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A Research on Partial Replacement of Fine Aggregate by Waste Foundry Sand

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Abstract. The by-products from metal casting industries, waste foundry sand is generated in huge amount which causes many pollution to the environment like infertility of sand, unsightliness, awful odour, etc., because of improper disposal. Such kind of environmental problems can be reduced when those wastes are used as building material during concrete production. So, a research work was carried out in concrete containing waste foundry sand in the range of 15% to 25% with 5% increase, as a partial replacement for fine aggregate(M-sand) for M-20 grade concrete. The concrete made of foundry sand in the proposed mix design was tested and compared with ordinary concrete for workability, compressive strength, Flexural strength and Tensile strength. The cubes were tested on 14th and 28th day for mix of 1:1.54:2.97 at a water-cement ratio of 0.45 and the results were carried out with comparison.

Introduction

The scope of the project is to reduce the environmental pollution caused by waste foundry sand and use them as partial replacement of fine aggregate in concrete. This concrete is subjected to compression, tensile, and flexural test with some percentage of partial replacement of fine aggregate by waste foundry sand[1]. The objective of the live foundry sand project is to foster the green procurement, waste prevention and recycling by studying. It is to improve acceptance of the generally valuable cleaned and recycling soil material to use geo engineering in future. It is having good durability and workability. Keep away contaminated materials from landfills. It is improved fertility, and to substitute synthetic fertilizers.

Materials

Admixtures

An unique pink colored liquid which is used for integral water-resistant component for mortar, plaster and concrete of surface-active agents, additives, and special selective polymers. The admixture has many characteristics as Compatibility enables easy to disperse and compatible with any type of Portland cement, including Slag Cement, Cohesiveness will minimize the mortar loss caused by rebound in plaster work, which makes it very easy for application and saving[2,8]. Economically necessary for a very low dose, low permeability will improve Water-tightness in large measure, the water reducer helps to reduce the water content, will improve workability without increasing the water content, Reduced Shrinkage cracks in concrete and mortar, a better finish, works to disturb the causing leakage capillary Concrete-formed structures that make it waterproof and durable, help improve strength, make concrete more cohesive and therefore waterproof better protects the steel against corrosion, less time is needed for plaster, which saves on the cost of labor per square foot, supplied under conditions favourable to the consumer[3,9].

The admixture can be used in various fields such as

- Slabs and roof supports
- Lower ground floor
- Water reservoir and water containment structures
- Washrooms and terraces
- External plastering
- Repairing and renovating.

Waste Foundry Sand

For metal castings, usually recycled sands will be used in order to reduce the usage of the natural materials. After several times of usage of the sand, it will lose its characteristics and it will become unsuitable for the manufacturing process of metal castings[4,6]. These unsuitable sands will become waste and will be discarded away. For compaction, molding sand will be used because it leads to the desired shape required during the casting process.

Table No. 1: Properties of Waste Foundry Sand

S. NO.	PROPERTY	RESULT
1	Water Absorption	0.42 %
2	Moisture Content	1.6 %
3	Specific Gravity	2.4
4	Fineness Modulus	3.92

Casting and Curing

Proper casting and curing are very important factor which controls the strength and durability of concrete. We decided to make three types of specimens, partially replaced natural fine aggregate by waste foundry sand with 15 % , 20 %, and 25%[5,7]. These specimens are made with water cement ratio 0.45 and are cured for 28 days, hardened concrete tests were carried out at an interval of 14 days and 28 days.

Concreting

All the materials are properly weighed and taken in separate bonds. The mixing tray is placed in position and is ensured to be dry and clean of dust and other particles. First fine aggregate and cement are mixed thoroughly, and then coarse aggregate is added and mixed. Finally, water of required quantity is added and the concrete paste is obtained.

Casting of Specimen

Concrete of M20 grade (1:1.54:2.97) with water cement ratio 0.45 is used. Cubes, cylinders, and beams (14 days and 28 days) were prepared by partial replacement of fine aggregate by foundry sand waste. After mixing fresh concrete tests are carried out and then the mixture ready to be casted if the test results are within the allowed standards. The moulds are taken cleaned and tightened completely after which oil or grease is applied on the inner face of the mould which ensures smooth de-moulding of specimens. The mould is filled in three layers of good annual compaction or mechanical compaction and the top of the mould is well finished.

Table No. 2: Size of Mould

S. No.	SPECIMEN	SIZE (mm)
1	Cube	150*150*150
2	Cylinder	150*300
3	Beam	100*100*500

Table No. 3: No. of Specimens Casted

S.NO.	PERCENTAGE OF REPLACEMENT	NAME OF SPECIMEN	NO. OF SPECIMENS		
			14 DAYS	28 DAYS	TOTAL
1	0	Cube	3	3	6
		Cylinder	3	3	6
		Beam	3	3	6
2	15% Foundry Sand	Cube	3	3	6
		Cylinder	3	3	6
		Beam	3	3	6
3	20% Foundry Sand	Cube	3	3	6
		Cylinder	3	3	6
		Beam	3	3	6
4	25% Foundry Sand	Cube	3	3	6
		Cylinder	3	3	6
		Beam	3	3	6

Fresh Concrete Test

Slump Cone Test

Table 4 Slump cone test

S. NO.	% OF WASTE FOUNDRY SAND	SLUMP VALUE (mm)	DEGREE OF WORKABILITY
1	0	110	True
2	15	62	Shear
3	20	80	Shear
4	25	73	Shear

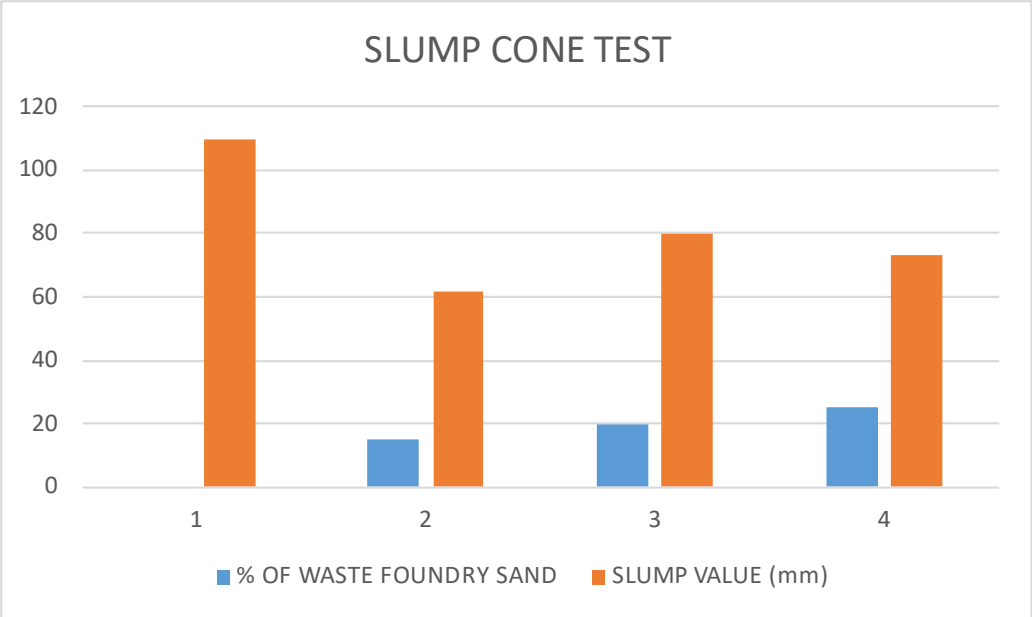

Fig. 1 Slump Cone Test Result

Hardened Concrete Test

Compressive Strength Test

Fig. 2: Compressive Test of Concrete Cube

Table No. 4 Compressive Strength Test Results

No. of Days	Sample (%)	Load (kN)				Cross-sectional Area (mm^2)	Compressive Strength (N/mm^2)
		Trial-1	Trial-2	Trial-3	Mean		
14	0	480	471	475	474.5	150*150	18.0
	15	295	296	294	295	150*150	13.1
	20	306	306	307	306	150*150	13.6
	25	299	301	302	300	150*150	13.33
28	0	486	468	477	476.6	150*150	21.3
	15	301	302	303	302	150*150	13.42
	20	308	307	307	306	150*150	13.6
	25	304	305	304	304	150*150	13.511

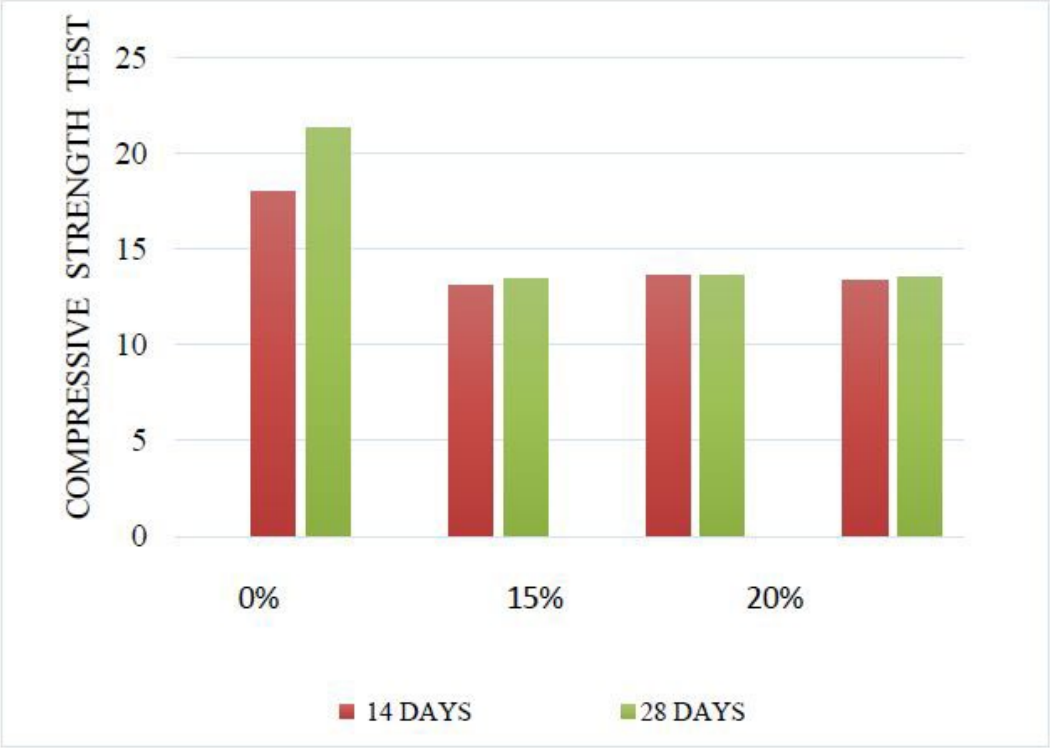

Fig. 3 Compressive Strength Test Result

Tensile Strength Test

Table No. 5 Tensile Strength Test Results

No. of Days	Sample (%)	Load (kN)				Cross-sectional Area (mm^2)	Tensile Strength (N/mm^2)
		Trial-1	Trial-2	Trial-3	Mean		
14	0	215	208	214	211.5	150*300	2.99
	15	183	176	181	180	150*300	1.79
	20	191	188	197	192	150*300	1.84
	25	180	171	184	178.3	150*300	1.71
28	0	233	239	236	236	150*300	3.34
	15	187	183	185	185	150*300	1.81
	20	193	192	196	194.33	150*300	1.86
	25	176	169	181	175.33	150*300	1.68

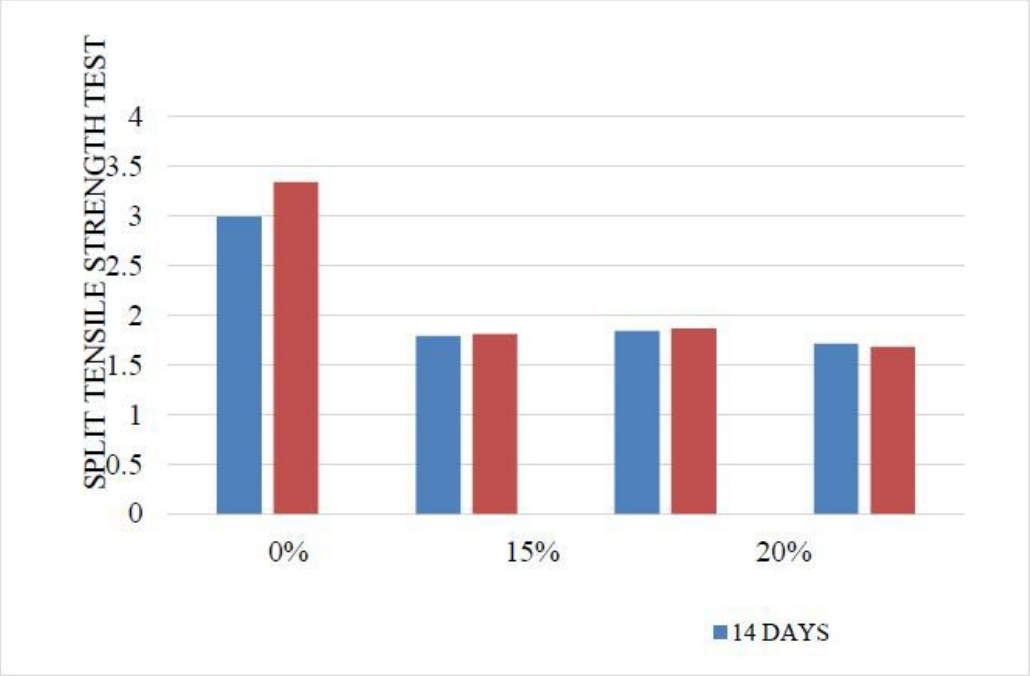

Fig. 4 Tensile Strength Test Result

Flexural Strength Test

Table No. 6 Flexural Strength Test Results

No. of Days	Sample (%)	Load (kN)				Cross-sectional Area (mm^2)	Flexural Strength (N/mm^2)
		Trial-1	Trial-2	Trial-3	Mean		
14	0	18	17	16	17.5	100*100*500	3.75
	15	10	11	11	10.6	100*100*500	1.95
	20	11	12	12	11.6	100*100*500	2.13
	25	10.5	10.5	10	10.3	100*100*500	2.2
28	0	24	23	22	23.5	100*100*500	4.15
	15	12	12.5	12	12.1	100*100*500	2.35
	20	13	13.5	13	13.1	100*100*500	3.2
	25	11.5	11	11	11.1	100*100*500	2.8

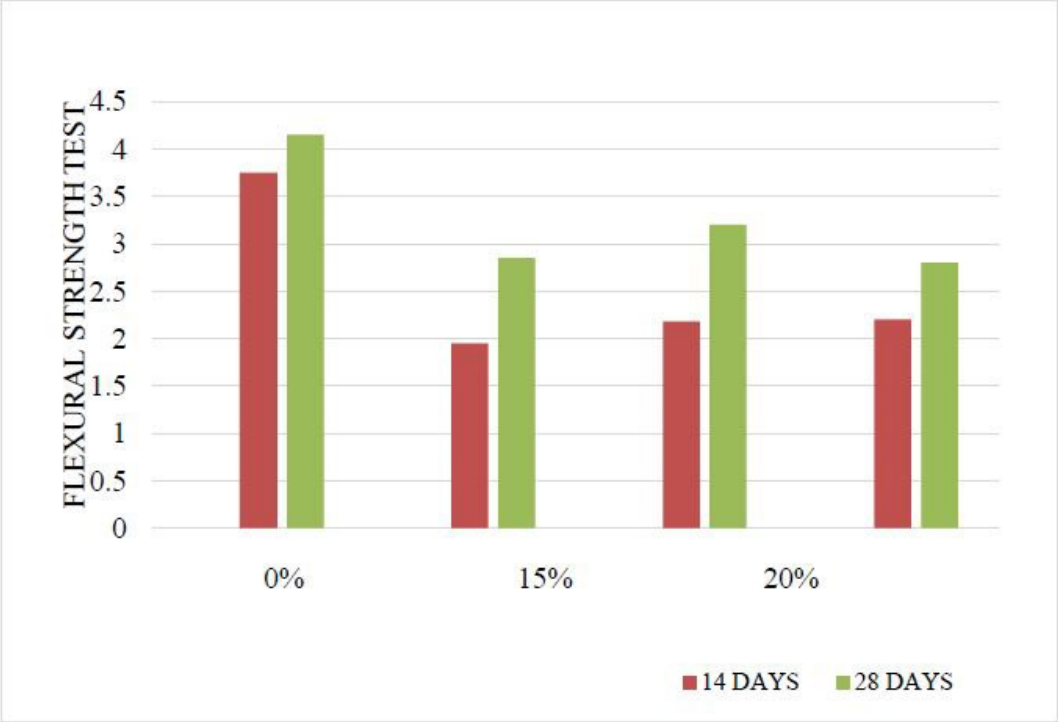

Fig. 5 Flexural Strength Test Result

Conclusion

- Comparing to the controlled mix of nominal concrete, there will be a slight decrease in the strength of the concrete when foundry sand is used as a partial replacement at 20%.
- Usage of waste foundry sand will also lead to eco-friendly environment since the wastes are not buried or thrown away after metal castings are done.
- By this point, the concrete can also be termed as a Green Concrete.

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