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Replacement of Course and Fine Aggregates in Concrete by using Mangalore Tile Wastage and Iron Ore Slag

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Abstract - *At present the use of Ferrous Slag in concrete gives environmental and economic benefits for concerned industries, especially in places where a considerable amount of Ferrous Slag is produced. Owing to the scarcity of sand for the preparation of mortar as well as concrete, partial and fully replacement of Ferrous Slag with sand have been attempted. Ferrous Slag are by-products obtained during smelting and refining of Ferrous Slag. This work reports an experimental procedure to investigate the effect of using Ferrous Slag as partial replacement of sand. Six series of concrete mixtures were prepared with varies proportions of Ferrous Slag ranging from 0% to 100%. The test results of concrete were obtained by adding Ferrous Slag to sand in various percentages ranging from 0%, 10%. 20%, 30%, and 40%. All specimens were cured for 7 & 28days before compression strength test etc. Results that workability increases with increase in percentage of Ferrous slag and feasibility study on the use of broken Mangalore tiles as coarse aggregate in combination with iron ore slag in the production of low to medium strength concrete is carried out.*

Key Words: **Ferrous slag, Mangalore tiles, Iron ore slag, Broken tiles, Split tensile Strength**

1. INTRODUCTION

In India large number of industries which are usually producing ferrous slag as waste every day. Use of *Ferrous slag* in concrete provides some benefits for related industries. In our project we made use of Iron ore dust (slag) as a fine aggregate with complete replacement of sand. Iron ore dust can be defined as residue, tailing or waste material which is left after the extraction and processing of iron ore in the mines to form fine particles less than 4.75mm. Usually, Iron ore dust is treated as a complete waste, and used to fill the low lying areas. Use of Iron ore dust as an alternative to normal aggregates in concrete M. Nadeem et al draws serious attention of researchers and investigators. And large quantity of construction waste as well as demolition waste such as paving blocks, tiles, timber, plastic, cardboards, metals and papers etc. After extraction from other construction and demolition waste then sieved & used as a constituent for natural coarse aggregates (CAs) in concrete. In this study broken Mangalore tiles as coarse aggregate in addition with iron ore slag in the production of low to medium strength concrete is carried out.

1.1 Experimental Objectives

Important aspects of the work is to strengthen the concrete economically for structural applications by decreasing the aggregate content.

- This work demonstrates the suitability of Mangalore tiles and iron ore slag as replacement of aggregates in concrete.
- Studying the behavior of concrete, replacing sand by iron ore slag in different replacement percentage to get optimum results and using it for M20 grade of concrete. Same done for coarse aggregate replacing Mangalore tiles.
- Comparison of the mechanical properties of conventional concrete and proposed concrete.
- Studying the cost analysis of conventional concrete and proposed concrete with the respective grade of concrete
- Possibility of using waste iron ore slag & tiles as an alternative construction material will be investigated by conducting different tests on prepared specimens, it is intended to analyze the results.

1.2 Materials Used

The materials such as

- OPC 53 Grade Cement
- Sand
- Coarse Aggregate
- Iron ore slag and Mangalore tiles
- Water

The cement used for the present work was OPC 53 Grade cement (Normal Portland cement). Fine aggregate is of Zone-II as per Grading of aggregates IS: 383-1970 .Crushed aggregates are 20 mm ground aggregates as per IS: 383-1970. The physical properties of aggregates are according to Indian Standard Specification IS: 10262(2009).

1.2 Iron ore dust (Slag)

Iron ore is crushed and allowed to pass through various processes in the manufacture of iron in mines and in this process large volume of dust or fine particles of iron ore is generated. They are known as iron ore dust or iron ore slag. The slag obtained has properties similar to that of sand and can be used for construction purposes. Ayano T, Sakata K. (2000), proposed a theory on concrete and this theory provides the feasibility of the usage of iron ore dust as hundred percent substitutes for Conventional Concrete.

Fig-1: Iron ore slag and Mangalore tile wastage

Mangalore tiles are fired clay tiles. The tiles produced by the factory are in great demand throughout the Indian subcontinent. Broken tiles are available in plenty at minimal cost. M .C. Nataraj proposed a theory on concrete and this theory provides the feasibility of the usage of broken tiles as hundred percent substitutes for conventional concrete.

1.3 Mix Proportion

The mix proportions were made for a control mix of slump 4 ± 1 in. (100 ± 25 mm) for 20 MPa of concrete with a w/c ratio of 0.50 respectively by using IS-10262-2009 method of mix design.

- Quality aggregates – The quality of aggregates is high.
- The other four concrete mixes were made by replacing the fine aggregate & coarse aggregates with slag as well as tiles by weight respectively.

2. EXPERIMENTAL RESULTS & DISCUSSION

The replacement of coarse aggregate by Mangalore tiles and sand by iron ore slag increases the workability of the concrete thus increasing the strength of the cube as well as the cylinder. The workability of this proposed concrete shows a decrease in slump with increase of tile wastage of total aggregate volume. The result of the normal concrete mix exhibited an increase in workability, the results of the slump test are as shown below.

Table -1 Slump test on M20 mix

% Replacement	w/c ratio	Slump Value in mm
0%	0.5	80
10%	0.5	62
20%	0.5	57
30%	0.5	46
40%	0.5	40

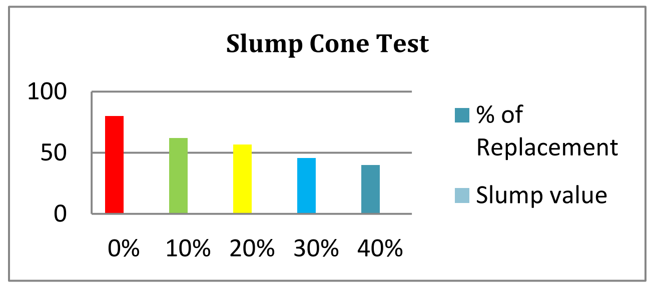

Chart-1 Bar Chart on M20 Mix Slump

2.1 Compressive Strength and Tensile Strength

Three cubes of same mix proportion. Cast the cubes and these cubes are kept at a temperature of 27±2ºC for 24 hours. After 24 hours the cubes are immersed in clean fresh water. The cubes are kept in water until time of testing. Specimens are removed from water after specified curing period and allowed to dry for 1 hour for surface drying. These cubes are tested for their compressive strength after 7 and 28 days curing in a compression testing machine, loading being uniform at the rate of 350 kg/cm^2/minute. The load at failure is noted and compressive strength is calculated. For 7 days and 28 days are as follows.

Table- 2 Compressive Strength Test Results for M20 Grade Concrete

Sl. No	Percentage Replacement Of Wastages	Average Compressive Strength For 7 Days (N/mm^2)	Average Compressive Strength For 28 Days (N/mm^2)
1.	0%	22.62	26.13
2.	10%	23.75	35.58
3.	20%	25.64	36.5
4.	30%	22.26	32.71
5.	40%	18.02	23.88

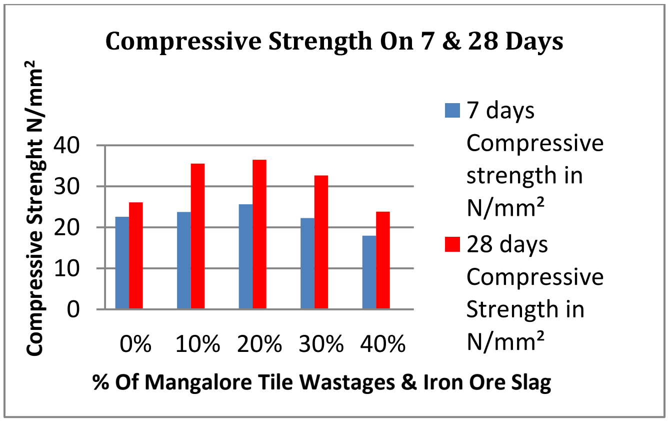

Chart-2 Compression Strength of Cubes for 7 & 28 Days

2.2.1 Observation

The graph indicates the variations of compression strength of cube and tensile strength of cylinder for a curing period of 28 days. It has been observed that the compression and split tensile strength of proposed mix increases up to 20% and thereafter the compression strength and tensile strength start decreasing, it can be concluded that the optimum compressive and tensile strength is gained for replacement percentage of 20%.

Fig-2 Cube Specimens Showing before and after failure

Table-3 Shows Split Tensile Strength Test Results

Sl. No	Percentage Replacement Of Wastages	Average Tensile Strength For 7 Days (N/mm^2)	Average Tensile Strength For 28 Day (N/mm^2)
1.	0%	2.27	3.05
2.	10%	2.29	2.81
3.	20%	2.35	3.24
4.	30%	2.31	3.05
5.	40%	2.23	2.89

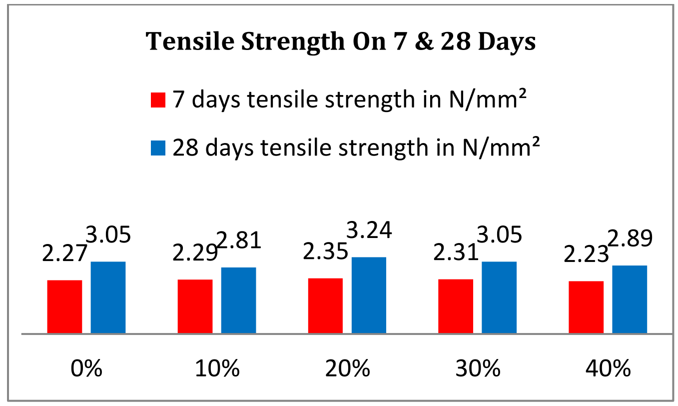

Chart-3 Split Tensile Strength for Cylinder of Curing Period 7 & 28 Days

Fig-3 Cylinder Specimen Showing before and after failure

3. COST ANALYSIS

For 1m³ Nominal Concrete
Mix Proportion (1: 1.71: 3.02)
Cost comparison of conventional concrete against proposed concrete is made in this section

Table-4 Cost Analysis for (M20) Mix

Particulars	Quantity	Rate per ton	Amount in R_s
Cement	8.4 Bags	400/bag	3360 /-
Fine Aggregate	716.23 kg	2350/ton	1683 /-
Iron Ore Slag	-	630/ton	-
Coarse Aggregate	1264.92 kg	730/ton	924 /-
Mangalore Tile Wastage	-	150/ton	-
Total Amount = **5967 Rupees**			

Table-5 Cost Analysis for Conventional Concrete

% OF REPLACEMENT	AMOUNT IN R_S	COST REDUCED IN PERCENT (%)
0%	5967 /-	0 %
10%	5770 /-	3.3%
20%	5568 /-	6.7%
30%	5379 /-	9.86%
40%	5180 /-	13.2%

4. CONCLUSIONS

- From graph of compressive strength we can conclude that strength increases with addition of iron ore slag and Mangalore tile wastages up to 20%, further increase in the amount of replacement decreases the cube strength.
- The split tensile strength increases with increase in percentage of Mangalore tile wastages and iron ore slag by 20% by weight of the fine aggregate. The split tensile strength decreases or varies with further increase in the amount of Mangalore tile wastages and iron ore slag.
- The designed concrete mix (M20) showed higher water absorption of nearly 10 %, which is due to porous structure of Mangalore tiles as a coarse aggregate
- Eco-friendly and Mass utilization of waste material is possible in construction by using iron ore slag and Mangalore tile wastages for partial replacement of fine & coarse aggregate in concrete.
- In comparison to M20 mix nominal concrete, the proposed concrete is economically cheaper by about 15 percent.

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3. Kiran Bhat P (June 2018), "Study on Compressive Strength of Concrete by Partial Replacement of Coarse Aggregates with Highly Heated Mangalore Tiles", Volume-9, issue-6, june-2018.

4. Mix is considered and designed as per Indian Standard Specification IS: 10262(2009)

5. IS 383-1970 specifications for coarse and fine aggregate from natural sources for concrete IS 2386 part III-1963 methods of test for aggregates of concrete

6. IS 5513-1969 specification for Vicat apparatus

7. IS 516-1959 method of tests for strength of concrete

BIOGRAPHIES

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