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UTILIZATION OF IRON ORE TAILINGS AND MARBLE POWDER AS PARTIAL REPLACEMENT FOR FINE AGGREGATES IN THE RIGID PAVEMENTS

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ABSTRACT
As the demand of concrete structures is more nowadays and to emphasizing the usage of eco-friendly materials in concrete, in this project the cement is partially replaced by marble powder and natural sand is partially replaced by iron ore tailings. The practical examination has been carried out in order to determine the strength characteristics of concrete. Moreover, the effect of replacing various percentages of marble powder and iron ore tailings on the compressive strength, splitting tensile strength (Indirect tensile strength) & flexural strength has been observed and compared with conventional concrete mix of M30. The Marble powder and iron ore tailings (MP 0%: IOT 10%), (MP 0%: IOT 10%),(MP 10%: IOT 10%),(MP 10%: IOT 15%),(MP 15%: IOT 10%),(MP 15%: IOT 15%) has been used as the partially replacement of cement and sand. As per the investigation, better results are at (MP 10%: IOT 15%) for all cubes, cylinders and beams.

Keywords: Control mix (CC), Marble powder (MP), Iron Ore Tailings (IOT), Tensile strength, Compressive strength, Flexural strength.

1. INTRODUCTION

The modernism of concrete technology can decrease the utilization of natural resources and energy sources. Economical and easily available waste materials are costless and widely available, which can be easily replaced by cement and sand in concrete. Marbles are mainly used in flooring purpose in building construction. A large amount of waste is produced during the working of processes like sawing, grinding and polishing. Hence marble is the better option of replacement with cement. This project explains the possibility of using the marble dust powder in concrete manufacturing as the partial replacement of cement. On the other hand, the demand for natural sand is growing day by day which lead to the usage of different alternative materials, which are naturally available in India. Iron ore tailings is the best source for replacing natural sand because of its availability all over India from different Iron and Steel producing Units. The major aim of this study is to evaluate IOT as replacement of sand in concrete and compare with the results of conventional concrete.

2. LITERATURE REVIEW

(01) Aalok D. Sakalkale et al (2014), replacement of natural sand by marble dust. The replacement is partially and fully done in proportion of 0%,25%,50% and 100% and its effect on properties of concrete were investigated. The compressive strength of concrete is increased with the addition of waste marble powder up to 50% by weight in place of sand and further any addition of waste marble powder, the compressive strength decreases.
(02) Devesh Meena et al (2015), the replacement ratios which have been studied were 0.0%, 10%, 20%, 30%, 40%, and 50% by weight. Water cement ratio kept 0.55, Concrete made with marble dust as sand replacement achieved better performance compared to normal concrete.
(03) Kia Liu et al (2015), the IOS cement mortar not only has high performance on thermal conductivity but also has low cost feature. The new thermal conductive material presented in this paper facilitates applications in fields such as chemical industries, petroleum pipeline, snow melting and heating.

(04) Prof. N. Kisku et al (2016) used marble dust powder in M20 grade of concrete at(0%,5%,10%,15%,20%,25% and 30%) with partial replacement by weight of cement. Water/Cement ratio (0.5) was kept constant in all the concrete mixes. The concrete samples were tested for compressive strength and split tensile strength after 7&28 days of proper curing. The results of the laboratory tests showed that replacement of cement with marble dust powder increases up to 10% both for compressive strength and split tensile strength of concrete.

3. MATERIALS

3.1 Marble powder

Marble powder is taken from the marble computing plants during the cutting, shaping, and polishing. Marble powder was collected from the Soami marble, Kharar. Sieved by IS-90 micron sieve before mixing in concrete.The physical and chemical properties of marble dust powder are listed in Table 1 and Table 2 respectively.

Fig.1 Marble powder

Physical Characteristics	Value
Loss of ignition	43.63
Specific gravity	2.63
Fineness(kg/m^3)	350
Color	White
Water absorption	0.97%

Table 1. Physical Properties of Marble Powder

Chemical characteristics	Value
SiO_2	13.8
CaO	43.2
MgO	2.70
AI_2O_3	2.50
Fe_2O_3	1.9
SO_3	0.07
K_2O	0.60
CL	0.03
Na_2O	0.90

Table 2. Chemical properties of Marble powder

3.2 Iron Ore Tailings

The physical and chemical properties of Iron Ore Tailings used in this project are listed in Table 3 and Table 4 respectively.

Fig 2. Iron Ore Tailings

Chemical Characteristics	Value
Silicon dioxide	73.41
Aluminum oxide	7.34
Calcium oxide	3.55
Magnesium oxide	2.93
Sodium oxide	0.31
Potassium oxide	0.045

Table 3. Chemical properties of Iron Ore Tailings

Physical Characteristics	Value
Color	Brown
Specific gravity	3.33
Moisture content	6%
Bulk density	1480 kg/m^3
Water absorption	3.97%
Fineness modulus	2.545

Table 4. Physical properties of Iron Ore Tailings

3.3 Cement

The basic component of the concrete is cement. The Portland Pozzolona cement of grade 53 has been used. Physical properties of cement are as per the Table 5.

Characteristics	Value
Specific Gravity	3.15
Consistency	32%
Initial Setting Time	30 min
Final Setting Time	600

Table 5. Physical properties of cement

3.4 Fine aggregates

Aggregates passing through 4.75mm IS Sieve & retained on 150 microns have been used. The specific gravity of fine aggregates found to be 2.72.

3.5 Coarse aggregates

The aggregates are locally accessible. 50% are of 10-12 mm size and the remaining 50% are of 20mm size. The specific gravity of coarse aggregates found to be 2.72.

3.6 Water

Normal water available in the University has been used for concreting and curing, guidelines as per IS-456:2000

4. MIX DESIGN (IS 456 – 2000, IS 10262:2009) [4], [5]

In India generally, mix design is carried out using Indian standard codes IS 456-2000, & IS 10262-2009. In this dissertation work, M30 grade has been designed of 1: 1.92: 3.01 by volume and the water-cement ratio of 0.45 has been used.

5. EXPERIMENTAL WORK

The size of moulds used for the cubes is (150x150x150) mm, 42 in number. Cylinders of 150mm height, 300mm diameter, 42 in number and beams of (100x100x500)mm,42 in number. The final strength of cubes, cylinders, and beams has been tested after 7 and 28 days curing. Compression testing machine has been utilized for testing the compressive strength of cubes and split tensile strength of cylinders and the flexural testing machine has been used for finding the flexural strength of the beams.

6. RESULTS AND DISCUSSIONS

6.1 Compressive Strength of cubes

The specimens for the concrete cubes have been tested for 7 days & 28 days in order to determine the initial strength after 7 days and final strength after 28 days. The cubes are tested in the compression testing machine; the results are shown in Table.6

Percentage of marble powder and iron ore tailings	7 days strength of Cube (N/mm^2)	28 days strength of Cube (N/mm^2)
CCO%	23.81	35.26
0%MP:10%IOT	32.59	41.85
0%MP:15%IOT	30.98	42.55
10%MP:10%IOT	33.59	43.67
10%MP:15%IOT	34.02	45.26
15%MP:10%IOT	32.78	43.77
15%MP:15%IOT	31.07	42.36

Table 6. Compressive strength test results

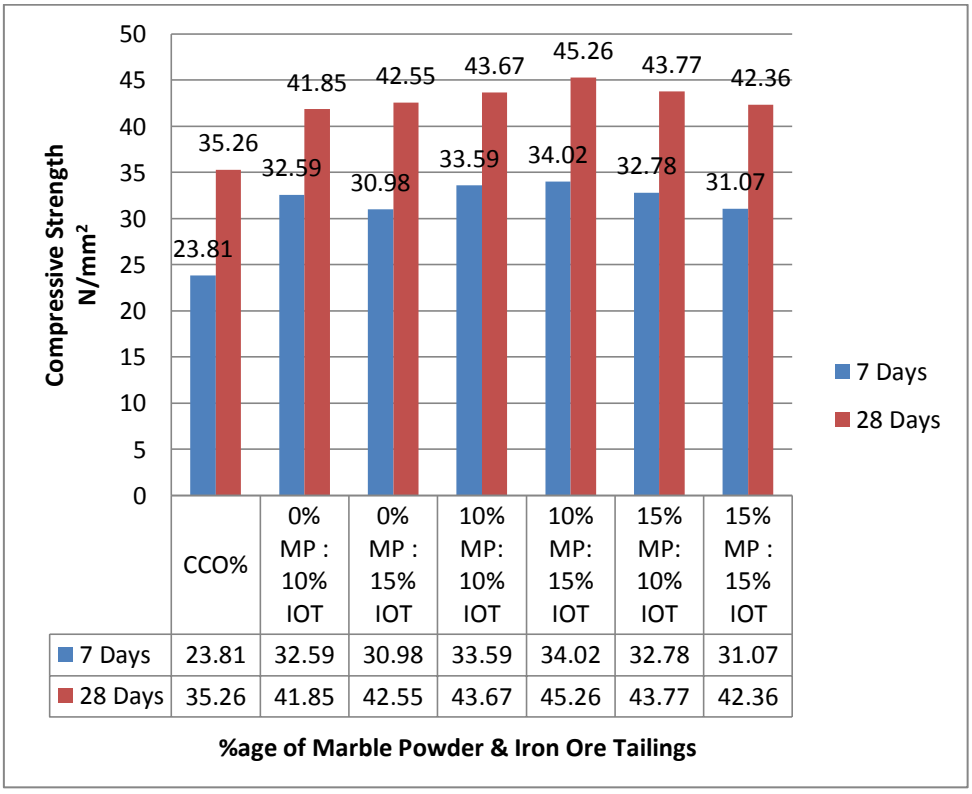


Fig. 3 Compressive strength of cubes

Fig.3 is showing the graph of compressive strength of cubes for control mix and various percentages of iron ore tailings and marble powder.

6.2 Split tensile strength

Total 42 cylinders have been tested in compression testing machine, the testing has been done for 7 and 28 days in order to find the split tensile strength of cylinders, and the results are shown in Table. 7

Percentage of marble powder and iron ore tailings	7 days strength of Cylinder (N/mm^2)	28 days strength of Cylinder (N/mm^2)
CC0 %	3.09	4.62
0% MP : 10% IOT	3.64	4.81
0% MP : 15% IOT	4.16	5.15
10% MP: 10% IOT	3.98	5.33
10% MP: 15% IOT	3.71	5.89
15 % MP: 10% IOT	3.59	5.53
15% MP : 15% IOT	3.43	5.31

Table 7. Split Tensile Strength Test Results

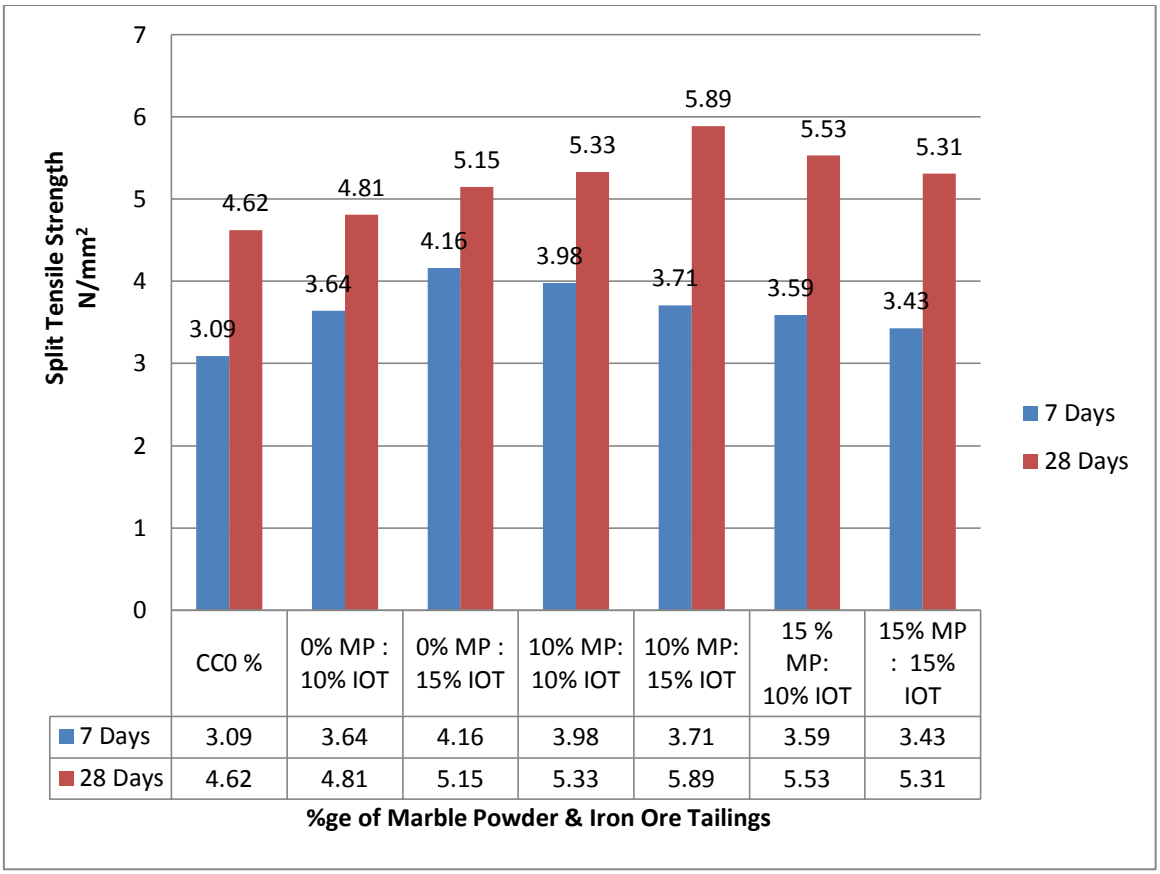


Fig. 4 Split tensile strength of cylinders

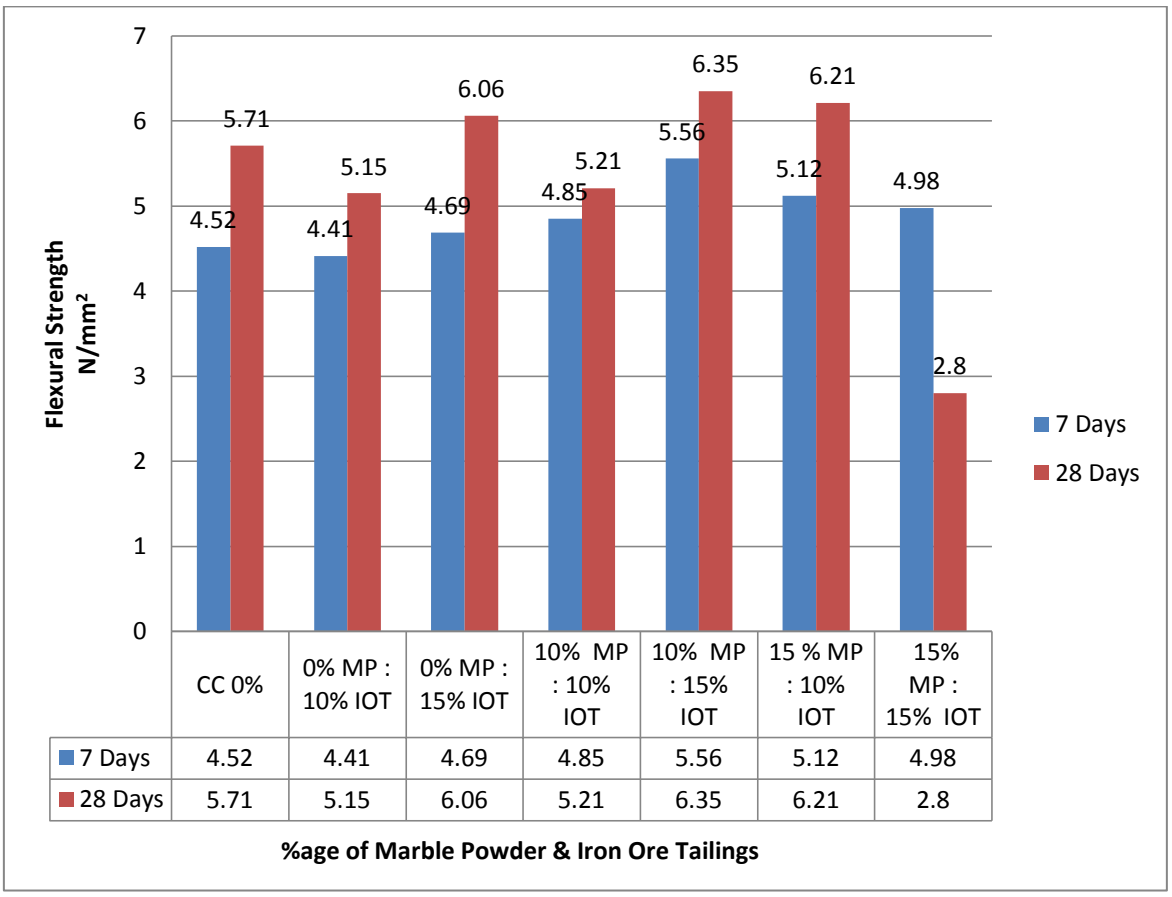
Fig.4 is showing the graph of tensile strength of cylinders for control mix and various percentages of iron ore tailings and marble powder.

6.3 Flexural Strength

The beams have been tested for the flexural behavior of hardened concrete. The flexural strength for 7 and 28 days curing are shown in Table.8

Percentage of marble powder and iron ore tailings	7 days strength of Beam (N/mm^2)	28 days strength of Beam (N/mm^2)
CC 0%	4.52	5.71
0% MP : 10% IOT	4.41	5.15
0% MP : 15% IOT	4.69	6.06
10% MP : 10% IOT	4.85	5.21
10% MP : 15% IOT	5.56	6.35
15 % MP : 10% IOT	5.12	6.21
15% MP : 15% IOT	4.98	6.03

Table 8. Flexural Strength of Beams



	CC 0%	0% MP : 10% IOT	0% MP : 15% IOT	10% MP : 10% IOT	10% MP : 15% IOT	15 % MP : 10% IOT	15% MP : 15% IOT
7 Days	4.52	4.41	4.69	4.85	5.56	5.12	4.98
28 Days	5.71	5.15	6.06	5.21	6.35	6.21	2.8

Fig. 5 Flexural strength of beams

Fig. 5 is showing the graph of flexural strength of beams for control mix and various percentages of iron ore tailings and marble powder.

7. CONCLUSIONS

From the respective study following conclusion can be seen:

1. As per the investigation, better results are at (**MP 10%: IOT 15%)** for all cubes, cylinders and beams.
2. The Compressive strength of Concrete increases up to **(MP 10%: IOT 15%)** and starts decreasing for the further % values.
3. The Split tensile strength of concrete increases up to **(MP10%: IOT 15%)** and starts decreasing for the further % values.
4. The Flexural strength increases up to **(MP 10%: IOT 15%)** and starts decreasing for the further % values.
5. To save the environment, MP and IOT may be used as a better partial substitute of cement and sand in concrete.
6. Iron ore tailings and marble waste powder both wastes can be effectively used in the concrete mix as an eco-friendly construction material.
7. The use of marble waste powder represents good performance due to proficient micro filling ability.

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