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Mechanical and durability characteristics of marble powder concrete

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ABSTRACT

The main objective of this research is to investigate the performance of concretes contained marble dust as a cement replacement. Replacement of marble dust different percentage as 5%, 10%, 15 %, 20% and 25% of marble dust as partial replacement of cement with M-25 grade of concrete age of concrete at 7, 14, 28 and 56 days. The results of the study, samples of concrete with 0 to 15% marble dust replacement have reached optimum strength. Finally Showed that concrete containing marble dust 0 to 15% showed the highest amount of compressive strength, and split tensile strength of concrete. To assess the corrosion and durability characteristics of marble dust concrete Acid and alkalinity resistance test, and Initial surface absorption test was performed. The results show that the optimum replacement of marble dust with cement was 15%. Up to 15% replacement, it is possible to gain the same strength as conventional concrete. Beyond 15% replacement the strength results following the decreasing trend. Moreover, initial surface absorption increases with an increase in replacement levels. It was also found that the Acid and alkalinity resistance is increasing with an increasing percentage of marble dust in concrete. Further studies can be carried out as this study only concludes that there is an increase in strength and durability of concrete up to 15% replacement of cement by the marble powder.

Keywords— *Marble powder, Admixture, Workability, Compressive strength, Split tensile strength, Durability*

1. INTRODUCTION

It is generally known that the fundamental requirement for making concrete structures is to produce good quality concrete. Good quality concrete is produced by carefully mixing cement, water, and fine and coarse aggregate and combining admixtures as needed to obtain the optimum product in quality and economy for any use. Waste marble powder is generated as a by-product during cutting of marble. The waste is approximately in the range of 20% of the total marble handled. The amount of waste marble powder generated at the site every year is in the range of 250-400 tones. The advancement of concrete technology can reduce the consumption of natural resources, energy sources and lessen the burden of pollutants on the environment. This project describes the feasibility of using the marble powder in concrete production as partial replacement of cement by weight. In India, marble processing is one of the most thriving industries.

2. MATERIALS USED

2.1 Cement

Ordinary Portland cement (OPC) from a single lot was used throughout the course of the investigation. The physical properties of the cement as determined from various tests 30 conforming to Indian Standard IS: 1489-1991(Part-1) are listed in Table 1. All the tests were carried out as per recommendations of IS: 4031-1988. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture.

2.2 Course aggregate

coarse aggregate with a maximum size 12.5mm having a specific gravity 2.67 and fineness modulus of 6.55%. Angular recycled aggregates from a local source were used as coarse aggregate. The specific gravity was 2.72.

2.3 Fine Aggregate

Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate. The specific gravity of sand is 2.62.

2.4 Marble Powder

It was sieved by IS-90 micron sieve before mixing in concrete.

3. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS

3.1 Workability of Concrete Mixes

The workability of concrete mixes was found out by slump test as per procedure & the compaction factor was found out using the procedure as given in chapter 3. Water-binder (w/b) ratio was kept constant 0.4 for all the concrete mixes. Super-plasticizer Gelenium hky 8765 was used to maintain the required slump. The dosage of super-plasticizer was kept 1.0% by weight of the binder.

Table 1: Workability and Compaction factor values for different concrete mixes

Mix no.	Description	Superplasticizer (%) by weight of the binder	Slump (mm)	Compaction factor
M1	100%OPC	1.00	56	0.89
M2	95%OPC+5%MP	1.00	55	0.86
M3	90%OPC+10%MP	1.00	54	0.854
M4	85%OPC+15%MP	1.00	46	0.842
M5	80%OPC+20%MP	1.00	44	0.822
M6	75%OPC+25%MP	1.00	43	0.820

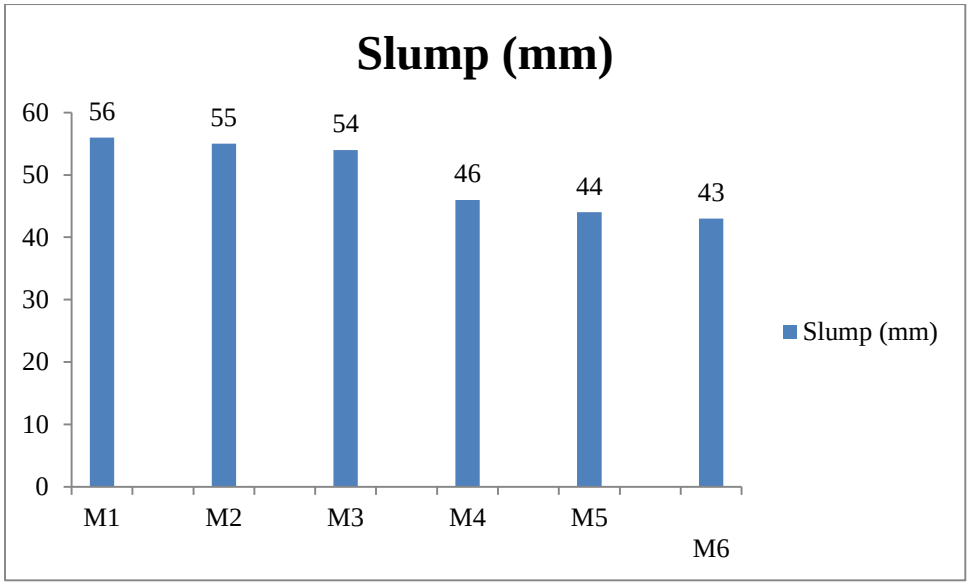


Fig. 1: Slump test results

Table 1 shows that as the addition of marble powder to concrete mix increases, the workability & compaction factor of the concrete mix was found to decrease as compared to the control mix. To achieve the required slump superplasticizer was added to the concrete mix. The lowest value of slump was obtained with mix 80%OPC+25% MP and the highest value was obtained with 95%OPC+5%MP. There is a decrease in workability of concrete with an increase in marble powder. Due to the high content of marble powder, it is very difficult to get required slump values without the addition of superplasticizer

3.2 Compressive Strength

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test was conducted at curing ages of 7, 14, 28 & 56 days. The compressive strength test results of all the mixes at different curing ages are shown in Table 2. Variation of compressive strength of all the mixes cured at 7, 14, 28 & 56 days is also shown in figure 2. It shows the variation of compressive strength of concrete mixes w.r.t control mix (100%OPC) after 7, 14, 28 & 56 days.

Table 2: Compressive stress (MPa) results of all mixes at different curing ages.

Mix no.	Description	7 Days	14 Days	28 Days	56 Days
M1	100%OPC	28.07	28.86	31.05	38.6
M2	95%OPC+5%MP	29.95	31.3	35.95	39.15
M3	90%OPC+10%MP	31.93	32.49	35.90	39.60
M4	85%OPC+15%MP	38.05	42.33	39.95	44.30
M5	80%OPC+20%MP	31.21	35.45	38.35	42.10
M6	80%OPC+25%MP	30.11	33.25	37.45	40.41

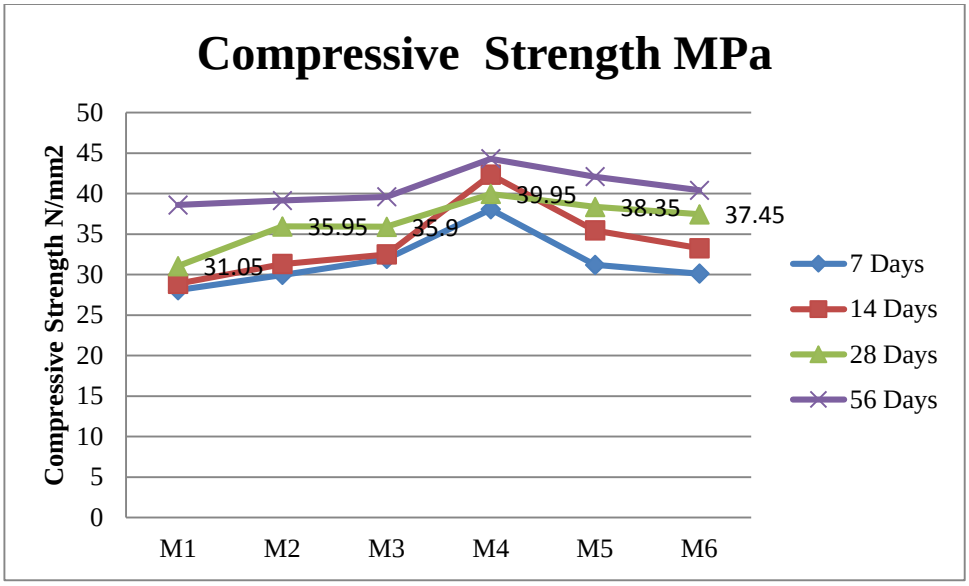


Fig. 2: Compressive strength test results

Table 2 shows that there is an increase in compressive strength up to 15% replacement thereafter decrease in compressive strength is observed. It is also observed that the value of compressive stress increases for every sample with the increase in the period of curing. It is clear from the figures 1 and 2 that as the percentage replacement of marble powder in the concrete mix increases there is an increase of compressive strength of the sample w.r.t the control mix up to 15 % replacement thereafter there is a decrease in the compressive strength.

3.3 Split tensile strength test results

The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The splitting tensile strength test was conducted at curing ages of 7, 14, 28 and 56 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in table 3.Variation of splitting tensile strength of all the mixes cured at7, 14, 28, & 56 days is also shown in figure 3. It shows the variation of splitting tensile strength of concrete mixes w.r.t control mix (100%OPC) after 7,14, 28, and 56 days respectively.

Table 3: Split tensile stress (MPa) results of all mixes at different curing ages.

Mix Number	Description	7 days	14 days	28 Days	56 Days
M1	100%OPC	3.33	3.87	4.46	4.73
M2	95%OPC+5%MP	3.38	3.45	3.79	4.63
M3	90%OPC+10%MP	3.40	3.59	3.75	3.98
M4	85%OPC+15%MP	3.84	4.19	4.93	4.20
M5	80%OPC+20%MP	3.14	3.29	3.35	3.75
M6	80%OPC+25%MP	3.02	3.11	3.20	3.45

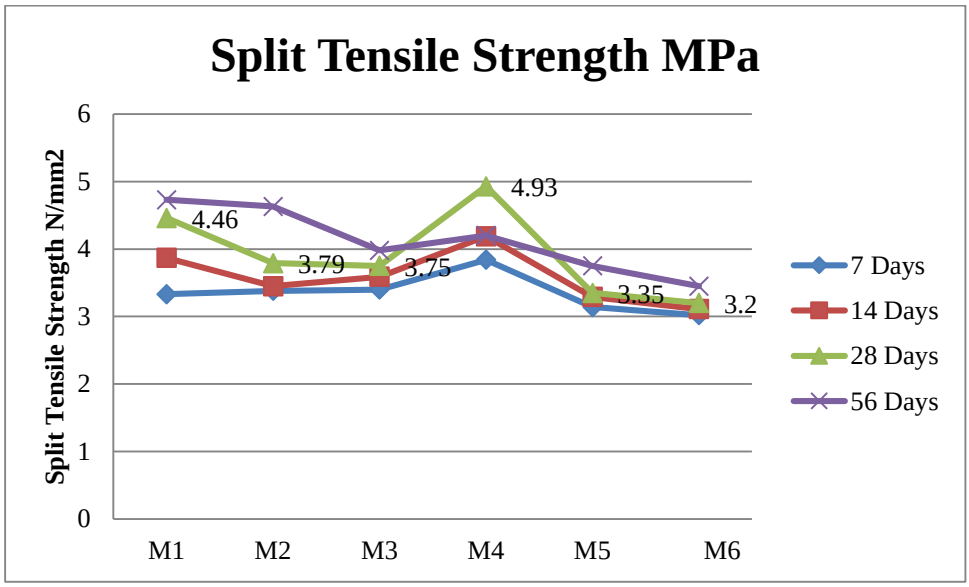


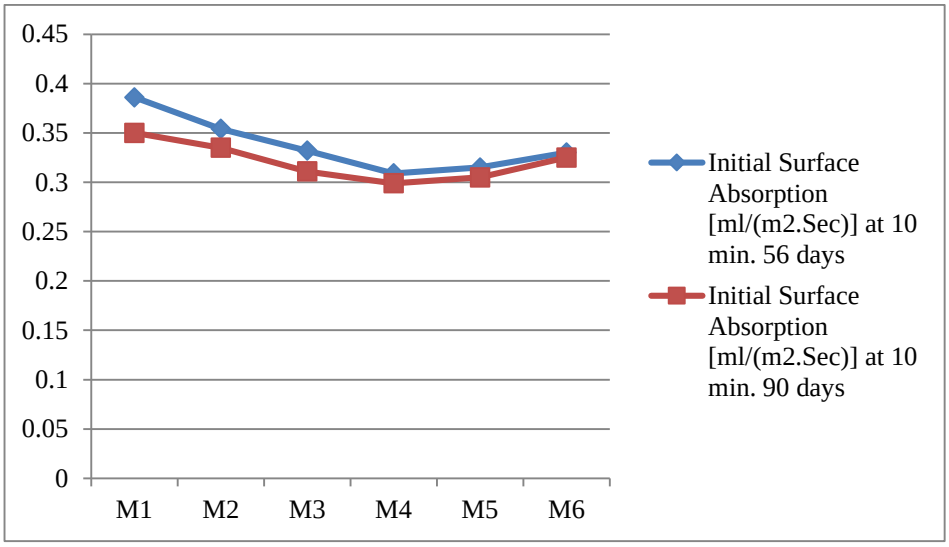
Fig. 3: Split tensile strength test result

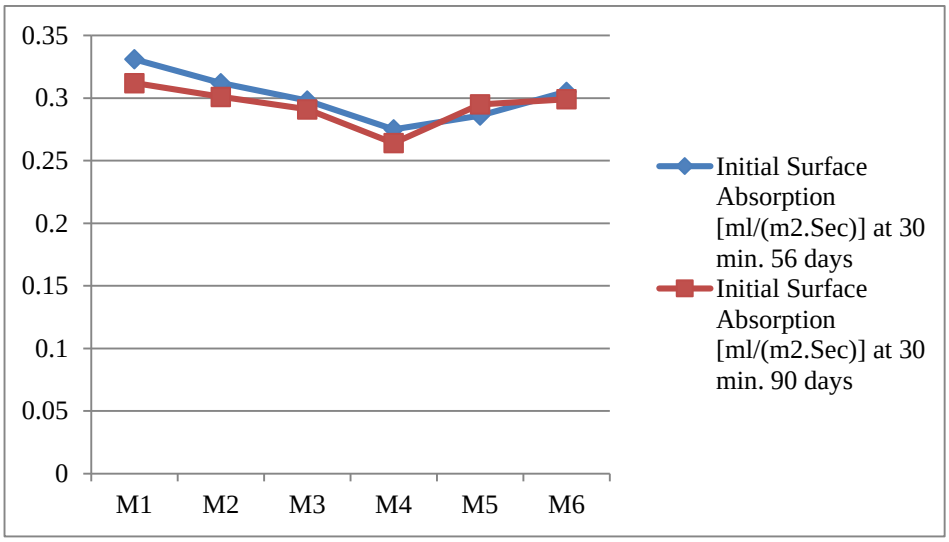
Table 3 shows that the splitting tensile strength test results of the samples follow an increasing trend till the 15% replacement thereafter there is a decrease in the tensile strength. As the percentage replacement of the marble powder increases in the mix

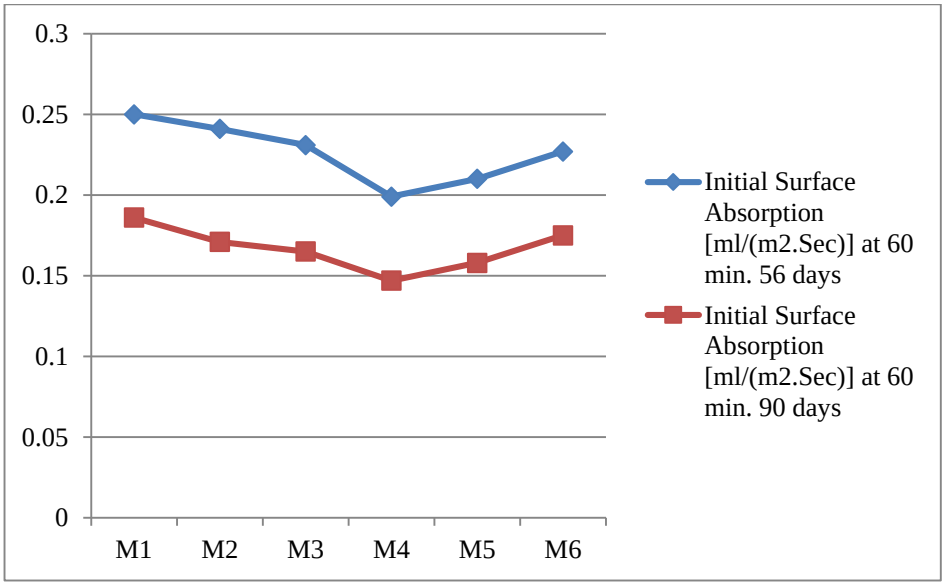
there is a rising trend in the graph observed in the tensile strength of the mix up to a replacement level of 15% and as the percentage replacement increases to 20% there is a decrease in the tensile strength observed probably due to an increase in marble powder replacement percentage.

4. INITIAL SURFACE ABSORPTION TEST RESULTS

The ISAT was performed to have an idea about the water permeation of concrete, particularly at the concrete surface. The concrete cover is the weakest, most permeable and absorptive part of the concrete matrix as compared to the internal microstructure. The near-surface concrete is highly heterogeneous in nature, due to the relative movement of cement paste and aggregates during the compaction of fresh concrete and bleeding of mix water in the early stages of cement hydration.







Figures shows the results obtained from the ISAT test performed on 6 mixes at 56 days and 90 days of curing age. The lowest value was recorded as 0.199, 0.147 ml/(m2.Sec) for mix 85%OPC+15%MP for 56 and 90 days at 60 min respectively. Whereas the highest value was recorded as 0.386, 0.350 ml/(m2.Sec) for mix 100%OPC+0%MP for 56 and 90 days at 10 min respectively. From figures, it can be seen that the increase in marble powder percentage in the mix is the reason for more absorption.

5. CONCLUSIONS

In the current investigation, marble powder was used to examine the strength and water absorption characteristics using the initial surface absorption test and acid resistance and Alkalinity resistance. The experimental data obtained has been analysed and discussed in Chapter-4, to fulfil to the best of ability, the objectives set forth for the present investigation.

- Reduction in bleeding is observed by the addition of marble powder in the marble powder concrete mixes.
- It was observed that as the addition of marble powder to concrete mix increases, the workability of the concrete mix was found to decrease as compared to the control mix.
- At a dosage of about 15% marble powder the increase in compressive strength of marble powder concrete mixes compared with control mix of concrete at 28 days. The compressive strength is observed 22.27% increasing compare to compare.
- The percentage increase of split tensile strength of marble powder concrete mixes compared with control mix at 28 days is observed varying from 15 to 20% marble powder by weight of the binder. The maximum value of tensile strength shows 4.93 MPa at 28 days.
- The concrete containing marble powder was found to be low resistant against H2SO4solution with the control mix concrete. The using 15-20% marble powder in concrete show low acid attack.
- The concrete containing the optimum dosage of marble powder by weight of binder shows the lesser value of initial surface absorption.

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