PRODUCTION AND CHARACTERIZATION OF FLY ASH BRICKS

Antim Sharma[1], Er. Neetu[1] & Niranjan Singh Rathee[2]

[1]Department of Civil Engineering,

Matu Ram Institute of Engineering & Management, Rohtak (India)

[2]Department of Basic Science, Jagannath University, Bahadurgarh.

ABSTRACT

Urbanization is continuously raised day by day in developing countries like India. Consumption of different building material is also increasing which leads more demand of cement and bricks. Therefore, a suitable material is required to be developed which can be used in building materials efficiently. That material should by coast effective, eco-friendly and should contribute towards waste management also. Fly ash may be good choice for this. In present study, Bricks containing fly ash have been prepared and characterized by different properties like appearance, colour, water absorption, compressive strength etc. It has been concluded from the study that the replacement of normal clay bricks with Fly ash bricks can be done effectively to increase quality of structures.

Key words: - Fly Ash, Fly ash bricks, Water Absorption, Compressive Strength.

1. INTRODUCTION

A large amount of Fly ash is obtained as waste material thermal power plants. It is generated as by-product of coal combustion and is collected by mechanical or electrostatic precipitator. It contains silicon dioxide, aluminium oxide, ferric oxide, calcium oxide and magnesium oxide etc. It also contains some trace elements and can cause air water and soil pollution. It has become important to take care of fly ash otherwise it can create environmental pollution. Therefore, disposal of Fly ash is a matter of great concern from environmental and ecological point of view. Due to advancement of technologies it has been observed that fly ash can be used as supplementary replacement of cement [1], and Fly ash bricks can also be prepared as is a waste material of thermal power plant obtained by burning of fine powdered coal and it can be collected using electrostatic and mechanical separators from thermal power plants [2]. According to a report of Central Electricity Authority on Fly Ash Generation at Coal/Lignite Based Thermal Power Stations and its Utilization in the Country for the Year 2014–2015, New Delhi [3]; near 150 thermal plants base on coal produce nearly about 185 million ton of fly ash yearly. As per the data, about 45% of the fly ash remains unutilized and create pollution problem. Therefore, it should be used in such a way that it should not go to environment [4-6]; while it must be used in proper way. Fly ash may be used as an important and prime material in many cement based products like poured concrete, concrete blocks & bricks.

Keeping above points in view, an attempt has been made to prepare bricks containing Fly ash and they are characterized by different parameters and compared with normal clay bricks.

2. METHODOLOGY

The technology of Fly ash bricks production contains regular mechanical type and hydraulic version of machines. The hydraulic version of machine is latest and provides higher production output with minimal inputs. The strength of bricks in hydraulic version is better than the others. It offers the pressure of 25 - 50 Ton in lieu of 15 ton in mechanical versions machines. The embossing of the monogram of the manufacturer then can be embodied on the bricks is easy. Production is high. Continuous operation is possible [7]. Fly ash was collected from Indira Gandhi National Thermal Power Plan, Jharli, District-Jhajjar (Haryana) while other raw material required was procured from local market.

In present study, raw material was grinded, sieved and following composition was taken to make Fly ash bricks:

Fly ash	-	60% by weight
Sand / Stone dust	-	30% by weight
Ordinary Cement	-	10% by weight

Ordinary tap water was used in the production of bricks.

Prepared Fly ash bricks were characterized according to their shape, strength and designing. Water absorption test and compressive strength test of prepared bricks were also be performed by using standard methods to evaluate their quality. For water absorption test, a sensitive balance capable of weighing within 0.1 % of the mass of the specimen and a ventilated oven were used.

For this, the specimen was dried in a ventilated oven at a temperature of 105 to 115 °C till it attained substantially constant mass (M1). Then, completely dried specimen was immersed in clean water at a temperature of 27 ± 2 °C for 24 hours. Removed the specimen and wiped out any traces of water with a humid cloth and weighed. Weighed the specimen 3 minutes and removed from water (M2). Water absorption, % by mass, after 24-hour immersion in cold water is given by the subsequent formula: (M2 – M1)*100 / M1.

For compressive strength test, unevenness observed was removed in the bed faces to provide two smooth and parallel faces by grinding. Sample was immersed in water at room temperature for 24 hours. Prepared cement mortar (1:1) and filled the frog and all void in bed faces with it. Stored the sample prepared under damp jute bag for 3 days in clean water. Removed and wiped out trace of moisture, area of two horizontal faces was measured. Then, specimen were placed with flat faces horizontal and mortar filled facing upwards between two plywood sheets and centre carefully between plates of testing machine. Load was applied axially at a uniform rate 14 N/mm2 per minute till failure occurs; maximum load at failure was noted and compressive strength was calculated using following formula:

$$\frac{\text{Max.Load at Failure in N}}{\text{Avg.Area of Bed face in mm2}}$$

3. RESULTS & DISCUSSION

(1) Fly Ash Brick Size Details:

The fly ash brick sizes prepared in this study are as follows:

[4 Inches] :- 230 x 100 x 75 mm

[6 Inches] :- 230 x 150 x 80 mm

(2) Density **:** 1700 Kg/m3

(3) Weight:

230x100x75 mm (Weight about 4.75 to 5.00 kgs.)

230x150x80 mm (Weight about 2.75 to 3.00 kgs.)

(4) Load Bearing Capacity: More than 25% as compare to clay bricks.

(5) Thermal Conductivity: 0.90 – 1.05 W/m^2 ^{0}C (0.75 – 0.90 K cal/m2 hr ^{0}C)

(6) Drying Shrinkage: Maximum Average drying test shrinkage 0.035-0.04 %

(7) Brick Colour: Gray / Dark Gray

Normal clay bricks and prepared Fly ash bricks have been compared as per some parameters as follows:

Table-1: Comparison of Normal Clay Bricks and Fly ask Bricks

S. No.	NORMAL CLAY BRICK	FLY ASH BRICKS
1	Varying colour as per soil	Uniform pleasing colour like cement
2	Uneven shape as hand made	Uniform in shape and smooth in finish
3	Lightly bonded	Dense composition
4	Plastering required	No plastering required
5	Heavier in weight	Lighter in weight
6	Compressive strength is around 35 Kg/cm2	Compressive strength is around 100 Kg/cm2
7	More porous	Less porous
8	Thermal conductivity - 1.25 – 1.35 W/m2 ºC	Thermal conductivity 0.90-1.05 W/m2 ºC
9	Water absorption 20-25%	Water absorption 6-12%

Table-2: Water Absorption Test Data

S.No.	Sample	Weight(dry) gm	Weight (wet, after 24 hr) gm	% of Water Absorption
1	A	3550	3825	7.746
2	B	3722	3942	5.910
3	C	3740	3953	5.695

Table-3: Compressive Strength Data

Sample	Length (mm)	Width (mm)	Height (mm)	Avg Surface Area of bed (mm^2)	Max load at failure (KN)	Compressive strength (N/mm^2)
A	230	100	75	23000	118	5.153
B	230	100	75	22800	104	4.582
C	230	100	75	22800	132	5.815
					AVERAGE	5.725

Prepared Fly ash bricks give smart looking to brickwork. These have high compressive strength which decreases breakages/wastages during transport and handling, the cracking of plaster is also lesser due to lower thickness of joints and plaster and basic material of the bricks, which is more compatible with cement mortar. Due to its comparable density the bricks don't cause any extra load for design of structures and provides better resistance for earthquake loads thanks to panel action with high strength bricks. These bricks are highly durable, after perfect pointing of joints, the bricks are generally directly painted in dry distemper and cement paints, without the backing coating of plaster. Rectangular faced along with sharp corners, solid, compact and uniformly Water absorption is 6-7% as against 20-25% for handmade clay bricks, decreasing dampness of the walls [7-8].

There are no definite studies on the toxic fume emissions or the indoor air quality of structures built with fly ash bricks, though claims of radioactive emissions by these blocks have been made at some scientific forums. Fly ash as a raw material is very fine and care has to be taken to prevent from being air-borne and causing serious air pollution as it can remain airborne for extensive periods of time, causing serious health problems relating to the respiratory system. Though block manufactured from ash has no such problems. Fly ash bricks have a good fire rating. It has no problems of vermin attacks or infestation.

4. CONCLUSION

It has been conclude from the study that, Fly ash bricks can be produced with some extra quality than normal clay bricks. Production of Fly ash bricks also decrease air, water and soil pollution as Fly ash is pollutant. Bricks produced with fly ash are better than normal clay bricks as observed in Table-1. Water absorption capacity of these bricks is better and these have high compressive strength. Therefore, Fly ash bricks may be good alternate of normal clay bricks. It has also been concluded from the study that the replacement of normal clay bricks with Fly ash bricks can be done effectively to increase quality of structures.

References

[1] Naidu, P. V. & Pandey, P. K. “Replacement of cement in concrete. International journal of environmental research and development”, 4(1), 91-98 (2014).

[2] Yao, Z. T., Ji, X. S., Sarker, P. K., Tang, J. H., Ge, L. Q., Xia, M. S., & Xi, Y. Q. "A comprehensive review on the applications of coal fly ash". Earth-Science Reviews, 141, 105-121 (2015).

[3] Central Electricity Authority, Report on Fly Ash Generation at Coal/Lignite Based Thermal Power Stations and Its Utilization in the Country for the Year 2014–2015, (2015) New Delhi.

[4] Pavithra, P.; Reddy, M.S.; Dinakar, B.H.; Rao, B.; Satpathy, A. & Mohanty, A. "Mix design procedure for geopolymer concrete with fly ash", J. Clean. Prod. 133 117–125 (2016).

[5] P. Dinakar, P.; Reddy, M., Sharma, M. "Behaviour of self-compacting concrete using Portland pozzolana cement with different levels of fly ash", Mater. Des. 46: 609–616 (2013).

[6] Aman Jatale et al- 'Effect on compressive strength when cement is partially replaced by fly ash,' IOSR Journal of Mechanical and Civil Engineering, , Vol. 5, Issue 4, pp. 34-43 (2013).

[7] Behl, V., Dahiya, V. & Singh, V. "Evaluation of Fly ash bricks for water absorption and compressive strength" Material Today Proceedings (2021) [In Press].

[8] Behl, V. "Production, Management and applications of Fly ash in production of Bricks and Fly ash Concrete Mix" A Master's Thesis submitted to Jagan Nath University, Bahadurgarh.