CERIS Civil Engineering Research and Innovation for Sustainability

Eco+RCEB – Eco-efficient Recycled Cement Compressed Earth Blocks

Summary

Although it is estimated that more than 30% of the world's population still inhabit earthen dwellings, in the last two centuries earth has fallen into disuse, due to the emergence of new building materials and construction techniques. However, in line with the increasing demand of more sustainable and eco-friendly building materials, earth construction has regained interest. The low environmental impact and embodied energy, the high availability of raw material, the recyclability, the high hygrothermal comfort, the improved indoor environmental quality, with nearly zero hazardous emissions, and the advances in new construction methods and in the materials science, are some reasons that contributed to the resurgence of earth construction. A promising approach to earth building materials is the compressed stabilised earth blocks (CSEB), increasing the processing speed and showing improved mechanical strength and durability when stabilised with cementitious materials, such as ordinary Portland cement or hydraulic lime. However, despite its adequate behaviour in real exposure conditions, this type of CSEB fails to address the sustainability issue, since it requires a considerable amount of non-eco-friendly stabilisers. Alternative more sustainable natural stabilisers have been explored by various investigators, but they are still far to be technically viable and to provide comparable mechanical and durability performance as cementitious materials. In this context, the low-carbon thermoactivated recycled cement, which is currently being developed by the research team of this project, is expected to be a very promising alternative for CSEB stabilisation, potentially providing adequate binding properties with reduced environmental impact. Comparing to conventional cement stabilizers, the new eco-efficient binder contributes to a lower consumption of natural resources and, potentially, over 60% reduction of CO_2 emissions, while adequately repurposing construction and demolition waste. Therefore, the main objective of this project is the innovative production and characterisation of more eco-friendly CSEB, by using low embody energy recycled cement from waste concrete as a more sustainable stabiliser. The idea is to also explore the incorporation of construction and demolition waste as partial earth replacement, further increasing the CSEB sustainability. The new CSEB will be characterised in terms of their main physical, mechanical, thermal and durability properties by means of laboratory tests, as well as in-situ tests involving the long term exposure of various CSEB walls to different natural environments. In addition, the project also aims the development and characterisation of new more eco efficient masonry earth mortars for CSEB joints, using recycled cement. Finally, the best compromise between the technical performance and eco-efficiency of this new CSEB product is assessed by economic and environmental life-cycle analysis. For the accomplishment of these objectives, a comprehensive experimental program was defined involving the following six main tasks: production of compressed earth blocks stabilised with recycled cement; masonry earth mortar characterisation and CSEB wall production; physical, mechanical and microstructural characterisation of CSEB; thermal performance of CSEB; durability of CSEB; life-cycle cost and life-cycle assessment of CSEB.

The multidisciplinary nature of the project's research team, covering the fields of geotechnics, mineralogy, earth building and cement-based materials, thermal behaviour and construction management allows a rounded approach to the topic and a more thorough analysis of all phenomena. Moreover, the research team has proven experience on the various domains covered in this project, namely regarding the production and characterisation of CSEB and thermoactivation of recycled cements from waste concrete. The project is developed in partnership with a CSEB producer, which has collaborated with the research team in other works with earth construction. In addition, the project involves the collaboration of Universidad de Alicante, following the emerging interest of earth construction in Spain and in other European countries.

To sum up, a new more eco-efficient CSEB should be provided at the end of this project, contributing for the resurging interest and confidence in using earth materials, towards a more eco-friendly and sustainable construction practice. The proposed CSEB should meet the new stringent environmental requirements of low embodied energy materials with reduced greenhouse gas emissions, energy consumption and waste disposal, without significantly affect their technical performance. To the best of the research team's knowledge, the production of an earth building material as innovative, sustainable and technically viable as the one this project is set to achieve has yet to be attempted.

Project Reference

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Leading Institution

IST-ID – Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (Portugal)

Partners

University of Alicante (Spain), UBI – University of Beira Interior (Portugal), Oficinas do Convento (Portugal)

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CERIS

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Project Website

https://cdwvalue.eu/project-ecorceb

Figure 1. Closing loop of production and recycling of compressed stabilised earth blocks (CSEB) with recycled cement.