INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 3)
Available online at: www.ijariit.com

The study of characteristic behaviour of quarry and furnace waste lightweight bricks

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ABSTRACT

Quarry Dust and the crushed brick as alternative aggregates for concrete production for low cost housing since it is clear that the rising cost of concrete materials coupled with environmental degradation has impaired the construction industry. The following tests were carried out to determine the physical properties of these materials; density tests, silt content, water absorption, sieve analysis, specific gravity, flakiness index and aggregate crushing value. The research was conducted by testing concrete cylinder and cubes specimens at ages of 7, 14 and 28days concrete with concrete mix ratios 1:1.5:3 with a target strength of 25N/mm2 and 1:2:4 with a target strength of 20N/mm2. Samples of concrete specimens were made using varying contents of quarry dust and laterite as fine aggregate. India is a developing contrary due to there is a huge need of infrastructure that is why construction is very important. In the construction the main material his problem we are making brick using Furnace Waste. This brick is stronger economical and effective than the clay brick. This process also helps in converting industrial waste material into quality building material. In this study, the fine and coarse aggregates were completely replaced by Furnace Waste aggregates in Furnace Waste concrete. 1) A mix design was done for M20 grade of concrete by IS method. Ordinary Portland cement of 43 grade was 2) Selected and Furnace Waste aggregates were prepared by mixing Furnace Waste with cement and water. The properties of Furnace Waste. In the present study we are making three types of Furnace Waste bricks in the different percentage of cement such as 3%, 5% and without cement. And after making these bricks various tests were performed such as compressive strength test, water absorption test, efflorescence, weight test, structural test and cost analysis and these results were compared with conventional bricks results.

Keywords: *Quarry dust, Brick, Furnace waste.*

1. INTRODUCTION

In conventional concrete, the weight of concrete is one of the parameters to compare with the weight of Furnace Waste aggregate concrete. Normally density of concrete is in the order of 2200 to 2600 kg/m3. This heavy self-weight makes an uneconomical structural material compared to low self-weight of Furnace Waste aggregate concrete. In order to produce concrete of desired density to suit the required application, the self-weight of structural and nonstructural members are to be reduced. Hence economy is achieved in the design of supporting structural elements which lead to the development of light weight concrete. Lightweight concrete is defined as a concrete that has been made lighter than the conventional concrete by changing the material composition or production method. Lightweight aggregate concrete is the concrete made by replacing the usual material aggregate by light weight aggregates Furnace Waste bricks are made of Furnace Waste, lime, gypsum cement and sand. These can be extensively used in all building constructional activities similar to that of common burnt clay bricks. The Furnace Waste bricks are comparatively lighter in weight and stronger than common clay bricks. Since Furnace Waste is being accumulated as waste material in large quantity near thermal power plants and creating serious environmental pollution problems, it 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 produces a lot of air pollution. The technology adopted for making. The Furnace Waste bricks are eco-friendly. It is no need for fire operation in production unlike the conventional bricks

Among the traditional fossil fuel sources, coal exists in quantities capable of supplying a 3large 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.

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Combustion of coal in thermal power plant not only produce steam to run electricity-generating turbine but also produces a large quantity of by-products like Furnace Waste etc.

These are about 80 thermal power plant in India are sources of Furnace Waste, where around millions of tonnes of coal is used annually. India currently generates 100 million tons of Furnace Waste every year. This produces 30-40 million tonnes of Furnace Waste unused every year. This disposal will need thousands of hectares of storage land, which may cause further ecological imbalance. In fact, this waste material is simply disposed of 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 the environment. The human development report (1998) of united nation development programme indicates that annually 83-163 million hectares of land are eroded in India causing productivity loss of about 4 to 6.3% of the total agricultural output worth $2.4 billion. Therefore, using Furnace Waste 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 Furnace Waste in many civil engineering projects by virtue of its good properties as an ingredient of concrete. But now it is seen as an ingredient for the manufacture of bricks also thereby, comparing the conventional clay.

Hence it will be of a large relief to all concerned if Furnace Waste from these thermal stations is used on a large scale. The government has formulated policies that for every construction agency within a radius 50 to 100 kilometer from a coal or lignite based thermal plant and engaged in the construction of building to use Furnace Waste brick or similar products as per minimum volume by percentage of the total brick as prescribed below:

- 25%by 31st August 2004
- 50%by 31st August 2005
- 75%by 31st August 2006
- 100%by 31st August 2007

2. EXPERIMENTAL PROGRAM

2.1 General

The main objective of this experimental program is to study and compare the compressive strength and water absorption of Furnace Waste brick with the conventional brick. The present study also involves the sieve analysis test of fine aggregate and physical property test of the cement.

The detail of these tests results is given in the Table-

2.2 Testing of Materials

The basic properties and strength of the specimens depends on its constituents materials. It is therefore, necessary to carry out tests as recommended by IS, on constituent materials namely cement, sand and bricks.

2.3 Testing of 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

2.3.1 Specific Gravity of Cement:

The object of conducting this test was to determine the specific gravity of cement. It is normally defined as the ratio between the mass of the given volume of material to the mass of equal volume of water . The method used for determining the specific gravity of cement is by the use of water free from kerosene which does not react with cement . A specific gravity bottle was employed for this task.

2.3.2 Standard Consistency of Cement:

The object of conducting this test was to find out the amount of water to be added to the cement to get a paste of normal consistency that is paste of certain standard solidity, which is used to fix the quantity of water to be mixed in cement before performing tests for the setting time, soundness and compressive strength. Vicat’s needle apparatus was used to calculate the standard consistency of the cement. Determine the specific gravity of cement. It is normally defined as the ratio between the mass of the given volume of material to mass of equal volume of water. The method used for determining the specific Gravity of cement is by the use of water free from Kerosene which does not react with cement. A specific gravity bottle was employed for this task.

2.3.3 Fineness of cement:

Fineness of cement was calculated by taking a sample of 1 kg cement and passing it through IS 90 micron sieve by shaking it thoroughly for 5 minutes. The matter passed through it was then weighed and its percentage calculated to know the fineness of cement.

2.3.4 Initial and Final setting time of cement:

The aim of these tests was to calculate the initial and final time of cement. It is necessary to know the initial setting time of cement. It is necessary to know the initial setting time in order to place the mortar or concrete in position conveniently. Hence it should not be less and after laying of concrete in position conveniently. Hence it should not be less and after laying of concrete or mortar hardening should be rapid so that the structure can be made use of as early as possible. Initial setting time is a stage in the process of hardening after which any crack, which may appear and will not reunite the concrete or mortar is said to be set finally when it has obtained sufficient strength and hardness. Vicat needle apparatus was used to calculate the initial and final setting tine of cement.

2.4 Testing of Bricks:

In the present study, Furnace Waste brick is developed with different composition

A. Lime (20%), Cement (5%), Sand (20%), Gypsum (5%) and Furnace Waste (50%).

B. Lime (20%), Cement (3%), Sand (20%), Gypsum (5%) and Furnace Waste (52%).

C. Lime (20%), Cement(0%) Sand (20%), Gypsum(5%) and Furnace Waste(55%) .

The Furnace Waste bricks were tested as per IS 12894-1990 that is coed for Furnace Waste-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

2.4.1 Compressive Strength test :

The red and Furnace Waste bricks were tested on the compressive testing machine of capacity 100 tones which read to the nearest 0.5 tonnes. The load was applied steadily and uniformly. 3 number bricks of each type were tested for compressive strength. The average compressive strength was calculated.

Details of these tests are given in the Tables

Table- 2.3 Compressive Strength of Conversional brick

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm^2)	Average Compressive Strength (Kg/cm^2)
1	220	96.80	92.87
2	198	89.70	
3	207	92.10	

Table-2.4 Compressive Strength of Furnace Waste brick (0% Cement)

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm^2)	Average Compressive Strength (Kg/cm^2)
1	277.8	125.8	126.1
2	287.3	127.9	
3	280.3	124.8	

Table-2.5 Compressive Strength of Furnace Waste bricks (3% Cement)

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm^2)	Average Compressive Strength (Kg/cm^2)
1	380.7	141.4	141.2
2	314.7	139.9	
3	319.72	142.2	

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Table-2.6 Compressive Strength of Furnace Waste bricks (5% Cement)

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm^2)	Average Compressive Strength (Kg/cm^2)
1	338.1	150.3	152.1
2	345.1	153.5	
3	343.3	152.6	

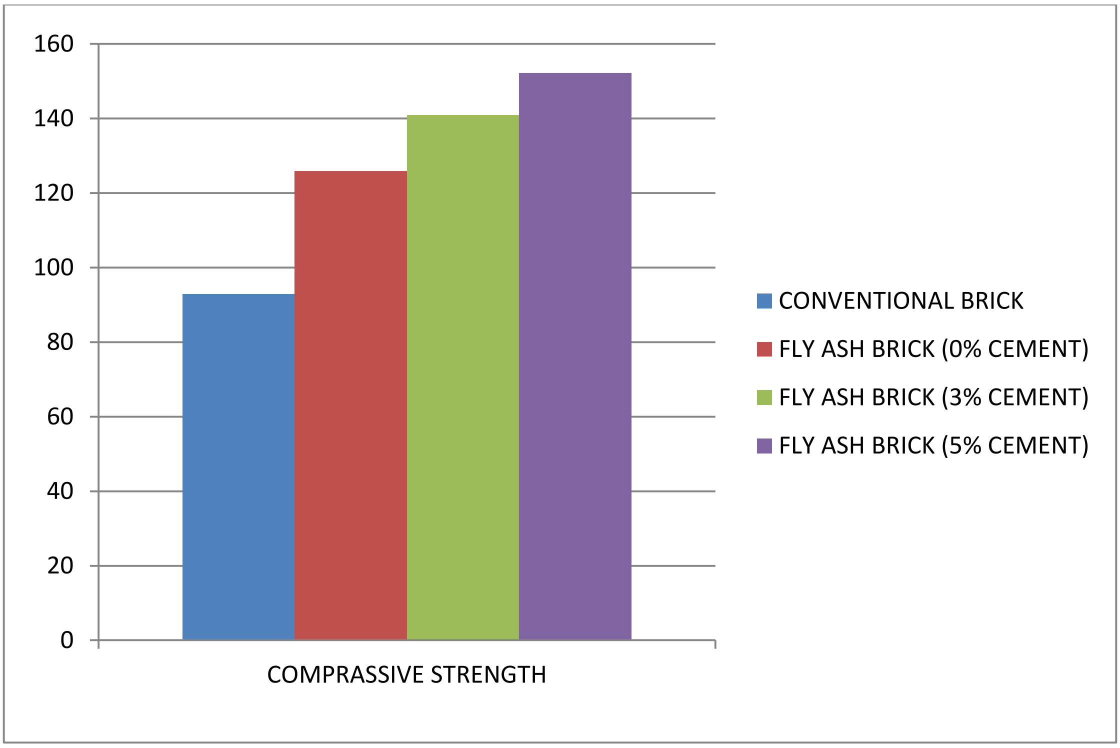

Fig-2.1 Compressive Strength graph

2.4.2 Water absorption test:

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

The result of this test is given in the tables

Table-2.7 Water Absorption Test of Conventional Brick

Specimen No	Dry Weight (Kg)	Moist Weight (Kg)	Water Absorption in %	Average Water Absorption %
1	3.12	3.43	9.93	10.46
2	3.11	3.46	11.25	
3	3.13	3.45	10.20	

Table-2.8 Water Absorption Test on Furnace Waste bricks (0 % Cement)

Specimen No	Dry Weight (Kg)	Moist Weight (Kg)	Water Absorption in %	Average Water Absorption %
1	2.610	2.821	8.09	7.82
2	2.580	2.775	7.55	
3	2.530	2.715	7.31	

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Table-2.9 Water Absorption Test on Furnace Waste Bricks (3 % Cement)

Specimen No	Dry Weight (Kg)	Moist Weight (Kg)	Water Absorption in %	Average Water Absorption %
1	2.66	2.81	5.63	6.07
2	2.74	2.91	6.20	
3	2.67	2.84	6.38	

Table-2.10 Water Absorption Test on Furnace Waste Bricks (5 % Cement)

Specimen No	Dry Weight (Kg)	Moist Weight (Kg)	Water Absorption in %	Average Water Absorption %
1	2.725	2.878	5.60	5.42
2	2.965	3.124	5.36	
3	2.830	2.980	5.30	

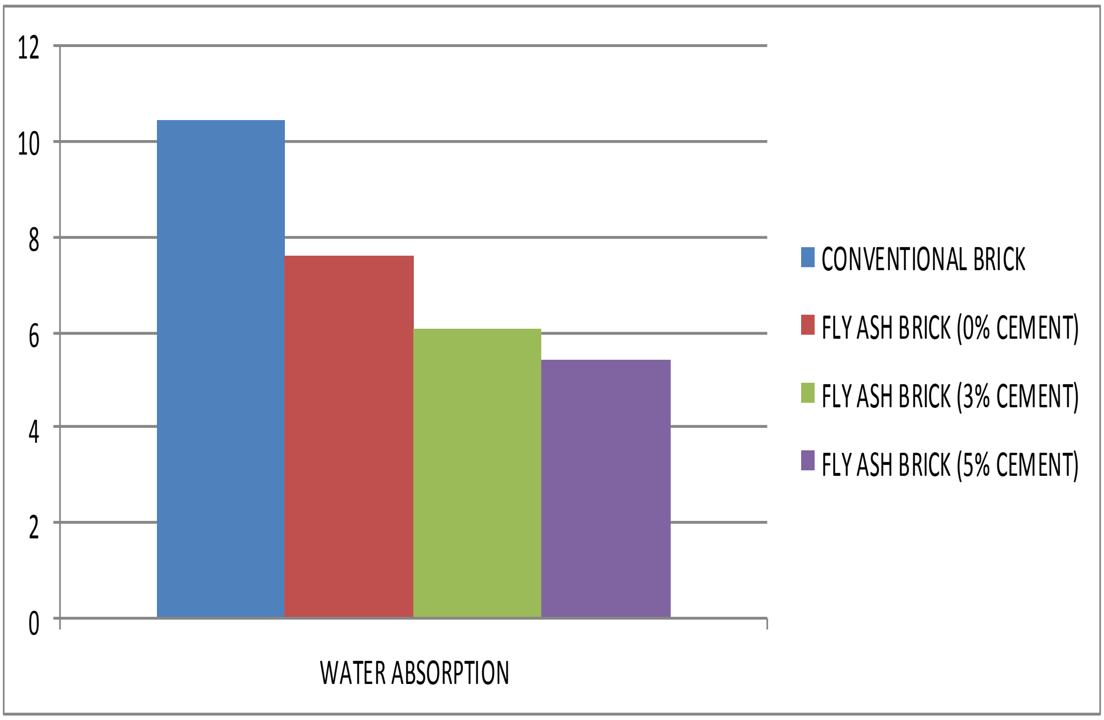

Fig-2.2 Water Absorption test graph in %

Table-2.11 Efflorescence test

Conventional brick	**Slight to moderate**
Furnace Waste brick (0%)	The grey deposit is less than 10%
Furnace Waste brick (3%)	The grey deposit is less than 8%
Furnace Waste brick (5%)	The grey deposit is less than 7%

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2.5 Discussion

2.5.1 Compressive Strength test:

As per the Table 4 & Fig 1 the compressive strength of conventional brick is found to be 92.87 kg/ cm2, for Furnace Waste brick without cement is found to be 126.1 kg/cm^2, Furnace Waste brick with 3% cement is found to be 141.2 kg/cm^2 and Furnace Waste brick with 5% cement is found to be 152.1 kg/cm^2.

Table-2.12 Compressive strength

Type of specimen	Mean load at failure	Average compressive Strength (kg/cm^2)	% Increase Average compressive strength
Conventional brick	208.4	92.87	-
Furnace Waste brick (0%)	281.8	126.1	36.11%
Furnace Waste brick (3%)	314.8	141.2	52.04%
Furnace Waste brick (5%)	342.1	152.1	63.77%

2.5.2 Water absorption test:

As per the Table 5 & Fig 2 the average absorbed moister content of conventional brick is found to be 10.46 %, for Furnace Waste brick without cement is found to be 7.65 %, Furnace Waste brick with 3% cement is found to be 6.07% and Furnace Waste brick with 5% cement is found to be 5.42%.

Table-2.13 Water Absorption Test

Type of specimen	Mean Dry Weight (Kg)	Mean Moist Weight (Kg)	Average Water Absorption %	% Decrease in Water Absorption
Conventional brick	3.13	3.46	10.46	-
Furnace Waste brick (0%)	2.58	2.78	7.65	26.86%
Furnace Waste brick (3%)	2.66	2.85	6.07	41.96%
Furnace Waste brick (5%)	2.83	2.99	5.42	48.18%

3. CONCLUSION

Concrete or mortar is very strong in compression but weak in tension so use steel wire mesh to increase the tensile strength and durability of the Ferro-cement mortar. Fly ash and silica fume are used to fill the pores and effect on the durability of mortar mix. Different proportions of the fly ash and silica fume are used in the mortar and determine the flexural strength and compressive strength.

Following are the conclusions which are coming from the results obtained in the experimental study.

- The combination of fly ash and silica fume which are used in different proportions increase the durability of mortar mix.
- Percentage of silica fume also increases the flexural and compressive strength of specimen as compared to the conventional mix.
- The increment in flexural strength is 11% of Ferro-cement panels containing Badarpur sand, flyash, and 8% silica fume. In case of Ganga sand, it increases by 9%.
- The increment in compressive strength is higher of ferrocement cube containing Badarpur sand, flyash and 8% silica fume compare to Ganga sand.
- Combination of Badarpur sand using fly ash and silica fume shows greater effect for increasing the quality as comparing to river sand.

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