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Effectiveness of Cement and Lime in Earth Bricks for Building Construction

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ABSTRACT

Earth, is an important building material which is present in the nature and is available in most of the regions. Currently people demand energy efficient and cost effective buildings that emphasize a healthy and balanced livelihood. In developing countries, a construction with earth is economically the most efficient means to meet the demand of the needy with least demand of the resources. Handmade unbaked bricks known as "mud bricks" or "adobes" are employed traditionally and they suffer from cracks and water attack which in turn need continuous maintenance to keep them in good condition. In order to improve the effectiveness of mud bricks stabilization is being practiced nowadays. This study is devoted to enhance the compressive strength and water absorption characteristics of mud bricks with the use of cement and lime as stabilizers at varying proportions to increase the properties of the basics earth mix for the making of mud bricks. The experimental results show that with the addition of stabilizers to a certain limit lead to an improved effectiveness of the mud bricks.

Keywords : Adobe, Stabilization, Cement, Lime, Compressive strength

I. INTRODUCTION

Earth is the most widely known and abundant building material available for various constructions for the human needs. Earth is a main part of construction from the ancient time onwards. Local availability of earth makes its use advantageous and ease of its processing to mud block makes it one of the most energy efficient, cost effective and very reliable building material in general.

But construction practices of today highly depend on materials like cement, burnt bricks and other materials like steel, aluminium etc which cause negative impact on environment and economy in many ways. Thus it's very much important to enhance the properties of traditional unbaked mud blocks. Looking towards this, the alteration was made to them by stabilizing the earth with stabilizers. It's known that constructions with mud brick technology has been widely used in regions soil containing high silt and clay contents. Therefore this study aims to investigate the enhancing the properties of mud bricks after its stabilization with cement and lime which are the stabilizing agents. In this research the compressive strength and water absorption characteristics of the mud blocks are investigated.

II. METHODS AND MATERIAL

A. Materials

The materials used in this study for mud brick making were red soil and sand as the main matrix, and cement and lime as stabilizers.

B. Methods

In the experimental investigation, physical tests were carried out on red soil obtained from Palakkad District, Kerala. The specific gravity of the soil sample taken was found to be 2.061 which is within the range of specific gravity range so that the soil belongs to organic soil. Liquid limit and plastic limit tests were conducted on soil sample. The liquid limit and plastic limit values were found to be 29% and 25% respectively. The physical properties of sand, cement and lime were also done. **Mixing of Raw Materials** The raw materials use4d in this investigation were mixed together at

various mix proportions of cement and lime to the mix of soil and sand. The proportions of cement and lime used were shown in the table 1.

Table 1. Mix Proportions of Cement And Lime

Mix Designation	Cement %	Lime %
Mix 1	0	10
Mix 2	2	8
Mix 3	4	6
Mix 4	5	5
Mix 5	6	4
Mix 6	8	2
Mix 7	8	0

The raw materials were mixed to reach optimum brick properties (Fig: 1). These properties include compressive strength and water absorption without sacrificing the superior advantage of the ordinary brick.

Figure 1: Mixing of Raw Materials

As per IS 1725- 1982 brick moulds of size 19cm x 9cm x 9 cm were used (Fig: 2).

Figure 2 : Timber Brick Moulds

Six number of stabilized earth blocks were made for each proportion. Out of which three were taken for compressive strength test and rest three for water absorption test. The tests were done after 28 days of drying under shade. The blocks were dried under natural ventilation and lighting (Fig: 3).

Figure 3: Stabilized earth blocks kept for drying

Experiment and Test Procedure The compressive strength of the bricks was tested in a Compressive Testing Machine with a load axially applied at a uniform rate of 14 N/mm2 per minute till failure occurs (Fig: 4).

Figure 4: Compression test on Stabilized Brick

The water absorption test was done by Immersion Method by immersing the specimen in clear clean water at a temperature of 270C for 24 hours (Fig: 5).

Figure 5: Immersion Test on Stabilized Bricks

III. RESULT AND DISCUSSION

Table 2 shows the compressive strength of stabilized earth blocks for all the mixes.

Table 2. Compressive Strength Of Stabilized Blocks

Mix Designation	Compressive Strength, N/mm^2
Mix 1	0.07
Mix 2	1.05
Mix 3	2.77
Mix 4	2.57
Mix 5	2.37
Mix 6	3.74
Mix 7	4.26

The compressive strength is low when the blocks were stabilised with lime only (Mix 1). With the addition of cement and by decreasing the percentage of lime usage the compressive strength is increasing. It can be found that the compressive strength is very much high if the block was stabilized with cement alone (Mix 7). It was found that minimum strength was obtained with Mix 4 and Mix 5. The Fig: 6 show the variation of compressive strength at various mixes.

As per IS 3494-1992 minimum compressive strength of a normal brick was 3.50 N/mm2. But the mix corresponding to mix 6 gives the optimum

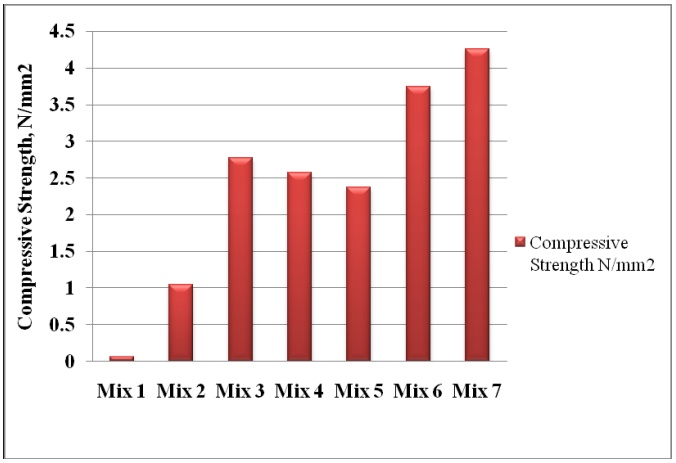

Figure 6: Variation of Compressive strength

Table 3 shows the water absorption rates of stabilized earth blocks for the various mixes.

TABLE 3 WATER ABSORPTION VALUES OF STABILIZED BLOCKS

Mix Designation	Water Absorption, %
Mix 1	13.57
Mix 2	13.9
Mix 3	10.77
Mix 4	9.52
Mix 5	12.8
Mix 6	12.9
Mix 7	11.48

The rate of water absorption is very high for mix 1. The water absorption rate is decreasing with the addition of cement and also by decreasing the percentage of lime. But the water absorption is increasing with increase in the cement content also that is blocks made with Mix 7 has also got high water absorption. Low water absorption was obtained for mix 4. The Fig: 7 show the variation of the water absorption at various mixes.

As per IS: 3495-1992 water absorption shall not be more than 20% by weight of a brick. Thus all the mix proportions of stabilizers were acceptable for making of stabilized bricks.

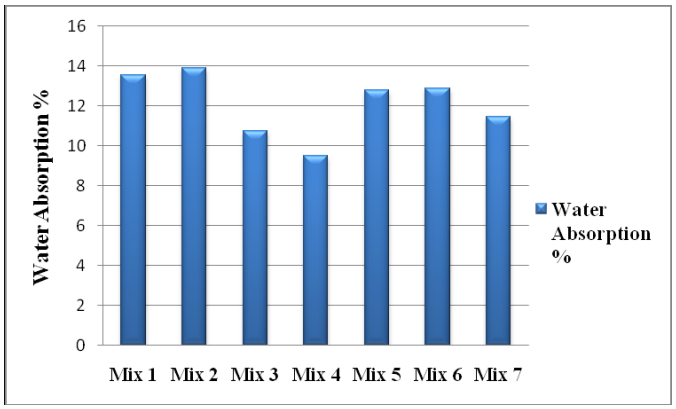

Figure 7 : Variation of Water Absorption

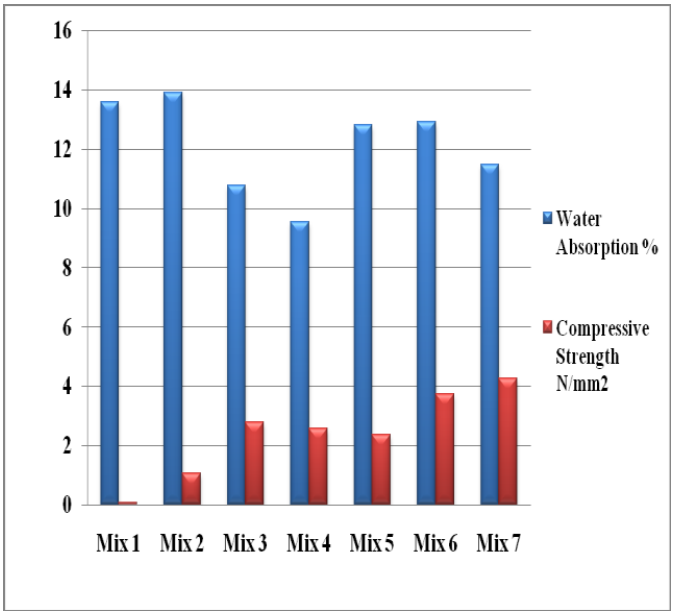

Figure 8 : Variation of Water Absorption and Compressive Strength

IV. CONCLUSION

Stabilized Earth Blocks are manufactured using stabilizers to provide adequate compressive strength and durability, so, as to make them suitable as building blocks. From the experiments, the obtained values of the physical properties of materials for the making of Stabilized Earth Block that is cement, soil and sand is within the range as per the Indian Standards. It is observed that while using cement as the stabilizer alone the compressive strength is found to be greater than that of ordinary brick. From the view point of compressive strength, the combination of stabilizers with 8% cement and 2% lime was found to have higher compressive strength of 3.74N/mm$_2$ with water absorption of 12.9%. And also it was found that the combination of stabilizers with 5% cement and 5% lime have the least water absorption with 12.52% having a compressive strength of 2.57N/mm$_2$, which is less than the minimum compressive strength of an ordinary brick as per Indian Standards. Hence it can be concluded that the most acceptable proportion for the making of Stabilized Earth Block was found to be 8% cement and 2% lime even though the water absorption rate is greater by 3.38% compared to 5% cement and 5% lime. The variation of water absorption and compressive strength is shown in Fig: 8.

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