A STUDY ON STRENGTH CHARACTERISTICS OF BUILDING BLOCKS USING INDUSTRIAL WASTES

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Abstract — Since there was a large development in construction and material industry the problems regarding the disposal of their harmful by-products has been increasing day by day. Also demand has been placed on building material industry especially in the last decade due to shortage of building materials and so, the civil engineers have been challenged to convert waste to useful building and construction material. Recycling of such waste as raw material alternatives may contribute in the exhaustion of the natural resources and reduction in waste disposal costs. In this the study reviews the utilization of those waste in block production. The effects had been carried out in production of solid blocks of size 400×200×200mm by 10 kg replacement of separate industrial waste of irregular shape in each block. A chips concrete has been made with M15 (1:2:4) mix and the industrial waste is placed and packed. Then the strength of each individual blocks with varying different industrial waste such has granite, steel slag waste, demolished concrete wastes and sand mould waste from steel industry has been tested and an comparison was been regarding their compressive strength and water absorption properties.

Index Terms—Building blocks, Industrial waste, Compressive strength, Water absorption, Sustainable development.

I. INTRODUCTION

Concrete building blocks are most familiar nowadays in construction industry due to their easy availability and their strength characteristics. But generally the strength and durability of these blocks are found to be quite far below building standards. Also the competition among the local manufacturers and scarcity of natural aggregates can be the main reasons for these criteria. On the other hand the disposal of industrial waste posses a major environmental impacts due to their harmful chemical composition. Some of the impurities such as Pb, MgO, SiO2, Al2O3, F2O3 and CaO, can cause serious damages to the environment, such as soil and underground water contamination, if not efficiently treated before disposal. The proper reuse of those waste in the construction material such as bricks production has been studied.(Alaa.A.Shakir,2013). The utilization of solid industrial waste in construction industry as a alternative source was been reviewed. (Md.Safiuddin,2010). Some industrial waste such as granite, iron& steel industry and building demolition has high direct impact on the environment and the society.

Need for utilization of waste in blocks

Waste management and disposal of industrial waste was the one of the most common and challenging problems in the world. The main aim of environment production agencies and government are to minimize the disposal problems and health hazards of industrial by-products. Construction and Demolition (C and D) wastes be grouped into concrete, blocks, bricks, mortar, rods. The reuse of this waste will help to conserve limited resources, conserve energy, save cost and protect the environment. The granite waste generated has negative impact to our environment. Hence reuse of this material need to be considered to minimize the disposal problems of granite waste. The building blocks can be made with less amount of concrete by utilizing industrial waste there by the impact on environment and block cost get reduced.

II. EXPERIMENTAL PROGRAM

The Experimental program included the first preliminary investigation of Materials used in the Study like Cement, fine aggregates, coarse aggregates and industrial wastes are grouped and their results are indicated below.

A. Materials

Cement

Cement used for this project is Chettinad OPC4 3 grade. As per IS: 12269. The various properties of the cement were determined and is tabulated as shown in Table 1.

Table 1: Properties of Cement

S.NO.	Properties		Values Obtained	Requirements as per IS: 12269-1987
1.	Specific gravity		3.1	----------
2.	Fineness		9.1% by weight	Should not exceed 10% by weight
3.	Standard consistency		31%	
4.	Setting time	Initial	55 minutes	Not less than 30 min
		Final	370 minutes	Not less than 600 min

Fine Aggregate

Fine aggregates are used in the concrete as the second ingredient. River sand is the most commonly used fine aggregate in concrete. Fine aggregates passing 4.75 mm (No.4) sieve but are retained on 75µm (No.200) sieve was been used. The Table 2 indicates the properties regarding fine aggregate.

Coarse Aggregate

As per IS 2386-1970 the coarse aggregate of 6mm size were been used for block casting. The physical properties of the coarse aggregate used were represented below in Table2.

Table 2: Properties of Aggregates

S.NO.	Properties	Fine Aggregates (River sand)	6mm Aggregate
1.	Specific Gravity	2.54	2.79
2.	Bulk Density	1452Kg/m^3	1433 Kg/m^3
3.	Porosity	0.428	0.487
4.	Void ratio	0.748	0.949

B. Industrial wastes

Some environmental impacting industrial waste from iron& steel industry, granite mines and building demolished concrete debris were been used. The four materials such as concrete debris, granite waste, steel slag and waste sand molds used in metal industries were been collected and reused.

C. Mix design

The building blocks had been casted with the mix ratio of 1:2:4 with water cement ratio of about 0.6 (as per IS 456 : 2000).These standard mix is made for all blocks and the mixing is done by mechanically with transit mixture.

III. FABRICATION OF SPECIMEN

A. Casting and testing of blocks

The mold of size 400×200×200mm is made in wood provided with easy de-molding facility.

Then the concrete was made with 1:2:4 ratio with W/C ratio of 0.6 as per IS 456 : 2000. All the mixes has been done by mechanical means as shown in fig.3.1.1. Before placing the concrete the mould is properly fixed and tightened with the fasteners provided and oil is applied at all sides of the mold. Then a layer of concrete is placed and tampered 25 times with tampering rod for each layer of placing. Then the individual industrial waste had placed at the middle of casting so that the entire remaining space can be filled with concrete as shown in fig.3.1.2. After complete filling of concrete the block is left undisturbed for 24hrs for setting of concrete. Then on the next day 24 ± 1 hrs the blocks are been de-molded and kept in water for curing for 28 days with use of gunny bags. Total number of 4 sets of blocks with varying individual waste in each and excluding 1 set of conventional blocks was been casted. Each set of 3 numbers of blocks, that are about 12 sample block and 3 conventional blocks have been casted. After the curing the blocks were taken out and tested for the compressive and water absorption properties.

Figure 3.1.1 Mechanical mixture

Figure 3.1.2 Placing of Industrial waste

B. Compression test

The minimum compressive strength at 28 days are tested being the average of 3 units on each particular industrial waste replacement. The samples are crushed using the compression testing machine.

Calculation,

Compressive strength = load applied / area of sample

C. Water absorption test

The test blocks shall be completely immersed in water at room temperature for 24 hours and then sp be weighed. Then all blocks shall be removed from the water and allowed to drain for one minute and immediately weighed.

Calculate the absorption is

Absorption, percent = A - B x 100 /B

Where

A -Wet mass of unit in kg,

B - Dry mass of unit in kg,

IV. RESULTS AND DISCUSSION

In the total four sets of blocks that had been prepared with differing industrial wastes in each set with standard mix of 1:2:4 concrete followed by w/c ratio of 0.6 as per IS 456:200 the total of 12 blocks were been casted. As shown in figure 4.1 the compressive strength of each waste induced block were been tested for compressive strength of about after 28 days of curing and their test results were been given in table 3. In the same way water absorption of each set of blocks were also been tested and tabulated in table 4.The results regarding these properties were tabulated in table 3. Based on the results a comparison was made regarding their properties and a conclusion was made depending on their strength characteristics.

Figure 4.1 Compression test on Blocks

Table 3: Results of Compressive strength

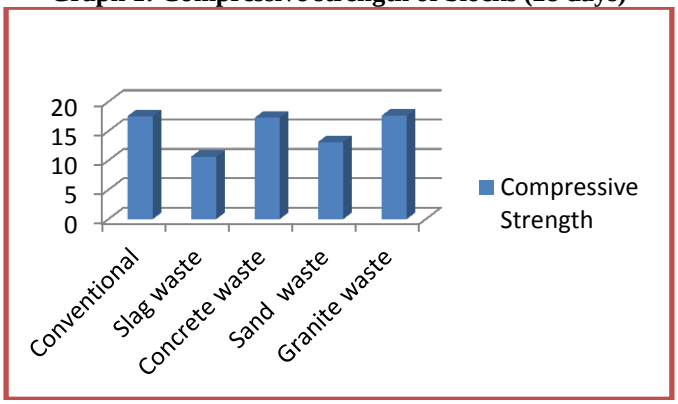
Type of Block	Compressive Strength (N/mm^2) For 28 days
Conventional concrete	17.5
Slag waste	10.6
Granite waste	17.25
Sand Mold waste	13.12
Concrete waste	17.6

Table 4: Results of Water absorption

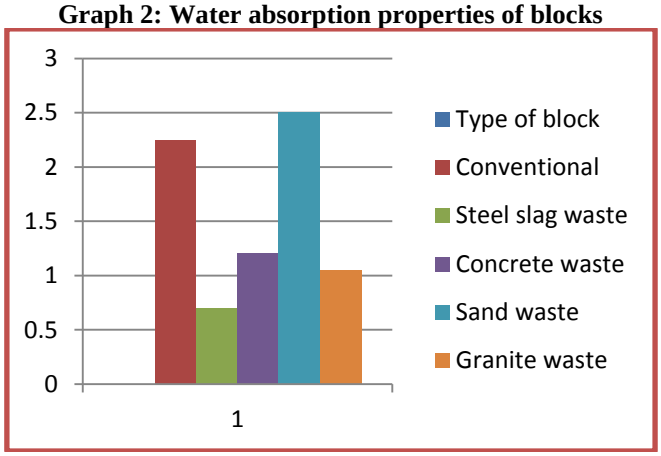
Type of Block	Water absorption (%)
Conventional concrete	2.25
Slag waste	0.7
Granite waste	1.19
Sand Mold waste	2.5
Concrete waste	1.05

Also the discussion were be made regarding their strength and water absorption properties and the graph had been made. The following Graph 1 were used to denote the compressive strength various waste induced blocks over conventional blocks. Also the water absorption were been also provided in Graph 2. Based on this graphs and results a conclusion was made.

Graph 1: Compressive strength of blocks (28 days)



Graph 2: Water absorption properties of blocks



V. CONCLUSION

Based on the results the following conclusion wee been made:

As per the graph 1 the compressive strength of the blocks using the waste materials such as granite , demolished concrete waste were obtained good results as compared to the conventional blocks hence it can be used in blocks production. Whereas the other two waste materials like sand waste and slag waste have less compressive strength than that of the conventional type. Also it was noticed that the block with steel slag waste block have less compressive strength than the all other blocks.

Then the water absorption property of the waste materials were been indicated in graph 2 and depending on the values the slag waste block have very less water absorption property over all other blocks.

Based on this study it was concluded that the block with concrete and granite waste were having good compressive strength and water absorption property hence it can be highly recommended for replacement of conventional solid blocks.

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Example:

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