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Feasibility Study on Fly Ash-Lime-Soil Bricks (FALSB)

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ABSTRACT

Fly ash is generated in large quantities especially by thermal power plants. A lot of research has been carried out for effective utilization of fly ash in building industry. Use of fly ash in manufacturing brick is one such project which is being studied by researchers. The following materials were used for preparing the samples. Clayey soil, Fly ash and Lime

In this study ratios 80:10:10, 70:20:10, 60:30:10, 50:40:10 (Fly ash : lime : soil) are taken for manufacturing FALSB. water content for bricks were taken by preparing sample bricks and was found by 50%. FALSB are tested by the compressive strength, water absorption, efflorescence, tolerance and density The highest compressive strength was found in 70:20:10. the water absorption, efflorescence and density value was found in 50:40:10. The tolerance length was 4.6 M, width was 2.6 M, and height was 1.7 M

KEYWORDS: *Lime, Soil, fly ash, compressive strength, water absorption, efflorescence, tolerance, density.*

I. Introduction

1.1 Background

Bricks are small rectangular blocks that can be used to form parts of buildings, typically walls. The use of bricks dates back to before 7,000 BC, when the earliest bricks were formed from hand-moulded mud and dried in the sun. During the Industrial Revolution, mass-produced bricks became a common alternative to stone, which could be more expensive, less predictable and more difficult to handle.

Bricks are still in common use today for the construction of walls and paving and for more complex features such as columns, arches, fireplaces and chimneys. They remain popular because they are relatively small and easy to handle, can be extremely strong in compression, are durable and low maintenance, they can be built up into complex shapes and can be visually attractive.

Usually bricks are manufactured by clay, by burning with high temperature but now days bricks are made up different materials in such materials we selected fly ash as the main material to manufacture the bricks

Fly Ash bricks are made of fly ash, lime, and soil. These can be extensively used in all building constructional activities similar to that of common burnt clay bricks. The fly ash bricks are comparatively lighter in weight and stronger than common clay bricks. Since fly ash is being accumulated as waste material in large quantity near thermal power plants and creating serious environmental pollution problems, its utilization as main raw material in the manufacture of bricks will not only create ample opportunities for its proper and useful disposal but also help in environmental pollution control to a greater extent in the surrounding areas of power plants. In view of superior quality and eco-friendly nature, and government support the demand for Fly Ash Bricks has picked up.

The excellent engineering property and durability of fly ash brick enlarges its scope for application in building construction and development of infrastructure, construction of pavements, dams, tanks, under water works, canal lining and irrigation work etc. Enormous quantities of fly ash is available in and around thermal power stations in all the states. The demand of bricks could be met by establishing small units near thermal power stations and to meet the local demand with less transportation costs

1.2 FLY ASH

Fly ash is a by-product of the combustion of pulverized coal in thermal power plants. It is removed by the dust collection system as a fine particulate residue from the combustion gases before they are discharged into the atmosphere. Fly ash particles are typically spherical, ranging in diameter from less than 1 micron to 150 micron, the majority being less than 45 micron

In recent years, there has been a recognition that fly ashes differ in significant and definable terms, reflecting their composition and, to some extent, their origin. Canadian and U.S specifications recognize two general classes of fly ash: Class C, produced from lignite or sub-bituminous coals; Class F, produced from bituminous coals. 35 The Class C ashes differ from the Class F materials principally in having a capacity for self-hardening in the absence of cement. The most notable chemical difference between these two classes of ash is that the class C ashes contain high levels of calcium.

This has led to the use of an alternative and in some ways preferable terminology: high-calcium and low-calcium ash for classes C and F, respectively. This distinction has not been made in North American specifications. These presently make no reference to CaO content.

Table.1 Chemical Composition of Fly Ash

Chemical Composition	% By Weight
Unburnt Carbon	12.00
SiO2	57.77
Al2O3	23.92
Fe2O3	9.56
TiO2	1.63
CaO	2.24
K2O	0.60
MgO	1.28
Mo2O	0.13

1.3 Lime

Lime: Lime can be used to treat soils to varying degrees, which depends on the objective of a particular project. The least amount is used to dry and treat soils, which provides a working technique, which produces permanent structural stabilization of soils. Most lime used for soil treatment is high calcium lime, which contains magnesium oxide or hydroxide. Lime can be applied in the form of quick lime (calcium oxide – CaO), hydrated lime (calcium hydroxide Ca [OH]2) or lime slurry to treat the soil. Hydrate lime is created when quick lime reacts with water. This hydrated lime reacts with clay particle and transform them into a strong cementitious matrix.

1.4 SOIL

"Soil is a natural body consisting of layers (soil horizons) that are composed of weathered minerals, organic matter, air and water; it is a natural medium for the growth of plants"

Soil is a natural body and formed under various ecosystems with the help of various factors. It is the end product of the combined influence of natural processes controlled by climate, topography, organisms, parent material and climate Engineers define soil as the unconsolidated material above the bedrock. Geologists define soil as the natural medium for the growth of plants on lands.

Mineral soils hardly contain 1-2% organic matter. Most of the soil materials are inorganic aluminum-silicates. Yet the soil is considered as a living body since it helps survival of numerous micro- and macro-organisms through physical and nutritional support. Many scientists believe that there are more species in existence below the soil surface than above it. Some organisms are plant and human pathogens and most of them are innocuous and benign water

II. LITERATURE REVIEW

Tabin Rushad S 2010 worked on Experimental Studies on Lime-Soil-Fly Ash Bricks. A lot of research has been carried out for effective utilization of fly ash in building industry. The aim of the present study is to investigate the strength and water absorption characteristic of fly ash bricks made of lime (L), local soil (S) and fly ash (FA). The experiments were conducted both on Hand moulded and Pressure moulded fly ash bricks.

Dayanada N 2016 worked on Experimental Study on Utilization of Fly Ash and Slag in the Production of Compressed Bricks. This investigation is done to study the utilization of fly ash and granulated blast furnace slag in compressed bricks. Methods of preparing the mix, molding and curing are described in detail. The bricks were cured under three conditions. In the first condition the bricks were cured by sprinkling the water for 28days whereas, in the second and third condition, the bricks were cured by immersing in alkaline and acidic water for 28 days respectively.

Thushar S Shetty 2016 worked on A Feasibility Study on the Compressive Strength of Fly ash and Lime Stabilized Laterite Soil Blocks .In this study, tests were conducted to investigate the properties of laterite soil sample such as moisture content, specific gravity, grain size analysis, consistency limits, optimum moisture content (OMC), maximum dry density (MDD), unconfined compression strength (UCS), compressive strength and water absorption .

Hari R 2018 worked on Experimental investigation on replacement of sand by quarry dust in fly ash bricks. In this study the experimental investigation was carried out to find the optimum mix percentage of fly ash brick. However the brick specimen of size 235mm x115mm x 65mm were cast for different mix percentage of Fly ash (15 to 50%)Gypsum (2%),Lime (5 to 30%) and Quarry dust(45 to 55%), compressive strength were studied for different mix proportions. As the compressive strength of the brick increases, the water absorption of the brick decrease. In this experimental work maximum compressive strength after 21 days is 5.845N/mm², where minimum water absorption is 5.52 % after 21 days in quarry dust Fly ash brick.

III. METHODOLOGY

3.1 Collection of Soil

The soil samples were collected from surroundings of Rajahmundry.

3.2 Determination of Soil Properties

The tests conducted for determining the properties of soil are-Sieve Analysis, Liquid Limit Test, Plastic Limit Test, Specific Gravity Test and Standard Proctor Test

3.3 Determination of Material Properties

Standard proctor test was conducted for both lime and fly ash .The OMC and MDD of lime were found to be 42% and 1.18 g/cm³ . The OMC of fly ash were found to be 45% and 1.01 g/cm³

3.4 Manufacturing of bricks

- The size of the brick mould was 230×110×90 mm
- The manufacturing of bricks is done by keeping soil content as constant and changing the values of fly ash and lime
- The ratios are 80:10:10, 70:20:10, 60:30:10, 50:40:10 (FA:L:S)
- Now take the materials as per the ratio and place them on the floor and mix it thoroughly
- Now add suitable amount of water and mix it thoroughly
- Clean the moulds and apply grease to the moulds
- Now put the mortar into the moulds. And do the tampering
- Adjust the top layer of the moulds and dry them for one day, now take out the brick from the mould
- Dry the bricks for two days and put them to the curing in jute bags for 7 and 28 days

Figure 1. Mixing of materials

Figure 2. Adding water to materials

3.5 LABORATORY TESTS

Table2: Schedule of laboratory model test

Type of brick test	Test performed
Compressive strength test	√
Water absorption test	√
Efflorescence test	√
Tolerance test	√
Density test	√
TOTAL	5

Figure 3. Compressive strength testing

IV. RESULTS

A total 4 number of model tests were performed as discussed. This section shows its results. Preliminary tests were conducted on soil and its results are discussed below.

The properties of soil found out in laboratory are given below.

Table 3. Properties of soil

TESTS	Soil
Liquid limit (%)	35.7
Plastic limit (%)	14.6
Gravel+sand (%)	46.2
Silt+clay (%)	53.8
Specific gravity (%)	2.61
Plasticity index	21
OMC (%)	12
MDD (g/cm3)	1.8
Soil classification	CI

Table 4. Result of Compressive Strength

SL.NO	RATIO	COMPRESSIVE STRESS (N\mm^2)	
		7 DAYS	28 DAYS
1	80:10:10	3.9	8.3
2	70:20:10	6.71	13.8
3	60:30:10	2.63	6.71
4	50:40:10	2.5	6.32

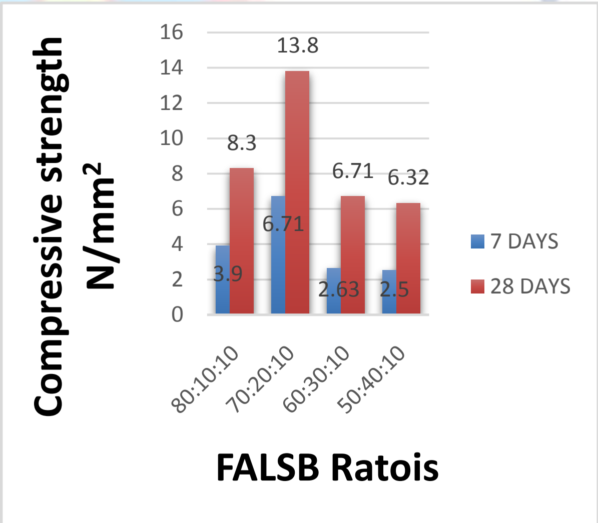

Figure 4 . Result of compressive strength

Table 5. Result of Water Absorption Test

SL.NO	RATIO	WATER ABSORBTION%
1	80:10:10	35
2	70:20:10	38
3	60:30:10	42
4	50:40:10	45

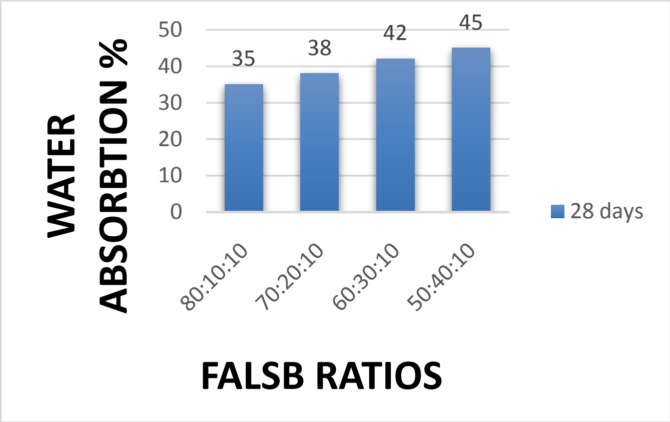

Figure 5. Result of Water Absorption Test

Table 6. Result of Tolerance Test

SL.NO		
1	LENGTH(m)	4.67
2	WIDTH(m)	2.6
3	HEIGHT(m)	1.7

Table 7. Result of Efflorescence Test

SL.NO	RATIO	EFFLORESCENCE
1	80:10:10	SLIGHT
2	70:20:10	MODERATE
3	60:30:10	MODERATE
4	50:40:10	HEAVY

Table 8. Result of Density Test

SL.NO	RATIO (FA:L:S)	AVERAGE WEIGTH KG	DENSITY KG/M³
1	80:10:10	3.133	1375.933
2	70:20:10	3.173	1393.500
3	60:30:10	3.180	1396.574
4	50:40:10	3.206	1407.997

V. Conclusion

- From the laboratory results, the compressive strength of the FALSB bricks was found to be that the ratio 70:20:10 was the moderate ratio among the ratio was 80:10:10,60:30:10,50:40:10 respectively
- The highest compressive stress of 7 days curing was found to be in the ratio70:20:10 was 6.71 N/mm² and followed by 80:10:10 was 3.9 N/mm² ,60:30:10 was 2.63 N/mm² and 50:40:10 was 2.5 N/mm²
- The highest compressive stress of 28 days curing was found to be in the ratio70:20:10 Was 13.8 N/mm² and followed by 80:10:10 was 8.3 N/mm² ,60:30:10 was 6.71 N/mm² and 50:40:10 was 6.32 N/mm²
- The highest water absorption value was found in the ratio 50:40:10 and followed by 60:30:10,70:20:10 and 80:10:10
- The water absorption values of the ratios 80:10:10;70:20:10,60:40:10,50:40:10 were 35%,38%, 42% and 45% respectively.
- Efflorescence was highest in the ratio 50:40:10 and the lowest was in the ratio 80:10:10
- Efflorescence was moderate in from the laboratory results, the compressive strength of the FALSB bricks was found to be that the ratio 70:20:10 was the moderate ratio among the ratio was 80:10:10,60:30:10,50:40:10 respectively.
- The water absorption values of the ratios 80:10:10;70:20:10,60:40:10,50:40:10 were 35%,38%, and 42% respectively.
- Efflorescence was highest in the ratio 50:40:10 and the lowest was in the ratio 80:10:10 the ratios 70:20:10 AND 60:30:10
- Tolerance of twenty bricks was length 4.67m, width 2.6 m, and height 1.7 m
- Density of the FALSB was found in the ratio 80:10:10, 70:20:10 ,60:40:10, 50:40:10 were 1375.9, 1393.5, 1396.5, and 1407.9 respectively

The highest density of brick was found in the ratio 50:40:10

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