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Compressed Stabilized Earth Block (Experimental Investigation of Compressed Stabilized Earth Block using Manufactured Sand)

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***Abstract*: In India, there is huge scarcity of construction material due to rapid industrialization and large scale infrastructural development. Hence there is a need of eco-friendly construction material which is also economical for the construction. Materials used for the construction are normally requires to possess adequate strength and erosion resistance. This paper investigates the suitability of stabilized red soil for the production of compressed earth blocks for low cost housing construction. Experiment is done to improve the strength characteristics, identify the best material for sustainable construction. Increase in utilization of local materials and demolished waste can reduce the hauling of construction over longer distances, thus reducing the greenhouse gas emission associated with transporting such materials.**

***Keywords*: Compressed Stabilized Earth Block (CSEB), Manufactured Sand (M-Sand)**

1. Introduction

A compressed earth block compressed at high pressure to form blocks and it is a building material made primarily from damp soil. These blocks are also known as pressed earth blocks or compressed soil blocks. The materials used for the construction of blocks will provide adequate strength. In the present work the attempt is made using red soil, manufactured san, fly ash for the production of earth blocks in western zone of Nagpur in Maharashtra (IND). 10% of OPC also used as stabilizer. As the stabilizers are used it is also called as compressed stabilized earth blocks. These wastes will be blended with red soil to form earth block. In previous research sand is used in rammed earth construction, but due to scarcity of natural sand, finding out the suitability of alternate material to replace natural sand. In 1948, 260 houses in Bangalore were built by using Cement-stabilized hand compacted blocks (size: 200 X 100 X 100 mm). CINVA RAM press was the first machine developed to compact soil into a high density block in Columbia during 1952. Better insulation and tremendous impact on environment especially in variation of climate and global warming is provided by this technique.

2. Literature review

- V.Reddyand Jagadish, 1989; Kerali, 1991; V.Reddy and Walker, 2005): http://www.ijser.org/, International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-1998, pp. 76-84: This paper is made to stabilize CSEBs which is casted using locally available soil & clay with lime, ash along with cement. The variation in properties like compressive strength and water absorption of the blocks are studied and compared.
- K. K. G. K. D. Kariyawasam, C. Jayasinghe: Construction and Building Materials105 (2016), pp.519–527: This paper covers a detailed research carried out on CSRE to establish strength and durability properties together with applications in the form of pilot projects. Therefore, three main types of laterite soil termed as sandy laterite, clayey laterite and gravelly laterite were tested to assess its suitability for CSRE construction.
- H. B. Nagaraja, M. V. Sravan, T.G. Arun, K. S. Jagadish: International Journal of Sustainable Built Environment (2014) 3,pp.54–61:This experimental study on CSEBs prepared using lime as a replacement to cement in certain proportions has clearly brought out the effectiveness of lime with cement in improving the long-term build-up of strength better than using cement alone.
- B. V. Venkatarama Reddy and A. Gupta, Materials and Structures 38 (July 2005), pp.651-658: The paper focuses on the study of various characteristics of soil-cement blocks using highly sandy soils through an experimental investigation.
- Cong Ma; Longzhu Chen; and Bing Chen: Journal of Materials in Civil Engineering, © ASCE January 20,

(2016), pp. 04016022:1-10: In this study, cement-based composites (CSCN) consisting of cement, sodium silicate, and composite promoter were used for substituting Portland cement, and the effect of fly ash was investigated by unconfined compressive strength (UCS) test.

- Mihir vora, Ankit patel, Mohammad Soyab Shaikh: International Journal of Research in Engineering and Technology, Volume: 03 Issue: 04, (Apr-2014), pp. 298-303: The aim of soil stabilization is to increase the soil's resistance to destructive weather conditions in one or more of the following ways: 1) By cementing the panicles of the soil together, leading to increased strength and cohesion 2) By making the soil waterproof or at least less permeable to moisture.
- Peter J. Walker: Journal of Materials in Civil Engineering, Vol. 16, No. 5, October 1, 2004, pp. 497–506: The objectives of the work presented in this paper were to study, compare, and report on the strength and erosion characteristics of compressed earth blocks and earth block masonry. Experimental results and conclusions are presented in this paper, together with recommendations for strength and erosion testing.

3. Material and methodology

Red Soil/ Laterite soil: lateritic soil remains one of the best natural materials to be used in compressed earth bricks, because, it is generally well graded soil that combines both cohesive (silt and clay) and the cohesion less (sands and gravels) parts of soil.

Red silty soil cohesive non swelling taken for further experimental program.

Table 1
Properties

S. no.	Property	Material	Result
1	Specific Gravity (By density Bottle)	Specific Gravity	2.44
2.	Atterberg's Limits	Liquid Limit, W_L Plastic Limit, W_p Plasticity Index, I_p	36.00 % 17.39 % 18.61%
3	Soil Classification	I.S. Classification	MI
4	Swelling	Free Swell Index	15%
5	Grain Size distribution	Gravel Sand Silt Clay	7.27 % 36.86 % 46.69 % 9.2 %

- *Manufactured sand:* Manufactured sand is produced from hard granite stone by crushing.
- *Fly Ash:* Fly ash is a fine powder that is a byproduct of burning pulverized coal in electric generation power plants. Fly ash is a pozzolan, a substance containing aluminous and siliceous material that forms cement in the presence of water.
- 10% OPC cement is mixed as stabilizer

Table 2
Engineering properties

S. No.	Property	Method	Results
1	Optimum Moisture Content (OMC) Maximum Dry Density (MDD)	Proctor Test	15.4% 16.6 KN/m^3
2	Shear Strength Parameters	Direct Shear Test	C= 18kPa $\phi = 14^{\circ}$

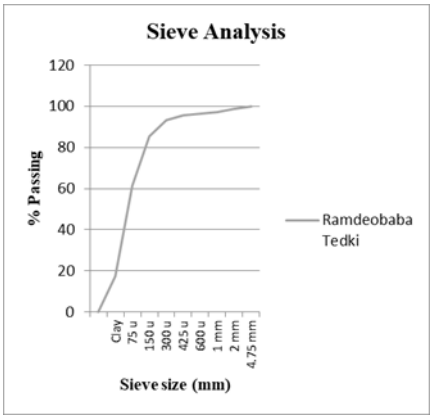

Fig. 1. Sieve analysis

4. Methodology

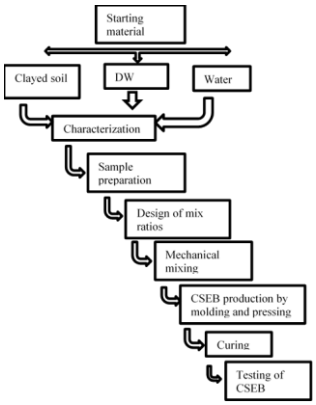

Fig. 2. Methodology

5. Casting and curing

The specimens were casted using metallic cubic mold of size 100mm. then the mold is filled with partially saturated soil cement mixture and then compacted in three layers. Each layer is tamped minimum 25 times by using rammer of weight 2.5 kg. The free fall height of the rammer is 305mm. the mass of the material in each compacted layer was controlled such that the final designation dry density for the cylinder was achieved. The sample is then removed from the metal mold after 24 hours of casting. The curing of sample is done by using gunny bags for 7 and 28 days. The cubes are then immersed in water for one day. After then they are taken out from water and then air dried for 1 hour. Testing is done by UCS testing machine. The strain is increased at the strain ratio of 1%. During this the load applied at the specific strain value is recorded.

6. Test results and analysis on the produced compressed stabilized earth block by using waste materials

Different combinations: As there is a huge scarcity of natural sand, following materials are considered as replacement of natural sand

- *Group 1:* M- sand (Obtained from industry and passing through 4.75mm sieve and retaining on 75 micron)
- *Group 2:* 10%PPC with 5%flyash

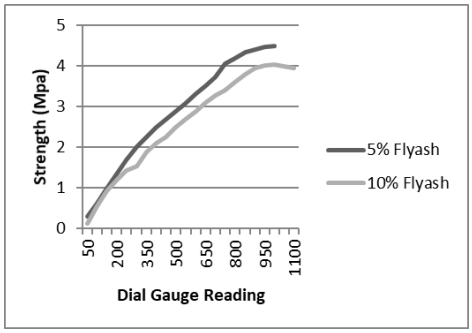

Fig. 3. Strength achieved by adding 5% and 10% fly ash

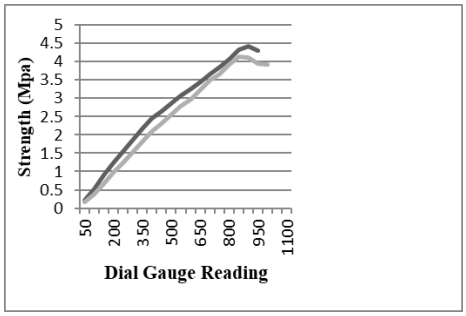

Fig. 4. strength achieved by replacing OPC by PPC in 10% fly ash brick

7. Conclusion

- Minimum Compressive strength of normal burnt brick is 3.5Mpa. The strength we obtained in CSEB using 10% OPC and 5% fly ash is 4.5Mpa. Hence we are getting relatively more strength of CSEB.
- Use of OPC as stabilizer in place of PPC gives more strength to the CSEB with same proportion of sand, clay and stabilizer.
- It has been found that use of M-sand gives more strength.

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