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Review Article

COMPRESSED STABILISED EARTH BLOCK: A CASE STUDY REPORT

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ABSTRACT
Compressed Stabilized Earth Block (CSEB) is an innovation which has revived the ancient method of carrying out the task of constructing economically affordable housing, in many countries around the world. In India, it has been tried in many different geographical locations. The Government of India have been taking efforts through the Ministry of Housing and Urban Development, with a view to popularize the scheme of implementing this technology, in rural areas, in each region. It is anticipated that the CSEB-technology will have a great scope in the future years. This study was undertaken with an objective of conducting a few trials of mix proportions of stabilizing agents such as lime, cement, or fly ash., in ensuring that the compressive strength of CSEB-specimens are satisfactory.

Key words: Compressed Stabilised Earth Blocks-Innovative Technology-Affordable Housing.

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INTRODUCTION

The use of earth and mud were in vogue for the past several thousand years , in many countries around the world. In some countries, the practice has been historically documented. In many other countries, the ancient monuments bear the testimony for the un-written history. During the 19th Century, a chemical material called 'cement' was invented, marking a turning point in the history of building technology. Due to a faster rate of urbanization, industrialization, and infrastructure development, and the environmental pollution that results has been increasing , leading to the undesirable effects such as 'global warming' and the consequent "climate change'. This has necessitated on the need for identifying 'sustainable' technology, in every phase of 'developmental activity', under the light of 'carbon foot print' and 'damage' caused to the three elements of the Environment, namely, air, water and land (soil). Therefore, the need for developing a sustainable technology, in the housing sector becomes a need of the hour.

In the light of the fact that 40-millon houses were estimated to be constructed by the year 2000, in India, in order to provide a housing for 'all', including the population below 'poverty-line', the task gains significance. With the advent of an ever-increasing population rate, the current scenario is much more challenging than the previous decades, considering the socio-economic aspects prevailing in rural India. Therefore, any innovative technology in the housing sector sounds reasonable.

Compressed Stabilized Earth Block (CSEB) is given importance, due to its many advantages, such as i) it uses environment-friendly natural materials, ii) it is a sustainable technology, iii) it cuts down energy wastage, in terms of carbon–foot print (in consideration of energy consumption by using manufactured products such as cement, burnt-bricks, etc, (as they require more energy to be spent for manufacturing them), iv) the CSEB-system supports the involvement of local persons for carrying out various operations, thereby, giving them the opportunity of local employment, v) an opportunity to self-building house owners to have the pleasant experience of building the walls of 'their own', and the houses longed for, and vi) the economical savings availed in the house construction task, can be invested in their children's education and health-care.

The manufacturing of CSEB is considered to be energy-efficient and cost-effective. Environment-friendly building materials are used. On the overall basis, contribution is made to maintain a sustainable development. Different research workers have made contributions to the development of the technology of Compressed Stabilized Earth Block, in terms of different scientific and technological parameters (1,2,3).

CSEBs are considered to be eco-friendly, as these blocks are used as 'un-burnt' products. On the contrary, Fired-Bricks use significant quantity of coal or any other fuel, during production, which causes the emission of harmful gases such as Carbon Dioxide (CO2). Similarly, the manufacture of cement requires the burning of many raw materials which leads to emission of many other harmful gases, including CO2, thus causing Environmental pollution, producing certain un-desirable effects such as Global Warming and the consequent Climate Change. This is referred to as "carbon foot-print'"in the international literature (4,5,6).

METHODOLOGY

Experiments were conducted in the Laboratory to prepare the specimens of Compressed Stabilized Earth Blocks (CSEBs),by following procedures indicated in the literature. Tests were conducted to evaluate the compressive strength of the dried and hardened specimens, These are the CSBEs without being subjected to burning.
The soil selected was Laterite (Red Earth);. River sand was used as an aggregate.
Plastic Limit of Soil =55.0%; Liquid Limit of Soil =65.0%. Plasticity index= 10.0 (Moderately Plastic).
Soil samples were prepared, and sufficiently mixed with water, and calculated quantities of stabilizing agents were added, using Cement (Ordinary Portland Cement, OPC). Lime, and Fly-Ash, in pre-determined proportions.
The ingredients in the Soil Specimens (labelled as SS-1 to SS-6) were proportioned as detailed below:

i) SS-1: Clay 30% plus Sand 70%.

ii) SS-2: Clay 20% plus Sand 70%.plus 10%OPC (Ordinary Portland Cement).
iii) SS-3 : Clay20% plus Sand 70% plus Lime 10%
iv) SS-4 : Clay 20%:plus Sand 70%plus Fly Ash 10%
v) SS-5 : Clay 20% plus Sand70%plusOPC5%plus Fly Ash5%
vi) SS-6 : Clay 20% plus Sand 70% plus Lime5% plus Fly Ash 5%

Experimental procedure for casting CSEB
The following steps were followed:

1. Preparation of Soil sample; 2. Quality charcterisation of Soil Sample; 3. Mixing of Specimens, with varying percentages of Plasticisers, namely, Lime, OPC, and Fly Ash, as indicated above. 4. The Mould of Specimens were prepared by Hand Operated Press). 5. Specimens were dried under the shade (Shelter).
2. The average size o each Soil Specimen (SS-1 to SS-6) was 273.0mm (L) x 114.0mm (W) x 76.0mm (H), where, L, is the Length, W is the Width, and H is the Height. The top surface area of each Soil Specimen was an average of 31300.0 Sq.mm. On comparison, 5-numbers of Wire-Cut Burnt Bricks were tested for Compressive strength. The size of Fired-Bricks (commercial Brand) was 280.0mm(L) x 114.0mm (W) x 80.0mm (H), having a Top Surface area of 31920.0 Sq.mm
3. Testing of Compressive Strength, was Carried out on 6-soil Specimens, and one Fired Brick Sample, by using UTM (Universal Testing Machine).

RESULTS

The compressive Tests on the 8-Specimens of CSEBs, and the Commercial Brand of Burnt-Clay Brick are shown in Table-1.

The Compressive Strengths of Compressed Stabilsed Earth Brick Specimens varied from a minimum value of 0.557 N/sq.mm (in SS-1, soil specimen without any Stabilising Agent) to a maximum value of 2.718 N/sq.mm (in SS-2, soil specimen with Cement as the Stabilising agent), as presented in Table-1. Figure-1 presents the variation of Dry Density of the CSEBs against Moisture content in the Soil Blocks. The optimum percentage was 12.5% yielding a DD of 1.70 gm/cc.

Table 1: Compressive Strength of Specimens of CSEBs tested in the Laboratory

Block Serial No.	Stabilizers & Ingredients (%)	Strength (N/mm^2)	Load (x 1000 N)
SS-1	Clay (30)+ Sand(70))	0557	17.43
2	Clay (20)+Sand(70) + OPC(10)	2.718	84.77
3	Clay (20)+ Sand (70)+ Lime(10)	1.61	50.53
4	Clay (20)+Sand(70) + Fly Ash(10)	0.857	26.701
5.	Clay (20)+ Sand(70+ OPC (5)+ Fly Aash(5)	0.916	28.67
6.	Clay(20)+Sand (70)+Lime(5)+ Fly Ash(5)	0.863	27.01
7.	Burnt (fired) Brick (SS-7)	3.984	104.46

CONCLUSIONS

1. The comparison of Compressive strength between CSEB specimens and the Burnt Brick samples indicated that the CSEB with 70% Sand and 20% Clay and 10% Ordinnary Portland Cement gave the maximum compressive strength of 2.718 N/sq.mm. This amounts to 68.2% o the Compressive Strength (3.984 N/sq.mm, as shown in Table-1) achievable in the case of Burnt-Bricks. .
2. The addition of Lime or Fly ah do not show a competitive performance in respect of Compressive strength..
3. The use of CSEBs seems to indicate a favourable trend in respect of strength considerations. However, the cost analysis and overall economic benefits need to be further investigated

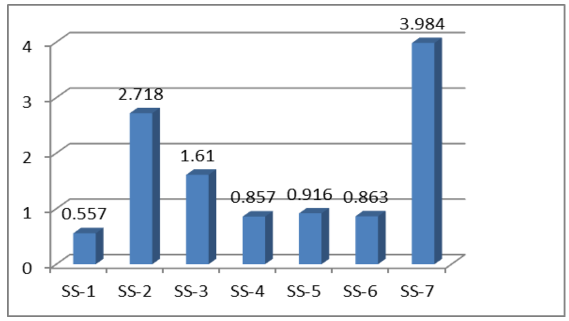

Figure 1: Variation of Compressive Strengrth

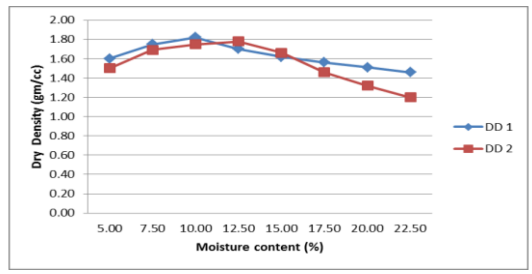

Figure 2: Variation of Dry Density versus Moisture Content

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