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Stabilized Mud Blocks Using Industrial Waste

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ABSTRACT: Increasing rate of construction to meet the needs of people is one of the solutions for the increase in population, day by day the construction materials present are getting expensive or improved. The need for lighter and insulating type of blocks at a reasonable price which provides thermal comfort and which eliminates the demand for resources is essential. Industrial waste which is a lighter material as compared to that of the normal earth sample is used for the study. With the usage of industrial waste several samples of stabilized mud blocks were prepared and physical properties are studied. This experimental study revealed that, out of all the samples, blocks which are produced from 25% soil, 40% sand, 15% industrial waste, 7% cement, 2% lime have compressive strength and water absorption values above the limiting value as per IS 1725:1992.

KEYWORDS: Stabilized, Industrial waste, Compressive strength.

I. INTRODUCTION

Earth or mud has been in use as a building material for wall construction in all parts of world. However, use of plain mud in wall construction has some disadvantages. These walls have good dry strength but hardly have any wet strength and they are more prone to termite-related problems in moist conditions. The walls thus built using plain mud require regular maintenance. For providing low-cost housing, we must rely on locally available raw materials. The use of soil for wall construction has distinct advantages, such as the readily available local material, lower cost, and being recyclable and environment friendly. Also, earthen buildings provide better thermal comfort than buildings made from other conventional materials. Some of the major drawbacks of mud walls are the larger wall thickness, loss of strength due to saturation, issues relating to durability and erosion due to rain impact. These disadvantages can be minimized or eliminated by the use of stabilized soil products/techniques for the walls.

Stabilization is a technique of improving the properties of mud in such a way that it will possess the adequate wet strength, durability and dimensional stability (retains its shape and size both in dry and moist conditions) without burning. Compacting a mixture of sandy soil with cement and small quantities of lime at optimum moisture in a press results in stabilised mud blocks (SMB). The overall energy consumption in SMB is quite small (about one-third) in comparison with the burnt bricks. Compaction of soil-stabilizer mix can be done by using a manually operated or a mechanised press. The press should be capable of generating sufficient force to produce a dense block. It is advantageous to use a manually operated press to eliminate additional energy needs in terms of electricity or diesel.

Mud brick 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.

II. RELATED WORK

The following are the research analysis made formerly based on the strength parameters and outcomes of earthen blocks and other materials used in this project.

[1] Malkanthi et.al (2020) this paper compares the various properties of mud blocks with various proportions of lime and cement, its stated that 10% lime stabilized block can be used for single-storey building. Maximum strength of the blocks were achieved with a proportion of 5% lime,5% cement for soil blocks containing 15% and 10% clay and silt and 7% cement. The dry density of the blocks made with 5% and 10% clay and silt are at the specification value of 1750 kg/m3 .

[2] Tripura et.al (2020) this paper compares the properties of the mud blocks with and without bamboo and coconut fibres. There is an increase of 139%-167% of flexural strength than that of the stabilized rammed earth blocks and also shows very good improvement in ductility properties too. The lateral load carrying capacity and ductility of bamboo and fiber reinforced CSRE wallettes was found to be higher amongst all Wallette types studied in this investigation.

[3] Medvey et.al (2019) in this paper the author has done a detailed analysis of the stabilized blocks durability characteristics. Various comparisons of tests done for the blocks are analyzed and studied in an elaborate fashion.

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The author also has studied regarding various stabilizers used and its properties to which it effects the durability of the mud blocks. Also the paper suggests that there must be an alternative stabilizers with low environmental impact is needed, most for their weather due to climatic factors.

[4] Akinwumi et.al (2019) This paper states the suitability of making compressed earth bricks (CEB) with a mixture of soil and varying percentages (0, 1, 3, and 7%) of shredded waste plastic. The compressive strengths and erosion rates of the CEB made with the mixture of soil and varying proportions of shredded waste plastic of two size-categories (<6.3 mm and >9.6 mm) were determined. The highest compressive strength was obtained for the CEB containing 1% waste plastic of sizes <6.3 mm and its compressive strength amounted to a 244.4% increase. Of the CEB samples stabilized with shredded waste plastic, the sample containing 1% waste plastic of sizes <6.3 mm also had the least erosion rate. Provided the exterior surfaces of walls produced using the CEB are protected from erosion, the use of 1% shredded waste plastic with particle sizes <6.3 mm was recommended.

[5] Vinu et al. (2016) studied the stabilized mud block as a building material. Using soil and stabilizers eleven samples types were prepared for testing.The investigations has discovered that, out of all block samples, blocks that are made from 10% cement, 3% coir with another 10% cement and also an addition of 3% plastic fibre which accounts to a good compressive strength and total water absorption values succeeding the minimum values for the work at structural level. Compressive strength increased with increase in the cement content. Increase in lime content indicated very little increase in strength. Cost analysis of production indicates that blocks with 10 % cement are about 55.7% cheaper than burnt bricks. Blocks having 10% cement 3% coir are about 17.14% inexpensive than burnt bricks.

[6]Wang et al. (2012) In this work, Industrial waste was utilized as a transporter for the bacteria. Industrial waste immobilized bacteria had much progressed ureolytic movement contrasted with that of un-immobilized microbes in concrete slurry. The result from a capillary water retention test exhibited that the precedents with industrial waste immobilized bacteria had the lower most water water assimilation (30% of the reference ones), which demonstrated that the precipitation inside the cracks developed the water penetration resistance of the crack examples. Cracks with a width of 0.15– 0.17 mm in mortar precedents were half way or totally filled by the guide of Industrial waste immobilized bacteria at the danger on the immersion media. The restricted water ingestion in the precedents with bacteria was about half (cracks were generally filled) or 70% (cracks were totally filled) lower than in the samples without bacteria.

III. METHODOLOGY

In the first phase soil samples were collected from Nirmithi Kendra, Surathkal. The entire sample was properly dried. Sieve analysis was done on the sample to get different fractions of gravel, sand, silt and clay. Only those passing through 4.75mm sieve are used for casting blocks. The industrial waste used in the making of blocks is also made to pass through 4.75mm sieve. The basic tests of the samples were conducted as per the IS code.

In the second phase of study 30 blocks were casted with more varying percentage of the mix proportions. The two proportions with higher 14 days dry compressive strength is selected. Referring to the proportions of higher compressive strength blocks, the combined standard proctor test and unconfined compressive strength test (18 samples) were conducted with less varying percentage of the mix proportions in order to find the optimum mix proportion for the stabilized mud blocks. The percentage of cement, industrial waste and lime were kept constant i.e. 7%, 15% and 2% respectively. The UCC samples were tested for 7 days and two proportions (I & II) with higher strength is selected. The blocks were casted for the obtained mix proportions. Wet mixture of the soil, industrial waste, sand, lime and cement is then pressed into blocks of size 290 X 140 X 90 mm using a manually operated block making machine ensuring zero wastage and gunny bag curing is provided.

(a) Dry Sample mix proportion

IV. EXPERIMENTAL RESULTS

The below proportions showed better compressive strength than the other mix proportions.

Name	Soil	Sand	Industrial Waste	Cement	Lime	Water
Proportion 1	25%	40%	15%	7%	2%	11%
Proportion 2	30%	30%	15%	7%	2%	16%

Compressive strength results:

Proportion-1 (290x140x90)mm

Dimensions	Days of Curing					
	7 Days Average strength (Mpa)		14 Days Average strength (Mpa)		28 Days Average strength (Mpa)	
	Dry	Wet	Dry	Wet	Dry	Wet
Horizontal	4.24	3.88	4.97	3.93	8.88	5.2
Vertical	2.95	2.33	2.97	2.84	4.11	3.6

Proportion-2 (290x140x90)mm

Dimensions	Days of Curing					
	7 Days Average strength (Mpa)		14 Days Average strength (Mpa)		28 Days Average strength (Mpa)	
	Dry	Wet	Dry	Wet	Dry	Wet
Horizontal	3.19	2.86	3.51	3.10	4.2	3.5
Vertical	1.88	1.72	2.50	2.20	3.8	3.1

Water Absorption Test Result:

Water absorption test on blocks is carried out as per IS 3495 (Part 2): 1992.

Proportion 1				
	Wt. of oven dried block(M1)g	Wt. of block immersed in water(M2)g	Water absorption (%) [(M2- M1)/ M1]	Average (%)
7 Days	970.6	1100.6	13.39	13.87
	1325.5	1505.5	13.60	
	990.7	1135.7	14.63	
14 Days	2200	2456.8	11.6	12.9
	1700	1927.5	13.3	
	1700	1934.6	13.8	
28 Days	2008.2	2233.8	11.23	11.37
	1678.5	1855.9	10.56	
	1500.5	1685.4	12.32	

Proportion 2				
	Wt. of oven dried block(M1)g	Wt. of block immersed in water(M2)g	Water absorption (%) [(M2- M1)/ M1]	Average (%)
7 Days	983.2	1145.2	16.40	15.89
	1829.8	2115.8	15.60	
	1995.7	2308.8	15.68	
14 Days	1998.7	2289.8	14.56	14.61
	1395.3	1608.2	15.25	
	1495.3	1705.2	14.03	
28 Days	1999.0	2239	12.0	13.26
	1325	1525	15.09	
	1605	1810	12.7	

(b) Samples kept or oven drying

(c) Compressive strength test of blocks

V. CONCLUSION

- The purpose of this study is to determine the physical properties of stabilized mud blocks (SMBs) with the usage of industrial waste. The soil used was classified as SC (clayey sand) based on the particle size distribution of the soil. The strength properties of the blocks with varying percentage of soil, sand, lime, industrial waste and cement are studied to optimize the mix proportions for makingSMBs.
- The optimum mix proportion was obtained from the standard proctor test and unconfined compressive strength test results, which shows that the proportion I has higher strength compared to all the mix proportions. Hence proportion I (25% soil, 40% sand, 15% industrial waste, 7% cement, 2% lime) and proportion II (30% soil, 30% sand, 15% industrial waste, 7% cement, 2% lime) were selected for casting of SMBs. Optimum water content should always be sought to get higher strength and higher durability.
- It was found that 28 days compressive strength of proportion I was 8.88 MPa which is more compared to proportion II. Also the compressive strength increased with increase in cement content. Although, increase in lime content showed very little increase in strength. The increase in the percentage of industrial waste also lead to the cause small cracks.
- The average water absorption for proportion I blocks was less than 15% satisfying the IS recommendation. From the observed values of engineering properties as listed above, it can be inferred that the Stabilized Earth blocks are a cost effective building material

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