Evaluating The Efficacy of Using Grog and Alternative Aggregates in Making Concrete Blocks

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Abstract- *The study covered in the present paper is an attempt to ascertain the technical feasibility of utilizing an industrial waste material (Grog i.e. crushed fired brick waste) for manufacturing of the construction building material i.e. solid masonry concrete blocks M15 grade solid concrete blocks are prepared by replacing the material i.e. sand by grog fine aggregates in varying percentages of 0%,10%,15%,20% and grit by grog coarse aggregates in varying percentages of 0%, 10% 20% and 30% by wt. The ingredients are mixed manually and making the solid concrete block unit. The blocks are cured by sprinkler system. The blocks are cured for 28 days and tested. The blocks thus prepared were tested for the functional efficacy like water absorption, bulk density, compressive strength, masonry prism test, temperature insulation test. The test results show that compressive strength up to 24.06 N/mm^2 is obtained for 20% replacement of coarse grog and 20% replacement of fine grog give better result. Also, bulk density of solid concrete block is as per IS 2185 part 1(2005) is for grade c block is not less than 1800 kg/m^3. Also, water absorption is less than 10% which satisfies codal requirement and thermal conductivity is 0.8 W/m. K.*

Keywords- Grog, physical and mechanical properties, compression strength of solid block prism

I. INTRODUCTION

In the last few years, a lot of research has been focused on look out for innovative and alternative building material in construction industry. It is the outcome of this research that various types of wastes such as agricultural waste, industrial waste, mine waste, construction and demolition waste etc. Here grog is used as an alternative material for the production of concrete blocks by replacing virgin material sand and grit. Grog is a granular material that has been crushed down from fired brick, or other pre-fired ceramic product. firebrick, or refractory brick is a block of refractory ceramic material used in foundry bed and walls, and lining of chimney, cooking chamber in wood fired ovens etc. Fire bricks are mostly used in inside lining of Crucible furnace, Cupola furnace. Induction furnace etc. that are used for melting the metal to be used to make a metal casting. Out of which most of the waste generates from cupola furnace. 25 to 30 tonne production of metal, inside fire brick lining of furnace needs to reconstruct. This reconstruction of lining generates about waste of 300 bricks around every month and as no proper solution for disposal of these waste we can think for sustainable development by reusing it. Therefore, here attempt is made to reuse of waste in production of solid concrete block. continuous use of such virgin materials in manufacturing the building materials is causing continuous depletion and environmental problem. Therefore, it becomes inevitable to steadily switch over to the use of energy efficient building materials and technologies and mechanisms to recycle and reuse of building wastes for the manufacture of building materials and products for the sustainable construction practices. Now, here we enlist the proven steps to publish the research paper in a journal.

II. EXPERIMENTAL WORK

A. Materials Cement

Ordinary Portland Cement of 53 Grade manufactured by Hathi cement company was used in concrete mixes corresponding to IS-8112. The specific gravity of cement is 3.15.

Sand

Natural river sand is used as fine aggregate. As per IS: 2386 (Part III)-1963, the bulk specific gravity in oven dry condition and water absorption of the sand are 2.6 and 1% respectively.

Grit

Crushed stones of maximum size 10 mm are used as coarse aggregate. As per IS: 2386 (Part III)-1963 [6], the bulk specific gravity in oven dry condition and water absorption of the coarse aggregate are 2.66 and 1.2% respectively.

Grog

The raw materials used in this study were the base material and waste material grog. Grog (refractory waste) was obtained from Foundry located at Naroda G.I.D.C.(Gujarat). In this study the fire brick waste was crushed and 10mm size coarse grog and 2.36mm size fine grog are use, which is denoted here as grog. Physical and chemical analysis of both the base material and grog was carried out. Result of chemical analysis shows that grog has good silica content which confirm its feasibility for production of blocks with base material. All the tests were carried out in accordance with the relevant Indian standards. The results of the tests are listed below.

Table 1. Physical properties of grog

Properties	value
Bulk Density	1738 kg/m^3
Specific Gravity	2.23
Water absorption	6%
Free Swelling ratio	0.476

Table 2. Physical properties of grog

CHEMICAL COMPONENTS	GROG
SIO_2	53.20%
Al_2O_3	21.28%
FE_2O_3	10.44%
CAO	1.03%
MGO	2.81%
NA_2O	1.40%
K_2O	1.21%
SO_3	0.40%
LOI	8.10%

B.Mix Design

A standard mix M15 grade was calculated as per Indian Standard (IS 10262-2009). The concretes were prepared at cementitious materials. For each material content, the W/C ratio is 0.55. Grog is replaced by different percentage with sand and grit for fixed proportion. The mix design is given in Table 3.

Table 3. mix design for M15 grade of concrete

Grade	M15
Mix Ratio	1:2.99:1.89
Water	208liter
Cement	378.182kg
Sand	1128.607kg
Aggregate (10 mm)	712.5141kg
W/C ratio	0.55

C. Testing Procedure

For preparing solid concrete blocks two methods are used either hydraulic press or machine press, mixing of concrete is done either by hand or by machine, a batch mixer was used. First coarse aggregates, fine aggregates, cement, grog, were mixed with ½ of the mixing water for 2 min. After this material is poured in to concrete block mould and pressing it.

For Compressive strength tests were conducted on 400x150x200 mm solid concrete blocks, after 28 days of proper curing. 3 blocks were casted and tested for each combination. Also, bulk density, water absorption, masonry prism, temperature insulation tests blocks are casting as same manner.

D. Concrete mix proportions

Table 4. Concrete Mix proportions of grog.

Fine Grog (%)	Coarse grog (%)	Proportions %
10	10	F10C10
10	20	F10C20
10	30	F10C30
15	10	F15C10
15	20	F15C20
15	30	F15C30
20	10	F20C10
20	20	F20C20
20	30	F20C30

III. TEST RESULTS AND DISCUSSION

A. compressive strength of solid concrete blocks.

The compressive strength of block is measured at 28 days. Average of four blocks is taken. For compressive strength test procedure as per IS 2185 part 1 (2005).

Table 5. Compressive strength of blocks.

Fine Grog (%)	Coarse grog (%)	Compressive strength N/mm²
0	0	22.49
10	10	15.69
10	20	22.80
10	30	21.06
15	10	15.14
15	20	19.23
15	30	18.59
20	10	19.86
20	20	24.06
20	30	17.93

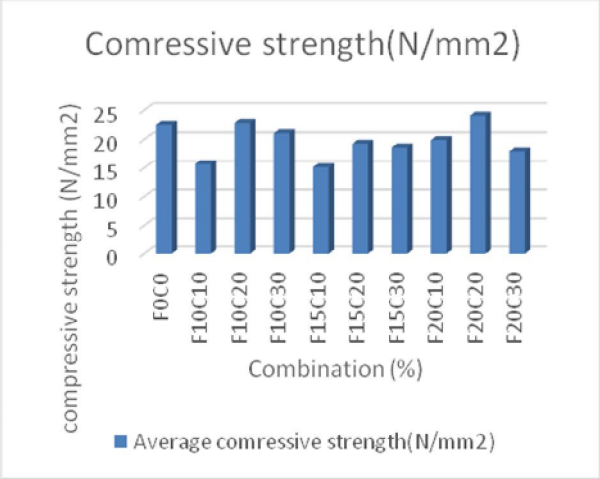

Figure. 1 graph of compressive strength at 28 days

B. Bulk density of solid concrete blocks.

For the testing of bulk density, the block is first oven dried at 1000 C and cooled down blocks to room temperature. The overall dimension of block is measured to obtain gross volume. The block weight is measured in kg.

Table 6. Bulk density of blocks.

Fine Grog (%)	Coarse grog (%)	Bulk densityKg/m³
0	0	2040.83
10	10	2101.83
10	20	2187.5
10	30	2125
15	10	2020.83
15	20	2041.66
15	30	2083.33
20	10	2166.66
20	20	2227.5
20	30	2150

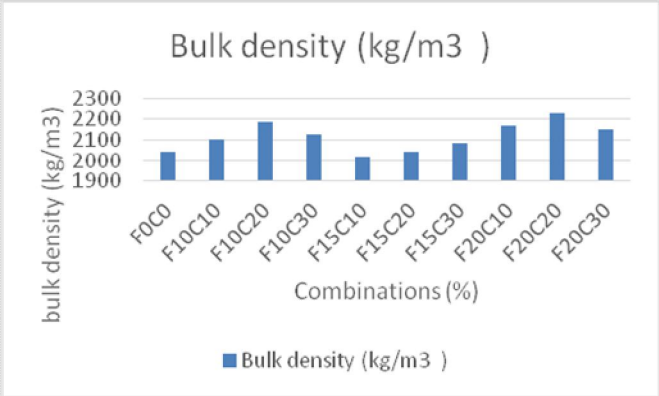

figure.2 Graph of bulk density

C. Water absorption of solid concrete blocks.

To determine the water absorption of blocks, all blocks are immersed in water for 24 hr. After 24-hour block is taken out and all the surface water is removed using cloth. Then the weight of block is measured. For drying the block, the block is put in oven at 1000 C for 24 hours. After the drying the weight of block is measured.

Table 7. Water absorption of blocks.

Fine Grog (%)	Coarse grog (%)	Water absorption (%)
0	0	5.26
10	10	7.53
10	20	5.6
10	30	6.98
15	10	6.72
15	20	5.14
15	30	4.32
20	10	4.69
20	20	5.87
20	30	4.18

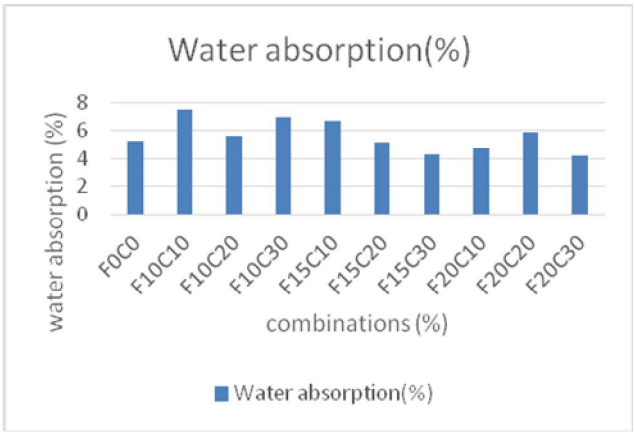

figure. 3 Graph of water absorption

D. Compressive strength of masonry prism of solid concrete blocks.

The blocks are prepared using IS 2185 part 1. The number of blocks prepared for compressive strength are 3. For making a prism stack bond is used. The mortar is applied on face shell and edge shell. Mortar proportion 1;6 is used for making joint. The prism is cure for 28 days.in compressive strength of masonry prism vertical crack is occurring. The block tested using IS 1905-1987.

Figure 1 Masonry prism

Table 8. Compressive strength of masonry blocks.

Fine Grog (%)	Coarse grog (%)	Compressive strength N/mm^2
0	0	42.69
20	20	48.205

E. Thermal conductivity of solid concrete blocks

Thermal conductivity of solid concrete blocks is measuring by using the IS code 3346. Guarded hot plate method is used. Specimen size is 0.3*0.3*0.05m.

Figure 2 Thermal conductivity Apparatus

Fine Grog (%)	Coarse grog (%)	Thermal conductivity (W/m. k)
0	0	1.20
20	20	0.80

IV. CONCLUSION

- This study demonstrated that it is possible to utilize grog as partial replacement for fine and coarse aggregates in solid concrete blocks.
- Result shows that blocks produced for all mixes satisfy the minimum codal requirements as per Indian Standard Code IS 2185 part 1(2005).
- Base material can be effectively replaced by grog up to 20% of fine grog and 20% of coarse grog for blocks.
- Compressive strengths of the grog added blocks are higher than the grog free blocks.
- As compared to conventional concrete block, the compressive strength for the combination of 20 % of fine aggregate and 20% of coarse aggregates of grog increases by 7%.
- Better value of bulk density and water absorption gives clear indication of dense packing of materials and less porosity of blocks made with addition of grog with fine and coarse aggregates.
- Greater saving of base material can be achieved up to 60%.
- Grog can be effectively utilized up to 40%
- Thermal conductivity of conventional block is 1.2 and thermal conductivity of fine and coarse combination is 0.80. F20C20 has lower thermal conductivity compared to solid concrete block.
- The strength of block made using the combination F20C20 increase by 12.91 %as compared to conventional solid concrete block in case of masonry prism test.

Parameter	Conventional blocks	Grog added blocks	Codal provision as per IS 2185 part1
Compressive strength N/mm^2	22.49	24.06	Concrete block greater than 12
Bulk density Kg/m^3	2040.83	2227.5	Not less than 1800
Water absorption (%)	5.26	5.87	Less than 10

- All the positive results give the reuse of grog waste in blocks production shows highly positive results in terms of environmental protection, waste management, and saving of raw materials for the production of eco-friendly building material.

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