International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 11 | Nov -2016 www.irjet.net p-ISSN: 2395-0072

"Beneficial Reuse of Waste Foundry Sand in Concrete & Mortar"

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ABSTRACT: Utilization of waste materials and solid waste management is important in the all world. Generally main application of industrial waste is Scarcity of land-filling space by recycling and utilization of industrial waste and one such industrial by-product is Waste Foundry Sand. In construction we can use the WFS as construction materials in concrete and mortar by replacement of fine aggregate. There is 1.71 million tons of industrial waste in India out of them 0.18 million tons of waste foundries is produced per year from industries. This experimental investigation is performed for comparative study of strength properties of normal concrete (M20) grades with high strength concrete (M-60) of concrete in which natural sand is replaced by waste foundry sand. Natural sand can be replaced with (0%, 5%, 10%, 15%, 20%, 25%, and 30%) of WFS by weight. Compressive strength test and flexural strength is carried out to evaluate the strength properties of concrete at the age of 7, 28 days.

In this investigation we can increase compressive strength, flexural strength and density for M20 & M-60 grades of concrete mixes with replacement of waste foundry sand (WFS) in range of (0%, 5%, 10%, 15%, 20%,25%, 30%) replacement by weight for concrete. We can achieve better strength of concrete and mortar. This research is conducted to investigate the performance of plastering by using foundry sands as a replacement of fine aggregate. As per IS 2250:1981 plastering mix design is proportioned to achieve compressive strength of 7.5MPa at 28 days.mix design of mortar is proportioned to replace 0-70% of natural/river sand by waste foundry sand of % by weight. Strength qualities of Mortar are evaluated by performing this experiment.

Keyword:- Compressive Strength, Flexure Strength, density.

I. INTRODUCTION

Metal foundries use large amounts of the metal casting process. Foundries successfully recycle and reuse the sand many times in a foundry and the remaining sand that is termed as foundry sand is removed from foundry. Use of foundry sand in various engineering Applications can solve the Problem of disposal of foundry sand and other purposes. Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder and dust. Foundry sand cans be used in concrete to improve its strength and other durability factors. Foundry Sand can be used as a partial replacement of cement or as a partial replacement of fine aggregates or total replacement of fine aggregate and as supplementary addition to achieve different properties of concrete. Test results showed that there is some increase in compressive strength after replacing the fine aggregates with certain percentage of foundry sand so foundry sand can be safely used in concrete for durability and strength purposes. This experimental investigation is performed for normal concrete (M20) grades in which natural sand is replaced by waste foundry sand. Natural sand can be replaced with (0%, 5%, 10%, 15%, 20%, 25%, and 30%) of WFS by weight. Compressive strength test and flexural strength is carried out to evaluate the strength properties of concrete at the age of 7, 28 days. This research is conducted to investigate the performance of fresh and hardened plastering containing discarded foundry sands as a replacement of fine aggregate. A control plastering mix was proportioned to achieve a 28-day compressive strength of 7.5MPa. Other mortar mixes were proportioned to replace 0-70% of regular plastering sand with clean/new foundry sand and used foundry sand by weight. Mortar performance was evaluated with respect to compressive strength.

II.METHODOLOGY

According to the objective of the project the minimum requirement of the strength of the structure is decided i.e. M20& M60 and from that mix design for concrete is carried out and sampling is to be decided and from that the overall quantity of the material has been calculated and material is purchased. Before casting to find out the property of materials different

tests on cement has been done such as normal consistency, initial & final setting time, soundness & fineness tests, etc. The sieving of CA through 20 mm sieve and the fine aggregate through 4.75 mm sieve is done and the sieving of Used Foundry Sand before grinding & after grinding is done for getting appropriate results. The concrete blocks are casted with UFS as a Fine Aggregate in Concrete. There are six blocks for each trial mix in which 3 blocks for 7 days testing & 3 blocks for 28 days testing. According to graphs two more trails are taken for required slump, water content and 7 days compressive strength. Then the final casting has been done as per the above mix design by using 0, 10, 15, 20, 25 & 30% Foundry Sand for 28 days testing and for each % there are four samples for each testing day and each sample there are three blocks.

According to the objective of the project the minimum requirement of the strength of the structure is decided i.e. 1:4 & 1:6and from that mix design for 1:4 & 1:6 mortar is carried out and sampling has been decided and from that the overall quantity of the material has been calculated and material is purchased. Before casting to find out the property of materials different tests on cement has been done such as normal consistency, initial & final setting time, soundness & fineness tests, etc. The sieving of cement through 20 mm sieve and the fine aggregate through 4.75 mm sieve is done and the sieving of used foundry sand before grinding & after grinding is done for getting appropriate results. The mortar blocks are casted with ufs as a fine aggregate in mortar. There are six blocks for each trial mix in which 3 blocks for 7 days testing & 3 blocks for 28 days testing. Then the two graphs are plotted, one is w/c ratio vs. 7 days compressive strength and second is slump vs water content.

III. MATERIAL PROPERTIES & BASIC PARAMETERS

3.1 Cement

Cement is a binder, a substance that sets and hardens independently, and can bind other materials together The chemical reaction that results when the anhydrous cement powder is mixed with water produces hydrates that are not water-soluble. Cement is fine grey powder. It is mixed water and material such as sand gravel, and crushed stone to make mortar. 53grade ordinary Portland cement (ultratech cement) was used for all casting. Testing of cement is done as per the IS: 8112-1989.

The results are given below.

Properties of cement

Sr. No.	Characteristics	Value obtained	Standard Value
1.	Normal consistency (%)	33%	26%-33%
2.	Initial setting time (min.)	65	Not less than 30
3.	Final setting time (min)	390	Not more than 600
4.	Fineness (%)	2.8 %	< 10
5.	Soundness (mm)	3	Less than 10mm

3.2 Fine Aggregate

Fine aggregate is defined as aggregate whose size is 4.75 mm and less. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent. Natural sand with 4.75mm maximum size is used as per IS: 383-1970. It satisfied all requirements. Results are given in table.

Properties of Fine Aggregate:-

Sr. No.	Characteristics	Value
1.	Type	(NATURAL)
2.	Specific gravity	2.886
3.	Total water absorption	3.45%
4.	Fineness modulus	3.79
5.	Grading zone	I

Sieve Analysis

Sr. No.	Sieve No.	Weight Retained (gms)	Cumulative Weight Retained (gms)	% Retained	% Passing
1.	4.75mm	35	35	3.5	96.5
2.	2.36mm	235	270	27	73
3.	1.18mm	320	590	59	41
4.	600µm	189	779	77.9	22.1
5.	300 µm	135	914	91.4	8.6
6.	150 µm	56	970	97	3
7.	75µm	17	987	98.7	1.3
8.	Pan	13	1000	100.0	0.00

Fineness Modulus=$Sum\ of\ Cumulative\ Weight\ Reatined \frac{gms}{100}$

= 379/100

= 3.79

Sieve analysis of Used Foundry Sand

The tests are conducted on UFS for its physical properties. Results are given in table.

Sr. No.	Sieve No.	Weight Retained (gms)	Cumulative Weight Retained (gms)	% Retained
1.	4.75mm	2.0	2.0	0.20
2.	2.36mm	9.2	11.2	1.12
3.	1.18mm	25.3	36.5	3.65
4.	600µm	30.0	66.5	6.65
5.	300 µm	432.3	498.8	49.88
6.	150 µm	456.2	955	95.5
7.	75 µm	45.0	1000	100.0
			Sum of Cumulative Weight Retained (gms)	257.0

FinenessModulus= $Sum\ of\ Cumulative\ Weight\ Reatined \frac{gms}{100}$
= 257.00/100

F.M.= **2.57**

Zone of Foundry Sand:-**Zone IV**

3.3 Coarse Aggregate

Coarse aggregate is defined as aggregate whose size is greater than 4.75 mm . It satisfied all requirements. Coarse aggregate passing through 12.5 mm sieve as given in IS 383 – 1970 was used for all the specimens. In addition to cement paste- aggregate ratio, aggregate type has a great influence on concrete dimensional stability Natural coarse aggregate is used size 20 mm and 10mm.

Shape: - Angular.

Results are given in table:-

Weight of the sample taken = 2.0 kg.

I.S. Sieve Size	Weight retained in grams	Percentage weight retained in grams	Cumulative percentage of weight retained	Percentage passing	BIS: 383-1970 Requirement
80mm	00	00	00	100	----
40mm	00	00	00	100	----
20mm	00	00	00	100	----
12.5mm	0.97	4.8	4.8	95.2	90-100
10mm	642	32.1	36.9	63.1	40-85
4.75mm	1184	59.2	96.1	3.9	0-10
pan	77	3.85	100	00	----

Physical properties of coarse aggragate:-

Sr. No.	Characteristics	Value obtained 20 mm	Value obtained 10mm	Standard Value
1.	Specific gravity	2.68	2.65	2.6-2.9
2.	Water Absorption (%)	0.7	0.9	Max.2.0%
3.	Elongation Index (%)	5.9	5.0	-
4.	Flakiness index (%)	6.9	9.3	-
5.	Aggregate Abrasion Value (%)	10.85	16.49	Max.45%
6	Aggregate Crushing Value(%)	29.84	21.77	Max.45%
7	Aggregate Impact value(%)	12.92	25.56	Max.45%

3.4 Water

The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to mortar or steel. Potable water is generally considered satisfactory for mixing. The pH value of water should be not less than 6. Generally, water that is suitable for drinking is satisfactory for use. Water from lakes and streams that contain marine life also usually is suitable. When water is obtained from sources mentioned above, no sampling is necessary. When it contains sewage, mine water, or wastes from industrial plants or canneries, it should not be used in the mix, unless tests indicate that it is satisfactory, Water from such sources should be avoided since the quality of the water could change due to low water or by intermittent discharge of harmful wastes into the stream. In the present experimental programmed potable tap water is used for casting.

IV.TEST ON HARDENED CONCRETE (FOR M20 & M60 CONCRETE)

4.1 Compressive Strength Test:

A cube compression test is performed on standard cubes of plain and Foundry sand Concrete of size 150 x 150 x 150 mm for concrete and 70.6x70.6x70.6mm for mortar after 7 and 28 days of immersion in water for curing. Arrange graphical presentation of compressive strength.

4.2 Flexural Test:

Standard beams of size 150 x 150 x 700mm are supported symmetrically over a span of 400mm and subjected two points loading till failure of the specimen. The deflection at the center of the beam is measured with sensitive dial gauge on UTM. The two broken pieces.

V.MIXING PROCESS ADOPTED:

(For mortar for FOR 1:4 & FOR1:6)

FOR 1:4

SR NO	Foundry Sand Replacement%	SAND	FOUNDRY
1	5	1.9	0.1
2	10	1.8	0.2
3	15	1.7	0.3
4	20	1.6	0.4
5	25	1.5	0.5
6	30	1.4	0.6
7	35	1.3	0.7
8	40	1.2	0.8
9	45	1.1	0.9
10	50	1	1
11	55	0.9	1.1
12	60	0.8	1.2
13	65	0.7	1.3
14	70	0.6	1.4
15	75	0.5	1.5
16	80	0.4	1.6
17	85	0.3	1.7
18	90	0.2	1.8
19	95	0.1	1.9
20	100	0	2

FOR1:6

SR NO	Foundry Sand Replacement%	SAND	FOUNDRY
1	5	2.035	0.107
2	10	1.927	0.214
3	15	1.82	0.321
4	20	1.713	0.428
5	25	1.606	0.535
6	30	1.499	0.642
7	35	1.392	0.749
8	40	1.285	0.856

9	45	1.178	0.963
10	50	1.071	1.071
11	55	963.9	1.178
12	60	0.856	1.285
13	65	0.749	1.392
14	70	0.642	1.499
15	75	0.535	1.606
16	80	0.428	1.713
17	85	0.321	1820
18	90	0.214	1.927
19	95	0.107	2.034
20	100	0	2.142

VI. RESULT AND DISCUSSION:

RESULTS :-

COMPRESSIVE STRENGTH FOR 1:6 MORTAR.

SR NO	Foundry Sand Replacement %	Compressive Strength of Mortar Blocks (MPa) 7 DAY	Compressive Strength of Mortar Blocks (MPa) 28 DAY
1	0	10.67	13.871
2	5	6.67	8.671
3	10	6.67	8.671
4	15	7.34	9.542
5	20	6	7.8
6	25	4.67	6.071
7	30	4.67	6.071
8	35	4	5.2
9	40	4	5.2
10	45	2.66	3.458
11	50	2	2.6
12	55	2	2.6
13	60	2	2.6

SR NO	Foundry Sand Replacement %	Compressive Strength of Mortar Blocks (MPa) 7 DAY	Compressive Strength of Mortar Blocks (MPa) 28 DAY
1	0	18.01	23.413
2	5	19.35	25.155
3	10	18.01	23.413
4	15	17.3	22.49
5	20	18.08	23.504

6	25	14.68	19.084
7	30	14.01	18.213
8	35	15.34	19.942
9	40	10.67	13.871
10	45	11.34	14.742
11	50	12.012	15.6156
12	55	8.67	11.271
13	60	6.67	8.671
14	65	6.67	8.671
15	70	6.67	8.671
16	75	5.338	6.9394
17	80	5.338	6.9394
18	85	5.38	6.994
19	90	5.38	6.994
20	95	4.67	6.071
21	100	3.33	4.329

STANDARD CRITERIA:-

FROM THE REFERENCE OF IS 2250:1981

Mix Design	**Standard Required Strength (Mpa)**		**Foundry sandreplacement (in%)**
	7 days	**28 days**	
1:4	5	7.5	0-70
1:6	3.5	5	0-40

RESULT DISCUSSION:-

1:4 70% of natural sand can be replaced by waste foundry sand to obtain the required strength for the mortar for 28 days.

1:6 40% of natural sand can be replaced by waste foundry sand to obtain the required strength for the mortar for 28 days.

VII. CONCLUSION

- According to literature we conclude that we can economize the cost of construction without compromising with quality and also investigate the utilization of Used Foundry Sand as Fine aggregate and influence of UFS on the Strength on concrete made with different replacement levels.
- We can also determinate & check the effect of Used Foundry Sand in concrete on properties of fresh concrete & compressive strength and suitability of Used Foundry Sand as an alternative construction material.
- We can also conclude that the Foundry waste from Foundries can be a replacement for fine aggregate and reduce the problem of disposal of Foundry Waste.

- Study the physical properties of Foundries waste and are the ingredients in plastering. Replace the fine aggregate by Foundry waste in different ratio such as 5%,upto 100% in 1:4 and 1:6 plastering also determine the compressive strength and compare it with the conventional plastering.

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