An Experimental Examination on Mechanical and Durability Properties of Cement Replacing with Marble Powder

S.Suresh, J.Revathi

Abstract: ***Leaving the waste products straight to the environment directly can cause environmental issues. Waste can be used as a mixture to create fresh products or can be used as admixtures .In order to make more efficient use of natural assets and protect the environment from waste deposits an inert material which is procured as an industrial by-product during sawing, grinding, and polishing of marble. These wastes can be used as concrete constituents by partly replacing the cement making it cost-effective. The main objective of this research is to examine whether there is any possibility of utilizing marble powder in concrete production or not. This research involves concrete m20 mixture by replacing cement with marble powder in different proportions (0%, 5 %, 10 % & 15 %) by weight to determine the optimum proportion of replacement. The properties of concrete such as compressive strength, flexural strength and modulus of elasticity were determined at age of 7 and 28 days. The durability characteristics of concrete with cement partially replaced by waste Marble powders were also evaluated.***

***Keywords**: Concrete, Durability, Mechanical Properties, Normal strength concrete Waste Marble Powder.*

I. INTRODUCTION

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. In India, the marble and granite stone processing is one of the most thriving industry the effects if varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated Marble waste are dumped in any nearby pit or vacant space near the marble processing industries, although notified area have been marked for dumping the same. This causes environmental problems and also affects the ground water .The environmental problem attributed by

Waste marble powder imposes threat to ecosystem, physical, chemical and biological components of environment. The durability as well as workability has increased to large extent by use of marble dust as replacement of fine aggregate and coarse aggregate. The effect on properties of concrete were investigated and concluded that optimum percentage for replacement of sand with marble powder in concrete is almost 50 %.On the other hand, the effect of using marble powder and granules as constituents of fines in mortar or concrete by partially reducing quantities of cement as well as other conventional fines has been found better in terms of the relative workability and compressive as well as flexural strengths. The results of the laboratory work showed that replacement of cement with MDP up to 10 % favors compressive strength, and up to 15 % favors split tensile strength & flexural strength of concrete. Ali Aliabdo *et al* studied the effect of replacement of cement and sand by Marble powder. The authors investigated the properties of cement modified with marble dust and that of concrete containing marble dust as a cement replacement and as a sand replacement (Cement addition). Use of marble dust in concrete production as cement replacement or as sand replacement (cement addition) enhanced both the mechanical and physical properties of concrete especially with lower water cement ratio.

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II. EXPERIMENTAL PROGRAMME

A. Cement

OPC of 53 grades was used for this study. The cement used for all the tests is from same batch. The various properties of cement were obtained according to IS: 455-1989 and IS: 12269-1987

B. Fine Aggregate

Natural River sand was used as fine aggregate The fine aggregate was tested for various properties such as specific gravity, sieve analysis and fineness modulus according to IS: 2386 - 1963

C. Coarse Aggregate

Crushed angular granite was used as coarse aggregate. The maximum size used was 20 mm sieve with a specific gravity of 2.77.

D. Marble powder

Waste Marble powder was collected from the local market at Pondicherry. It passed through 90 micron before mixing in concrete. Tests were carried out in order to find out the properties of Waste Marble Powder. The Specific gravity of marble powder used was 2.46.

Fig 1. Marble Powder

E. Water

Water used for mixing and curing was fresh potable water conforming to IS: 3025 - 1964 part 22, part 23 and IS: 456 – 2000.

III. RESULT AND DISCUSSION

A. Effect of Marble Powder on Compressive Strength:

The compressive strength of all the test specimens are presented in Table I. A compressive strength of 24.18 MPa, 27.4 MPa, 29.8 MPa and 21.52 MPa was obtained for the specimens NSC 0 %, NSC 5 %, NSC 10 % and NSC15 %.The specimen NSC 5 % exhibits an increase 13.31 % in compressive strength when compared to control specimen NSC 0 %.The specimen NSC 10 % exhibits an increase of 23.24 % in compressive strength when compared to control specimen (NSC 0 %). The specimen NSC 15 % exhibits a decrease of 11 % in compressive strength when ` compared to control specimen (NSC 0 %). The experimental results show that replacement cement with Marble Powder 5 % and 10 % in concrete improves its compressive strength and replacement of cement Marble Powder 15 % in concrete reduces its compressive strength. The graphical representations of compressive strength are shown in Fig. 2.

Table I Compressive Strength of Test Specimen

S.NO	Test Specimen	Marble powder dosage	Average flexural Strength (N\mm^2)	
			7Days	28 days
1	NSC 0%	0	3.16	4.88
2	NSC 5%	5	3.72	5.27
3	NSC 10%	10	3.97	5.75
4	NSC 20%	15	4.25	4.67

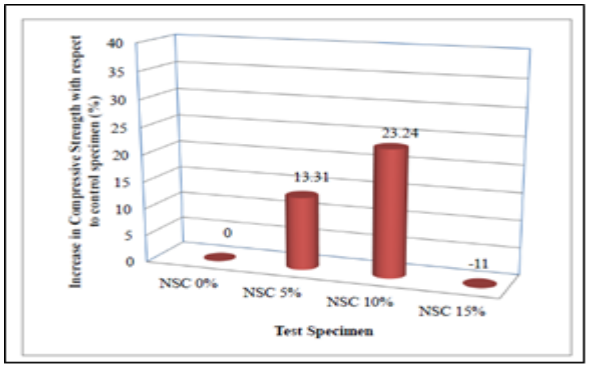

Fig 2 Compressive strength of test Specimen

B. *Effect of Marble Powder on Flexural Strength*

The flexural strength of all the test specimens is presented in Table 2. A flexural strength of 4.88 MPa, 5.27 MPa, 5.75 MPa and 4.67 MPa was obtained for the specimens NSC 0%, NSC 5 %, NSC 10 % and NSC 15 %. The specimen NSC 5% exhibits an increase of 7.99 % in flexural strength when compared to control specimen NSC 0 %. The specimen NSC 10 % exhibits an increase of 17.82 % in flexural strength when compared to control specimen NSC 0 %. The specimen NSC 15% exhibits a decrease of 4.3 % in flexural strength when compared to control specimen NSC 0 %. The experimental results show that replacement of cement with marble powder 5 % and 10 % in concrete improves its flexural strength and replacement of cement with marble powder 15 % reduces its flexural strength.

Table II Flexural Strength of Test Specimens

S.NO	Test Specimen	Marble Powder dosage	Average Compressive Strength (N\mm^2)	
			7 Days	28 Days
1	NSC 0%	0	16.51	24.18
2	NSC 5%	5	24.99	27.4
3	NSC 10%	10	26.52	29.28
4	NSC 20%	15	15.21	21.52

The graphical representations of flexural strength are shown in Fig.3. The test results on the various mechanical properties clearly indicate that the addition of marble powder at optimum dosage of 10 % resulted in increased performance and thereafter the strength was pronouncedly decreased at higher dosages. This is due to reduction in cementing material, C_3S and C_2S, which is responsible for concrete strength

C. Effect of Marble Powder on Elasticity Modulus

The modulus of elasticity all the test specimens are presented in Table 3 . Elasticity modulus of 21.23 GPa, 24.42 GPa, 26.26 GPa and 19.23 GPa was obtained for the specimens NSC 0 %, NSC 5 %, NSC 10 % and NSC 15 %.

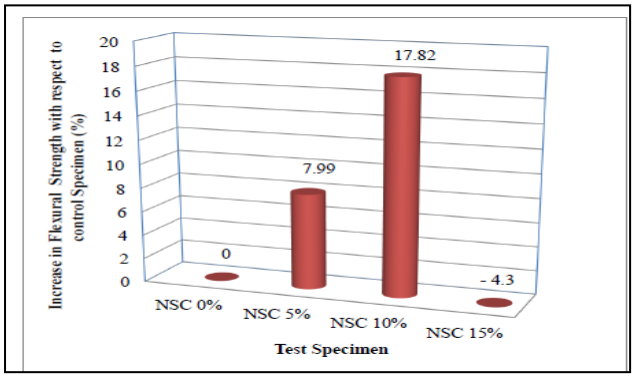

Fig 3. Flexural Strength of Test specimen

The specimen NSC 5 % exhibits an increase of 15.02 % in modulus of elasticity when compared to control specimen NSC 0 %. The specimen NSC 10 % exhibits an increase of 23.55 % in modulus of elasticity when compared to control specimen NSC 0%.The specimen NSC 15 % exhibits a decrease of 9.42 % in modulus of elasticity when compared to control specimen NSC 0 %.The experimental results show that replacement of cement with Marble Powder 5 %, 10 % in concrete improves its elasticity modulus and replacement of cement with Marble Powder 15 % in concrete reduces its elasticity modulus. Normally the elasticity modulus of concrete is directly proportional to the compressive strength, so the increase of compressive strength resulting in increased elasticity modulus. The stress-strain curve is presented in Fig. 4.

Table III Modulus of Elasticity of Test specimens

S.NO	Test Specimen	Marble powder dosage	Average flexural Strength ($N\backslash mm^2$)
			28 days
1	NSC 0%	0	21.23
2	NSC 5%	5	24.42
3	NSC 10%	10	26.26
4	NSC 20%	15	19.23

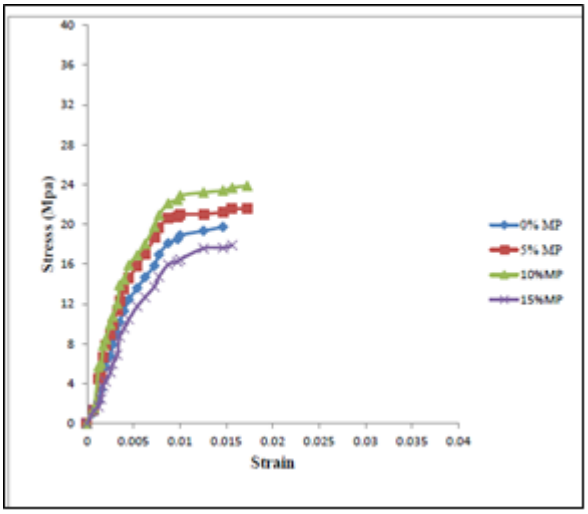

Fig 4. Stress –Strain Curve

D. Effect of Marble Powder on Chloride Penetration

The chloride penetration on conventional and marble powder at 28 days is given in Table IV. It was observed that with the addition of marble powder (10 %) there is a significant decrease in chloride penetration which shows that the marble powder is densely packed. The test results obtained are presented in Table IV.

Table IV Rapid chloride penetration test

Nature of Specimen	Volume fraction (%)	Charge Passed 'Q' in coulombs	Remarks
Cylinder	0%	1254	Low Penetration
	5%	1527	Low Penetration
	10%	986	Very Low Penetration
	20%	2218	Moderate

E. Effect of Marble Powder on Water Absorption

The percentage water absorption for conventional and marble powder mixed concrete cubes is presented in Table V. It was observed that there is no significant difference between the conventional concrete cubes and marble powder mixed concrete cubes.

Table V. Water Absorption Test Results

Nature of specimen	Volume fraction In percentage	Water absorption
Cube	0	1.56
	5	1.08
	10	1.21
	15	1.33

F. Effect of Marble Powder on Acid Resistance

After immersion for 15 days in acid, the loss in weight and loss in compressive strength of conventional and marble powder mixed concrete specimens obtained and presented. It was observed that with the addition of marble powder there is no percentage of loss in weight. The loss in compressive strength was more in comparison with conventional concrete.

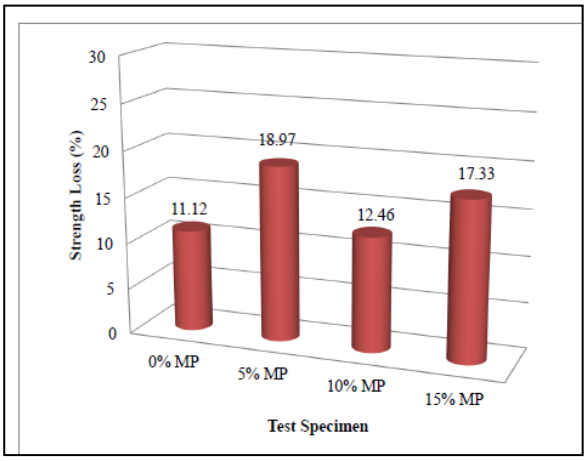

Fig. 5 Comparison of Compressive Strength after Acid Attack

IV. CONCLUSION

- The compressive strength of cubes are increased with the addition of waste marble powder up to 10 % replacement by weight of cement and further any addition of waste marble powder the compressive strength decreases.
- The addition of marble dust powder (10 % by weight of cement) into the concrete improved its compressive strength by 23.24 % when compared with controlled specimen.

- The flexural strength of cubes are increased with addition of waste marble powder up to 10 % replacement by weight of cement and further any addition of waste marble powder the flexural strength decreases.
- The addition of marble dust powder (10 % by weight of cement) into the concrete improved its flexural strength by 17.82 % when compared with controlled specimen.
- The marble powder can be used as a replacement material of cement and 10 % replacement of cement with marble powder gives an excellent result in strength when compared to the normal concrete.
- Use of these waste material leads to sustainable development in construction industry

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