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PREPERATION OF CONCRETE BRICKS BY USING FLYASH AND COCONUT SHELLS

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ABSTRACT

Most of the building material for construction of houses is the normal brick. The rapid growth in today's construction industry has obliged the civil engineers in searching for more efficient and durable alternatives far beyond the limitations of the conventional brick production. This project presents the experimental investigation of partial replacement of coconut shells as coarse aggregate and fly ash as replacement of cement in the preparation of concrete bricks. In this study M10 grade of concrete was made for concrete bricks. Concrete mix of 5%, 10%, 15%, 20% and 25% replacement of coconut shell as coarse aggregate and constant replacement of 25% of fly ash were made. The brick specimen was Casted a size of 190mm x 90mm x 90mm and the Shape and size test, Compression test, water absorption test, fire ignition, Soundness test, drop test, Efflorescence test, Colour test and Structure test were conducted to analyze their suitability as a construction material.

Keywords: M10 grade of concrete, fly ash, coconut shells, Shape and size test, Compression test, water absorption test, fire ignition, Soundness test, Drop test, Efflorescence test, Colour test, Structure test.

1. INTRODUCTION

1.1 General

Shelter is a basic human need and owing a house becomes a lifelong struggle as majority of Indians find housing costs prohibitively expensive. This problem becomes even more acute when considering the low-income families who accounts for about 60-70% of Indian population. This brings out the need to reduce the cost of housing and make it affordable for the booming population. Burnt clay bricks are being used extensively and the most important building material is the construction industry. In India the building industry consumes about 20000 million bricks and 27% of the total natural energy consumption for their production. The higher water absorption, high efflorescence, etc. have forced engineers to look for better materials capable of reducing the cost of construction. In this contest search for an alternative building material to clay bricks, various government agencies and research institutions have repeatedly recommended the use of waste materials such as Fly Ash, Red Soil, Quarry Dust etc., as an alternative building material in making bricks, blocks and tiles etc. Logically the unlimited use of clay is harmful to society, as all the conventional clay bricks depend on good quality clay available from agriculture fields. Presuming a weight of 2kg per brick, the total clay is taken out from agriculture lands per year for such brick works out to over 300 million tons.

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 Journal Volume 11, Iss 10, 2022

1.2 Flyash

Fly Ash is finely divided residue resulting from the combustion of powdered coal, transported by the flue gases and collected by electrostatic precipitators. Its proper disposal has been a cause of concern since long, which otherwise leads to pollution of air, soil and water. It also improves workability and reduces internal temperature. Fly ash consists primarily of oxides of silicon, aluminium iron and calcium. Magnesium, potassium, sodium, titanium, and sulphur are also present to a lesser degree. When used as a mineral admixture in concrete, fly ash is classified as either Class C or Class F ash based on its chemical composition. Class C ashes are generally derived from subbituminous coals and consist primarily of calcium alumino sulphate glass, as well as quartz, tricalcium aluminate, and free lime (CaO). Class C ash is also referred to as high calcium fly ash because it typically contains more than 20 percent CaO. Class F ashes are typically derived from bituminous and anthracite coals and consist primarily of an aluminosilicate glass, with quartz, mullets, and magnetite also present. Class F, or low calcium fly ash has less than 10 percent CaO.

1.3 Coconut Shell

Coconut is grown in more than 93 countries. India is the third largest, having cultivation on an area of about 1.78 million hectares for coconut production. Annual production is about 7562 million nuts with an average of 4248 nuts per hectare. The coconut industry in India accounts for over a quarter of the world's total coconut oil output and is set to grow further with the global increase in demand. However, it is also the main contributor to the nation's pollution problem as a solid waste in the form of shells, which involves an annual production of approximately 3.18 million tonnes. It also presents serious disposal problems for local environment, is an abundantly available agricultural waste from local coconut industries. In developing countries, where abundant coconut shell waste is discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of reduction in the cost of construction material and also as a means of disposal of wastes.

2. LITERATURE SURVEY

The challenge in making a lightweight concrete is decreasing the density while maintaining strength and without adversely affecting cost. Introducing new aggregates into the mix design is a common way to lower a concrete's density. Normal concrete contains four components, cement, crushed stone, river sand and water. The crushed stone and sand are the components that are usually replaced with lightweight aggregates. Lightweight concrete is typically made by incorporating natural or synthetic lightweight aggregates or by entraining air into a concrete mixture. Some of the lightweight aggregates used for lightweight concrete productions are pumice, perlite, expanded clay or vermiculite, coal slag, sintered fly ash, rice husk, straw, sawdust, cork granules, wheat husk, oil palm shell, and coconut shell. (Basri.H.B et al., 1999, Khedari et al., 2000, Mannan.M.A.. and Ganapathy 2002).

Dewanshu Ahlawat & L.G.Kalurkar (2014) explored the possibility of producing M20 grade of concrete by replacing conventional aggregate of granite by coconut shell. Forty-five cubes were casted.

Percentage of replacement of conventional coarse aggregate by coconut shell were 2.5%, 5%, 7.5%, 10%. Compressive strength was 19.71, 19.53, 19.08, 18.91 N/mm2 respectively at 28 days. Workability and compressive strength had been evaluated at 7, 14 and 28 days. The compressive strength of concrete reduced as the percentage replacement increased. By these results it can be concluded that coconut shell concrete can be used in reinforced concrete construction. Author concluded that its utilization is cost effective and eco-friendly.

P. Jayabalan and A. Rajaraman (2014)) carried out experimental investigation to know the effects on concrete by addition of natural coconut fibre and replacement of cement (by weight) with different percentages of fly ash on flexural strength, splitting tensile strength, compressive strength and modulus of elasticity. Test results demonstrate that the replacement of 43 Grade ordinary Portland cement with fly ash showed an increase in compressive strength, modulus of elasticity, flexural strength, and splitting tensile strength for the chosen mix proportion. Addition of coconut fibres resulting in fly ash mixed concrete composite (FMCC) did enhance the mechanical properties of fly ash mixed concrete composite and at the same time increased the energy levels reflected by increased failure strain, making the material suitable or seismic sustenance.

3. OBJECTIVE OF THE STUDY

3.1 Aim

The aim of study is to evaluate the performance and suitability of replacement of coconut shells with coarse aggregate and cement with flyash in concrete bricks manufacturing.

3.2 Objective

The objectives of experimental study are:

- Study on strength characteristics of M10 grade concrete bricks with replacement of 25% cement by flyash and replacement of 5%, 10%, 15%, 20% and 25% coarse aggregate by coconut shell.
- To determine the Shape and size test, Compression test, water absorption test, fire ignition, Soundness test, Drop test, Efflorescence test, Colour test, Hardness test and Structure test for concrete flyash coconut bricks (CFCB)

3.3 Methodology

The present study requires preliminary investigations in a systematic manner.

- Selection of type of grade of mix, mix design by an appropriate method, trial mixes, final mix proportions.
- Estimating total quantity of concrete required for the whole project work.
- Estimating quantity of cement, flyash, fine aggregate, coarse aggregate, coconut shells required for the project work.
- Preparing the concrete bricks with partial replacement of cement by flyash, coarse aggregates by coconut shells and fine aggregates, water-cement ratio kept constants.
- Prepared bricks cure for 7days by sprinkling of water daily 2times.

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 10, 2022

4. EXPERIMENTAL WORK

4.1 Materials Used

For the preparation of concrete bricks, we are used Cement, Flyash, Coarse aggregates, Fine aggregates, Coconut shells, water.

Table. 1: Properties of cement and fly ash.

Characteristics	Cement	Fly ash
Fineness of cement	5%	3%
Standard consistency	31%	-
Initial setting time	45min	-
Final setting time	315min	-
Specific gravity	3.14	2.3

Table. 2: Properties of coconut shell & aggregates.

Properties	Coconut shells	Coarse aggregates	Fine aggregates
Specific gravity	1.33	2.69	2.57
Water absorption	23%	1.2%	1%
Minimum size	12.5 mm	4.75mm	75microns
Shell Thickness	2-8mm	80-4.75mm	-

4.2 Mix Design

Adopted Grade was **M10** for preparation of concrete bricks.

4.2.1 General

Density of cement = 1440kg/m^3

Density of sand = 1600kg/m^3

Density of aggregates = 1800kg/m^3

Dry volume = 1.54 to 1.57 x wet volume

M10 =1:3:6

Sum of ratios =1+3+6 = 10

Assuming 1.54 (wet volume) = dry volume.

4.2.2 Basic calculations:

For 1m^3 volume

Volume(V) = length(L) x breadth(B) x height(H)

V = 1m x 1m x 1m = 1m^3

Weight of cement = 1/10 x 1.54 x 1440 = 221.76kg

Weight of sand = 3/10 x 1.54 x 1 x 1600 = 739.2kg

Weight of aggregates = 6/10 x 1.54 x 1 x 1800 = 1663.2kg

4.2.3 For standard modular size

FOR 190 x 90 x 90mm size brick

Volume = 190 x 90 x 90 = 0.001539m^3

Assume 10% wastage, n = 1 brick

Final volume of brick = n x [1+wastage] x 0.001539

= 1x [1+10/100] x 0.001539

= 0.0016929m^3

Weight of cement = 0.00169290 x [1/10 x 1.54 x 1440]

= 0.0016929 x 221.76

= 0.37541

= 375.4175gm

Weight of sand = 0.0016929 x [3/10 x 1.54 x 1600]

= 0.0016929 x 739.2

= 1.251391

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 10, 2022

= 1251.39gm

Weight of aggregates = 0.0016929x [6/10 x 1.54 x 1800]

= 0.0016929 x 1663.2

= 2.81563

= 2815.63gm

Weight of water:

w/c = 0.55 (assume)

w = 0.55 x 375.4175 = 206.4796gm

4.2.4 Coconut shells and fly ash replacement in concrete bricks

For 1 Brick making (25% Replacement of cement with fly ash and 0% to 25% replacement of coarse aggregates with coconut shells)

Table. 3: Material weights requirement for making 1 brick.

Fly ash (%) - Coconut shells (%)	CEMENT (gm)	Fly ash (gm)	Fine aggregates (gm)	Coarse aggregates (gm)	Coconut shells (gm)	Water contents (ml)
0 – 0	375.41	0	1251.39	2815.63	0	206.47
25 – 0	281.55	93.85		2815.63	0	
25 - 5				2675.63	140	
25 – 10				2534.63	281	
25 - 15				2393.63	422	
25 – 20				2252.63	563	
25 – 25				2112.63	703	

4.3 Sample Production

Control mix: The cement, fine and coarse aggregates were weighted according to mix proportion of M10. All are mixed together in a bay until mixed properly and water was added at a ratio of 0.55. The water was added gradually and mixed until homogeneity is achieved. Any lumping or balling found at any stage was taken out, loosened and again added to the mix.

Flyash based Concrete bricks: The cement, flyash (25% of cement weight replacement), fine and coarse aggregates were weighted according to mix proportion of M10. All are mixed together in a bay until mixed properly and water was added at a ratio of 0.55. The water was added gradually and mixed until homogeneity is achieved. Any lumping or balling found at any stage was taken out, loosened and again added to the mix.

Coconut shells & flyash based concrete bricks: The cement, flyash (25% of cement weight replacement), fine aggregates, coarse aggregates and coconut shells (0% - 25% with interval of 5% replacement of coarse aggregates) were weighted according to mix proportion of M10. All are mixed together in a bay until mixed properly and water was added at a ratio of 0.55. The water was added gradually and mixed until homogeneity is achieved. Any lumping or

balling found at any stage was taken out, loosened and again added to the mix.

A standard 190x90x90 mm brick specimens were casted for all above various types of concrete mixes. The samples were then stripped after 24hours of casting and are then be sprinkling of water for curing 7days (daily 2 times). As casted, a total of (28) 150x150x150mm bricks specimens were produced.

Fig. 1: Concrete bricks moulds.

Fig. 2: Sprinkling water curing of bricks.

4.4 Concrete Bricks Testing

4.4.1 Compression Test

- The brick specimen to be tested is placed on a horizontal surface and the specimen is to be centered between the plates on Compression testing machine.
- Apply the load at a uniform rate till the failure occurs.
- Note down the maximum load at failure.

4.4.2 Water Resistance Test

In this the bricks first weighted in dry condition, and they are immersed in water for 24 hours. After that they are taken out from water, and they are wipe out with cloth. Then the difference between the dry and wet bricks percentage are calculated.

The less water absorbed by bricks the greater its quality. Good quality bricks don't absorb more than **20%** water of its own weight.

4.4.3 Efflorescence test

The presence of **alkalis** in bricks is harmful and they form a gray or white layer on the brick surface by absorbing moisture. To find out the presence of alkalis in bricks this test is performed. In this test, a brick is immersed in fresh water for **24** hours and then it's taken out of the water and allowed to dry in shade. If the whitish layer is not visible on the surface it proofs that absence of alkalis in brick.

If the whitish layer visible about **10%** area of the brick surface, then the presence of alkalis is in the acceptable range. If that is about **50%** of surface area then it is moderate. If the alkali's presence is over **50%** of the brick surface area, then the brick is severely affected by **alkalis**.

4.4.4 Shape and Size Test

Shape and size of bricks are very important consideration. All bricks used for construction should be of same size. The shape of bricks should be purely rectangular with sharp edges. Standard brick size consists of length x breadth x height as 19cm x 9cm x 9cm.

4.4.5 Colour Test

A good brick should possess bright and uniform colour throughout its body.

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 10, 2022

4.4.6 Soundness test

Soundness test of bricks shows the nature of bricks against sudden impact. In this test, 2 bricks are chosen randomly and struck with one another.

Then sound produced should be clear bell ringing sound and brick should not break. Then it is said to be good brick.

4.4.7 Hardness test

A good brick should resist scratches against sharp things. So, for this test a sharp tool or fingernail is used to make scratch on brick. If there is no scratch impression on brick then it is said to be hard brick.

4.4.8 Drop test

When bricks are dropped from the height of 1 to 1.2m (4 feet), it should not crack or break. This ensures the durability and quality of bricks.

4.4.9 Structure of Bricks

To know the structure of brick, pick one brick randomly from the group and break it. Observe the inner portion of brick clearly. If there are any flaws, cracks or holes present on that broken face then that isn't a good quality brick.

5. RESULTS AND DISCUSSIONS

As per experimental programme results for different experiments were obtained. They are

shown in table format or graph, which is to be presented in this chapter.

5.1 Brick Test Results

5.1.1 Compression Test

Table. 4: Compression test results for 7 days.

Flyash (%)- Coconut shells (%)	Compression(N/mm2)
0 – 0	6.7
25 – 0	7.2
25 - 5	7.0
25 – 10	6.8
25 - 15	6.3
25 – 20	5.6
25 – 25	5

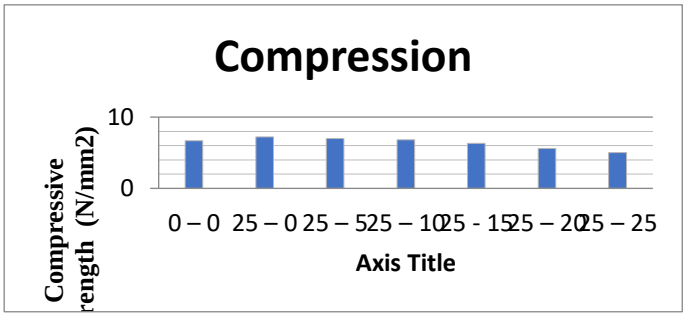

Fig. 3: Compressive strength test results graph.

5.1.2 Efflorescence test

No efflorescence visible on all bricks.

5.1.3 Shape and Size Test

For all bricks are rectangular shape and size 150x150x150 mm.

5.1.4 Water Resistance Test

Table. 5: Water resistance test results.

Flyash (%)- Coconut shells (%)	Water Resistance (%)
0 – 0	9.5
25 – 0	9.3
25 - 5	9.7
25 – 10	12
25 - 15	14

25 – 20	14.8
25 – 25	16.2

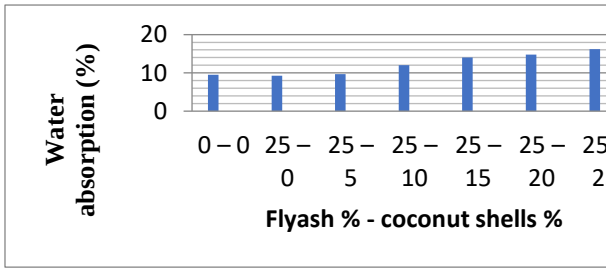

Fig. 4: Water absorption test results graph.

5.1.5 Colour Test

All the bricks having the uniform colour for entire structure.

5.1.6 Soundness test

For all the bricks ringing sound produced and bricks are not breaked. Then the bricks are good quality bricks.

5.1.7 Drop test

For all the bricks can't breaked while performed drop test, then the bricks are good quality bricks.

5.1.8 Structure of Bricks

There are no flaws, cracks or holes present on that broken face then that is a good quality brick.

5.1.9 Hardness test

Little bit scratch visible on all bricks except concrete bricks.

5.2 Advantages

1. The main advantage of this project is it is utilization of industrial waste and agricultural waste.
2. Using of flyash reduce the amount of Cement in the concrete brick's preparation and its giving good strength compare to normal concrete bricks.
3. This type of bricks can be used in all types of constructions except sea shores structures because of it have higher water absorption capacity but it's under specified limit of water absorption for bricks (<20%).
4. As these bricks are constructed with waste materials like coconut shells, fly ash. this is considered a value product out of waste and economical (lesser cost).

6. CONCLUSIONS

1. The aggregates are vital elements in concrete Bricks. The usage of enormous quantities of aggregates results in destruction of hills causing geological and environmental imbalance. The environmental impacts of extracting river sand and crushed stone aggregates become a source of increasing concern in most parts of the Country. Pollution hazards, noise, dust, blasting vibrations, loss of forests and spoiling of natural environment are the bad impacts caused due to extraction of aggregates. Landslides of weak and steep hill slopes are induced due to unplanned exploitation of rocks.
2. Considering the depletion of natural sources and the effect on environment, the disposal problems involved in disposing fly ash, light weight characteristics of coconut shell aggregates with good mechanical properties (Impact value 15.6%) as seen in the above investigation, a particular attention may be focused on the usage of fly ash, Coconut shell aggregates in concrete.

3. Trying to replace aggregate by coconut shell partially to make concrete structure more economic along with good strength criteria. This can be useful for construction of low-cost housing society. Solves problems of disposal of coconut shell.
4. Up to 10% of aggregate replaced by coconut shell and 25% of cement replaced by flyash is good according to strength and cost wise.
5. Up to 10% of aggregate replaced by coconut shell and 25% of cement replaced by flyash gives higher compressive strength compare to control mix.
6. The water resistance value is increasing by increasing coconut shells replacement by coarse aggregates. The structure test, soundness test, drop test, Colour test, Size and shape test the properties are similar to good quality bricks. And these bricks are very lesser cost compare to normal concrete and flyash bricks.

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