EAMT Project

Eco-sustainable thermal mortars

ecodesign | eco-innovation | circular economy | production process | eco-friendly products | reducing environmental impact | environment sustainability

PROJECT DESCRIPTION

The EAMT (Eco Alternative Mortar Thermic) project responds to the growing demand in the construction market for products that combine environmental sustainability, recyclability and energy saving.

The EAMT project has gained experience in the study and launch of mortars developed with recovered scrap materials, having high technological content and oriented towards the maximum respect for the environment.

OBJECTIVES

The main objective was to create thermal mortars to be coupled with high-performance bricks by creating a "thermal block + mortar" package that as a whole was able to meet thermal and acoustic performance needs in compliance with the stringent limits prescribed by current regulations in force at European level (in Italy Leg. Decree n. 311/06 envisaging also transmittance limits accordingly to UNI EN ISO 6946, in Spain Directive 2002/91/CE, and inFrance RT2005 and RT2012.)

The study was only the beginning of a real project that involved the analysis, formulation and marketing of the ecological thermal mortars.

The research and development laboratory has studied and developed three types of mortar that differ in the thermal characteristics, in order to ensure the same performance regardless of the characteristics of the base substrate. The choice sprang from the need to limit the thickness of the mortar in the applications, permitting a consequent reduction of the related costs. The mortars were then blown into the brick blocks before they were fired in blast furnaces, to create a single block proposed as single infill solution for buildings.

The added value of the project essentially consists in the composition of the mortar's formulations compared to traditional mortars. In fact, the new product is made of secondary raw materials, i.e. reused scrapes, such as polyester fibers and pumice stone, coming from the industrial processes of local companies.

During the project the three types of mortar were customized to satisfy also more traditional uses such as the bonding between the brick blocks and their covering and, therefore, tested with tests not only in the laboratory but also *in-situ*.

In parallel with the laboratory activities, an expansion of the production plant was implemented to adapt to the particular characteristics of the raw materials of mortars and in order to obtain a finished product perfectly compliant with all the envisaged quality standards.

PROJECT PHASES

The phases of the program were identified on the basis of temporal needs of the project objectives. The first part was dedicated to the study of the formulas to determine the optimal mixture, the second part focused on the construction of the production plant, and the final phase was aimed at the marketing of the finished product, creating all the tools necessary for sale.

The project was structured in 6 phases of which the three most relevant were:

PHASE 1: FORMULATION AND TECHNICAL ANALYSIS OF THERMAL MORTARS

Three types of mortar containing recycled materials have been developed in the laboratory:

- **THERMAL MORTAR TYPE "I"** applied by insufflation. Due to its technical characteristics, the insufflation mortar makes insulation efficient in saving energy. The data of compressive strength of the I-type mortar makes it belong to class M10. The construction system studied is therefore suitable for use in seismic areas, respecting both the thermal requirements and seismicity-related requirements provided for in the current regulations.

- MALTA TERMICA TIPO "T" applied to bedding. The T-type mortar is a thermal insulating mortar with low specific weight based on cement, light mineral aggregates and selected sands with suitable granulometric characteristics. It is a mortar for seismic areas, with a low coefficient of heat dispersion which is therefore used to build thermal blocks of various kinds, improving the final performance and sharply reducing the dispersions and thermal bridges generated by common masonry mortars. The compressive strength of T-type Mortar makes it belong to class M10, which can be used in construction systems with thermal brick blocks and can be used in seismic zones as bedding mortar for ordinary, load-bearing and reinforced walls, being characterized by f_m > 10 N/mm² (as envisaged by the standard NTC 2008).

- **THERMAL MORTAR TYPE "S"** applied to cover the blocks. The S-type thermal mortar is applied to cover the blocks, as far as it can limit, thanks to its low conductivity, the thermal losses caused by thermal bridges in correspondence with mortar joints. This type of mortar has been designed to be the lightest, so that it can be used in the latest generation bricks with extremely low conductivity. The S-type thermal mortar was tested to be used as thermal plaster and not for structural purposes, so it is not concerned by the provisions of the TSC (Technical Standards for Construction). The studied construction system, S-type spray mortar on thermal blocks, is also suitable for use in seismic areas as thermal plaster (not for structural purposes).

These three types of mortar have been prepared with scraps recovered from local industries, such as:

- PUMICE STONE (which gives lightness to the mortar and increases its warmth);

- POLYESTER FIBERS (which contribute to increase the mortar's mechanical strength).

Combining differently the dosage of each srcrap material during the numerous trials, the three types of thermal mortar have been defined with the aim of increasing the thermal properties of the bricks, and thus better complying with the European legislation. The choice of mortar depends on the specific case, or rather on the type of brick to be used. To have a wall with the right thermal transmittance (U), it will be necessary to use - homogeneously over the entire surface - a mortar that has a thermal conductivity (?) as similar as possible to that of the interested block. In this way, having three types of thermal mortars with different ? available, there is a bigger variety of possible applications. This choice was made in order to allow the product's application in different climatic zones and with different types of brick.

Several formulation tests were carried out before identifying the 3 definitive mixtures, as the use of scraps as raw material is innovative and technologically advanced. In order to certify products for sale on international and national markets, a series of technical tests were carried out in the Company's laboratory and at MECCANO Spa, the certified Research Institute of the Polytechnic University of Marche, to determine the main performances of the blends. Some of the features:

- Thermal Conductivity ? (UNI EN 1745: 2002),
- Water absorption by capillarity (UNI EN 1015-18: 2004),
- Resistance to the diffusion of water vapor μ (UNI EN ISO 12572: 2006),
- Mechanical resistance to compression and flexion (UNI EN 1015-11),
- Sound absorption,
- Fire resistance.

PHASE 2: IMPLEMENTATION OF THE MORTAR PRODUCTION PLANT AND ADAPTATION OF BRICK MANUFACTURING PLANTS

The company's already existing powder production plant has been upgraded to adapt to the particular characteristics required in weighing, mixing, additive dosage and raw materials processing, thus to allow the finished product to achieve the planned technical performance. To this purpose the system was integrated with different instruments and machinery, specifically created by the engineers of the supplier company, allowing the production of a performing product in less time (44% reduction in production time compared to the old system), and with much lower energy consumption. With the old system the energy consumption was estimated, for one working day, equal to 8h x 100kWh = 800 kW while after the modification the consumption for the production of the same quantity of product was equal to 4,5h x 150kWh = 675kW (16% reduction in energy consumption).

PHASE 3: STUDY OF THE ENVIRONMENTAL BENEFITS

The main purpose of the project was to apply the mortars on thermal blocks to enhance their characteristics, in order to improve our living environment, and thus cope with current regulations.

The improved environmental sustainability refers both to the materials used in the compounds (scraps) and the thermal and acoustic performance of the applied product, that ensures an improved energy efficiency.

The CO2 emission reduction is mainly due to the choice of scraps, such as polyester fiber and pumice stone, coming from local manufacturing companies, used as secondary raw material for the production. The reuse of scraps in the production cycle of thermal mortars allows to reduce waste to be disposed of in the environment. Pumice scraps are so reused for 60%.

The use of thermal mortars in combination with thermal insulation materials, reduces the energy consumed in residential construction for heating purposes, both of the rooms and domestic water, thanks to the high thermal performance (type "I" mortar: thermal conductivity ? = 0,20 W/mK, water vapor resistance μ = 3; type "S" mortar: thermal conductivity ? = 0,12 W/mK, water vapor resistance μ = 4; type "T" mortar: thermal conductivity ? = 0,244 W/mK, water vapor resistance μ = 11). The low value of thermal conductivity, comparable to that of the support base, allows the elimination of thermal bridges that are the cause of heat losses into the environment. A poor thermal performance would lead to an increase in heat losses and therefore to the formation of thermal bridges, causing a decrease in the temperature of the building's internal surface, such as to cause risks of surface condensation.

Thermal bridges can be responsible of up to 30% of the total heat dispersion in dwellings and can form in correspondence with beams, pillars, window sills, balconies or even in not heterogeneous structures, such as the mortar joints between the blocks of thermo-bricks.

The use of solutions with thermal mortars of type "I", "S" and "T" allow to significantly reduce the problems related to thermal bridges and therefore the heat dispersion in dwellings, decreasing energy consumption required by heating.

The created products, being made of extremely light and highly breathable materials, regulate the internal humidity of the dwellings, lowering also the need of air conditioning, thus allowing a consumption reduction even in the summer months.

PROJECT RESULTS

The fundamental purpose of the project was the recycling of scraps/ use of secondary raw materials and the formulation of products that reduce polluting emissions into the atmosphere. For example, with the use of the products developed within the project, ozone pollution can be reduced by 70%. Furthermore, in a pallet of mortar (of about 1.200 kg), about 60 kg are constituted by pumice stone and polyester fibers, scraps recycled from other processes.

A special study was carried out to determine the environmental and economic benefits of using thermal mortars. It refers to a basic building of 100 square meters with reinforced concrete bearing structure and infill of bricks coupled with blown thermal mortar, in "D" climatic zone.

The data was processed with a software (Docet) that calculates the energy performance index of the buildings. The results have shown a marked improvement in the energy framework as regards the emissions of polluting agents into the atmosphere (CO2, ...). Using brick with thermal mortar injected inside, CO2 emissions reduce from 56 Kg/m2 to 41 Kg/m2; as the simulation referred to a single apartment, the calculated saving is to be proportionally multiplied for the entire building.

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