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Study On Compressed Interlocking Laterite Soil-Cement -Fly Ash Bricks

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ABSTRACT

Laterite soil bricks are more commonly used types of bricks in the construction of residential and commercial types of buildings. Laterite bricks are easy to manufacture and transport. Even though, before using for construction, laterite bricks has to be mandatorily shaped. Also, the percentage of mortar required to develop the bond between two bricks are more. After seeing the above limitations, many literature studies were conducted to replace laterite soil with cement, fly ash etc,. inorder to get accurate finishing, thus reducing quantity of mortar to be used and more strength. In the current research, 30*20*15cm sized bricks were prepared. The laterite soil was replaced by constant percentage of cement and varying percentage of fly ash. The results shows that the compressive strength of fly ash mixed laterite soil cement brick was 8.5N/mm^2 which is similar to that of first class brick and water absorption is less than 15%.

Keywords— Laterite quarry waste, cement, fly ash, compressed brick, water absorption

I. INTRODUCTION

In all around the world selection of sites with the best soil is very important in the building of any structure. India is the second largest producer of the brick in the world after china. The brick production in India is estimated at 140 billion bricks, consuming 24 million tonnes of coal along with huge quantity of bio mass fuels. The CO_2 emissions are estimated to be 41.6 million tonnes and it accounts for about 4.5% of total Green House Gas emissions from India. House is a third need of human in the world. Laterite block is a commonly using building material in Dakshina Kannada district. Some laterite soil are suitable for mix in the natural state, which other requires additives in order to satisfy the certain requirements to make them suitable for intended application. In addition to that Cement is very expensive and its usage cannot be sustained by the people below poverty line. The usage of the Cement can be slightly reduced by using Fly-ash as a partial replacement to the Cement. The utilization of Fly-ash will reduce the cost of Cement purchase. Brick is a common building material which is used for various construction purposes such as to make walls and other elements in masonry construction. Use of brick for the construction purpose has been practiced for many years and the techniques have been upgraded and modified along the civilization.

II. LITERATURE REVIEW

Mr. Kishore kumar B.R et. al (2015) made a study to improve the properties of laterite quarry waste with the use of lime and fly ash as stabilizing agents. Laterite quarry waste mixed with 5%, 10%, 20% and 30% of fly ash and lime. The tests conducted include particle size distribution, specific gravity, plasticity index, compaction, CBR test. The tests results showed that properties of laterite quarry waste were improved by addition of these admixtures. Fly ash and lime are found to be an effective stabilizer for laterite soil.

Dr.George Rowland Otoko (2014) analysed the use of laterite for production of soil cement blocks. In this study they conducted some test, such as compressive strength, direct shear strength, flexural strength, longitudinal strain and initial rate of absorption. It can be using highly sandy soils for soil cement block of laterite soil with 4 different cement content (6, 8, 10, 12%) which conclude that adding of 12% of cement content, then increases the compressive strength, direct shear strength, flexural strength, longitudinal strain and initial rate of absorption decreases. This paper was demonstrated how the compressive strength and water absorption properties of soil cement are influenced by using highly sandy laterite soil for soil cement block production.

Ch. Devi (2017) made a study on fly ash mixed laterite soil cement blocks. In the study addition of 10% of cement and 20% of fly ash by the weight of soil the optimum strength is obtained. It can be used for 15×15×15 cm of mould size. In the study conducted block density and compressive strength test. For

compressive strength test results it was observed that compressive strength of fly ash mixed laterite cement block is 9.5 N/mm^2 which is similar to that of first class brick and density of block 2.13gm/cm^3.The optimum strength shown by the bricks is similar to that of class-A burnt clay bricks. And the cost of brick is not expensive and it is easily affordable by poor people.

III. MATERIALS AND METHODOLOGY

Several materials are to be used in manufacturing good quality of compressed interlocking soil cement bricks with addition of fly ash. The raw materials used to produce the bricks are laterite quarry waste, cement and fly ash mixed together in a desired proportion as per mix. The overall strength of the bricks depends on this material and hence it is very important to study their characteristics. In this chapter the properties of all major raw materials which contribute to the strength of compressed interlocking soil bricks are discussed briefly
All the materials used in the experimental investigation were locally available at lower costs. The material in this present experimental research include laterite quarry waste, cement and fly ash.

A. **Laterite Soil**

Laterite is a word derived from the Latin word means brick. Laterite soil is a type of soil which is rich in iron and aluminium and is formed in hot and tropical regions. Laterite soil used in this study was collected at the depth of 5m from huliyadka region which is at a distance of 7 km from Sullia located in Dakshina kannada district. Moisture content, specific gravity ,wet sieve analysis, dry sieve analysis, Atterbergs limit, field density, compacted test are conducted for the collected soil samples.

B. **Cement**

Cement is a binding material in the compressed soil cement bricks. Cement is an extremely fine grained material with adhesive and cohesive properties and well known construction material that binds the other materials get harder when reacting with water. Cement used in brick construction in order to create continuous structural form and to bind together the individual units in brick work. Cement provides high strength in brick work system. The properties of soil is very much influenced with the properties of cement, hence if it worth importance to know the cement properties. The ordinary Portland cement 53 grade ultra tech cement confirming to IS 12269:1987 has been used in compressed soil cement bricks 53 grade cement indicates that the particular cement gives compressive strength of 53N/mm^2 at the age of 28 days.

C. **Flyash**

Fly ash is the by-product of coal combustion collected by the mechanical or electrostatic precipitator before the flue gases reach the chimneys of thermal power stations in very large volumes. All fly ash contain significant amounts of silicon dioxide (SiO_2), aluminium oxide (Al_2O_3), iron oxide (Fe_2O_3), calcium oxide (CaO), and magnesium oxide (MgO).However, actual composition varies from plant to plant depending on the burned and the type of burner employed. Fly ash also contains trace elements such as mercury, arsenic, antimony, chromium, selenium, lead, cadmium, nickel and zinc. The fly ash was collected from Padubidre near Mangalore.

A.**Collection of quarry waste**

The laterite soil waste was collected from ubaradka near Sullia. This waste sieved in 10mm sieve. This sieved laterite waste was brought to industry for preparation of bricks.A mould of size 300×200×150 mm has been used for the production of bricks in this present work. The laterite soil bricks are produced by the process of manual press, solar press and thermal press .But in this present study only hydraulic press was adopted. Here about 210Kg/cm^2 of compression load was applied to manufacturing of a single brick.

B. **Preparation of Mix and Brick Production Procedure**

Firstly, optimum moisture content and maximum dry density was determined using standard proctor test for the laterite quarry waste and cement with and without fly ash. And then from the optimum moisture content and maximum dry density of standard proctor test the weight of soil and water calculated. The materials required making the mixture taken and are weighed .after the weighed materials are placed inside the mixing machine and are mixed. Then the materials are uniformly mixed, water is then added to mix. After the mix is placed inside the batching container and the oil is applied on the sides of brick mould and mix is poured into mould. After 210kg/cm^2 compressed load was applied for drying the brick is kept under atmospheric conditions for one day.

C. **Curing and Stacking of Interlocking Bricks**

The bricks were first allowed to air dry under atmospheric temperature for 24 hours. There after curing was continued by sprinkling of water morning and evening and covering the bricks with polythene sheet for one week to prevent the rapid drying out of the bricks which could lead to shrinkage cracking. After curing bricks

are stacked in 7 days in rows and column with five bricks in a column until they ready for strength and water absorption test.

D. **Testing on Interlocking Stabilized Bricks**

The Various Test Conducted on Interlocking Stabilized soil Bricks such as Water Absorption and Compressive Strength.

IV. RESULTS AND DISCUSSIONS

Table 1 shows the results of tests on various properties of Laterite soil which was used in the current study.

Table 1. Properties of Laterite Soil

SL No.	***Properties***	***Results***
1	Specific Gravity	2.61
2	Moisture Content	6.76%
3	Grain Size Distribution (%) wet sieve analysis a) Gravel b) Sand c) Silt and Clay	 1.98 52.10 45.916
4	Grain Size Distribution (%) dry sieve analysis a) Gravel b) Sand c) Silt and Clay	 63 93.675 0.025
5	Consistency Limits a) Liquid limit b) Plastic limit c) Plasticity index d) Flow index	 28.5% 22.87% 5.63% 10.6
6	IS Soil Classification	CL-ML
7	Engineering Properties a) MDD (g/cc) b) OMC (%)	 1.86 15.8
8	Unconfined Compression test(kN/m^2)	9.67

The water absorption was carried out after 28^{th} day. Water absorption for ranged between 12.4 % to 14.9% the brick when tested in accordance with code IS: 3495 (PART 2)1976, after immersion in water for 24 hours. Average water absorption shall not more than 15 percent by its weight.

Wa= [(W s-Wd)/Wd]*100

Where

Wa= percentage moisture absorption

Ws= weight of soaked block

Wd= weight of dry block

Table 2. Water absorption

Sl. No	***Type of Bricks***	***(%)***
1	Laterite (100%)	-
2	Laterite soil(88%) +12% cement	4.10
3	Laterite soi(83%) +12% cement+5% fly ash	10.17
4	Laterite soil(78%) +12% cement+10% fly ash	5.50
5	Laterite soil(73%) +12% cement+15% fly ash	6.50

Below Table 3 shows the result of various properties of cement used in the current research study.

Table 3. Test results of cement

Sl.No	***Properties***	***Results***
1	Fineness of Cement	3.54%
2	Specific Gravity of Cement	3.15
3	Consistency of Cement	32%
4	Initial Setting Time	100minutes

The below Table 4 shows the compressive strength of laterite-cement-flyash bricks.

Table 4. Compressive strength of Bricks

Sl. no	***Type of Bricks***	***7day(Mpa)***	***21day (Mpa)***	***28day (Mpa)***
1	Laterite(100%)	1.2	1.2	1.2
2	Laterite soil(88%) +12% cement	5.8	7.2	8.2
3	Laterite soil(83%) +12% cement+5% fly ash	3.4	5.2	5.9
4	Laterite soil(78%) +12% cement+10% fly ash	5.6	6.7	7.4
5	Laterite soil(73%) +12% cement+15% fly ash	5.9	7.2	8.5
6	Laterite soil(68%) +12% cement+20% fly ash	5.1	5.8	6.3

Compressive test conducted at 7, 21 and 28 days of curing. The block that have attained the ages for strength test of 7, 21 and 28 days were taken from curing and drying for 7 days .then bricks are placed truly horizontal to the metal plate and recessions filled with metal plate of exact size to prevent sheaving of the bricks during testing. The brick was crushed and corresponding failure load recorded. The crushing force was divided by sectional area of the block to arrive at the compressive strength.

Graphically, the variation of compressive strength of bricks on 7, 21 and 28 days respectively is shown in below graph.

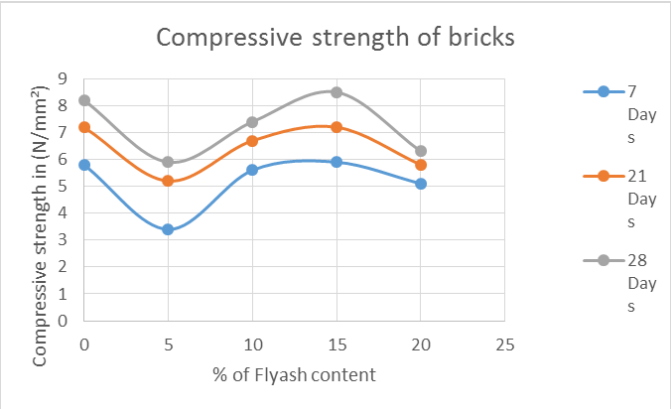

Fig 1. Compressive strength of bricks

V. CONCLUSIONS

Many research studies found that the addition of cement and admixtures to the laterite soil bricks increases its durability and strength. In the current study, a try is made to replace soil with fly ash in the presence of constant cement content. The results obtained shows that, there is an increase of compressive strength which is 2.5 times higher than normal laterite brick. Also as per IS: 3495 (Part 2)-1976, water absorption for first class brick should not be more than 15%. In the current study, the aspects required for first class brick were fulfilled. Also it has more surface finish when compared to normal laterite brick, which in other terms reduces quantity of mortar to be used during plastering work. Also, in terms of production, the cost required for the current brick is somewhat higher than normal laterite brick, but, the cost get compensated due to lower use of quantity of mortar to be used. Thus, the present study conclude that, the replacement of 15% of fly ash with 12% of cement to the soil will give maximum compressive strength with lower water absorption.

Scope of Future Work

In regard to the project "Study on compressed Interlocking Laterite soil-cement-Fly ash bricks", following thing can be taken future:

- This test has been performed only using laterite soil, cement and fly ash. However it can be performed using some admixtures to improve the binding properties and overall strength of bricks.
- This particular project used 12% of cement content as fixed percentage and 15% of fly ash as optimum content. However this can also tried by 15% of fly ash and reducing the cement content to give better results.

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