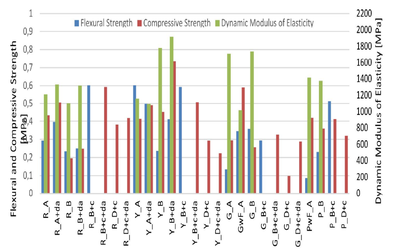

Fig.7

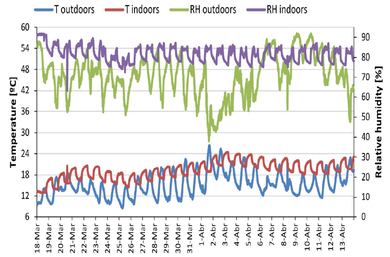

Fig.9