

Development of pre-mixed external renderings for rammed earth constructions

Summary

The external renderings are essential to the longevity of the rammed earth constructions. This construction method is characterized by its high susceptibility to water damage. The search for mechanical compatibility between external renderings and rammed earth is also important to enhance the longevity of these constructions. Some of their commonest anomalies occur due to the interaction between the rammed earth background and the rendering materials, as a result of their different characteristics and performance. Pre-mixed renderings and suitable application procedures will enhance the longevity of the external renderings and of the rammed earth substrates. Nowadays, the market does not provide pre-mixed external rendering solutions to this type of substrates. Characterization tests were performed at the National Laboratory of Civil Engineering (LNEC) and on-site. Mechanical, physical, hydric, mineralogical and chemical properties were evaluated, using both laboratory and *in situ* characterization procedures: i) compressive strength; ii) flexural strength; iii) elasticity modulus; iv) surface hardness; v) open porosity; vi) porosimetry; vii) water absorption and drying; viii) water permeability; ix) surface humidity; x) thermogravimetric analysis; xi) x-ray diffractometric analysis. A first characterization stage was performed regarding 15 ancient existing rammed earth constructions in the Algarve. Their renderings and substrates were tested, allowing the comprehension of the degradation phenomena of renderings and rammed earth substrates. As a result of this analysis a search was endeavored for clues on the adequacy of applying certain rendering compositions, either in rehabilitation scenarios or in new construction.

A second stage was performed to characterize a universe of 5 pre-mixed renderings solutions available in the market, suitable for other ancient substrates such as stone or brick masonries. Samples were applied on an existing rammed earth construction. The same laboratory and *in situ* tests were carried out for comparison purposes. These pre-mixed renderings revealed incompatibility with the rammed earth substrates. Inspired by the ancient renderings longevity and characteristics, a third and final characterization stage was performed: 15 new mortar formulations were set and tested in laboratory. 3 of those were then selected to be applied on an existing rammed earth construction. These 3 rendering samples were tested in laboratory and *in situ*. This allowed a full year *in situ* monitoring period. Integrated results analysis was developed. An optimized rendering formulation was set, based on hydrated lime, siliceous sand, natural kaolin and polypropylene fibers. That formulation can be used in the production of pre-mixed dry mixes suitable to be applied on rammed earth substrates after addition of a given water content, allowing a higher quality control of the final product. On site application recommendations were established, regarding the substrates surface treatment, mortar mixing and manual application procedures in a multi-layer rendering system, in order to promote an adequate homogenization of the fresh mortars, their adhesion to the substrate and between layers, and the shrinkage control which occurs during the drying stage.

Keywords

Rammed earth, compatibility, external pre-mixed rendering, product engineering.



New pre-mixed renderings samples. Monitoring and *in situ* characterization.



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