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RESEARCH ARTICLE

Experimental Study on the use of Glass Powder, GGBS, & Perlite in Fly ash Brick.

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Abstract

Bricks are manufactured by grinding or crushing the clay in mills and mixing it with water to make it plastic. This paper presents a parametric experimental study, by utilization of glass powder, GGBS, Perlite ore in fly ash brick manufacturing. Glass powder, Perlite ore is taken as constant of 2%, 10% and GGBS is replaced with 10%, 20% and 30% for each proportion that have been calculated. The physical and mechanical properties of fly ash brick are investigated. These bricks were tested for compressive strength, water absorption, efflorescence, Density and soundness test after 21 days curing as per Indian Standards. Based on the results obtained from these experiments, the suitability use of fly ash bricks is ascertained.

Introduction:-

Shelter is a basic human need and owning a house becomes a life long 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 the 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. In addition to this, Clay bricks available in certain region are poor in quality and have lower compressive strength, higher water absorption, high efflorescence etc., which 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, Glass powder, Ground granular blast furnace slag (GGBS) etc., as an alternative building material in making bricks, blocks and tiles etc. Logically the unlimited use of clay is harmful to the society, as all the conventional clay bricks depend on good quality clay available from agriculture fields. Perfuming a weight of 3 kg per brick, the total clay is taken out from agriculture lands per year for such brick works out to over 300 million tones. The use of fly ash and other industrial wastes for making bricks is ecologically advantageous since apart from saving precious top agriculture soil, it meets the social objective of disposing Industrial wastes otherwise are pollutants and nuisance.

Materials:-

Fly Ash:-

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. Fly ash can be referred as either pozzolonic or cementious. A cementious material is one that hardens when mixed with water. It also improves workability and reduces internal temperature.

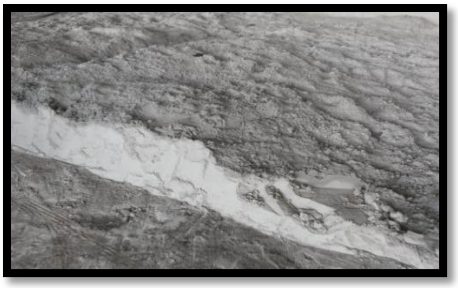

Fig.1 Fly Ash

Perlite:-

Perlite is an amorphous glass that has a relatively high water content typically formed by the hydration of obsidian. It occurs naturally and has the unusual property of greatly expanding when heated sufficiently. It is an industrial material and a commercial temperatures of 850°C-900°C. Unexpanded perlite has a bulk density around 1100 Kg/m^3 typically expanded perlite has a bulk density of about 30-150Kg/m.

Fig.2 Perlite

Lime:-

Lime is obtained from calcium carbonates such as lime stone, chalk, kanker and sea shells.
On burning, calcium carbonate decomposes into carbon dioxide and calcium oxide.

$$CaCO3 + Heat \longrightarrow CaO + CO2$$

The calcium oxide, called quick lime, is obtained in the form of lumps by the heat process and is very reactive to moisture. Quick lime, when exposed to moisture, absorbs water and swells and breaks into powder form.

$$CaO + H_2O \longrightarrow Ca(OH)2 + Heat$$

The powder thus obtained is calcium hydroxide and it is called slaked lime or hydrated lime. The process of obtaining slaked lime is called slaking or hydration. Lime is important ingredient for manufacturing of fly ash brick. It is produced in the form of calcium hydroxide sludge.

Lime should satisfy the following requirements:

- Availability of CaO should minimum of 60%.
- During lime slaking, it should not attain less than 600^o C temperatures and slaking time should not be more than 15 minutes.

Fig.3 Lime

GGBS:-

It is obtained by quenching molten iron slag (a product of iron and steel making) from a blast furnace in water or stream, to produce glassy, granular product that is then dried and ground into a fine powder. Common crystalline constituents of blast furnace slags are merwinite and melilite. Other minor components which can from during progressive crystallization are belite, monticellite, rankinite, wollastonite, and forsterite. Minor amounts of reduced sulphur are commonly encountered as oldhamite.

Fig.4 GGBS

Quarry dust:-

Quarry dust is a waste product produced during the crushing process which is used to extract stone. It has rock particles. When huge rocks are brake in too small parts for the construction in quarries. It is like sand but mostly grey in color. It has mineral particles.

Fig.5 Quarry dust

Glass powder:-

Glass powder is an extremely fine powder made from ground glass. Glass powders consist of various glass compositions ground down into very small particles. The particle size of >30μm down to as low as 0.4μm. It can be used in a number of industrial and craft application and is often available through suppliers. It is non biodegradable and increases workability.

Fig.6 Glass powder

Material testing:-

Bulk Density:-

The determination of bulk density of the each material was carried out as per standard practice. The following Table 1 shows the bulk density of materials used in the casting of brick.

Table.1 Bulk density of Materials

Materials	Result
Fly ash	785 kg/m^3
Quarry dust	1734 kg/m^3
Lime	988 kg/m^3

Specific Gravity:-

The determination of specific gravity of the each material was carried out as per standard practiced. The following Table 4.2 shows the specific gravity of materials used in the casting of brick.

Table.2 Specific gravity test

Materials	Result
Fly ash	2.2
Quarry dust	1.49
Lime	1.44

Mix proportion:-

The mix proportion of brick is calculated.

Table.3 mix proportion

Particulars kg/m^3	Trial 1	Trial 2	Trial 3
Flyash	1.625	1.462	1.3
Quarry dust	0.325	0.325	0.325
Lime	0.487	0.487	0.487
Gypsum	0.162	0.162	0.162
GGBS	0.163	0.325	0.4875
Glass powder	0.065	0.065	0.065
Perlite	0.325	0.325	0.325

Casting:-

The required raw materials like Fly ash, Rice husk ash, Lime, Cement, Quarry dust have to be mixed as per the ratio. These mixed materials are conveyed to the brick moulds by pan. After processing, as per required size of bricks were casted and taken in pallet truck for curing purpose. At early stages, bricks were cured by normal water curing and then by sprinkling of water.

Fig.7 Bricks

Experimental Procedure:-

Tests on specimens:-

The specimens were taken for testing such as compression test, water absorption, Density, Soundness test, efflorescence. Three numbers of specimens in each were tested and the average value is calculated. The results were compared and analyzed with that of control mix.

Compressive strength test:-

The determination of compressive strength of the prepared samples was carried out as per standard practiced. The following Table 3 shows the compressive strength of various mix proportion of samples after testing. The specimen was tested after 21 days of curing.

Table.4 Avg. Compressive strength

Sl.No	Mix	Avg. Compressive Strength N/mm^2
1	GGBS 10%	12.26
2	GGBS 20%	16.186
3	GGBS 30%	15.48

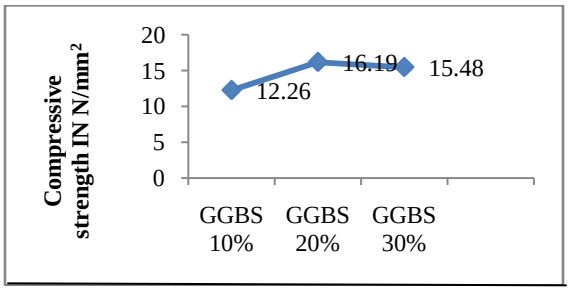

Fig.8 Avg. Compressive strength

Water Absorption test:-

The determination of water absorption of the prepared samples was carried out as per standard practiced. The following Table 4 shows the water absorption of various mix proportions of samples after testing. The specimen was tested after 21 days of curing.

Table.5 Water absorption

Sl.No.	Dry wt Kg	Wet wt Kg	% of water absorption
G 10%	2.505	2.700	7.7%
G 20%	2.505	2.630	4.9%
G 30%	2.505	2.580	3.01%

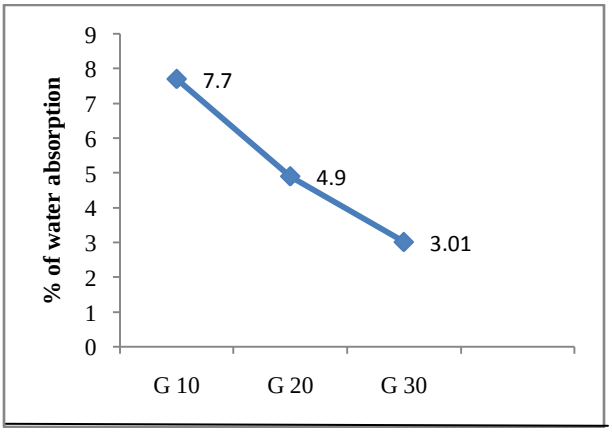

Fig. 9 Water Absorption

Density test:-

The determination of density of the prepared samples was carried out as per standard practiced. The following Table 5 shows the density of various mix proportions after testing.

Table.6 Density test result

Sl.No	Weight Kg	Volume (10^{-3}) m^3	Density kg/m^3
1	2.505	1.8975	1320.16
2	2.505	1.8975	1320.16
3	2.505	1.8975	1320.16

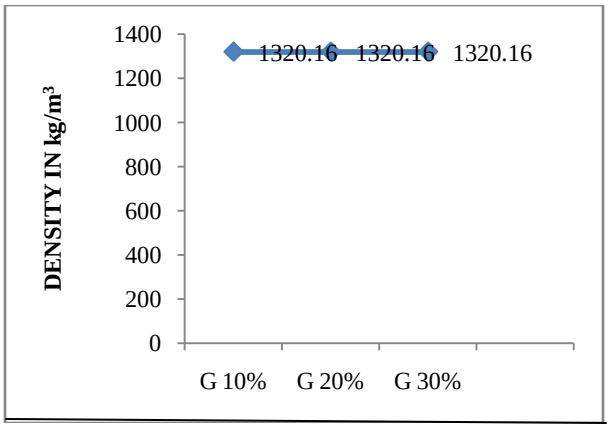

Fig. 10 Density test results

Efflorescence test:-

The determination of efflorescence of the prepared samples as carried out as per standard practiced. The following Table 6 shows the efflorescence of various mix proportion samples after testing.

Table.7 Efflorescence test results

Mix ID	Shape and Size	Efflorescence
G 10%	Rectangular with sharp edges (230 mm x 110 mm x 75 mm)	Nil
G 20%		
G 30%		

Soundness test:-

The determination of sound of the prepared samples as carried out as per standard practiced. The following Table 7 shows the sound of various mix proportion samples after testing.

Table.8 Soundness test results

Mix ID	Shape and Size	Sound
G 10%	Rectangular with sharp edges (230 mm x 110 mm x 75 mm)	Clear ringing sound
G 20%		
G 30%		

Conclusion:-

- Bricks made with 20% OF GGBS, 10% of perlite,2% of glass powder gives a compressive strength of 16.186 N/mm^2 which is greater than the requirement of first class bricks i.e. 7 N/mm^2 (as per IS 1725-1982).
- As the percentage of the GGBS increases above 20%, the compressive strength of the brick decreases.
- As the percentage of the GGBS decreases, the water absorption of the bricks increases.
- The density of bricks is within the range of 1300-1500 kg/m^3.
- As the percentage of the GGBS increases, density of the bricks increases.
- When the bricks are immersed in water and dried, white patches are not formed, so the results of efflorescence for bricks are nil.
- The bricks are when struck with each other it gives clear ringing sound.
- These bricks can be utilized for the construction of low height walls where loads are high, construction of sheds, boundary wall and huts with roofs other than RCC.
- Bricks are also used in areas that are exposed to rain.
- It is used for construction of load bearing walls.

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