Manufacturing of Bricks using Laterite Soil (Tilla Soil)

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***Abstract*:- House is the third need of human in the world. While considering about India the population is increasing day by day which required Food, Cloths & shed / house for living. Affordable housing is needed in many countries of the world especially the developing ones. Building material makes up for 75%of the total cost of construction. The high demand for housing has increased the use of conventional building material which causes various environmental problems. To address these situations, attention has been focused on low-cost alternative building materials using industrial, agricultural, and natural wastes. Using the waste as substitute raw material in manufacturing of building products is an innovative way of waste utilization. In this paper we have given a thrust on the use of waste material such as fly ash, Rice husk with other raw materials to manufacture a masonry unit. And the results of experiments conducted for various percentages of laterite soil, cement and rice husk mixed with varying percentages of fly ash. Objective of this study is to obtain a best percentage of fly ash that can be added with soil and cement as stabilizing agent to manufacture bricks at a low cost which can fulfill the requirement of homeless people in the rural and urban parts of the country. Hence bricks in different percentages of fly ash, soil, cement and rice husk mix were added in this manufacturing process.**

The laterite soil was collected from Dhumnsur Village Taluka Humnabad in the Bidar district. Bricks of 2.5% of cement and 3% of rice husk by weight of the soil & varying percentage of fly ash (2.5%, 5%, and 7.5%) with weight of the soil are used and different mix proportions of bricks were prepared and tested for compressive strength in the compressive testing machine (CTM) and water absorption test for 3days. After testing the bricks for 3 days we noticed that the best quality of brick with high compressive strength & The better degree of compactness of bricks by water absorption test were obtained for a mix proportion of Cement: 2.5% Rise husk: 3% Fly ash: 7.5% .

By this study we concluded that the addition of excess fly ash reduces the compressive strength of the brick and should be added in desired quantity. Addition of desired quantity of fly ash can result in better bonding of the raw materials and give a better-finished product with sharp and fine edges. Bricks have the compressive strength that satisfies IS code limits

Key Words: Laterite soil, cement, fly ash, rice husk, compressive strength.

1. INTRODUCTION

A house is one of the major amenities for the human being everywhere in the world. Different types of materials and method are adopted for constructing a house or a building. As far as country like India is concerned, low cost materials and its availability is the main factor controlling the selection of material and mode of construction. In olden days mud walled houses were used by poor people in rural areas.

Brick is one of the most important materials for the construction industry. The conventional method of bricks production has brought undeniable shortcomings. The consumption of earth-based materials as clay, shale and sand in brick production resulted in resource depletion, environmental degradation, and energy consumption. Virgin resources are mined from riverbeds and hillsides to service brick industry leaving mines areas un-reclaimed. Environmental degradation accompanies such mining activities with air pollution and remains after the mines cease operations, leaves scars on the landscape.

Objective: Production of laterite bricks with enhanced mechanical properties by using locally available laterite soil.

To determine the physical strength properties of bricks by partial replacement of cement with fly ash.

2. MATERIALS

Laterite Soil: The Laterite stone is good building material and people using laterite stone for the construction of buildings, but the waste laterite soil is available in the laterite quarries are used for filling purpose.Laterite soil is obtained from the well digging site which is used for the preparation of the bricks and the physical and mechanical properties of laterite soil are tested such as specific gravity, liquid limit, shrinkage limit, plastic limit, optimum moisture content, maximum dry density. These tests are conducted on the laterite soil.

Characteristics of laterite soil:

1.The laterite soil is slightly red in colour

2.These soils are coarse or rough in touch. They are porous as they allow water or air to pass through it.

3. Due to intensive leaching, laterite soils are not so fertile by themselves.

4.The significant features of the lateritic soils are their unique colour, poor fertility, and high clay content.

5.Lateritic soils have the advantages of good porous properties.

6.The behavior of laterite soil in an undisturbed as well as in laboratory conditions is essential since they are often used as foundation or base layers for road construction.

The laterite soil is taken from the village Dhumnsur near Humnbad which 56.5km away from Bidar.

Cement:

Cement used for the preparation of brick is Ordinary Portland Cement. The good quality of cement is required

for the manufacturing of bricks. The cement also possesses various properties such as Fineness, Specific gravity, Consistency, Setting time and many more.53 grade of Ordinary Portland cement is used confirming IS: 12269.

Rice Husk:

Rice husk has been used as insulating material for cold storage for many years in many countries, and it is available locally. Rice husk is usually used for wall and roof insulation. Occasionally it is used for floor insulation in small cold storages. Rice husk can absorb water ranging from 5% to 16% of unit weights, and the unit weight of rice husk is 83–125 kg/m3.Rice husk is abundantly available waste materials and serve as an inert filler to increase the intermolecular bonding and increase compressive strength within the bricks.

Fly Ash:

An Overview Fly ash is the by-product of coal combustion collected by the mechanical or electrostatic precipitator (ESP) before the flue gases reach the chimneys of thermal power stations in very large volumes. All fly ash contain significant amounts of silicon dioxide (SiO2), aluminium oxide (Al2O3), iron oxide (Fe2O3), calcium oxide (CaO), and magnesium oxide (MgO). However, the actual composition varies from plant to plant depending on the coal 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.

India's power generation has undergone a tremendous growth since independence. The production of ash also increased from 110-130 million tonnes in 2010-11 to 150-170 million tonnes in 2020-21, likely to cross 200 million tonnes in next decade.The ash should be managed properly or otherwise it will cause land, air and water pollution and there is a serious concern about utilizing it to the maximum extent. It is obvious that building the infrastructure will require large quantities of construction materials. At the same time, due to the growing worldwide concern for climate change caused by the "greenhouse" gases such as CO2 emissions. So, in order to pursue the goal of infrastructure development in a sustainable manner it would be necessary to use much larger amount of industrial by-products such as fly ash in place of raw materials.Unfortunately, despite increasing awareness of potential of fly ash, the response of Indian builders and material manufactures towards fly ash utilization has been quite lukewarm until recent past with the level of utilization in Indian context being a meagre 5% utilization in construction industry mostly by brick manufacturing. Gainful utilization of fly ash in the production of bricks could serve the dual purpose of conserving valuable agricultural land and augmenting brick production in the country.

Fly ash has potential for the development of new environment friendly, economical and safe building materials. Further Fly ash mixed laterite soil bricks have many advantages like

1. Light weight.
2. Saving of fertile land, pure water.
3. More compressive strength.
4. Use of wastage etc.
5. Minimizing environmental impact of direct disposal.
6. Minimizing disposal costs.
7. Procuring financial returns from the sale of the by-product.

Coal ash is also the largest waste materials and reusing coal ash can improve strength, durability, and workability of materials.

Water:

Portable water is used for mixing ingredients and making bricks. Water test is not carried out in this case. It should be free from any amount of oils, acids, alkalis, sugar, salts and organic materials or other substances that may be deleterious to brick.

3.TESTS ON SOIL

The soil samples were analysed and compared with the results found by previous researches. Various tests were performed on the soil are as follows:

a)
article size distribution test(sieve analysis).
b)
oisture content test.
c)
pecific gravity test.
d)
ry density test.
e)
tterberg limit test.
f)
ompaction test.

Particle size distribution test

This test is done to determine the particle size distribution of soil. The analysis is conducted by sieve which is capable of determining the particle‘s size ranging from 0.075to100mm.

Table 1: The sieves typically utilized in the Grain Size Analysis test

Sieve #	Opening diameter (mm)
4	4.75
10	2
20	0.85
40	0.425
60	0.25
100	0.15
140	0.105
200	0.075

Table 2: Particle size distribution

Soil type		Particle size(mm)
Clay		< 0.002
Silt		0.002-0.075
Sand	Fine	0.075-0.42
	Medium	0.42-2.0
	Coarse	2.0-4.75
Gravel		4.75-75

Moisture content test

This test is used to determine the moisture and water content in the soil. Various methods like Calcium Carbide method, oven drying method, Sand bath method, Radiation method, and Alcohol method.

Table.3. Soil Moisture Content

Soil Moisture Content	Condition
>30%	Very wet
25-30%	Wet
20-25%	Moderate
15-20%	Dry
<15%	Very Dry

Specific gravity test

Specific gravity is defined as the ratio of the weight of an equal volume of distilled water at that temperature both weights taken in air. The test is carried out by pycnometer.

Dry density test

Dry density of soil is defined as the ratio of mass of soilds to the total volume of the soil. Density test helps to classify the soil into three types-loose, medium and dense, with weight of the soil samples. The lesser the density, the stronger the foundation. It can be done by using sand replacement method, core cutter method and water-displacement method. Typical values of the dry or bulk density of most soil vary within the range of 1.1-1.6g/cm^3.

Atterberg limits test

It is used to measure the critical water content of the soil. There are plastic limits, liquid limit and shrinkage limit, which displays the attributes of fine-grained soil at different conditions.

4. MANUFACTURING PROCESS

MIX PROPORTION

Laterite bricks were manufactured with mix proportion of 2.5% of cement and 3% of Rice Husk by the weight of soil. The proportion of laterite was progressively replaced with fly ash thereby having unlike mix proportions of 2.5%, 5%, 7.5% by weight of soil while keeping the quantity of cement and rice husk constant. In the first mix proportion, 1.67 kg of cement, 2 kg of rice husk and 2 kg of fly ash were mixed with 67 kg of laterite soil sample and water was added until a consistent mixture was obtained. In the second mix proportion, 1.67 kg of cement, 2 kg of rice husk and 3.5 kg of fly ash were mixed with 67 kg of laterite soil sample. In the third mix proportion, 1.67 kg of cement, 2 kg of rice husk and 5 kg of fly ash were mixed with 67 kg of laterite soil.

Mix Design Ratio

Table 4. Proportion of ingredients

Soil Sample (kg)	Cement (kg)	Rice Husk (kg)	Fly Ash (kg)
67	1.67	2	2
67	1.67	2	3.5
67	1.67	2	5

The above table represents the various mix design in kgs where all the ingredients were encapsulated into different proportion indicating three different mix proportions.

Casting Of Bricks:

The resulting combination was relocated into a steel mould of size 190 mm x 90 mm x 90 mm. The mixture was compacted by levitating the mould to a height of 1m and consenting it to fall freely to the ground. It was filled again to the brim, compacted manually and the mould removed. The process was repeated for the same mix proportion. The mix proportion of the cement: fly ash: laterite ratio was varied to the next fly ash and laterite mixture, that is, 1.67kg of cement 3.5kg of fly ash and 67 kg of laterite. The production process was also repeated and continued until all the bricks of the three different mix proportions were casted.

Curing Of Bricks

After removing the mould all the produced cement fly ash–stabilized laterite bricks produced were left in the open air under normal temperature to cure. Water was sprayed on the bricks once in the morning and once in the evening for required number of days for curing. In this project we cure the bricks for 7 days and 28 days before conducting the laboratory test and field test of bricks

5. TESTS ON BRICKS

The various tests performed on bricks are as follows:

a. Crushing Strength

1) The minimum crushing strength of should be 105kg/cm2.

2) The crushing strength of brick can found out with the help of crushing testing machine.

3) Brick is fixed to the crushing testing machine and then crushing force is applied to the brick during the test operation.

Compressive strength=Maximum load at failure/Area of specimen

Table 5: Compressive strength of bricks

Class of bricks	Compressive strength N/mm2
Engineering A	70
Engineering B	50
Damp proof course 1	5
Damp proof course 2	5
All others	5

b. Water Absorption Test

1) A dry brick is weighed (w1).

2) It is then immersed in water for period of 24 hours.

3) It should not exceed 20% of the weight of dry brick fir first class brick.

4) It is weighed again and the difference in weight indicates the amount of water absorbed by the brick (w2).

Waterabsorption (%)= [(w2-w1)/ w1]*100

Table 6:Water absorption of bricks

Class of bricks	Water a absorption p percentage b by mass
Engineering A	4.5
Engineering B	7.0
Damp proof course 1	4.5
Damp proof course 2	7
All others	No limits

c. Efflorescence Test

1) For finding out the presence of soluble salts in brick, it is immersed in water for 24hours.
2) It is then taken out and allowed to dry.
3) If white deposit covers about 10% surface, the efflorescence is said to be slight and it is considered as moderate when the white deposit covers about 50% of the surface.
4) If white deposits are found on more than 50% of the surface, the efflorescence is heavy, and it is treated as serious and brick is rejected.

d. Hardness test

In this test, a scratch is tried to make on the brick surface with the help of a fingernail. If no impression is left on the surface, the brick taken as enough hard.

e. Shape and size test

In this test, a brick is closely observed. It should be of standard size and its shape should be truly rectangular with Sharp edges and corners. For good bricks, the results should be within the following permissible limits:

a) Length: 3680mm to 3920mm
b) Width: 1740mm to 1860mm
c) Height: 1740mm to 1860mm

f. Soundness test

In this test, two bricks are taken and they are stuck with each other. The bricks should not break and clear ringing sound should be produced.

g. Structure test

A brick is broken and its structure is examined. It should be homogeneous, compact and free from any defects such as holes, lumps etc.

h. Color test

A good brick should have uniform deep red, cherry or copper colour.

i. Impact test

In this test, take a brick and drop it from a one-meter height. A good quality brick should not break at all. If the bricks are broken that means its impact value is low and its impact value is low and it should be rejected.

6. RESULTS AND DISCUSSIONS

EXPERIMENTAL INVESTIGATION ON SOIL

Physical Properties Of Soil

SI NO	PARTICULARS	VALUES
1	Specific gravity	2.9
2	Liquid limit	49%
3	Plastic limit	31%
4	Shrinkage limit	17.89%
5	Plasticity index	18
6	Optimum moisture content	21%
7	Maximum dry density	1660kg/m3

Table. 7. Physical properties of soil

The above table represents the physical properties of Laterite soil samples taken and their values obtained from various experimental investigations. Those values were correlated with the actual specifications confirming to IS 1077-1992 and found to be much relevant and allowed to be used in the practice of construction. The permissible liquid limit for medium plasticity holding clay soil ranges from 40%- 50%, so that it has been obviously proved that the soil is well workable. It's shrinkage limit indicates that there will be negligible reduction in volume of the soil during water absorption and the soil lost its elastic nature considerably after a long time and it also holds good compressive strength and hence chosen as a constructional member or ingredient in construction. The similar property like linear shrinkage and dry density have also been correlated with IS 1077 – 1992 and has been found below the permissible limit. Hence this soil sample has been accepted as an ingredient in the manufacturing of bricks.

Chemical properties of soil

SI NO	PARTICULARS	VALUES
1	Silica(SiO2)	49.68
2	Alumina(Al2O3)	25.56
3	Iron(Fe2O3)	16.3
4	Calcium oxide(CaO)	0.34
5	Magnesium oxide(MgO)	0.22
6	Potassium oxide	10.14
7	Magnesium oxide(MnO)	0.08
8	Sodium oxide(Na2O)	0.1

Table.8. Chemical properties of soil

The above table represents the chemical properties of Laterite soil samples taken and their values collected from numerous experiments. It has been observed that its major constituent is silica and next to it is alumina. The line up is followed by Iron and potassium in the order of their proportion. Since the major constituents are of acidic nature, the pH level of Laterite soil is found to be 4.5-6.5.

LAB TESTS ON BRICKS

After the culmination of restoring period, the bricks were dried in daylight for three to four hours, the accompanying tests are led on the blocks to discover their reasonableness.

1. Crushing quality

2. Water Absorption

Crushing Strength: The bricks are engrossed in water for 24 hours. The frog of the block is filled flush with 1:3 concrete mortars and the sample are put away in moist jute pack for 24 hours and subsequently swamped in clean water for 24 hours. The paradigm is set in pressure testing machine with 6 mm condensed wood on top and base of it to get consistent load on the sample. At that point load is applied pivotally at a uniform pace of 14 N/mm2. The upsetting burden is noted.

Water Absorption : Brick samples are gauged dry. At that point they are inundated in water for atime of 24 hours. The samples are taken out and cleaned. The solidity of every paradigm in wet condition is resolved. The distinctions in weight show the water consumed. At that point the rate incorporation is the proportion of water ingested to dry weight. The normal of three samples are taken. This worth ought not to surpass 20percent

Sl. No.	Brick Number	Compressive Strength (N/mm2)	Water Absorbed (%)
1.	Brick 1	4.89	11.2
2.	Brick 2	5.34	11.2
3.	Brick 3	5.12	11.2

Sl. No.	Brick Number	Compressive Strength (N/mm2)	Water Absorbed (%)
1.	Brick 1	3.12	7.6
2.	Brick 2	3.76	7.6
3.	Brick 3	3.19	7.6

Results

For mix (Soil=67 kg, cement= 1.67 kg, rice husk=2 kg, Fly ash= 2 kg) Test Results for 3 days

Table.9. Results of bricks for 3 days for fly ash 2.5%

This table illustrates the 3 days compressive test results for three different specimens which contain the Fly ash of 2 kg. Its water absorption is 7.6% at the end of 3 days and it has been stated that water absorption less than 7 % are said to be more resistant to damage by freezing. It is just slightly more than 7% and so it will not give a disruptive damage to the brick.

Sl. No.	Brick Number	Compressive Strength (N/mm2)	Water Absorbed (%)
1.	Brick 1	3.94	9.2
2.	Brick 2	4.27	9.2
3.	Brick 3	4.23	9.2

For mix (Soil=67 kg, cement= 1.67kg, rice husk=2 kg, Fly ash= 3.5 kg) Results for 3 days

Table.10. Results of bricks for 3 days for fly ash 5%

This table illustrates the 3 days compressive test results for three different specimens which contain the Fly ash of 3.5 kg. Its water absorption is 9.2% at the end of 3 days and it has been stated that water absorption less than 7 % are said to be more resistant to damage by freezing. It is just slightly more than 7% and so it will not give a disruptive damage to the brick.

For mix (Soil=67 kg, cement= 1.67kg, rice husk=2 kg, Fly ash=5 kg) Results for 3 days

Table.11.Results of bricks for 3days for7.5%

This table illustrates the 3 days compressive test results for three different specimens which contain the Fly ash of 5 kg. Its water absorption is 11.2% at the end of 3 days and it has been stated that water absorption less than 7 % are said to be more resistant to damage by freezing. It is just more than 7% and so it will not give a disruptive damage to the brick.

7. CONCLUSION

1. This laterite can be created in any ideal sizes as bricks and strong squares as building materials.
2. The continuous use of natural resource-based building materials has led to many environmental problems. Therefore, it is essential to develop alternative materials that can give a comparable performance with respect to appearance, structural properties, and durability.
3. The maximum Compressive strength is obtained for the mix proportion of cement 2.5% and fly ash of 7.5% which is 5.97 N/mm2.
4. Addition of excess fly ash reduces the compressive strength of the brick and should be added in desired quantity. Addition of desired quantity of fly ash can result in better bonding of the raw materials and give a better finished product with sharp and fine edges.
5. Bricks have the compressive strength which satisfies the IS code limits

8. REFERENCE

[1] International Research Journal of Engineering and Technology (IRJET)
[2] Investigation on strength parameters of lateritic interlocking block strengthened with fly ash and cement. Amit Rajendra Phadatare1, Aniket Sanjay
[3] International Journal of Engineering Research & Technology (IJERT) Study on Flyash Mixed Laterite-Cement Bricks
[4] Gaurav Keshav1 M-tech in Structural Engineering,Srinivas School of Engineering,Mukka, Manglore, India
[5] Karuna Basavraj Jamdade2M-tech in Structural Engineering,Srinivas School of Engineering,Mukka, Manglore, India
[6] International Journal of Engineering Science Invention Research & Development; FEASIBILITY STUDY ON BRICK USING LATERITIC SOIL Muraleedharan. M. A1 Dr Sunilaa George, Prof. M. Praveen Kumar
[7] IS 3620-1979 for methods of laterite soil.
[8] IS 4032-1977 for cement.
[9] IS 3025-1964 for water.
[10] IS 3495-1992 part 1. For compressive strength.
[11] IS 3495-1992 part 2 water absorption.
[12] IS 3495-1992 part 3 efflorescence.
[13] IS 1077-1992 common burnt clay building specification.