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GREEN CEMENT FOR SUSTAINABLE CONCRETE USING MARBLE DUST

[*1.]J.V.Desmukh, Rahul Varhade[*2], Kunal Tandel[*2], Mangesh Gadekar[*2], Pradip Alhat.[*2]

[*1] Associate Professor, Department of Civil Engineering, Imperial College of Engineering, Wagholi Pune Maharashtra, India

[*2]Student, BE, Research Scholar, Department of Civil Engineering, Imperial College of Engineering, Wagholi Pune Maharashtra, India

ABSTRACT

Abstract-Improving the properties of concrete by addition of waste marble powder is becoming more popular now days because it helps in achieving the economy and superior alternative for the concrete ingredient, which offers high strength. In this paper we are going to test the cubes and cylinder with varying percentage of waste marble powder and then testing them on Compression Testing Machine (CTM). The focus of our paper will be strengthening concrete by replacing cement by marble powder in the most economical way. By using the proper grade of concrete for increasing Load Carrying Capacity.

Keyword: Waste Marble Powder (WMP), Compression Testing Machine (CTM), Economy, Ingredient, Strength

1.INTRODUCTION

A marble powder, obtained as a by-product of marble 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.

Mineral additions in general influence the performance of fresh concrete and mortar. Therefore, a rheological study was carried out on various cement pastes prepared with marble powder in combination with cement. In particular, the goal was to investigate the influence of marble powder on rheological properties of cement pastes for predicting the effect of its addition on self-compacting concrete mixtures.

Marble as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in mortar or concrete. The result is that the mass which is 40% of total marble quarried has reached as high as millions of tons. This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problems around the world.

2.LITERATURE REVIEW

"International Journal of Civil and Structural Engineering Volume 1, No 4, (2011)." By Baboo Rai, Khan Naushad H , Abhishek Kr , Tabin Rushad S, Duggal S.K, (Influence Of Marble Powder/Granules In Concrete Mix),

In this paper 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 studied in terms of the relative workability & compressive as well as flexural strengths. Partial replacement of cement and usual fine aggregates by varying percentage of marble powder and marble granules reveals that increased waste marble powder (WMP) or waste marble granule (WMG) ratio result in increased workability and compressive strengths of the mortar and concrete.

Prof. P.A.Shirulea, AtaurRahmanb, Rakesh D. Guptac. (2011)"Partial Replacement of Cement with Marble Dust Powder"

This paper describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. In INDIA, the marble 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. Test results show that this industrial bi product is capable of improving hardened concrete performance up to 10%, Enhancing fresh concrete behavior. 30 cubes and 30 cylinders have been casted. The compressive strength and split tensile strength of cubes and natural stone processing plants with an important impact on environment and humans .Cylinders were measured for 7 and 28 days.

The Open Construction and Building Technology Journal,(2011) "Effect of Marble Powder on the Properties of Self-Compacting Sand concrete"

In this study, Self-compacting sand concrete (SCSC) can be regarded as a flowing sand concrete, containing as principal aggregate natural sand, without compaction or vibration which can be cast. Due to the finesses of aggregates

in SCSC, it requires a high amount of fine materials than other types of concretes. In this paper we studies the effect of marble powder content (MP) on the properties of the sand concrete (SCSC) at fresh and hardened states.

3.OBJECTIVES

3.1 To study the influence of partial replacement of cement with marble powder, and to check its compressive strength and spilt tensile strength of ordinary M25 concrete.
3.2 We are also trying to find the percentage of marble powder replaced in concrete that makes the strength of the concrete maximum.
3.3 To determine reduction in cost with partial replacement of marble powder.

4.BACKGROUND OF MARBLE

Marble is a 'minor mineral' as defined in Clause of Section 3 of Mines and Minerals (Development & Regulation) Act, 1957. The term “marble" is derived from the Latin word Murmur which in turn is said to have been coined from Greek word Marmorous meaning shining stone. It is known for its pleasant colors, smooth and uniform texture, moderate hardness, and amenability to be quarried into big blocks, smooth & shiny polished surface and silky feel. Marble occupies a unique position among other dimension stones because of its aesthetic value.
In terms of geological definition, it is a metamorphosed limestone produced by recrystallization under condition of thermal and also regional metamorphism. In commercial parlance almost any rocks consisting of calcium and/or magnesiumcarbonate which can take polish easily more especially metamorphosed limestone are termed as marble.

4.1 Physical & Chemical Properties

Table1: Physical Properties of Marble

Marble - Physical Properties	
Hardness:	3 to 4 on Mohr's Scale
Density:	2.5 to 2.65 Kg/m3
Compressive Strength:	1800 to 2100 Kg/cm2
Water Absorption:	Less than 1%
Porosity:	Quite low
Weather Impact:	Resistant

Table2: Chemical Properties of marble

Marble - Chemical Properties	
Lime (CaO):	38-42%
Silica (SiO2):	20-25%
Alumina (Al2O3):	2-4%
Other Oxides like Na, Mg:	1.5 to 2.5%
Loss On Ignition (LOI):	30-32%
Chemically Green marble has 38-40% Sio2, 34-38% MgO, 2-3% Al2O3, 5-6% Iron Oxides, 1-2% CaO& 12-13% LOI.	

5.METHODOLOGY AND INVESTIGATION

5.1 Analytical Study

This topic is devoted to the analytical study on Cubes with waste marble powder and conventional cubes and cylinder strength. The purpose of this chapter is to predict the Compressive behavior of cubes and cylinder when the load applied on it and also to predict which type of crack is developed during testing. Also In this topic we are going to see how much amount of strength increase by adding the waste marble powder in concrete with varying percentage of 0%,5%,10%15% and 20% likewise as compared to conventional concrete cube and cylinder. Also we try to increase the percentage of adding of waste marble powder up to best possible percentage to reduce the waste from cutting of marble at factory.
In this topic we also study on how much cost of cement as well as a particular cost a construction project can be reduced as by replacing the cement by waste marble powder. There is no chemical admixture so it is interesting to see variation developed in compressive strength and split tensile strength.

5.2 Experimental Study and Observation of test Result

In this paper we are going to see the test result conducted on the conventional concrete cube and cylinder as well as the cube and cylinder with varying percentage of marble powder. And the strength at end curing days of 7, 14 and 28.

5.2.1 Compression test

The cured specimens were allowed to dry in air. The dried specimens were centered on a compression testing machine of capacity 2000 kN. The load was applied at a uniform rate of 14 kN/mm2/min. The test setup is shown in Image 1.

Image1: Compressive Testing of Concrete Block

5.2.2 Split tensile strength

Split tensile strength of concrete is usually found by testing plain concrete cylinders. Cylinders of size 150mm x 300 mm were used to determine the split tensile strength. After curing, the specimens were tested for split tensile strength using a calibrated compression testing machine of 2000kN capacity. The test setup is shown in Image 2 and 3.

Image2: Split tensile Testing of Concrete cylinder

Image3: Failure Pattern of Concrete cylinder

5.3 MIX DESIGN

The Bureau of Indian Standards recommended (BIS) a set of procedure for design of concrete mix mainly based on the work done in national laboratories. The mix design procedures are covered in IS 10262:1982. The method given can be applied for both medium strength and high strength concrete. However, in the absence of revision of Indian Standard on method of mix design, the existing method i.e. IS 10262:1982. Wherever it is possible, the new information given in IS 456:2000 has been incorporated and the procedure is modified to that extent.

Table3: Mix proportion

Water	Cement	Fine Aggregate	Coarse Aggregate
197.16 Lit	492.5 KG	534.81 KG	1095 KG
0.45	1	1.10	2.10

6.RESULTS & DISCUSSIONS

6.1Compressive strength of cubes of M25with varying percentage and days

6.1.1 Compressive Strength – 7 days

Table4: Compressive Strength – 7 days

Proportion	0%	05%	10%	15%	20%
	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)
Block1	19.01	18.98	17.76	19.09	18.16
Block2	18.54	17.32	18.46	18.19	18.71
Block3	20.28	17.01	18.92	21.12	16.42

6.1.2 Compressive Strength – 14 days

Table5: Compressive Strength – 14 days

proportion	0%	05%	10%	15%	20%
	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)
Block1	29.00	28.01	29.44	29.10	24.16
Block2	28.17	28.94	28.56	28.48	26.32
Block3	28.61	27.15	28.27	29.82	24.89

6.1.3 COMPRESSIVE STRENGTH – 28 DAYS

Table6: Compressive Strength – 28 days

proportion	0%	05%	10%	15%	20%
	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)	(compressive strength N/mm^2)
Block1	31.27	32.76	31.12	33.14	29.16
Block2	31.94	31.09	32.44	32.41	29.10
Block3	32.10	31.88	32.09	33.17	29.78

6.2Split tensile strength of cylinder of M25with varying percentage and days

6.2.1. Split Tensile Strength – 7 days

Table7: Spilt Tensile Strength – 7 days

proportion	0%	05%	10%	15%	20%
	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)
Block1	2.01	2.27	1.99	2.04	1.91

Block2	1.93	1.98	2.09	2.12	1.76
Block3	2.40	2.07	2.20	2.45	1.73

6.2.2 Split Tensile Strength – 14 days

Table8: Spilt Tensile Strength – 14 days

proportion	0%	05%	10%	15%	20%
	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)
Block1	3.12	2.24	3.46	3.14	3.10
Block2	2.87	3.40	4.01	3.60	2.96
Block3	2.68	2.92	3.83	4.03	2.71

6.2.3 Split Tensile Strength –28 days

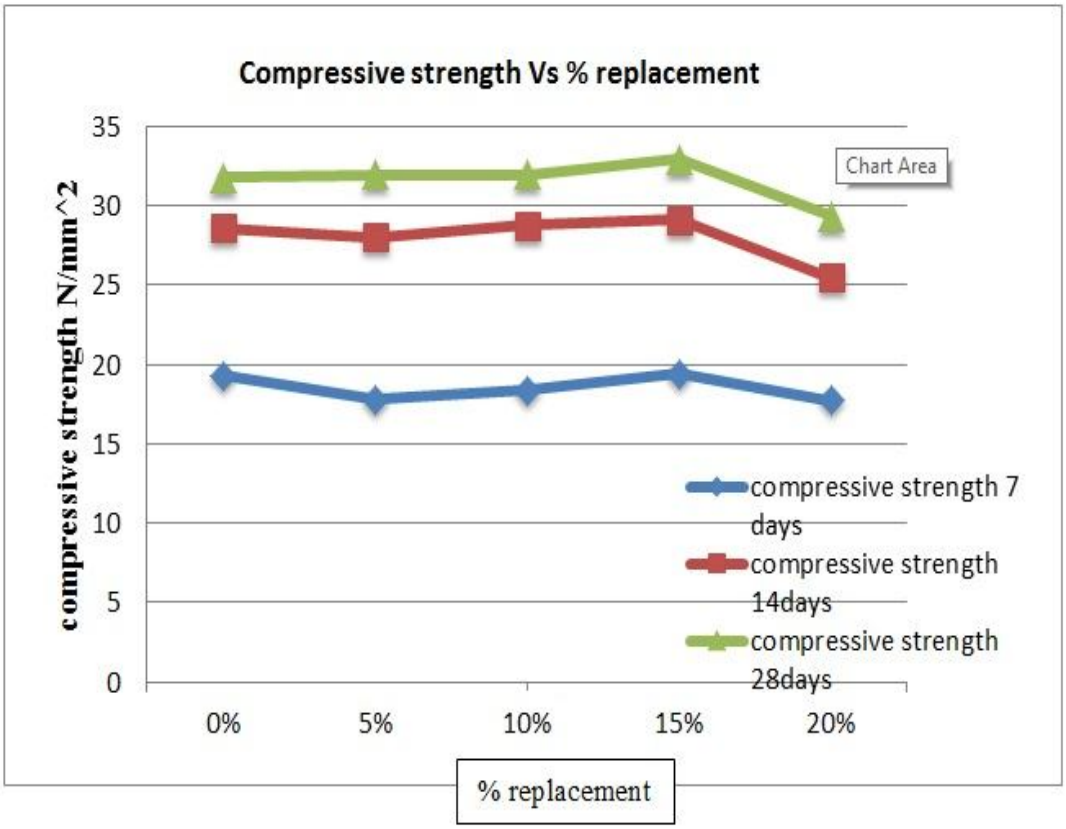
Table9: Spilt Tensile Strength – 28 days

proportion	0%	05%	10%	15%	20%
	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)	(spilt tensile strength N/mm^2)
Block1	4.73	4.25	4.58	4.82	3.31
Block2	4.98	4.08	4.89	3.46	3.89
Block3	4.67	5.13	3.92	5.03	3.03

6.3 Graphical Representation of Compressive strength and spilt tensile strength.

In this topic we see the variation of in compressive strength and split tensile strength of concrete by graphically to improve the detailed information of it. Also it helps us to conclude the specific result about the strength.

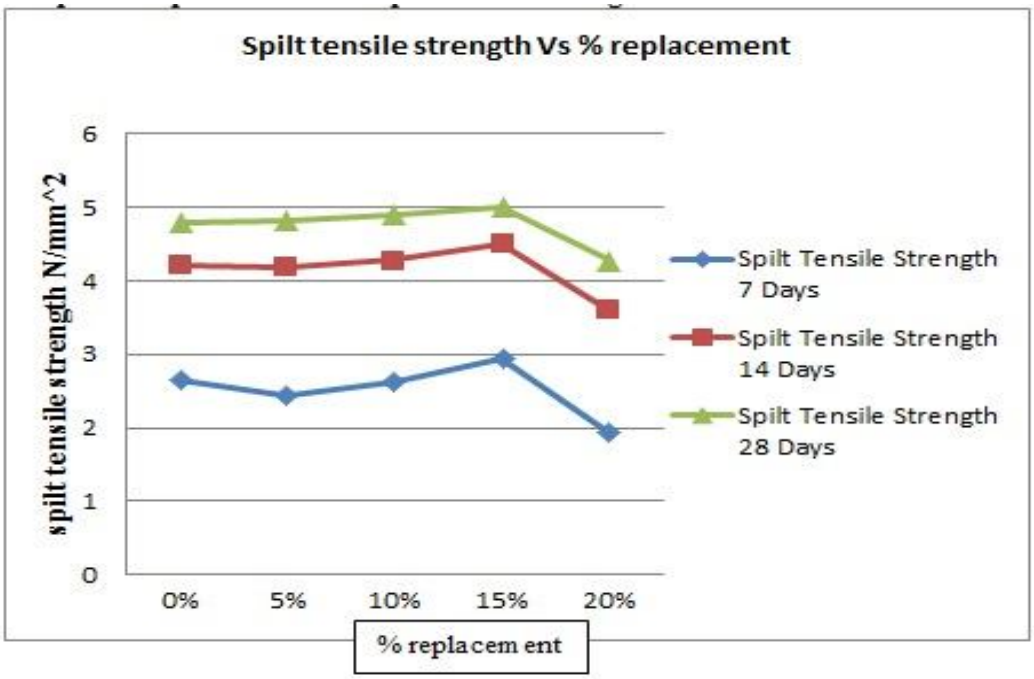
6.3.1 Graphical representation of Compressive strength



Graph1: Graphical representation of Compressive strength

From above graph we get cleared idea about the compressive strength variation of concrete.

6.3.2 Graphical representation of Spilt Tensile strength



Graph2: Graphical representation of Spilt Tensile strength

From above graph we get cleared idea about the variation of compressive strength and spilt tensile strength of concrete.

6.4 Cost Analysis for consumption of cement for Per Cubic Meter

Consumption of Cement for Cubic Meter as per M25 Grade Concrete.

- Proportion of M25 Grade Concrete =

Table10: Mix proportion of M25

• Water	• Cement	• Fine Aggregate	• Coarse Aggregate
• 197.16 Lit/cu.m	• 492.5 KG/cu.m	• 534.81KG/cu.m	• 1095 KG/cu.m
• 0.45	• 1	• 1.10	• 2.10

- No of cement bag = 492.5/50= 10 Bag.
- 15% replacement of cement By WMP = 15/100 X 492.5= 73.87 Kg/Cu.m
- Reduction in Cement Bag = 1.5 Bag.
- Cost of 1 bag Cement = Rs.400 = 10 bags X 400= Rs.4000.
- Cost of reduced Cement Bag= 1.5X 400= Rs.600.

7.CASE STUDY

7.1 Cost Analysis for a typical project From Result

Cost Analysis for structure will help in to conclude the how much cost will be reduce in cement if we replace it with waste marble powder up to a 10% to 20%. The following analysis is an example taken from small Estimate for structure is not detailed Estimate of that particular structure. For getting idea about it this example is taken.

7.2 Site Details

We have visited on site Mantri Garden which is located on Sr.No.48, opposite Kalyani Steel Company, Milind nagar, Mundhwa, Pune, Maharashtra, India. The name of contractor and owner is J.R.Borude and Mr.Yogesh Patil respectively.

7.3 Specification of Structure

The structure consists of R.C.C. framed structure which includes 2 building of G+1 floor. Plot area of site is 943.00 Sq.ft and total built up area of ground floor and first floor is 598.75Sq.ft and 730.00Sq.ft respectively.

7.4 Salient Feature of Structure

According to estimation, cost required for ground and first floor is Rs.264969 and Rs.138752 respectively. Total concrete required in ground floor is 30.33 cu.m and first floor is 15.21 cu.m. After finding out the quantity of concrete we have get total no of cement bag required for that site is 236.

7.5 Analysis of cost for Cement Bag and Marble Powder

After finding out the total bag of cement required on that site (i.e. 236), we have find out total cost required for cement as per market prize which is 236.1 X Rs. 400 which is Rs. 94,440. And then calculating cost after replacement of 15% WMP, which reduced to 80,274.We required 35.42 bag of WMP (i.e. 35.42 X 400 = Rs, 14,166)

So From Above Calculation We can save cost of cement by 15%. We replaced 15% WMP because it gives maximum strength as compare to other replacement.

8.CONCLUSION

Replacement of cement with marble powder is found to improve the strength of concrete. The optimal dosage of replacement is found to be 15%. Utilization of marble powder will avoid the disposal problems and related to environmental issues. Utilization of marble powder will reduce the usage of cement and conserve natural resources.

Also we conclude that some amount of cost of cement can be reducing up to 15%. There is best possible way of disposal of waste material like marble powder by using it in concrete, which will reduce environmental burden.

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