ISSN No:-2456-2165

Compressed Stabilized Earth Blocks by Using Lime and Fine Aggregate

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Abstract:- The study explored the durability performance of lime and fine aggregate stabilized alluvial soil blocks. A locally available alluvial soil was collected and tested in the laboratory for its geotechnical properties. The soil was then stabilized using lime and fine aggregate of various combinations. The blocks were tested for their compressive strength. The investigation revealed that lime-fine aggregate stabilization was capable of producing stabilized blocks meeting the standard requirements of Indian codes in terms of compressive strength. According to BIS (IS 1725_1982), The results revealed that our all proportions satisfying CLASS 30. CSEB materials must be easily available and be renewable. The production costs of CSEB are less as compared with flamed bricks, so this problem would be solved by this. The CSEB need less energy than the flamed bricks, and the emission of the carbon dioxide to the atmosphere is 85 % less than that of the flamed bricks.

Keywords:- *BIS, Alluvila, CSEB, Reveled.*

I. INTRODUCTION

Since the development of man, the soil is used for the construction the structures. Compressed Stabilized Earth Blocks (CSEB) is the procedure of soil come into practices. Maximum of the time, compressed stabilized earth blocks is made by lime.

Stabilization of soil can be mean as improving the properties of soil to increase the construction quality of the soil. CSEB materials must be easily available and be renewable. So this problem of flamed bricks would be solved by this. At the old time of the civilization period the construction of masonry was introduced. Now days, the most common material used for the wall of building construction is bricks. India is the second-largest brick producer globally with an estimated annual production of 250 billion bricks a year. Due to the problem identified with fired clay bricks, compressed stabilized earth blocks are introduced. CO_2 emission during the manufacturing process of fired clay bricks is much dangerous for environment, it causes many environmental problems.

The CSEB need less energy as compared to the flamed bricks, and the emission of carbon dioxide to the atmosphere is 85 % less than flamed bricks. Carbon dioxide emissions can be controlled by using compressed stabilized earth blocks (CSEB). flamed bricks are most expensive than unflamed bricks. A comparison between carbon dioxide and emissions of energy among different types of bricks are shown in the table no.1.

Table no.1: comparison of CO_2 and energy emission

Type of brick	Initial Embodied Energy per m^3 of Wall	CO_2 Emission (CO_2 in kg) per m^3
CSEB	630 MJ / m^3	57 kg / m^3
flamed Brick (Kiln)	2400 MJ / m^3	230 kg / m^3
flamed Brick (country)	6400 MJ / m^3	548 kg / m^3

II. LITERATURE REVIEW

PAPER 1]
PAPER NAME: compressed stabilized earth blocks by using lime.
AUTHOR: Abhijeet. D. Patil, M. Tech Final Year Student, Department of Civil Engineering, Rajarambapu Institute of Technology, Sakharale(MH), India.
JOURNAL: International Journal of Engineering Research & Technology (IJERT) 09, September-2015
ABSTRACT:
Stabilization of soil can be mean as improving the properties of soil by chemically or physically to increase the construction quality of the soil. CSEB materials must be easily available and be renewable. So this problem of flamed bricks would be solved by this.

The dry density will also increase with increase in lime content. The dry density increases with an increase in lime content. Compressive strength also increases with increase in lime content. It gives 80 % strength after 7 days curing.

PAPER 2]
PAPER NAME: Case studies in construction material case study in Lime stabilization for compressed stabilized earth blocks with reduced clay and silt
AUTHOR: S.N. Malkanthia, N. Balthazaara, A.A.D.A.J. Pererab
JOURNAL: Elsevier, 10 December 2019

ABSTRACT:

The problems of fired bricks can be overcome by CSEB. Cement and lime are the common stabilizers used for the production of CSEB. Lime is less effective to environment than cement.

According to SLS 1382 the result showed that alone lime didn't give enough properties. After the percentages tested for compressive strength, 10 % lime showed the maximum compressive strength. the combination of lime and cement stabilizers get higher compressive strengths. 15 % content achieved the grade 2 block strength and 10 % clay and silt with 5 % lime: 5 % cement combined stabilizer and 5 % clay and silt contents with 3 % lime: 7 % cement combined stabilizer.

PAPER 3]
PAPER NAME: performance of fly ash - lime stabilized lateritic soil blocks subjected to alternate cycles of wetting and drying
AUTHOR: Jijo JAMES, Rajasekaran SARASWATHY
JOURNAL: Sciendo, 2020.

ABSTRACT:

The result discovered the durability performance of lime and fly ash stabilized lateritic soil blocks subjected to conditions of alternate wetting and drying. The geotechnical properties of nearby accessible lateritic soil, it was collected and characterized in the laboratory. Then soil was stabilized in various proportion by usig lime and fly ash. The blocks were tested for their compressive strength, water absorption, and efflorescence properties.

PAPER 4]
PAPER NAME: Role of lime with cement in long-term strength of compressed stabilized earth blocks.
AUTHOR: H. B. Nagaraj, M. V. Sravan, T. G. Arun, K. S. Jagadish
JOURNAL: International Journal of Sustainable Built Environment, hosted by ELSEVIER.

ABSTRACT:

This study on CSEB prepared using lime as a replacement to cement in certain proportions has brought out the efficiency of lime with cement in improving the long-term build-up of strength better than using cement alone. Herein, the combination of cement and lime is equally very beneficial in imparting strength to the blocks in a much well way, because cement has taken care of stabilizing the sand portion with hydration products obtained from cement and lime to stabilize the clay portion present in the mix. This would help in increasing the strength of the blocks, which would be a reflection of the durability and performance of buildings constructed using such CSEB.

III. OBJECTIVE

- The main objective of the project is to reduce the price of block which is usable for lower- class people
- To make a block which is an alternative to fired bricks
- Increase the strength of compressed stabilized earth blocks by using fine aggregate.

IV. STUDY WORK

A. Defination and aim:

- Definition of soil stabilization:

The soil stabilization means modification properties of the soil-water-air system to get long-standing properties and strength when the soil gets wet. Silt and clay, which are bonding materials of earth, are not stable when they both get immersed.

- Aim of soil stabilization:

The aim of soil stabilization is to stabilize the clays and silts against water attacks.

- The objectives of the soil stabilization are:

To decrease the volume of interstitial voids
To decrease in the porosity and increase the density.
To increase the bonding and the mechanical characteristics.
Materials required for CSEB:

a) Alluvial soil: -

The soils deposited by surface water after the floods are called alluvial soil. It is available along the rivers. Alluvial soils have a coated look because every time floods deposit new sediment at the surface. It has alternately dark and light colors, and mixed sizes of round gravel particles.

Image no.1: Alluvial soil

This unique layering process is called stratification and is produce in many floodplains. The alluvial soils are generated by flooding. The new sediment that is added comes from the stream crunch and this is sensitive to changes in land use.

b) Lime: -

Lime has a pozzolanic reaction with clay. most possibly the lime is used for the being plastic. Therefore, lime is better suitable for clayey soils. The pozzolanic reaction is the first one to occur with clay in the soil. Due to the increase in plastic index, modification of properties of soil has been done. Lime will have more reactions on clay's high plastic index. Because of the quality of the latter, velocity and severity for change of plasticity are contradicted.

Image no.2: lime

c) Water:

It is a transparent fluid. It should not contain any dust particles and will be clean.

d) Fine aggregate:

It is a particle that is passed through 4.755 mm and retains on the pan.

B. Role of lime stabilization in CSEB:

Soil Stabilization is used to improve the properties of compressed stabilized earth blocks. Lime is the eldest material used in soil stabilization. When lime is added to clayey soil, the soil properties will change. When the calcium ion in lime reacts with clay soil then metallic ion and cation exchange between them occurs. Therefore, the clay particles are surrounded by a diffuse hydrous double layer. This reasons and change in the electrical charge density around the particles that make the particles closer and forms flocks in a process called flocculation. This is the primary influence on the change in the engineering properties of lime-treated clay soils.

C. Preparation of blocks:

Sieving: -

For the production of block fine-grained soil is needed and it is not possible by course-grained. The 4.75mm sieve should be used for minimizing course grain materials. Hand sieves may be used if the soil content is less.

Image no.3: Sieves

Good mixing can't be achieved, due to the coarse aggregates. These results impact the compressive strength of the block. There are many types of sieves which we are going to use for sieving. The big sieve should be kept at the top of set and the small hole's sieve should be kept at the bottom. The bucket should be kept at the bottom of all sieves, so the remaining may be stored at it.

Proportioning: -

Before the start of production, some blocks test should be adopted to find out the best proportion. After study lots of research work, we did not get any idea about proportion. so we decided that make a trail sample on basis of proportion lime to fine aggregate to the soil, that means if we are taking one part of lime then adjusting fine aggregate and soil regarding the lime.

Image no.4: Sample materials

Image no.5: Sample of block after test

We are using three types of proportion which are lime: fine aggregate: soil is

1) 1: 2: 4 (lime: fine aggregate: soil)
2) 1: 2.25: 4
3) 1: 2.5: 4

Mixing: -

The use of a long bar or same dimensional object may have to be adopted for the best mixing. The mixing should be done properly. Hand mixing is done for less quantity; machine mixing is used for greater accuracy. Hand gloves should be used for the mixing of lime. The precautions should be taken for the whole process. The quantity of lime used for the experiment is constant, according to lime content other

materials are calculated. The water content should be minimum as compared to other mixes. The lime is dangerous for use. The smell is quite dangerous. The whole process is difficult for a single person. The binding of material between each other is an important part of mixing. The important part is the removal of air voids. So the brick can achieve its maximum compressive strength. The mixing also effects on finishing. Plastering costs can minimize by keeping the plane surface.

V. TESTING

A] Physical properties of alluvial soil:

The physical properties of the soil are shown in Table. Alluvial soil is used to modify the fines proportion of the soil.

TESTS: cone penetration test (CPTU), vane test (VT), and dilatometer test (DMT)

Table no.2: physical properties of soil

PROPERTIES	RESULT
Plastic limit (%)	27
Liquid limit (%)	38
Plasticity index (%)	11.2
Specific gravity	2.5
Silt and clay percentage (%)	40

B] Actual Procedure Of Block Casting:

The materials which we are going to use should be kept in the air so their porosity will be best. To find out moisture content, the soil sample should be kept in the electrically operated air-dried oven for 24 hours. For 1-hour soil sample is kept as it is so it will come at normal temperature. the actual process is started after 1 hour. Take the weight of the soil sample and then calculate its optimum moisture content, based on moisture content decide the lime content. After taking various proportions to make maximum strength CSEB we will get actual water content.

For our experiment, we are going to make three types of blocks that are proportioning different types of fine aggregate. For the first proportion take 2.55kg lime and its 2 times fine aggregate and its 4 times soil, 10% water which is the reference with moisture content. For the second proportion take 2.55kg lime and its 2.25 times fine aggregate and its 4 times soil and 10% water. For the third proportion take 2.55kg lime and its 2.5 times fine aggregate and 4 times soil and 10% water. Each proportion contains three samples. All the samples are going to use for the compressive strength test.

Took the materials in proportion in the pan. Mixed it properly, the sprinkling method is used for the addition of the water. The blows should impact on it, so it will help to remove air voids.

Image no.6: Mixing of materials

Use the 15cm x 15cm x 15 cm mold for casting. First is the oiling of the inside wall of the mold. Put the material inside the mold. Due to gravitational force, the soil is going to settle down. Blows should be adopted for the settlement of material. After 24 hours remove the mold, and put it for curing. The sackcloth vesical should be used for pouring water into blocks. Seven days of curing should be adopted. Due to the sackcloth, the water will continually be poured into it.

Image no.7: Casted blocks

Due to sackcloth's, we will save the time required for pouring of water. For the compressive test, no of samples t should be of three numbers of various proportions and they should be kept at normal condition. Sackcloth curing should have to be done. The testing should be allowable of only 3 specimens in BIS code _IS 5454 – 1974 5.

C] Comparison of Finishing

Comparison between convention brick and compressed stabilized earth block are below. The finishing of our CSEB is greater than convention brick.


Image no.8: CSEB Block


Image no.9: Conventional Brick

D] Test Performed On Blocks:

1) Water absorption

To find out the water absorption of the blocks, given blocks will oven-dry and immersed in water for 24 hrs., after that the increase in the weight of oven-dried sample was calculated and said as a percentage of the initial dry mass of the sample

$$W = \frac{Saturated\ surface\ dry\ mass - oven\ dry\ mass\ (g)}{Oven\ dry\ mass\ (g)} \times 100$$

2) Dry density

To calculate the dry density, the block should be oven dry for more than 24 h at 100 to 105^{0}C. after It will be weighted and calculated for dry density.

$$D_d = \frac{Dry\ mass\ (kg)}{volume\ (m^3)} \times 100$$

3) Compressive strength:

For calculating compressive strength, a universal testing machine is used. After completing the curing of 7 days, the compressive strength test will be conducted on the blocks.

So the accurate processes of testing must be followed by one. At the upper and lower side of the machine the soft side of the block will be placed.

Image no.10: Set up of block

So it will give accurate results. Fine aggregate is a water absorption material, so by changing its percentage the water absorption will be changed. At some point of fine aggregate, the water absorption will also maximum. But the cost study is also important. Due to change in the content of fine aggregate, it will also affect in compressive strength of CSEB

Image no.11: Reading on the dial of UTM

The best fine aggregate content should be taken. The fine aggregate content which one gives maximum compressive strength it should be taken as the best content. For the 2.5 times of lime, fine aggregate gives 6.15 N/mm^2 strength after the curing of 7 days.

E] Results:

1) Compressive strength:

Table dry compressive strength in N/mm^2 with various proportion of lime, fine aggregate and soil.

Proportion	S_1	S_2	S_3	average
1: 2: 4	4.35 N/mm^2	5.02 N/mm^2	5.50 N/mm^2	4.95 N/mm^2
1: 2.25: 4	5.14 N/mm^2	4.84 N/mm^2	4.96 N/mm^2	4.98 N/mm^2
1: 2.5: 4	6.84 N/mm^2	6.11 N/mm^2	5.50 N/mm^2	6.15 N/mm^2

Table no.3: Compressive strength

VI. COST COMPARION

- FOR 9 NO. OF BLOCKS

MATERIAL NAME	DSR per item	MATERIAL USED IN PROJECT IN KG	COST	TOTAL COST
Soil	0.7 Rs per kg	30.6	21.42	89.42 Rs
Lime	7.5 Rs per kg	7.65	57.37	
Fine aggregate	0.57 Rs per kg	17.2	9.80	
Water	0.15 Rs per liter	5.54	0.83	

Table no.4: Cost of 9 blocks

We are adding 2% of total cost to labor charges = 1.78 Rs
10% of total cost to contractor charges = 8.94 Rs
Total cost of 9 blocks are = (89.42+1.78+8.94) = 100.14 Rs
Cost of one block is = (100.14 ÷ 9) = 11.12 Rs

We need a 300 blocks for 1 cubic meter
i,e 300 × 11.12 for 1 cubic meter = 3336 Rs

The rate of one fired brick is 12 Rs, there are 500 bricks in one cubic meter.
i.e for one cubic meter (500 × 12) = 6000

Then we can conclude that compressed stabilized earth blocks are economical than fired bricks

VII. CONCLUSION

These are the conclusions which are from our results:
1] the compressive strength of CSEB increases with an increase in fine aggregate. (Refer Table No. 3 and Graph No.1)
2] It gives a good finish, then plastering cost should be deducted. (Refer point no. 6.3)
3] It can be used for low cost as well as ordinary building. (Refer Table No. 4)

- Advantages:

1. The material will be available easily and nearly places. So it will minimize the cost of the block.
2. It can bear against all of the problems like snowfall, flood, heavy rain, and all of the similar problems.
3. The power consumption for CSEB is 15 times less than fired bricks.
4. The unskilled labor can be made the blocks and it may available in life threatening (critical) areas also, due to this the cost will reduce
5. It is a job opportunity for labors who are unskilled.

- Disadvantages of CSEB:

1. Compared to concrete blocks compressive strength is low.
2. Because of unskilled labor, production of low-quality products.
3. Non-usable production techniques.
4. Soil may be unavailable in nearby areas.

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