International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.85 (SJIF-2019), e-ISSN: 2455-2585
Volume 6, Issue 11, November-2020

EFFECT OF MARBLE POWDER ON THE COMPRESSIVE STRENGTH OF CONCRETE

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***Abstract*— In India, a marble waste powder industrial waste makes it the most suitable materials for cement-based applications. Concrete is a construction material that consists of cement (commonly Portland cement), aggregate (generally gravel and sand), water and admixtures. Cement acts as a binding material, sand acts as a void filler and coarse aggregates provide strength to the concrete mixture. For special cases to enhance or to retard the properties of the concrete mix, admixtures are added to it. This paper discusses the design of M30 concrete mix by replacing cement with marble powder accordingly in the range of 0%, 5%, 10%, 15% and 20% respectively. The comparative study of the compressive strength of all the cubed is tested and the graphs were plotted accordingly.**

***Keywords*— Marble powder, concrete, aggregate, admixture, strength**

I. INTRODUCTION

Concrete can be defined as the combination of active and inert materials. Active materials are those material which reacts in the concrete mix. The active materials in concrete are water and cement. Inert materials are those which do not react in the mix. Sand and coarse aggregate are inert material.

Active material + Inert Material = Concrete

Engineers usually specify the required compressive strength of concrete, which is normally given as the 28-days compressive strength in N/mm2. 28 days is a long wait to determine if desired strengths are going to be obtained, so three-day and seven-day strengths can be useful to predict the ultimate 28-day compressive strength of the concrete. It is studied that the concrete mixture attains partial compressive strength with certain duration of curing. A study shows the strength gain by the concrete in specific days of curing which is shown below: -

Table I

Age	Strength percent
1 day	16%
3 days	40%
7 days	65%
14 days	90%
28 days	99%

The w/c ratio (mass ratio of water to cement) is the key factor that determines the strength of concrete. A lower w/c ratio will yield a concrete which is stronger and more durable, while a higher w/c ratio yields a concrete with a larger slump, so it may be placed more easily. The water and cement paste hardens and develops strength over time. In order to ensure an economical and practical solution, both fine and coarse aggregates are utilised to make up the bulk of the concrete mixture.

- In this project we have used M-30 grade concrete whose ratio is 1 : 1.82 : 3.18 i.e. 1 part of Cement, 1.82 part of sand and 3.18 part of Coarse Aggregate.
- The exact grade is obtained when the mixture is prepared with 100% accuracy and the mixture is mixed in machines. In this project we have mixed the mixture by hands.

II. MARBLE POWDER

Marble is a metamorphic rock that may be foliated or non-foliated, composed of recrystallized carbonate minerals, most commonly calcite or dolomite. Geologists use the term "marble" to refer to metamorphosed limestone; however,

stonemasons use the term more broadly to encompass unmetamorphosed limestone. Marble is commonly used for sculpture and as a building material.

Table II

Component	Weight %
SiO_2	3.89
CaO	68.6
MgO	22.13
Cr_2O_3	0.603
TiO	0.549
Al_2O_3	2.785
ZnO	0.20
Fe_2O_3	0.603

III. METHODOLOGY

In this study, considering the previous studies, properties of concrete and waste marble investigated in detailed manner according to Indian standard concrete design parameter. All results are compared suggesting that, waste marble could be utilize in concrete. All results were analysed for each study in detailed manner and these results were tabulated in two parts.

IV. MIX PROPORTION

In this study M30 grade of concrete has been used and mix design done according to IS code method. The following proportions has come after the mix design.

Table III

Ingredients	Content for $1M^3$	Content for per cube
Cement	372 kg	2.20 Kg
Water	186 kg	1.06 Kg
Fine aggregate	686.53 kg	4.0 Kg
Coarse aggregate	1220 kg	7.0 Kg
Total	2464.53 kg	14.26 Kg

V. PROCEDURE

The following procedure was adopted.

Mix design of M30 grade concrete with ratio is designed

C : F.A : C.A.: WATER = 1 : 1.82 : 3.18 : 0.5

- Sieve analysis was performed on aggregate available the aggregate came under Zone III using IS 456 2000.
- Slump test was performed on the basic concrete mix.
- The cubes were casted of standard dimensions 150*150*150 mm.
- The compressive tests were performed for 7, 14, 21 & 28 days using Compressive Testing Machine.
- The cubes were casted by cement replacement with marble powder for 0%, 5%, 10%, 15%, 20%.

VI. PROPORTIONS FOR MARBLE POWDER

To carry the proposed study cubes with varying partial replacement of cement with marble powder in the percentage of 0%, 5%, 10%, 15% and 20%, the proportions are taken out as follows.

- These are only replaced by cement content and not from sand or coarse aggregate.
- The proportion remains same as per the mix design.

Table IV

% Replacement	0%	5%	10%	15%	20%
Cement	2.20 Kg	2.075 Kg	1.98 Kg	1.87 Kg	1.76 Kg
Sand	4.0 Kg	4.0 Kg	4.0 Kg	4.0 Kg	4.0 Kg
Marble Powder	0.00 Kg	0.125 Kg	0.220 Kg	0.330 Kg	0.440 Kg
Coarse Aggregate	7.0 Kg	7.0 Kg	7.0 Kg	7.0 Kg	7.0 Kg
Water	1060 Ml	1060 Ml	1060 Ml	1060 Ml	1060 Ml
W/C Ratio	0.50	0.50	0.50	0.50	0.50

VII. Result and Discussion

Mechanical behaviour of concrete cubes prepared without chemical admixtures was studied by compression tests (Grade M30 and curing time of 7, 14, 21and 28 days. It can be noticed that 10% replacement of cement by marble dust in severe condition are showing increase in compressive strength.

Table V Reference Cube

Specimen Number	Days	Compressive Strength (N/mm^2)
1	7 days	18.6
2	14 days	23.5
3	21 days	29.7
4	28 days	33.7

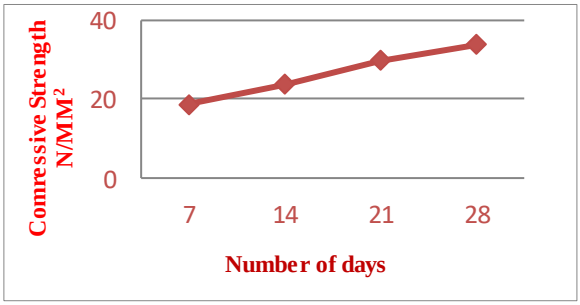

FIG. 1 (GRAPH SHOWS NUMBER OF DAYS VS COMPRESSIVE STRENGTH)

Table VI

S. No	% of Marble	days	Compressive Strength (N/mm^2)
1	5	7	21.33
		14	24.44
		21	32
		28	34.11
2	10	7	22.44
		14	33.33

		21	34.6
		28	35.7
3	15	7	13.33
		14	20.44
		21	28
		28	30.02
4	20	7	16.88
		14	19.11
		21	22.53
		28	25.31

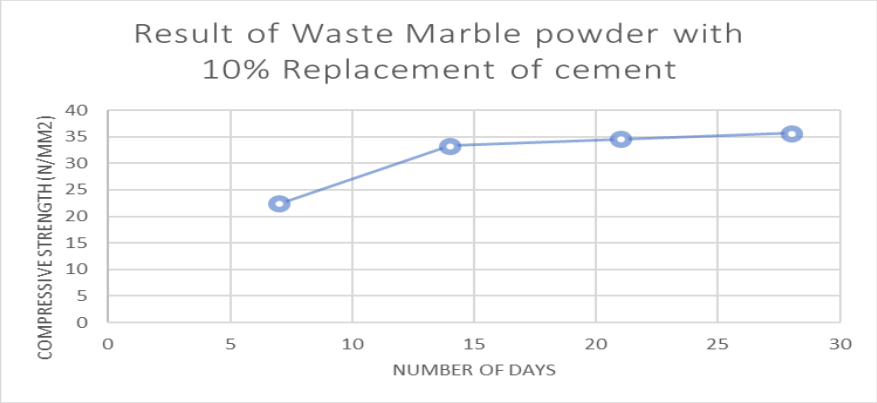

FIG. 2

VIII. CONCLUSIONS

Due to marble dust it proved to be very effective in assuring very good cohesiveness of mortar and concrete. From the above study, it is concluded that the marble dust can be used as a replacement material for cement 10% replacement of marble dust gives an excellent result in strength aspect and quality aspect and it is better than the control concrete. The results showed that the substitution of 10% of the cement content by marble stone dust induced higher compressive strength, higher splitting tensile strength, and improvement of properties related to durability.

- We concluded that by replacing cement by 10% with marble powder gives increasing compressive strength in 28 days in comparison with other percentage replacement of 5%, 15%, 20%.
- 10% Replacement of marble powder gives compressive strength of 35.7 N/mm^2 after 28 days which is maximum in all the replacements.
- While replacement by 5% marble dust gives slightly less compressive strength to that of 10% replacement.
- Further replacement by 15% and 20% marble dust gives even as less strength as that of 5%.

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