CERIS : Civil Engineering Research and Innovation for Sustainability

Earthen plasters based on illitic soils from Barrocal region of Algarve: contributions for building performance and sustainability

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Summary

The focus of this doctoral project is the evaluation of earth-based plasters eco-efficiency for indoor plastering through its contribution for important aspects of building performance and sustainability. Mainly due to the use of raw clay as a natural binder, earth-based plasters present low embodied energy, are easily reciclycable, and to some extent, its life cycle does not generate pollutants or toxic waste or by products. Driven by clay minerals high hygroscopicity, earthen mortars may give a significant contribution to health and comfort of buildings indoor environment. The clay high adsorption and desorption capacity allow the plaster layer to act as a moisture buffer, balancing the relative humidity, thus improving confort and air quality of the indoor environment. Concurrently earth-based plasters may passively promote the energy efficiency of buildings by allowing lower air renovation rates, therefore decreasing the needs of mechanical ventilation and air conditioning.

More specifically this research aims to assess how earth-based plasters eco-efficiency performance for indoor plastering might be influenced by mortar specific formulations aspects and raw material properties. For mortars performance assessment the following properties were monitored: adsorption and desorption capacity; water capillary absorption; drying shrinkage; flexural and compressive strength; adhesive strength; dry abrasion resistance; water dripping resistance and thermal conductivity. The analysis of mortar formulations and raw material properties comprised: clay minerology; sand particle size distribution; earth/sand ratio; chemical stabilization by mineral binders addition; polymeric stabilization by vegetable proteins addition; and mechanical stabilization by natural fibres addition. To conduct the extensise set of tests, a reference mortar was defined specifically formulated with soils extracted from Portuguese «Barrocal» region, in the Algarve sedimentary basin. Due to the regional geomorphology this region presents soils with the prevalence of illite clay mineral, characterized by a high water vapor adsorption capacity and low swelling when wetted. These are of utmost importance properties for interior plastering since it maximizes the plaster moisture buffering capacity and mitigate the occurrence of shrinkage cracking during their drying.

The preliminary results show that clay minerology, along with clay content, play a key role on earth-based plasters performance, clearly driving vapour adsorption and desorption capacity, water capillary absorption, linear dry shrinkage, and shrinkage cracking, and has significant influence on mechanical strength, dry abrasion and thermal conductivity. Till some extent the addition of natural fibres can contribute for mechanical stabilization, while gypsum presents better results rather than air lime for chemical stabilization. Concurrently some vegetable proteins, like linseed oil, can significantly improve plaster water resistance.

Keywords

Earth-based plasters, illitic soils, hygroscopicity, mineralogy, moisture buffering.

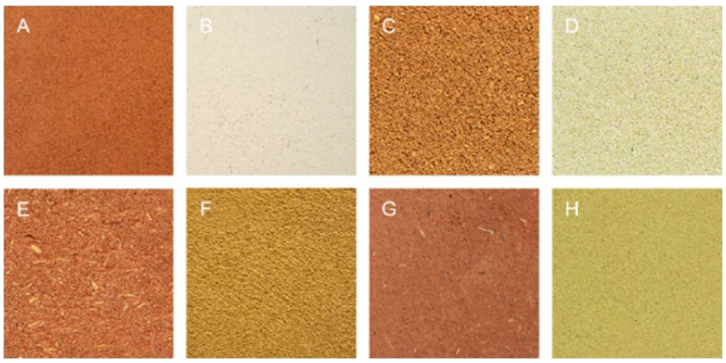

Figure 1 – Colours and textures of earth-based plasters: (A) brown illitic clayish earth and fine sand, smooth finish; (B) white kaolinitic clay, fine sand and natural fibres; (C) brown illitic clayish earth and coarse sand; (D) white kaolinitic clay and fine sand; (E) brown illitic clayish earth, fine sand and natural fibres; (F) yellow illitic-kaolinitic clayish earth coarse sand; (G) brown illitic clayish earth, coarse sand and natural fibres; (H) montmorillonitic clayish earth and fine sand.