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Strength and Durability of Concrete Made with Marble Dust

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ABSTRACT

As per preservation endeavors, this examination concentrates on the waste marble dust as partial replacement with cement. Concrete creation, the counter active action of ecological contamination with considering the components of reasonable and cost-sparing development ventures, particularly material utilization. Moreover, many of the construction industry in India produce construction waste that contributes largely to solid waste. Utilizing marble waste, this research will focus on marble wastes obtained from the construction industry in India. Presently, much of ceramic industries production goes to waste, which is not undergoing the recycle process yet. Replacement of marble dust of different percentage 5%, 10%, 15% and 20% of marble dust as partial replacement of cement with M-25 grade of concrete. The age of concrete at 7, 14, 28 and 56days.From the results of the study, samples of concrete with 0 to 15% marble dust replacement have reached optimum strength. Findings showed that concrete containing marble dust 0 to 15%showed the highest amount of compressive strength, and split tensile strength of concrete.

Further studies can be carried out as this study only concludes that there is an increase in strength upto 15% replacement of cement by the marble powder. Further scope is to find out the optimal %age of marble powder to replace.

Keywords: *Workability, Compressive Strength, Tensile Strength, Porosity, 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 Indian marble industry has been growing steadily at an annual rate of around 10% per year. 20 to 30% of marble blocks are converted into powder. 3,172 M tons of marble dust was produced in year 2009-10. Recently, marble dust powder has been used in the construction industry and research has been carried on to examine their fruitful result. So, this is to study the utilization of marble dust powder in the construction industry to address environmental problem due to the waste and to seek alternative for cement and sand based material and for efficient use of natural resource. This research aims to study the effect of using marble powder as partially replacement of cement on the properties of concrete. The influence of using marble powder on the behaviour of reinforced concrete slabs is also investigated. The main variable taken into consideration is the percentage of marble powder as partial replacement of cement content in concrete mixes. The experimental results showed that, using definite amount of marble powder replacement of cement content increases the workability, compressive strength and tensile strength

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 3.1. 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.

Table 3.1 Properties of OPC

Characteristic Properties	Observed Value	Codal Requirements IS:8112-1989(Part 1)
Fineness (m /kg)	300	225 minimum
Standard consistency (%)	32	----------
Initial Setting time (minutes)	62 minutes	30 Minimum
Final setting time (minutes)	270	600 Maximum
Specific gravity	3.15	----------

2.2 Coarse Aggregate

The coarse aggregate with a maximum size 12.5mm having a specific gravity 2.65 and fineness modulus of 6.51%.Angular recycled aggregates from a local source was used as coarse aggregate. The specific gravity was 2.71.

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 2.60.

2.4 Marble Dust

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

2.5. Admixtures

Water-reducing and set-retarding admixtures are permitted in order to increase the workability of the concrete. Super plasticizer Gelenium hky 8765 was used for the workability.

3. MIX PROPORTIONS

Table3.1Mixes

MIX	OPC (%)	MARBLE POWDER (%)
M1	100%	0%
M2	95%	5%
M3	905	10%
M4	85%	15%
M5	80%	20%

4. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS

4.1 Workability & Compaction factor 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. Dosage of super-plasticizer was kept 1.0% by weight of binder. The workability & compaction factor results of different concrete mixes were shown in Table 4.1

Table 4.1 Workability & Compaction factor values for different concrete mixes

Mix no.	Description	Super plasticizer (%) by weight of 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

Table 4.1 shows that as the addition of marble powder to concrete mix increases, the workability & compaction factor of concrete mix was found to decrease as compared to control mix. To achieve the required slump super plasticizer was added to concrete mix. The lowest value of slump was obtained with mix 80%OPC+20% MP and highest value was obtained with 95%OPC+5%MP. There is decrease in workability of concrete with increase in marble powder. Due to high content of marble powder it is very difficult to get required slump values without addition of super plasticizer.

4.2 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 4.2. Variation of compressive strength of all the mixes cured at 7, 14, 28 & 56 days are also shown in Fig. 4.1. Fig. 4.1 shows the variation of compressive strength of concrete mixes w.r.t control mix (100%OPC) after 7, 14, 28 & 56 days.

Table 4.2 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

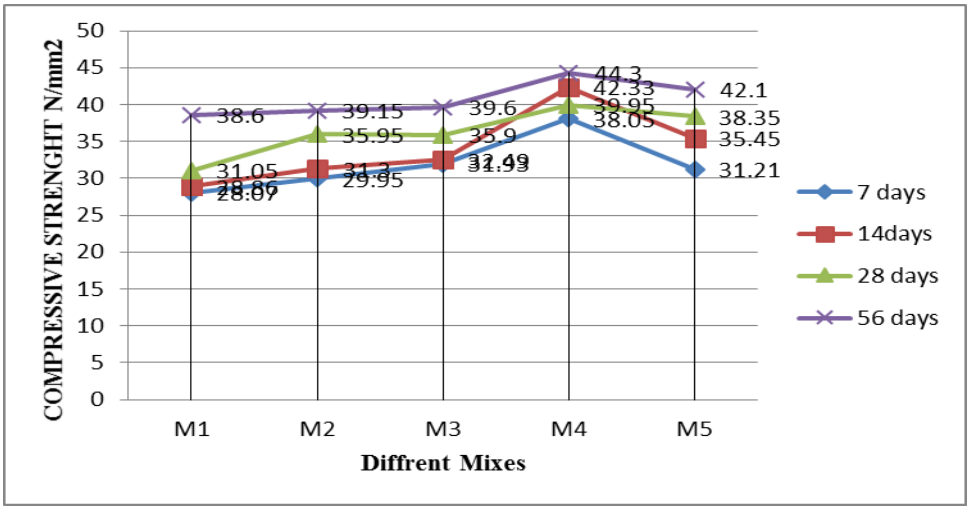


Table 4.2 shows that there is an increase in compressive strength upto 15% replacement thereafter decrease in compressive strength is observed.It is also observed that the value of compressive stress increases for every sample with the in increase in the period of curing. It is clear from the figures 4.1 and 4.2 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 upto 15 % replacement thereafter there is a decrease in the compressive strength.

4.3. Splitting Tensile Strength

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 & 56 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in Table 4.3.Variation of splitting tensile strength of all the mixes cured at7, 14, 28, & 56 days is also shown in Fig. 4.2. Fig. 4.2 shows the variation of splitting tensile strength of concrete mixes w.r.t control mix (100%OPC) after 7,14, 28, & 56 days respectively.

Table 4.3 Split tensile stress (MPa) results of all mixes at different curing ages.

Mix	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

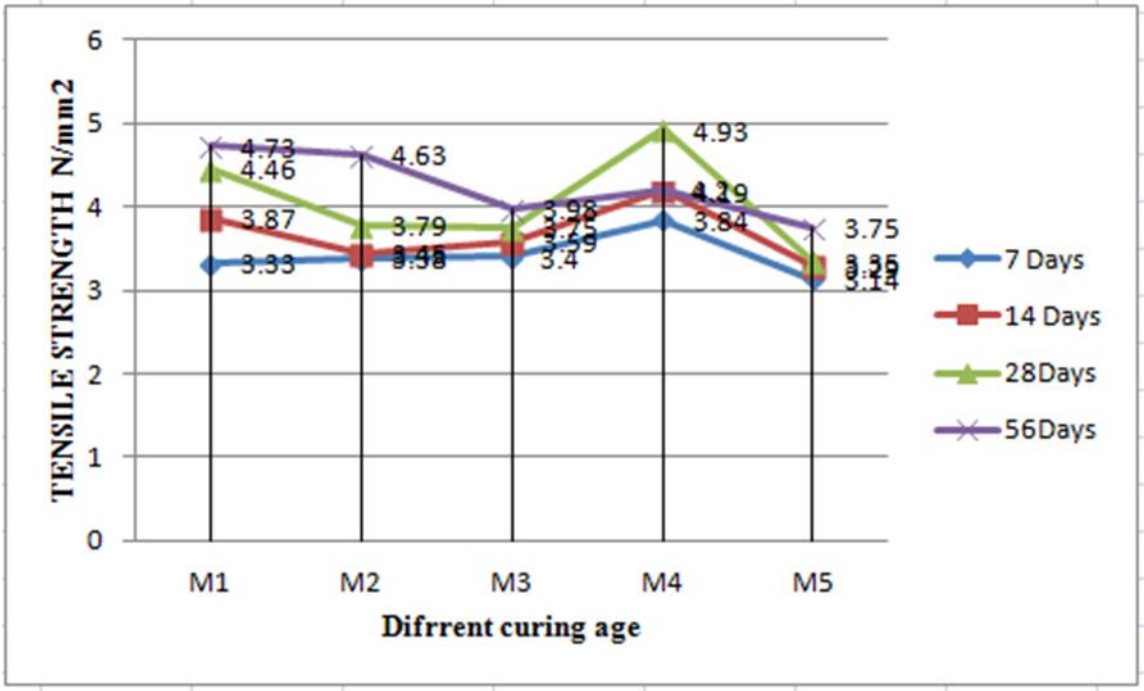


Table 4.3 shows that the splitting tensile strength test results of the samples follow an increasing trend till the 15% replacement thereafter there is decrease in the tensile strength. As the percentage replacement of the marble powder increases in the mix there is a rising trend in the graph observed in the tensile strength of the mix upto replacement level of 15% and as the percentage replacement increases to 20% there is decrease in the tensile strength observed probably due to an increase in marble powder replacement percentage.

4.4 Porosity

The results of the porosity of different concrete specimens cured at different ages are presented and discussed in this section.

Table 4.4 Porosity results of all mixes at different curing ages

Mix number	Description	7 days	14 days	28 days	56 days
M1.	100% OPC	9.88	9.49	9.49	9.80
M2.	95% OPC + 5% MP	8.76	6.60	5.94	8.49
M3.	90% OPC + 10% MP	10.29	11.23	10.78	9.62
M4.	85% OPC + 15% MP	7.60	8.57	8.51	6.97
M5.	80% OPC + 20%MP	9.87	10.75	10.97	9.67

Table 4.4 indicates that the porosity of the control mix first decreases for the 14 days and 28 days then increases for the 56 day sample. Similar is the case for sample of 5% replacement. But for 10% and 15% replacement there is first increase of porosity for the 14 days w.r.t 7 days sample thereafter there is slight decrease observed in the porosity for the 56 day sample. For 20% replacement level there is first increase of porosity for 14 and 28 days sample then there is slight decrease on 56 days. From the above table and the graph below it is observed that upto 10% replacement level there is an increase of porosity for 7, 14 ,28 and 56 days which decreases from the 15 % replacement onwards for different curing ages.

5. DURABILITY TEST

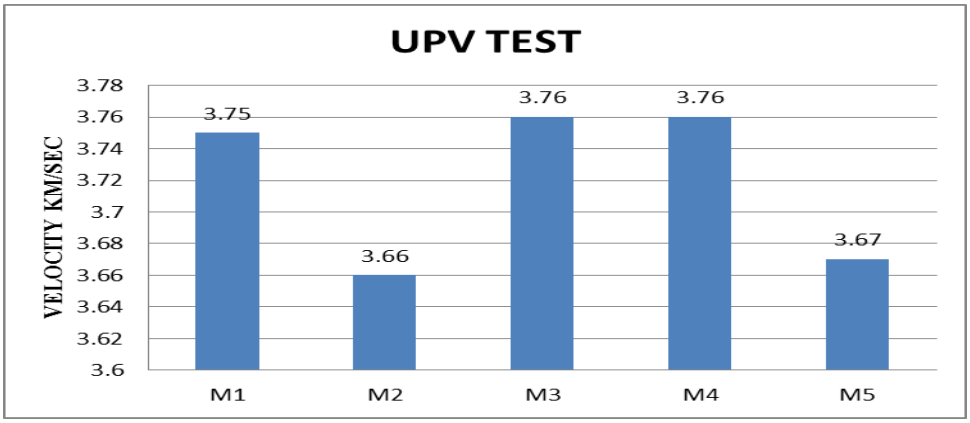
5.1 UPV Test Results

The results of the UPV tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The UPV test was conducted at curing ages of 7, 14, 28 & 56 days. The UPV test results of all the mixes at different curing ages are shown in Table 4.5 to 4.8.

Table 4.7 UPV values at 28 days of curing

Mix Number	Description	Distance (mm)	Transit Time (µ sec)	Average pulse Velocity (km/sec)	Quality of Concrete
M1	100%OPC	100	26.60	3.75	Good
M2	95%OPC+5%MP	100	27.30	3.66	Good
M3	90%OPC+10%MP	100	26.50	3.76	Good
M4	85%OPC+15%MP	100	26.60	3.76	Good
M5	80%OPC+20%MP	100	27.25	3.67	Good

It is observed from the above graph that the UPV values are the highest for M3 and M4 mix i.e. 3.76 km/sec while it is observed to be the lowest for the M2 and M5 mix.



6. CONCLUSIONS

In the current investigation, marble powder (MP) was used to examine the strength and water absorption characteristics using the Capillary Suction test and UPV test. 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. This chapter gives the broad conclusions that may be drawn from the investigation.

Based on the scope of work carried out in this investigation, following conclusions are drawn.

a. Reduction in bleeding is observed by addition of marble powder in the marble powder concrete mixes.
b. It was observed that as the addition of marble powder to concrete mix increases, the workability of concrete mix was found to decrease as compared to control mix.
c. At 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 compressive strength is observed from 18% to 20%.

d. 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 binder.
e. UPV value found to be higher for concrete containing 15% marble powder by weight of cement. The average value was 3.75 (km/sec.) at 7, 14, 28 and 56 days of curing respectively.
f. The concrete containing 5% marble powder by weight of binder shows less capillary rise in concrete while the maximum value of absorption was found in the mix containing 10% and 15% of marble powder as replacement.
Further studies can be carried out as this study only concludes that there is an increase in strength upto 15% replacement of cement by the marble powder. Further scope is to find out the optimal %age of marble powder to replace.

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