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Experimental Investigation on Compressive and Tensile Strength of Concrete with Partial Replacement of Natural Sand by Metal Foundry Waste Sand

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Abstract – Metal manufacturing plant ventures square measure utilizing large quantity of sand as a molding material within the casting procedure thanks to its heat conduction. Metal foundries unquestionably re-use the utilized sand for a few periods within the metal casting. At the purpose once the sand will nevermore be re-used within the metal foundry, it is expelled from the metal foundry and is known as metal foundry waste sand. High gauge of silicon dioxide is accessible within the metal Foundry waste sand and it is an identical physical and substance qualities within it. Metal Foundry waste sand is utilized as a halfway substitute of cement or a fine aggregate of concrete. Within the contemporary work, a check and close to investigation of the properties of fresh and hardened concrete The replacement were 0%(M1), 10%(M2), 20%(M3), 30%(M4) & 40%(M5) by the weight of fine aggregate & tests were done in all stages of sand substitutes for M25 grade concrete. The testes were done for the specimens by using different curing conditions (7, 14 & 28 days).

Index Terms – Metal foundry waste sand, Sand replacement, Compressive strength, Tensile strength.

1. INTRODUCTION

Metal Foundry waste sand is a surprising silica sand with uniform physical properties. It is a by-aftereffect of ferrous and non-ferrous metal casting production lines, where sand has been used for a significant long time as a moulding material in perspective of its warm conductivity. It is a by - thing from the era of both ferrous and non-ferrous metal castings. The physical and compound qualities of Foundry waste sand will depend in marvelous part on the kind of casting methodology and the processing plants region from which it starts. In present conditions foundry sharpen, sand is regularly reused and reused through various creation cycles. The Automobile organizations and its parts are the genuine generators of foundry sand. Foundries purchase magnificent size-specific silica sands for use in their embellishment and casting works. The crude sand is ordinarily of a higher quality than the ordinary bank run or common sands utilized as a part of fill development destinations. The sands frame the external state of the form pit. These sands ordinarily depend upon a little measure of betonies mud to go about as the binding material. chemical binders are likewise used to make sand "cores". Contingent on the geometry of the casting, sands centers are embedded into the shape hole to frame interior entries for the liquid metal. Once the metal has set, the casting is isolated from the embellishment and center sands in the shakeout procedure.

In the casting procedure, shaping sands are reused and recycled numerous circumstances. In the long run, in any case, the reused sand corrupts to the point that it can never again be reused in the molding procedure. By then, the old sand is uprooted from the cycle as by-item, new sand is presented, and the cycle starts once more. In spite of the fact that there are other casting strategies utilized, including bite the die cast moulding and changeless shape casting, sand casting is by a long shot most pervasive form casting strategy.

Sand is utilized as a part of two diverse routes in metal castings as a trim material which centers the outer state of the give part and a role as centers that shape inner void spaces in items, for example, engine pieces. Since sand grains don't normally cling to each other so fasteners must be acquainted with make the sand stick together and holds its shape amid the presentation of liquid metal into form and cooling of moulding.

2. MATERIALS AND TESTS

2.1 Cement

2.1.1 Fineness test of cement:

100 gm of cement is taken in a standard is sieve no 90 µ. The material is sieved continuously for 15 minutes using sieve shaker. The residue left on the sieve is weighed.

Table 1 Result of fineness modulus of cement

Sl. No	Observation	Trial - 1	Trail-2	Trail-3
1	Weight of sample taken	100	100	100
2	Weight of material retained after sieving no 90 µ	2.3	2.2	2.5
3	% of residue left on the sieve on 90 µ	2.3	2.2	2.5

Fineness modulus of cement = 2.34

2.1.2 Specific gravity of cement

The dry pycnometer is weight as weighed as w_1 kg. The pycnometer is filled with distilled water and weighted as w_2 kg. The is dried and filled with cement and kerosene and weighed as w_3 kg. Weight of pycnometer, with kerosene w_4 kg.

Table 2 Result of specific gravity of cement

Sl. No	Description	Trial-1	Trial-2	Trial-3
1	Weight of pycnometer (w_1)kg	0.64	0.64	0.64
2	Weight of pycnometer + cement (w_2)kg	0.97	1	1.2
3	Weight of pycnometer + cement + kerosene (w_3)kg	1.605	1.605	1.765
4	Weight of pycnometer+ kerosene (w_4) kg	1.38	1.38	1.38
Specific gravity		3.14	3.18	3.2

Specific gravity of cement = 3.15

2.2 Fine aggregates

2.2.1 Sieve analysis for fine aggregate

A concrete with better quality can be made with sand consisting of rounded grains rather than angular grains. River or pit sand must be used and not the sea sand as it contains salt and other impurities .it is found that sand confirms to grading II as per table 4 of IS 383-1970. From the results mean value is 3.6.

2.2.2 Specific gravity of fine aggregate

The dry pycnometer is weighed as w_1 kg. thepycnometer is filled with distilled water and weighed asw_2 kg . thepycnometer is drilled and filled with sand and water and weighed as w_3 kg. weighed of pycnometer with water is w_4 kg.

Table 3 Result of specific gravity of fine aggregate

Sl.No	Description	Trial-1	Trial-2	Trial-3
1	Weight of pycnometer (w_1)kg	0.655	0.655	0.655
2	Weight of pycnometer + sand (w_2)kg	1.165	1.145	1.150
3	Weight of pycnometer + sand+ water (w_3)kg	1.850	1.830	1.843
4	Weight of pycnometer+ water (w_4) kg	1.530	1.530	1.530
	Specific gravity	2.68	2.71	2.71

Specific gravity of fine aggregate = 2.65 and the Water absorption of sand is 0.6%.

2.3 Coarse aggregates

2.3.1 Sieve analysis for coarse aggregate

Sample weight of 5kg is used for sieve analysis and got a fineness modulus of 7.764.

2.3.2 Specific gravity of coarse aggregate

The dry pycnometer is weighed as w_1 kg. the pycnometer is filled with coarse aggregate and weighed asw_2 kg . the pycnometer is drilled and filled with coarse aggregate and water and weighed as w_3 kg. weighed of pycnometer with water is w_4 kg.

Table 4 Result of Specific Gravity of Coarse Aggregate

Sl. No	Description	Trial-1	Trail-2	Trail-3
1	Weight of pycnometer (w_1)kg	4.3	4.3	4.3
2	Weight of pycnometer + coarse aggregate (w_2)kg	9.44	9.39	9.46

3	Weight of pycnometer + coarse aggregate+ water (w_3)kg	17.53	17.28	17.35
4	Weight of pycnometer+ water (w_4) kg	14.1	14.1	14.1
Specific gravity		2.68	2.66	2.69

Specific gravity of cement = 2.68 and the Water absorption of coarse aggregate is 1.4%.

2.4 Metal foundry waste sand

Foundry waste sand comprises essentially of silica sand, covered with a thin film of consumed carbon, remaining folio and clean.

Fig. 1 Metal Foundry waste Sand

Table 5 Properties of Metal Foundry waste sand

Constituent	Value(%)
SiO_2	87.91
Al_2O_3	4.70
Fe_2O_3	0.94
CaO	0.14
MgO	0.30
SO_3	0.09
Na_2O	0.19
K_2O	0.25
TiO_2	0.15
P_2O_5	0.00
Mn_2O_3	0.02
SrO	0.03
LOI	5.15
Total	99.87

2.4.1 Water absorption of metal foundry waste sand

The dry weighed of a sample Foundry waste sand as w_1 gm. The Foundry waste sand with is submerged in water for 24 hrs after that is weighed as w_2 gm.

Water absorption of Foundry waste sand = 1.4%

2.4.2 Sieve analysis for metal foundry waste sand

The sieve analysis procedures were done as per IS383-1970. The Fineness modulus has been calculated as 3.04.

2.4.3 Specific gravity of metal foundry waste sand

The dry pycnometer is weighed as w_1 kg. the pycnometer is filled with distilled water and weighed as w_2 kg . the pycnometer is drilled and filled with Foundry waste sand and water and weighed as w_3 kg. weighed of pycnometer with water is w_4 kg.

Table 9 Result of specific gravity of metal foundry waste sand

Sl.No	Description	Trial-1	Trial-2	Trial-3
1	Weight of pycnometer (w_1)kg	0.665	0.665	0.665
2	Weight of pycnometer + F.sand (w_2)kg	1.165	1.163	1.157
3	Weight of pycnometer +F. sand+ water (w_3)kg	1.850	1.848	1.843
4	Weight of pycnometer+ water (w_4) kg	1.530	1.530	1.530
Specific gravity		2.78	2.76	2.74

specific gravity of Foundry waste sand = 2.76

3. MIX DESIGN METHODOLOGY

3.1 Mix propotion

Mix design were done as per IS 10262:2009 standards and the proportions of concrete mix has been arrived. Trial mixes were made to obtain economical mix satisfying workability and strength requirement and details of final mix is arrived.

Water (lit/m^3)	Cement (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)
191.6	425.78	545.28	1199.19
0.45	1	1.28	2.81

Mix Proportion 1 : 1.28 : 2.81

3.1 Mixing of Concrete.

The concrete mixture was prepared by hand mix. Cubical moulds of size 150mm*150mm*150mm were casted for compression strength testing. The moulds were cleaned & oiled properly before every pouring. The concrete was filled in the moulds in three layers, each layer being tamped with tamping rod. Also the vibrations were given by putting the cubes on the chasis of the mier. The specimens were allowed to remain in the steel mould for the first 24 hours at ambient condition and were covered with plastic sheet to prevent moisture loss due to evaporation.

Fig.2 Mixing and Moulding process.

4. TESTS ON HARDENED CONCRETE SPECIMENS

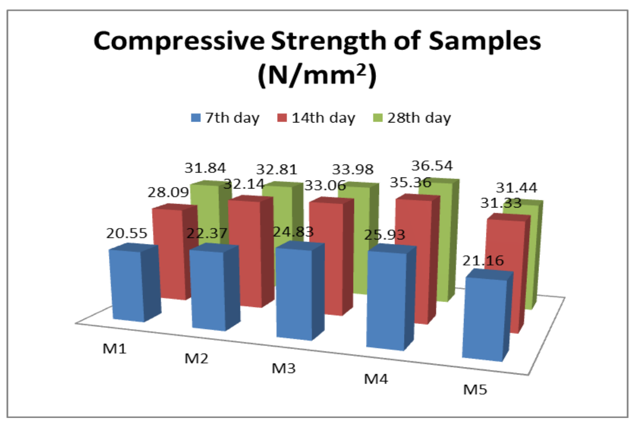
4.1 compressive Strength Test

Fig.3 Compression testing machine

After the curing period the cubes are taken out from the curing tank and wipe it clean. The dimensions of the specimens and the weight of the specimens were noted down with accuracy. Then the specimen is placed on the loading surface of the CTM and the load is applied till the specimen fails. The ultimate load at the time of failure is noted down. The test procedure were adopted as per ASTM standards. The load was applied at the rate of 140 Kg/cm^2/minute till the cube breaks.

Table 10 Compressive Strength of Samples

Composition	7th day Strength N/mm^2	14th day Strength N/mm^2	28th day Strength N/mm^2
M1	20.55	28.09	31.84
M2	22.37	32.14	32.81
M3	24.83	33.06	33.98
M4	25.93	35.36	36.54
M5	21.16	31.33	31.44



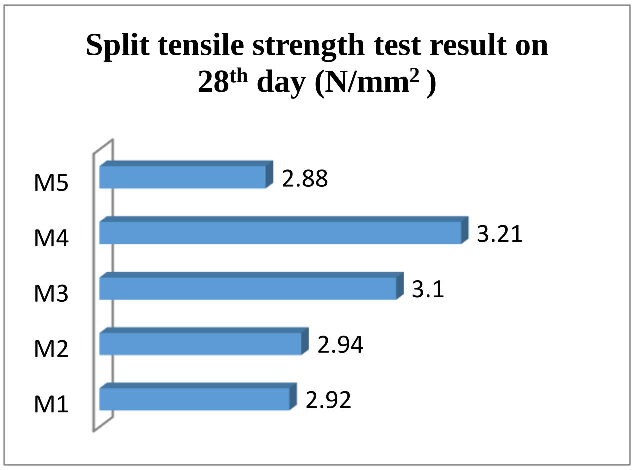
Graph 1 Comparison of Compressive Strength

4.2 Split Tensile Test

The sample is set up with outlining a blend of size 150 mm distance across and 300 mm stature. The solid is loaded with three layers and compacted well and it is vibrated utilizing table vibrator. The sample is subjected to curing for 28 days. After the curing time frame the sample is taken out from the curing tank and wipes it clean. The measurements of the examples and the heaviness of the examples were noted down with precision. The pressure testing machine is utilized for the test. The barrel example is set on a level plane between the stacking surfaces and connected load ceaselessly up to the example get tricked. The most extreme load is connected to the example is recorded. The rigidity is computed by the accompanying recipe.

Table 11.Split tensile strength test result

Composition	Loads (KN)	28th day Split tensile Strength (N/mm^2)
M1	206.76	2.92
M2	208.33	2.94
M3	219.02	3.10
M4	227.15	3.21
M5	203.62	2.88



Graph 2 Split tensile strength test result on 28th day

5. SUMMARY AND CONCLUSIONS

- Compressive strength of M1, M2, M3 and M4 mixes are gradually increased were M5 mix has dropped in the test of 7th, 14th and 28th days.
- It clearly shows that M4 (30%) replacement of FWS shows a 25% of increase in compressive strength when compare to normal mix (M1).
- Compressive Strength properties of concrete blends increment with the expansion in foundry waste sand substance and furthermore with the age.
- Split tensile strength improvement by replacing fine aggregate with foundry waste sand, at M4 (30%) replacing it gives the maximum strength the 28th day value is 3.21 N/mm^2 at the same days the ordinary concrete value is 2.92 N/mm^2.
- The metal foundry waste sand mixed concrete split tensile strength value is 9.03% increased.
- Foundry Waste sand can be utilized as a swap for natural sand in making concrete and concrete related items.
- Compressive and tensile Strength properties outputs demonstrate that foundry waste sand could be helpfully utilized as a part of making great quality concrete and construction material.

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