Experimental Investigation by Partial Replacement of Fine Aggregate with Foundry Sand and Addition of Steel Fibre in Concrete

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***Abstract*: Concrete is the most used material world wide due to development of infrastructure. As sand is an important factor of concrete and it is not sufficiently available for construction activities and its cost increasing day by day due to a huge demand. In this experiment waste foundry sand is used as an alternative to sand in concrete up to 80% replacement by the addition of steel fibers as the strength material. As waste foundry sand is a by- product of metal casting industries and is a cause of concern due to its harmful effects on environment due to its improper disposal. Waste foundry sand consists of silica sand, coated with thin film of burnt carbon, residual binder (bentonite, sea coal, resins) and dust. Waste foundry sand can be used in concrete to improve its strength and other durability factors. An experimental investigation is carried out on a concrete of mix design M45, with the replacement of sand with the waste foundry sand in the range of 0%, 50%, 60%, 70%, 80%, with the addition of Hooked steel fibers as a strength material in concrete. Material was produced and was tested for workability and strength. Tests were carried out on a cube of 150mm x 150mm x 150mm for 7 and 28 days. The result shows the optimum compressive strength at 60% waste foundry sand after that it starts decreasing; same is the case with the split tensile strength and flexural strength. .**

***Keywords:* Fine aggregate replacement, Foundry sand, Steel Fiber, Compressive strength, Flexural Strength, Split Tensile Strength.**

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1 INTRODUCTION

Concrete is a mostly commonly used material made from mixture of broken stone or gravel, sand, cement, and water, which can be poured into mould and forms a stone like mass on hardening the admixtures, may be added in concrete in order to enhance some of the properties desired specially. In its simplest form, concrete is a mixture of paste and aggregates. The foundry sand is normally high quality silica sand with uniformly physical characteristics. It is a byproduct of ferrous and nonferrous metal casting industries, where sand has been used for centuries as a moldings material. In this experiment waste foundry sand is used as an alternative to the natural sand in the concrete up to 80% replacement with the hooked steel fibres as the strength material. Nowadays natural sand is not easily available due to ban on extraction from river beds which causes in the rise of its costs. For this reason alternative sources are used to our come this problem and to fulfill the demand of fine aggregate in the concrete. Waste foundry sand being the byproduct of metal casting industries causes environmental problems. Hence, it is necessary to develop the building material from them.

2 LITERATURE REVIEW

Manjunathan *M et.al (2016)* in this experiment, waste foundry sand is used as alternative to natural sand in concrete by replacing up to 50%. The effects on environment and disposal problem can be minimized by using WFS in concrete structures. The research work is carried out to study the mechanical properties such as compressive strength, split tensile strength, and flexural strength of the concrete specimen by partial replacement of natural sand with WFS up to 50% replacement and compared with referral mix. Total mix proportions is taken as six in 10%, 20%, 30%, 40%, 50% with and without WFS are made. And all the mechanical were carried out to assess the strength properties of hardened concrete at the age of 7 and 28 days. The result shows that the compressive strength of cubes is maximum at 20% WFS after that it decreases. The split tensile strength and flexural strength increases as percentage of WFS increases.

Mohamed Anjum et.al (2017) In this study Fine aggregate, was partially replaced by foundry sand in M20 concrete and found that the compressive strength decreases with increase in foundry sand up to 20% of replacement and there after increases with the least value obtained nearly equal to the desired minimum compressive strength for M20 concrete .The split tensile strength increases with increases in percentage of foundry sand replacing fine aggregates. The 28 days compressive strength of concrete decreases with increase in percentage of foundry sand up to 20% of replacement and there after increases. However the compressive strength so obtained is still more than that of minimum value prescribed. The split tensile strength increases with increases with increase in the percentage of foundry sand compared to conventional concrete. As per the result s, the partial replacement of fine aggregate with foundry sand is feasible up to 40% as far as the slump, compressive strength and split tensile strength properties of concrete are concerned.

3 MIXTURE PROPORTIONING

The mix proportion was done as per the IS 10262- 1982.The target mean strength was 53.25 MPa (M45) for the OPC control mixture The concrete cubes, beams, cylinder moulds were cured in the tank for 7,and 28 days for compression test, Flexural strength test and tensile strength test.

Table 3.1 Concrete mix proportioning for M45 design mix per m^3

Design Mix Ratio For M45 Grade	Ingredients	Surface Dried Weights
1	Cement	492.5 kg
1.32	Fine Aggregates	650 kg
2.18	Coarse aggregates	1073.4 kg
	Water	197 litres.
	Water cement ratio	0.4
	Steel fibre	24.13kg

4 EXPERIMENTAL METHODOLOGY

Workability of concrete

It is the property of concrete which determines its ease in mixing, placing and compaction

1 Slump test

The tests which were carried on a fresh concrete shows the slump value decreases with the increase of percentage of waste foundry sand in the concrete.

2 Compaction factor test

The compaction factor test shows the decreasing trends with the increase of waste foundry sand in concrete.

Table 4.1 Shows Workability Results

S.NO	MIX DESIGN	SLUMP TEST VALUE	COMPACTION FACTOR TEST VALUE
1	MX F1	100mm	0.83
2	MX F2	100mm	0.83
3	MX F3	90mm	0.81
4	MX F4	80mm	0.80
5	MX F5	70mm	0.79

4.1 TESTS ON HARDNED CONCRETE

Tests were done as per following codes of Bureau of Indian Standards. The test for compressive strength on cubes were measured at 7, and 28 days of curing as per IS: 516 1959[14], test for flexural strength on beam was measured at7, 28 days of curing as per IS: 516 1959 and test for split tensile strength on cylinder was measured at 28 days of curing as per IS: 5 816 1999

4.1.1 Compressive Strength Test

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M45 grade of concrete. The moulds were filled with different proportions of cement, waste foundry sand and steel fibre. Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 7, and 28days. After 7 and 28 days curing, these cubes were tested on manual compression testing machine as per I.S. 516 1959. The failure load was noted. In each category, three cubes were tested and their average value is reported.

The compressive strength was calculated as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

4.1.2 Flexural Strength Test.

The standard sizes of beam specimen were 15x15x70 cm. The beam moulds conform to IS:10086 1982 uring: The specimens were demoulded after 24 hours of casting and were transferred to curing tank wherein they were allowed to cure for 28 days.. Test specimens shall be stored in water at a temperature of 24^0 34 ^{0}c for 48 hours before testing. These specimens were tested under flexural testing machine the specimens shall be tested immediately on removal from the water while they are still in the wet condition. Flexural strength is calculated by $fb=pl/bd^2$

4.1.3 Tensile Strength Test.

For tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank wherein they were allowed to cure for 28 days. These specimens were tested under compression testing machine. In each category, three cylinders were tested and their average value was reported

Tensile strength was calculated as follows as split tensile strength:

Tensile strength (MPa)=2P/π DL Where, P = failure load, D = diameter of cylinder, L = length of cylinder.

5 EXPERIMENTAL RESULTS

Results of M45 grade of OPC concrete filled with various proportions of Rice Husk Ash and Brick kiln Powder for compressive strength, split tensile strength also for flexural strength test are shown in table below

Table 5.1 Results of Compressive Strength Test after 7 and 28 Days of Curing

Mix Design	Mix proportion of waste foundry sand And steel fibre		Compressive Strength in N/mm^2	
	%WFS by weight of sand	Steel fibre(1%) by weight of total weight of material	7 Days	28 Days
Control Mix	0%	0%	35.89	56.22
Mix 1	50%	1%	36.33	57.03
Mix 2	60%	1%	34.88	54.51
Mix 3	70%	1%	34.44	50.66
Mix 4	80%	1%	30.03	45.77

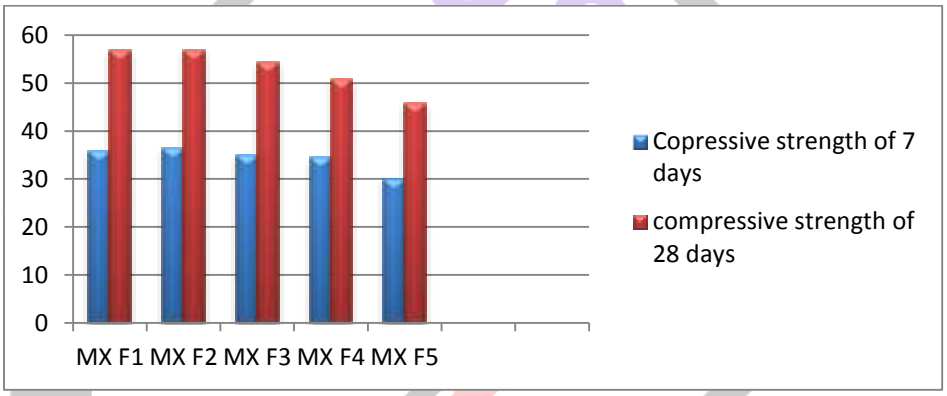

Fig 5.1 Comparison between 7 and 28 days Compressive strength

Table 5.2 Results of Flexural Strength Test after 28 Days of Curing

Mix Design	Mix proportion of waste foundry sand And steel fibre		Flexural Strength in N/mm^2 7 Days	Flexural Strength in N/mm^2 28 Days
	%WFS by weight of fine aggregate	%Steel fibre(1%) by total weight of material		
Control	0%	1%	5.22	8.39
Mix 1	50%	1%	5.35	8.56
Mix 2	60%	1%	5.11	7.8
Mix 3	70%	1%	4.55	7.25
Mix 4	80%	1%	3.72	6.41

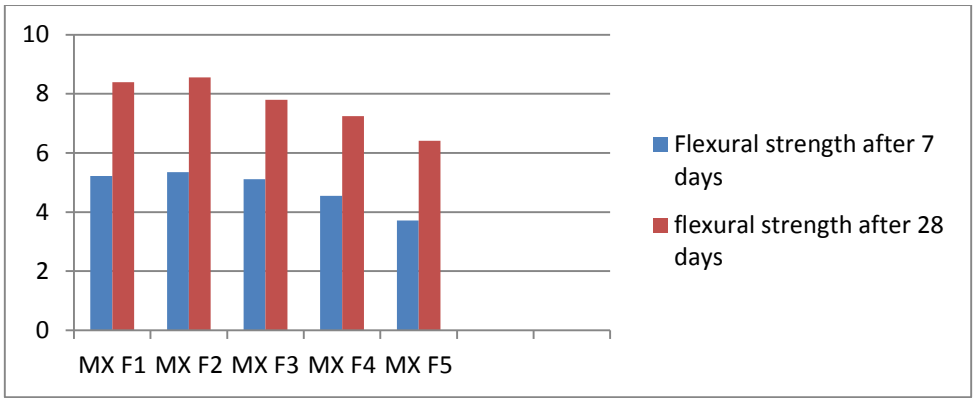

Fig 5.2 comparison after 7 & 28 days flexural strength

Table 5.3 Results of Tensile Strength Test after 28 Days of Curing

Mix Design	Mix proportion of waste foundry sand And steel fibre		Tensile Strength in N/mm^2	Tensile Strength in N/mm^2
	%WFS by weight of fine aggregate	%Steel fibre(1%) by total weight of material	7 Days	28 Days
Control Mix	0%	0%	4.28	6.66
Mix 1	50%	1%	4.35	6.78
Mix 2	60%	1%	4.02	6.26
Mix 3	70%	1%	3.57	5.28
Mix 4	80%	1%	3.22	5.02

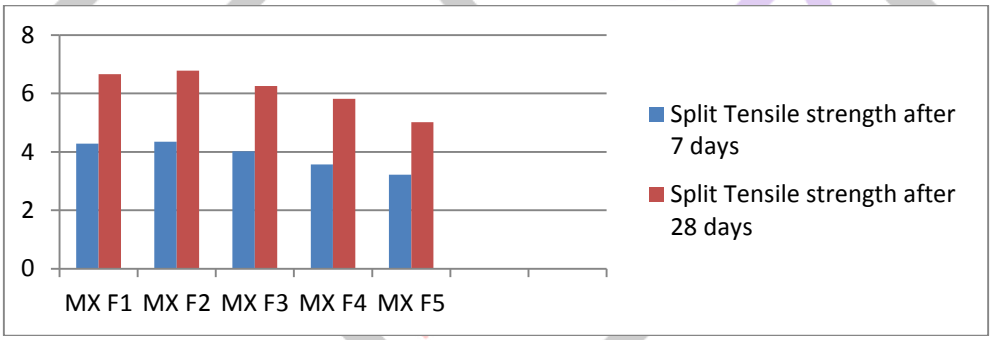

Fig 5.3 comparison of 7 & 28 days of Split tensile strength

6 CONCLUSIONS

1. It shows compressive strength increases after 50% replacement for 7 days by 1.2% and after 28 days 1.1% and it further decreases as the replacement of 60% sand by waste foundry sand foundry 7 days 2.78% and after 28 days 3.4%. It further decreases after replacement of 70 & 80% for 7 & 28 days by 4.01 & 9.90% and 16.30% & 18.90%.
2. It shows Flexural strength increases after 50% replacement for 7 days by 2.45% and after 28 days 2.0% and it further decreases as the replacement of 60% sand by waste foundry sand foundry 7 days 2.10% and after 28 days 7.0%. It further decreases after replacement of 70 & 80% for 7 & 28 days by 12.85% & 13.5% and 28.75% & 23.5%.
3. It shows Split tensile strength increases after 50% replacement for 7 days by 1.65% and after 28 days 1.80% and it further decreases as the replacement of 60% sand by waste foundry sand foundry 7 days 6% and after 28 days 6%. It further decreases after replacement of 70 & 80% for 7 & 28 days by 16.5% & 12.60% and 24.75% & 24.65%.
4. Maximum compressive strength is obtained when 60% replacement of fine aggregate by waste foundry sand with the addition of steel fibers as strength materials.
5. Use of waste foundry sand in concrete reduces the production of waste through the metal industries.
6. Waste foundry sand is an eco- friendly building material, so its use helps in reducing the pollution problems.
7. The problems regarding the disposal and the maintenance cost of land filling is reduced. This study gives the use of more waste foundry sand at higher percentages by adding the hooked steel fibers

REFERENCES

[1] Pathariya Saraswati C (2013) 'Application of Waste Foundry Sand for Evolution of Low Cost Concrete". International Journal of Engineering Trends and Technology. Volume 4 Issue 10.

[2] Manish Kaushal (2014) "To Examine the Strength of Characteristics of Concrete with the Replacement of Sand by Foundry Sand ". International Journal of Recent Research Aspects ISSN: 2349-7688, Vol 1, Issue 3.

[3] Manjunatha M (2016) "Performance Evaluation of Strength Properties of Concrete by Using Waste Foundry Sand". International Journal of Innovative Research in Science, Engineering and Technology. Vol 5, Issue 4.

[4] Mohammed Anjum (2017) "Partial Replacement of Fine Aggregate with Foundry Sand in Concrete". International Journal for Scientific Research and Development Vol 5, Issue 6.

[5] Pranita Bhandari (2016) "Use of Foundry Sand in Conventional Concrete". International Journal of Latest Trends in Engineering and Technology. Vol 6, Issue 3.

[6] Vema Reddy Chevuri (2015) "Usage of Waste Foundry Sand in Concrete" SSRG International Journal of Civil Engineering. Volume 2, Issue 12.

[7] Xerses N. Irani (2015) "Utilization of Foundry Waste Sand in the Preparation of Concrete".IOSR Journal of Mechanical and Civil Engineering. Volume 12 Issue 6.

[8] Amrutha K (2017) "Partial Replacement Of Fine Aggregate By Used Foundry Sand In Concrete". International Research Journal of Engineering and Technology. Volume 4, Issue 3.