Characteristics of Bricks with Virgin Plastic and Bottom Ash

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Abstract. Disposal of Plastic waste was turning to be a serious problem for Environment as well as human life. A new generation material can be produced by recycling this waste plastic called as Virgin Plastic. This can be effectively used in the production of Building materials such as Bricks etc., Bottom Ash is another material which comes from the coal burning power plants as a by-product. In this Experimental Investigation both Virgin Plastic and Bottom ash are used in the production of Bricks in the proportion of 1:6. Here in Place of Fine Aggregate, Manufactured Sand (Crusher Sand) was used and it is replaced with Bottom Ash at 5%, 10%, 15% and 20%. Along with bottom ash Virgin plastic has been used at a percentage of 2%, 4%, 6% and 8%. For Economy point of view and to reduce cement usage, GGBS and Gypsum are used in place of cement at 50% and 5%. Different trial mixes are prepared by varying both Virgin plastic and bottom ash. Properties like Water Absorption and Compressive strength are investigated. Based on test results, water absorption is in decreasing manner while Percentage of Plastic is increasing. In compressive strength the trials with 5% Bottom Ash i.e., Trial 1 and with 5% BA, 2% Virgin plastic i.e., Trial 5 have shown better results.

Key words: Virgin Plastic, Virgin Plastic Bricks, Bricks, Mortar Bricks, Eco friendly Bricks, Bricks with Plastic Waste, Bottom Ash, Plastic Waste

1. Introduction.

The present construction industry is on the wheels of fast-moving scenario with the fast and easy construction methods. Common Burnt clay bricks are the major materials used for structural elements like Exterior and interior walls. But in view of cost and time of construction, it’s time to go on research in various alternatives of Bricks.

Plastics are basically Non-biodegradable in nature. So, the disposal of Plastics Creates problems for both environment and human life. Research is going on making use of plastics wastes effectively as additives in Civil Engineering Applications like Roads etc. Reengineered/Recycled plastics are used to solve the problems of solid waste management. This study mainly focused on the effective use of waste plastics in the manufacture of bricks in order to prevent the ecological and environmental problems caused by them. Another main objective is to limit the high amount of environmental Decay in order to get sustainable and eco-friendly construction activities.

Greenpeace report declares that around 260 million tons of plastic producing every year throughout the world. About 10 percent ends up in the ocean as a waste. In India, every year 66,000 tons of plastic producing as a waste – CPCB (Central pollution control Board).

The main objective of this present investigation is to reduce the deposition of waste plastic into the Environment by using effectively in making Eco-Friendly Building materials.
2. Literature Review

Shiri, Noel Deepak, et al., [1] investigated the use of Plastic Waste into useful building materials like bricks. In his investigation Polypropylene/Rubber composite brick showed better results in compression. Sahu, et al.[2] in "Utilization of Waste Plastic in Manufacturing of Plastic Sand Bricks" investigated the use of waste plastic in making Eco friendly plastic sand bricks. The manufactured bricks showed some better results in water absorption and compressive strength.

Effect of Sugar cane Bagasse Ash, Fly Ash and Silica Fume on the Properties of Clay Bricks were studied by V Jimenez Quero [5]. Physical and Mechanical Properties were investigated by using. Elliche Quesada D et al., [4] investigated the suitability of Several types of Bottom Ash in the Production of Ceramic Clay Bricks. Clay and Biomass bottom Ash are Characterized by XRD and XRF analysis. The Brick Samples with Biomass bottom Ash have shown some better properties and met minimum standards.

Effect of crushed HDPE and PE Plastics in making ecofriendly bricks was investigated by Prem Kumar K [3] in “Production of Construction Bricks by Partial Replacement of Waste Plastics”. The properties like Water Absorption and Compressive strength were investigated by incorporating 0% to 20% of Waste Plastic proportion in the Mix. The Bricks specimens with 5 to 10 % of Plastic have shown some better performance.

3. Materials

3.1. Cement
Cement used is of Ordinary Portland Cement 53 grade confirming to IS 12269-1987.

3.2. GGBS
GGBS is one of the major materials which is replaced in cement. GGBS is obtained from Local Supplier, Hyderabad. Lime and Gypsum powder are the other materials which had included to improve the binding capacity of raw materials.

3.3. Fine Aggregate
Crusher Sand is the major constituent in this experimental work as a Fine Aggregate. The crusher sand is obtained from the nearest crusher unit from the locality.

3.4. Virgin Plastic
Virgin Plastic is the recycled material produced from the reengineering process or recycling of waste plastic in a systematic manner. The raw materials for plastic recycling plants are the used plastic waste from consumers like household and industrial resources. It is obtained from Sri Krishna industries Hyderabad.
3.5. **Bottom Ash**
Bottom ash is the waste that is generated from thermal power plants. It consists of combustibles in the form of clinkers which attach to the hot side walls of the furnaces and this are accumulated in the boiler and from the boiler it is typically collected in the wet system and the slurry is pumped out for the disposal treatment. From the Coal Burning Process, 80% of ash will generate as fly ash and the remaining 20 % is bottom ash. The bottom ash that is produced is similar to that of fine aggregate and it is little coarser in nature.

3.6. **Gypsum**
Gypsum powder is another major material used to replace cement to maintain better bonding and strength. Detailed sieve analysis is done for Crusher sand and is confirming to Zone-II.

| Material       | Specific gravity | Fineness modulus |
|----------------|------------------|------------------|
| Cement         | 3.15             | 285 m\(^2\)/Kg   |
| GGBS           | 2.15             | 380 m\(^2\)/Kg   |
| Gypsum         | 2.31             | 320 m\(^2\)/Kg   |
| Crusher Sand   | 2.66             | 2.88             |
| Virgin Plastic | 1.65             | 2.92             |
| Bottom Ash     | 1.27             | 2.86             |

4. **Experimental Investigations**
In the mix design process, cement sand mortar ratio was taken as 1:4 and 1:6. From this 1:6 was selected for casting of the bricks. The detailed material proportions are given here.

| Material Replacements |
|-----------------------|
| Crusher sand with Virgin Plastic | 2%, 4%, 6% and 8% |
| Crusher sand with Bottom Ash       | 5%, 10%, 15% and 20% |
| Cement with GGBS              | 45%                 |
| Cement with Gypsum powder     | 5%                  |
| Cement – Sand Mortar ratio    | 1:6                 |
The Brick specimens are casted of size 300 X 150 X 100 mm in order to find out the necessary properties. These specimens are tested after 7 days, 14 days and 28 days age of curing.

5. Trial Mix Details

Table 3 Trial Mix details

| Mix           | Fine Aggregate (%) | Cementitious Materials (%) |
|---------------|--------------------|----------------------------|
|               | Crusher sand       | Bottom Ash | Virgin Plastic | Cement | GGBS | Gypsum |
| Control Mix   | 100                | 0          | 0              | 100    | 0    | 0      |
| Trial Mix 1   | 95                 | 5          | 0              | 50     | 45   | 5      |
| Trial Mix 2   | 90                 | 10         | 0              | 50     | 45   | 5      |
| Trial Mix 3   | 85                 | 15         | 0              | 50     | 45   | 5      |
| Trial Mix 4   | 80                 | 20         | 0              | 50     | 45   | 5      |
| Trial Mix 5   | 95                 | 5          | 2              | 50     | 45   | 5      |
| Trial Mix 6   | 90                 | 10         | 4              | 50     | 45   | 5      |
| Trial Mix 7   | 85                 | 15         | 6              | 50     | 45   | 5      |
| Trial Mix 8   | 80                 | 20         | 8              | 50     | 45   | 5      |

6. Results and Discussions

6.1. Water Absorption:
For calculating water absorption, the bricks are initially measured for its weight before curing. The weight is calculated after 24 hours of curing. The water absorption is calculated by using the necessary formula.

\[(W_2 - W_1)/100\]

Table 4 Water Absorption of Bricks

| Mix           | Composition       | Water Absorption (%) |
|---------------|-------------------|----------------------|
| Control Mix   | 100 % Crusher Sand| 1.52                 |
| Trial Mix 1   |                   | 1.65                 |
| Trial Mix 2   | Without Plastic   | 1.7                  |
| Trial Mix 3   | Replacement       | 1.79                 |
| Trial Mix 4   |                   | 1.85                 |
| Trial Mix 5   |                   | 1.80                 |
| Trial Mix 6   | With Plastic      | 1.72                 |
| Trial Mix 7   | Replacement       | 1.65                 |
| Trial Mix 8   |                   | 1.60                 |
Fig 3. Water Absorption of Bricks without Plastic

Fig 4. Water Absorption of Bricks with Plastic

Fig 5. Water Absorption of Bricks
6.2. Crushing Strength of Bricks:

It is obtained by Applying crushing on the surface area of the brick in Compression Testing Machine. Here we have mainly concentrated on the testing at 7 days and 28 days of Age of Curing for Brick specimens. The minimum compressive strength of clay brick is 3.5 N/mm² and for mortar brick in the range of 10-14 N/mm².

For water cured specimens, moisture content was eliminated by surface drying before testing in CTM. The Test results are tabulated as follows.

Table 5 Compressive Strength of Bricks

| MIX           | Composition                  | Crushing Strength (N/mm²) |
|---------------|------------------------------|---------------------------|
|               |                              | 7 days  | 28 days  |
| Control Mix   | Without any Replacement      | 8.5     | 15.0     |
| Trial Mix 1   | With Bottom Ash and Without Plastic | 7.6     | 15.55    |
| Trial Mix 2   | Without Bottom Ash and Plastic | 7.2     | 15.0     |
| Trial Mix 3   | Plastic                      | 6.5     | 14.1     |
| Trial Mix 4   |                             | 6.4     | 11.9     |
| Trial Mix 5   |                             | 6.2     | 11.33    |
| Trial Mix 6   | With Bottom Ash and Plastic  | 5.90    | 10.95    |
| Trial Mix 7   |                             | 5.89    | 10.6     |
| Trial Mix 8   |                             | 5.6     | 10.1     |

Fig 6. Compressive strength of Bricks without Plastic
Fig 7. Compressive strength of Bricks with Plastic

Fig 8. Compressive Strength of Bricks

Fig 9. Casting of Brick Sample
7. Conclusions

In this Experimental investigation, water absorption and compressive strength results are successfully attained. The Dimensions of the bricks are measured and are in the proper limits. No extra deviation has occurred more than 5mm. By comparing Water absorption results, maximum water absorption had observed 1.52 % for Bricks in Control Mix and 1.85 % for Trial 5 (with 2% Plastic).

These bricks can be useful for all types of structural elements for Building works such as Exterior walls and Partition walls Etc. When comparing with other types of bricks, these bricks are hard and durable in strength. By the usage waste alternatives like Bottom Ash, Virgin plastic and GGBS in the mix composition, these bricks will be available in less cost when compared to other types of bricks.

Eco Friendly environment will be created by the replacement of waste plastic as a replacement of sand. When comparing compressive strength results for bricks without plastic, maximum compressive strength is observed as 7.6 Mpa for 7 days and 15.55 Mpa for 28 days. When comparing compressive strength results for bricks with plastic, maximum compressive strength is observed as 6.2 Mpa for 7 days and 11.33 Mpa for 28 days.

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