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Experimental Study on Eco-Friendly Low Cost Concrete

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***Abstract* - To produce low cost concrete by blending various ratios of manufactured sand with used foundry sand & to reduce disposal and pollution problems due to used foundry sand. It is most essential to develop profitable building materials from foundry sand. The innovative use of used foundry sand and manufactured sand in concrete formulations as a fine aggregate replacement material was tested as an alternative to traditional concrete. The fine aggregate has been replaced by 95%, 90%, 85%, 80% and 70% of manufactured sand and used foundry sand is used accordingly in the range of 5%, 10%, 15%, 20% & 30% by weight for M-30 grade concrete. Concrete mixtures were produced, tested and compared in terms of strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties for 7, 14 and 28 days. As a result, the compressive strength and split tensile strength increased up to 20% addition of used foundry sand with 80% manufacturing sand. The compressive strength is increased by 28% and split tensile strength is increased by 33% as maximum. Keeping all this in view, the aim of investigation is the behavior of concrete by fully replacing fine aggregate (river sand) with different proportions of manufacturing sand and used foundry sand in concrete by using test like compression strength and split tensile test.**
***Keywords:* Concrete, Eco-Friendly, Tensile Strength**

I. INTRODUCTION

Concrete is the most widely used composite construction material. To produce low cost concrete by blending various ratios of foundry sand and M sand & to reduce disposal and pollution problems due to used foundry sand. It is most essential to develop profitable building materials from foundry sand.

Quality of construction is the most important aspect under consideration in the construction sector. Factory manufactured items always play a vital role in the quality of products. Used Foundry sand (UFS) is a discarded material coming from ferrous and nonferrous metal-casting industry. It's a mixture of high quality size-specific silica sand, few amount of impurity of ferrous and nonferrous by-products from the metal casting process itself and a variety of binders.

A. Eco-Friendly Low Cost Concrete

This describes a product that has been designed to do the least possible damage to the environment. Products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. Generation of waste foundry sand as by-product of metal casting industries causes environmental problems because of its improper disposal. Thus, its usage in building material, construction and in other fields is essential for reduction of environmental problems. This research is carried out to produce a low-cost and eco-friendly concrete.

B. Salient Features of Eco- Friendly

1. High compressive strength
2. low cost concrete
3. Low water-binder ratio
4. Reduced flocculation of cement grains
5. Wide range of grain sizes
6. Densified cement paste
7. No bleeding homogeneous mix
8. Less capillary porosity
9. Discontinuous pores
10. Stronger transition zone at the interface between cement paste aggregate
11. Low free lime content
12. Endogenous shrinkage
13. Powerful confinement of aggregates
14. Little micro-cracking
15. Smooth fracture surface.

II. SCOPE AND OBJECTIVE OF THE WORK

1. The major objective of the study was to examine the suitability of M-sand and UFS as fine aggregate concrete.
2. Apart from characterizing the properties of M-sand and UFS, test was performed on the concrete using M-sand and UFS as well natural river sand.
3. To show the pictorial representation of strength aspect such as compressive strength and split tensile test.

III. MIX DESIGN STIPULATIONS

1. Grade designation =M30
2. Type of cement =OPC 43 grade
3. Maximum size of aggregate =20mm
4. Minimum cement content =320 kg/m3
5. Maximum w/c ratio =0.4
6. Workability =100mm
7. Exposure condition =severe

8. Type of aggregate = crushed angular aggregate
9. Maximum cement content =450 kg/m3

IV. MIX CALCULATION

1. Volume of concrete =1 m3
2. Volume of cement =(492.5/3.15) x(1/1000) =0.111m3
3. Volume of water =0.197 m3
4. Volume of all aggregate =1-(0.111+0.197) =0.692
5. Mass of coarse aggregate =0.692x0.56x 2.77 x1000 =1073.4 kg
6. Mass of fine aggregate = 0.692 x0.44x 2.34x 1000 =712 kg

TABLE I PROPORTION OF M-30 GRADE CONCRETE

Sample	Cement (Kg/m3)	Fine Aggregate (Kg/m3)		Coarse Aggregate (20mm), Kg/m3	Water (Lts/m3)
		M-Sand	Foundy Sand		
S-1	492.5	676.4	35.6	1073	197
S-2	492.5	640.0	71.2	1073	197
S-3	492.5	605.2	106.8	1073	197
S-4	492.5	569.6	142.4	1073	197
S-5	492.5	498.4	213.6	1073	197

TABLE II ECONOMICAL FEASABILITY: MATERIALS COST

S. No.	Materials	Rate (Rs/kg)
1	Cement	6.00
2	Fine aggregate (sand)	1.67
3	M-sand	0.60
4	Coarse aggregate (> 20mm)	0.65
5	Foundry sand	0.15

TABLE III TOTAL COST OF MATERIALS FOR M30 GRADE PER M3

CT	Consumption of mix proportion for M30 grade in Kg.				Total cost/m3	% cost changes
	C	F.A (M-sand)	F.A (U.F.S)	C.A		
NM	492.5	600(sand)	-	1073	5356.55	-
S-1	492.5	676.4	35.6	1073	4161.05	22.4
S-2	492.5	640.0	71.2	1073	4135.55	22.8
S-3	492.5	605.2	106.8	1073	4110.05	23.3
S-4	492.5	569.6	142.4	1073	4084.55	23.8
S-5	492.5	498.4	213.6	1073	4033.55	24.7

Note: CT = Concrete type, C = Cement, F.A = Fine Aggregate, C.A = Coarse Aggregate, U.F.S = used Foundry Sand

Fig. 1 % Savings

V. EXPERIMENTAL RESULTS

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality controlled program for concrete, which helps to achieve higher efficiency of material used and greater assurance of performance of the concrete with regards to both strength and durability. The test methods should be simple, direct and convenient to apply.

A. Compression Test

Out of many test applied to the concrete, this is the most important test which gives an idea about all the characteristics of concrete. By this single test, one can judge that whether casting of concrete has done properly or not. For cube test two type of specimens either cubes of 15cm X 15cm X 15cm (or) 10cm X 10cm X10cm depending upon the size of aggregate are used. Mostly cubical moulds of size 15cm X 15cm X 15cm are commonly used.

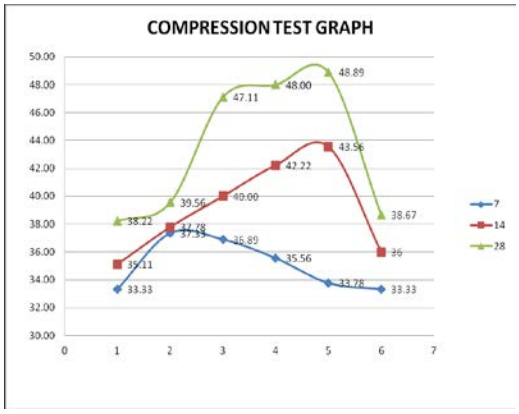

Fig. 2 Compression Test

B. Split Tensile Strength Test

Out of many test conduct to the concrete, split tensile test is important one and carried out by calibrated compression testing machine. From this test, we can able to find out tensile strength of concrete. The tensile strength of concrete is approximately 10% of its compressive strength. Mostly cylindrical moulds of size 15cm X 30cm are commonly used. Tensile splitting strength test of concrete block specimens were determined as per IS: 5816-1999.

This concrete is poured in the mould and tampered properly so as not to have any voids. After 24hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen.

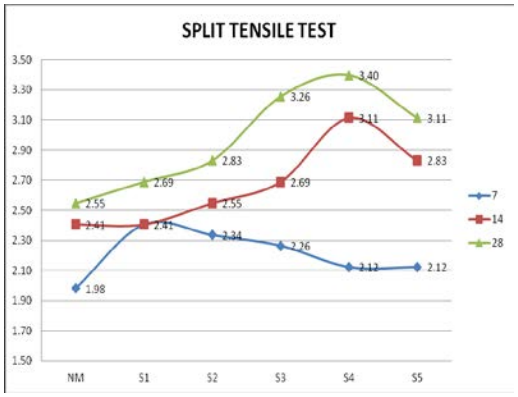

Fig. 3 Split Tensile Strength Test

VI. CONCLUSION

The effect of concrete with replacement of manufactured sand and used foundry sand on the properties of normal strength concrete with water cement ratio of 0.40 and 28 day's compressive and split tensile strength of 30Mpa were studied. The effect of percentage replacement of manufactured sand and used foundry sand on strength property and workability were evaluated and compared with reference mix of 0% replacement of natural sand by manufactured sand and used foundry sand.

1. The compressive and split tensile strength of concrete with 100% replacement of natural sand by 80% of manufactured sand and 20% of foundry sand reveals higher strength as compared to reference mix.
2. The overall strength of concrete linearly increases from 100% replacement of natural sand by 95%, 90%, 80% of manufactured sand and 5%, 10%, 20% of used foundry sand respectively as compared with reference mix (NM). These results were compared with previous work then found that, present study gives better strength and higher water cement ratio gives better workability.
3. Manufactured sand with used foundry sand has a potential to provide alternative to natural sand and helps in maintaining the environment as well as it decrease the cost of concrete by economical balance.
4. Non-availability of natural sand at reasonable cost, forces to search for alternative material. Manufactured sand qualifies itself as suitable substitute for river sand at reasonable cost.
5. The results indicate that the % change in cost reduce up to 24.7% for 70% replacement of M-sand and 30% of used foundry sand.
6. The manufactured sand found to have good gradation and nice finish which was lacking in natural sand. This had been resulted in good cohesive concrete. This sand is considered as an ideal for concrete.
7. Use of waste foundry sand in concrete reduces the production of waste through metal industries i.e. it's an eco-friendly building material.
8. In 100% replacement of natural sand by 80% of M-sand and 20% of used foundry sand, the compressive strength increases by 32%, which is maximum.
9. Results show that the river sand can be fully replaced by manufactured sand.

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