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An Experimental Study on Utilization of Marble Powder for Sustainable Construction

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Abstract - *Marble dust powder is a waste that causes environmental troubles because millions of tonnes of marble dust powder are generated per year. The aims of this paper are to utilize the marble dust powder by replacing cement with marble dust powder. This helps in sustainable construction and also protects the environment. Marble dust powder is generated from lime stone mines, Glass and Paper industries etc. In this experiment, marble dust was used as an admixture in concrete, It contributed to better strength as compare to normal concrete (by replacing cement with marble dust powder in a limited amount). In this experimental study, preparation of concrete cube is done by replacing cement with marble dust powder at various percentages (0% ,5%, 10%, 20%, 30% & 40%) and study of the workability and compressive strength of concrete. It is done after seven days and twenty-eight days.*

Key Words: **Marble dust powder (MDP), Compressive Strength, Workability , Cement.**

1.INTRODUCTION

In this project, we have study about the utilization of a very fine grinding calcareous compound known as marble dust powder, which is produce per year in very large amount as waste. We have studied the utilization of marble dust as replacement for the pozzolanic material used in Portland pozzolanic cement. In this study, we have concluded that marble can be a good enough replacement for pozzolanic material. This result in decrement in hazardous issues caused by carbon emission from the production of pozzolana cement and also concludes the management of waste marble dust powder produced per year.

After the mixing of marble dust powder in ordinary Portland cement, this reduced the increment of the concrete compressive strength and enhanced the binding properties of the cement. The Marble dust has high calcium oxide content more than 50%. Concrete (plastic concrete) is freshly mix material. It can be moulded into any shape. The water/cement ratio required based on concrete workability and concrete workability determined by slump value.

In this experiment, prepared 12 concrete cubes with a size of $15cm \times 15cm \times 15cm$ for each and also prepared a sample by replacing cement with marble dust powder at different percentages (0%, 5%, 10%, 20%, 30%, & 40%). Using the M25 mix design for determining the compressive strength and workability of each sample. It is tested after 7 days and 28 days. The increment of marble dust powder show the reduction of strengths concrete (with marble dust powder replacing 10% cement). It improved the prozzolanic reaction. Marble dust is a solid waste material. It can be used in concrete by replacing cement or fine aggregate with limited amount.

1.1. Objective of this experimental study

In this experiment, replacing cement with marble powder with various percentages, also determines the workability and compressive strength of concrete.

To compare results between normal concrete and various percentages of replacement cement with marble dust powder.

2. EXPERIMENTAL MATERIAL AND METHODOLOGY

2.1. Experimental materials

2.1.1. Cement

Ordinary Portland cement is most common type of cement. We generally use a high grade of cement and it offers many advantages for making strong concrete. Portland cement consumption to a 10% to 20%

reduction in cement consumption. As well as the physical properties depicted below.

Table -1: Physical properties of cement

Physical properties of cement		
Sr.no.	Physical properties	Test result
1	Initial setting time	52 min
2	Final setting time	376 min
3	Specific gravity	2.89
4	Standard consistency	29%

2.1.2. Fine aggregate

Fine aggregate consisting of natural sand fills the void between aggregates.

Fig -1 Fine Aggregate

It makes concrete more economical because fine aggregate is available in nature and provides the resistances against shrinkage and cracking. IS CODE 456:2000 recommends fine aggregate sizes ranging from 4.75mm and 0.15mm.it is granular material.

Table -2: Physical properties of fine aggregate

Physical properties of fine aggregate		
Sr.no	Properties	Test result
1	Water absorption	0.8%
2	Specific gravity	2.53
3	Bulk density	1.26(g/cc)
4	Fineness modulus	4.039

2.1.3. Coarse aggregate

Aggregate is an important constituent in concrete. It occupies 70-80% volume of concrete. The study of cement is incomplete unless the aggregate depth and range are studied. Aggregate passing though 63mm sieve and retained on 4.75mm sieve are called coarse aggregate.

Fig -2 Coarse Aggregate

In this experiment, the size of aggregates was used. Ranging from 20mm and 10mm. cement is the only factor that makes a standard composition in concrete. it is a natural, solid material. The study of aggregate is done under following: size, textures, specific gravity, soundness, sieve analysis, shape, strength, moisture contain.

Table -3: Physical properties of coarse aggregate

Physical properties of coarse aggregate		
Sr.no	Properties	Test result
1	Water absorption	1%
2	Specific gravity	2.69
3	Bulk density	1.65(g/cc)
4	Fineness modulus	4.13

2.1.4. Water

The amount water depends on IS Code 456:2000, and the amount of water contained can also be adjusted by

slump value. The range of water required for M25 (1:1:2) is 21 to 27 liters with the weight of 563 kg cement, keeping water cement ratio between 0.4 to 0.6. it is required at normal pressure and temperature. It is polar molecule.

2.1.5. Marble dust powder

There is large amount of marble dust generated the during cutting of marble, extracting, polishing, processing and grading. It can be used in various sector such as agriculture, construction, glass and paper industries. The replacement of cement with the marble dust powder make concrete more economical the chemical composition of marble dust powder is given below in the table.

Fig -3 Marble dust powder

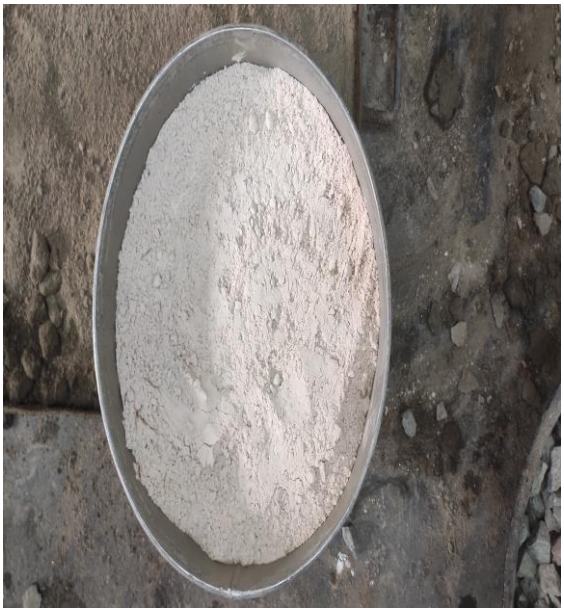


Table -4: chemical composition of marble dust powder

Chemical composition of marble dust powder	
Oxide compound	Percentage
CaO	42.45
Al2O3	0.520
SiO2	26.35
Fe2O3	9.40
MgO	1.52

2.2. Methodology

In this experiment, we are using M25 (1:1:2) mix design as per IS CODE 456:2000.
Equipment and collection of material such as ordinary Portland cement, fine aggregate, coarse aggregate and marble dust powder.
Batching of material by weight and mixing of material by hand mixing.
A sample of concrete is prepared in this experiment by replacing it with marble dust powder at different percentages (0%, 5%, 10%, 20%, 30% & 40%).
The size of the cube mould using in this experiment is $15cm \times 15cm \times 15cm$.
Clean the cube mould and apply oil in the inner surface.
Place concrete in to mould in four layers, compacting each layer and finally providing a smooth surface.
After 24 hours, remove the concrete cube from the cube mould.
After 7 days or 28 days of curing, the concrete cube is removed from water tank for testing.
The strength of cubes is determined by testing after 7 days and 28 days because the concrete cube gains 99% strength in 28 days.
Testing after 7 days and 28 days gave a quick idea about the quality of concrete.

3. TEST AND RESULTS

3.1. Workability test

There is large amount of marble dust generated the during cutting of marble, extracting, polishing, processing and grading. It can be used in various sectors such as agriculture, construction, glass and paper industries. The replacement of cement with the marble dust powder make concrete more economical the composition of marble dust powder is given below in the table.

The factor affecting the workability of concrete.

Water content
Mix proportion
Size of aggregates
Shape of aggregates
Surface texture of aggregates
Gradin of aggregate
Use of admixture

Measurement of workability (by slump test)

The most common test method is the slump test. It is used to measure the consistency of concrete. It is not suitable method for very wet or very dry concrete.

Fig -4 Slump test

The most common test method is the slump test. It is used to measure the consistency of concrete. It is not suitable method for very wet or very dry concrete.

3.2. Compression test

The compression test is the most common test because it is easy to perform. The goal of testing compressive strength of concrete is ensure that the concrete used on-site has developed the necessary strength. Testing of compressive strength plays important role in controlling and confirming the quality of concrete work.

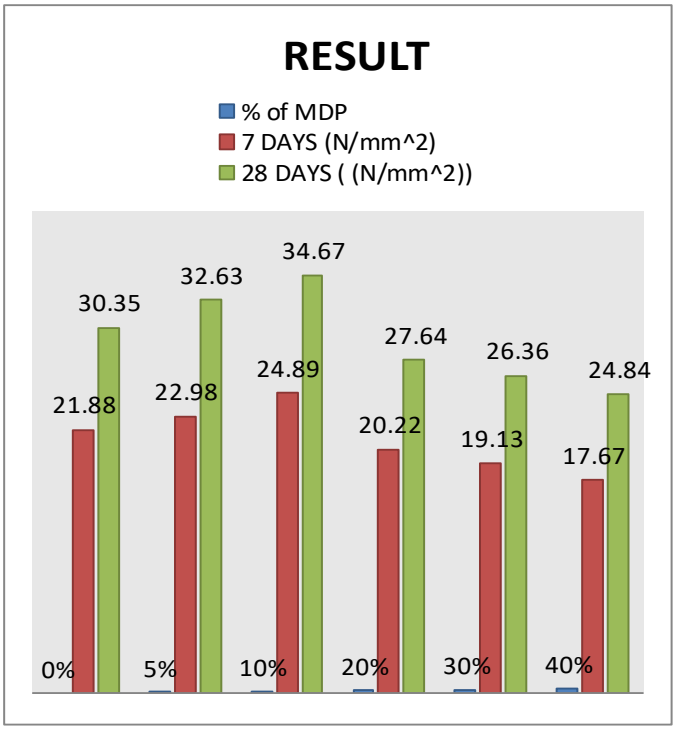
Fig -5 The compression test

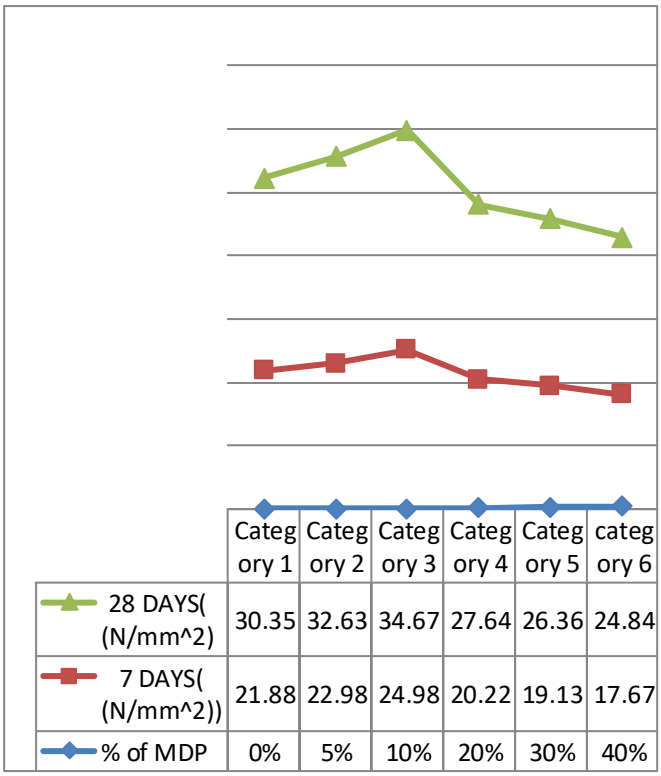
In this experiment, determine compression strength after 7 days and 28 days because concrete gain strength 65% in 7 days and 99% strength in 28 days. The purpose of testing compressive strength because it provide a quick idea about the quality of concrete.

Compressions test result

Table -5: Compressions test result

%OF MDP	7 DAYS ((N/mm^2))	28 DAYS ((N/mm^2))
0%	21.88	30.35
5%	22.98	32.63
10%	24.98	34.67
20%	20.22	27.64
30%	19.13	26.36
40%	17.67	24.84





	Category 1	Category 2	Category 3	Category 4	Category 5	category 6
28 DAYS((N/mm^2)	30.35	32.63	34.67	27.64	26.36	24.84
7 DAYS((N/mm^2))	21.88	22.98	24.98	20.22	19.13	17.67
% of MDP	0%	5%	10%	20%	30%	40%

4. CONCLUSIONS

The conclusion of the experiment is explained in the following points.

Marble dust powder is a good enough waste product that can be used as a replacement for cement.

When marble dust powder containing less then ten percentage or equal to ten percentages slightly increase the compressive strength of the concrete.

When marble dust powder containing more than ten percentages and up to forty percentage slightly decreases the compressive strength of the concrete.

Replacement of cement with marble dust powder reduces the consumption of cement and helps to utilize the marble dust powder in the most efficient way.

During the experiment, we got the conclusion that when adding marble dust powder 5%or 10% by replacement of cement, it increases the setting time.

In the second mixture, after adding 20% and more than 20% of marble dust powder by replacement of cement, then the amount of water required 50% less, and workability is normal, but it has increased setting time of concrete.

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[5] M.S. SHETTY BE, ME, FICI, FIIBE, FIE, MACCE Technical Advisor, MC Bauchemie (Ind) Pvt. Ltd. Principal Technical Consultant, Grasim Industries, Ltd. Consultant to IMCC Delhi Metro Corporation Formerly Senior Prof. and Head of Department of Construction Engineering College of Military Engineering (CME), Pune Ministry of Defence

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