

Compressed Stabilized Earth Block using Fly Ash and Quarry Dust



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Abstract: Buildings made of earth material is an attempt for sustainable development to overcome the threats of rapid pollution rate caused by huge application of cement in construction industry almost in all forms as building blocks, all kinds of structural elements and infrastructure. The main objective of this project is to identify the better stabilization material for stabilized earth blocks for partial replacement of cement in the manufacture of CSEB's. The scope of work is to achieve a harmonious integrated performance of buildings with physical environment by using natural earth material for preparing building blocks. In this project fly ash and quarry dust has been compared to find out the most suited stabilization material for CSEB's providing efficiency as well as sustainability as a substitute material for cement. In this project CSEB's prepared using 70% laterite soil and 30% of cement has been compared with specimens in which cement is replaced with fly ash and quarry dust in ranges of 10% and 20% of its weight. The 28 days compressive strength results shows 12.5% increase in strength for 10% optimum replacement of cement using fly ash and about 7.5% increase in strength for 10% optimum replacement of cement using quarry dust. The reduced water absorption has been notified in CSEB's using fly ash and quarry dust which will facilitate good bonding with fresh mortar by avoiding high rate of water absorption from fresh mortar by blocks finding its effective application in construction of load bearing walls for general buildings.

Index Terms: CEB: Compressed Earth Blocks, CSEB – Compressed Stabilized Earth Block.

I. INTRODUCTION

Soil either in a stabilized (or) without any stabilization after getting slightly moistened, being placed in steel mould and getting compressed either manually (or) using machines to produce compressed earth blocks. Compressed earth blocks (CEB) can be cast in any desired shapes and sizes based on requirement and its applications^[4]. The application of earth blocks includes various advantages. The CSEB's finds its effective application in low cost housing projects. The construction using earth develops harmony of buildings with nature^[4]. The effective utilization of locally available earth materials is more economical^[2]. The cost breakup for CSEB's production is very low when compared to conventional concrete blocks and fired bricks.

Manuscript received on April 02, 2020.
Revised Manuscript received on April 15, 2020.
Manuscript published on May 30, 2020.

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II. OBJECTIVE OF STUDY

The main objectives of the experimental investigation are:

- i. To investigate the potential usage finding the optimum quantity of commercially available fly ash, quarry dust for producing compressed stabilized earth block.
- ii. To study and compare the results for the determination of optimum content of Rice Husk Ash and lime.

III. MATERIALS USED

The different materials used in order to conduct the experimental investigation are:

A.Laterite Soil

Soil is a natural concrete comprising of gravel, sand, silt and clay in definite proportions. In this research work, laterite soil has been selected and its properties were studied for its suitability in application for CSEB's.

The soil properties are listed in Table 1 after conducting laboratory tests.

Table.1. Properties of Laterite soil

S.No	Description	Observed Values
1	Fineness modulus	2.7
2	Specific gravity	2.65
3	Optimum moisture content	14.6%
4	Bulk Density	2.153 g/cc
5	Dry Density	2.01 g/cc

B.Cement

Ordinary Portland cement (53 grade) is used. Cement plays an important role in strength development with time. Cement and lime are the conventional stabilization materials for earth construction.

C.Flyash

Fly ash is one of the residues generated during combustion of coal. Fly ash added CEB exhibits excellent physiochemical and mechanical properties including low density, negligible shrinkage, thermal stability, fire and chemical resistance than conventional clay bricks.

D.Quarry Dust

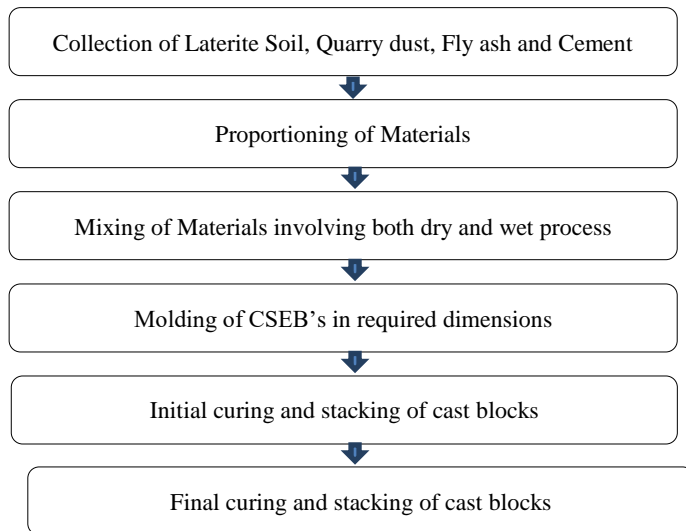
Quarry dust is generally used as one of the best alternative for fine aggregate. The increasing demand for river sand in construction activities facilitates the rapid utilization of quarry dust as an alternative.

E.Water

Water free from impurities and acids has been used for preparing the CSEB's.

IV. EXPERIMENTAL METHODS

The investigation is carried out on CSEB's containing laterite soil, cement and fly ash / quarry dust. This investigation is done to know whether the partial replacement of conventional cement stabilization in combination with fly ash and quarry dust brings about enhanced properties. The preparation of CSEB's is done in the following sequential process.



The following laboratory experiments were conducted such as:

1. Compressive strength test,
2. Water absorption test,
3. Block density test.

These tests were carried out for both control CSEB specimen's using 70% laterite soil and 30% of cement and CSEB's produced involving partial replacement of cement using stabilizing materials in varying proportions as 70% laterite soil, 20% and 10% of cement, 10% and 20% percentages of fly ash and quarry dust. For each mix specifications including 70%LS+30%C, 70%LS+20%C+10%FA, 70%LS+10%C+20%FA, 70%LS+20%C+10%QD and 70%LS+10%C+20%QD three number of CSEB's were prepared for tests to be conducted.

V. RESULTS AND DISCUSSIONS

A. Compressive Strength Test

The average test results are calculated for the specimen cast for various mix proportions (3 no. of blocks for each mix proportion) with partial replacement of cement using fly ash and quarry dust.

Table 2. Compressive Strength Test Results

S. No	I			Average Compressive Strength (N/mm ²)
	Laterite Soil (%)	Cement (%)	Fly ash (%)	
1	70	30	0	1.65
2	70	20	10	1.858
3	70	10	20	1.708
S. No	II			Average Compressive Strength (N/mm ²)
	Laterite Soil (%)	Cement (%)	Quarry Dust (%)	
1	70	30	0	1.65
2	70	20	10	1.775
3	70	10	20	1.733

From the above test results it has been observed that compressive strength increases with increase in percentage replacement of cement by fly ash and quarry dust only up to an optimum level of 10%.

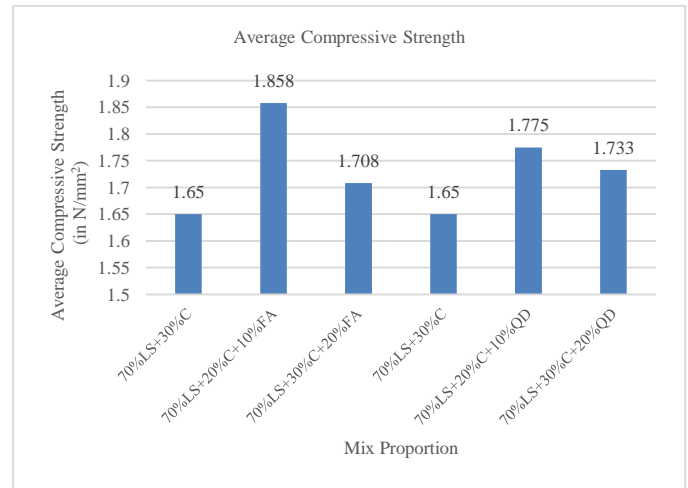


Fig 2. Compressive Strength Test Results on CSEB's

B. Water Absorption Test

The water absorption test was conducted on CSEB's to find its suitability as effective building block.

Table 3. Water Absorption Test Results

S. No	Description	Weight of Specimen (in kg)		Water Absorption (in %)
		Dry Condition	Wet Condition	
1	70%LS+30%C	13.08	14.84	13.46
2	70%LS+20%C+10%FA	14.05	14.68	4.48
3	70%LS+10%C+20%FA	12.88	13.92	8.07
4	70%LS+20%C+10%QD	12.96	13.58	4.78
5	70%LS+10%C+20%QD	14.86	15.21	2.36

C. Block Density Test

The block density test was conducted on Compressed Stabilized Earth Blocks.

Table 4. Block Density Test

S. No	Description	Block Dimensions			Weight of Specimen (kg)	Block Density (kg/m ³)
		L (m)	B (m)	D (m)		
1	70%LS+30%C	0.4	0.1	0.2	13.08	1635
2	70%LS+20%C+10%FA	0.4	0.1	0.2	14.05	1756
3	70%LS+10%C+20%FA	0.4	0.1	0.2	12.88	1610
4	70%LS+20%C+10%QD	0.4	0.1	0.2	12.96	1620
5	70%LS+10%C+20%QD	0.4	0.1	0.2	14.86	1858

The block density has been increasing with increase in percentage of quarry dust. While using 70% Laterite soil, 20% cement and 10% fly ash, the block density is greater than conventional CSEB's.

VI. CONCLUSION

In this research work, after conducting various laboratory experiments on CSEB's by keeping proportion of laterite soil as constant of about 70% and varying the proportion of fly ash as 10% and 20% by weight of cement,

it has been observed that the optimum replacement level of cement using fly ash as a stabilization material is about 20%. In case of CSEB's prepared by keeping proportion of laterite soil as constant of about 70% and varying the proportion of quarry dust as 10% and 20% by weight of cement, it has been observed that the optimum replacement level of cement using quarry dust as a stabilization material is about 10%. From the experimental investigation conducted, the following conclusions can be made:

- 1) It was found that the mix which contains laterite soil (70%), fly ash (10%) along with cement (10%) has 12.5% increased compressive strength due to cementation process involving formation of an inert cement mix. Further increase in fly ash content reduces the compressive strength.
- 2) It was found that the mix which contains laterite soil (70%), quarry dust (10%) along with cement (10%) has 7.5% increased compressive strength. Further increase in quarry dust content reduces the compressive strength.
- 3) It was also found that in case of CSEB's using 70% laterite soil, 10% cement and 20% fly ash, the rate of water absorption has been reduced by 40% when compared to CSEB's using 70% laterite soil and 30% cement.
- 4) It was also found that in case of CSEB's using 70% laterite soil, 20% cement and 10% quarry dust, the rate of water absorption has been reduced by 65% when compared to CSEB's using 70% laterite soil and 30% cement.

As a result of conducting this research, I propose that 70% of laterite soil along with 10% of quarry dust, 10% of fly ash and 10% of cement by weight can be used as mix proportion for preparing compressed stabilized earth blocks with adequate compressive strength. It has been observed from the findings that usage of quarry dust and fly ash as stabilizing materials reduces rate of water absorption of blocks which prevents blocks from absorbing more water from fresh mortar resulting in good bonding between block and fresh mortar.

The future work on this investigation can be done involving construction of walls using earth blocks with different stabilization materials.

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