Analysis of concrete by partial replacement of waste foundry sand and GGBS

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Abstract – Generation of waste foundry sand as byproduct of metal casting industries which affects environment because of its improper disposal. Thus, its usage in building material, construction and in other fields and reduces environmental problems. This research is carried out to produce a low-cost and eco-friendly concrete. In this project the behavior of concrete is assured by partially replacing the natural sand with foundry sand. The experimental work is mainly concern with the study of properties like compressive strength, workability of concrete by partial replacement of foundry sand as fine aggregate and GGBS as cement. Foundry sand was replaced with four percentages (0%, 30%, 40% & 50%) of Waste Foundry Sand by weight and GGBS was replaced with 40% by constant weight. The tests were conducted for the above replacements of foundry sand and GGBS for M30 Grade concrete. Compression test was carried out to evaluate the strength properties of concrete at the age of 7, 14 & 28 days. Test results showed a nominal increasing strength and decreasing workability properties of concrete by the addition of waste foundry sand as a partial replacement of natural sand and addition of GGBS as a partial replacement of cement

***Key Words*: Compressive strength, Industrial Waste, workability, etc**.

1. INTRODUCTION

Foundry sand is high quality silica material with uniform physical characteristics. It is a by-product of ferrous and non-ferrous metal casting industries, where sand has been used as a moulding material because of its thermal conductivity. It is a by-product of both ferrous and non-ferrous metal castings Fig.no.1 shows the storage of Waste Foundry Sand.

(Fig no 1)

Ground Granulated Blast furnace Slag is a by-product of iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace, and the resulting molten slag floats above the molten iron at a temperature of about 1500oC to 1600oC. The molten slag has a composition of 30% to 40% Silicon Dioxide (SiO_2) and approximately 40% Calcium Oxide (CaO), which is close to the chemical composition of Portland cement

(Fig no 2)

1.1 Objectives

- To check the relationship between percentage of foundry sand and GGBS replaced and compressive strength of the cube.
- To determine the change in the cost of concrete without compromising the strength.
- To reduce stress on environment by using waste foundry sand, and prove it as eco-friendly building material.

2. Methodology (Material & Testing)

A. Foundry Sand

The quality of foundry sand can be quantified by its durability and soundness, chemical composition, and variability. Durability/Soundness of foundry sand is important to ensure the long-term performance of civil engineering applications. Durability of the foundry sand depends on how the sand was used at the foundry. Successive moulding can cause the foundry sand to weaken due to temperature shock. Chemical Composition of the foundry sand relates directly to the metal moulded at the foundry. This determines the binder that was used, as well as the combustible additives. Reducing the variability of the foundry sand is critical if consistently good engineering products are to be produced.

B. GGBS

Ground granulated blast furnace slag is a by-product of from the blast furnace used to make iron and steel. Blast furnace fed with controlled mixture of iron ore, coke and limestone, and operated at a temperature of about 1500C. When iron ore, coke, and limestone melt in the blast furnace, two products are produce-molten iron and molten slag. The molten slag is lighter and floats on the top of the molten iron. The molten slag comprises of mostly silicates and alumina from the original iron ore, combine with some oxides from limestone.

C. Cement

Cement is a binder a substance used in construction that sets and hardens and can bind other materials together. Cement used in construction can be characterized as being hydraulic or non-hydraulic, depending upon the ability of the cement to set in presence of water. Non-Hydraulic cement will not set in wet conditions or underwater, rather it sets as it dries and reacts with carbon dioxide in air.

D. Fine Aggregate

Fine aggregates consist of natural sand or crushed stone with particle diameters smaller than 3/8 inch. The fine aggregate particle size distribution can affect cement and water requirements, as well as concrete workability, economy, porosity, shrinkage and durability. Too many fine particles can lower the concrete strength and adversely affect durability. ASTM C33 requires that the fine aggregate used in concrete have a fineness modulus, an index of aggregate fineness, in the range of 2.3 to 3.1.

E. Course Aggregate

Course aggregate can have round, angular, or irregular shape. Rounded aggregates because of lower surface area will have lowest water demand and also have lowest mortar paste requirement. Maximum size of aggregate affects the workability and strength of concrete. Higher the surface area, greater is the water demand to coat the particles and generate workability. Material strength of course aggregate is indicated by crushing strength of rock, aggregate crushing value, aggregate impact value, aggregate abrasion value

F. Water

Water used for mixing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic matters. Potable water is generally considered satisfactory for mixing concrete. The pH value should not be less than 6.

G. Chemical Admixture

In general, foundry sand can be used with any concrete containing chemical admixtures. Retarders and water reducers are compatible with most foundry sands. As with natural sands, any organic material in the foundry sand may affect the dosage and effectiveness of air entraining agents. Trial mixtures should always be examined for any potential compatibility problems

3. MIX DESIGN (M30)

Table no. 1: Parametric combination of concrete mixes

Sr no.	Parametric combinations	No. of cubes
1	Mix 1 (0% GGBS + 0%WFS)	9
2	Mix 2 (40% GGBS + 30% WFS)	9
3	Mix 3 (40% GGBS + 40% WFS)	9
4	Mix 4 (40% GGBS + 50% WFS)	9

Table 2: Designed Proportion of Materials for 1 m3 of Concrete (by weight kg/m^3)

% Replacement	0%	30%	40%	50%
Cement	422	253	253	253
C.A 20 mm	782.50	778	778	778
F.A 10 mm	421.34	419	419	419
Sand	820.30	563	518.75	406
GGBS	0	169	169	169
WFS	0	243	348.65	406
Water(Lt/m3)	156	156	156	156
Admixture	3.37	3.2	3.2	3.2

4. Experimental methodology

Compressive Strength test

• General Description -

Out of many test applied to the concrete, this is the most important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm x 15 cm x 15 cm or 10cm x 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15 cm x 15 cm are commonly used.

This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

• Objectives -To determine compressive strength of concrete.

5. Result

A. Compressive strength at 7 days

Compressive strength or compression strength is the capacity of material or structure to withstand loads tending to reduce size

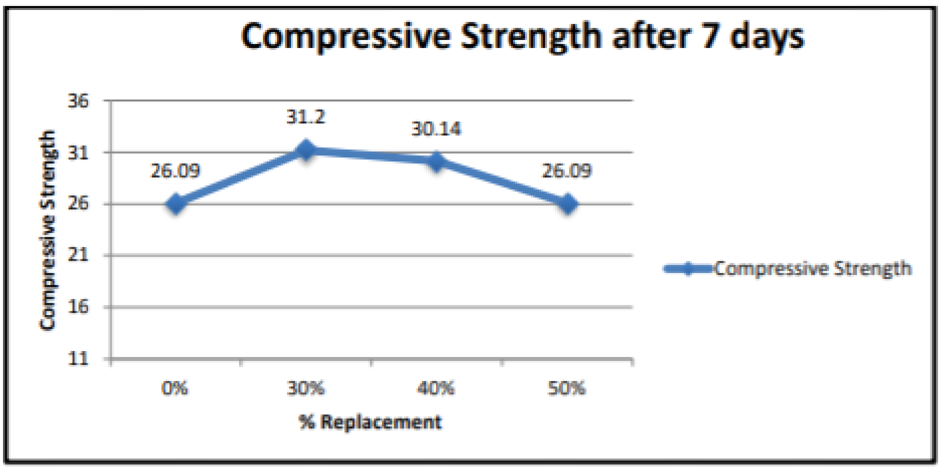

Fig 3- Compressive strength at 7 days

B. Compressive strength at 14 days

Compressive strength or compression strength is the capacity of material or structure to withstand loads tending to reduce size

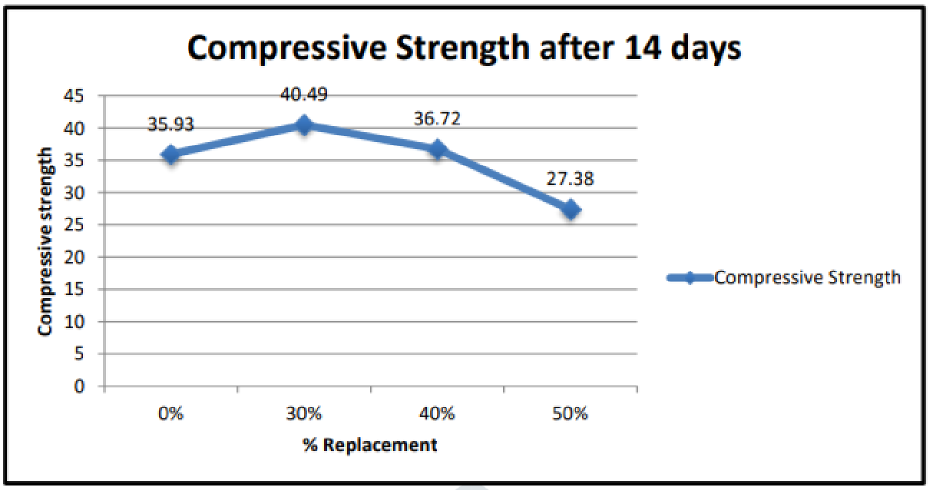

Fig 4- Compressive strength at 14 days

C. Compressive strength at 28 days

Compressive strength or compression strength is the capacity of material or structure to withstand loads tending to reduce size

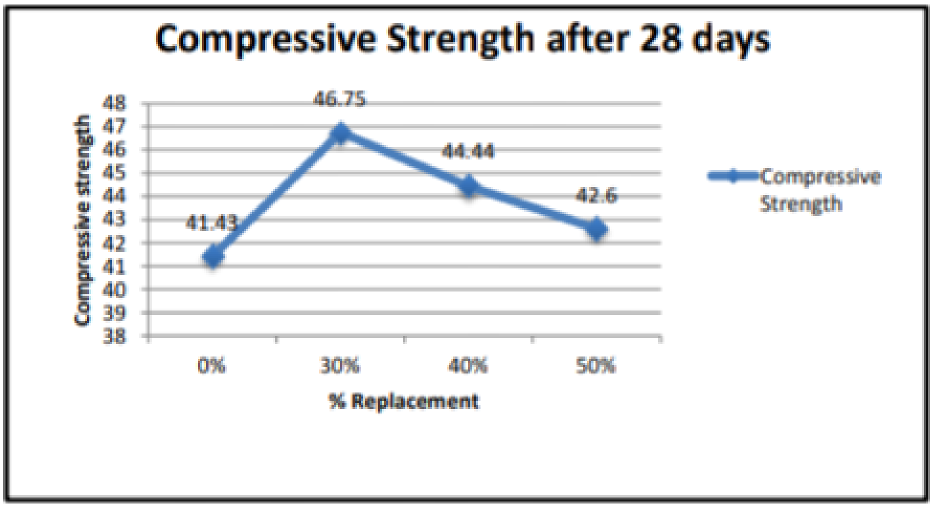

Fig 5- Compressive strength at 28 days

6. Conclusion

Based on above study the following observations are made regarding the properties and behavior of concrete on partial replacement of fine aggregate by waste foundry sand.

- Compressive strength increases with increase in percentage of foundry sand after 7 days as compared to traditional concrete.
- Compressive strength increases with increase in percentage of foundry sand after 28 days as compared to traditional concrete.
- The slump value decreases with increase in the percentage of foundry sand in the concrete mix. The decrease of workability may be due to round shape of foundry sand which rolls down and decreases the slump. Workability also decreases due to higher water absorption.
- The result of percentage cost change reduces up to 9.27% for 60%replacement of waste foundry sand. This shows that the concrete produced is economical.

7. REFERENCES

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