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STUDY OF PROPERTIES OF LIGHT WEIGHT FLY ASH BRICK

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ABSTRACT
In this paper, efforts has been made to study the behavior of fly ash bricks by taking different proportions of fly ash, cement, lime, gypsum and sand. Three types of fly ash bricks in the different percentage of cement such as 3%, 5% and without cement are designed and then various tests such as compressive strength test, water absorption test, efflorescence, weight test, structural test were performed in order to have comparison with conventional bricks. In the experimental study it is found that the compressive strength of fly ash brick containing 5% cement is 152.1 kg/cm2 which is more than that of class I conventional bricks by 40% approximately. Effort has been made by making different proportions of ingredients having composition of fly ash, cement, lime, gypsum, and sand.

Keywords: Cement, Fly ash, Fly ash brick, Fine aggregate.

I. INTRODUCTION

Fly Ash bricks are made of fly ash, lime, gypsum cement 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.

Manufacturing of commercial brick produce a lot of air pollution. The technology adopted for making. The fly ash bricks are eco-friendly. It is no need fire operation in production unlike the conventional bricks Among the traditional fossil fuel sources, coal exists in quantities capable of supplying a large portion of nation's energy need. That's why the power sector in India is a major consumer of coal in India and will continue to remain so far many years to come. Combustion of coal in thermal power plant not only produces steam to run electricity-generating turbine but also produces a large quantity of by-products like fly ash etc.

About 80 thermal power plants in India are sources of fly ash, where around millions of tonnes of coal are used annually. India currently generates 100 million tones of fly ash every year. This produces 30-40 million tonnes of fly ash unused every year. This disposal will need thousands hectares of storage land, which may cause further ecological imbalance. In fact, this waste material is simply disposed off in the form aqueous slurry on the adjoining areas. This type of disposal not only converts useful agricultural land to waste ones but also possesses a threat to the quality of environment. The human development of united nation development programme indicates that annually 83-163 million hectares of land is eroded in India causing productivity loss of about 4 to 6.3% of the total agricultural output worth $2.4 billion. Therefore, using fly ash as a building material has assumed great significance like never before. Several investigations have been carried out throughout the world to make an attempt to use fly ash in many civil engineering projects by virtue of its good properties as an ingredient of concrete. The Comparison between Clay brick and Fly ash Brick is shown in Table 1.

Table 1: Comparison between Clay brick and Fly ash Brick

Clay Brick	**Fly Ash Brick**
Varying colour as per soil	Uniform pleasing colour like cement
Uneven shape as hand made	Uniform in shape and smooth in finish
Lightly bonded	Dense composition
Plastering required	No plastering required
Heavier in weight	Lighter in weight
Compressive strength is around 35 Kg/Cm^2	Compressive strength is around 100 Kg/Cm^2
More porous	Less porous
Thermal conductivity 1.25 – 1.35 W/m2ºC	Thermal conductivity 0.90-1.05 W/m2ºC
Water absorption 20-25%	Water absorption 6-12%

II. MARKET DEMAND

The country consumes about 180 billion tones bricks, exhausting approximately 340 billion tones of clay every year and about 5000 acres of top soil land is made unfertile for a long period. The Government is seriously concerned over soil erosion for production of massive quantities of bricks, in the background of enormous housing needs. 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 are 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.

III. EXPERIMENTAL INVESTIGATION

In the present study we are making investigation on different percentage of cement such as without cement, 3%, and 5% in the fly ash bricks. And after making these bricks various tests were performed such as compressive strength test, water absorption test, efflorescence, and these results were compared with conventional bricks results.

IV. MATERIALS USED

Materials used are cement, fly ash, gypsum, sand and lime.

4.1 Cement

Ordinary Portland cement of grade 43 was used for making the brick mortar. The quality of cement was checked through various tests and was compared with specifications given IS 269-1976 for OPC. The properties of cement used are given in Table 2.

Table 2: Physical properties of Ordinary Portland Cement Used

Sr. No	Characteristics	Value obtained Experimentally	Value specified in IS :8112-1989
1	Specific Gravity	3.16	3.15
2	Fineness by sieve through IS 90 micron standard sieve	300	225
3	Setting Times (minutes) i. Initial ii. Final	 81 480	 >30 <600
4	Compressive strength(N/mm2) I. At 3 day (Average 6 samples) II. At 7 day (Average 6 samples) III. At 28 day (Average 6 sample	 28.8 38.87 47.94	 >23 >33 >43

4.2 Fine Aggregate

Locally available river sand was used. The sand was cleaned from all inorganic impurities and passed through 2.36 mm size sieve and retained on 150 micron sieve have been used. Particle size and other properties are listed in Table 3.

Table 3: Sieve Analysis of fine Aggregate

Size of Sieve	Weight Retained in IS Sieve (gm)	Cumulative Weight Retained in IS Sieve	Percentage Retained	Percentage passing	Grading Limit according to IS :383-1970
10 mm	0	0	0	100	Zone III
4.75 mm	0	0	0	100	
2.36 mm	11	6	2.1	97.9	
1.18 mm	34	30	4.5	95.5	
600 micron	165	195	21	79	
300 micron	622	832	83.2	16.8	
150 micron	98	930	93	7	

Fineness Modules=496.2/100=4.96
Weight of sample taken=1 KG

V. EXPERIMENTAL PROGRAME

In the present study, fly ash brick is developed with different composition.

- Fly ash (55), Lime (20%), sand (20%), gypsum (5%), Cement (0%)
- Fly ash (52), Lime (20%), sand (20%), gypsum (5%), Cement (3%)
- Fly ash (50) Lime (20%), sand (20%), gypsum (5%), Cement (5%)

The fly ash bricks were tested as per IS 12894-1990 that is coed for fly ash-lime bricks and the conventional bricks were tested as per procedure laid down in IS 3495-1973 for the following test:

- Compressive Strength
- Water absorption
- Efflorescence

1. Compressive Strength test

The red and fly ash bricks were tested on the compressive testing machine of capacity 100 tones which read to the nearest 0.5 tonne. The load was applied steadily and uniformly. 6 bricks of each type were tested for compressive strength. The average compressive strength was calculated.

2. Water absorption test

The red and fly ash bricks were dried and weighted. These were then immersed in water for 24 hours and then weighted again. The bricks were tested in accordance with procedure laid down in IS 3495 (Part-II) 1976 (36).

3. Efflorescence test

Red and fly ash bricks 5 number each were selected at random out of the samples of red and fly ash bricks. Then each bricks was placed on edge in dish containing distilled water, the depth of immersion of the brick was not less than 2.5 cm. The whole arrangement was placed to in a ventilated room at 20 to 30 C until whole of water in the dish evaporated .when the water has been absorbed and bricks appeared to be dried, a similar quantity of distilled water was put in the dish and same was allowed to evaporate as before. At the end of this period, the brick was examined for efflorescence.

VI. EXPERIMENTAL RESULT & DISCUSSION

6.1 Compressive Strength Test

As per the Table 4 & Fig 1 the compressive strength of conventional brick is found to be 92.85 kg/cm^2, for fly ash brick without cement is found to be 125.9 kg/cm^2, fly ash brick with 3% cement is found to be 141 kg/cm^2 and fly ash brick with 5% cement is found to be 152 kg/cm^2.

Table 4: Compressive strength

Type of specimen	Mean load at failure	Average compressive Strength (kg/cm^2)	% Increase Average compressive strength
Conventional brick	208.3	92.85	-
Fly ash brick (0%)	281.8	125.9	35%
Fly ash brick (3%)	314.7	141	51.8%
Fly ash brick (5%)	342.2	152.1	63.3%

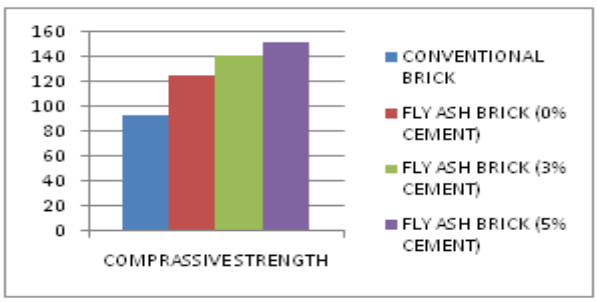

Fig 1: Compressive Strength graph

6.2 Water absorption test

As per the Table 5 & Fig 2 the average absorbed moister content of conventional brick is found to be 10.45% , for fly ash brick without cement is found to be 7.63%, fly ash brick with 3% cement is found to be 6.06% and fly ash brick with 5% cement is found to be 5.41%.

Table 5: Water Absorption Test

Type of specimen	Mean Dry Weight (Kg)	Mean Moist Weight (Kg)	Average Water Absorption %	% Decrease in Water Absorption
Conventional brick	3.12	3.45	10.45	-
Fly ash brick (0%)	2.57	2.77	7.63	27%
Fly ash brick (3%)	2.66	2.85	6.06	42%
Fly ash brick (5%)	2.83	2.99	5.41	48%

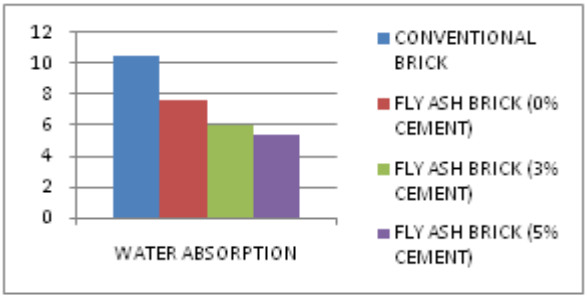

Fig 2: Water Absorption test graph in percentage

6.3 Efflorescence test

Table 6 shows the details of efflorescence test. The Efflorescence test of conventional brick, fly ash brick without cement, fly ash brick with 3% cement & fly ash brick with 5% cement and the result were compared in which grey or white deposits are slight to moderate in conventional brick, less than 10% on surface area in fly ash brick without cement, less than 8% on surface area in fly ash brick with 3% cement and less than 7% on surface area in fly ash brick with 5% cement.

Table 6: Efflorescence test

Conventional brick	Slight to moderate
Fly ash brick (0%)	The grey deposit are less than 10%
Fly ash brick (3%)	The grey deposit are less than 8%
Fly ash brick (5%)	The grey deposit are less than 7%

VII. CONCLUSION & FUTURE WORK

On the basis of the experimental work it is concluded that the compressive strength of fly ash brick with 0% cement is 27% more than that of class I conventional brick but when 3% cement is added in the fly ash brick then compressive strength is 51.8% more than that of class I conventional brick and also when 5% cement added in fly ash brick then the compressive strength is more than 63%. It is also analyzed that water absorption of fly ash brick with 0% cement is 27% less as compared to that of conventional bricks and 42% less as compared to conventional brick when 3% cement is added and 48% less as compared to conventional brick when 5% cement is added. The Efflorescence test of conventional brick, fly ash brick without cement, fly ash brick with 3% cement & fly ash brick with 5% cement and the result were compared in which grey or white deposits are slight to moderate in conventional brick, less than 10% on surface area in fly ash brick without cement, less than 8% on surface area in fly ash brick with 3% cement and less than 7% on surface area in fly ash brick with 5% cement. Fly-Ash bricks are eco friendly as it protects environment though conservation of top soil and utilization of waste products of coal or lignite used in thermal power plants. It is three times stronger than the conventional burnt clay bricks. It plays a vital role in the abatement of carbon dioxide a harmful green house gas mass emission of which is threatening to throw the earth's atmosphere out of balance. Being lighter in weight as compared to conventional bricks, dead load on the structure is reduced and hence saving is overall cost of construction.

The possibility of using innovative building materials and eco-friendly technologies, more so covering waste material like fly ash is the need of the hour. Fly ash affects the plastic properties of concrete by improving workability, reducing water demand, reducing segregation and bleeding, and lowering heat of hydration. It also increases strength, reduces permeability, reduces corrosion of reinforcing steel, increases sulphate, resistance, and reduces alkali-aggregate reaction.

REFERENCES

[1] Gupta P.C, Ray S. C. ," Commercialization of Fly ash", *The Indian Concrete Journal*, 167, 1993, 554-560.

[2] Sengupta J. , "Availability of Fly ash and its Application in Construction Industry", *NBO Journal, XXXIX*, 1984, 17-22.

[3] Thorne , D.L. , Watt , J.D. , "Composition and Properties of pulverized fuel ashes",

Part II, *Journal of Applied Chemistry, London,*15 ,1965, 595-604.

[4] Arya D. S., "Steel and Masonry Structure", ISBN 086186168X.

[5] Butterworth B., "Bricks made with pulverized Fuel Ash.", *Trans. Brit. Ceram.Soc*' ENGLAND, 53 (5), 1954, 293-313.

[6] Gupta, R.L. , Bhagwan, Gautam, D.K., Garg, S.P., "A Press for Sand Lime Bricks Research and Industry", 22(40), 1977, 246-249.

[7] Parul, R. Patel, "Use of Fly ash in Brick Manufacturing", *National Conference On Advances in Construction Materials*, " *AICM*-India, 2004, 53-56.

[8] Peter George Kenneth Kingth, "Pulverized fuel ash as a construction material", *proceedings of institution of Civil Engineers*, 16, 1960, 419-432.

[9] Rai, Mohan, Gupta, R. L., "Energy Conservation in the Manufacture of sand Lime Bricks", Proc. of National Seminar on Energy Conservation in Process Industries, *Institution of Engineers India*, 1985.

[10] I.S Code 12894-1990 for Fly ash – Lime Bricks- Specification.

[11] I.S Code: 8112-1989, Ordinary Portland Cement, 43 Grade- Specification

[12] IS: 3495(P-I)-1976, Determination of Compressive Strength (Second Revision).

[13] IS: 3495 (P-II) -1976, Determination of Water Absorption (Second Revision).

[14] IS: 3495 (P-II)-1976, Determination of Effloresce (Second Revision).

[15] S.C Rangwala, "Engineering Material", *Charotar Publications*, 15th Edition, 1991, 72-112.

[16] Bhanumathidas, N., "Fly ash in precast products- The Indian Scenario*"*, 1999, 31-35.