Ecological and Functional Technical Mortars

Introduction

The finishing coatings of buildings such as plasters and floor coatings present a crucial rule in what concerns to solutions' durability, the spaces' healthiness and the energetic consumption related to their use. In this way, the development of new, multifunctional, sustainable and eco-efficient mortars (EFTM) represents a relevant technological advance, which replies to the most recent requirements of national/international markets and also to the environmental concerns related to climatic changes.

Considering these aspects, a research project is in the final stages of development, in which those new multifunctional, sustainable and eco-efficient mortars were analysed and characterised.

It was intended that the final product respects the needs of national and international markets, the requirements of the products standards and it would be easy to apply (projecting materials for plasters, self-levelling for floors and quick setting).

Two entities were involved in this project: one ID institution – IteCons (Institute for Research and Technological Development in Construction, Energy, Environment and Sustainability) and one enterprise – Primefix (Adhesives and Technical Mortars Ltd).

Description and objectives of the project

In order to reduce CO_2 emissions and mitigate some of the consequences of climate change, the European Union has set a priority set for sustainability and defined a set of development strategies that include innovation, energy efficiency and protection of the climate.

Concerning the construction sector, mitigation of the effect of CO_2 emissions requires the implementation of measures such as the use of integrated renewable energy sources, the improvement of the equipment efficiency, the increasing of the energy efficiency of building systems and the management of the useful life of buildings.
This last point depends essentially on the durability of building materials, which should be produced using low-energy materials and CO_2 emissions and should have a reduced life-cycle impact.

This project aimed to develop innovative mortars for plasters and floors, multifunctional, with superior performance, which allow minimizing energy costs, increase durability and mitigate some of the most frequent pathologies leading to their early degradation.

The studied mortars were designed integrating residues / by-products from other productive sectors, selected in order to confer thermal and acoustic properties.

Studied mortars

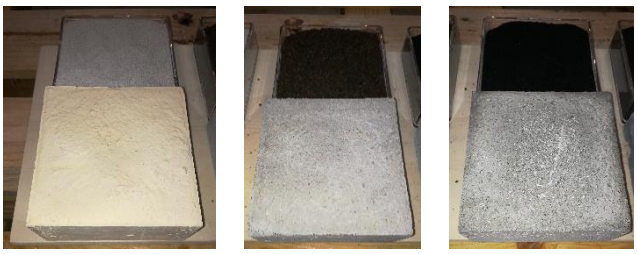
The selected mortars to be part of this investigation were cement mortars with incorporation of recycled glass, cork granules and rubber.

The recycled glass introduced in the studied mortars was 'Poraver" which is a lightweight aggregate made from recycled glass. Poraver's manufacturing process involves the crushing of broken glass and its expansion in order to obtain spherical granules. The result of this process is a very light material with high compressive strength, good thermal and acoustic insulation and good chemical resistance (Figure 1).

The second residue introduced was cork. It is verified that in the processing industry of this product, there is a significant proportion (about 30%) that is refuted, mainly in the form of granules, which, from the environmental, economic and technical point reinforces the interest in the incorporation of this by-product into building materials. The physical properties of the cork confer unique characteristics to the mortars, being able to make them lighter, ecological and with mechanical, hygrothermic and thermo-acoustic optimised performance (Figure 1).

The third residue used in this investigation was rubber. Tire is a non-biodegradable product and it is in a solid state. The large amount of unused tires causes a huge environmental problem due to its shape and durability. Old tires, when improperly disposed, can become a serious public health problem due to the possible proliferation of mosquitoes and the pollution caused by their burning. Their disposal in landfills is also discouraged because rubber fibres are very resistant to the degradation and the tires complicate the compaction by its low compressibility. Tire recovery is a process that, through mechanical and chemical resources, converts vulcanised rubber into a lightweight material that is easily incorporated, with specific physical and mechanical advantages (Figure 1).

Figure 1 – Analysed mortars



Mortar with recycled glass | Mortar with cork granules | Mortar with rubber granules

The experimental campgain consisted in the determination of the properties presented in table 1, for all the mortars.

Table 1 - Properties determined for all the mortars

Properties	Standard procedures
Mechanical characterization	
Flexural strength - Stf and Compressive strength - Stc (MPa)	EN 1015-11:1999; EN 1015-11:1999/A1:2006
Dynamic Modulus of Elasticity – Ed_L (MPa)	Based on NP EN 14146:2006 - Method 5.2, for natural stone
Physical characterization	
Vapor diffusion resistance factor - μ (-)	NP EN 1015-19:2008
Dry bulk density – Dbd (kg/m³)	EN 1015-10:1999; EN 1015-10:1999/A1:2006
Water absorption coefficient - Wac (kg/(m².min$^{0.5}$))	EN 1015-18:2002
Thermal conductivity – λ (W/(m.K))	EN 12664:2001; ISO 8302:1991

All mortars were prepared with a water amount that provided a good workability, determined according to EN 1015-3:1999. Prisms and cylinders with dimensions according to the menthioned dtandards were made for the determination of all the preperties. All specimens were kept at 20 ºC and 95 % relative humidity (HR) in the first 5 days of curing, remained 2 more days at 20 ºC and 65 % HR and were then demolded. Specimens remained in these conditions until tested (28 days of curing).

Results

After the period of curing all the test were performed according to the standards and the results for the mechanical and physical properties are presented in table 2 and 3 respectively.

Table 2 - Mechanical Properties

Residue introduced	Ed_L	Stf	Stc
None	7960	3.3	8.1
Recycled glass	1870	1.8	4.8
Cork	520	1.0	5.7
Rubber	910	1.4	4.6

Table 3 - Physical Properties

Residue introduced	Dbd	μ	Wac	λ
None	1620	10.8	0.25	0.470
Recycled glass	620	9.2	0.45	0.203
Cork	620	8.8	1.00	0.185
Rubber	1010	16.2	0.15	0.202

Conclusions

As part of the project "EFTM - Ecological and Functional Technical Mortars", which aims to develop ecological mortars with thermal properties, which can be applied in different types of supports, mortars incorporating recycled glass, cork granules and rubber were studied. These mortars were characterised, in the laboratory, from a mechanical and physical point of view.

The results are very interesting and allowed to obtain formulations that will be liable to obtain CE marking. This will allow to introduce more environmentally friendly multifunctional mortars with improved properties.

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