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An experimental study on utilization aspects of coir fibre in fly ash bricks

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Abstract: **Fly ash is generated in large quantities especially by thermal power plants. The worldwide agricultural footprint is fast growing, with vast agricultural land cultivation and active expansion of the agro-based industry. The resulting large quantities of agricultural wastes, unfortunately, are not always well managed or utilised. These wastes can be recycled, such as by retrieving fibres from disposed leaves and fruit bunches, and then incorporated in brick-making. This way the fly ash bricks are made a 'greener' building material and the discarded natural wastes can be reutilised, avoiding otherwise wasteful landfill and harmful open incineration. The aim of the present study is to investigate the strength and water absorption of fly ash bricks made of fibre, and fly ash. This study examined the physical and mechanical properties of fly ash bricks made by adding natural fibre to a fly ash-water mixture. The fibre was sourced from coir fibre added within the range of 0.2-0.8 %. In the present study, 4 different mixes of fibre fly ash bricks are tested for parameters like: crushing strength, weight, water absorption and cost.**

Keywords: **Fly Ash Bricks, Coir Fibre, Compressive Strength, Water Absorption.**

I. INTRODUCTION

Looking to the environmental impact ofClay bricks, it is high time that construction industry shifts towards brick production which uses ingredients with no adverse effect on environment. Fly ash generated during the combustion of coal for energy production is one of the industrial by-products and it is recognized as an environmental pollutant. Because of environmental problem of fly ash, a good deal of work and applications on the utilization of fly ash has been undertaken world over. Fly Ash bricks are made of fly ash, lime, gypsum and sand. 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.

In this study, I used coir fibre in fly ash bricks. Fibre fly ash bricks are made of fly ash, lime, and quarry dust, sand and coir fibre. Fibre Fly ash made bricks uses all ingredients which are having minimum negative environmental impact. Hence, Fibre Fly ash bricks are the materials for achievement of real sustainable development. Fibre Fly Ash bricks can be considered as bricks for the next generation. Fibre Fly Ash bricks are advantageous over conventional clay bricks as per following aspects: Less water absorption, less weight, better finishing, high strength, less mortar consumption for joints filling, less number of bricks requirement, reduced wastage. Looking to these advantages, more and more stakeholders from construction industry are getting attracted towards using Fibre Fly Ash bricks instead of clay bricks. But, it requires proper use of mix of various available ingredients so that quality is achieved along with minimum investment.

FLY ASH

FLY ASH is a finely divided residue resulting from the combustion of ground or powdered bituminous coal or sub bituminous coal (lignite) and transported by the flue gases of boilers fired by pulverized coal or lignite. Fly ash is a waste by product material that must be disposed of or recycled. It consists mainly of spherical glassy particle ranging from 1 to 150 µm in diameter, of which the bulk passes through a 45-µm sieve.

FIGURE 1: FLY ASH

CLASS C FLY ASH

Fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolonic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and Sulphate (SO_4) contents are generally higher in Class C fly ashes.

Class C has $SiO_2 + Al_2O_3 + Fe_2O_3 = 50\%$

CLASS F FLY ASH:

The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolonic in nature, and contains less than 10% lime (CaO). Possessing pozzolonic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds. Alternatively, in addition of a chemical activator such as sodium silicate (water glass) to a Class F ash can leads to the formation of a geo-polymer.

Class F has SiO_2 + Al_2O_3 + Fe_2O_3 = 70%

II.EXPERIMENTAL MATERIALS

a) Fly Ash (Class F)

An Experimental work was carried out with Class F type of Fly Ash. The chemical compositions of Fly Ash are given in following Table 1.

TABLE 1
CHEMICAL COMPOSITIONS OF FLY ASH

S.NO	CHEMICAL COMPOSITIONS	%
1	Silicon dioxide	62.22
2	Magnesium oxide	6.09
3	Total Sulphur trioxide	3.00
4	Calcium Oxide	5.30
5	Aluminium Oxide	7.63
6	Ferric Oxide	7.63
7	Loss on ignition	0.13

b) Sand

Sand is one type of the natural material. The composition of sand is highly variable, depending on the local rock sources and conditions, but the most common constituent of sand is silica (Silicon dioxide, or SiO2), usually in the form of quartz.

c) Quarry dust

Quarry dust is a waste product produced during the crushing process which is used to extract stone. It is rock particles. When huge rocks brake in too small parts for the construction in quarries. It is like sand but mostly grey in colour. It is mineral particles. The density of Quarry dust is 1650 kg/m³.

d) Lime

An Experimental work was carried out with Acetylene carbide waste lime. The chemical compositions of lime are shown in following Table 2.

TABLE 2
CHEMICAL COMPOSITIONS OF LIME

S.NO	CHEMICAL COMPOSITIONS	%
1	Silicon dioxide	5.39
2	Magnesium oxide	2.42
3	Total Sulphur trioxide	0.98
4	Calcium Oxide	28.60
5	Aluminium Oxide	1.06
6	Ferric Oxide	0.39
7	Loss on ignition	25.25

e) Coir Fibre

Coir is stiff coarse fibre that has been obtained from the outer husk of the coconut. The fibres range from sturdy strands suitable for brush bristles to filaments that can be spun into coarse, durable yarn. Coir has been traditionally used in the making of ropes and mats. Coir is a flexible natural yarn that is hauled out from mesocarp tissue, or husk of the coconut fruit. Generally coir is of rich yellow in colour once it has been cleaned after the removal of the coconut husk; and hence it is often called “The Golden Fibre".

FIGURE 2: COIR FIBRE

TABLE 3
PHYSICAL PROPERTIES OF MATERIALS

MATERIALS	TESTS	RESULTS
Fly ash	Fineness	20%
	Specific gravity	2.45
Sand	Sieve analysis (Fineness modulus)	9.21

	Specific gravity	2.64
Quarry dust	Sieve analysis (Fineness modulus)	9.22
	Specific gravity	2.51

TABLE 4
PROPORTIONS OF INGREDIENTS OF DIFFERENT SAMPLES FOR FLY ASH BRICKS

Samples	Fly ash	Sand	Quarry dust	Sludge lime	Coir fibre
A	60%	-	20%	20%	-
B	60%	20%	10%	10%	-
C	60%	20%	10%	10%	0.2%
D	60%	20%	10%	10%	0.4%
E	60%	20%	10%	10%	0.6%
F	60%	20%	10%	10%	0.8%

TABLE 5
SOURCES OF MATERIAL

S.NO.	INGREDIENTS	SOURCES
1	Fly Ash	Bhavani
2	Sand	Bhavani
3	Quarry dust	Bhavani
4	Sludge lime	Bhavani
5	Coir fibre	Dharapuram

III. EXPERIMENTAL METHODOLOGY

Various raw materials of brick mix in desired proportion are blended intimately in dry or wet form. In this Standard Mix proportion Coir fibres are added 0.2%, 0.4%, 0.6% and 0.8% by weight of brick.

Size of brick is 22.8cm x 10.8cm x 7.6cm

- ✓ The wet brick-mix is fed into the machine mould. The vibration is given for a while and the mould is again fed. The striper head is pressed and vibration is given simultaneously for about 8 seconds. The mould is lifted and bricks produced pallet is removed and kept on the platform for air drying.

FIGURE 3: BRICK MOULDING MACHINE

- ✓ Next day the bricks produced on the previous day are put in the stack. The stack is formed with care to see that curing water and air for drying reach to every brick.
- ✓ After 3 days the hot water from the solar collector in small quantity is poured on the fresh stack without any pressure.
- ✓ After 5 days the solar collector water is poured on the bricks stack for 2 times a day.
- ✓ The bricks in stack after each watering are immediately covered with black PVC tarpaulin, with a clear space of 250 mm form the layers of the bricks, inside the closed cover.
- ✓ The curing is continued for 15 days and the tarpaulin cover is removed. The bricks are then left in the stack for drying or heating the bricks stack.
- ✓ The bricks are ready for dispatch after 22 days from the date of manufacture.

FIGURE 4: FINAL FINISH PRODUCTS

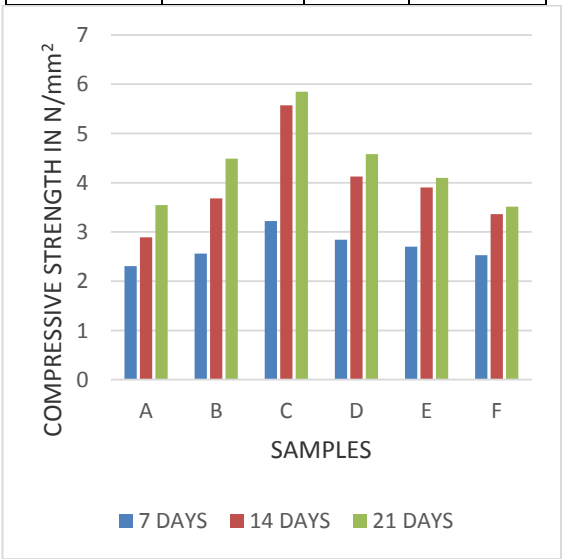
FIGURE 5: FLY ASH BRICKS WITH COIR FIBRE

IV TEST RESULTS

FIGURE 6: COMPRSSIVE STRENGTH TESTING MACHINE WITH BRICK

TABLE 6
RESULTS OF COMPRESSIVE STRENGTH TEST

SAMPLES	Average Compressive Strength (N/mm^2)		
	7Days	14 Days	21 Days
A	2.304	2.892	3.545
B	2.561	3.683	4.486
C	3.221	5.568	5.845
D	2.843	4.127	4.577
E	2.700	3.900	4.100
F	2.526	3.362	3.512



RESULTS OF WATER ABSORPTION TEST

SAMPLES	WATER ABSORPTION %
A	6.5
B	6.16
C	5.52
D	5.63
E	5.71
F	5.89

V CONCLUSIONS

After all the effort and present experimental work the following observation are made by added coir fibre in fly ash bricks with different percentage and conclude that….

Class F Fly ash is utilized in the brick manufacturing work as judicious decision taken by Engineers.

As the percentage of the coir fibre in brick increases, the compressive strength of the brick decreases.

In this experimental work 0.2% fibre addition in the brick gives the maximum strength 5.845 N/mm2 after 21 days.

As the compressive strength of the brick increases, the water absorption of the brick decreases. In this experimental work maximum compressive strength after 21 days is 5.845 N/mm2, where minimum water absorption is 5.52% after 21 days in Coir Fibre Fly Ash Brick.

Use of fly ash and Coir fibre help in prevention of environmental degradation and use of agriculture land utilised in clay brick production.

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