

An Experimental Investigation of Fly Ash Brick with Addition of Waste Glass Powder and Copper Slag

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ABSTRACT: In this study, the experimental investigation was carried out to find the optimum mix percentage of fly ash brick with addition of waste glass powder and copper slag. The fly ash brick have different percentage of the copper slag and waste glass powder adding like 10%, 20%, 30%, 40%, and 50%. The addition of copper slag and waste glass powder in fly ash bricks resulted in compressive strength was increased up to 30% and above 30% the compressive strength was decreased. Also, the results of water absorption decreased as copper slag and waste glass powder ratios in brick increases. The optimum mix percentage of fly ash brick with addition of waste glass powder and copper slag was 30%.

KEYWORDS: Fly ash, waste glass powder, copper slag, brick, strength.

I. INTRODUCTION

As we know that now a day, most development country facing shortage of post consumers disposal waste site and it's become very serious problem. For the reason, regenerating and using waste product as prevent environmental pollutions. Therefore in research, considering the postconsumer waste glass and copper slag, there is effort to recover and use waste glass or otherwise its end up disposal landfill. Currently most of recovered waste glass is used by glass manufactured company in the production of new glasses such as bottle and etc. But only a limited amount from the waste glass collect is that can be used toward the production of new glass. These is because manufactures only can use waste glass that is has been pre-sorted by colour and type and this is exclude waste glass that mixed with colour were it is very expansive to produce new glass and even all the black and green glass bottles, car windshield, glass for cathode-ray tubes, glass for liquid crystal panels, glass building materials such as windowpane, and the like other than the colourless and brown bottles have come to the increasingly recycled, but are mostly discarded now and this wastes colour mixed glass still it end up at landfill site. The main reason of this study is to create better environment that free from polluted space and also to find a better solution for can give higher strength to brick from the waste glass product. Copper slag is a by-product obtained during matte smelting and refining of copper. One of the greatest potential applications for reusing copper slag is in fine aggregate and cement in concrete production. The use of copper slag in cement and concrete provides potential environmental as well as economic benefits for all related industries, particularly in areas where a considerable amount of copper slag is produced. Out of the total cost of construction, building materials, contribute about the 70% of cost in developing countries like India. Therefore, the need of hour is replacement of costly and scares conventional building materials by innovative, cost effective and environment friendly alternate building material. The new material should be environment friendly and preferably utilize industrial wastes generated as a result of rapid industrialization.

II. MATERIALS AND METHODS

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Materials Used

Cement

Ordinary Portland cement is recognized as a major construction material throughout the world. It is the basic ingredient of concrete, mortar and plaster. Ordinary Portland cement (OPC) of 53 grades available in market was used in this investigation.

Waste Glass powder

Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and CaCO_3 at high temperature followed by cooling during which solidification occurs without crystallization. A glass powder is also used as a binder with partial replacement of cement which takes some part of reaction at the time of hydration; also it is act as a filler material. A denser (less porous) and more homogeneous structure is produced when milled waste glass is used as partial replacement for cement, which benefits the resistance to moisture sorption and the long-term durability of cementitious materials.

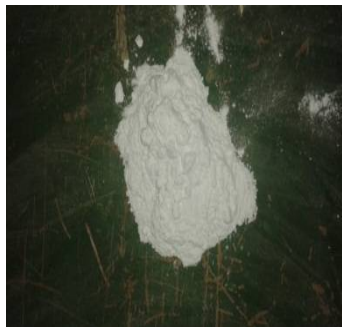


Figure 1: Glass Powder content

Copper slag

Copper slag is a by-product during copper smelting and refining process. Copper slag is considered as one of the waste material generated during the production of copper which can have a promising future in construction industry. For every ton of copper produced about 2.2 ton of slag is generated. Nearly 24.5 million tons of copper slag is generated worldwide. In India, production is about 10 lakhs tones/annum.



Figure 2: Copper Slag content

Fly Ash

Pulverized fuel ash commonly known as fly ash is a useful by-product from thermal power stations using pulverized coal as fuel and has considerable pozzolanic activity. Fly is collected from different rows of electrostatic precipitators in dry form. It is a fine-grained, powdery particulate material in nature. It is carried through the flue gas and collected from the flue gas by means of electrostatic precipitators, bag-houses, or mechanical collection devices such as cyclones. Fly ash is generally light tan in colour and consists mostly of clay-sized and silt-sized glassy spheres.

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Figure 3: Fly Ash content

Mix Proportions

To make the flyash brick with addition of waste glass powder and copper slag following mix proportions are arrived by trial and error method. The Table.1 shows the various mix proportions.

Table 1: Mix Proportions

Mix	Identification	Fly ash (gm)	Sand (gm)	Copper slag (gm)	Cement (gm)	Glass powder (gm)
1	Fly ash brick	1750	1400	-	350	-
2	CSGP ₁₀	1575	1260	175	315	175
3	CSGP ₂₀	1400	1120	300	280	350
4	CSGP ₃₀	1225	980	525	245	525
5	CSGP ₄₀	1050	840	700	210	700
6	CSGP ₅₀	875	700	875	175	875

Experimental Procedure

Compressive Strength Test

The compression testing machine is used for testing the compressive strength of bricks. After the curing period of 7days and 21days gets over bricks are kept for testing. To test the specimens the bricks are placed in the calibrated Compression testing machine of capacity 2000 kN applied a load uniform at the rate of 2.0 kN/min. The load at failure is the maximum load at which specimen fails to produce any further increase in the indicator reading on the testing machine. In that five numbers of bricks were tested for each mix proportion. Each brick may give different strength. Hence, average of five bricks was taken.



Figure 4: experimental set up for compressive strength test

Water absorption test

Fly ash Bricks should not absorb water more than 12%. The bricks to be tested should be dried in an oven at a temperature of 105 to 115° C till attains constant weight cool the bricks to room temperature and weight (W1). Immerse completely dried and weighed W1 brick in clean water for 24 hrs at a temperature of 27±20 Degree Celsius. Remove

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the bricks and wipe out any traces of water and weigh immediately (W2). Water absorption in % by weight = $(W2 - W1/W1) \times 100$. The average of five bricks should be taken. Our bricks absorb 09.114 % of water only; it has less water absorption property.

Density test

Density is how dense an object, it is calculated by dividing the mass by volume of an object. Density can be changed by changing the size or shape of the object. The standard international unit to measure density is kilogram per cubic meter (kg/m^3).

Efflorescence test

For this test, brick was placed vertically in water with one end immersed. The depth of immersion in water being 2.5 cm, then this whole arrangement should be kept in a warm-well-ventilated room temperature of $20-30^{\circ}\text{C}$ until all evaporates. When the water in the dish is absorbed by the brick and surplus water evaporates. When the water is completely absorbed and evaporated place similar quantity of water in dish and allows it to absorb and evaporate as before. Examine the brick after this and find out the percentage of white spots to the surface area of brick. If any difference is observed because of presence of any salt deposit then the rating is reported as 'effloresced'. If no difference is noted, the rating is reported as 'not effloresced'. Percentage of white spot in the brick = Nil.

Soundness test

This sound is carried out to find out that a clear ringing sound is produced or not when the two bricks are struck with each other without breaking any of the two bricks. If the two bricks are not broken after striking with each other and a clear ringing sound is produced then it means that the bricks are sufficiently sound.

III. RESULTS AND DISCUSSION

Compression strength test

About five specimens in each mixes are tested for compressive strength according to IS: 3495(1 to 5):1992. The compressive strength of bricks for various mix proportions are given in Table 2. From Fig.5, it can be seen that, for specimens without copper slag and waste glass powder, the compressive strength values are comparatively higher as compared to that of bricks. It was also observed that, compressive strength increases with increase up to 30% of addition in copper slag and waste glass powder content. The optimum mix percentage is 30% addition of copper slag and waste glass powder with fly ash brick.

Table 2: Compressive Strength test at 7 and 21 days

S.No	Mix Identification	Average compressive strength at 7 days (N/mm^2)	Average compressive strength at 21 days (N/mm^2)
1	Fly ash brick	3.63	6.19
2	CSGP ₁₀	4.25	6.53
3	CSGP ₂₀	4.80	7.06
4	CSGP ₃₀	5.50	8.5
5	CSGP ₄₀	5.05	8.05
6	CSGP ₅₀	4.76	7.38

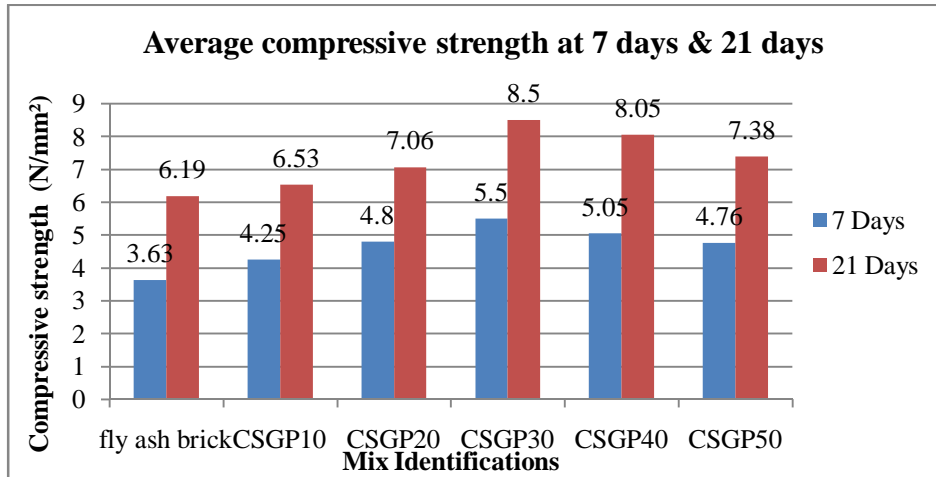


Figure 5: Compressive Strength test at 7 and 21 days

Water absorption test

The values of percentage of water absorption of the bricks at 21 days were found out and tabulated in the Table 3. From the test results, it can be seen that the water absorption values for all the bricks for all the mix ratios were decreased. It was also found that, for bricks without copper slag and waste glass powder, the water absorption values are comparatively lower as compared to that of fly ash bricks. It was also observed that, water absorption decreases with addition of copper slag and waste glass powder. The water absorption decreases by about 8%, 11%, 17%, 21%, and 28% respectively with respect to fly ash brick.

Table 3: Average percentage of water absorption at 21 days

S.No	Mix Identification	Average percentage of water absorption at 21 days (%)
1	Fly ash brick	7.91
2	CSGP ₁₀	7.31
3	CSGP ₂₀	7.04
4	CSGP ₃₀	6.56
5	CSGP ₄₀	6.20
6	CSGP ₅₀	5.66

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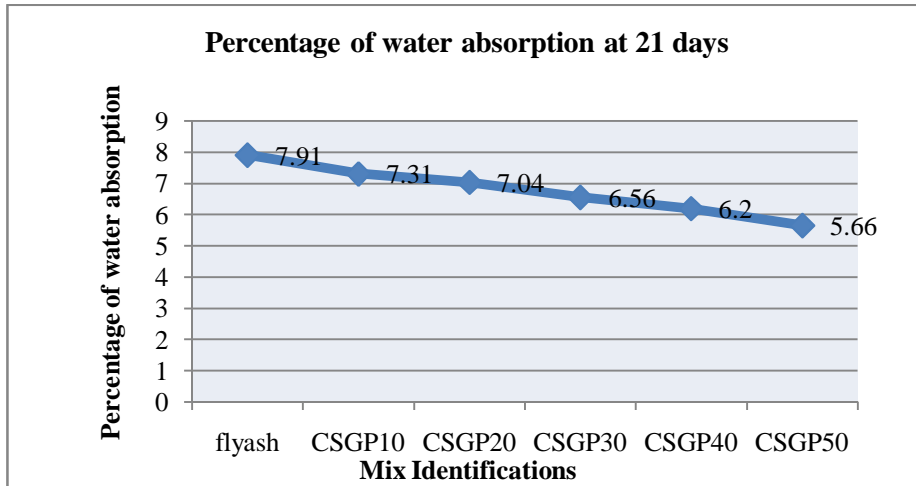


Figure 6: Percentage of water absorption at 21 days

Density test

The density values of bricks for various mix proportions are given in Table 4. From Fig.7, it was observed that, for bricks with copper slag and waste glass powder, the density values are comparatively higher as compared to that of fly ash bricks. It was also seen that, density values increases with increase in copper slag and waste glass powder content. Density values are 1642.07 kg/m³ to 1830kg/m³.

Table 4: Average density at 21 days of curing

S.No	Mix Identification	Density (kg/m ³)
1	Fly ash brick	1642.07
2	CSGP ₁₀	1705.30
3	CSGP ₂₀	1747.45
4	CSGP ₃₀	1793.11
5	CSGP ₄₀	1812.43
6	CSGP ₅₀	1830.00

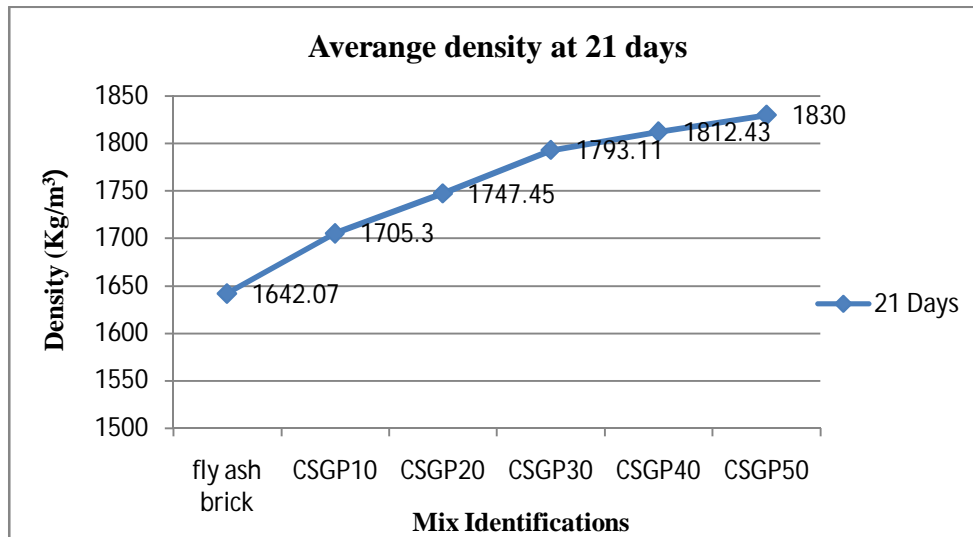


Figure 7: average density at 21 days

Efflorescence test

Percentage of white spot in the all proportions of brick = Nil.

Soundness test

Ringing sound in the all proportions of brick= clear ringing sound produced.

IV. CONCLUSION

From the results of compressive strength, the brick shows higher value at addition of 30% of copper slag and waste glass powder. Compressive strength is increased due to toughness of copper slag. Waste glass powder is also used as a filler material. Water absorption decreases with addition of copper slag and waste glass powder. The water absorption decreases by about 8%, 11%, 17%, 21%, and 28% respectively with respect to fly ash brick. The density of bricks is within the range of 1642.07 kg/m³ to 1830kg/m³. Density values increases with increase in copper slag and waste glass powder.

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