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Effects of Cinder in Slag Based Solid Concrete Blocks

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Abstract—Since globalization, day by day construction activities have enormously taken place. The raw materials used for making concrete have become an acute shortage, especially aggregates. In the present study, we have made an attempt to replace natural crushed coarse aggregate by cinders, which is a by-product of steel manufacturing industry in slag based concrete blocks. Blocks of size 400*200*150mm are chosen and mix proportion is selected as per IS: 2185 i.e., 1:4:8 and w/c is 0.6. The blocks were casted by replacing (0%,20%,40%,60%,80%, & 100%) natural crushed coarse aggregate by cinders using concrete block making machine (egg laying machine), and cured for 28 days. After curing, the blocks were tested to know the mechanical properties such as compressive strength, modulus of elasticity and water absorption. From the results obtained, 20% replacement is found to be suitable in terms of strength development, water absorption and modulus of elasticity.

NEED TO STUDY

Concrete is one of the most important materials used in building construction. We know that masonry wall constitutes larger volume in building and is constructed by using traditional bricks, stones, mud blocks, concrete blocks etc. often we use solid concrete blocks for wall construction due to its availability throughout the year. The raw materials used for making concrete blocks are cement, fine & coarse aggregate. Nowadays, availability of natural coarse aggregate for making concrete block has become an acute shortage; hence cinder (by-product of steel manufacturing industries) could be an alternative to natural coarse aggregate. The advancement in the new construction materials has lead to develop high strength materials, which are generally selected to reduce the weight of the construction.
In structural applications, the self-weight of the structure is quite important as it represents a major portion of its dead load. Replacing partially or entirely the coarser normal weight aggregate in conventional concrete can be replaced partially or fully with low density aggregates will produces lightweight concrete that can reach a reasonably good compressive resistance. The advantages of lightweight concrete are its reduced mass and improved thermal and sound insulation properties, while maintaining adequate strength.

MATERIALS AND METHODOLOGY

Cement: Ordinary Portland cement of 43 grade (coromandel cement) confirming to IS 8112:1989 is used.

TABLE I
PHYSICAL PROPERTIES OF CEMENT

Tests Conducted	Results
Specific gravity	3.08
Consistency limit	30%
Initial &Final setting time	50min & 270min

Cinder: Cinder is the material that comes under the category of light weight aggregate and it is a by-product of steel, iron manufacturing companies.

TABLE 2
PHYSICAL PROPERTIES OF CINDER

Tests Conducted	Results
Specific gravity	2.17
Water absorption	10.2%

Coarse Aggregate: Crushed granite aggregates passing 12.5 mm IS sieve confirming to IS 2386:2016 are used.

TABLE 3
PHYSICAL PROPERTIES OF C0ARSE AGGREGATE

Tests Conducted	Results
Specific gravity	2.58
Water absorption	1.01%
Bulk density	Uncompacted- 1343kg/m3 Compacted- 1500kg/m3
Fineness modulus	6.35
Size & Shape test	Flakiness index- 14.3% Elongation index-6.82%

M Sand: Locally available manufactured sand conforming to zone II. is used in this study

TABLE 4
PHYSICAL PROPERTIES OF M SAND

Tests Conducted	Results
Specific gravity	2.59
Moisture content	0.18%
Bulk density	Uncompacted-1493kg/m3 Compacted- 1740kg/m3
Bulking of sand	29.70%
Fineness modulus	2.22

GGBS: Ground Granulated Blast Furnace is a by-product from the Blast furnace slag and is a solid waste discharged in large quantities by the iron and steel industry. Ground granulated blast furnace slag (JSW Cement) confirming to IS 12089:1987 is used.

TABLE 5
PHYSICAL PROPERTIES OF GGBS

Tests Conducted	Results
Specific gravity	2.79
Fineness	387m2/kg (Test results as per JSW cement Ltd.)

Trail Mix

As per IS: 2185 the mix should not be richer than 1:6 for solid concrete blocks. Hence trial mixes were conducted for the ratios 1:4:8 and 1:3.5:7 with w/c ratio of 0.6. After the trial mix, the ratio 1:4:8 was chosen by keeping the minimum compressive strength criteria 4-5N/mm2 for load bearing structures.

TABLE 6
PROPORTION OF TRIAL MIX

MIX PROPORTION	SL NO	LOAD IN KN	COMPRESSIVE STRENGTH FOR 3 DAYS IN MPa (55 to 60% of 28 days strength)
1:4:8	1	75	3.33
	2	80	3.55
	3	80	3.55
1:3.5:7	1	140	6.22
	2	150	6.66
	3	140	6.22

RESULTS AND DISCUSSION

WATER ABSORPTION

TABLE 7
WATER ABSORPTION RESULTS FOR 28 DAYS

PERCENTAGE (%)	WATER ABSORPTION (%)
0	1.11
20	2.66
40	3.74
60	4.48
80	6.62
100	8.23

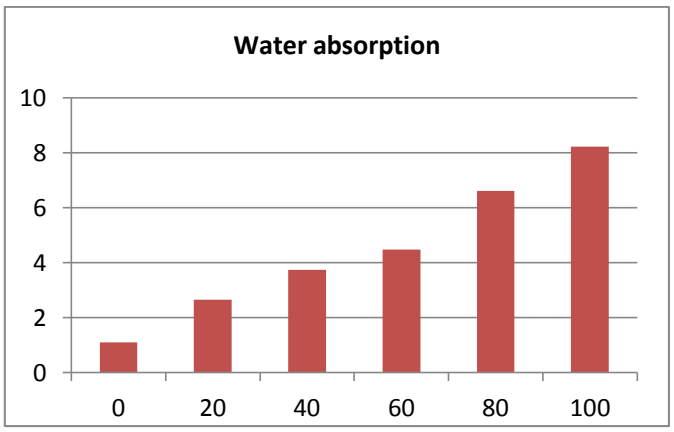

Fig1 comparison of water absorption with conventional block

Influence on Water Absorption- It can be observed from table 7 that with increase in the percentage replacement of natural coarse aggregate by cinder increases the water absorption of the blocks.

Compressive Strength

TABLE 8
COMPRESSIVE STRENGTH TEST RESULT FOR 28 DAYS

PERCENTAGE (%)	AVERAGE COMPRESSIVE STRENGTH IN MPa
0	7.5
20	5.66
40	2.99
60	2.94
80	1.77
100	1.66

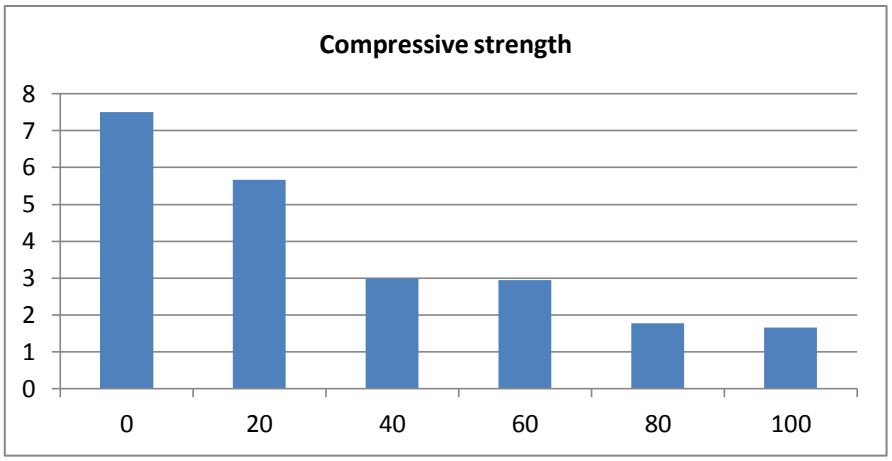

Fig: - 2 comparison of compressive strength with conventional block

INFLUENCE ON COMPRESSIVE STRENGTH

It is found that the 28 days compressive strength of blocks is decreasing continuously with increase in the percentage of cinders from table no 8 and up to 20% replacement of cinders by conventional aggregate provides the strength required for load bearing structures

Modulus of Elasticity

TABLE 9
MODULUS OF ELASTICITY RESULTS FOR 28 DAYS

Percentage (%)	Modulus of Elasticty In Mpa
0	
20	2631.33
40	1916.58
60	1506.31
80	348.8
100	798.39

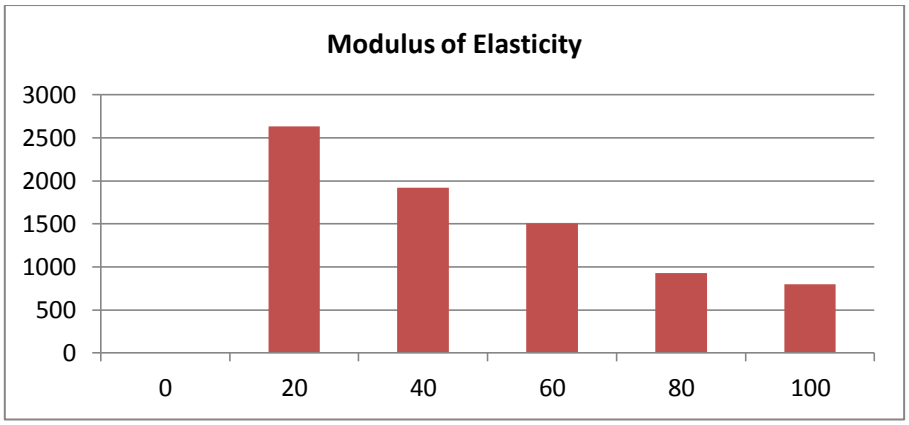

Fig: - 3 comparison of modulus of elasticity with conventional block

Influence on Young's Modulus - With increase in percentage of replacement of granite by Cinder aggregate, the E value is found to decrease continuously up to 100% as shown in fig 3. These values are tabulated in table no 9

Conclusion

- Density of blocks decreases with increase in percentage of cinders
- Water absorption of blocks increases with increase in percentage of cinders. But even 100 percentage replacement of natural coarse aggregate by cinders, the water absorption of blocks within 10 percentage as per IS provision

- Compressive strength of blocks decreases with increase in percentage of cinders. But at 20 percentage replacement of natural coarse aggregate by cinder gives more than 5 MPa, which is adequate strength for load bearing masonry structures as per IS provision
- Modulus of Elasticity decreases with increase in percentage of cinders
- Partially replaced cinder blocks can be used effectively as load and non-load bearing masonry structures where cinders are available locally

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