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STUDIES ON STABILIZED MUD BLOCK AS A CONSTRUCTION MATERIAL

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ABSTRACT- Soil as a building material is available in most areas of the world. In developing countries, earth construction is economically the most efficient means for house construction with the least demand of resources. Investigation is carried out to find the suitable proportion of locally available materials such as soil , coir , straw etc. with cement as stabilizers for improving the strength of locally available mud blocks and thus to provide affordable housing. Using soil (from areas of Neriamangalam) and stabilizers (cement, lime, straw fibre, coir fibre, plastic fibre), eleven different types of samples were prepared. Tests were conducted on these samples in order to evaluate their performance such as compressive strength and total water absorption on which the durability of the blocks depend. The investigation has revealed that, out of all block samples, blocks which are produced from10% cement (C10), 10% cement with 3% coir fibre (C10C) and 10% cement with 3% plastic fibre (C10P) have compressive strength and total water absorption values above the recommended minimum values for structural work.(IS 1725:1992)

Keywords: Stabilizers, compressive strength, water absorption, affordable housing.

1. INTRODUCTION

Adequate shelter is one of the most important basic human needs. Currently, the majority of developing countries are faced with a problem of providing adequate and affordable housing in sufficient numbers. In the last few decades, shelter conditions have been worsening: resources have remained scarce, housing demand has risen and the urgency to provide immediate practical solutions has become more sensitive [4], [5].

For providing low-cost housing, we must rely on locally available raw materials. Home brick-makers have long been using fibrous ingredients like straw to improve the tensile strength of mud bricks. However, they have not had a chance to do scientific experimental investigation on the balance of ingredients and the optimisation of this production [9]. The fibres, which are connected together by mud, provide a tensile strength in mud bricks. The fibres provide a better coherence between the mud layers. The stress–strain relation of mud bricks under compression is very important. The compressive strength of fibre reinforced mud brick has been found to be higher than that of the conventional fibreless mud brick, because, fibres are strong against stresses. Furthermore, such materials are abundantly available and renewable in nature. Local soil has always been the most widely used material for earthen construction in India. However, such type of construction has some serious drawbacks such as, i) Water penetration ii) Erosion of walls at the plinth level/ lower level by splashing of water from ground surfaces. iii) Attacks by termites and pests. iv) High maintenance requirements. v) Low durability.

Mudbrick has several advantages over conventional fired clay or concrete masonry. Mud bricks perform considerably better, in environmental terms, then fired bricks. They have significantly less embodied energy, contribute fewer CO_2 emissions and help to promote the local economy and local labour. At first glance they appear to be an ideal candidate for an economically viable sustainable construction material. However, the major drawback of unfired mud bricks is that they tend to be less durable than their fired counterparts and are more susceptible to water damage. Traditionally, unfired mud bricks have been stabilised with cement to overcome these short comings but the use of cement and other stabilizers reduces the environmental differential between unfired bricks and fired ones. Research into alternative stabilisers is both relevant and necessary to ensure unfired mud bricks remain a competitive alternative to modern construction methods. They have high thermal mass and sound absorbing property. Stabilized mud blocks can be produced easily without any skilled labour and sophisticated machinery.

2. SCOPE OF THE PROJECT

Relevance of the project includes providing a low cost alternative to the contemporary building materials. Especially in the areas of low rainfall, stabilized compacted earth blocks are a better alternative considering cost as a factor. Since India is a tropical country, mud blocks preserves a good living atmosphere inside the houses, it prevents too much heat from entering the building.

3. OBJECTIVE

The objectives of this project are [2]:-

- To investigate local soils to identify their suitability in stabilized earth block production.
- To study experimentally the effect of altering important variables such as cement, lime, straw fibre, coir, plastic fibre content on the properties and performance of stabilized earth blocks.
- To meet the economic requirements of the local situation by: reducing dependence on outside sources and ensuring low cost alternatives.
- To determine the percentage of stabilizer and the most effective stabilizer for the chosen soil [11].

4. EXPERIMENTAL SETUP

4.1 COLLECTION OF SAMPLES

Different soil samples were collected from Koothattukulam, Neriamangalam, Nellikuzhy, and Cheladu of Ernakulam district. All the samples were properly dried. Sieve analysis was done on the samples to get different fractions of gravel, sand, silt and clay. A good soil sample for mud block construction should have 10-15% gravel, 50-75% sand, and 15-30% silt & clay.

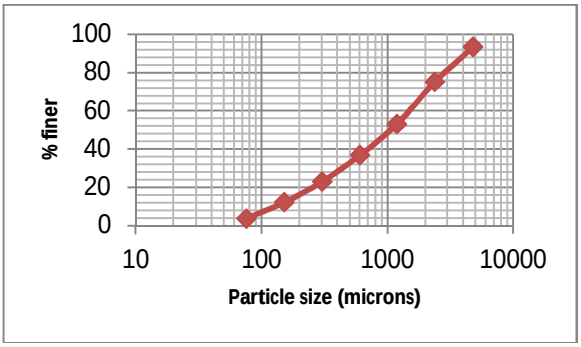
4.2 MOULD

Moulds were prepared with dimensions 254 mm X 127mm X 76 mm size. And the mould was prepared with wood [1].

4.3 SIEVE ANALYSIS

Purpose: This test is performed to determine the percentage of different grain sizes contained within a soil. The mechanical or sieve analysis is performed to determine the distribution of the fine and coarser or larger-sized particles [10].
This test consists of filtering the soil through a series of standard mesh sieves placed one above the other in decreasing order (i.e. the finest mesh at the bottom) and in determining the proportion of soil particles left in each sieve. The final test result gives a complete and quantitative proportion of the different grain sizes within the soil mass.

Observations:-The results obtained from different samples are,



Percentage of gravel = **6.6%**
Percentage of sand = **89.6%**
Percentage of silt & clay = **3.8%**

Figure 1: Sieve analysis results of sample 1.

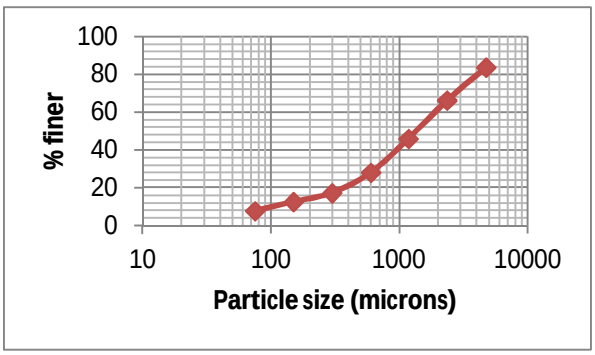


Figure 2: Sieve analysis results of sample2.

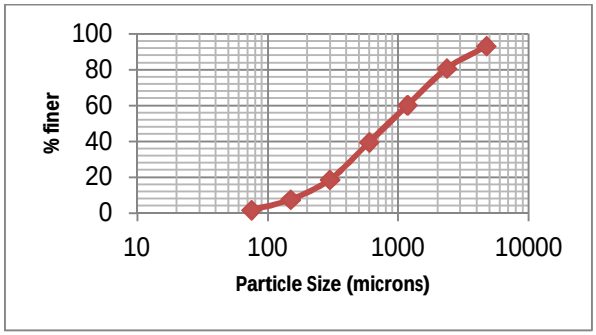


Figure 3: Sieve analysis results of sample3.

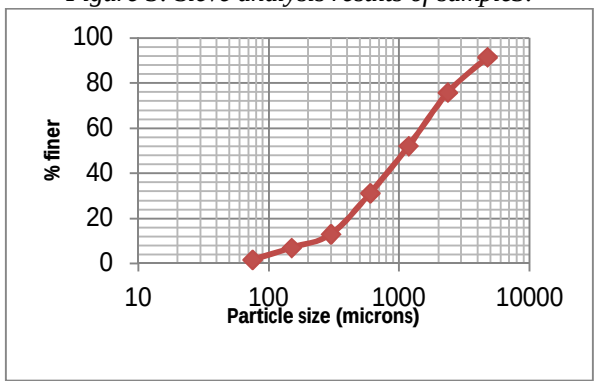


Figure 4: Sieve analysis results of sample4.

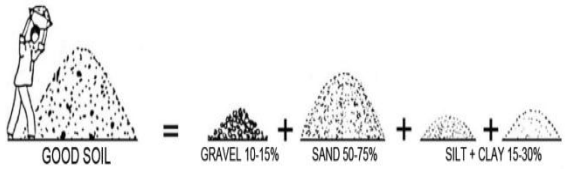


Figure 5 : Desirable proportions for brick making.

From the results obtained from sieve analysis of the collected samples ,it was found that sample 2,has almost similar proportions for making a good brick as shown in Figure 5.Sample 2 contains 16.2% gravel , 76% sand & 7.8% silt and clay.

Proportions selected

The various proportion of stabilizers used are [6],

TABLE 1: STABILIZER PROPORTIONS.

PROPORTIONS SELECTED	DESCRIPTION
S	Soil only
L5	Lime-5%
C5	Cement-5%
L10	Lime-10%
C10	Cement-10%
C5C	Cement-5%,coir-3%
C5P	Cement-5%,plastic fibre-3%
C5S	Cement-5%, straw fibre-3%
C10P	Cement-10%, plastic fibre-3%
C10S	Cement-10%, straw fibre-3%
C10C	Cement-10%, coir-3%

4.4 COMPRESSION TEST

Compressive strength of each mud blocks were tested in the compression testing machine, initially the self-weight of the compression testing machine was balanced. The maximum compressive strength value obtained was 3.20 N/mm^2 for the mud block with 10%cement and 3% coir fibre. As per IS 1725,the compressive strength range is between 2-3 N/mm^2 [3].Results of compression test are shown in Table 2.For mud blocks with cement as stabilizing agent showed more compressive strength than the mud blocks with lime as the stabilizing agent. For lime when percentage of stabilizer is increased, the change/increase in compressive strength was very slight. Whereas for the mud blocks with cement as stabilizer, the compressive strength were increased reasonably [7].

For mud blocks which are reinforced with coir showed more compressive strength than the plastic fibre and straw fibre, for the same proportion of stabilizer. Mud block with 5% cement & 3% straw fibre showed more compressive strength than the mud block reinforced with plastic fibre (3%).But when the percentage of stabilizer (cement) increased to 10%, the strength is more shown by the mud blocks which were reinforced with plastic fibre. The size of fibre used in the experiment for coir, straw fibre and plastic fibre were 2.5 cm. Maximum dry density was shown by the mud block with 10% cement and 3% straw fibre(C10S).

TABLE 2: RESULTS OF COMPRESSION TEST.

ITEM	DESCRIPTION	FIBER SIZE	WEIGHT (KG)	AVERAGE COMPRESSIVE STRENGTH 28 DAYS (N/MM2)
S	Sand only	---	3.60	1.06
L5	5% lime	---	3.58	1.09
C5	5% cement	---	3.63	1.33
L10	10% lime	---	3.61	1.15
C10	10% cement	---	3.60	1.52
C5C	5% cement+3%coir	2.5cm	3.65	2.03
C5P	5% cement+3% plastic	2.5cm	3.65	1.94
C5S	5% cement +3% straw	2.5cm	3.68	1.99
C10P	10% cement +3% plastic	2.5cm	3.60	2.86
C10S	10% cement+3%straw	2.5cm	3.64	2.53
C10C	10%cement +3% coir	2.5cm	3.62	3.20

4.5 WATER ABSORPTION TEST

Initially the weight of each of the mud block specimen were taken (W1), then mud block specimen were soaked in water . After 24 hours of water absorption, specimens were taken out, wiped and weighed (W2).The % water absorption can be calculated as :-

$$\% \text{ water absorbed} = \frac{W2 - W1}{W1} \times 100$$

Results of water absorption test are given in Table 3.

Adding 5 percent cement failed to satisfy the water as absorption criteria, but this level of cement addition can be useful for applications where stability is not a governing criteria such as in internal walls, partition walls, etc. and appears to be the most economical option [8].

As per IS specification the maximum allowable percentage of water absorption is 15 percentage [3]. Some of the bricks failed in the test, since the water absorption rate of the bricks were higher than the allowable value. Mud blocks stabilized with lime absorbed more amount of water and failed IS criteria, and cannot be used effectively. The mud block with 10 percentage cement and 3 percentage plastic fibre showed maximum reduced water absorption rate of 12.50 percentage

TABLE 3: RESULTS OF WATER ABSORPTION.

ITEM	WEIGHT BEFORE WATER ABSORPTION(KG)	WEIGHT AFTER WATER ABSORPTION (KG)	% WATER ABSORPTION
S	3.60	4.45	23.61
L5	3.58	4.33	20.94
C5	3.63	4.35	19.83
L10	3.61	4.25	17.72
C10	3.60	4.10	13.88
C5C	3.65	4.25	16.44
C5P	3.65	4.23	15.89
C5S	3.68	4.40	19.56
C10P	3.60	4.05	12.50
C10S	3.64	4.30	18.13
C10C	3.62	4.10	13.25

5. COST ANALYSIS

RAW MATERIALS	RATE	C10	C10C
Soil	200 per truck(180 ft)	4.05 kg - Rs .09	3.915 kg - Rs. .08
Cement	335 per bag (50 kg)	.45 kg - Rs 3.01	.45 kg - Rs 3.01
Coir fiber	20 per kg (aprox)	----------	.135 kg - Rs 2.7
Total	----------	Rs 3.10/-	Rs 5.80/-

Cost of a burnt brick = Rs 7/-
Therefore, from cost analysis, it is understood that blocks with 10 % cement are about 55.7% cheaper than burnt bricks. Blocks having 10% cement 3% coir are about 17.14% cheaper than burnt bricks.

6. CONCLUSION

1. *Compressive strength increased with increase in cement content. However, increase in lime content showed very little increase in strength.*
2. *Compressive strength increased by 43.39% for 10% cement content.*
3. *Compressive strength increased by 201.88% for 10% cement content & 3% coir .*
4. *Compressive strength increased by 169.811% for 10% cement & 3% plastic.*
5. *The average water absorption for blocks having 10% cement (C10),10% cement 3% coir (C10C) , 10% cement 3% plastic fibre (C10P) were less than 15% satisfying the IS recommendation.*
6. *Cost analysis of production shows that blocks with 10 % cement are about 55.7% cheaper than burnt bricks. Blocks having 10% cement 3% coir are about 17.14% cheaper than burnt bricks.*

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