

## **Properties of concrete incorporating waste marble powder as partial substitute of cement and sand**

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### **ABSTRACT**

Waste marble powder is a result of sawing and shaping of parent marble rock. Due to presence of high oxide content in marble powder it is harmful to environment, but it is also a cementing property. In this research work, the effects of using waste marble powder (WMP) as a partial replacement of cement and sand on the properties of the concrete have been investigated. The compressive strength and ultrasonic pulse velocity were tested for seven different series prepared by partially replacing cement, sand with WMP at proportions of 0-15% by weight separately and in combined form. Finally, all of the data were compared with each other & it was observed that the addition of WMP such that would partially replace the sand and cement separately at particular proportions.

### **1. INTRODUCTION**

India is rich in its marble resources which vary from place to place. Marble is a metamorphic rock composed of recrystallized carbonate minerals, most commonly calcite or dolomite. The marble is one of the minerals produced in India used in construction industry so there is a huge production of marble wastes too. Kushwah et al. (2015), presented in his paper that the marble can be utilized in concrete mix by replacement of fine aggregates. Mohammedan (2012), looks into the effect of marble powder and silica fume of different percentages as partial substitute for cement on mortar. (Aruntas et al. 2010, Hebhouh et al.2011, Firat et al.2012, Aliabdo et al. 2014, Djebien et al. 2015), indicates marble dust, fly ash & waste sand have properties of good additive materials, which enhances the material properties. According to Aliabdo et al. (2014) studied the replacement of cement or sand by marble powder for

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improvement in concrete properties. It shows that sand replacement gives better results as compare to cement replacement. Givi et al. (2010) studied that average particle size of rice husk provides positive effect on compressive strength and water permeability of hardened concrete. Hebhouh et al. (2014) studied the effect of marble wastes replacement of sand (25, 50, 75, 100%) in the mortar. Aruntaş (2010) investigated the serviceability of waste marble dust as an additive material in blended cement. Kumar et al. (2014, 2015), Ashish et al. (2011), Verma et al. (2014), Dar (2015), Kumar et al. (2014), Kumar et al. (2015a, 2015c), Wani et al. (2015) recommended the new and innovative building materials and eco-friendly technologies, covering waste material is the need of the hour.

## 2. EXPERIMENTAL METHODOLOGY & INVESTIGATION

In this experimental study, the mix design is taken as M30. Water binder ratio is taken as 0.42. Refer to Table 1 different mixes was prepared by using a different percentage of marble powder (0%, 10%, 10%, 15%, 15%, 20% and 30%) namely MX0, MX1, MX2, MX4, MX5 & MX6 as a partial replacement in the cement sand mix.

Table 1 Marble dust based concrete mix

Sr. No.	Mix Designation	Percentage of WMP (%)	Water (lt/m <sup>3</sup> )	Cement (kg/m <sup>3</sup> )	Coarse Aggregates (kg/m <sup>3</sup> )	Fine aggregate (kg/m <sup>3</sup> )	Marble Powder (kg/m <sup>3</sup> )
1	MX0(Control)	0	186	432.00	1123.57	648.46	0
2	MX1 (Sand)	10	186	432.00	1123.57	583.62	64.84
3	MX2(Cement)	10	186	388.80	1123.57	648.46	43.20
4	MX3 (Sand)	15	186	432.00	1123.57	551.20	97.26
5	MX4(Cement)	15	186	367.20	1123.57	648.46	64.80
6	MX5(Cement and Sand)	20	186	388.80	1123.57	583.62	108.04
7	MX6 (Cement and Sand)	30	186	367.20	1123.57	551.2	162.06

### 2.1 Compressive Strength

It can be noted that from Table 2 when cement is partially replaced by the marble powder up to 10% then the compressive strength of the mix after 7 days decreased upto 4.72%, after 28 days it decrease upto 2.8% and after 90 days it decrease upto 4.16% and when partially replace it with sand then again compressive strength after 7 days increased up to 10.81%, after 28 days it increase upto 11.24% and after 90 days it increase upto 15.64% but when marble powder dust is partially replaced by cement (15%), compressive strength after 7, 28 & 90 days decreases 12.42%, 11.24% and 14.06% respectively and when partially replaces it with sand then it increases up to 26.06%, 23.24% & 16.24 after 7, 28 & 90 days respectively also when together replaces by 20% (10%+10%) by marble powder then its compressive strength after 7, 28& 90 days increased upto 0.57% and decreased 3.11% & 6.34 respectively and 2.03%, 11.33% & 8.51 when partially replaces both cement and sand by 30%

(15%+15%) marble waste. Hence result shows that marble powder when mixes with sand and up to 15% has high compressive strength and mixed with cement strength decreases.

Table 2 Comparison of compressive strength after 7, 28 & 90 days

Sr. No.	Mix Designation	Average Compressive strength (N/mm <sup>2</sup> ) after 7 Days	% Increase Average Compressive Strength after 7 Days	Average Compressive strength (N/mm <sup>2</sup> ) after 28 Days	% Increase Average Compressive Strength after 28 Days	Average Compressive strength (N/mm <sup>2</sup> ) after 90 Days	% Increase Average Compressive Strength after 90 Days
1	MX0	21.18	0	32.82	0	50.5	0
2	MX1	23.47	10.81	36.51	11.24	58.4	15.64
3	MX2	20.18	-4.72	31.90	-2.80	48.4	-4.16
4	MX3	26.70	26.06	40.45	23.24	58.7	16.24
5	MX4	18.55	-12.42	29.13	-11.24	43.4	-14.06
6	MX5	21.30	0.57	31.80	-3.11	47.3	-6.34
7	MX6	20.75	-2.03	29.10	-11.33	46.2	-8.51

## 2.2 Ultrasonic Pulse Wave

All the mixes containing the waste marble powder has high ultrasonic pulse wave as compare to control mix presented Table 3. So there is a slightly increase in the durability of concrete.

Table 3 Comparison of ultrasonic pulse wave after 28 days

Sr. No.	Mix Designation	Average ultrasonic pulse wave	% Increase average ultrasonic pulse wave
1	MX0	4.132	0
2	MX1	4.694	13.6
3	MX2	4.545	10
4	MX3	4.773	15.5
5	MX4	4.290	3.8
6	MX5	4.420	6.97
7	MX6	4.220	2.13

## 5. CONCLUSIONS

Experimental investigation showed the following conclusions:

- Based on the experiment result it showed that replacement of sand by marble powder upto 15% increases the compressive strength but replacement of cement upto 15% content of marble powder decreases the compressive strength.
- The Durability of the mix containing different percentages of waste marble powder slightly increases with reference to the control mix.
- Ultrasonic pulse wave shows better results when partially replaces sand by 15% as compare to the other mixtures.

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