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Effect of Waste Foundry Sand on the Different Properties of Concrete

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Abstract - Used-foundry sand is a by-product of ferrous and nonferrous metal casting industries. Foundries successfully recycle and reusable 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 waste foundry sand. In an effort to utilization waste foundry sand in large volume, research is being carried out for its possible large-scale utilization in making concrete as partially replacement of fine aggregate. This paper presents the results of an experimental investigation carried out to evaluate the different properties of concrete mixtures in which fine aggregate (regular sand) was partially replaced with waste-foundry sand (WFS). Fine aggregate was replaced with five percentages (5%, 10%, 15%, 20%, and 25%) of WFS by weight. Tests were performed for the properties of fresh concrete. Compressive strength, splitting- tensile strength, flexural strength and on-destructive test were determined at3, 7and 28 days. Test results indicated a marginal increase in the strength properties of plain concrete by the inclusion of WFS as partial replacement of fine aggregate (natural sand) and that can be effectively used in creating good quality concrete and construction materials.

Key Words: Industrial waste, waste-foundry sand, Compressive strength

1.INTRODUCTION

Over the past several decades an enormous amount of research has been carried on the use of industrial waste as a substitute/replacement material for fine aggregate. Their search findings revealed that the substitution of an alternative material in concrete could improve both the mechanical and durability properties and the practice led to the sustainable concrete development. Foundry Sand (FS) is a by-product from the metal alloys casting industry with high silica content. Silica sand is bonded with clay or chemicals, and is used for the material casting process. Foundries recycle the sand many times and when the sand is no longer recyclable, it is disposed of this is called foundry sand. 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? With increased restrictions on disposal in nearby areas industries are constrained to find alternative ways to reuse waste. Past few decades FS have been utilized in highway applications but the amount of waste re-utilized in this way is still negligible. For this reason there is a need to utilize FS in other ways become very imperative. Recently research has been carried out on the utilization of FS in concrete and concrete related products

2. MATERIALS AND METHODOLOGY

The materials used in this present work are foundry sand, Ordinary Portland cement.

Table No. 2.1 Observation table for fineness modulus of waste foundry sand

Sieve Size	Mass Retained (gms	Cumulative Mass Retained (gms)	Cumulative Percentage Retained (%)	Cumulative Percentage Passing (%
4.75 mm	7 7	1.5	1.5	98.5
2.36 mm	4	11	2.3	97.7
1.18 mm	6	17	3.6	96.4
600 µ	15	32	6.4	93.6
300 µ	235	267	51.8	48.2
150 µ	201	468	92.8	7.2

Fineness modulus = sum of cumulative % of mass retained on the sieve/100

=158. /100

=1.58

Table 2.2 - Physical properties of Waste Foundry Sand

Characteristics	value
Colour	Grey (Blackish)
Specific Gravity	2.51
Water Absorption	1.17%
Fineness Modulus	1.58%

Table 2.3 Chemical properties of Waste Foundry Sand and fine Aggregate

Constituents WFS	WFS % by Weigh	Fine Aggregate
Silica (SiO_2)	78.81-95.10	80.78
Iron Oxide	0.94-5.39	1.75
Alumina (AL2O3)	0.81-10.41	10.52
Calcium Oxide (CaO)	3.21	3.21
Magnesium oxide (MgO)	0.30-1.97	0.77
Titanium Dioxide	0.04-0.22	Nil
Sodium Oxide (Na2O)	0.19-0.87	1.37
Potassium Oxide (K2O)	0.25-1.14	1.23

Table No 2.4 Observation for fineness of the cement

Sr.No	Mass of cement (gms)	Mass of residue (gms)	Residue (%)
1	100	2	2
2	100	3	3
3	10	2	2

Table No 2.5 Observation for standard consistency of the cement paste

So.No	Mass of cement (gms)	Mass of water added in (ml)	Percentage measure From the bottom (mm)
1	400	25 x 4 = 100	29
2	400	30 x 4 = 120	15
3	400	35 x 4 = 140	2
4	400	31 x 4 = 124	9
5	400	32 x 4 = 128	7

Percentage of water required to produce a paste of standard consistency = 128 ml
Standard consistency of cement paste= (Qty. of water / wt. of cement) x 100
Standard consistency of cement paste =(128/400) x 100=32%

Table No.2.6 Initial and final setting time of the cement

Sr.No	Description	Value
1	Quantity of the cement	300 gms
2	Standard consistency of cement paste	32%
3	Qty of the water	0.85 x 128 = 108.8 ml
4	Initial setting time	92 min
5	Final setting time	376 min

Table No. 2.7 Observation table for fineness modulus of fine aggregate

Sieve size	Mass retained (gms)	Cumulative mass Retained (gms)	Cumulative mass Retained (%)	Mass passing (%
4.75 mm	0	0	0	100
2.36 mm	74	74	7.4	92.2
1.18 mm	268	342	34.2	65.8
600 µ	194	536	53.6	46.4
300 µ	266	802	80.2	19.8
150 µ	140	942	94.2	5.8

Table No. 2.8 Observation table for fineness modulus of fine aggregate

IS sieve	Mass retained	Cumulative mass retained	Cumulative mass retained %	Cumulative mass passing (%)
25	00	00	00	100
20	2064	2064	41.28	58.72
12.5	1175	3239	64.78	35.22
10	1289	4528	90.56	9.44
4.75	389	4917	98.34	1.66
2.36	83	5000	100.00	00
1.18		5000	100.00	00

Table2.9 Allowable limits of Aggregates as per I.R.C

Sr.No	Aggregate Impact value	Comment
1	<10	Exceptionally strong
2	10-20	Strong
3	20-30	Satisfactory
4	>35	Weak

Table No.2.10 Observation table for the aggregate impact value

Sr.No	Sample 1	Sample 2	Sample 3
1	400 gms	400 gms	400 gms
2	37 gms	38 gms	39.5 gms

Impact value of aggregate for sample 1 = 37/400 x100 = 9.25%
Impact value of aggregate for sample 1 = 38/400 x 100 = 9.5%
Impact value of aggregate for sample 1 = 39.5/400 x 100 = 9.87%
Average aggregate impact value=9.54%
As Average aggregate Impact value less than 10% the sample exceptionally strong

Table No.2.11 Observation table for aggregate crushing

Sr.No	observations	Sample 1	Sample 2	Sample 3
1	Wt. of sample	3000 gms	3000 gms	3000 gms
2	Wt. of sample passing through 2.36 mm in sieve after impact	605 gms	608 gms	606 gms

aggregate crushing value for the sample 1 = 605/3000 x 100 = 20.16
Aggregate crushing value for the sample 1 = 608/3000 x 100 = 20.26
Aggregate crushing value for the sample 1 = 606/3000 x 100 = 20.20
Average aggregate crushing value = 20.21%
Crushing value is less than 30% value used for the wearing and non-wearing surfaces

Table No2.12 Properties of the coarse and fine aggregate

Sr.No	Test	Result
1	Specific gravity for coarse agg	2.75
2	Specific gravity for Fine agg	2.60
3	Water absorption for coarse agg	1.35%
4	Water absorption for fine agg	0.7%
5	Crushing value	20.21%

6	Impact value	9.54%
7	Fineness modulus for coarse agg	4.92%
8	Fineness modulus for fine agg	2.9%
9	Elongation Index	9.45%
10	Flakiness Index	9.60%

Table No.2.13 Summary of Concrete Mix Design Observation and Calculation

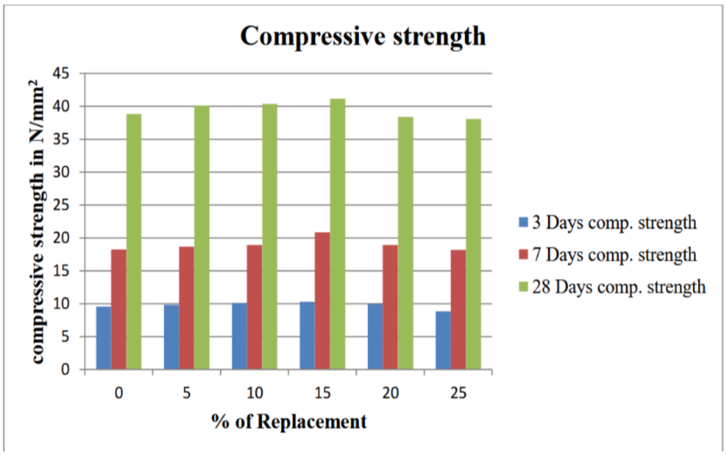
Design proportion for M25 grade of concrete = 1 : 1 .52 : 2.64 (W / C = 0.45)

1	Characteristic Compressive Strengt	25N/mm2
2	Degree of quality control	Good
3	Standard deviation(S)	5
4	Target mean compressive strength, Ft = Fck+ 1.65×S	31.60 N/mm
5	W/C ratio	0.45
6	Type of cement	OPC
7	Nominal size of coarse aggregate	20mm
8	Specific gravity of cement, Sc	3.15
9	Specific gravity of fine aggregate. Sfa	2.60
10	Specific gravity of coarse aggregate, Sca	2.75
11	Water content per m3 of concrete	192 kg/m3
12	Cement content for W/C=0.45	426 kg/m3
13	Total fine aggregate per m3 of concrete, Fa	648 kg/m3
14	Total coarse aggregate per m3 of concrete, Ca	1124 kg/m3

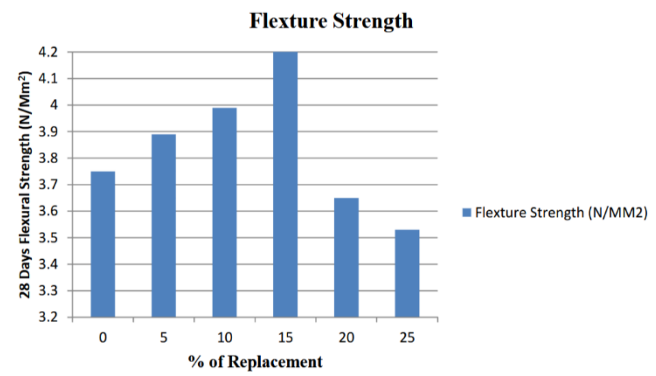
Table No. 2.14 Concrete Mix Proportions With and Without Waste Foundry Sand

Mixture no.	P1	P2	P3	P4	P5	P6
Cement (kg/m3)	426	426	426	426	426	426
Natural sand (kg/m3)	648	616	583	551	518	586
WFS (%)	0	5	10	15	20	25
WFS (kg/m3)	0	32	62	97	130	162
Coarse aggregate (kg/m3)	1124	1124	1124	1124	1124	1124
W/C ratio	0.45	0.45	0.45	0.45	0.45	0.45
Water (kg/m3)	192	192	192	192	192	192

Graph No 2.1 Conventional concrete using waste foundry sand compressive strength after 3, 7 & 28 Days of Curing



Graph no.2.2 Conventional concrete using waste foundry sand Flexural Strength after 28 Day



3.CONCLUSION:

1) Natural sand can be possibly replaced partially waste foundry sand in concrete.

2) It has been observed that the workability of slump value of concrete decreases with the addition of waste foundry sand.

3) In workability of compaction factor test. compaction factor increases with the addition of WES

4) In workability of vee bee consistency time required for conical shape are increases with addition of WFS.

5) The compressive strength of concrete from 0% to 15% replacement of sand by waste foundry sand is satisfactory.

6) The maximum compressive strength of concrete is observed at natural sand replacement by 15% of waste foundry sand at 28 days.

7) Replacement of natural sand with waste foundry sand showed increases in the split tensile strength and flexural strength up to the 15% replacement then after split tensile strength reduced.

8) Water absorption of concrete reduces as the percentage of waste foundry sand in concrete increases. As voids in the concrete reduce water absorption goes on reducing Also unit

weight of concrete goes on reducing with the replacement of cement due to lower specific gravity of WFS,

9) Use of Phenolphthalein indicator changed the colour of hardened concrete to pink which indicates that concrete was not affected by the atmospheric carbon dioxide.

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