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Effect of Iron Ore Tailing on the Flexural Strength of Concrete

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Abstract: ***The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on the environment. Presently a large amount of IOT generated from various Iron industries. This waste usually collected in dumping grounds of the industries and they cause harmful effects to the environment. This paper describes the use of IOT (Iron Ore Tailing) and its feasibility in use of it as a partial replacement to sand (or Fine Aggregate).***
The use of iron ore tailing (IOT) from Eurobond industries Hargrah near Sihora in Jabalpur district will ensure economy in concrete production as well as a better way of disposing the tailing. Mix design was carried out for concrete of grade M25. The constituent materials were batched by weight. The mix with only sand as fine aggregate served as the control mix, while sand was replaced in the other mixes by 5%, 10%, 15% and 20% iron ore tailing (IOT). Flexural Strength test were conducted on both concrete beam specimens of size 150mm*150mm*700mm. It was observed that concrete workability reduced with increase in the percentage of iron ore tailing in the mix. Twenty-eight (28) days flexural strength values of 16.96N/mm ^{2}***, were obtained for concrete when 15% iron ore tailing (IOT) was used as partial replacement with sand.***
Keywords: Concrete, Flexural Strength, Mix, IOT (Iron Ore Tailing), Fine aggregate

I. INTRODUCTION

Concrete is a composite construction material made primarily with Cement, fine aggregates, water and coarse aggregates, and may contain chemical admixtures. The worldwide consumption of sand as fine aggregate in concrete production is very high, and several developing countries have encountered some difficulty in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years, a situation that is responsible for increase in the price of sand, and the cost of concrete. Expensive and lack of river sand (RS) which is one of the constituent material used in the production of conventional concrete was reported in India. To overcome the stress and demand for river sand, researchers and practitioners in the construction industries have identified some alternatives namely Iron Ore Tailing fly ash, slag, limestone powder and siliceous stone powder.

The increasing demand for heavy construction material like steel and iron has resulted in the establishment of many iron ore mining companies. Iron Ore Tailing is a waste generated from the Iron Ore industry. It is a very fine aggregate residue resulting from the extraction of Iron from Iron Ore. The residue left after extraction is in the form of slurry. Problems involved in the disposal of iron ore tailing are lack of space, technical problems, cost and environmental hazards.

An attempt is made to use preparation of reinforced concrete by replacing the sand by iron ore tailing for sand in different percentages viz 0, 5, 10, 15 and 20 with 1.703% of steel reinforcement. The flexural strength is determined to utilize the iron ore tailings as a replacement to sand in steel reinforced concrete beam and hence avoiding environmental pollution.

II. LITERATURE REVIEW

In recent decades rigorous research and development efforts have been directed towards finding cost effective and economic compatible solutions for utilizing the waste produced in Iron Ore mining operations.

In the Kogi state of Nigeria T.I. Ugama [1] studied the effect of tailings on the properties of concrete by replacing sand with IOT. The mix with only sand as fine aggregates served as the control mix, while sand was replaced in the other mixes by 20%, 40%, 60%, 80% and 100% Tailings. Based on the experimental investigation they also concluded that increasing percentage of tailing reduces the workability of concrete. IOT performed better in terms of splitting tensile strength in concrete than that of control mix. Hence they concluded that by limiting IOT to 20% (optimum) tailings can be used in concrete.

Chaithanya M.B [2] is found that the flexural strength for curing period of 28 and 56 days. Total eight different mixes viz 0%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5% and 30% of replacements for both cement and sand with COT and IOT respectively, with 0.6% of steel fibres, for M20 grade of concrete

Dr. Prema kumar W.P [3] performed the experimental work by replacing sand partially or completely with IOT and concluded that due to sand replacement the compression strength increases by about 40% as compared to normal concrete and the flexural strength of reinforced concrete beam is in no way impaired by replacement of sand by IOT. Hence the sand in cement concrete may be replaced by IOT in concrete production without compromising on strength and it greatly reduces the water and land pollution that could otherwise have occurred due to dumping of IOT on land.

Swetha K S [4] are studied the pre and post factor of M20 concrete by partial replacement of cement by copper ore tailing of 5%, 10%, 15%, 20%, 25% and sand by iron ore tailing of 10%, 20%, 30%, 40%, 50%. The effect of copper ore tailing and iron ore tailing for the partial replacement of cement and sand on strength and durability characteristics were analysed and compared with normal concrete. The test results shows that 15% copper ore tailing and 30% iron ore tailing shows the good and optimized results. Its use will lead to a reduction in cement and sand quantity required for construction purposes and hence sustainability in the construction industry.

III.MATERIAL

A. Cement

Portland Pozzolana Cement of 43 grades available in local market was used in the research. The specific gravity of cement is 3.15

B. Fine Aggregate

Narmada River sand is used as fine aggregate. Sand used in the present work was from zone II. The specific gravity was found to be 2.645

C. Coarse Aggregate

Coarse aggregates are those which are retained on IS sieve size 4.75 mm. Crushed stone angular metal of 10 mm and 20 mm size from a local source was used as coarse aggregate. The specific gravity was found to be 2.735.

D. Reinforcement

For the investigation 36 sets of specimens having square cross sectional beam (150 mm x 150 mm x 700mm) the reinforcement details of the specimen are shown in table 1. The reinforcement pattern used in the specimens is shown in fig.1

TABLE I
Reinforcement detail of beam specimen

Specimen No.	Percentages of IOT	Specimen size(mm x mm x mm)	Reinforcement in specimen	
			Longitudinal Reinforcement	Stirrups
S-1	0	150x150x700	2 Nos 10 mm top bar & 2 Nos 12 mm bottom bar	8mm @100mm c/c spacing
S-2	5	150x150x700	2 Nos 10 mm top bar & 2 Nos 12 mm bottom bar	8mm @100mm c/c spacing
S-3	10	150x150x700	2 Nos 10 mm top bar & 2 Nos 12 mm bottom bar	8mm @100mm c/c spacing
S-4	15	150x150x700	2 Nos 10 mm top bar & 2 Nos 12 mm bottom bar	8mm @100mm c/c spacing
S-5	20	150x150x700	2 Nos 10 mm top bar & 2 Nos 12 mm bottom bar	8mm @100mm c/c spacing

Fig.1 Reinforcement detail with mould

E. Iron Ore Tailing

The iron ore tailings used in the experimental study was procured from Eurobond Industries Private Limited Hargrah, Situated at a distance of 10 km from Sihora in Jabalpur district, Madhya Pradesh, under dry mode of condition. The properties of the IOTs are indicated in Table II

TABLE III
Physical properties of IOT

Parameters	IOT
Particle shape	Spherical
Density	14.4 kN/ m³
Specific gravity	3.10
Color	Dark tan (brown)
Optimum dry density (ODD)	1.71 gm/cc
Optimum moisture content (OMC)	21 %

Fig. 2 Eurobond Industries Pvt. Ltd., Hargrah

Fig. 3 IOT at dumping yard

IV. RESULTS AND DISCUSSIONS

Reinforced cement concrete beams of length 700 mm and cross-section 150 mm x 150 mm with 2 bars of 12 mm diameter at bottom, 2 hanger bars of 10 mm diameter at the top and two legged stirrups of 8 mm diameter at 100 mm c/c throughout were cast. The fabricated reinforcement cage was kept in the beam mould of size 700 mm x 150 mm x 150 mm with adequate cover on all the sides. M 25 concrete and Fe 415 steel were used. The beams were cast by replacing 0%, 5%, 10%, 15% and 20% of sand

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successively by iron ore tailing and then cured for 7, 14 and 28 days and tested by UTM which have capacity of 400 kN. The three point loading method was used for flexural strength test. The test result of reinforced concrete beams are shown in Table III.

TABLE III
Flexural Strength in MPa

S.No.	Percentages of IOT	Flexural Strength (MPa)		
		7 days	14 days	28 days
1	0 %	13.94	15.5	17.22
2	5%	14.55	15.87	17.42
3	10%	14.82	16.49	17.65
4	15%	14.67	16.70	17.88
5	20%	14.01	16.21	16.96

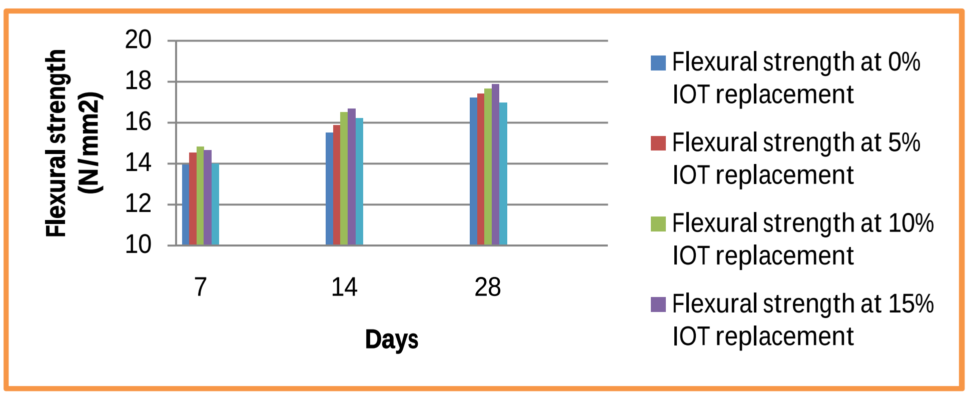

Chart -1: Flexural strength of M25 grade concrete with partial replacement of sand by IOT

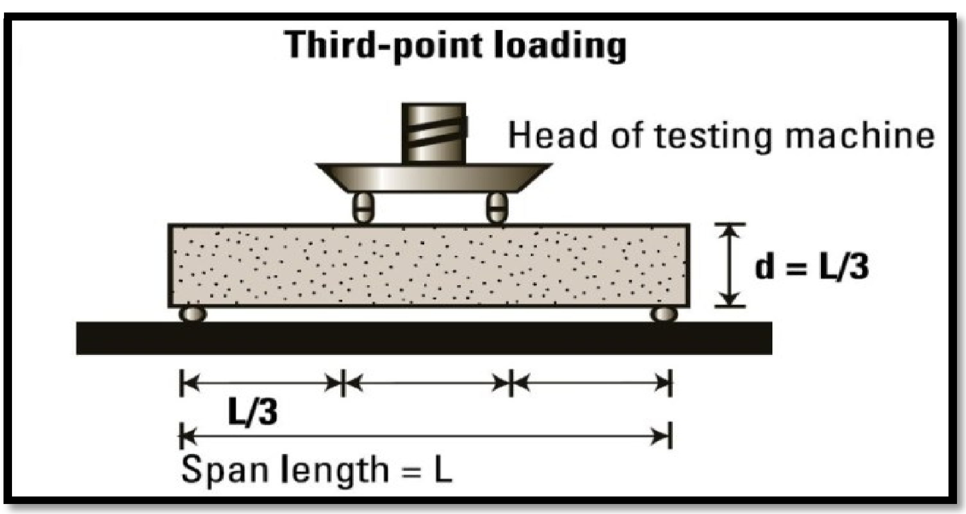

Fig. 4 Ideal figure of three point loading for flexural strength of concrete

Fig. 5 Measuring and marking of beam specimen

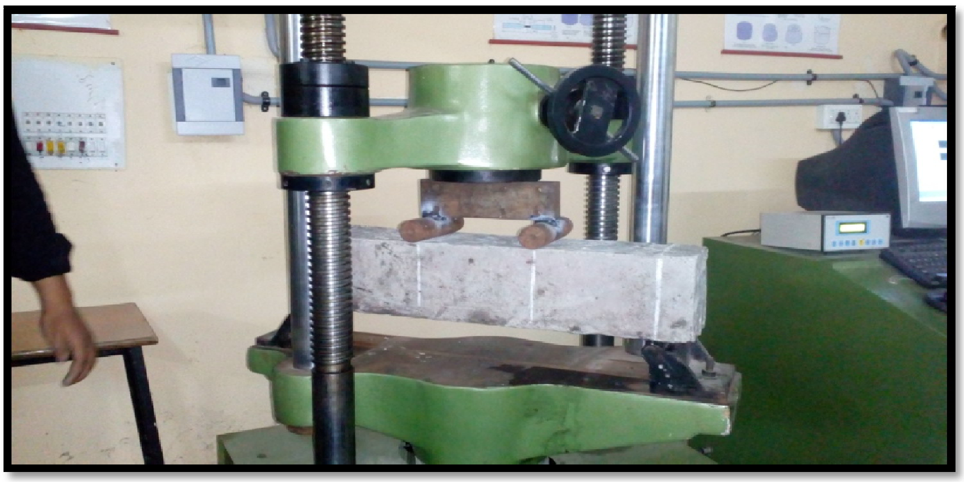

Fig. 6 Testing of beam specimen under three point loading in UTM machine

Fig. 7 Failure of beam under three point loading in UTM

V. CONCLUSION

The flexural strength of reinforced concrete beams is in no way impaired by replacement of sand by iron ore tailing. On the other hand, there is enhancement of flexural strength for all percentages of sand replacement. The increase in flexural strength is not very substantial. The mix with 15% IOT performed better in terms of flexural strength with values 3.86% higher than the flexural strength of the control mix respectively.

It is feasible to produce cost effective concrete, possessing acceptable 7, 14 days and 28 days strength by partial replacement of IOT

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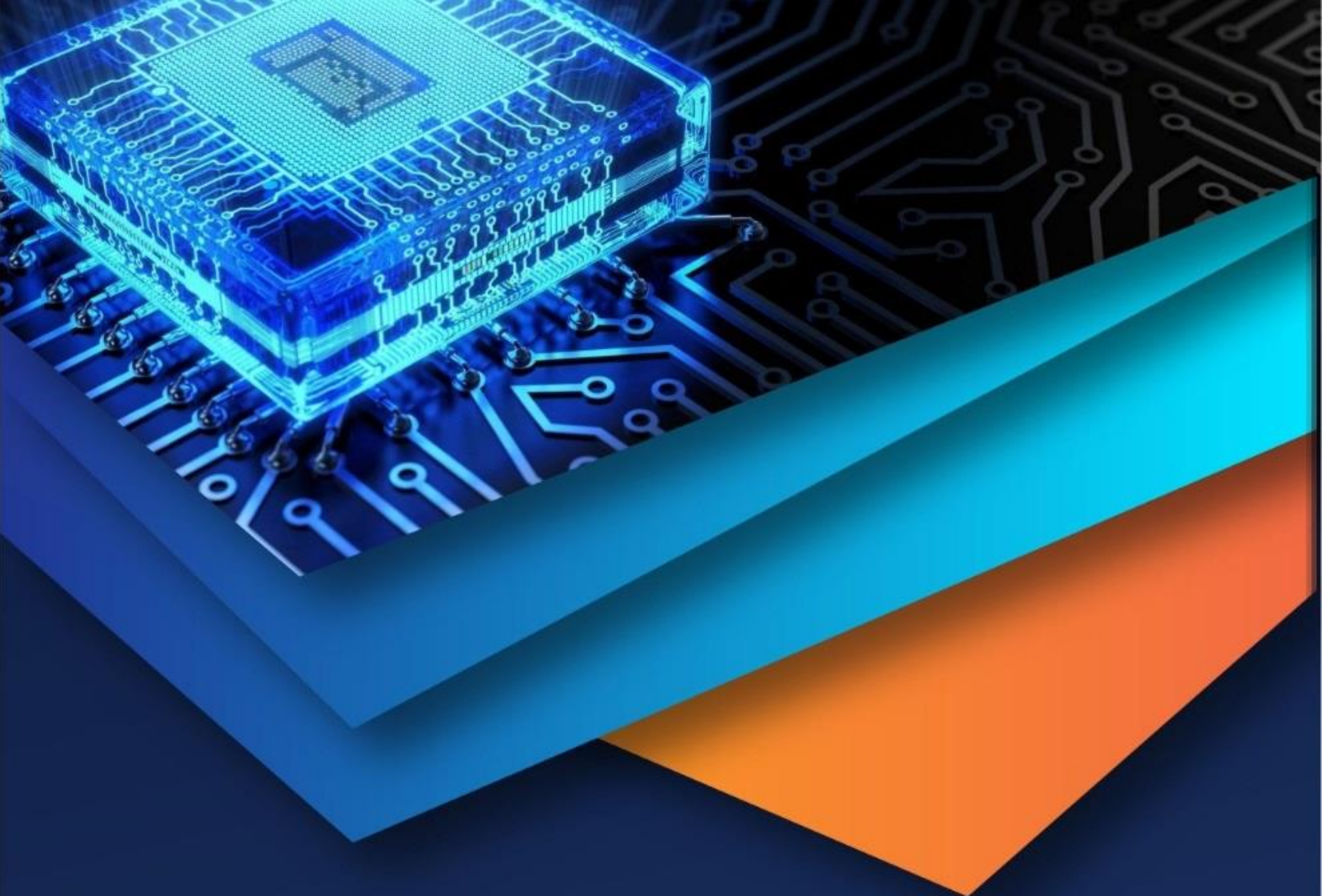

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