Effect Of Foundry Sand On Strength Characteristics Of Concrete

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Abstract **- Concrete is the most extensively used construction material in the world, second to water. The use of concrete in the development of architecture and constructions is an integral part of modern human civilization. The key constituents of modern concrete are cement, river sand and coarse aggregates which play significant roles in mix design. Since the consumption of river sand is high in the rapid infrastructure growth, the demand for the same is also very high in developing countries like INDIA and thus there is need to tackle this problem. One such promising material which can be used as an alternative to natural sand in concrete is Waste foundry sand which is major by-product of casting industry and creates land pollution. Hence the reuse of this waste foundry sand is very vital and should be emphasised. Foundry sand is high quality silica sand. From centuries foundry sand has been used as a moulding casting material because it's high thermal conductivity.**

keywords **- Concrete,waste Foundry Sand,m30,strength**

I.INTRODUCTION

Used-foundry sand is a by-product of ferrous and nonferrous metal casting industries. Foundries successfully recycle and reuse the sand many times in a foundry. When the sand can no longer be reused in the foundry, it is removed from the foundry and is termed used/spent foundry sand. Foundry sand is high quality silica sand. From centuries foundry sand has been used as a moulding casting material because it's high thermal conductivity. About 15% of sand used by foundries is ultimately disposed of, amounting to millions of tons. In India, many foundries dump this waste in nearby vacant areas, which creates an environmental problem. So this waste foundry sand is being used by us as a replacement of river sand on concrete. Being rich in Silica content it results in denser concrete matrix and gives increased strength of concrete.

II. OBJECTIVES

Experimental work was conducted on cubes, cylinders and beams so that it leads to evaluate compression strengths, split tensile strengths and flexural strengths. The main objectives of this research is as follows :-

- Testing of constituent materials of concrete for their physical properties as per relevant codes of practice.
- Design of mixes and casting of cubes, cylindrical and rectangular beam specimens for M30 grade of concrete.
- Detailed laboratory investigation for the determination of mechanical properties of Foundry sand concrete like
  - ✓ Compressive strength,
  - ✓ Split tensile strength
  - ✓ Flexural strength

  to be performed with 0%, 10%, 20%,30 % replacement of fine aggregates with foundry sand at 3,7,28 days.
- To analyze the laboratory results of mechanical properties obtained at 3, 7, 28 days.

This study aims to demonstrate the feasibility of using waste foundry sand in concrete as a substitute for fine aggregate by evaluating the strength and durability properties of concrete.

III. MATERIALS

A. Foundry Sand

In the present study waste foundry sand was obtained from mini steel plant in Ludhiana. Some of the physical properties of waste foundry sand are as shown in Table 1.1.

Table 1 Physical properties of waste foundry sand.

Property	Value
Specific gravity	2.66
Water absorption	1.81%
Bulk density	1440 kg/m^3
Voids ratio	0.60
Porosity	36.20%
Fineness modulus	0.866

B. Cement

Ordinary Portland (43 grade) cement was used. It was tested as per the Indian Standard Specifications IS: 8112-2013.

Table 2 Properties of OPC 43 Grade Concrete

Sr.No.	Characteristics	Values Obtained Experimentally	Values Specified By IS 8112:2013
1.	Specific Gravity	3.10	-
2.	Standard Consistency	27%	-
3.	Initial Setting Time, minutes	149	30 minutes (minimum)
4.	Final Setting Time, minutes	257	600 minutes (maximum)
5.	Compressive Strength 3 days 7 days 28 days	27.8 N/mm^2 36.5 N/mm^2 \48.6 N/mm^2	23 N/mm^2 33 N/mm^2 43 N/mm^2

C. Coarse Aggregates

The coarse aggregate used were a mixture of two locally available crushed stone of 20 mm and 10 mm size in 70:30 proportion. The aggregates were washed to remove dirt, dust and then dried to surface dry condition.

Table 3 Physical properties of Coarse Aggregates (20mm and 10mm).

Characteristics	Value
Colour	Grey
Shape	Angular
Maximum Size	20 mm/10mm
Specific Gravity	2.73/2.72
Water Absorption	0.20%/0.35%

D. Fine Aggregates

In this experimental program, fine aggregates (stone dust) were collected from Jhelum Stone Crusher, Mirthal, Pathankot and conforming to grading zone II. It was coarse sand light grey in colour.

Table 4 Physical Properties of fine aggregates

Characteristics	Value
Specific gravity	2.49
Bulk density,	1.3
Fineness modulus	2.52
Water absorption, %	0.89
Zone	II

IV. MIX DESIGN

In the present study of Mix Design for M30 design value at the age of 28 days grade concrete is done according to BIS: 10262-2009.

M30 design mix Data:

1. Characteristic strength at 28 days = 30 N/mm^2
2. Maximum size of aggregate = 12.5mm
3. Degree of workability desired (C.F.) = 0.9 (Medium)
4. Type of exposure = Mild, No sulphate attack
5. Concrete use = Concrete structure
6. Target mean strength = 40 N/mm^2
7. Slump = 90 mm

Table 5 Mix Proportion M30.

Unit of Batch	Water (Litres)	Cement (Kg)	F.A (Kg)	C.A. (Kg)
Cubic meter content	189	450	55 4	1139
Ratio of ingredients	0.42	1	1.23	2.53

V. RESULTS & DISCUSSION

Waste foundry sand was used as a partial replacement of fine aggregate at the percentage of 0%, 10%, 20% and 30%. The specimens were tested for compressive strength, tensile strength and flexural strength was determined from failure load measured using compression testing machine, tensile testing machine and flexural testing machine respectively.

A. Compressive Strength

Effect of WFS on concrete mixes M-0 (0% WFS), M-1 (10% WFS), M-2 (20% WFS), M-3 (30% WFS) is shown in Table 6. Compressive strength of control concrete mix M-0, without waste foundry sand, was 28.41 MPa at the age of 28 days. It was observed that concrete mixes made with WFS exhibited higher compressive strength than control concrete. Compressive strengths of control mixture M-1 (0% WFS) were 12.09 MPa at 3 days and 19.56 MPa at 7 days.

Table 6 Compressive strength of concrete mixes with replacement of fine aggregate with waste foundry sand.

Mix	% of Fine Aggregate	%Replacement of Waste foundry Sand	Comp. Strength			Increase in Compressive Strength (%)		
			3 Days	7 Days	28 Days	3 Days	7 Days	28 Days
M0	100	0	12.09	19.56	28.41			
M1	90	10	13.84	20.63	29.09	14.5	5.47	2.4
M2	80	20	14.19	21.31	29.67	17.4	8.94	4.43
M3	70	30	14.9	21.87	30.84	23.2	11.8	8.55

From these results, it was found that for 3 days curing compressive strength increased by 14.5%, 17.4%, and 23.2% for mixtures M-1 (10% WFS), M-2 (20% WFS) and M-3 (30% WFS) respectively than control mix M-0 (0% WFS). Similarly for 7 days compressive strength increased by 5.47%, 8.94%, and 11.8% for mixtures M-1 (10% WFS), M-2 (20% WFS) and M-3 (30% WFS) respectively than control mix M-0 (0% WFS). At 28 days, increase in strength was 2.4%, 4.43% and 8.55% for M-1, M-2, and M-3 mixes, when compared with M-0 (28.41 MPa) respectively.

B. Split Tensile Strength

The tests were carried out on cylinder specimens for splitting tensile strength according to IS: 5816-1999(17). In this test compressive line loads were applied along a vertical symmetrical plane, which causes splitting of specimen. The average values of 3 specimens for each category at the ages of 3,7 & 28 days are tabulated in the Table 7. The increase in the splitting tensile strength of various concrete mixtures over plain concrete is also tabulated in Table 4.2. There is a considerable improvement in the split tensile strength of concrete with inclusion and increase in the percentage of waste foundry sand up to 30%.

Table 7 Tensile strength of concrete mixes with replacement of fine aggregate with waste foundry sand.

Mix	% of Fine Aggregate	%Replacement of Waste foundry Sand	Tensile Strength			Increase in Tensile Strength (%)		
			3 Days	*7 Days*	*28 Days*	*3 Days*	*7 Days*	*28 Days*
M0	100	0	1.01	1.83	2.76			
M1	90	10	1.14	1.94	2.81	12.8	6.01	5.8
M2	80	20	1.34	2.06	2.97	32.7	12.6	7.6
M3	70	30	1.56	2.47	3.48	54.4	34.9	26.1

From these results, it was found that for 3 days curing tensile strength increased by 12.8%, 32.7%, and 54.4% for mixtures M-1 (10% WFS), M-2 (20% WFS) and M-3 (30% WFS) respectively than control mix M-0 (0% WFS). Similarly for 7 days compressive strength increased by 6.01%, 12.6%, and 34.9% for mixtures M-1 (10% WFS), M-2 (20% WFS) and M-3 (30% WFS) respectively than control mix M-0 (0% WFS). At 28 days, increase in strength was 5.8%, 7.6% and 26.1% for M-1, M-2, and M-3 mixes, when compared with M-0 (2.76 MPa) respectively. As we increase the foundry sand we observe that the tensile strength consequently increases.

C. Flexural strength

Flexural strength tests were performed about flexural testing machine. The comparative research was produced on flexural strength properties of concrete after replacing of natural fine sand by waste material foundry sand in the number of 0%, 10%, 20%, and 30%. The tests were completed confirming to IS usually: 516-1959(8). The Table 8 shows the results of flexural strength at different percentage replacements. Test outcomes shows that there is significant rise in the flexural strength of concrete when we increases the percentage of WFS up to 30%. In nutshell it can be said that 30% is the best replacement percentage level for cement concrete production.

Table 8 Flexural strength of concrete mixes with replacement of fine aggregate with waste foundry sand.

Mix	% of Fine Aggregate	%Replacement of Waste foundry Sand	Flexural Strength	Increase in Flexural Strength (%)

			3 Days	*7 Days*	*28 Days*	*3 Days*	*7 Days*	*28 Days*
M0	100	0	1.31	2.23	3.35			
M1	90	10	1.62	2.32	3.46	23.66	4.03	3.28
M2	80	20	1.93	2.41	3.57	47.32	8.07	6.57
M3	70	30	2.13	2.54	3.62	62.6	13.9	8.06

As we increase the foundry sand we observe that the tensile strength consequently increases. From these results, it was found that for 28 days curing flexural strength increased by 3.28%, 6.57 %, and 8.06 % for mixtures M-1 (10% WFS), M-2 (20% WFS) and M-3 (30% WFS) respectively than control mix M-0 (0% WFS).

Table 9 Summary of strengths obtained at 3, 7 and 28 days.

3 Days Curing					
Mix	**% of Fine Aggregate**	**%Replacement of Waste foundry Sand**	**Comp. Strength**	**Split tensile strength**	**Flexural Strength**
M0	100	0	12.09	1.01	1.31
M1	90	10	13.84	1.14	1.62
M2	80	20	14.19	1.34	1.93
M3	70	30	14.9	1.56	2.13
7 Days Curing					
Mix	**% of Fine Aggregate**	**%Replacement of Waste foundry Sand**	**Comp. Strength**	**Split tensile strength**	**Flexural Strength**
M0	100	0	19.56	1.83	2.23
M1	90	10	20.63	1.94	2.32
M2	80	20	21.31	2.06	2.41
M3	70	30	21.87	2.47	2.54
28Days Curing					
Mix	**% of Fine Aggregate**	**%Replacement of Waste foundry Sand**	**Comp. Strength**	**Split tensile strength**	**Flexural Strength**
M0	100	0	28.41	2.76	3.35
M1	90	10	29.09	2.81	3.46
M2	80	20	29.67	2.97	3.57
M3	70	30	30.84	3.48	3.62

VI. CONCLUSIONS

The study was conducted to find out the influence of waste foundry sand on strength properties of concrete. The effects of following parameters were studied - Compressive strength, Split tensile strength and flexural strength at various percentage replacement of fine aggregate with waste foundry sand on concrete. Waste foundry sand can be effectively used as fine aggregate in place of conventional river sand, in concrete. Replacement of fine aggregate with waste foundry sand showed increase in the compressive strength of concrete up to 30%. The maximum compressive strength was achieved with 30% replacement of fine aggregate with waste foundry sand at 28 days. 8.55% increment in the compressive strength was found at 30% replacement of fine aggregate with waste foundry sand at 28 days compared to normal concrete. Replacement of fine aggregate with waste foundry sand showed increase in the split tensile strength of concrete up to 30%.Compressive strength, splitting-tensile strength and flexural strength of concrete mixtures increased with age for all the foundry sand contents. Results of this investigation suggest that used-foundry sand could be very conveniently used in making good quality concrete and construction materials.

VII. SCOPE FOR FUTURE WORK

1. In the present study upto 30 percent replacement of foundry sand by fine aggregate in M30 concrete has been considered. The other percentages i.e. 40 and 50 percent can be explored for further investigations.
2. Other waste material like stone quarry, Plastics and steel fibres etc. can also be tried to know the effect of various type of reinforcement in concrete.
3. The similar studies can be performed on other cement grades as well which are in wide use in civil engineering applications.
4. The studies can be conducted to know the performance under impact and torsion loadings as well.
5. Studies can also be conducted by incorporation of platicizers, admixture, accelerators.
6. Mathematical / Emperical models can be developed for the foundry sand concrete
7. Durability studies such as resistance to sulphate attack, acid resistance etc., can also be carried out on foundry sand concrete.
8. Durability of foundry sand needs to be checked, by conducting the tests for different curing period.

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