Experimental Study of Concrete Using Iron and Marble as Partial Replacement of Sand

R. Urmila, B. Balraj, Prudhvi Vasanth Saikumar, R. Sridhar, P. Vetriselvan

Abstract— Now-a-days environmental problems are very common in India due to generation of industrial by-products. Due to increase in industrialization the waste products also increase and to utilize these waste products is a big concern. Iron granules and marble dust are some of the industrial by-products from the iron and marble making industries. Large number of studies are going on to improve the performance of concrete with the help of innovative chemical admixtures and supplementary materials. The materials are used in majority of by-products or industrial waste from other processes. This paper presents experimental investigation on effect of addition of marble and iron as partial replacement of fine aggregates on the mechanical properties of concrete such as compressive strength, split tensile strength and flexural strength. The concrete specimen is casted for 7 days, 14 days and 28 days curing to obtain the test results. Optimum strength of concrete is achieved at 15%. Compressive strength of concrete is carried out by varying the percentage of iron and marble at 5%,15%, 25% &35% by increase in weight as a partial replacement of sand.

Index Terms— Compressive strength, Flexural strength, Iron powder, Marble powder, Split tensile strength.

1 Introduction

Concrete is currently the most widely used construction material worldwide its numerous applications include that in bridges, dams, house constructions, highway pavements, and sidewalks. The advancement of concrete technology can reduce the consumption of natural resources and energy sources which in turn further lessen the burden of pollutants on the environment [11]. The use of manufactured fine aggregates has been increasing in the United States because good-quality natural sand is not economically viable in many areas [5]. Manufactured fine aggregates differ from natural sand in terms of grading, particle shape, and texture. Industrial wastes from the steel industry such as iron ore tailings andiron powder wastes from steel production can be hazardous to the environment [2]. An aggregate constitutes about 70-80 percent volume of concrete and significantly impacts its various properties. Due to rapid growth in the demand of concrete throughout the world, even some developed countries have undergone some shortage in the supply of aggregates. Therefore, there is a need for research to find an eco-friendly and easily available alternative to the use of constituent materials in concrete [8]. Thus, artificial sand/fine aggregate appear as an attractive alternative to natural sand for concrete [10]. The study investigated the utilization of the huge amount of iron waste from workshops, factories, and demolished buildings in building construction [4].

2 Materials and Methods

2.1 Cement

Ordinary Portland cement (53 Grade) was used for casting all the specimens. The following experiments were conducted to find the properties of cement as per IS-4031.

2.2 Fine Aggregate

Aggregates of size less than 4.75mm are considered as fine aggregates. The sand particles should be free from any clay or inorganic materials.

2.3 Coarse Aggregate

The aggregates of size greater than 4.75mm are called coarse aggregates. They generally range between 9.75mm to 37.5mm.

TABLE 1

Properties of marble

S. No	Properties	Values
1)	Colour	White
2)	Form	powder
3)	Specific gravity	2.028
4)	Water absorption	1.121%

2.4 Marble

Marble dust which is used in this investigation was obtained during polishing and cutting of marble [7][1]. Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased. We can reduce the environmental pollution by utilizing this marble powder.

2.5 Iron

Iron waste is a by-product material. When the waste material is disposed of, it will affect the environment. Over the past few years, the amount of this material has been increased by steel factories. In order to reduce the impact of waste material on the environment, iron waste could be used instead of sand concrete mixture. Slag is a partially vitreous by-product of the process of smelting ore, which separates the desired metal

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fraction from the unwanted mass [3].

TABLE 2
PROPERTIES OF IRON

S. No	Properties	Values
1)	Colour	Silvery grey
2)	Form	Granules
3)	Specific gravity	6.705
4)	Water absorption	2.089%

2.6 Specific Gravity test

Specific gravity test of Cement, Coarse Aggregate, Fine Aggregate, Marble and Iron are listed below

TABLE 3
SPECIFIC GRAVITY OF ALL MATERIALS

CEMENT	2.977
FINE AGGREGATE	2.49
COARSE AGGREGATE	2.66
MARBLE	2.028
IRON	6.705

2.7 Mix proportions

TABLE 4
MIX PROPORTIONS / M3FOR MARBLE

TABLE 5

SPECIMEN	CEMENT (kg)	FINE AGGREGATE (kg)	MARBLE (kg)	COARSE AGGREGATE (kg)	WATER (kg)
A (5%)	13.5	18.083	0.951	33.22	6.08
B (15%)	13.5	16.8	2.855	33.22	6.08
C (25%)	13.5	14.8	4.758	33.22	6.08
D (35%)	13.5	12.37	6.66	33.22	6.08

MIX PROPORTIONS /M3 FOR IRON

3 RESULT AND DISCUSSION

SPECIMEN	CEMENT (kg)	FINE AGGREGATE (kg)	IRON (kg)	COARSE AGGREGATE (kg)	WATER (kg)
A (5%)	13.5	18.083	0.951	33.22	6.08
B (15%)	13.5	16.18	2.855	33.22	6.08
C (25%)	13.5	14.28	4.758	33.22	6.08
D (35%)	13.5	12.37	6.66	33.22	6.08

3.1 Casting of Concrete

The specimens were casted by altering the percentages of fine aggregate with marble and iron by 5%, 15%,25%& 35%.

The cube specimens of standard dimension 150mm X 150mm X 150mm were casted with the following proportions.

FIG. 1 CUBE SPECIMENS

3.2 Testing Specimens

3.2.1 Compressive Test

Compressive strength test for Marble & Iron to be conduct on cubes in different percentages i.e. 5%, 15%, 25%, 35% for 7, 14, & 28 days with proper curing and proper placement of cubes.

FIG. 2 TESTING OF CUBES

3.3 Compressive Strength

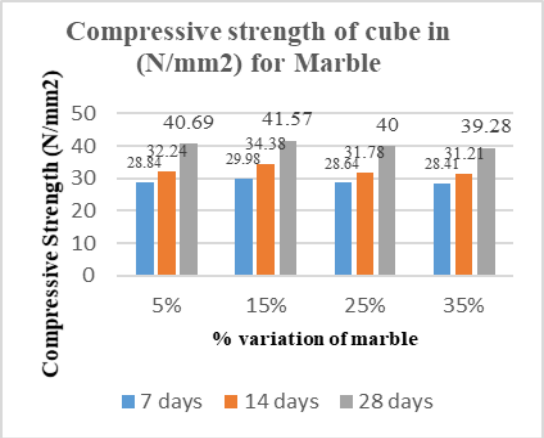

Fig 5: Compressive strength of cube in (N/mm2) for Marble

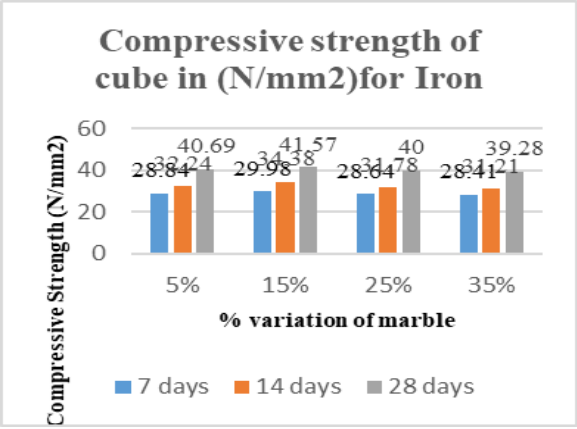

FIG 6: COMPRESSIVE STRENGTH OF CUBE IN (N/MM2) FOR IRON

3.4 Splint Tensile Strength

TABLE 6

LOAD OCCURRING ON CYLINDER BY15% OF MARBLE

Specimen	7th Day (N/mm²)	14th Day (N/mm²)	28th Day (N/mm²)
B (15%)	1.50	2.05	2.87

TABLE 7

LOAD OCCURRING ON CYLINDER BY15% OF IRON

Specimen	7th Day (N/mm²)	14th Day (N/mm²)	28th Day (N/mm²)
B (15%)	1.10	1.78	2.80

3.5 Flexural Strength

TABLE 8

LOAD OCCURRING ON PRISM BY 15% OF MARBLE

Specimen	7th Day (N/mm²)	14th Day (N/mm²)	28th Day (N/mm²)
B (15%)	0.00	1.5	4.5

TABLE 9

LOAD OCCURRING ON PRISM BY 15% OF IRON

Specimen	7th Day (N/mm2)	14th Day (N/mm2)	28th Day (N/mm2)
B (15%)	0.00	1.5	3.75

4. CONCLUSION

As per 7, 14- & 28-days test results, the following conclusions were made: The partial replacement of fine aggregate by marble and iron increases the strength of concrete mix [6]. The optimum replacement of fine aggregate by marble powder and iron was found to be 15%. At 15% replacement the compressive strength of concrete was found to be increased by 14.3% in marble [10] and 8.7% when compared to conventional concrete.

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