Study of Compressive Strength of Concrete by Partial Replacement of Cement with Marble Dust Powder

[1]Abdullah Anwar, [2]Juned Ahmad, [3]Meraj Ahmad Khan, [4]Sabih Ahmad, [5]Syed Aqeel Ahmad

[1234] Department of Civil Engineering, Integral University, Lucknow, Uttar Pradesh, India 226026
Email: [1]a.anwar14330@gmail.com, [2]sjahmad123amu@gmail.com, [3]merajrafi@rediffmail.com, [4]sabihahmed10@gmail.com, [5]syedaqeel@iul.ac.in

Abstract— Marble Dust Powder is one of the most dynamic research areas that cover a number of subjects including civil engineering and building fabrics. Marble Dust Powder is settled by sedimentation and then dumped away, which results in environmental contamination, in addition to forming dust in summer and threatening both agriculture and public wellness. Therefore, utilization of the Marble Dust Powder in various industrial sectors, especially the construction, agriculture, glass and paper industries would help to protect the environment.

In this research work, Marble Dust Powder has replaced the (OPC & PPC) cement accordingly in the reach of 0%, 5%, 10%, 15% 20%, & 25% by weight of M-20 grade concrete. Concrete mixtures were developed, tested and compared in terms of compressive strength to the conventional concrete. The purpose of the investigation is to analyze the behavior of concrete while replacing the Marble Dust Powder with Different proportions in concrete.

Index Terms— Cement, Concrete, Compressive Strength, Marble Dust Powder, Partial Replacement.

I. INTRODUCTION

Marble is a metamorphic rock produced from limestone by pressure and heat in the earth's crust due to geological process [1]. Marble Dust Powder is an industrial waste produced from cutting of marble stone. In INDIA, the marble processing is one of the most flourishing industry. Marble industries in India grow more than 3500 metric tons of marble powder slurry per day. The cement industry is one of the principal producers of carbon dioxides, a major greenhouse gas 5-10% [2]. Marble stone industry generates both solid waste and stone slurry. Whereas solid waste results from the rejects at the mine sites or at the processing units. Marble Stone slurry is a semi liquid substance consisting of particles originating from the sawing and the polishing processes and water used to cool and lubricate the sawing and polishing machines. Marble Stone slurry generated during processing corresponds to around 40% of the final product from stone industry. This is relevant because the stone industry presents an annual output of 68 million tonnes of processed products. Hence, the scientific and industrial community must commit towards more sustainable patterns. In that respect, are several reuse and recycling results for this industrial byproduct, both at an experimental phase. These industrial wastes are dumped in the nearby land and the natural fertility of the soil is spoiled. The advancement of concrete technology can reduce the use of innate resources and energy sources which in turn further lessen the burden of pollutants on the environment. The use of partial replacement of cement by marble dust powder, cut down some cement production, thus brings down the requirement for land area for drawing resources and disposal of industrial waste too. Presently, big amount of marble dust is brought forward in natural stone processing plants with an important impact on the environment and humans. Going along the waste materials to the environment right away can cause environmental problems (Siddharth Pareek, 2001; Binici et al. 2007; Stone 2000; 1998; 1992; Kearey, 2001) [3] -[6].

Valeria et al (2005) in their study observed that marble powder had very high Blaine fineness value of about1.5 m 2 /g, with 90% of particles passing through 50 μmsieves and 50% through 7 μm [7]. The authors also noted that the marble powder had a high specific surface area, meaning that its gain as a mineral in mortars and concretes, especially in self-compacting concrete should impart more cohesiveness. Satish et al [8], worked extensively on the hardened properties of bituminous concrete with marble dust as filler. Fillers are fine aggregate material that passes 0.063mm sieve [9]. The behavior of bituminous concrete with marble dust compared very well with bituminous concrete with lime and stone dust. Houari et al [10] investigated the abrasion resistance of concrete produced by the percentage substitution of sand by marble waste powder, the result compared well with concrete without marble powder. India is among the top world exporters of marble stone. The Indian marble industry has been growing steadily at an annual rate of around 10% per year. 20 to 30% of marble blocks are converted into

powder. 3,172 M tons of marble dust were produced in year 2009-10. Recently, marble dust powder has been used in the construction industry and research has been carried on to examine their fruitful result.

So, this is to study the utilization of marble dust powder in the construction industry to address environmental problem due to the waste and to seek alternative for cement and sand based material and for efficient use of natural resource.

We are also straining to determine the percentage of marble powder replaced with concrete that achieve the optimum strength of the concrete. Therefore, by partially replacing cement with marble powder, we are suggesting a method that can be of great use in reducing pollution to a large extent. Trial results demonstrate that this industrial bi-product is capable of improving concrete performance up to the optimum percentage of 10%. Therefore, enhancing fresh concrete behavior and can be employed in architectural concrete mixtures containing white cement.

The marble dust powder replacement was kept at 0%, 5%, 10%, 15%, 20% and 25%. There were 18 cubes of OPC and 18 cubes of PPC (150mm × 150mm × 150mm) were examined and results were analyzed after curing 28 days.

II. EXPERIMENTAL MATERIALS

A. Cement

Commercially available Portland Pozzolana Cement and Ordinary Portland Cement of 43 grade manufactured by the JP Cement Company confirming to IS 8112:1989 was used in the study [11]. The Properties of Cement are shown in Table 1

Table 1 : Propeties of Cement

S. No	Details	Normal Consistency (%)	Specific Gravity	Setting Time(Min.)	
				Intial	Final
1.	PPC	28.50	2.93	110	270
2.	OPC (G-43)	26.75	3.05	80	190

B. Fine Aggregate

Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate. The specific gravity of sand is 2.60 and fineness modulus is 3.30%. The free and compacted bulk density values obtained are 1556 Kg/m3 and 1644 Kg/m3 and water absorption is 1.10%.

C. Coarse Aggregate

The Coarse aggregate are obtained from a local quarry is used. The coarse aggregate with a maximum size 10mm having a specific gravity 2.65 and fineness modulus of 6.51%. The loose and compacted bulk density values obtained are 1481 Kg/m^3 and 1570 Kg/m^3 respectively, water absorption of 1.50%.

D. Marble Dust Powder:

The Marble dust powder was collected from the locally available manufacturing unit in Lucknow. It was sieved by IS-90 micron sieve before mixing in concrete.

III. NOMINAL PROPORTION

The concrete mix is designed as per IS: 10262-1982 [12], IS: 456-2000 [13] for the normal concrete. The grade of concrete, which we adopted is M20. The concrete mix proportion (cement: fine aggregate:coarse aggregate) is 1:1.5: 3 by volume and a water cement ratio of 0.50.

IV. EXPERIMENTAL METHODOLOGY

The evaluation of Marble Dust Powder for use as a replacement of cement material begins with the concrete testing. The study is conducted to analyze the compressive strength of concrete when the base materials, i.e. cement is replaced with marble dust powder respectively. The marble dust powder replacement was kept at 0%, 5%, 10%, 15%, 20% and 25%. In all total 18 cubes of OPC and 18 cubes of PPC (150mm × 150mm × 150mm) were examined and results were analyzed after curing 28 days. Data obtained from the replacement is compared with data from a Conventional concrete.

V. EXPERIMENTAL SET-UP

Subsequently, on a detailed study we have obtained the following outcomes for the compression tests as shown in the table below:

A. FOR PPC

Table 2: Compressive Strength of Concrete

S. No.	Specimen	Compressive Strength at 28 days (N/mm^2)
1.	Conventional Concrete	24.27
2.	5%	23.74
3.	10%	22.79
4.	15%	21.57
5.	20%	20.24
6.	25%	19.00

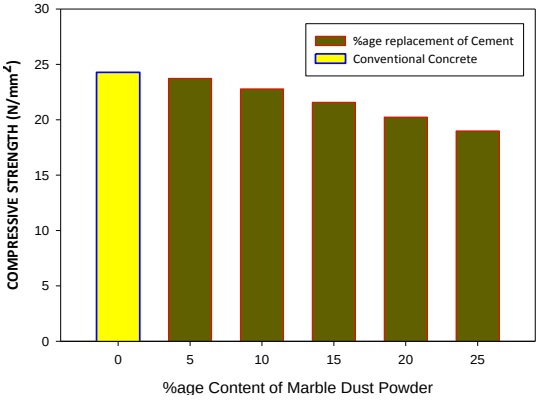

Fig.1 Compressive Strength on different types of Specimen

B. FOR OPC (G-43)

Table 3: Compressive Strength of Concrete

S. No.	Specimen	Compressive Strength at 28 days (N/mm^2)
1.	Conventional Concrete	30.24
2.	5%	28.32
3.	10%	27.24
4.	15%	26.23
5.	20%	24.30
6.	25%	22.59

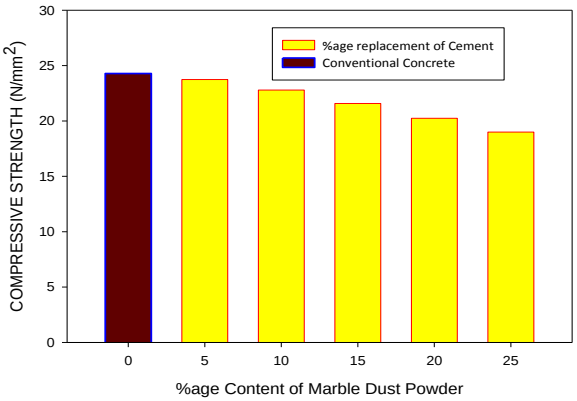

Fig.2. Compressive Strength on different types of Specimen

VI. RESULTS AND DISCUSSIONS

Compressive strength of concrete is tested on cube at different percentage of marble powder content in concrete. The strength of concrete cube has been tested with partial replacement of Cement (PPC and OPC) by Marble Dust Powder at different proportions of 5%, 10%, 15%, 20% and 25%, for the period of 28 days. Compression testing machine is employed for testing the compressive strength test on concrete.At different proportions, varying strength of concrete was observed which are measured in N/mm^2. The different proportion of marble dust in concrete, shows the reduction in compressive strength as compared to the conventional concrete. The result obtained for 28-day compressive strength confirms that the optimal percentage for replacement of cement with marble dust powder is about 10% as shown in Fig.1 (PPC) and Fig.2 (OPC).

VII. CONCLUSION

Marble dust powder has a potential to provide an alternative to cement and helps in maintaining the surroundings every bit well as economical balance. This paper investigated the Compressive Strength properties of concrete containing Marble Dust Powder at 0%, 5%, 10%, 15%, 20% and 25% of Portland cement. The investigation was primarily to determine a resolution to the disposal problem of marble dust by making usage of it in concrete production for sustainable construction development. The results so far have yielded some benefits. The result obtained for 28-day compressive strength confirms that the optimal percentage for replacement of cement with marble dust powder is about 10% as shown in Fig.1 (PPC) and Fig.2 (OPC). This will post less on the production of carbon dioxide and solving the environmental pollution by cement production; thereby enhances the urban surroundings.

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