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**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****PARTIAL REPLACEMENT OF CEMENT BY MARBLE DUST IN CONCRETE
FOR ENVIRONMENTAL SUSTAINABILITY****S Rehan Ali*¹, Abhi Jain², Saurav Tripathi³, Altamash Khan⁴, Sagar Sen⁵**

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ABSTRACT

Disposal of the marble dust from the marble industry, consisting of very fine powder, is one of the environmental problems worldwide today. In this work, marble powder, obtained as a by-product of marble quarrying, sawing and shaping, was characterized from a physical and chemical point of view for evaluating the possibility of using it in mortar and concrete production. But it can only be done without compromising the strength of concrete and construction. For achieving this goal, we have testified the compressive strength of the concrete after replacing cement by 5% , 10% and 15% by marble dust to check whether the strength is compromising or not. In addition to this we have also tested the workability of the concrete after partial replacement of cement by marble dust for the above mentioned proportion of marble dust in concrete. Results of the experimental work suggest that we can replace the cement up to 10% by marble dust in concrete use for construction.

KEYWORDS: Marble dust, Compressive strength, Workability, Cement, Concrete

1. INTRODUCTION

It has been estimated that several million tones of marble dust powder are produced during the quarrying, sawing and shaping the marble worldwide. Hence utilization of marble powder has become an important alternative material towards the efficient utilization in concrete with improved properties of concrete. The marble has been commonly used as a building material since ancient times. Marble dust additions in general influence the performance of fresh concrete and mortar. Therefore, an experimental study was carried out on various cement pastes prepared with marble powder in combination with cement in concrete. The basic objective was to investigate the influence of marble powder on properties of cement pastes for predicting the effect of its addition in concrete mixtures. In this study, very fine marble powder was used. It was obtained as a by-product of marble sawing and shaping. It was characterized from a physical and chemical point of view for evaluating the possibility of using it in mortar and concrete production.

2. OBJECTIVES

1. Use of marble as a substitute of cement in concrete to reduce the burden of cement thereby the carbon in atmosphere
2. To test the compressive strength and workability of concrete after the partial replacement of cement by marble powder in different proportions.
3. To reduce marble waste by consuming it in concrete without compromising the strength of concrete

3. LITERATURE REVIEW

Omar *et al.*, (2012) [1] studied the influence of limestone waste as partial replacement material for sand and marble powder in concrete properties. The different types of tests which was conducted during the experiment are: flexural strength test, compressive strength test, tensile strength, modulus of elasticity and water permeability. The results of Compressive strength test on the normal concrete with marble powder with different

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[16]



addition percentages 5%, 10% and 15% respectively are 33.7 MPa for 7 days, 40.6 MPa for 28 days and 44.5 MPa for 90 days.

Mohd 2015[2] studied on the effects which are arises in the strength of the concrete, when the polypropylene fibre is added with the concrete with different types of ratios. It was observed that there is the increment in the strength of the concrete. Other related procedures should be done to check more properties about such type of concrete.

Chaid and Perrot 2015 [3] studied on the effect of marble powder on the properties of high performance concrete in which he observed that the marble powder is suitable for the development of high performance type of concretes and their properties are better compared to that of reference concrete. His investigations showed that if there is the addition of 15% content of marble powder with a fineness modulus of 11500cm²/g then the mechanical properties of the concrete increases.

Singh *et al.*, (2016) [4] studied the effects of marble slurry on the process of hydration. In the procedure, the hardened concrete properties and durability properties were also tested. The different types of tests conducted during the experiment were: consistency, microstructure analysis, drying shrinkage, compressive strength, soundness, slump, % air entrained in concrete, flexural strength, modulus of elasticity, ultrasonic pulse velocity, split tensile strength, Schmidt hardness, carbonation and surface resistivity. Sample which is having marble dust with the proportion of 25% marble dust content showed highest carbonation depth of around 19mm. Hence, resistance to carbonation of mix was observed to be reducing.

Kore and Vyas 2016 [5] studied the effect of the marble waste as coarse aggregate on properties of lean cement type of concrete. The main objective of this study was utilization of marble waste as a replacement for conventional natural coarse aggregate in concrete. Conventional natural aggregate was replaced by marble aggregate in different percentages may be from 0%- 100% by weight with water- cement ratio of 0.60. It was observed that workability of concrete mixes containing marble aggregate was 14% more than that of control concrete.

Deepankar (2017) [6] studied the changes in the properties of the concrete by partial replacing the marble waste powder with sand and cement in a proportions of 10% and 15% respectively. It was observed that after replacing cement and sand by the marble powder, there was no change in the workability of the concrete. Due to the higher specific area, it was found that there was a very small decrement in the value of slump after the replacement of cement by marble waste powder.

Sharma *et al.*, (2017) [7] investigated the changes in the properties of the cement, when it is partially replaced by marble dust powder. The different types of tests conducted during the experiments were: flexural strength test, compressive strength test and durability test. The compressive strength test on the specimen was performed at the age of 7, 14 and 28 days. The maximum value of compressive strength was observed when the replacement is done with a proportion of 14 %.

Dhiman and Bhardwaj (2018) [8] observed that the use of marble dust offers cost reduction, energy savings and environmentally sustainable. In addition, the authors found that marble powder adsorbs more water than cement. As a result of this, the water ratio available for hydration is reduced leading to better mechanical strength.

4. MATERIALS AND METHODS

1. **Cement:** Cement in general sense are adhesive and cohesive materials which are capable of binding together particles of solid matter into a compact durable mass. For our project work, 43-grade Ordinary Portland Cement (OPC) was used.
2. **Aggregate:** It was used for providing bulk to the concrete. Both coarse and fine aggregate were used in our project work.
 - a) **Coarse Aggregate:** The aggregates which are retained on 4.75 mm IS sieve is termed as coarse aggregates: Coarse aggregates provide strength to concrete. For our project work. The aggregates

passing through 16 mm IS sieve and retained on 12 mm IS sieve was used. The aggregate thus used consist of both angular and rounded shape aggregate [9]

- b) **Fine Aggregate:** The aggregate which passes through 4.75 mm IS sieve is termed as fine aggregate. Fine aggregate assists in producing workability and uniform mixture. For our project work, the sand passing through 4.75 mm IS sieve was used. [9]

3. **Marble dust:** The marble dust was collected from the dressing unit of our college. The marble dust thus collected was sieved by 600 micron sieve as suggested by Shirula et. al. [10].

For the comparative study on cement, aggregate and concrete, following tests were performed:

4.1 Tests on Cement

Table 1 Consistency of Cement by Vicat's Apparatus [11]

Weight of the cement (gm)	% of the water	Amount of water (ml)	Vicat's Penetration (mm)
400	29.5	118	4.5
400	28	112	7.1
400	28.5	114	6.2

As per the above observations the percentage of cement which gives the penetration depth lies between 5mm and 7mm. The consistency of cement is 28.5% [11].

Table 1 Specific Gravity of the Cement

Samples	W1 (gm)	W2(gm)	W3(gm)	W4(gm)
1	132	182	384	340
2	132	182	383	340
3	132	182	383.5	340

The specific gravity of the cement on the basis of experiment performed was 3.2

4.2 Tests on Concrete

Table 3 Workability of the Concrete having marble dust in different proportions by Slump test [12]

% Replacement of Marble Dust	Workability Concrete + Marble Dust (mm)	Percentage increase
0	26	-
5	29	11.5
10	29.5	13.46
15	30	15.38

It was observed from the experimental work that the workability of normal concrete will increase, when the amount of marble dust was increasing as shown in the Table 3.

Table 4 Compressive Strength test of the normal Concrete [13]

S. No.	Days	Compressive strength (N/mm ²)
1	7	20
2	28	30.5

As per the above observations, it was found that the compressive strength of the concrete in 7 days obtained was 20 N/mm² and it was 30.5 N/mm² in 28 days.

Table 5 Compressive Strength of Concrete having Marble Dust in different proportion (7 Days)

%Replacement of Marble Dust	Compressive strength (7 days) Concrete + Marble Dust (N/mm ²)	Percentage decrease
0	20	-
5	19.73	1.35
10	19.7	1.5
15	15.34	23.3

Results showed that the 5% and 10% replacement is enough as the decrease in compressive strength is negligible but by 15% replacement, there was a decrease in strength by 23.3%. So we concluded that replacement up to 10% can be done.

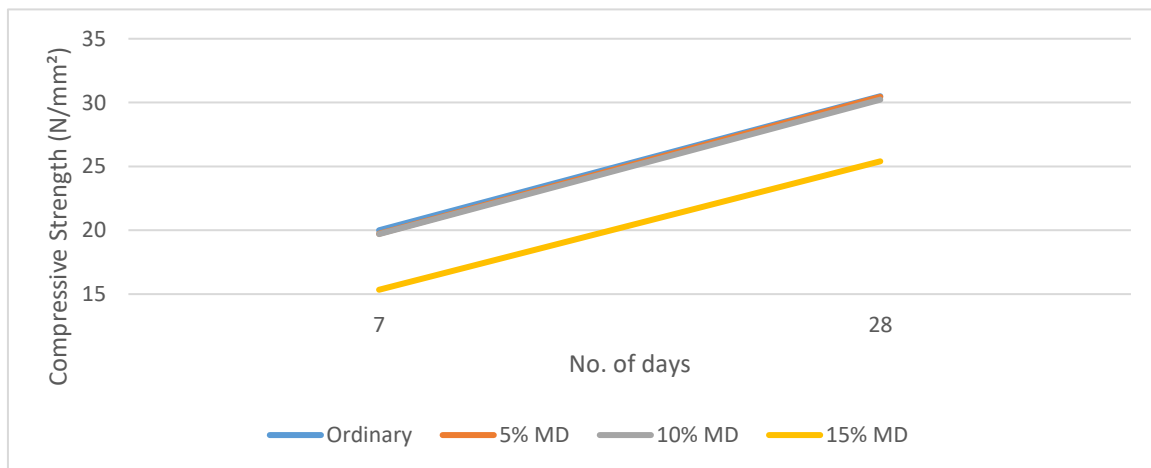
Table 6 Compressive Strength of Concrete having Marble Dust in different proportion (28 Days)

% Replacement of Marble Dust	Compressive strength (28 days) Concrete + Marble Dust (N/mm ²)	Percentage decrease
0	30.5	
5	30.45	0.065
10	30.23	0.88
15	25.4	16.7

5. RESULTS AND DISCUSSION

As per the above observations, we see that the 5% and 10% replacement is enough as there is no or negligible change in the compressive strength and workability of concrete. But the 15% replacement is not preferable, as it decreases the strength of concrete by 16.7%.

Graph 1 Comparison between Compressive Strength of Ordinary Concrete, and with replacement by Marble Dust in Concrete



6. CONCLUSION

As per the above observations, we found that the 5% and 10% replacement of cement by marble dust do not produce much impact on the strength of normal concrete in 7 and 28 days, thus we can replace up to 10% of cement by the marble dust from the concrete without compromising the strength and workability of the concrete. The marble waste which is causing environmental problem can thereby be resolved by consuming it. In addition to this the cement consumption will also be reduced by 10% i.e. it can reduce the cost of construction as well as energy consumption.

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REFERENCES

- [1] Omar M., Omar, G.D., Abdel hammed, Sharif, M.A., Hassan A. M. "Influence of limestone waste as partial replacement material for sand and marble powder in concrete properties" HBRC JOURNAL, pp. 193-203, 2012
- [2] Mohd, V.M. "Study of performance of polypropylene fibre reinforced concrete" JOURNAL OF MECHANICAL AND CIVIL ENGINEERING (IOSR-JMCE), Vol.12 (1), pp.28-36, 2015

- [3] Chaid, R., Ghernouti Y., Perrot A., "Study of durability of concrete with marble powder" FRENCH 5TH INTERNATIONAL CONFERENCE ON ENVIRONMENT SCIENCE AND ENGINEERING, Vol. 83,p.6, 2015
- [4] Singh, M., Srivastava A., and Bhunia D., "An investigation on effect of partial replacement of cement by water marble slurry," CONSTRUCTION AND BUILDING MATERIALS, Vol.6, pp. 471-488, 2016
- [5] Kore, D. S, and Vyas. A. K. "Study of impact of marble waste as coarse aggregate on properties of lean cement concrete", CASE STUDIES IN CONSTRUCTION MATERIALS, Vol. 4, pp. 85-92, 2016
- [6] Deepankar, A. K. "Feasibility of waste marble powder in concrete as partial substitution of cement and sand amalgam for sustainable growth" JOURNAL OF BUILDING ENGINEERING, Vol.4, pp.236-242, 2017
- [7] Sharma, S., Parstariya S., Verma G. K., "Experimental investigation on partial replacement of cement with marble dust powder on properties in concrete" INTERNATIONAL JOURNAL OF SOFTWARE & HARDWARE RESEARCH IN ENGINEERING, Vol.5. pp. 2-3, 2017
- [8] Dhiman, H. And Bhardwaj, S., "Partial Replacement of Cement with Marble Dust Powder and addition of Polypropylene fibres", INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING AND TECHNOLOGY, Vol. 5(9), pp.995-998, 2018
- [9] Bureau of Indian Standards (BIS), Coarse and fine aggregates for Concrete-Specifications, IS383, BIS, New Delhi 2016
- [10] Shirula, P. A., Rahman, A., Gupta, R.D. "Partial Replacement of Cement with Marble dust Powder", INTERNATIONAL JOURNAL OF ADVANCED ENGINEERING RESEARCH AND STUDIES, Vol.1, pp.175-177, 2012
- [11] IS: 4031-2019 (Part 4): Methods of Physical Tests for hydraulic Cement, 2019
- [12] IS: 1199 (1959): Methods of Sampling and Analysis of Cement
- [13] IS:516-1959: Methods of Tests for Strength of Concrete