Ceramic Matrix Composites

25_BUILD_CMC_HEALmortar

Title: Self-healing mortar for ETICS facade systems

Summary If facade final coats are cracked rain water penetrates inside the facade system, which reduces thermal insulation properties of the ETICS system and can damage also the buildings load-bearing structure. The developments of new materials, like self- healing materials, are highly needed to repair cracks instantly to prolong facade service life.

External thermal insulation composite facade system (ETICS) is assembled from different materials and each has its own specific function.

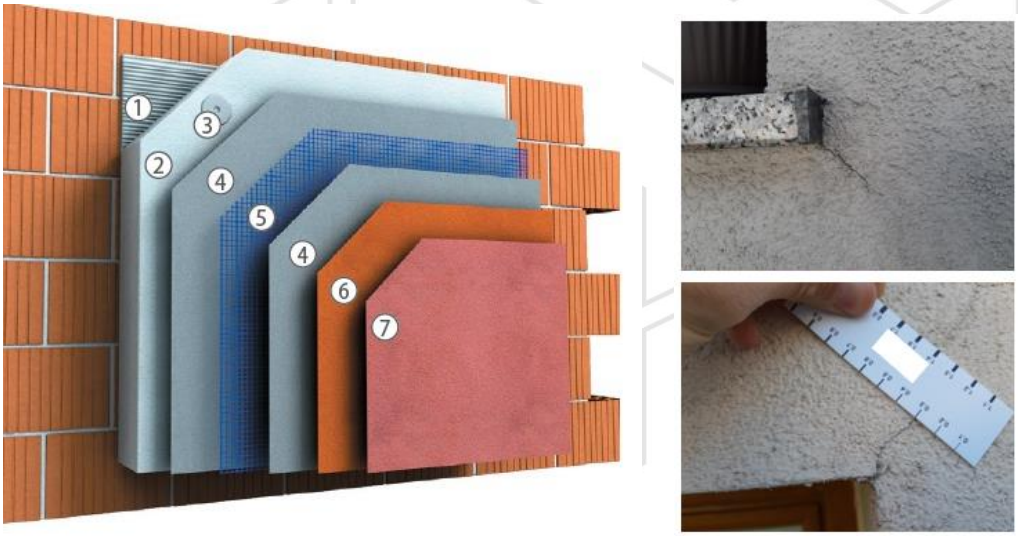

Figure: left - 1 Primer, 2 Thermal insulation, 3 Anchor, 4 Base coat, 5 Reinforcement mesh, 6 Primer, 7 Top coat; right - crack examples

Basic function of Base coat is to bear stresses due to thermal expansions and possible impacts (e.g. hail, ball...). Usually base coat is made by cementitious mortars in thickness 3 to 5 mm and reinforced with glassfibre mesh. Quite common cracking of base coat occurs (up to 0.5 mm) together with decorative top coat before end of life, which is usually considered to be 25 years.

Concrete self-healing solutions are already on the market, but self-healing solutions for cement-based mortars are still not well defined. From literature the known self-healing solutions are: superabsorbent polymers (SAPs), shape memory polymers (SMP), bacteria- based self-healing, encapsulated healing agents (macro and microcapsules), engineered fibres, which provide crack closures for crack widths greater than 0.15 mm; while shape memory composites (SCMs) seal smaller cracks widths (< 0.15 mm).

Scope of the project would be to develop self-healing mortar for base coat that in the case when cracking occurs cracks up to 0.2 to 0.3 mm would self-filled and prevent water to penetrate deeper

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into the facade system. We prefer the solutions with microencapsulated agent, which is present in mortar and it is released when crack occurs. Solution with SCMs and expansive minerals as fly ash, silica fume, BFS, CSA, bentonite clay or any other material which make a strong bond between the crack faces… It would be desired using waste material from local productions, that we can contribute to circular economy and also, we would like to contribute to reducing pollution.

We are seeking self-healing solution for achieving crack-free mortars in normal conditions (without further heating or compressing). The know how should include the knowledge about the effect of self-healing additive on the properties of cement mortar especially durability improvements. Challenge-giver would provide basic formulation of the mortar.

Objectives:

- To develop formulation of mortar with self-healing properties.
- To quantify properties of developed mortar (chemical, mechanical, applicable, healing).

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26_BUILD_CMC_MgOconstruction

Title: Magnesium-based by-products and slags for alternative construction materials

Summary: The challenge is focused on the potential application of two magnesium-based compounds. On the one hand, the reuse of Magnesium oxide by-products obtained during the industrial calcination process of magnesite. On the other hand, potential uses of refractory ceramic residues from steel industry.

MgO by-product relevant information: collected as the cyclone dust from the kiln as a fine brown powder. It is mainly composed by MgO, and carbonates from the mineral ore because of the uncompleted calcination decomposition. The MgO content is between 60-65% (on ignited basis) and the CaO, SiO_2 and Fe_2O_3 around 7, 3 and 2,5 % respectively. This by-product is currently used as soil stabilization agent, and as a precursor for developing alternative cements, such as Magnesium Phosphate Cements (MPCs), among other applications. MPCs developed by using this by-product presents excellent properties as insulating material, as repairing material, and as matrix of natural fibers due to its neutral pH. However, the cost is very high in comparison to Portland Cement, mostly due to the cost of the phosphate source.

Refractory residues relevant information: refractory material obtained after service in the steel industry. These refractory residues contain different metals that can be cleaned by magnetic treatment. Subsequently, the material is properly conditioned reducing the particle size by crushing and milling. It is mainly composed by Mg, Si, Ca, Al and Fe. The main issue is the large amount of these type of wastes obtained by the steel industry. Besides, they are poured into landfills. Our company seeks for a valorization of this kind of wastes in order to reduce CO_2 emissions and to enhance the sustainability by promoting the circular economy.

Scope: The main purpose is based on the development of sustainable and valuable construction materials as an alternative to the conventional ones. To seek the CO_2 emission reduction, and the development of lightweight construction materials with relevant properties. Start TRL4, end TRL7.

Objectives:

- Use of both materials in the development of sustainable construction materials considering or including lightweight brick and mortar material solution (under the material classification considered into the UNE EN 998). This can be achieved by using them as secondary raw materials, and/or as an addition for improving some properties of conventional construction materials.
- Economically viable construction materials (brick and mortar) for the proposed alternative construction solutions. Realistic scenarios in order to be competitive in the market.
- Interesting technical targets are considering, regarding their properties, for these objective and developed products/materials in this project: densities around 500-525 kg/m^3 and 1000-1250 kg/m^3 (UNE EN 998), for the brick and mortar respectively, and thermal conductivities ((UNE EN 1745 for thermal properties) of no more than 0,4 W/mK for both products, are targeted for these sustainable construction materials/products to be developed in this project, by keeping resistance and other expected and required properties for the conventional construction materials solutions.

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