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COMPRESSED STABILIZED MUD BLOCK AS AN ALTERNATE BUILDING MATERIAL

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Abstract— Soil or earth is an alternate building material to conventional materials like steel and concrete. Earth is a commonly available building material in most areas of the world and used by almost 40% of the world population. Mud block construction exists in earlier years because of the least demand of resources, low energy consumption and simplicity of production process. Stabilized mud block construction in the industry has been the focus of research for economic, environmental and technical reasons. It has good thermal comfort and sound insulation property. Stabilized mud block consumes energy 4 times less than country fired bricks, it requires less amount of mortar for plastering and it gives good architectural appearance. Stabilized mud block is manufactured by compacting the raw earth and stabilized with cement under a pressure of 20-40kg/cm by using manual, mechanical or hydraulic soil press. In the present work Compressed Stabilized Mud blocks are manufactured with various proportions of cement with refractory bricks with a size of 240 x 140 x 120 mm. As cement and refractory bricks as stabilizer, recycled plastic is also used to make compressed stabilized mud block .These blocks with different combinations of cement, refractory bricks and recycled plastic was tested for 28 days compressive strength, water absorbtion and density.Based on the results, compressive strength increases with increasing percentage of cement and refractory bricks,water absorption is reducing with addition of recycled plastic and density is within the acceptable limit as per IS code.

Keywords: Compressed Stabilized Mud Block, Stabilizer, Refractory bricks, Recycled Plastic, Manual Press

INTRODUCTION

A hundred years ago, there were a lot of forests, which were our main material resources for building constructions. Nowadays it is deployed because of rapidly increasing population and their increasing demand .In the last few decades, shelter condition have been worsening: resources have remained scarce, housing demand has risen and the urgency to provide immediate practical solutions has become more sensitive. However 25% of the world's population does not have any fixed home, and 50% of the urban population lives in slums. Indeed, 80% of urban settlements in developing countries consist of slums and spontaneous settlement made of temporary materials.

The compressed earth block is the modern descendent of the moulded earth block, more commonly known as adobe block. The idea of compacting earth to improve the quality and performance of moulded earth block is, however, far from new, and it was with wooden tamps that the first compressed earth blocks were produced. Nowadays adobe blocks are converted into compressed stabilized mud block. These blocks were prepared by using raw earth with stabilizer and compressed by using manual, mechanical and hydraulic presses. In the present investigation manual presses are used for the production of blocks.

From the past 40 to 50 years, there has been an increasing interest in the use of stabilized compressed earth blocks for residential construction. They maximize the use of locally available materials require relatively simple construction methods. Stabilized blocks offering favourable thermal and acoustic insulation properties. Environmental benefits include reduced energy consumption in production and a lessening demand for non-renewable resources. In western countries, thousands of luxury earth homes have been built in the last few decades. These have showed the feasibility of this material as a natural building material. The strategy will have the potential to reduce costs, conserve energy and minimize waste. However, the main deficiency of unstabilized clay soil is its susceptibility to water damage. This problem is now over by stabilizing the clay soil with addition of a small amount of cement, lime, gypsum or flyash thereby enhancing many of the engineering properties of the soil and producing an improved construction material.

Providing an affordable housing is a big issue nowadays, especially in developing countries. Ideally, low cost housing

must rely on locally available raw materials. Local soil has always been the most widely used material for earthen construction in India. Approximately 55% of Indian homes still use earth for wall construction. Stabilized mud blocks have been used for masonry construction in Australia, France, India, Columbia, Chile, Algeria, Brazil, Thailand and many other countries.

From the review done on sustainable construction practices and materials and also on Compressed Stabilized Earth Brick (CSEB) on previous year, there is a growing interest in stabilized earth building materials with respect to less energy consumption and ecological design, which fulfills all strength and serviceability requirements for thermal transmittance.

1.1 SCOPE OF THE INVESTIGATION

The scope of the project is soil samples collected from palakkad district in Kerala , whether the samples are suitable for making compressed stabilized earth blocks. Soil collected from this region are consists soil, stone chips and clay. A more useful range of particle sizes suitable for building with earth block is from 40 - 75% sand and from 25 - 60% fine (silt and clay). As there was no easy method to segregate clay from the silt some variation in clay and silt content in a particular design mix was expected. Therefore, while designing a particular mix, definition of good soil was not completely followed. The present samples which contain 8.24% gravel,54.62% sand and 37.14% silt and clay ,which is suitable for making the blocks.

1.2 MATERIALS USED

The materials used for the production of compressed stabilized mud block were locally available raw earth which is collected from palakkad district in Kerala, and it is suitable for the production. Along with raw earth cement (OPC 53 grade conforming to IS 12269-2013 in the range of 5-15%) is used as a primary stabilizer. Reusing of refractory bricks which consists of silica and lime act as a better stabilizing agent and it is adding along with cement as 2%. Apart from stabilizers, 2% of recycled plastic is used with cement in the form of polypropylene for the production of blocks.Portable water which is free from impurities with neutral P^H .Compressed stabilized mud block of size 240mmx140mm x120mm by using manual press was used in this investigation.

1.3 SAMPLES PREPERATION

The compressed stabilized earth blocks are prepared. After drying, the blocks were removed from the moulds and the blocks were then weighed separately this condition to calculate the block density. Then the blocks were placed outside for sundry. Finally, the blocks were tested for their compressive strengths at 7 days and 28 days. In addition, they were tested for water absorption using standard procedure as laid down in IS: 3495 (part-2) this condition to calculate the block density. The combination of materials for the preparation of blocks for testing were given in Table 1.1.Abbreviations in the tables are CM –Cement,RP-Recycled Plastic,RB-Refractory Bricks

Table 1.1 Sample Proportions

Cat. No	Mix	Proportions	Size of Specimen
1	Soil	100%	240x140x120mm
2	CM+Soil	5%+95%	240x140x120mm
		10%+90%	
		15%+85%	
3	CM+RP+ Soil	5%+2%+93%	240x140x120mm
		10%+2%+88%	
		15%+2%+83%	
4	CM+RB+ Soil	5%+2%+93%	240x140x120mm
		10%+2%+88%	
		15%+2%+83%	
5	CM+RP+ RB+Soil	5%+2%+2%+91%	240x140x120mm
		10%+2%+2%+86%	
		15%+2%+2%+81%	

2. EXPERIMENTAL SET UP

A. COMPRESSIVE STRENGTH

The compressive strength of compressed stabilized mud block was carried out in compression testing machine (CTM) as per IS 3495 (Part I):1992.The compressive strength was calculated by dividing the maximum load at failure in 'N' by average net area of the two faces under compression in '$mm^{2'}$ specimen. Three blocks of each category were tested and the average value is taken as compressive strength of block. Result of compressive strength were shown in Table 2.1

Table 2.1 Compressive strength Results

Cat. No.	Mix	Proportions	7^{th} day (N/mm^2)	28^{th} day (N/mm^2)
1	Soil	100%	1.358	1.984
2	CM +Soil	5%+95%	1.240	1.984
		10%+90%	1.612	1.984
		15%+85%	1.860	2.232

3	CM + RP + Soil	5%+2%+93%	1.480	1.984
		10%+2%+88%	1.740	2.210
		15%+2%+83%	1.984	2.232
4	CM+ RB+ Soil	5%+2%+93%	1.860	1.980
		10%+2%+88%	1.984	2.108
		15%+2%+83%	1.984	2.138
5	CM + RP +RB +Soil	5%+2%+2%+91%	1.984	2.400
		10%+2%+2%+86%	2.230	2.728
		15%+2%+2%+81%	2.350	2.850

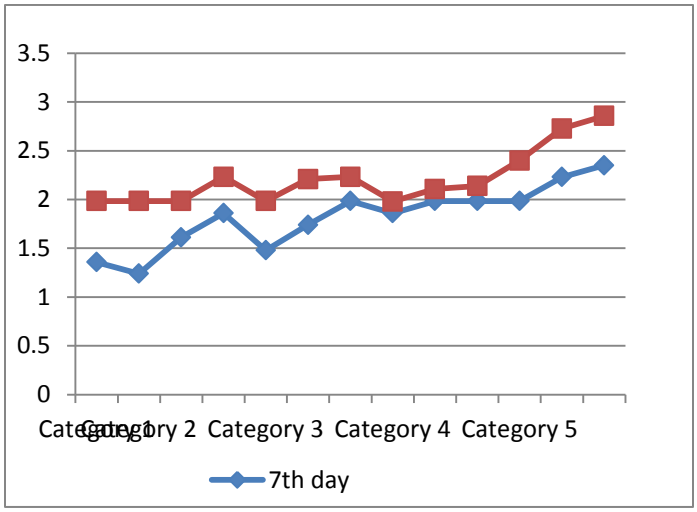

Figure 2 1 Compressive Strength

B. WATER ABSORPTION

Water absorption of blocks were tested in accordance with IS 3495 (Part 2):1992.This test method to determine the water absorbed in 24 hours. After immersing the specimens in water at room temperature,then remove the specimens from water and allow it to drain for 1min by placing them on wire mesh,remove the surface water with a damp cloth and weigh the specimen and record as a weight (M_2).Then dry the specimen in a ventilated oven at 105^0c till it attains substancially constant mass.Cool the specimen to room temperature and obtain its weight (M_1).

The water absorption is calculated by using the following formula:

$$\text{Water absorption (\%)} = \frac{M_2 - M_1}{M_1} \times 100$$

Results of water absorption were shown in Table 2.2 and the graphical representation shown in Figure 2.2.

Table 2.1 Water Absorption Results

Cat. No.	Mix	Proportions	Dry Mass M_1 (g)	Wet Mass M_2 (g)	% of water absorption
1	Soil	100%	7290	7430	2.24
2	CM +Soil	5%+95%	6890	7200	4.50
		10%+90%	6900	7450	7.97
		15%+85%	7020	7440	5.98
3	CM + RP + Soil	5%+2%+93%	6440	6530	1.40
		10%+2%+88%	6950	7020	1.00
		15%+2%+83%	6770	6950	2.65
4	CM+ RB+ Soil	5%+2%+93%	6960	7050	1.29
		10%+2%+88%	6920	7120	2.89
		15%+2%+83%	7010	7160	2.14
5	CM + RP +RB +Soil	5%+2%+2%+91%	6770	6940	2.50
		10%+2%+2%+86%	6920	7030	1.60
		15%+2%+2%+81%	7010	7120	1.57

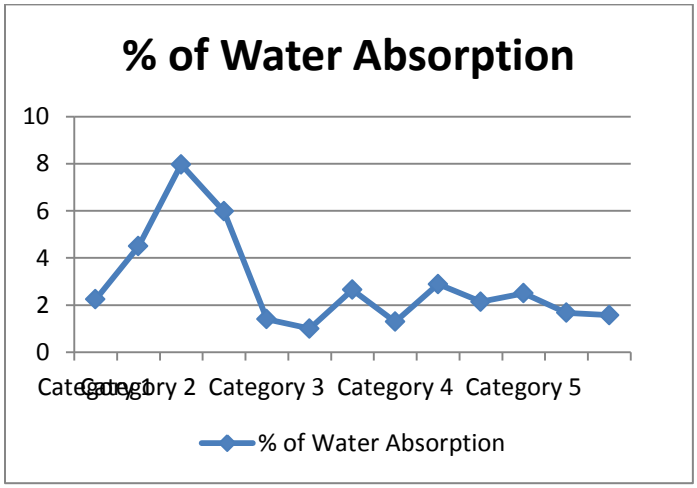

Figure 2.2 Water Absorption

C. BLOCK DENSITY

Block density was calculated by dividing the mass of the block in gram by volume of the block in cubic centimeter.Block density at 28 days maturity age was

calculated and shown in Table 2.3 and graphical representation was shown in Figure 2.3.

Table 2.3 Block Density Results

Cat. No.	Mix	Proportions	Mass (gm)	Volume (cm^3)	Density (gm/cc)
1	Soil	100%	7290	3711.83	1.960
2	CM +Soil	5%+95%	6870	3794.31	1.810
		10%+90%	7020	3761.19	1.866
		15%+85%	6900	3766.82	1.832
3	CM + RP + Soil	5%+2%+ 93%	6440	3594.75	1.792
		10%+2%+ 88%	6950	3788.45	1.834
		15%+2%+ 83%	6780	3594.75	1.886
4	CM+ RB+ Soil	5%+2%+93%	6960	3695.78	1.880
		10%+2%+ 88%	6930	3953.16	1.753
		15%+2%+ 83%	7070	3705.18	1.908
5	CM + RP + +Soil	5%+2%+ 2%+91%	6960	3847.5	1.808
		10%+2%+ 2%+86%	7020	3782.52	1.855
		15%+2%+ 2%+81%	7060	3953.16	1.785

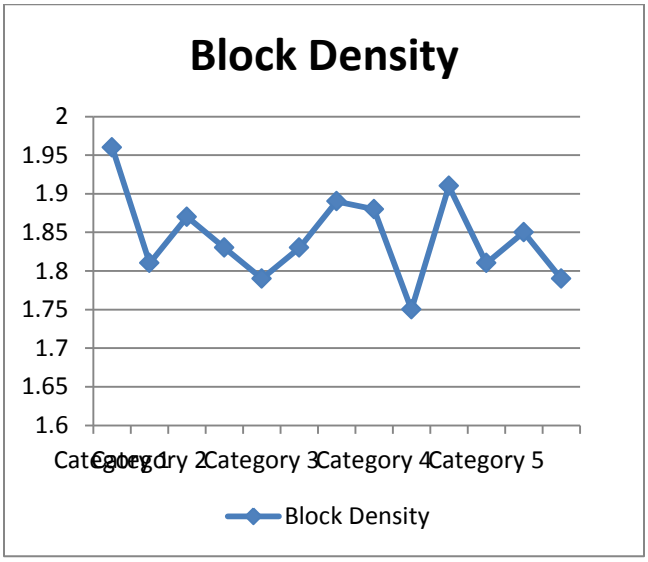

Figure 2.3 Block Density Results

3. RESULTS AND DISCUSSION

Characteristics of compressed stabilized mud block stabilized with cement and refractory bricks of different proportions are examined. Characteristics of compressive strength, water absorption and block density were determined according to IS 3495-1992 (Part 1-4) and performance of the block is based on IS 1725-1982.From Table 2.1 ,It is observed that 7 days compressive strength ranges from 1.30 to 2.50 N/mm^2 and 28 days compressive strength ranges from 1.90 to 2.90 N/mm^2.From Table 2.2 shows the water absorption results and it is ranging from 1 % to 8% and it is within the limit as per IS code. Table 2.3 shows the block density and it is ranging for each category is 1.75 to 1.96 gm/cc and highest block density shown for category 1 that is 100% of soil block.

From the earlier investigation, compressive strength of the compressed earth block were improved by the presence of gypsum [14].Any cementious material which can be improved the strength of compressd stabilized earth block, combination of cement and jute fibre with 5%-10% having the compressive strength ranging from 1.2 to 6.5N/mm^2[12] .In the present investigation it is ranging from 1.30 to 3.0 N/mm^2.According to the previous studies wet compressive strength of compressed block ranging from 1 to 4 N/mm^2 and the dry compressive strength ranging from 5 to 7 N/mm^2,in the case of water absorption it was satisfying the IS recommendation [7].In the present investigation also satisfying the IS recommendation in the case of water absorption.These investigation recommends the use of compressed stabilized mud block should be a suitable alternative building material.

CONCLUSION

From the results obtained for the various tests conducted for the compressed stabilized mud block were found and it is concluded that;

1. Compressive strength increases according to the
2. increase in
3. cement content and it boost up the strength with addition of 2% of refractory bricks and 2% of recycled plastic.80% of the strength was achieved within 7 days maturity.

2. Category 1 shows the strength ranging from 1.20 to 1.50 N/mm^2 at 7 days and 1.60 to 1.90 N/mm^2 at 28 days age of the block without any stabilizing agents.

3. In each category 15% addition of cement shows the higher strength than 5% and 10%.Addition of refractory bricks improve the strength of blocks than recycled plastic.

4. Water absorption of all the category blocks satisfy the criteria as per IS 1725.Average water absorption having cement varies from 5 to 15% were less than 15% as per IS recommendation and addition of recycled plastic reduces the water absorption is noticeable.

5. Block density of the blocks ranges from 1.75 to 1.96 gm/cc and it is ranging more or less constant with addition of cement from 5 to 15%.

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