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LABORATORY STUDY ON M40 GRADE CONCRETE BY PARTIAL REPLACEMENT OF M- SAND BY WASTE FOUNDRY SAND

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Abstract — ***The foundry sand is used in metal casting industry, they are repeatedly used till the sand loses their properties and then they are disposed as waste foundry sand. This foundry sand has the properties similar to fine aggregate. In this paper an attempt was made to replace M-Sand with waste foundry sand for M-40grade of concrete with W-C ratio 0.38 and obtained mix ratio is 1:1.87:3.17. The various percentage of waste foundry sand replaced with M-Sand is 0%, 10%, 20%, 30%, 40% and 50%. The Workability of fresh concrete was determined by slump test, vee-bee test and compaction factor test. The strength test was determined for 7th day and 28th day of curing period. Compressive strength test, split tensile strength test and flexural strength test was done on hardened concrete. M-Sand can be successfully replaced by 30% of Waste foundry sand with low cost when compared to conventional concrete.***

Keywords-component; Waste foundry sand, M-Sand, slump test, vee-bee test, compaction factor test, compressive strength test, split tensile strength test, flexural strength test.

I. INTRODUCTION

There are two types of metal casting they are ferrous and non-ferrous metal casting. During the production of metal, a by-product is formed know as waste foundary sand which contains high quality of silica, foundry sand is also known as molding sand. They have their own physical, chemical and mechanical properties. Millions and millions tons of Foundry sand are disposed as waste.

Pcc is composed of 10% of water, 20% of cement, and 45% of coarse aggregate, 25% of fine aggregate. The different properties of foundry sand can influence the concrete with less fines of fine aggregate In roadways and highways of USA, the popularly used materials for paving materials are asphalt concrete. In HMA as partial replacement of fine aggregate is done with foundry sand, about 8-25% by the weight of fine aggregate can be replaced by foundry sand.

II. OBJECTIVE OF THE STUDY

- *To determine basic properties of materials used in concrete.*
- *To design M40 grade concrete.*
- *To find optimum percentage of waste foundry sand for partial replacement of M-Sand.*
- *To determine the properties of fresh concrete and hardened concrete.*
- *Comparison of results and Cost analysis.*

III. LITERATURE REVIEW

Vema Reddy Chevuri [(1)] (2015) In this paper the natural sand is replaced by 0%, 20%, 40%, 60%, 80% and 100% of waste foundry sand. To determine compressive strength, spilt tensile and flexural strength the test was conducted for 7th day and 28th day for hardened concrete. The obtain mix ratio is 1:1.41:3.099 with w-c ratio of 0.52. The strength was high at 60% of replacing the foundry sand with the natural sand.

Pranitha Bhandri [(1)] (2016) She made an attempt to develop low cost concrete by replacing fine aggregate with 0%. 10%, 20%, 30%, 40%, 60%, 80% and 100% of waste foundry sand. The basic test was conducted on foundry sand, cement, coarse aggregate, fine aggregate and water. The mix design was done for M-25 grade and the obtain mix ratio is 1:1.01:2.5 with w-c of 0.4 the strength test was done for 3rd, 7th and 28th day. In every strength tests at 20% of replacing waste foundry test with fine aggregate the maximum strength was occurred.

Demse Dhananjay G [(1)] Nikam Madhuri [(2)] Karpe Balraj [(3)] Khairnar Pramod R [(4)] Suryawanshi Priyanka R [(5)] (2016) They made an attempt to use foundry sand as cementitious material. Basic test was done on materials used in concrete and the obtain mix ratio is 1:1.5:3.18, they started replacing fine aggregate with 0%, 10%, 20%, 30%, 40% and 50% of foundry sand. They conducted compressive strength test and flexural test for 3days, 14days and 28days. The maximum strength obtained is at 30%.

Deepak Chaurasiya [(1),] Kiran Koli [(2),] Suraj Chaudhari Vardan [(3).] P.C. Satpute[(4)] (2016). In this paper this student made an attempt to produce low cost concrete by replacing fine aggregate with foundry sand. Mix design was done M-30 grade and obtain mix ratio is 1:1.41:1.6 with w-c of 0.43. Fine aggregate was replaced by 0%, 10%, 20% and 30%. The maximum obtain strength is at 20% of replacement.

Augustine Uchechukwu Elinwa [(1)] The concrete had a mix a ratio of 1:1.71:2.56 with w-c of 0.52 the mix was prepared for 0%, 10%, 20%, 30% and 40% by replacing fine aggregate wit foundry sand. The test was conducted for 3rd, 7th 28th, 60th and 90th day to determine their strength property. The slump value started decreasing after adding the foundry sand. The compressive strength was maximum at 10% of replacing.

IV. METHODLOGY

The following steps are adopted for the present study:

- Materials were collected from local place and basic test was done on Cement ,M-sand, waste foundry sand and on coarse aggregate.
- Mix design was done for M40 grade.
- For the fresh concrete workability was determined by slump test, vee-bee test and compaction factor test.
- The Cube, Cylinder and Beam specimen were casted and kept for curing period of 7days and 28 days.
- Compressive test, Tensile test was done for 7 days and 28 days and flexural test was done for 28days.

V. MATERIALS INVESTIGATION

a) **Cement:** OPC 53 grade cement was used which is fresh and dry for this project. The basic test is done according to IS: 12269-1987 the results were listed in the table 4.1.

Table 4.1 Properties of cement

SL NO	Properties	values
1	Specific Gravity	3.15
2	Normal Consistency	32%
3	Initial Setting time	40min
4	Final Setting time	480min
5	Fineness	6%

b) **M-Sand:** The aggregates are sieved through the sieve size of 4.75mm, the passing aggregates through 4.75mm are known as fine aggregates. M-sand is used as fine aggregate. All the tests were conducted according to IS: 383-1970. The obtained results are tabulated below in the table 4.2

Table 4.2 Properties of M-Sand

SL NO	Characteristics	values
1	Specific Gravity	2.65
2	Sieve Analysis	Zone I
3	Water Absorption	1.74%

c) **Waste Foundry sand:** The foundry sand was collected from ASHA COAT- silica sand dealers in Tumkur. In this sand silica content is more, this are mainly used in molding and casting purposes. The test for foundry sand is done as per IS: 383-1970, the properties are listed in the table 4.3

Table 4.3: properties of waste foundry sand

SL NO	Properties	Values
1	Specific gravity	2.6
2	Sieve analysis	Zone IV
3	Water absorption	1.42%

d) **Coarse Aggregate**: For this project Coarse aggregate is collected from stone quarry near Bidadi which is 34km far away from Bengaluru. The maximum size of aggregate taken is 20mm, test is conducted according to IS: 2386-1963 to determine their physical properties. The properties are listed in the table 4.4.

Table 4.4 Properties of Coarse Aggregate

SL.NO	Characteristics	Values
1	Specific gravity	2.71
2	Water absorption	0.80 %
3	Combined Index	19.52 %
4	Sieve Analysis	Confirming Table 10 of IS 383-2016
5	Loss angles value	17.6 %

e) **Water:** For this project portable water (tap water) is obtained from college campus. The water was free from visible impurities and was clean. For mixing of the concrete and for curing of the concrete the water which is used should be free from harmful substance as per IS:456:2000.

f) **Super plasticizer:** Admixture is added to improve property of the concrete. Chemical admixture is taken in small quantity based on required amount, this are added to the dry mix of the concrete. As super plasticizer, chemical admixtures know as KALMATROA-A is used. It's represented as KF-A. It has a feature of water reducing in it.

V. RESULTS AND DISCUSSION

5.1 Workability of fresh concrete: workability of concrete is very important for the concrete. Admixtures are used to improve the workability, the results of workability is shown in the blow table 5.1

Table 5.1 Workability of Fresh Concrete

SL.NO	% of Waste Foundry Sand	SLUMP (mm)	VEE-BEE (sec)	COMPACTION FACTOR
1	0%	23	7	0.84
2	10%	22	8	0.83
3	20%	21	9	0.82
4	30%	21	9	0.81
5	40%	19	10	0.79
6	50%	17	11	0.77

5.2 Compressive strength Test: Cube moulds were casted and the hard mould is kept for curing period of 7days and 28days. The cubes were tested and the ultimate compressive strength is recorded and tabulated in the table 5.2 and graphically represented in figure 5.1

Table 5.2 compressive strength for 7days and 28 days

Sl.No	Percentage of waste foundry sand	Percentage of M-Sand	Compressive strength (N/mm^2)	
			7 days	28days
1	0%	100%	32.53	47.15
2	10%	90%	35.66	49.24
3	20%	80%	37.27	51.77
4	30%	70%	37.62	52.26
5	40%	60%	36.35	50.9
6	50%	50%	34.68	49.55

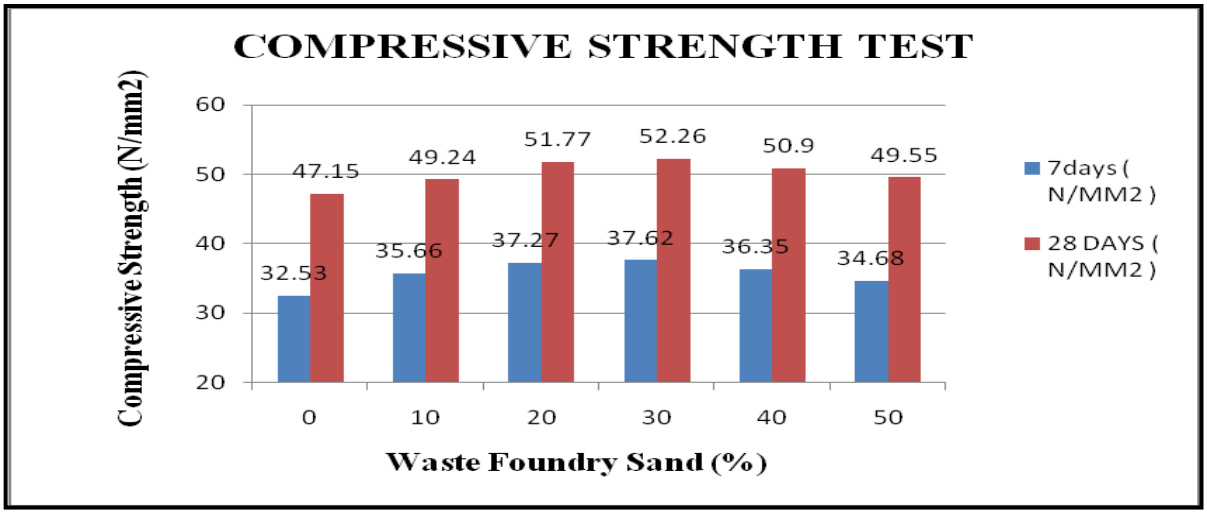

Figure 5.1 Compressive strength results for M40 concrete

5.3 Split Tensile Strength Test: The hardened cylindrical specimens were tested for 7days strength and 28days strength in CTM and the maximum strength value is recorded and tabulated in the table 5.3 and graphically represented in the figure 5.2

Table 5.3: Split Tensile Strength for 7days and 28 days

Sl.No	Percentage of Waste foundry sand	Percentage of M-Sand	Tensile strength (N/mm^2)	
			7days	28days
1	0%	100%	3.47	4.89
2	10%	90%	3.96	5.51
3	20%	80%	4.11	5.72
4	30%	70%	4.30	5.90
5	40%	60%	3.99	5.47
6	50%	50%	3.82	5.31

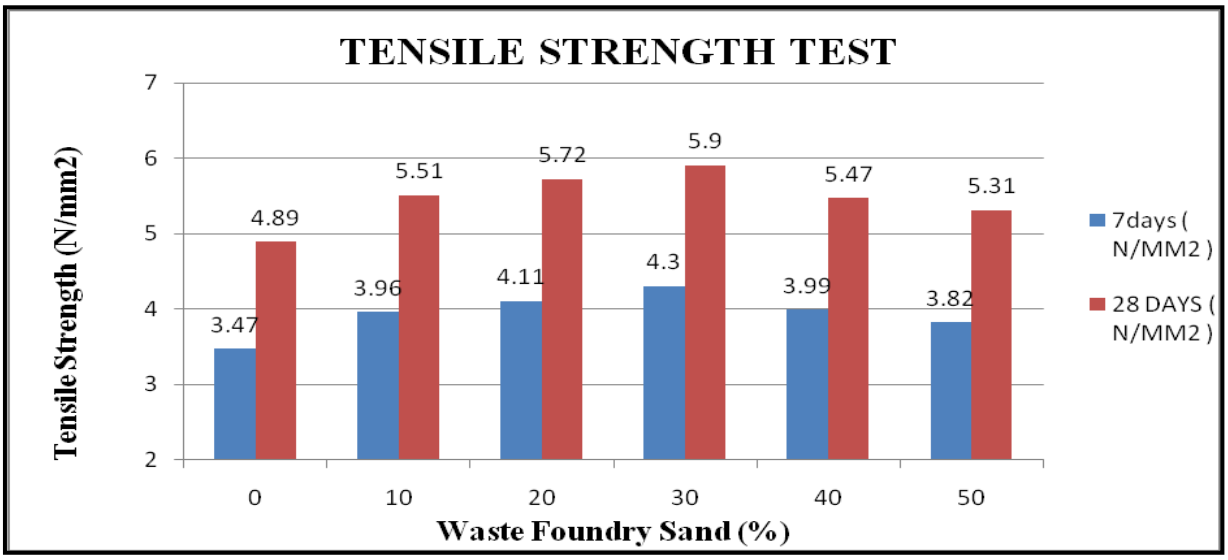

Figure 5.2 Tensile strength results for M 40 concrete

5.4 Flexural strength test: Beam specimens were tested in UTM for their 28 days strength test, the results were recorded and tabulated in the table 5.4 and graphically represented in figure 5.3

Table 5.4 flexural strength test results for 28days

Sl.No	Percentage of Waste foundry sand	Percentage of M-Sand	Flexural strength (N/mm^2)
			28 days
1	0%	100%	7.08
2	10%	90%	7.29
3	20%	80%	7.54
4	30%	70%	8.43
5	40%	60%	7.49
6	50%	50%	6.28

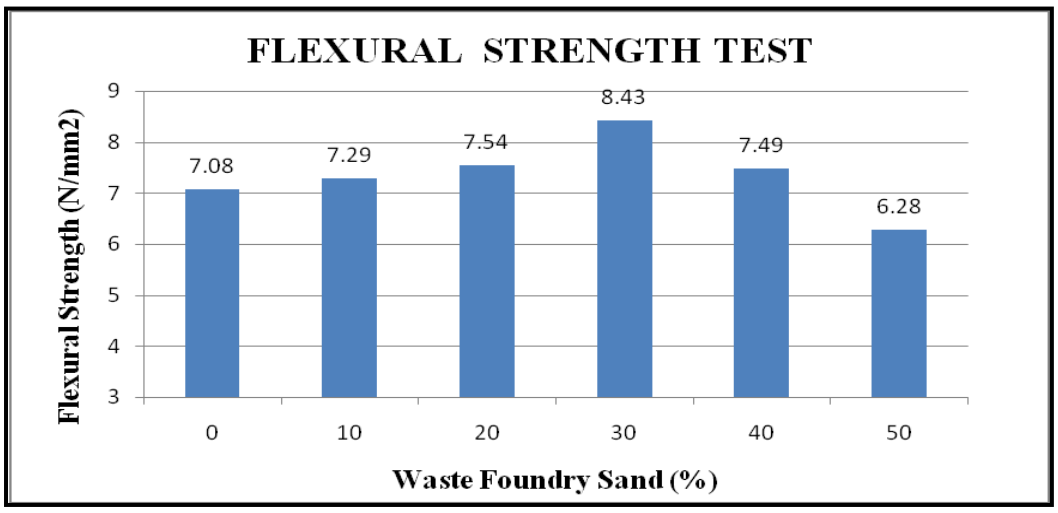

Figure 5.3 flexural results for M40 concrete

5.5 Cost Feasibility

Table 5.5 Cost Analysis for 70% of M- SAND — 30% of Waste foundry sand

SL.NO	Materials	Quantity	Rate/ Qty	Total Cost (Rs)	Cost/m^3 (Rs)		% Saving
					70%MS + 30%wfs	100%MS + 0%wfs	
1	Cement	7.74 bags	320 Rs	2477	4665	4784	2.55
2	M-Sand	0.191 m^3	1450 Rs	277			
3	Foundry sand	0.082m^3	-	-			
4	Coarse aggregate	0.453 m^3	1000 Rs	453			
4	Super Plasticizer	11.22 kg	130 Rs	1458			

VI. CONCLUSION

1. The basic test conducted on materials used in concrete satisfies all the standard conditions
2. The obtained mix proportion for M40 grade concrete is 387 kg/m^3 of cement, 724 kg/m^3 of fine aggregate, 1229 kg/m^3. The mix ratio is 1:1.87:3.17 with w\c of 0.38.
3. M-sand can be effectively replaced by 30% of Waste Foundry sand in the concrete.
4. (a) The workability by Slump and compaction factor decreases with the increase of waste foundry sand along with this workability by Vee-Bee consistometer increases.

   (b) The maximum Compressive strength in the concrete obtained for 7days is increased by 37.62 N/mm^2 i.e. 15.64% and for 28days the strength increased by 52.26 N/mm^2 i.e. 10.83 % when compared to conventional concrete.

   (c)The Tensile Strength for 7 days is 4.30 N/mm^2 i.e. 3.91% more strength gained and for 28 days the strength gained is 5.90 N/mm^2 i.e. 20.61% when compared to conventional concrete.

   (d)The maximum flexural strength in the concrete for 28days when compared to conventional mix the strength is increased by 8.43 N/mm^2 i.e. 19.06%.
5. Cost analysis for 70% of M-Sand – 30% of waste foundry is 2.55% less when compared to conventional concrete. The concrete is Eco-Friendly and also disposal problem is also reduced

VII. SCOPE OF FUTURE WORK

- Strength test was conducted for 7 days and 28 days, it can also be further study to 60 days and 90 days.
- As fine aggregate Red mud can be used along with M-Sand.
- Waste foundry sand concrete can be developed by adding fibres like steel fibres, Recon fibres, Synthetic fibres, natural fibres extra.
- Further research can be done by partial replacement of cement by different mineral admixtures for waste foundry sand concrete.
- Durability studies like Sulphate attack and Acid resistance can be carried out on waste foundry sand concrete.

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