

# Experimental Study on the Partial Replacement of Cement by Marble Dust on Concrete Pavements and Mortar

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## ABSTRACT

*This paper aims to focus on the possibilities of using waste materials from different manufacturing activities in the preparation of innovative mortar and concrete. The use of waste marble powder (dust) was proposed in partial replacement of cement, for the production of Mortar and Concrete Mix. In particular, tests were conducted on the mortars and concrete mix cured for different times in order to determine their workability, compressive strength. Partial replacement of cement by varying percentage of marble powder reveals that increased waste marble powder ratio result in increased workability and compressive strengths of the mortar and concrete at each curing age.*

*The marble dust from marble processing is a waste utilized. The use of this waste was proposed in different percentages both as an addition to and instead of cement, for the production of concrete mixtures. In the study, the use of marble dust collected during the shaping process of marble blocks has been investigated in the concrete mixtures as cementitious material. The study showed that marble wastes, which are in the dust form, could be used as cementitious material in concrete mixtures where they are available and the cost of construction is lower than ordinary concrete materials. The concrete and mortar is prepared containing 0, 10, 15 and 20% waste of marble dust with cement compared to the total quantity of normal concrete and mortar. The prepared mixtures were then studied in terms of their properties both in fresh and in hardened state. In particular, tests were conducted and cured at different times to find compressive strength and without partial replacement of marble dust in cement concrete and for mortar also determined for 7 and 28 days.*

**Keywords:** *Concrete, Compressive Strength, Industrial Waste, Low Cost, Marble Dust, OPC cement.*

## 1. INTRODUCTION

Rajasthan is known for mining of minerals and marbles. District Ajmer (Makrana), Rajsamand, Udaipur, Chittorgarh, Banswara, Alwar, Sirohi, Jaipur etc is known for the mining of Marble and at the same time it has led to growth of many processing units engaged in cutting of marble in the

form of Gang saw and cutters. These two activities in state of Rajasthan have been extended in 20-25 years and have played important role in the economy of the state providing direct and indirect employment to lacs of people and also raising the living standard in country by using marble in flooring temples etc. The marble explosion and cutting giving good revenue to state and central government and also currency increase by export.

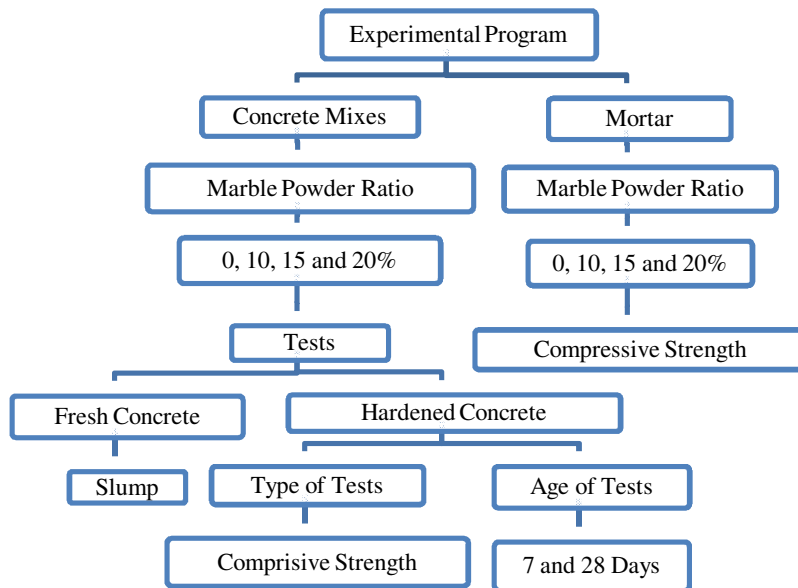
Blended cements based on the partial replacement of Portland cement clinker (PC) by wastes have been the subject of many investigations in recent years. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. In building industry, Marble has been commonly used for various purposes like flooring, cladding etc., as a building material since the ancient times. The industry's disposal of the marble powder material, consisting of very fine powder, today constitutes one of the environmental problems around the world. In India, marble dust is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. Therefore, utilization of the marble dust in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment. Some attempts have been made to find and assess the possibilities of using waste marble powder in mortars and concretes and results about strength and workability were compared with control samples of conventional cement sand mortar/concrete. So many losses from the Marble powder like as

- The waste is indestructible
- The sites which can be used as dumping ground are limited and gives repulsive dirty look/
- Erosion of top fertile soil cover
- Contamination of the rivers and other water bodies there by adversely affecting irrigation and drinking water resources
- Contamination of air
- Public out cry due to general losses.

Many researchers have performed several numerical and experimental studies on partial replacement of cement by marble dust. Marble is a metamorphic rock produced from limestone by pressure and heat in the earth crust due to geological process [1]. Chemically, marble are crystalline rocks composed predominantly of calcite, dolomite or serpentine materials. The other mineral constituents vary from origin to origin. Physically, marble are re-crystallized hard, compact, fine to very fine grained metamorphosed rocks capable of taking shining polish[2]. Marble dust is an industrial waste produced from cutting of marble stone. In recent times, marble dusts have found some use in the construction industry and research has been conducted to

examine their applications. Satish et al [3]. worked extensively on the hardened properties of bituminous concrete with marble dust as filler. Fillers are fine aggregate material that passes 0.063mm sieve [4, 6 ]. The behaviour of bituminous concrete with marble dust compared very well with bituminous concrete with lime and stone dust. Houari et al [5] investigated the abrasion resistance of concrete made by percentage substitution of sand by marble waste powder, the result compared well with concrete without marble powder.

## 2. METHODOLOGY



## 3. MORTAR

To carry out the proposed study cubes of mortar (1:3) with varying partial replacement of cement with the same amount of waste marble powder were cast and tested at 7 & 28 days. Their results were compared with those of standard (1:3) mortar. Detail of mortar mix has been shown in Table 1.

**Table 1: Material**

%Replacement	0%	10%	15%	20%
Cement	1.2	1.08	1.02	.96
Sand	3.6	3.6	3.6	3.6
Marble Powder	0	0.12	0.18	0.24
Water	0.528	0.528	0.528	0.528
W/C ratio	0.44	0.49	0.51	0.53



**Figure 1: Mortar moulds empty**



**Figure 2: Mortar moulds filled**

**Concrete**

**Table 2: Material Properties**

Material	Fineness/Fineness Modulus	Specific Gravity
Cement	0.225 (m <sup>2</sup> /g)	3.12
Fine Aggregate	2.60	2.71
Course Aggregate	2.96	2.85
Marble Powder	1.5 (m <sup>2</sup> /g)	2.67

**Mix Design**

Based on the Indian Standard for M20 grade of concrete was prepared by partially replacing cement with marble granules (0%, 10%, 15%, and 20%). The mix proportion for M20 Grades of concrete with varying percentage of marble granules is presented in Table 3.

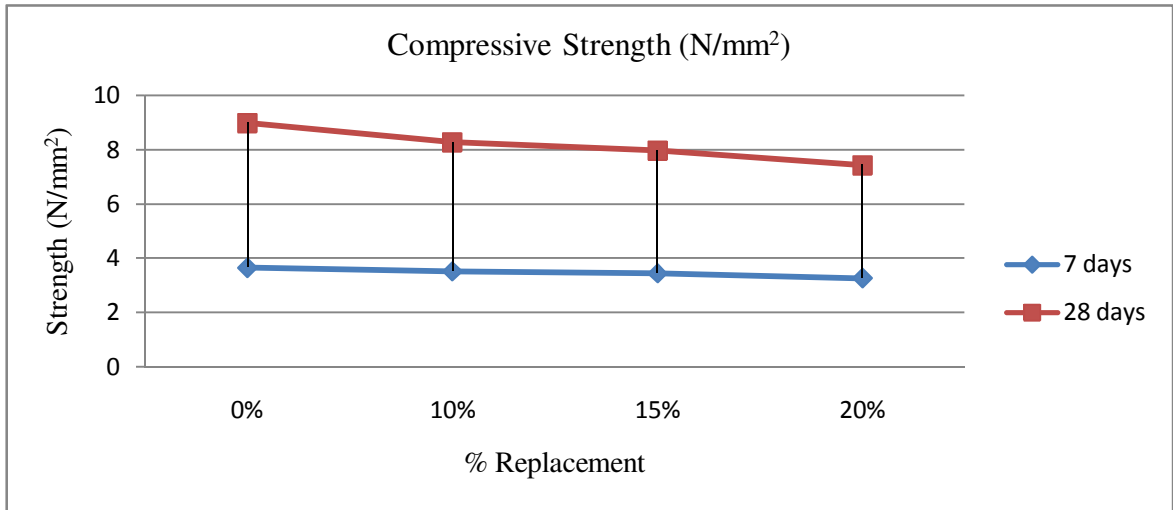
**Table 3: Mix Proportion**

Mix	Materials	Mix Proportion
M20	%Marble	C:w:fa:Ca
	0	1:0.5:1.5: 3
	10	1:0.5:1.5: 3
	15	1:0.5:1.5: 3
	20	1:0.5:1.5: 3

#### 4. RESULTS AND DISCUSSIONS

##### *Mortar Mix*

Compressive Strength test on Mortar test results for every specimen were shown in below figure.

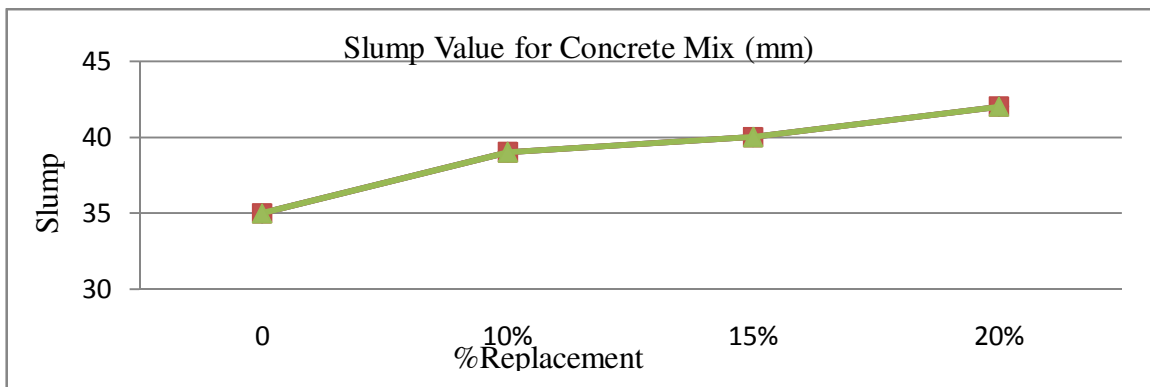


**Figure 3: Compressive Strength for Mortar (N/mm<sup>2</sup>)**

##### *Concrete Mix*

##### *Workability*

It is observed here that degree of workability is medium as per IS 456-2000. The slump values of the concretes obtained from waste marble granules mix gave negligible effect as compared to normal concrete mix as shown in below figure.



**Figure 4: Slump Value for Concrete Mix (mm)**

### 5. COMPRESSIVE STRENGTH

The test results are presented in figure 7. By increasing the waste marble granules the compressive strength values of concrete tends to increase at each curing age. This trend can be attributed to the fact that marble granules possess cementing properties. It is also as much effective in enhancing cohesiveness due to lower fineness modulus of the marble powder or granules both. Furthermore, the mean strength of concrete mixes with marble granules was 5-10% higher than the reference concretes. However, there is a slight decrease in compressive strength value concrete mix when 20% marble granule is used as compared with that of 15% marble granule mix.



Figure 5: Cubes Testing



Figure 6: Cubes Testing

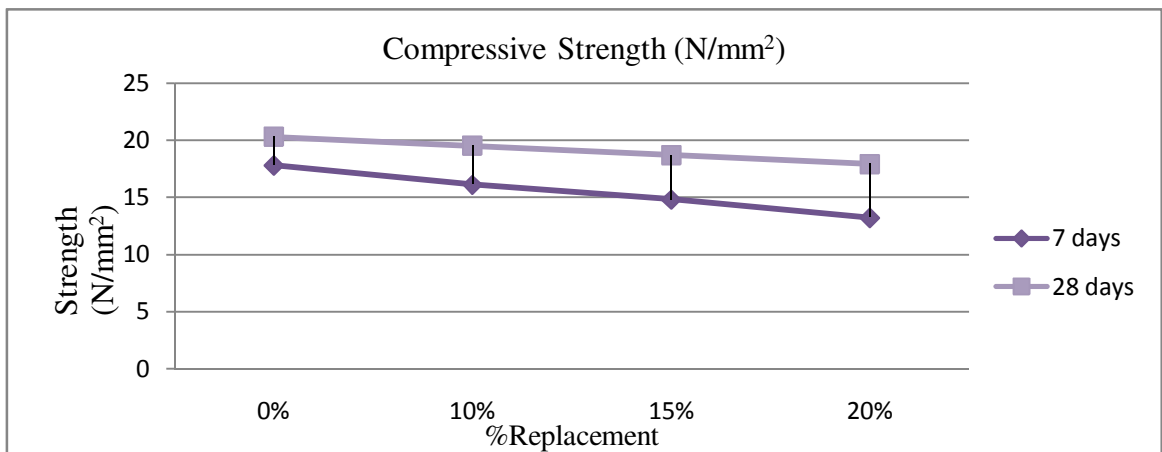


Figure 7: Compressive Strength for Concrete (N/mm<sup>2</sup>)

## 6. CONCLUSIONS

### *Mortar Mix*

Marble powder is partially replaced in cement by weight. there is a marked reduction in compressive strength values of mortar mix with increasing marble powder content when compared with control sample at each curing age.

### *Marble Mix Concrete*

The slump values of the concretes obtained from waste marble granules mix gave negligible effect as compared to normal concrete mix. Degree of workability is medium conforming to IS: 456 – 2000. The mean strength of all concrete mixes with marble granules was 5-10% higher than the references concrete conforming to IS: 456-2000.

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