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To Examine the Strength Characteristics of Concrete with the Replacement of Sand by Foundry Sand

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Abstract— **Although foundry sand is a by-product of metal casting industries which is left as waste. Due to scarcity of land-filling space and its ever increasing cost, it has become an attractive proposition to disposal. So, such a byproduct of metal casting industries can be used in construction, building materials and in other fields for reduction of environmental problems. Research has being carried out for its possible utilization in making concrete as partial replacement of fine aggregate. The present study has been undertaken to study the strength characterstics of high strength concrete, when a part of fine aggregate is replaced by foundry sand in different percentages. The percentages of replacements were 15%, 30%, 45% and 60 % by weight of fine aggregate.**

Keywords: **Foundries, Foundry sand, Landfill**

I. INTRODUCTION

Recent research aimed to study the mechanical properties of concrete with addition of industrial by-products. These by-product has the ability to enhance the properties of concrete. Lately some attention has been given to the use of foundry sand as a replacement to ordinary sand. In actual, a part of ordinary sand is being replaced with the foundry sand in concrete mixture. Foundry sand is a by-product of metal casting factories. Although the foundry sand is a waste of metal industries but, due to scarcity of land-filling space it can be used in construction as well as in building materials. Currently, it is widely used in concrete or cement at various places. Moreover, using foundry sand in concrete can benefit the environment.

Need of present study:- The main objective of this paper is to study the behavior of concrete in which fine aggregate in ordinary concrete is replaced with foundry sand at room temperature. The main parameters studied are compressive strength, split tensile strength and flexural strength for all replacement levels of foundry sand at curing period of 28-days & 56-days, and their results are studied and compared with control mix concrete.

II. EXPERIMENTAL PROGRAMME

In order to achieve the objectives of the present study, an experimental program was planned to investigate change in behaviour of high strength concrete, when a part of fine aggregate is replaced by foundry sand in different percentages i.e. 15%, 30%, 45% & 60% with the use of superplasticisers. The main parameters investigated were compressive strength, split tensile strength and flexural strength at a curing period of 28-days & 56-days.

The aim of studying properties of the materials used in concrete is to check the conformance with codal requirements and to enable an engineer to design a concrete mix for a particular strength. The different materials used in the present study are cement, sand, coarse aggregate, foundry sand, superplasticisers and water. Laboratory tests were conducted on these materials and their properties have been reported

Cement: In the present investigation, ordinary Portland Cement 43 grade conforming to IS 8112 (1989)3 is used. The total quantity of cement needed for the investigation is obtained in one lot from a fresh stock and without any lumps.

Fine Aggregate: The sand used for the experimental work was locally obtained and conformed to grading zone II as per IS: 383-1970. A lump of clay and other foreign materials were separated out carefully. Sieve analysis of sand was done.

Coarse Aggregate: The coarse aggregate used were a mixture of two locally available crushed stone of 10 mm and 20 mm size in 40 : 60 proportion. The aggregates were washed to remove dirt, dust and then dried to surface dry conditions. The specific gravity and fineness modulus was found to confirm the requirements of IS: 383 – 1970.

Foundry Sand: Foundry sand is used in cement concrete as a replacement for sand to study the behavior of concrete. Foundry sand obtained from Insaf foundry, Mandi Gobindgarh, Punjab was used. Foundry sand received was grey (Blackish) in color.

Water: The water used in the concreting work was the potable water as supplied in the concrete laboratory of our college. Water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalies, salts and sugar, organic materials or other substances that may be deleterious to concrete.

Superplasticisers: Sika viscocrete-10R of SIKA brand complying with BIS: 9103–1999 was being used. It is a poly-carboxylic ether based superplasticizer

Concrete Mix Design for M 30 grade conventional concrete: In the present investigation the existing method as per IS: 10262 (2009) has been used for selecting the concrete mix M30, however new information given in IS 456 (2000) have been incorporated, procedure is modified to that extent. Specific relationships, charts, graphs that are given in this method of mix design have been developed from extensive experimental investigation at the cement research institute of

India as well as on the basis of data on concrete being designed and produced in the country. Test specimens: various tests conducted on the high strength concrete with varying percentage of foundry sand 0%, 15%, 30%, 45% and 60%. For each percentage variation of sand with foundry sand 3 samples were tested and average value of these three observations was taken as final result.

Moulds used for conducting following tests:

1. Cubical specimens of size 150mm x 150mm x 150mm and cylindrical specimens of size 300mm x 150mm dia. were tested for the compressive strength of concrete.
2. Cylindrical specimens of size 200mm x 100mm dia. were tested for split tensile strength.
3. Beam specimens of size 100mm x 100mm x 500mm were tested for flexural strength of concrete.

III. TEST PROCEDURE

COMPRESSIVE STRENGTH TEST: The cubes were tested at the age of 28 and 56 days. The time was reckoned from the time of addition of water to the dry ingredients. The specimens were tested on compression testing machine. The specimens were removed from curing tank and wiped with cloth for any traces of surface water. After keeping at room temperature for half an hour they were placed in position. According to Indian standard procedure laid down in IS: 516-1959

SPLIT TENSILE STRENGTH TEST: The test was conducted according to IS Code 5816-19706. This test was carried out by placing a cylindrical specimen of size 200mm x 100mm dia. horizontally between the loading surfaces of a compression testing machine and the load was applied until failure of the cylinder, along vertical diameter

FLEXURAL STRENGTH TEST: The test was conducted according to IS Code 516-19597.The dimensions of each specimen (100mm x 100mm x 500mm) were noted before testing. No preparation of the surface was required. The bearing surfaces and loading rollers are wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers. The specimen was then placed in the machine in such a manner the load is applied to the uppermost surface as cast in the mould, along two lines spaced 13.3 cm apart. The axis of the specimen was carefully aligned with the axis of the loading device. The load was applied without shock and increasing continuously at a rate such that the extreme fibre stress increased at approximately at a rate 180 kg/min for the 10.0 cm specimens. The load was increased until the specimen fails, and the maximum load applied to the specimen during the test was recorded

IV. DISCUSSION AND RESULTS

COMPRESSIVE STRENGTH TEST: In this research the values of compressive strength for different replacement levels of foundry sand contents (0%, 15%, 30%, 45% and 60%) at the end of different curing periods (28 days, 56 days) are given in Table 4.1.

It is evident that compressive strength of concrete mixtures with 15%, 30% and 45 % of foundry sand as sand replacement was higher than the control mixture (M-1) except 60% of foundry sand. Moreover, the strength of M-2, M-3, M-4 mixtures continued to increase with the age.

The result showed that the compressive strength increases with the increase in foundry sand upto certain amount. The compressive strength increases by 1.01%, 3.18%, & 6% when compared to M-2, M-3, M-4 ordinary mix without foundry sand at 28-days. However after 45% of foundry sand replacement there was decrease in the strength compared to normal concrete mixture. When mix M-5 is compared with the ordinary mix, there is decrease in value of compressive strength by 2.6%.

Compressive strength at 56 days increases by 1.6 %, 4.04 %, & 5.55% compared to ordinary mix. Except, when M-5 compared the ordinary mix the compressive strength decreases by 0.8%. Compressive strength at 56 days was 6.7%, 7.3%, 7.43%, 6.25%& 8.65% higher than the 28 days compressive strength.

SPLIT TENSILE STRENGTH TEST:

It was found that split tensile strength of concrete incorporating foundry sand (using 15 %, 30 %, 45 % and 60 % replacement levels with fine aggregate and a w/c of 0.44) depended on the percentage of foundry sand used The variation of split tensile strength was shown in Table 4.2.

The result shows the variation of split tensile strength with replacements of foundry sand with various levels of fine aggregate at 28-days & 56 days. For control mix, the split tensile strength was increased by 10.9%, 20%, 30% and 22.8% with respect to different replacement levels of sand with foundry sand at 28 days with respect to ordinary mix. At 56 days the split tensile strength varies as 12.7%, 22.2%, 29.1% & 23.3% than control mix without foundry sand to the various replacement levels.

FLEXURAL STRENGTH TEST:

Prism specimens were tested for flexural strength. The tests were carried out confirming to IS: 516-1959(8). The specimens are tested under two-point loading. The average value of 3 specimens for each category at the age of 28 days is tabulated in the Table 4.3.

There is considerable increase in the flexural strength of concrete with the inclusion and increase in the percentage of waste foundry sand upto 45%. However after 45% there was decrease in the strength compared to normal concrete mixture. For control mix, flexural strength was increased by 14.25%, 18.3%, 20% & 13.2% with respect to different replacement levels of sand with foundry sand at 28 days with respect to ordinary mix. At 56 days the flexural strength varies as 6.4%, 15.6%, 18.25, & 5.2% than control mix without foundry sand to the various replacement levels.

Foundry Sand Content, %	Designation	Compressive Strength, MPa	
		28 days	56 days
0	M-1	39.83	42.50

15	M-2	40.23	43.18
30	M-3	41.16	44.22
45	M-4	42.22	44.86
60	M-5	38.80	42.16

Table 4.1: Compressive Strength (MPa) of Concrete with various levels of Replacement of Foundry Sand

Foundry Sand Content, %	**Designation**	**Split tensile strength, MPa**	
		28 days	**56 days**
0	M-1	4.2	4.32
15	M-2	4.66	4.87
30	M-3	5.06	5.28
45	M-4	5.46	5.58
60	M-5	5.16	5.33

Table 4.2: Split tensile strength (MPa) of concrete with various levels of replacement of foundry sand

Foundry Sand Content, %	**Designation**	**Flexural Strength, MPa**	
		28 days	**56 days**
0	M-1	5.19	5.86
15	M-2	5.93	6.24
30	M-3	6.14	6.78
45	M-4	6.23	6.93
60	M-5	5.88	6.17

Table-4.3 Flexural Strength of Concrete with various levels of Replacement of Foundry Sand

V. CONCLUSION

On the basis of the results and discussions on this investigation the following conclusions are drawn:

1. The Compressive strength of concrete increases with the increase in sand replacement with different replacement levels of foundry sand. However, there was decrease in the compressive strength as compared to normal concrete mixture with replacement level more than 45% of foundry sand. Although, an increase in strength was observed with the increase in age.
2. The compressive strength increased by 1.01%, 3.18%, & 6% when compared to ordinary mix without foundry sand at 28-days.
3. Compressive strength at 56 days increased by 1.6 %, 4.04 %, & 5.55% compared to ordinary mix.
4. In this study, maximum compressive strength is obtained at 45% replacement of fine aggregate by waste foundry sand.
5. Split Tensile Strength also showed an increase with increase in different replacement levels of Foundry Sand with fine aggregate. But after 45% of foundry sand replacement it showed marginal decrease.
6. Split Tensile Strength also increased with increase in age.
7. There was increase in flexural strength of concrete upto 45% replacement.
8. Use of foundry sand in concrete reduces the production and disposal of waste through metal industries.

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