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Investigation of the engineering properties of cementless stabilized earth blocks with alkali-activated eggshell and rice husk ash as a binder

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HIGHLIGHTS

- Possibility of geopolymer technology for stabilized earth blocks was investigated.
- Eggshell powder, rice husk ash and caustic soda were used.
- Geopolymer blocks falls under light weight block according to the ASTM C55-11.
- Compressive strength of optimal combinations of geopolymer blocks meet the minimum requirements of local standards.
- Geopolymer blocks shows better energy efficiency and less CO_2 emission.

GRAPHICAL ABSTRACT

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ABSTRACT

Employing appropriate waste materials in place of cement is the possible practical solution that addresses the issues of construction material scarcity and the environmental concerns pertained to the industry as a whole. This method also helps to dispose of a considerable amount of waste in a sustainable way. The usage of waste materials is economically beneficial. The present study was conducted to develop geopolymer technology to produce stabilized earth blocks using rice husk ash, eggshell powder and caustic soda. Different combinations of the mixture were taken into consideration to determine the optimum mix proportions of the constituents. In the present study, experimental research has been carried out including variations of the binder content (10%, 15% and 20%), the eggshell powder to rice husk ash ratio (10:90, 20:80, 30:70 and 40:60) and the calcination of the eggshell powder (raw and calcination at 700 °C). A total of 288 cubes sized 50 × 50 × 50 mm^3 and 36 beams at a size of 40 × 40 × 160 mm^3 were cast and tested after a curing period of 7, 14 and 28 days, respectively. The analysis of the density, moisture absorption, compressive strength, flexural tensile strength, impact strength, production cost, energy requirement and CO_2 emissions during production showed that the 10:90 and 20:80 eggshell powder to rice husk ash binder are suitable for block production. The results show that the optimal combinations of geopolymer blocks achieved the strength limits recommended by the Sri Lankan standard for non-load bearing masonry units, even though the compressive strengths of the geopolymer blocks were comparatively less than that of the conventional cement stabilized earth blocks. The study results also indicate that the cost, energy requirements and CO_2 emissions during block production can be reduced considerably using geopolymer technology.

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