CERAMIC TILE SYSTEMS FOR CONSTRUCTION BASED ON NATURAL, ENVIRONMENTALLY FRIENDLY MATERIALS

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INTRODUCTION

Bio-construction establishes criteria for the configuration of healthy, sustainable and environmentally-friendly housing by making use of natural, low environmental impact, recycled, recyclable or reusable materials.

Ceramic tiles are not considered to be a bio-construction material due to the high energy costs involved in manufacturing them and to their use of raw materials that are non-renewable and entail high-impact extraction. Therefore, incorporating ceramic tiles into bioconstruction is a challenge and calls for significant efforts in making the production process energy efficient, reducing raw materials consumption (for example, by reducing tile thickness or using recycled raw materials), or providing functional features that enhance the habitability of buildings.

1. REQUIREMENTS FOR COVERING MATERIALS USED IN BIO-CONSTRUCTION

The guidelines established for building materials and fittings are as follows:

- *Acoustic comfort*: Optimising acoustic conditioning and soundproofing.
- *Thermal comfort:* Ensuring a balanced ratio between thermal insulation and heat accumulation.
- *Humidity control:* Using hygroscopic materials that can regulate humidity in the air by absorbing moisture in humid conditions and releasing it in dry conditions. Breathable materials that allow water vapour to pass through them to minimise humidity in the building.

2. INTRODUCING CERAMIC TILES INTO BIO-CONSTRUCTION

The aim of this work is to study the incorporation of tiles into a ceramic system in which materials commonly used in bio-construction, such as lime mortar, are involved, providing hygroscopicity or humidity-regulating functionalities.

For this purpose, a comparative study was carried out of the mechanical properties regarding bending and compressive strength of lime mortar (with no reinforcement or reinforced with natural fibres) compared to those of the cement mortar used in current construction. Water diffusion through a ceramic tile is then assessed in comparison to that of cement mortar and lime mortars.

Figure 1: *Left: Hemp fibre. Right: Wool fibre.*

Test specimens measuring 40x40x160 mm were prepared with the following compositions:

Material \ Reference	CEMENT	NHL-5	NHL-3.5	NHL 5 – 1.5 Wool	NHL 5 – 1.5 Hemp
Ready-mixed mortar (g)	100				
NHL 5 lime (g)		33		33	33
NHL 3.5 lime (g)			33		
Mortar sand (g)		67	67	67	67
Water (g)	14	22.5	22.5	22.5	22.5
Carded wool fibre (%v)				1.5	
Carded hemp fibre (%v)					1.5

2.1 BENDING STRENGTH

***Figure 2**:Left: Experimental set-up.Right: Broken test specimen.*

Reference	CEMENT	NHL 5	NHL 3.5	NHL 5 - 1.5 Wool	NHL 5 - 1.5 Hemp
Mechanical strength (kg/cm^2)	87	7.7	5.2	9.8	9.1
Mechanical strength (MPa)	8.6	0.8	0.5	1.0	0.9

2.2 COMPRESSIVE STRENGTH

Figure 3: *Left: Experimental set-up. Right: Broken test specimen.*

Reference	CEMENT	NHL 5	NHL 3.5	NHL 5 - 1.5 Wool	NHL 5 - 1.5 Hemp
Mechanical strength (kg/cm^2)	330	31	19	29	27
Mechanical strength (MPa)	32	3.0	1.9	2.8	2.6

2.3 WATER ABSORPTION BY DIFFUSION

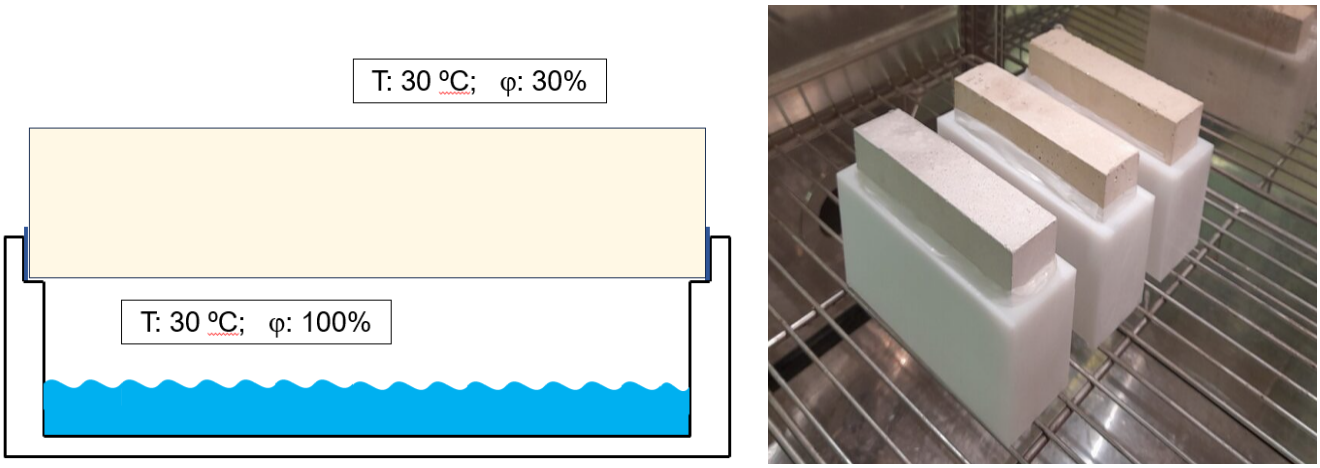

Figure 4: *Left: Diagram of the experimental set-up. Right: Test specimens left in the climate chamber for 15 days.*

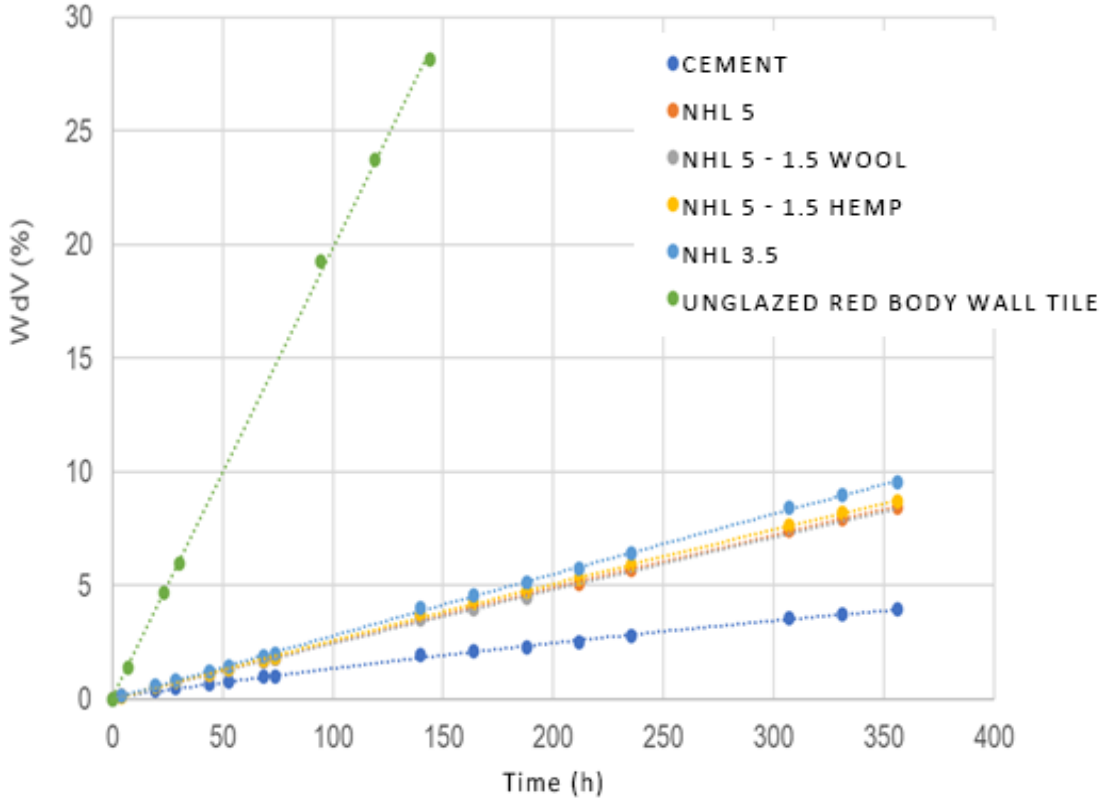

Figure 5: *Variation in long-term water absorption by diffusion (%) with time*

3. CONCLUSIONS

The mechanical properties of lime mortar are inferior to those of cement mortar. In uses where they are not so relevant, such as partition walls, they do not restrict the use of lime mortar-based ceramic systems.

In uses with greater mechanical requirements, such as flooring, the addition of natural reinforcement fibres does not represent a significant improvement, so work needs to continue on optimising the mechanical behaviour of ceramic systems with lime mortar.

A very interesting result was obtained in the study of water vapour permeability in unglazed porous ceramic tiles, which opens the door to further work on this line of research to enable ceramic tiles to be introduced as a covering with hygroscopic properties that will improve comfort in housing.

4. ACKNOWLEDGEMENTS

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