Strength Assessment of Hollow Concrete Block using Grog and Quarry Dust as a Replacement of Sand

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Abstract— the sand mining from river beds creates environmental problem. The fine aggregate is one of the important constitute of concrete. It is required to find out the alternative of fine aggregate. The possibility of use of refractory waste and stone quarry dust as a suitable replacement of fine aggregate in concrete blocks is explored in this study. This study is very helpful to predict the compressive strength and other property of concrete block, which is made using Grog and Quarry dust, as a partial replacement of fine aggregate. Large volumes of Grog and Quarry dust are generated in refractory and quarries. Due to lack of waste disposal management, these wastes are disposed on the open lands. In this study the following tests will be done on concrete block: (1) Compressive strength (2) Water absorption (3) Test for block density.

Key words: Hollow Concrete Blocks, Sand Mining

I. INTRODUCTION

Hollow concrete blocks are substitutes for conventional bricks and stones in building construction. They are lighter than bricks, easier to place. A hollow concrete block is concrete masonry unit having one or more large holes or cavities which either open cavity or closed cavity and having the solid material between 50 and 75 percent of the total volume of the block calculated from the overall dimensions.

Grog is a refractory brick waste having high amount of silica makes it appropriate for replacement of sand in concrete. Every 30 to 40 days period, 300 kg of waste Grog is produced from one refractory.

In quarrying activities, the rock has been crushed into various sizes, during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution. Quarry Dust is a waste material having high amount of silica makes it appropriate for replacement of sand in concrete.

A. Material Used

1) Coarse Aggregate

The aggregates having maximum size of 10 mm are used. Bulk density is 1600 kg/m^3. Specific gravity and water absorption of aggregates are 2.60 and1.2% respectively.

2) Sand

The natural river sand having zone-2 and specific gravity and water absorption 2.58 and 0.2 % is used. Bulk density of sand is 1650 kg/m^3.

3) Quarry Dust

The quarry dust having fineness modulus 2.52, specific gravity 2.24, Bulk density 1711 kg/m^3, SiO_2 38.66%, Al_2O_3 30.56% is used.

Fig. 1: Sample of Quarry Dust

4) Grog

The quarry dust having fineness modulus 2.68, specific gravity 2.45, Bulk density 1824 kg/m^3, SiO_2 53.20%, Al_2O_3 21.28% is used.

Fig. 2: Sample of Grog

5) Cement

The 53 Grade OPC cement is used.

B. Mix Proportion

There are seven batch mix for different replacement percentage of fine aggregate and cement.

Batch mix	Grog : Quarry Dust : Natural sand
mix-1	0:0:100
mix-2	5:5:90
mix-3	10:10:80
mix-4	15:15:70
mix-5	20:20:60
mix-6	30:30:40
mix-7	40:40:20

Fig. 3: Mix Proportion

- Grade of Concrete: The proportions used for casting cubes are 1:3:3 (cement: sand: aggregate) and 1:2:4 (M15).
- Casting of Cubes: The concrete cubes of standard size 150 mm×150 mm × 150 mm are casted. Total 42 cubes are casted for 7 different mixes.

C. Compression test on cubes

1) 1:3:3

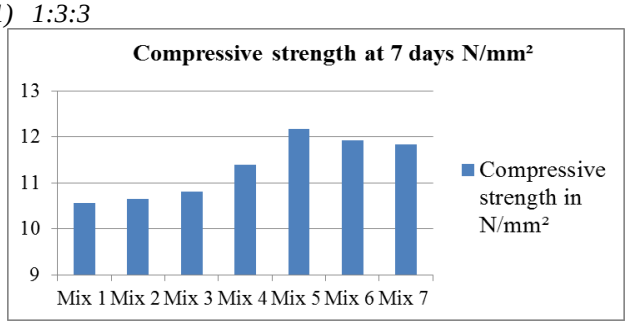

Fig. 3: Test result for compression test on cubes at 7 days (in N/mm^2) is given below.

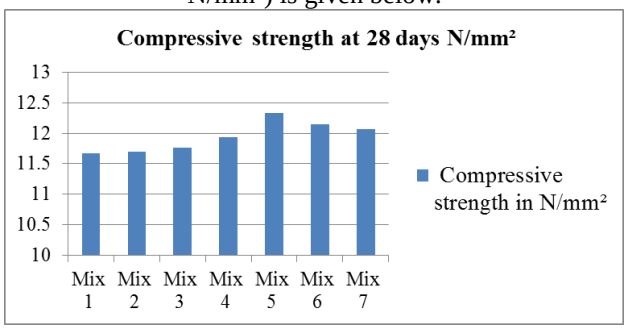

Fig. 4: Test result for compression test on cubes at 28 days (in N/mm^2) is given below.

2) 1:2:4 (M15)

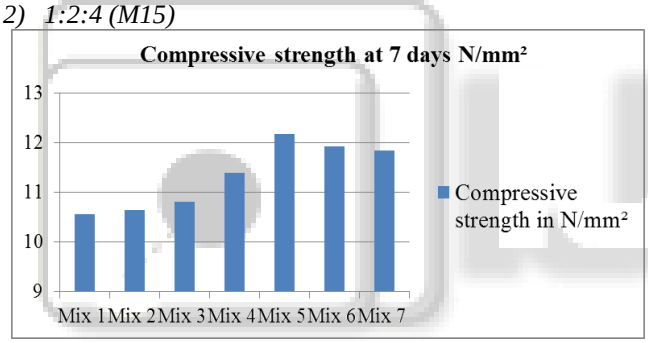

Fig. 5: Test result for compression test on cubes at 7 days (in N/mm^2) is given below.

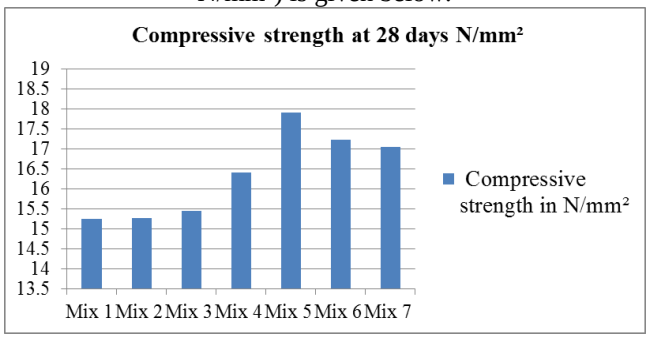

Fig. 6: Test result for compression test on cubes at 28 days (in N/mm^2) is given below.

Here, for both the proportions (1:3:3 and 1:2:4), mix-5 is giving maximum strength among all the mixes. Mix-5 indicates 40% replacement of sand with Grog and Quarry Dust. Therefore the casting of hollow concrete blocks is done for the mix giving maximum compressive strength which is mix-5 here.

D. Testing the property of hollow concrete block

The concrete hollow blocks of size 400 mm× 200 mm× 200 mm are casted.

Fig. 7: Hollow Concrete Block

E. Mix proportion for hollow concrete blocks

Mix	Cement : Sand : Grit
B1	1 : 3 : 3
B2	1 : 3 : 6
B3	1 : 2 : 4
B4	1 : 2 : 4 With 40 % replacement of sand with Quarrry Dust and Grog

Table 2: Mix proportion for hollow concrete blocks

Here, B1, B2 and B3 are the mixes having conventional concrete having no Grog and Quarry Dust. But the B4 is a mix having proportion of 1:2:4 (Cement: Sand: Grit) with 40% replacement of sand with Grog and Quarry Dust.

F. Compressive strength test of hollow concrete blocks

Hollow concrete block is placed having two steel plates of thickness 12 mm and sides 6 mm greater than the block on all the four sides.

Fig. 8: Compressive Strength test for Hollow Concrete Block

G. Compressive strength of hollow block at 28 days

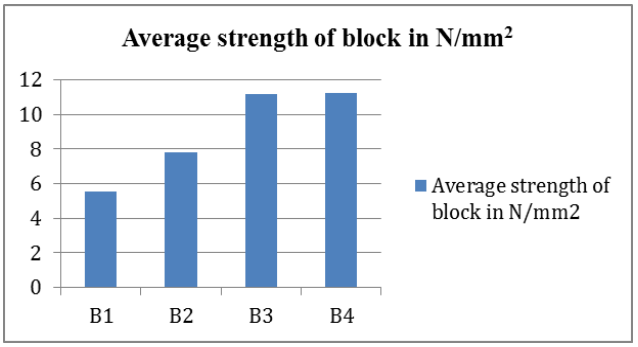

Fig. 9: The maximum strength is obtained for B4 is 11.24 N/mm^2

H. Bulk Density of Hollow Concrete Block

Three blocks are kept in oven at 100°C; after cooling the blocks to room temperature, the dimensions are measured and

the volume is computed. The block then be weighed and density of each block is calculated.

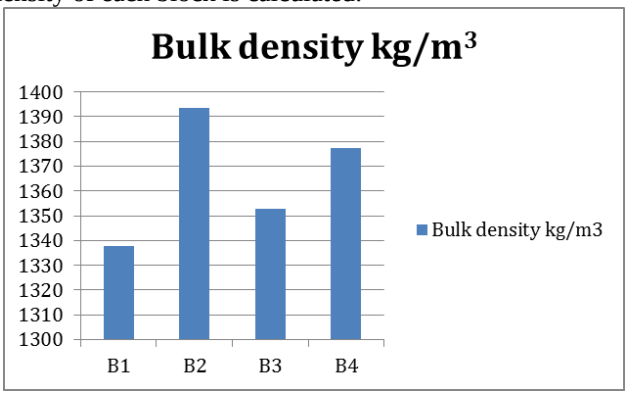

Fig. 10: Bulk Density of Hollow Concrete Block

I. Water absorption for hollow concrete block :-

The blocks were completely immersed in water at room temperature for 24 hours. After 24 hours blocks were brought out of water and weighed; this weight was called W_1. Then blocks were dried in a ventilated oven at 110°C for 24 hours. After 24 hours of drying, the blocks were brought out of the oven and weighed again; this weight is called W_2. Then water absorption for the blocks are calculated as per formula given below:

$$\text{Water absorption} = \frac{W1 - W2}{W2} \times 100$$

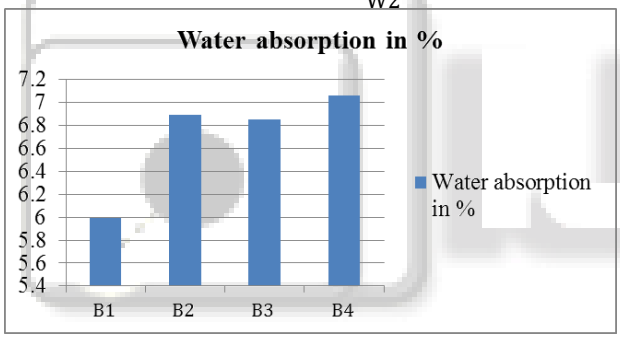

Fig. 11: Water absorption

II. Conclusion

1) Different percentage replacement of sand with Grog and Quarry Dust were tried and maximum strength is obtained in 40% replacement.
2) According to IS 2185 (part 1) : 2005 , hollow load bearing concrete block of Grade B(5.0) requires bulk density between 1100 kg/m^3 to 1500 kg/m^3 , compressive strength of minimum 5 N/mm^2 and water absorption of maximum 10 % by mass.
3) For B4 block, Bulk density obtained is 1377.33 kg/m^3, compressive strength is 7.64 N/mm^2 and water absorption is 7.06 % by mass.
4) All the above criteria for hollow concrete load bearing block are satisfied for the B4 blocks.
5) Therefore, the B4 blocks are perfect to use them as a load bearing unit.

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