Effects of Partial Replacement of Cement with Marble Dust Powder on Properties of Concrete

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Abstract

Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. Marble stone industry generates both solid wastes and stone slurry. This paper focus on the utilization of waste of Marble dust powder in concrete and enhancement of strength of concrete more economically. The Marble dust powder was added in M20 grade of concrete at (0%, 5%, 10%, 15%, 20%, 25% & 30%) with partial replacement by weight of cement. Water/Cement ratio (0.50) was kept constant, in all the concrete mixes. The concrete samples (cube & cylinder) were tested for compressive strength and split tensile strength after 7 & 28 days of proper curing. The results of the laboratory work showed that replacement of cement with Marble dust powder increases up to 10% for both compressive strength and split tensile strength of concrete.

Keywords: Marble Powder, Cement, Compressive Strength, Split Tensile Strength

I. INTRODUCTION

Marble has been commonly used as a building material since the ancient times. The industry's disposal of the marble powder material, consisting of very fine powder, today constitutes one of the environmental problems around the world. Marble blocks are cut into smaller blocks in order to give them the desired smooth shape. During the cutting process about 25% the original marble mass is lost in the form of dust [1].

Now a day's marble waste is one of the causes of environmental problems around the world. Therefore, maximum utilization of marble waste in various industrial sectors, especially the construction, agriculture, glass and paper industries would help to protect the environment. Concrete is the most widely used construction material in the civil construction work because of its high structural strength and stability. Concrete is a heterogeneous mix of cement, aggregate (coarse and fine aggregate) and water. Aggregate can not only limit the strength of concrete but also affect the durability and performance of concrete. The advancement of concrete technology can reduce the consumption of natural resources and energy sources which in turn further decreases the burden of pollutants on the environment. One of the logical means for reduction of the waste marble masses is by utilizing them in building construction. Waste Marble powder can be used to improve the mechanical and physical properties of the conventional concrete. The possibility of utilizing waste marble powder as cementitious material in the production of concrete will also induce a relief on waste disposal issues. Now-a-days the demand for cement is quite high in developing countries owing to rapid infrastructural growth which results in supply scarcity and increase in the cost of material. If the waste material is used in the production of the concrete the construction cost decreases [2-6].

In addition to marble powder, silica fume, fly ash, pumice powder and ground granulated blast furnace slag are widely used in the construction sector as a mineral admixtures instead of cement. Marble dust can be used either to produce new products or as an admixture so that the natural sources are used more efficiently and the environment is saved from dumpsites of marble waste [1]. Therefore, the aim of this current study is both to avoid the environmental pollution and to investigate the usability of the marble dust.

II. MATERIALS AND METHODS

A. Testing of Cement

Portland Slag Cement with conforming to BIS (IS: 455-1989) was used in the entire experimental study. The detail of physical properties of cement is presented in table I. The cement used in the test is Portland slag cement manufactured by "LAFARGE CONCRETO".

Table – 1
Physical Properties of cement (Lafarge PSC)

Properties	*Test method*	*Results*	*Standard Limits (IS: 455)*
Consistency	*Vicat Apparatus (IS: 4031 Part - 4)*	*33%*	-
Soundness	*Le-Chatlier method (IS: 4031 Part –3)*	*Expansion 4 mm*	*<10mm*
Initial setting time (min)	*Vicat Apparatus (IS: 4031 Part -5)*	*85 minutes*	*>30 min*
Final setting time	*Vicat Apparatus (IS: 4031 Part -5)*	*270 minutes*	*<600 min*
Specific gravity	*Specific. gravity bottle (IS:4031 Part - 4)*	*3.12*	-
Fineness	*Sieve test on sieve no.9 (IS: 4031 Part –2)*	*3.5% Retain on 90 micron sieve*	*<10%*
Compressive strength *3days* *7days* *28 days*	*(IS: 4031 Part-6)*	*N/mm^2* *20.00* *24.25* *37.15*	*N/mm^2* *>16* *>22* *>33*

According to table I: the test results are within permissible limits.

B. Aggregate

The results of the test conducted on fine and coarse aggregate for this Research work are given in table II and III respectively.

Table – 2
Tests of Fine Aggregate

S. No.	*Test*	*Fine Aggregate*
1	*Zone*	*II*
2	*Moisture content*	*0.25%*
3	*Specific gravity*	*2.64*
4	*Bulk density*	*1.61 gm/cc*
5	*Fineness Modulus*	*2.42*
6	*Water Absorption*	*1.27%*

Table – 3
Tests of Coarse Aggregate

S. No.	*Test*	*Coarse Aggregate*
1	*Bulk density*	*1.86 gm/cc*
2	*Moisture content*	*0 %*
3	*Water absorption*	*0.40 %*
4	*Specific gravity*	*2.81*
5	*Crushing value*	*24.43 %*
6	*Impact value*	*17.55 %*
7	*Elongation index*	*9.70%*
8	*Flakiness index*	*10.50 %*

C. Marble Dust Powder

The results of the test conducted on marble dust powder are given in table IV.

Table – 4
Physical properties of marble dust powder

Properties	*Test Result*
Specific Gravity	*2.64*
Colour	*White*
Form	*Powder*
Odour	*Odourless*
Fineness	*2.7% Retain on 90 micron sieve*

D. Water

In this research work, potable water free from organic substance was used for mixing as well as curing of concrete.

E. Concrete mix grade

M 20 grade of concrete has been used for the present work. The concrete mix proportion was 1:1.5:3 and water cement ratio was 0.50.

III. RESULTS AND DISCUSSION

A. Test Results for Hardened Concrete

The most valuable property in concrete is the compressive strength because it gives the overall quality of hardened concrete. The hardened concrete tests conducted were compressive strength test and split tensile strength test.

B. Compressive Strength Test

The compressive strength test was conducted on 150 mm size of cubes at 7 & 28 days. The compressive strength is determined using 1000 KN compression testing machine in accordance with IS: 516-1959.

The values of compressive strength for M20 grade concrete at different percentages of marble dust powder after 7 & 28 days of proper curing are given in table V & fig. 1.

Table – 5
Compressive strength test result for M20 grade concrete at 7 & 28 days

Concrete mix	*Avg. compressive strength after 7 days in N/mm²*	*Variation of compressive strength w.r.t. M_0 after 7 days*	*Avg. compressive strength after 28 days in N/mm²*	*Variation of compressive strength w.r.t. M_0 after 28 days*
M_0	19.21	0%	24.84	0%
M_5	20.47	+6.56%	26.51	+6.72%
M_{10}	20.85	+8.54%	28.03	+12.84%
M_{15}	19.84	+3.28%	25.55	+2.86%
M_{20}	15.96	-16.92%	23.07	-7.13%
M_{25}	13.73	-28.53%	20.25	-18.48%
M_{30}	12.25	-36.23%	18.18	-26.81%

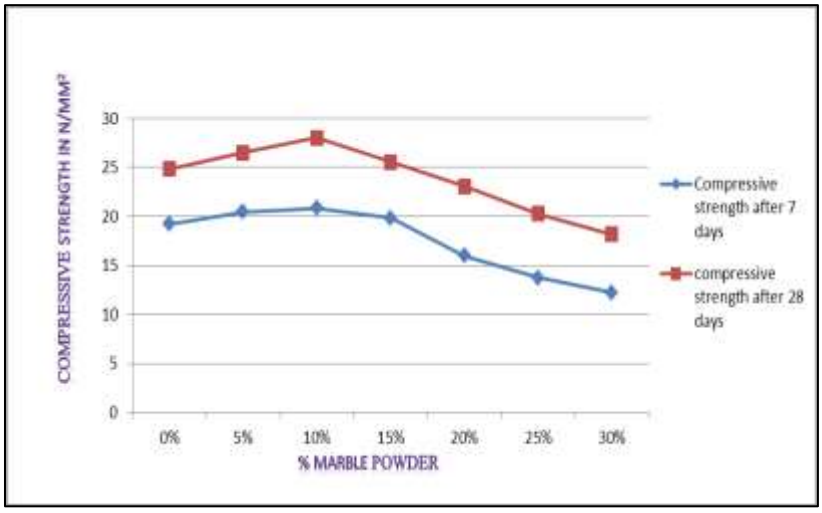

Fig. 1: Compressive strength of M20 grade concrete at 7 & 28 days

From fig.1, it was found that the compressive strength of M20 grade concrete at both 7 & 28 days increases with the increase in the percentage of marble dust powder for up to 10% partial replacement of cement with marble dust powder. With further increase in the percentage of marble dust powder the compressive strength of concrete decreases. The addition of marble dust powder (10% by weight of cement) into the concrete improved its compressive strength by 8.54 % and 12.84 % respectively at 7 & 28 days.

C. Split Tensile Strength Test

This test was conducted using 1000 kN compression testing machine as per the procedure given in IS: 5816-1999. The split tensile strength test was conducted on cylindrical specimens of 150 mm diameter x 300 mm height at 7 and 28 days.

The values of split tensile strength for M20 grade concrete at different percentages of marble dust powder after 7 & 28 days of proper curing are given in table VI & fig. 2

Table – 6
Split tensile test result for M_{20} grade concrete at 7 & 28 days

Concrete Mix	*Avg. split tensile strength after 7 days in N/mm²*	*Variation of split tensile strength w.r.t. M_0 after 7 days*	*Avg. split tensile strength after 28 days in N/mm²*	*Variation of split tensile strength w.r.t. M_0 after 28 days*
M_0	*2.25*	*0%*	*3.12*	*0%*
M_5	*2.40*	*+6.67%*	*3.37*	*+8.01%*
M_{10}	*2.60*	*+15.55%*	*3.68*	*+17.95%*
M_{15}	*2.36*	*+4.89%*	*3.32*	*+6.41%*
M_{20}	*1.85*	*-17.78%*	*2.60*	*-16.67%*
M_{25}	*1.72*	*-23.55%*	*2.41*	*-22.76%*
M_{30}	*1.63*	*-27.55%*	*2.30*	*-26.28%*

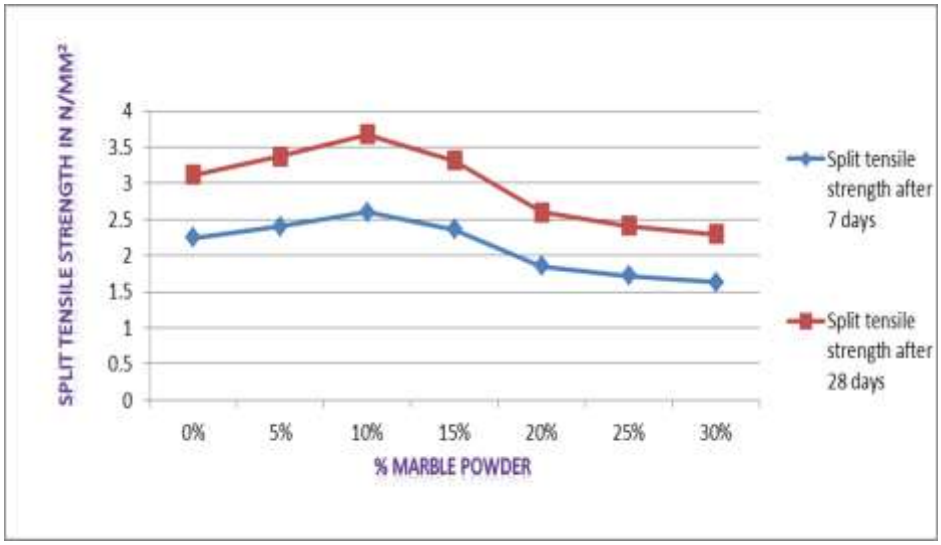

Fig. 2: Split tensile strength of M20 grade concrete at 7 & 28 days

From fig.2, it was found that the split tensile strength of M20 grade concrete at both 7 & 28 days increases with the increase in the percentage of marble dust powder for up to 10% partial replacement of cement with marble dust powder. With further increase in the percentage of marble dust powder the split tensile strength of concrete decreases. The split tensile strength of concrete improved by 15.55 % and 17.95 % for M20 grade concrete (10% by weight of cement) at 7 & 28 days respectively.

IV. CONCLUSIONS

It may be concluded that-

- The Compressive strength of Concrete increases up to 10% replacement of cement by marble dust powder and further increasing of percentage of marble dust powder leads to decrease in compressive strength of concrete. The addition of marble dust powder (10% by weight of cement) into the concrete improved its compressive strength by 8.54 % and 12.84 % respectively at 7 & 28 days.
- The split tensile strength of concrete increases up to 10% replacement of cement by marble waste powder. The split tensile strength of concrete improved by 15.55 % and 17.95 % for M20 grade concrete (10% by weight of cement) respectively after 7 & 28 days.
- Thus we found out the optimum percentage for replacement of marble dust powder with cement and it is almost 10% cement for both cubes and cylinders.
- We have put forth a simple step to minimize the costs for construction with usage of marble dust powder because it is freely or cheaply available.
- We have also stepped into a realm of saving the environmental from pollution by cement production; being our main objective as Civil Engineers.

REFERENCES

[1] Bahar Demirel, "The effect of the using waste marble dust as fine sand on the mechanical properties of the concrete", International Journal of the Physical Sciences Vol. 5(9), pp. 1372-1380, 18 August, 2010.
[2] Baboo Rai, Khan Naushad H , Abhishek Kr, Tabin Rushad S, Duggal S.K, " Influence of Marble powder/granules in Concrete mix", INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING Volume 1, No 4, pp 827-834, 2011.

[3] Jayesh Patel, Prof. M.A.Jamnu, " Study on Properties of Concrete Using Marble Dust and Rise Husk Ash", IJSRD - International Journal for Scientific Research & Development| Vol. 2, Issue 05,pp 304-306, 2014.
[4] Nitisha Sharma, Ravi Kumar, "Review on Use of Waste Marble Powder as Partial Replacement in Concrete Mix", SSRG International Journal of Civil Engineering (SSRG-IJCE) – EFES, pp 1-4, April 2015.
[5] Jashandeep singh, Er. R S Bansal, "PARTIAL REPLACEMENT OF CEMENT WITH WASTE MARBLE POWDER WITH M25 GRADE", International Journal of Technical Research and Applications, Volume 3, Issue 2, PP. 202-205, (Mar-Apr 2015).
[6] Prof. Veena G. Pathan, Prof. Md. Gulfam Pathan, "Feasibility and Need of use of Waste Marble Powder in Concrete Production", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, PP 23-26, 2014.
[7] Devesh Meena, "A STUDY ON BEHAVIOR OF MARBLE DUST IN CONCRETE PAVEMENT", International Research Journal of Engineering and Technology (IRJET) Volume: 02, Issue: 05, pp 475-478, Aug-2015.
[8] Aalok D. Sakalkale, G. D. Dhawale, R. S. Kedar, "Experimental Study on Use of Waste Marble Dust in Concrete", Int. Journal of Engineering Research and Applications, Vol. 4, Issue 10(Part - 6), pp.44-50, October 2014.
[9] Prof. P.A. Shirule, Ataur Rahman, Rakesh D. Gupta, "PARTIAL REPLACEMENT OF CEMENT WITH MARBLE DUST POWDER", International Journal of Advanced Engineering Research and Studies, IJAERS/Vol. I/ Issue III/April-June, 2012/175-177.
[10] IS 456:2000, "Indian standard code of practice for plain and Reinforced concrete", Bureau of Indian Standard, New Delhi.
[11] IS 383: 1970, "Specification for Coarse aggregate Fine aggregate from Natural sources for concrete", Bureau of Indian Standard, New Delhi.
[12] IS 516: 1959, "Method of test for strength of concrete", Bureau of Indian Standard, New Delhi.