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A STUDY ON PARITALLY REPLACEMENT OF CEMENT BY MARBLE DUST IN RIGID PAVEMENT

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ABSTRACT

Annually billion tons of cement manufactured around the world consumes enormous amount of energy. For better environment the demand is to decrease because cement manufacturing is largest contributor of carbon dioxide in the atmosphere. Various mineral additives like silica fume, fly ash and blast furnace slag have been used in concrete production, whereas marble dust can be used as replacement of sand as well as replacement of cement content in concrete. It has been seen that the usage of by-products of marble as hundred percent substitutes for natural sand in concrete has displayed an enhancing effect on the compressive strength and split tensile strength of concrete. The main objective was to study the influence of partial replacement of cement with Marble dust powder and Compressive strength, tensile strength & flexural strength to be obtained for 5%, 10%, 15%, 20% and 25 % replacement of cement with marble dust by weight.

The analysis of the characteristics of concrete namely the workability, strength and durability were made based on the fundamental study initiated to arrive at the feasibility and suitability of using marble powder as a partial replacement material by 0, 5, 10, 15, 20 and 25% weight of cement in M30 grade concrete.It was observed from the test results that the compactor factor increased with the increase in the level of replacement upto 15% and thereafter decreased for further higher level of replacement. But, the slump value decreased with the increase in the level of replacement.The compressive strength at 7, 14 and 30 days increased with the increase in the replacement level of cement with marble powder up to 14.80% replacement at which the compressive strength 14.51% higher compared to conventional concrete.The tensile strength at 7, 14 and 30 days increased with the increase in the replacement level of cement with marble powder up to 15% replacement at which the tensile strength 14.25% higher compared to conventional concrete. The flexural strength of concrete increased up to 20% replacement level and was maximum recorded for 15% replacement level and is found 7.1% more than the conventional concrete.

***KEY-WORDS**: Rigid, Strength, Marble Dust, Replacement, M30 Grade*

1. INTRODUCTION

Marble is a metamorphic rock that develops when limestones are subjected to extreme heat and pressure. Marble is mostly made up of calcium carbonate. Marbles are highly expensive stones that are used for decoration and other uses all over the world. It should be mentioned that marbles vary in color based on the environmental circumstances.

Marble dust is an important construction material and is commonly used in the following:

i. ***Use with Cement:*** Marble dust is mixed with concrete, cement or synthetic resins to make counters, building stones, sculptures, floors and many other objects.

ii. ***Paint Filler:*** Marble Dust is added to some oil paint to in order to reduce fluidity and stiffening from paints.

iii. ***Synthetic Objects:***Many synthetic objects are also made with marble dust and are more commonly used than 100 percent solid marble objects

iv. ***Use as Fillers:***It is added to material (plastics, composite material, and concrete) to lower the consumption of more expensive binder material or to better some properties of the mixture material.

v. **Other Uses**Apart from this marble dust is used in a number of purposes.

A tremendous quantity of energy is consumed each year by the billion tons of cement produced throughout the world. Because cement manufacture is the greatest producer of carbon dioxide to the atmosphere, demand is expected to decrease for a better environment. Various mineral additives such as silica fume, fly ash, and blast furnace slag have been utilized in the manufacture of concrete, whilst marble dust may be used as a replacement for sand as well as a replacement for cement content in concrete. The use of marble by-products as 100 percent replacements for natural sand in concrete has been shown to improve the compressive strength and split tensile strength of the concrete.

2. OBJECTIVES OF THE STUDY

The primary goal was to investigate the impact of partial cement substitution with marble dust. Compressive strength, tensile strength, and flexural strength will be obtained for 5%, 10%, 15%, 20%, and 25% substitution of cement with marble dust by weight. 0 The water cement ratio must be maintained constant during the project's research. The following were the main objectives of the research during the duration of the study:

1. To study the physical properties of Marble dust dust.
2. To characterize the particle size of Marble dust dust.
3. Marble dust dust as a replacement of cement material.
4. To study the effect of Marble dust dust inclusion on the properties of concrete.

3. LITERATURE REVIEW

JashandeepSingh andR.S Bansalin 2015 performed a study on the "Partial replacement of cement with waste marble dust with M 150 grade" and found that adding up to 12% marble dust enhanced the overall strength of the concrete.

Aalok D et al 2014also conducted a study on the partial substitution of cement with marble dust, concluding that for M25 concrete, there was a significant improvement in the strength of the concrete. Using the right quantity of dust resulted in a 50 percent boost in strength.

RochakPandey et al 2011conducted a study on the partial substitution of cement in concrete using waste marble dust. According to them, it is highly beneficial to mix a little quantity of these waste materials with concrete in order to minimize the mess of pollution and, more significantly, they may be utilized to increase the strength of the materials.

VeenaPathan and GulfamPathan in 2014 haveconducted aresearch on the significance ofpartial replacement ofcement with waste marbledust. In their opinion the amount of marble dust added to the concrete add to compressive tensile and flexural strength of the concrete.

B. V.M. Sounthararajan et.al conducted study on the effect of lime concentration in MDP on the production of high strength concrete. Up to 10% marble dust was shown to be useful for increasing the strength of the concrete. According to their findings, adding a small amount of marble dust to concrete increased its strength by a factor of ten.

G.Latha in the year 2015 did ExperimentalInvestigation on strengthcharacteristics of concrete usingWaste marble dust ascementitious material. According to her, adding marble dust to cement concrete improves everything, including improving the strength of the concrete and lowering environmental pollutants.

4. EXPERIMENTAL STUDY

Selection of material and methodology are the first criteria for any type of experimental investigation. The summation of the experimental study is as:

A. Materials Used:

i. Ordinary Portland Cement:

In my research OPC Grade 43 of Brand Khyber and TCI Max were used for investigation. It was tested for its physical properties in accordance with Indian Standard specifications as follows

Properties of Cement

Properties	Values
Specific Gravity	3.12
Normal Consistency	29 %
Initial Setting Time	65 Minutes
Final Setting Time	275 Minutes
Fineness	330 Kg/m^2
Soundness	2.5 mm
Bulk density	830-1650 m^3

ii. Fine Aggregates:

Fine aggregates are essentially any natural sand particles won from the land through the mining process. Fine aggregates consist of natural sand or any crushed stone particles that are ¼" or smaller. The particle size distribution curve of the fine aggregate is characterized by an S-curve. The fine aggregate is well graded and has a gradation of particle size that spans evenly the size from coarsest to finest.

iii. Coarse Aggregates:

Coarse aggregates are irregular broken stones or naturally occurring round gravels that are used to make concrete, coarse aggregates for structural concrete consist of broken stones of hard rock like granite and limestone (angular aggregates) or river gravels (round aggregates). Aggregates larger than 4.75 mm in size are termed as coarse aggregates. These aggregates are obtained from stone quarries and stone crushers, the size between 4.75 mm to 80 mm.

iv. Marble Dust

Being composed of calcium carbonate, marble dust will react in contact with many acids, neutralizing the acid. It is one of the most effective acid neutralization materials. Marble dust is often used for acid neutralization in streams, lakes, and soils. It is used for acid neutralization in the chemical industry as well. Pharmaceutical antacid medicines such as "Tums" contain calcium carbonate,which is sometimes made from dusted marble. These medicines are helpful to people who suffer from acid reflux or acid indigestion. Dusted marble is used as an inert filler in other pills.Marble dust of 90 Micron passing is used.

B. Testing Procedure

i. Casting and Curing:

The acceptance criteria of quality of0concrete is laid down inIS:456-2000. The criteria are mandatory and various provisions of the code have to be complied before the quality of concretes accepted. In all the samples, the 28-days compressive strength shall alone be the criterion for acceptance or rejection of the concrete. In order

to get a relatively quicker idea of the quality of concrete, optional test for 7 days compressive strength of concrete be carried out.

6 Cubes of 1500x 150 x 150 mm size (the nominal size of aggregatedoes not exceeds 38 mm) shall becast, 3 for 7-daystesting and 3 for28-days testing. A set of3 cubes (specimen) average strength will bea sample. The individual variation of a setof 3 cubes should0not be more than ± 15% of the average. If more, the test result of the sample is0invalid.

The casted cubes were stored under shed at a place freeform the vibration at temperature 220 C to 330 C for 24 hours covered with wet straw or gunny sacking. The cubes were removed from the moulds at the end of 24 hours and immersed in clean water till the 7 or 28-days age of testing. The cubes were tested in the saturated and surface dry condition.

ii. Slump Test

Slump test is laboratory or at sitetest used to measure the consistency of concrete. Slump test shows an indication of the of concrete in different batches.

iii. Compression Strength test:

The capacity of a material or structure to carry stresses on its surface without cracking or deflection is referred to as compressive strength. A material under compression tends to shrink in size, whereas a material under tension tends to lengthen in size. For any material, the compressive strength formula is the load applied at the point of failure to the cross-section area of the face on which the force was applied.

Compressive Strength = Load / Cross-sectional Area

iv. Split Tensile Strength Test:

For the splitting tensile strength test, cylinders of 1500mm diameter and 300mm length were cast and tested on a compression testing equipment in accordance with IS: 5816-1999.

v. Flexural Strength Test

Flexural strength of concrete, also known as Modulus of rupture, is an indirect measure of unreinforced concrete's tensile strength. The modulus of rupture may alternatively be defined as the measure of the extreme fibre stresses when a part is bent.

c. RESULTS OBTAINED

Sample 1: M30 Grade Concrete and 0 % Marble Dust.

Table 1

Case 1	Compressive Strength Test Results After			Tensile Strength Test Result After			Flexural Strength Result	Slump Value
M30 Grade Concrete and 0 % Marble Dust.	***7 Days***	***14 Days***	***30 Days***	***7 Days***	***14 Days***	***30 Days***	5.63 Mpa	74 mm
	23.2 N/mm^2	26.2 N/mm^2	38.1 N/mm^2	3.66 N/mm^2	3.77N/mm^2	4.47N/mm^2		

Sample 2: M30 Grade Concrete and 5 % Marble Dust.

Table 2

Case 2	Compressive Strength Test Results After			Tensile Strength Test Result After			Flexural Strength Result	Slump Value
M30 Grade Concrete and 5 % Marble Dust.	***7 Days***	***14 Days***	***30 Days***	***7 Days***	***14 Days***	***30 Days***	5.55Mpa	74 mm
	26.2 N/mm^2	27.3 N/mm^2	35.3 N/mm^2	3.62 N/mm^2	3.72 N/mm^2	4.65 N/mm^2		

Sample 3 : M30 Grade Concrete and 10 % Marble Dust.

Table 3

Case 3	**Compressive Strength Test Results After**			**Tensile Strength Test Result After**			**Flexural Strength Result**	**Slump Value**
M30 Grade Concrete and 10 % Marble Dust.	***7 Days***	***14 Days***	***30 Days***	***7 Days***	***14 Days***	***30 Days***	5.93 Mpa	74 mm
	25.75 N/mm^2	31.11 N/mm^2	42.8 N/mm^2	3.86 N/mm^2	4.33 N/mm^2	4.88 N/mm^2		

Sample 4: M30 Grade Concrete and 15 % Marble Dust.

Table 4

Case 4	**Compressive Strength Test Results After**			**Tensile Strength Test Result After**			**Flexural Strength Result**	**Slump Value**
M30 Grade Concrete and 15 % Marble Dust.	***7 Days***	***14 Days***	***30 Days***	***7 Days***	***14 Days***	***30 Days***	6.32Mpa	63 mm
	28 N/mm^2	31.2 N/mm^2	45.1 N/mm^2	4.15 N/mm^2	4.75 N/mm^2	5.16 N/mm^2		

Sample 5: M30 Grade Concrete and 20 % Marble Dust.

Table 5

Case 5	**Compressive Strength Test Results After**			**Tensile Strength Test Result After**			**Flexural Strength Result**	**Slump Value**
M30 Grade Concrete and 20 % Marble Dust.	***7 Days***	***14 Days***	***30 Days***	***7 Days***	***14 Days***	***30 Days***	5.85 Mpa	60 mm
	26.62 N/mm^2	30.1 N/mm^2	42.78 N/mm^2	3.95 N/mm^2	4.57 N/mm^2	4.82 N/mm^2		

Sample 6: M30 Grade Concrete and 25 % Marble Dust.

Table 6

Case 6	**Compressive Strength Test Results After**			**Tensile Strength Test Result After**			**Flexural Strength Result**	**Slump Value**
M30 Grade Concrete and 25 % Marble Dust.	***7 Days***	***14 Days***	***30 Days***	***7 Days***	***14 Days***	***30 Days***	5.13Mpa	58 mm
	26.41 N/mm^2	30.2 N/mm^2	42.67 N/mm^2	3.79 N/mm^2	4.59 N/mm^2	4.69 N/mm^2		

5. DISCUSSION

a. General

Based on the study, the analysis of the characteristics of concrete, namely the, workability, strength, and durability are made which prompted the use of marble, dust as a partial replacement, material by 0, 5, 10, 15, 20, and 25 percent with M30 concrete.

b. Workability

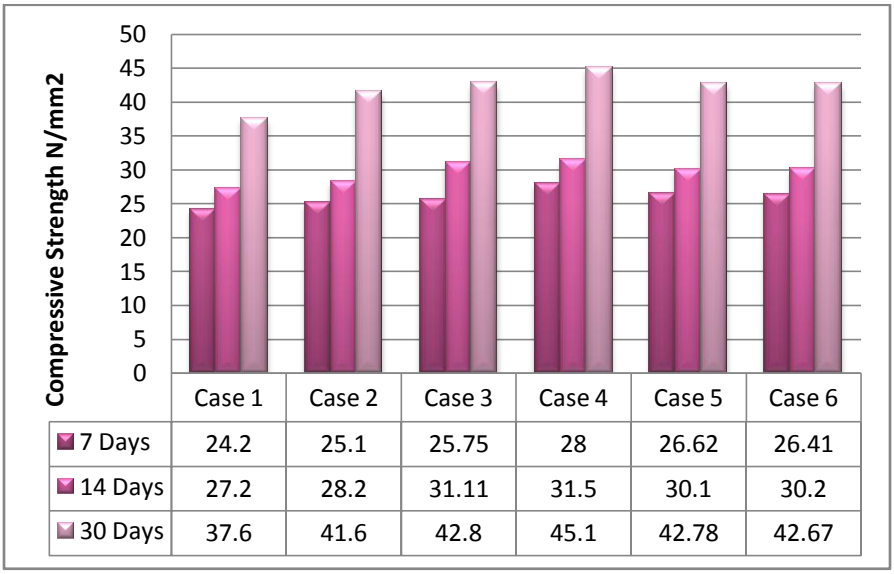
It is observed from the test results, that, the compactor factor increased with the increase in the level of replacement up to15%. There was decrease in slump also.

c. Compressive Strength

The compressive strength at 7, 14 and 3 days is increasing with the, increase inthe replacement, level of cement with, marble, dust up to 14.80% replacement at which the, compressive strength14.51% higher compared, to conventional concrete.

Comparative Analysis of Compressive Strengths

Figure 1



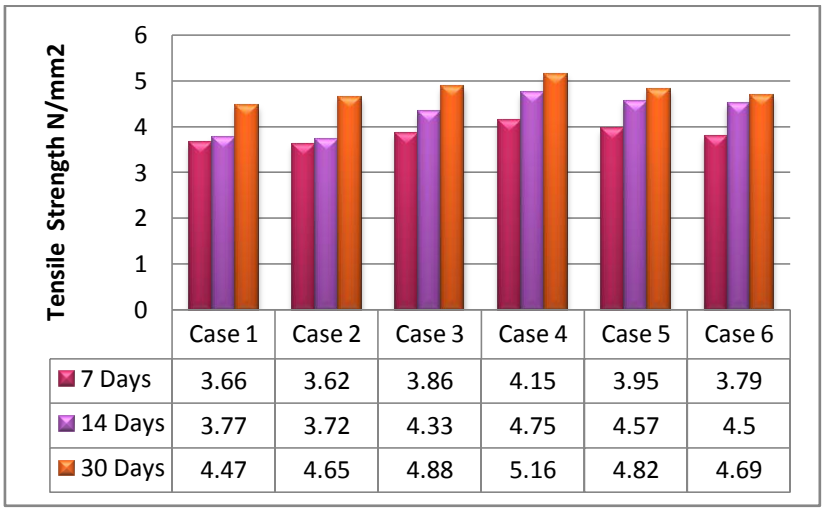
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
7 Days	24.2	25.1	25.75	28	26.62	26.41
14 Days	27.2	28.2	31.11	31.5	30.1	30.2
30 Days	37.6	41.6	42.8	45.1	42.78	42.67

Tensile Strength

The tensilestrengthisincreasing with the increase, in the replacement level of cement with marbledust up to 15% replacement.

Comparative Analysis of Tensile Strengths

Figure 2



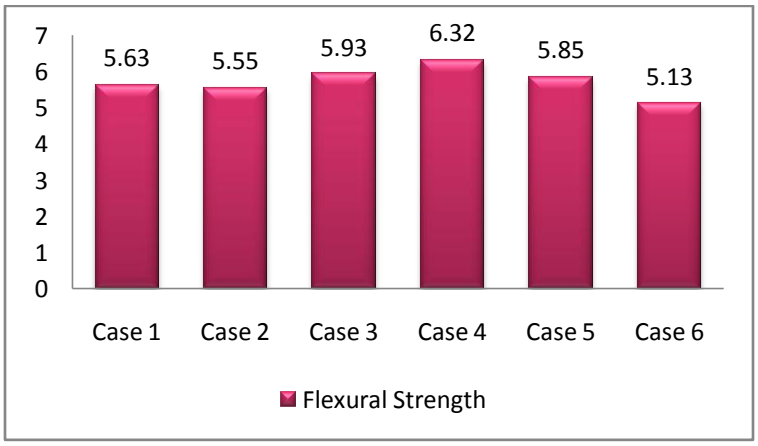
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
7 Days	3.66	3.62	3.86	4.15	3.95	3.79
14 Days	3.77	3.72	4.33	4.75	4.57	4.5
30 Days	4.47	4.65	4.88	5.16	4.82	4.69

Flexural Strength

The flexural strength of concrete increases upto 20% replacement level and the maximum is recorded for 15% replacement level and is found 7.1% more than the normal concrete.

Comparative Analysis of Flexural Strengths

Figure 3



6. RECOMMENDATION AND CONCLUSION

1. During the research it was, found that marble dust, increases the cohesiveness of the concrete.

2. From the above study, it was evident that, around 15 % or something in the, range is very useful in increasing, the strength of concrete. Marble dust can easily, be used as a admixture, for strength purposes.

3. Marble dust, with 15 % showed overall, good values of compressive, and tensile strengths.

4. Marble dust or any, other waste, materials can, be used with conventional materials to increase the strength of the materials, and at the same time, environmental mess can be reduced

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