In-situ Mud-Concrete as a material for load-bearing walls and sustainable building practices

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Declaration

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Abstract

The world is still struggling to find solutions for the increasing demand for housing with the growing population. To deal with this problem the greater importance has given in researching alternative materials and technologies which can cater sustainable solutions to these evolving demands. However, this materials and technologies must be suitable and appropriate to the local economy, social background and the cultural setting of that country. In the context of innovating sustainable building materials, 'soil' receives great attention as an environmental-friendly material, due to its economic affordability, low embodied energy and enhanced natural moisture buffering capacities.

Self-compacting Mud-Concrete load-bearing walling (MCW) system is an in-situ cast walling system that combines well-graded soil, cement (stabilizer) and water in their correct proportions. It receives great attention due to its sustainable advantages such as less raw material wastage, low-cost methods, quick construction technology and the low embodied energy consumption. This research presents a detailed analysis of mix design development, system development, thermal performances, long-term performance and cost-effectiveness of self-compacting Mud-Concrete load-bearing walls (MCW).

Results demonstrate that optimum usable gravel range is 4.75-32mm in MCW technology. Further, the mix design was finalized as fine - 5% (≤ sieve size 0.425mm), sand - 50 % (sieve size 0.425mm ≤ sand ≤4.75 mm) and gravel - 45% (sieve size 4.75mm ≤ gravel≤ 32mm) with 4% minimum cement of the total dry mix. In addition, optimum 20% of water can use to keep the self-compacting quality of the mix. Grading curves were developed constantly at 4%, 6%, 8% and 10% cement produced the best mix design with standardized methods. Also, the methods were introduced to predict the exact strength of MCW prior to construction. Accelerated erosion tests were conducted to determine the durability of MCW cast of the best mix design and the results satisfied the standard durability requirements under SLS1283. In addition, MCW can be listed as one of the excellent moisture buffering materials according to NORDEST classification system.

Optimum lifting height of a wall segment was found as 1200mm which can cast at once without proposing any joints. In every 1200mm height, the proper horizontal joint should be introduced in in-situ cast process and the introduced joint should keep the maximum continuity in between the wall segments. In addition, the results show maximum horizontal shrinkage is 0.23% and maximum vertical shrinkage is 0.22% within 07 days of curing period. Increasing the curing period from 07 days to 14 days, the shrinkage strain was reduced from 0.23% to 0.15%. It depicts that shrinkage strain can reduce in 65% by increasing the curing period for 14 days. Thus 14 days proper

curing procedure was recommended to in-situ cast MC wall and the curing should start soon after dismantling the formwork of the wall segments. MCW has 1.2 W/m.K of conductivity, 1440 J/kg.K of specific heat capacity, 1540 kg/m^2 of density, 0.366 m^2.K/W of R-value and 2.17 W/m^2.K of U-Value. MCW acts as a good thermally resistive material due to its thermal mass and insulation characters. Comparatively, MCW has a low embodied energy and life-cycle cost due to the less material wastage, high reusability, fewer labour consumption and quick in-situ construction technologies. Ultimately the research invented a self-compacting in-situ cast load-bearing walling system through Mud-Concrete, which can highly cater to sustainable demands in the construction industry.

Keywords: Sustainability, Construction industry, Soil-based technologies, Mud-Concrete, Self-compaction, in-situ cast walling, load-bearing characteristics

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Symbol	Description
CB	Cement Block
CSCB	Compressed Stabilized Earth Block
C_u	Coefficient of uniformity
C_k	Coefficient of gradation OR Coefficient of curvature
EE	Embodied Energy
GSD	Grain Size Distribution
LCC	Life cycle costing
MC	Mud-Concrete
MCB	Mud-Concrete Block
MCW	Self-compacting in-situ cast Mud-Concrete load-bearing wall
MBV	Moisture Buffering Value
$MBV_{practical}$	Practical Moisture Buffering Value
MBV_{ideal}	Ideal Moisture Buffering Value
RE	Rammed Earth
USCS	Unified Soil classification system