Experimental Investigation with Marble Dust Powder as a Partial Substitution of Cement for M20 Grade Concrete

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Abstract- *Concrete is the most extensively used and adaptable building material which is generally used to resist compressive forces. Since the use of cement and production of cement creates much more environmental issues and is costlier also. Marble Dust is a developing composite material that will allow the concrete industry to optimize materiel use, produce financial profit and construct structures that will be strong, durable and sensitive to the environment. The potential use of Marble Dust can be an ideal choice for substituting in a cementitious binder as the reactivity efficiency increases due to the presence of lime. The waste generated from the industries causes environmental problems. Hence the reuse of this waste material has to be emphasized. It has been estimated that several million tons of Marble dust are produced during quarrying worldwide. Hence utilization of marble powder has become an important alternative materials towards the efficient utilization in concrete for improved harden properties of concrete. A marble dust, obtained as a by-product of marble cutting, sawing, shaping was characterized from physical and chemical point of view for using it as binding material in production of concrete and mortar. Marble is a metamorphic rock resulting from the transformation of a pure limestone. Marble dust contains high calcium oxide content of more than 50%. To avoid adverse environmental circumstances, the content of cement is reduced in concrete and replaced by marble dust which reduces cost and addition of marble dust also increases strength and durability of concrete. The marble dust was replaced with cement at 0%, 3.5%, 7%, 10.5%, 14%, 17.5% & 21% by weight for M20 grade concrete. Concrete mixes were experimentally tested and compared in terms of compressive strength of the conventional cement concrete at 28 days for 150mm cubes.*

Keywords- Marble Dust, Compressive Strength, W/C Ratio, Replacement.

I. INTRODUCTION

It has been estimated that several million tons of MDP are produced during quarrying worldwide. Hence utilization of marble powder has become an important alternative materials towards the efficient utilization in concrete for improved harden properties of concrete. Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its color and appearance it is white if the limestone is composed solely of calcite (100% CaCO3). Marble is used for construction and decoration; marble is durable, has a noble appearance, and is consequently in great demand. Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. The other mineral constituents vary from origin to origin. The main impurities in raw limestone (for cement) which can affect the properties of finished cement are magnesia, phosphate, leads, zinc, alkalis and sulfides. A large quantity of MDP is generated during the cutting process. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons. Leaving these waste materials to the environment directly can cause environmental problem.

Moreover, there is a limit on the availability of natural aggregate and minerals used for making cement, and it is necessary to reduce energy consumption and emission of carbon dioxide resulting from construction processes, solution to this problem are sought through usage of MDP as partial replacement of Portland slag cement. In India, MDP is settled by sedimentation and then dumped away which results an environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. Therefore, utilization of the MDP in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently

II. PROJECT OBJECTIVE

The research will cover studying physical and chemical properties of marble waste powder blended Portland cement and studying compressive strength , flexural strength , stress-strain characteristic, split tensile strength and water permeability of concrete produced by marble dust blended cement and marble waste blended sand. Throughout the investigation, the research will be limited to the same factories which process marble waste powder.

The main objectives of this study are:

1. To study the influence of percentage replacement of cement by marble waste powder on the physical properties of Portland cement paste.
2. To study the effects of percentage replacement of cement by marble waste powder on different properties of concrete.
3. To achieve desired strength of M-20 grade of concrete.

III. MATERIALS USED

1. CEMENT:

Ordinary Portland cement (OPC) Of 53 grades satisfying the requirements of IS: 8112- 1939 is used. The specific gravity of cement was found to be 3.0.

2. Sand:

Natural sand which is easily available and low in price was used in the work. It has cubical or rounded shape with smooth surface texture. Being cubical, rounded and smooth texture it give good workability. Sand which is used here is taken from Ganga River. Particles of this sand have smooth texture and are blackish. Sieve analysis was done to find out fineness modulus which comes out to be 3.14% which is under limit as per IS 383-1970.

3. COARSE AGGREGATES:

The aggregate used in this project mainly of basalt rock which comes under normal weight category. The aggregates are locally available. 50% of the aggregate used are of 10-12 mm size and remaining 50% are of 20mm size.

4. MARBLE DUST:

Marble has been commonly used for various purposes like tiles; shell etc., as a building material since the ancient times. The industry's removal of the marble powder material, consisting of extremely fine powder, today constitutes one of the environmental problems around the world. In India, marble dust is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. Therefore, utilization of the marble dust in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment. Some attempts have been made to find and assess the possibilities of using waste marble powder in mortars and concretes and results about strength and workability were compared with control samples of usual cement-sand concrete. The use of the replacement materials offer cost decrease, energy reserves, arguably superior products, and fewer hazards in the environment. These materials participate in the hydraulic reactions, contributing significantly to the composition and microstructure of hydrated product.

Figure 1. Marble Dust Powder

IV. RESULTS AND DISCUSSIONS

Compressive Strength Test: A minimum of three cubes are casted in each batch mix for determining compressive strength. Tests are performed at the age of 28 days of the specimens. Specimens are placed in the test machine as per IS: 516-1959 clause no 5.5.1 page no 11, also loading is applied on the specimen as per the same IS code.

Table 1. Compressive Strength Test Result

Mix	Replacement %	Compressive Strength (N/mm^2)		
		7 days	14 days	28 days
M-1	0	18.20	20.66	24.15
M-2	3.5	15.38	17.72	20.33
M-3	7	17.26	19.88	22.84
M-4	10.5	18.93	21.76	25.17
M-5	14	21.76	24.73	28.68
M-6	17.5	21.10	24.05	27.34
M-7	21	21.58	23.03	28.16

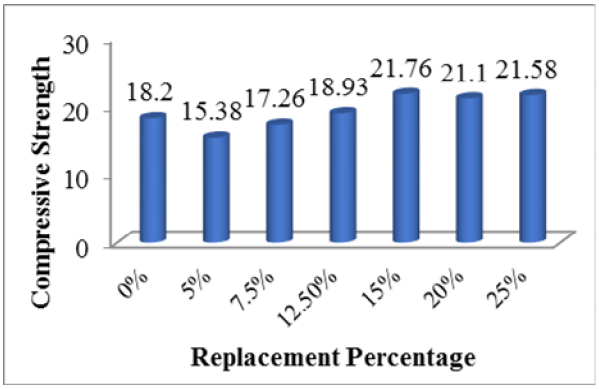

Figure 2. Graph 1: Compressive Strength for 7 days (in N/mm2)

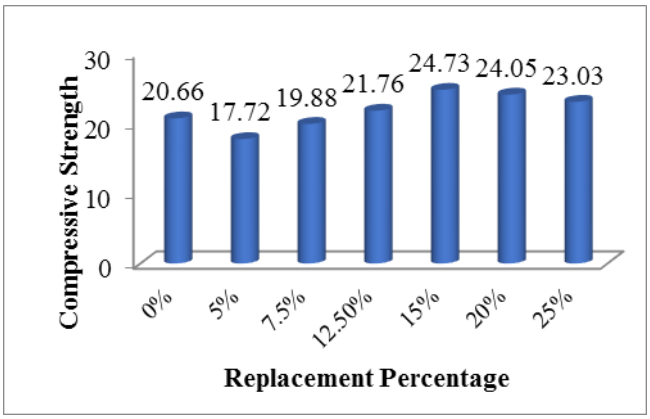

Figure 3. Graph 2: Compressive Strength for 14 days (in N/mm2)

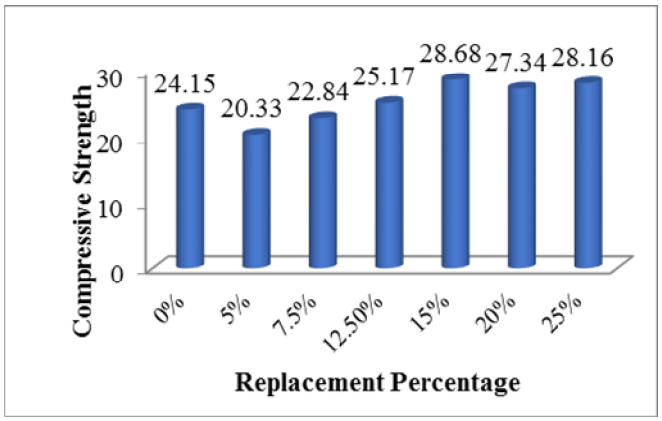

Figure 4. Graph 3: Compressive Strength for 28 days (in N/mm2)

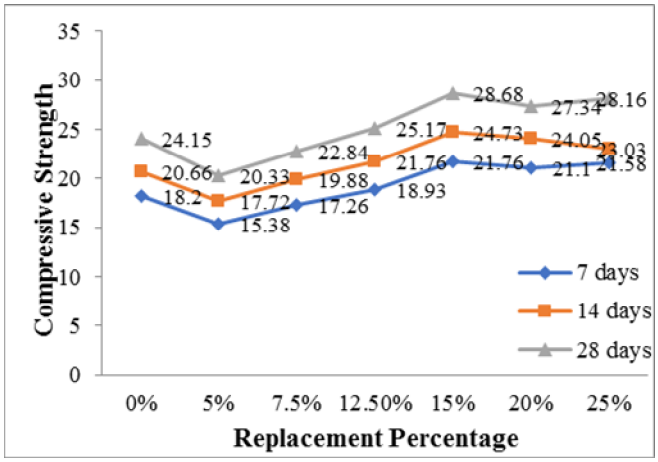

Figure 5. Graph 4: Compressive Strength at various age (in N/mm2)

As shown in the graph 1: (7 days strength), when cement is partially replaced 14% by MD, compressive strength is increased by 27.68%. Afterwards when addition of % of MD is replaced, strength starts decreasing, a minimum strength is achieved.

When graph 2: (14 days strength) is analyzed, 14 % replacement of marble dust gives 24.5% more strength when compared with conventional concrete.

28 days strength in graph 3 shows an increment of 26.85% of strength of 14% replacement of marble dust as compared with conventional concrete. Again strength is decreased when addition of percentage of marble dust As discussed here, it can be said that an increment in compressive strength of 14 % replacement of marble dust gives 27% strength is achieved as compared with conventional concrete mix i.e. Mix-01.

V. CONCLUSION

After performing the test and analyzing their result, the following conclusions have been derived:

1) The results achieved from the existing study shows that Marble Dust is great potential for the utilization in concrete as replacement of cement.
2) Workability of concrete decreases as proportion of Marble Dust increases.
3) Maximum compressive strength was observed when Marble Dust replacement is about 14%.

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