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Exploring the Use of Iron Ore Tailings in Concrete by Partial Replacement of Fine Aggregates

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Abstract: *Concrete is the most durable, resilient, available and affordable material in the built environment. The manufacture of large quantities of iron ore has created difficulties for the environment and disposal. The utilization of IOT as fine aggregate in building material production is relatively feasible. Experiments were conducted to determine the suitability of iron ore tailings as replacement of fine aggregates for concrete. The iron ore waste was collected from Gua Iron Mines, Singhbum. Mix Design was carried out for concrete of grade M35 using standard practice for selecting proportions for normal weight. Iron ore waste replaced with fine aggregates in mixes by 30% and 35% respectively. The materials used for M35 grade of concrete is coarse aggregate 10-20mm, fine aggregate is of Zone 2, cement of 53 grade. Tests were performed on materials, for cement and fine Aggregate Fineness test, Specific Gravity were performed. Water absorption test, specific gravity, Impact value these were performed for Coarse aggregate. It was observed that compression values of concrete for 30% for 3 days its 13.703 Mpa, For 7 days its 16.503 Mpa, and for 28 it was 28.033 Mpa*

Keywords: IOT (Iron Ore Tailings), Fine aggregate of Zone 2, Impact value test.

I. INTRODUCTION

Concrete is the most durable, resilient, available and affordable material in the built environment, supporting sustainable economic, social and environmental development priorities. The investment in the infrastructure construction, the demand for concrete has increased sharply. This results in a shortage of natural sand in some areas and a series of environmental problems due to irrational overexploitation. On the other hand, mining activities not only destroy and occupy lots of land resources but also bring about many serious environmental and social problems The manufacture of large quantities of iron ore has created difficulties for the environment and disposal Iron ore tailings which is the waste products of mining industries is used as an alternative to the river sand in the manufacturing of concrete.

The utilization of IOT as fine aggregate in building material production is relatively feasible because the composition of IOT is similar to that of natural aggregate which mainly contains silica, alumina, iron, magnesium, and calcium. The generation of tailings is estimated to be 10-25 wt% of total iron ore mined, thus amounting to around 18 million tons (mt) per year in India. Iron ore tailings (IOT) are mining waste obtained during the beneficiation process to concentrate the iron ore. The discharge capacity of tailings in China is always increasing every year, accounting for more than 50% of the world's tailings discharge. The storage of IOT accounts for nearly one-third of all kinds of tailings. Presently, the annual production of IOT is nearly 600 million tons, but the utilization rate of IOT in China is very low, only 7%. IOT is often stored in the tailings dam by natural accumulation, which occupies large areas of land, consumes high management cost, and often causes dust easily raised by the wind around the surrounding area because of the fine particles.

Therefore, disposing of IOT using proper methods is quite crucial. The most common secondary utilization is recycling metal from IOT [8], but it needs advanced technology and upscale equipment, and there are also still 70% iron ore tailings left after recycling. It was reported that the use of waste materials in concrete products will lead to sustainable concrete and greener environment that the industrial and other wastes used in concrete-making will improve concrete properties and reduce cost. Growth in construction industries and the consequent increase in consumption of natural

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fine aggregate dwindle the natural resource. Recent studies have shown that the IOT have potentials that can be utilized effectively to produce concrete.

II. TEST SPECIMEN

A. Material Used

Cement

Ordinary Portland Cement (OPC) of 53 grade of Birla Cement is used in this experimental work. Weight of each cement bag is 50 Kg. The standard consistency of cement sample is found to be 32%. Fineness modulus was obtained 2.801%.

Aggregates

Specific gravity of fine aggregates 2.94. Natural Coarse aggregate consist of 10-20 mm. Impact value of coarse aggregates 7.22%.

Iron Ore waste.

The material was sent from Gua iron ore mines, Singhbum, and collected from Courier office of Pune station. The specific gravity of iron ore waste 3.35.

B. Mix Proportion and Casting Procedure

Mixing was done with the help of electric concrete mixer. Fine aggregates were replaced with iron ore waste for 30%. The materials were first mixed thoroughly for 1 minute in dry condition itself. Water was added while the mixing was in continuation. Concrete was then placed in IS specified molds in three layers, each layer was being compacted by standard tamping rod with more than 35 strokes. A total of 18 (i.e 9 cubes of conventional concrete,9 cubes of mix 1) concrete specimens of dimension 150 × 150 × 150 mm for compressive strength test and similarly, Specimens were prepared to obtain characteristic cube strength of 35 Mpa. The fine aggregate was replaced with iron ore waste respectively, by percentage 30. Specimens were cured by immersing them in curing tank and tested for 3rd, 7th and 28th days.

Fig:1 Specimen Casting

Table 1: Mix Design composition.

Mix	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregate (Kg)	Replacement%	Replacement (Kg)
Mix 1	14.912	22.696	42.381	0	0
Mix2	14.912	15.887	42.381	30	6.809

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C. Test Program

Compression testing of cubes.

Cubes as casted of size 150 × 150 × 150 mm were tested using Compression testing machine (CTM) of capacity 2000 kN. Testing of the cubes was done at the age of 3rd,7th, and 28th day. The measuring strength of specimen is calculated by dividing the maximum load applied to the specimen during the test by the cross-section area.

D. Results and Discussion

Following are the obtained results of Compression Test

Table 2: Strength gained by concrete.

Mix	Day of testing	Compression Test	
		Strength (Mpa)	Average (Mpa)
Mix1	3rd	16.933	17.200
		17.289	
		18.289	
	7th	22.311	22.844
		23.555	
		22.666	
	28th	35.066	35.703
		36.222	
		35.822	
Mix 2	3rd	13.333	13.703
		12.666	
		15.111	
	7th	16.177	16.503
		18.222	
		15.511	
	28th	28.202	
		27.542	28.033
		28.356	

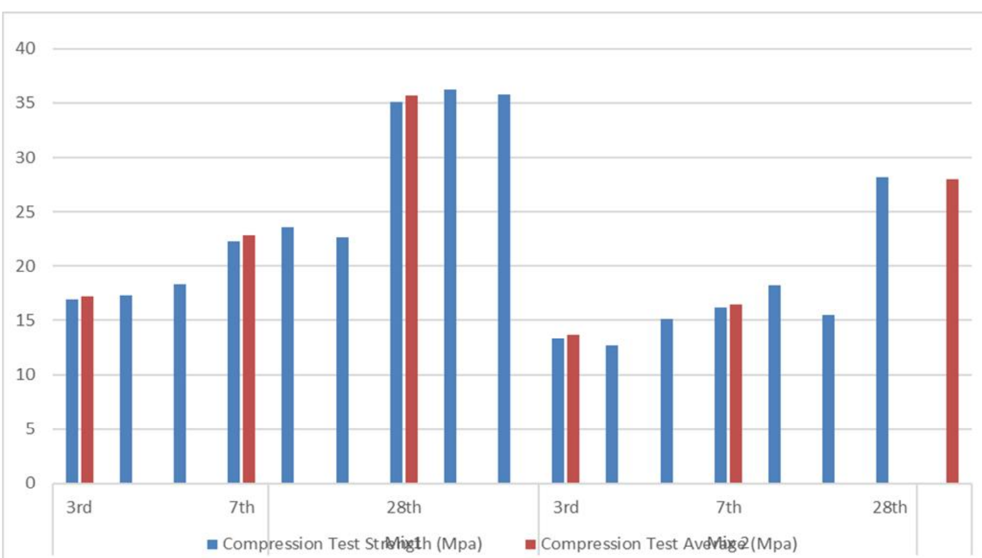

Fig:2. Compressive Strength of concrete

III. CONCLUSION

The following conclusions can be drawn from this experimental study:

- Compressive Strength of concrete made by using 30 % iron ore waste replacing fine aggregate respectively is decreased by a very less amount that its almost negligible.
- Studies illustrate that IOT can improve specific properties like compressive strength, density, and stability when appropriately integrated into concrete mixes.
- Challenges such as reduced workability and the necessity for optimal dosage levels need to be addressed.
- Additionally, the environmental benefits of repurposing IOT, including mitigating disposal issues and reducing reliance on traditional aggregates, are highlighted.
- Despite the challenges, the findings suggest that IOT offers a promising avenue for sustainable construction practices.

IV. ACKNOWLEDGMENTS

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