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Technical Report

Flexural strength of compressed stabilized earth masonry materials

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ABSTRACT

The flexural strength of masonry, which can be defined both parallel and perpendicular to bed joints, is an important strength parameter especially in lightly loaded walls. Due to scarcity of conventional masonry materials and energy related issues associated with them, alternative masonry materials are promoted. Compressed stabilized earth (CSE) masonry is one such material with adequate compressive strength for single and two storey load bearing construction. Flexural strength of such alternative materials is important to evaluate the performance when subjected to lateral loads due to wind, floods or any other load that can cause out-of-plane bending in a wall. This paper covers the findings of a detailed research carried out on flexural strength of alternative masonry materials such as compressed stabilized earth (CSE) bricks and blocks and stabilized rammed earth. The stabilization agent used to manufacture compressed stabilized earth was cement. The results were compared with the values obtained for conventional masonry to highlight the suitability of compressed stabilized earth masonry for wider application with confidence. The results indicate that the flexural strength of compressed stabilized earth masonry walls can be in the range of 0.25 N/mm^2 or above which can be comparable with conventional masonry such as burnt clay brickwork.

1. Introduction

Masonry is one of the most popular materials in many countries for construction of houses due to useful properties such as durability, relatively low cost, wider availability, good sound and heat insulation, acceptable fire resistance, adequate resistance to weathering and attractive appearance. Masonry can be either of conventional types or alternative types. The conventional types can be identified as burnt clay bricks or cement sand blocks. The alternative types of comparable performance and appearance can be identified as compressed stabilized earth (referred as CSE) consisting of solid bricks (Fig. 1), solid blocks (Fig. 2), interlocking blocks with a horizontal groove (Fig. 3), interlocking hollow blocks (Fig. 4) or rammed earth (Fig. 5). All these can be considered as CSE masonry. These have gradually gained popularity in recent times due to various reasons such as high cost of conventional masonry or keenness to adopt materials that can be considered to promote sustainable construction. A particular type of soil identified as laterite is readily available in countries with tropical climatic conditions located closer to the equator such as Sri Lanka, India, Thailand, etc. The term laterite had been originated from the Latin word 'Later' which means 'brick' since laterite blocks have been used as bricks in India [1]. One special feature of this soil is the possibility to stabilize with relatively low percentages of cement. The samples shown in Figs. 1–5 have been manufactured with laterite soil commonly available in Sri Lanka. The blocks of Figs. 1–4 have been manufactured with machines with strong steel moulds. Hence, they have high dimensional accuracy and a good finish that allows completing the walls without further finishes. This is also an advantage from the point of view of promoting sustainable construction practices. Fig. 6 shows a three-storey house constructed with compressed stabilized interlocking blocks completed without a wall plaster. This house has also been provided with a boundary wall constructed with rammed earth with cement as the stabilizing agent.

Thus, there would be a wider usage of CSE masonry in future. Hence, there is a necessity of ensuring adequate performance in CSE masonry with respect to compressive strength, flexural strength, durability and thermal performance parameters. Some very useful collection of information on the use of compressed stabilized earth as a building material can be found in Norton [1], Houben and Guillaud [2], and Stulz and Mukerji [3].

For masonry construction associated with houses, an important parameter for load bearing construction is compressive strength. In the previous research, a lot of attention was placed in selection of appropriate soil, types and contents of stabilizer and the compressive strengths that can be obtained. Since CSE bricks and blocks can be cast to accurate dimensions, a lot of attention was placed on finishing without a wall plaster. Thus, a considerable number of construction issues also have been addressed in previous research.

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Fig. 1. CSE brick of 230 mm × 110 mm × 75 mm (length × width × height).

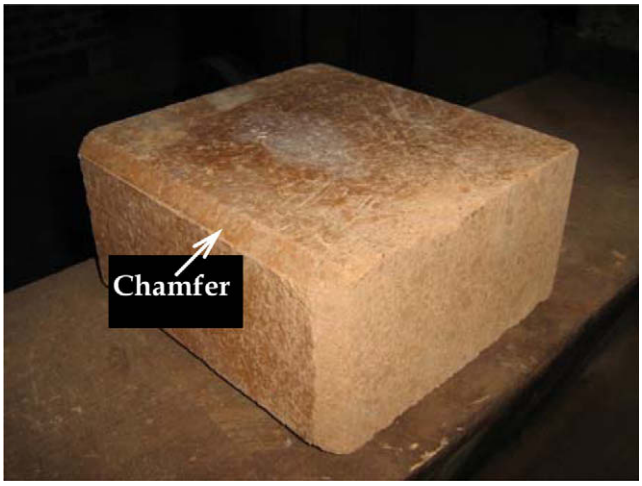

Fig. 2. CSE plain solid block of 225 mm × 225 mm × 115 mm (length × width × height).

Fig. 3. CSE interlocking solid block of 225 mm × 225 mm × 115 mm (length × width × height).

Fig. 4. CSE interlocking hollow block of 300 mm × 145 mm × 100 mm (length × width × height).

Fig. 5. Rammed earth panel of 600 mm of length × 900 mm of height × 150 mm of thickness used for testing.

Useful information on compressive strength with different types of soil, including laterite have been presented in, Perera and Jayasinghe [4], Reddy and Jagadish [5], Bryan [6–8], Guillaud et al. [9]. Another important parameter for satisfactory performance of load bearing walls is flexural strength. Flexural strength is a useful property in resisting lateral loads in lightly loaded walls especially in the case of single leaf walls as often used in climates with tropical conditions since especial insulation needs do not arise due to winters. However, this has not received the same type of attention as compressive strength since CSE masonry with adequate compressive strength generally would have sufficient stability in small houses with many partition walls. Nevertheless flexural strength deserves special attention since adequate knowledge on strength parameters can allow structural design engineers to check the adequacy with suitable design methods. Such an approach is gradually becoming a necessity with the new trends with disaster resistance of houses are given considerable attention in order to minimize casualties and damages.