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# Exploratory Study of Machine Crushed Over Burnt Brick as Coarse Aggregate in Concrete Hollow Blocks

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***Abstract*—The main objective of the study is to explore and assess the possibility of using crushed over burnt brick aggregate (industrial waste) as an alternative for the costly conventional stone aggregate in concrete hollow blocks (masonry in fills) to reduce their production cost, construction cost, and in addition dead weight of a building structure. The study has been carried out at 0%,20%, 40%,60%,70%, 80% and 100% replacement levels of normal crushed stone aggregate with crushed over burnt brick aggregate by Arbitrary standards method. Cube specimens of sizes 150mm with different percentages by weight of normal stone aggregate to over burnt brick aggregate were casted and tested after 7 & 28 days. Whereas hollow block specimens of size 200×200×150mm were tested only after 28 days, as per IS standards. For the purpose of current study, batching operation by weight approach (Arbitrary standards method) has been adopted. Nominal mix of 1:8 (1 cement: 8 combined aggregates) or 1: 4: 4 has been investigated with water/cement ratio of 0.55. The constituents used in the mix were Portland pozzolana Cement (PPC) with 25% fly ash, fine aggregate (natural sand), coarse aggregates (locally available crushed stone aggregates 10 mm maximum size) and (crushed Over burnt brick aggregate of 10 mm maximum size), and potable water as per IS 456-2000.Comparative study among strengths of mixes, prepared at different replacement levels reveled that, crushed Over burnt brick aggregates can be confidently used upto 69% replacement level of normal crushed stone aggregate with crushed over burnt brick aggregate, with compromising with strength**.

***Keywords*— Cube, Hollow blocks, water cement ratio, aggregates, Compressive strength, burnt brick aggregate, concrete.**

## I. INTRODUCTION

Concrete hollow block is one of the most important developments in concrete masonry and it is widely used for both load bearing and non-load bearing masonry construction. It is made of cement and sand mix or concrete mix with dense or lightweight aggregates. It is an effective means of utilizing wastes generated by stone crushers, quarrying and stone processing units and other industries. The technology has high potential in areas where raw materials are easily available. The Concrete Block Technology package is a highly profitable business for micro and small scale building material producers and construction companies.

### *A. Appearance*

Concrete blocks have a light grey concrete colour, and on close inspection may show a granular texture depending on the type of aggregate used. Machine production provides even finish which offers savings on further cement plaster etc. Concrete blocks can be surface engineered by using pieces of stone or ceramic waste on their face.

### *B. Thermal properties*

Concrete blocks have an excellent thermal property, comparable to other masonry units. The cavities in the blocks provide better thermal protection and also do not need external or internal plastering. The performance of these blocks increases with the increase in the number of hollow cores, which may or may not be filled in with some insulating materials.

### *C. Sound insulation*

Concrete hollow blocks provide an acceptable degree of sound insulation. Insulation of concrete hollow blocks can further be improved by filling the cavities with an insulating material.

## II MATERIALS USED

### *A. over burnt brick aggregate.*

Over burnt brick aggregate can be considered as a good material suitable for plain concrete works as well as for reinforced works where stresses are not very high. Brick aggregate should be saturated with water before use to avoid absorption of the mixing water which is necessary for the hydration of cement and for the setting and hardening of the concrete. Brick aggregate is more fire resistant and sound absorbent than crushed stone aggregate.

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Fig.2.1 Typical shapes of Over Burnt Aggregate

TABLE: 2.1 Properties of coarse aggregate.

| Properties | Over burnt brick | Normal stone |
|---|---|---|
| Maximum | 10 mm | 10 mm |
| Specific gravity | 1.75 | 2.05 |
| Water absorption | 4.71 | 1.00 |
| Bulk density | 1161.3 | 1587.1 |
| Percentage void | 33.64 | 22.58 |
| Aggregate | 35.75 | 25.50 |
| Fineness modulus | 3.338 | 3.407 |

Fig: 2.2 particle size distribution curve of Over Burnt Aggregate

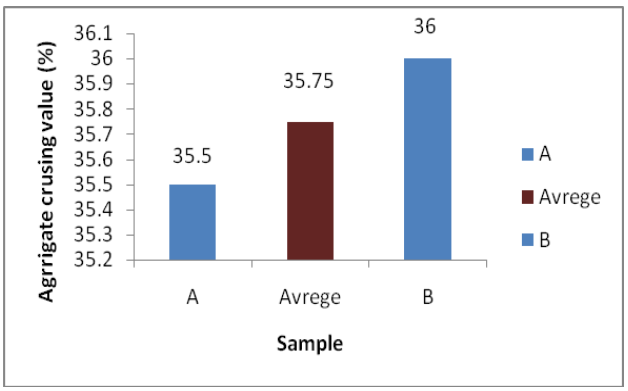


Fig: 2.2 Aggregate crushing value of Over Burnt Aggregate

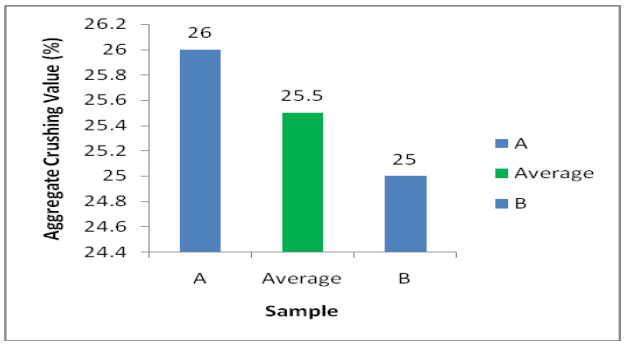


Fig: 2.3 Aggregate crushing value of normal stone aggregate

*B. Fine aggregate*

Natural sand conforming to Zone I with fineness modulus of 3.016 has been used in the present study. The maximum size of sand was taken to be 4.75 mm. The testing of sand has been done as per IS-2386 (part I) 1963. Fineness modulus of sand = 3.016 (Coarse sand)

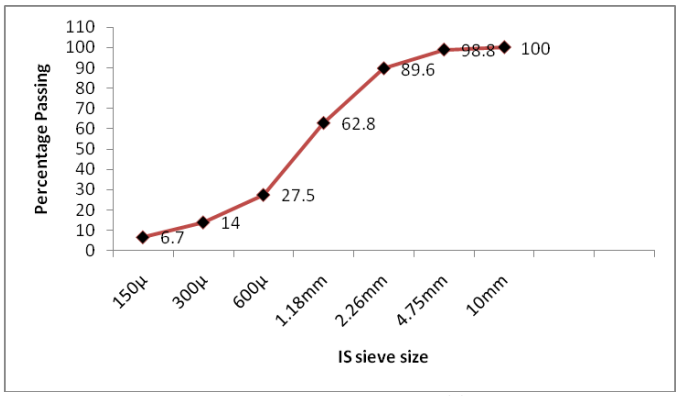


**Fig 2.4** particle size distribution curve of fine aggregate

*C. Cement*

Portland Pozzolana cement conforming to Indian Standard: 1489(part I)-1991 has been used in the study. The various physical and mechanical properties investigated in the study are presented in table 2.2.

TABLE 2.2: properties of cement

| | | |
|---|---|---|
| Fineness (%) | | 2.56 |
| Standard consistency (%) | | 33 |
| Initial setting time (min.) | | 192 |
| Final setting time (min.) | | 273 |
| Average expansion (mm) | | 0.75 |
| Compressive strength (N/mm²) | 3 day | 23.82 |
| | 7 day | 31.71 |
| | 28 day | 43.06 |

*D. Water*

Tap water, potable without any salts or chemicals was used in the study.

## III TEST PROGRAM

- To explore and assess the possibility of using crushed Over burnt brick aggregate as an alternative for the normal crushed stone aggregate in concrete masonry unit (concrete hollow blocks) to reduce, the production cost of the unit, construction cost, and in addition, dead weight of a building structure.
- To study the physical and mechanical properties of the over burnt brick aggregate concrete hollow block as per the specifications given by IS- codes of practice.
- To carry out comparative study among strength, Economy.

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## IV COMPRESSIVE STRENGTH TEST

All batches described above in the experimental program were prepared, cured, and tested for compressive strength after 7 and 28 day. Standard 150 x 150 x 150 mm cubes & hollow block specimens of size 200×200×150mm cubes were used for compressive strength. hollow block specimens of size 200×200×150mm were tested only after 28 days. As shown in Figure 1, three identical specimens were crushed at 7 days and three identical specimens were crushed at 28 days. The compressive strength was calculated by dividing the failure load by average cross sectional area.

Fig.3.1 concrete hollow blocks with Different percentage of OBA

Fig.3.2 concrete cube specimens with and without replacement level

Fig.3.3 test setup of cube specimen

from the experimental observations, concrete hollow block with 60% over burnt brick aggregate gives the 28-day block strength of 1.87 n/mm$^2$ the strength of over burnt brick aggregate concrete hollow block is inversely proportional to the percentage replacement of normal stone aggregate (p ά 1/rnormal stone aggregate).

TABLE : 3.1 - Compressive strength test results for cube samples 150mm x 150mmx150mm & hollow block specimens of size 200×200×150mm

| Mix | CUBE SAMPLES | | | | HOLLOW BLOCK | |
|---|---|---|---|---|---|---|
| | Compressive strength N/mm² | | Average compressive strength N/mm² | | Compressive strength N/mm² | Average compressive strength N/mm² |
| | 7DAYS | 28 DAYS | 7 DAYS | 28 DAYS | 28 DAYS | 28DAYS |
| 0% | 9.83 | 17.7 | 9.74 | 17.66 | 3.96 | 3.98 |
| | 9.74 | 17.6 | | | 4.06 | |
| | 9.65 | 17.69 | | | 3.93 | |
| 20% | 8.71 | 17.15 | 8.82 | 16.94 | 3.63 | 3.5 |
| | 8.80 | 16.97 | | | 3.40 | |
| | 8.94 | 16.71 | | | 3.46 | |
| 40% | 7.91 | 15.64 | 7.86 | 15.64 | 3.03 | 2.95 |
| | 7.73 | 15.77 | | | 2.90 | |
| | 7.95 | 15.51 | | | 2.93 | |
| 60% | 7.51 | 15.15 | 7.33 | 15.07 | 1.93 | 1.93 |
| | 7.15 | 14.97 | | | 1.80 | |
| | 7.33 | 15.11 | | | 2.06 | |
| 70% | 7.06 | 14.97 | 7.12 | 14.75 | 1.60 | 1.45 |
| | 7.15 | 14.53 | | | 1.40 | |
| | 7.15 | 14.75 | | | 1.36 | |
| 80% | 7.02 | 14.31 | 6.84 | 14.08 | 1.10 | 1.12 |
| | 6.80 | 14.04 | | | 1.20 | |
| | 6.70 | 13.91 | | | 1.06 | |
| 100% | 6.31 | 12.80 | 6.18 | 12.81 | 0.86 | 0.82 |
| | 6.17 | 12.93 | | | 0.83 | |
| | 6.08 | 12.71 | | | 0.77 | |

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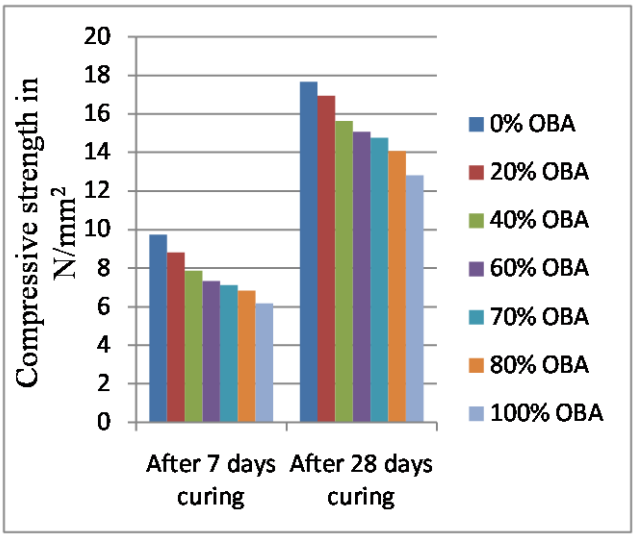


Fig.3.4 Comparison of 7 & 28 days compressive strength of cube specimens at different OBA levels.

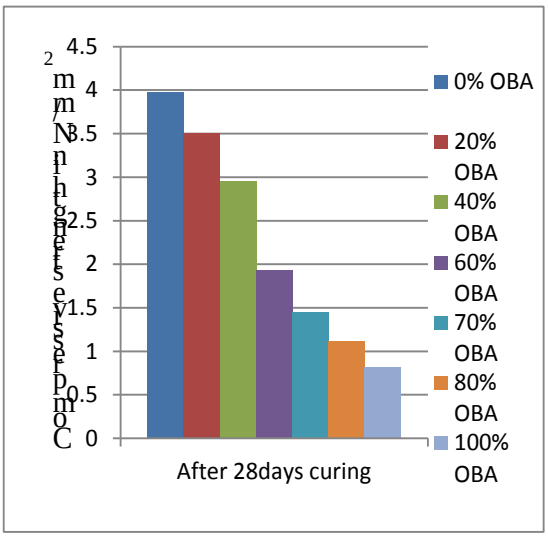


Fig.3.5 Comparison of 28 days compressive strength of Hollow Block specimens at different OBA levels.

## V CONCLUSIONS

In general, OVER BURNT BRICK AGGREGATE has good potential as coarse aggregate in the production of concrete hollow blocks. The following observations and conclusions can be made on the basis of the current study.

- The crushing value of Over burnt brick aggregate is 10.25% higher than normal stone aggregate of 10mm maximum size but it is within the limits specified by IS codes of practice.
- From the experimental observations, concrete hollow block with 60% over burnt brick aggregate gives the 28-day block strength of 1.87 n/mm$^2$ and with 70% over burnt brick aggregate gives 1.44 n/mm$^2$. however, from the regression the required block strength of 1.5n/mm$^2$ is attained at 69% inclusion of over burnt brick aggregate.
- The percentage reduction in the production cost of the unit per month per factory at 69% replacement of normal stone aggregate by over burnt brick aggregate is 8.53% hence economical than normal concrete hollow block.
- Besides achieving the above advantages, the suggested block also proves Eco-friendly as it utilizes the industrial waste which creates the large dumping problems.

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