Significance

Properties of unfired illitic clay brick for sustainable construction

Environmental impact is currently a global concern that needs urgent and effective measures to contain. Different sectors and activities contribute to environmental problems in many ways. In particular, the construction industry, a huge consumer of natural resources and energy, has significant impacts on the environment. Since this industry is indispensable, various measures have been adopted to promote using materials and construction methods with minimal impact on the environment and the people. Notably, brick is a widely used construction material, produced mostly through firing, which is an energy-intensive method characterized by numerous environmental impacts. Therefore, using unfired bricks is deemed as an effective alternative solution to increase the sustainability of construction.

The firing process involved in the manufacture of bricks uses mainly non-renewable fossil fuels, which results in massive emissions of greenhouse gases such as carbon dioxide, carbon monoxide and sulfur dioxide. With the predicted economic growth and subsequent increase in the demand for bricks, adopting sustainable construction materials and processes is inevitable. In the quest to promote sustainable construction, using local materials coupled with vernacular construction have attracted significant research attention. Such materials should be natural, sourced locally, and require minimal or no industrial processing. Generally, research has shown that using unfired bricks produces 80% less carbon dioxide than using fired bricks, and that unfired bricks require minimal processing and are easily recyclable, causing small environmental impacts.

The authors in the laboratory.

Properties of unfired illitic clay brick for sustainable construction

D. Mulheise-Aaralia and S. Pavia

On this account, engineer Mulheise-Aaralia and Professor Sara Pavia from the University of Dublin Trinity College studied the properties of unfired illitic clay bricks and their potential application in sustainable construction.

Illite is the major constituent of many brickmaking clays all over the world. The illite clay studied is used by Kingscourt brick for the production of fired bricks in Ireland. The authors calculate the approximate expenditure and Carbon emissions by the producers today, and the economy that using unfired brick would implicate.
The main objective was to explore the use of these bricks, in unfired form, and hence lower the associated environmental impact. First, the authors assessed the applicability of illitic clay for construction by testing its mechanical properties and comparing the standard values in construction. Next, the illitic clay was tested both raw and stabilized with hydrated and hydraulic limes. Several mixes were produced, their mechanical properties and performance tested and compared with those of fired bricks. Their work is currently published in the journal, Construction and Buildings Materials.

Results showed that illitic clay can be used in earth construction unfired, and either alone or stabilized with lime. Its geotechnical properties fell within limits provided in the literature and the building standards used in construction. For all the mixes, both raw and stabilized, the compressive strengths ranging from 2.20 to 4.98 M/mm$^2$ and the flexural strengths ranging from 0.48 to 1.43 N/mm$^2$ also fell within the recommendable limits. Moreover, masonry constructed using unfired illitic bricks attained a 28-day strength of 2.45 N/mm$^2$ which also met some European structural requirements.

Compared with the performance of the fired bricks, the durability and strength of the unfired bricks are lower, the vapor permeability was superior, and the thermal conductivity similar. Furthermore, even though stabilization enhanced the durability, it lowered water permeability and strength, and did not change much the thermal properties of the resulting unfired bricks.

In a nutshell, the authors explored the potential use of unfired illitic clay bricks in earth construction. From the results, unfired illitic clay bricks exhibit potential use in many applications as an effective alternative to fired brick. The strength reduction caused by lime stabilization was attributed to the adsorption of calcium ions by clay minerals and to the hygroscopic nature of the clay minerals, competing for moisture and consequently undermining the lime hydration and carbonation.

Overall, the authors noted that if half of the annual production of Kingscourt brick (approximately 1.5 million bricks annually) were unfired, the producers would save over 4 million euros in the carbon tax and kiln fuel in 10 years. This move could consequently half their carbon emissions. Therefore, the authors noted that substituting fired with unfired brick could facilitate attaining the much-needed sustainable construction.

About the authors

Dennys Muheise Araali is a Civil Engineer and alumni of Trinity College Dublin. He is currently working with the Office of the Auditor General, Uganda and is in charge of public infrastructure works audits. He is passionate about sustainable construction materials and climate change.

Sara Pavia is an Associate Professor of Civil Engineering in Trinity College Dublin. She investigates sustainable materials and construction, the activation of waste for binder production, building thermal performance, ceramic technology, and historic building conservation. She has published profusely including four books.

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