



# Improvement on Mechanical Properties of Fresh and Hardened Concrete by Marble Waste and Pumicite

SrijaJuluru, R. Sanjaykumar, Adarsh, Ajith, K SShiyas Ismail

**Abstract:** Development, world-over is fuelled by growth of the economy and the growth of economy is fuelled by growth in infrastructure. Estimates record a consumption of 6.6 Gigatonnes of concrete in China in earlier part of this decade, for infrastructure development. But today the world is poised on a tipping point environmentally, and sustainable growth is the need of the hour. This requirement is leading to research in replacement of energy intensive materials, along with capture and utilization of available waste. Marble powder waste which has deleterious impact on environment is one such material. Existing literature majorly focus on utilization of marble powder as fine aggregates in concrete. This study aims to study the suitability of marble powder as a filler material and as a replacement of cement. Pumice breccias are used as coarse aggregates. Experimental investigations were conducted to ascertain the compressive and split tensile strength in concrete with marble powder replacing cement by various percentages. The results indicate a general improvement in both compressive and split tensile strength.

**Keywords :** Pumices, Marble Dust, Compressive, Flexural

## I. INTRODUCTION

Concrete and steel are literally the building blocks of modern civilization and development. A strong and positive correlation is observed between economic growth and consumption of these materials. Parallel to this economic narrative of growth, runs the degradation of ecosystems and environment. Thus developing nations, are challenged to route their country's growth on a sustainable path. It is hence imperative to lower the ecological footprint of concrete by reducing consumption of new resources and utilizing waste materials generated in other processes. The utilization of LWA concrete has numerous focal points such as decrease of dead load, high warmthprotection and lowering haulage and handling cost. LWA comprises of natural and artificial aggregates. Pumice stones are used in this study.

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These LW concrete have a unit weight ranges from 350 to 1900kg/m<sup>3</sup>. This study investigates partial replacement of cement with waste marble powder, concurrently with pumice LA in concrete. Lokesh.S et.al (2013) had investigated work on LWC with silica fume and HVFA and concluded the tests on hardened concrete increases by using mineral admixtures. Sudarshan Raj P etal (2017) had conducted research and results shown that 10% is optimum for marble waste powder, 15% for coconut shells, 25% for quarry dust replacement are suitable alternative materials for cost reduction in construction. N Venkata Ramana (2015) had done his work on basic properties of pumiicities and concluded the suitable percentage of 15% in concrete and regression model was created for both compressive and split tensile

## II. MATERIALS AND METHODOLOGY

### A. Marble Dust

Marble powder dust was acquired during cutting and processing of marble slabs from production lines and its synthetic structure is tabulated in fig 1

**Table 1 Chemical composition of marble powder**

Constituent	percentage
SiO <sub>2</sub>	61
Al <sub>2</sub> O <sub>3</sub>	18.4
Fe <sub>2</sub> O <sub>3</sub>	06.00
CaO	04.5
MgO	2.5
Na <sub>2</sub> O	Nil
K <sub>2</sub> O	03.02

Various marble tests and results

- Consistency of marble = 22%
- Specific gravity = 2.19
- Specific surface area=2400cm<sup>2</sup>/gm

### B. Cement

For the present investigation, OPC 53grade confirming to BIS : 12269-19879 [4 ]was used.

Initial setting time of cement = 33minutes

Final setting time of cement = 8 hrs 20 min

Consistency =33%

Specific gravity = 3.01

### C. Fine Aggregate

Sand going through IS 4.75mm Sieve was utilized for all samples. The physical properties of sand are tested. Its specific gravity is obtained as 2.741. Fineness modulus as 2.6 and water absorption as 0.9%



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## D. Coarse Aggregate

For experimental work pumice stone is utilized collected from Nellore.

**Table 2 Preliminary Tests for coarse aggregates**

S.No	Preliminary Tests	Result Value
1.	Specific gravity	0.9
2.	Water Absorption	29%
3.	Flakiness Index	3.6%
4.	Elongation Index	5%
5.	Impact Test	35%

E potable water is utilized for work which is free from impurities

## III. METHODOLOGY

Cement was partially replaced by marble powder and pumice stone as coarse aggregate in concrete. Marble waste product are mixed in concrete mix M-25 in different percentage (5%, 10%, 15%, 20%) by weight. After curing (7 and 28 days), cubes, cylinders, beams were tested and compared with conventional concrete. Prewetting of aggregate is achieved before concreting due to the high water absorption property of pumice light weight. A wetted product lasting 24 hours is removed and moisture is washed out. The mix ratio is calculated based upon IS 10262:2009 [6] to obtain the volume of cement, fine, coarse aggregates. The corresponding proportion of the combination is as follows. For control concrete the mix design is 1:1.2:2.25 with a Water/Cement ratio of 0.496 and for LWC the mix design ratio is 1:1.45:0.65:0.41.

## IV. RESULTS AND DISCUSSIONS

### A. Test On Fresh Concrete

To determine Slump value for normal and concrete with marble powder and pumices. The following workability tests are conducted.

- 1) Slump test
- 2) Compaction factor test

**Table 3: Results of workability tests**

	Test for Workability	Conventional Concrete	Replacement (%) by marble powder and pumice in concrete			
			5	10	15	20
1	Slump Cone	74	70	68	65	61
2	Compaction Factor	0.9	0.8	0.81	0.83	0.84

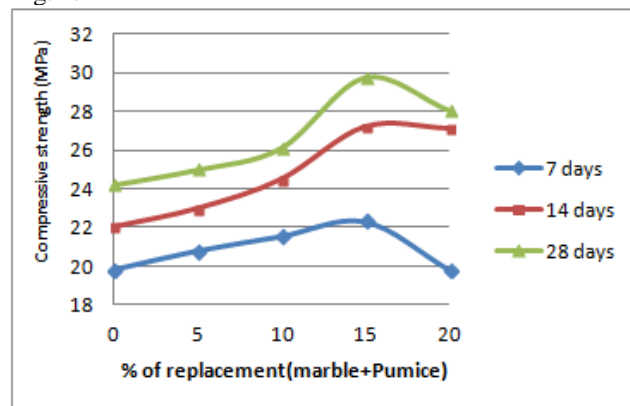
### B. Tests for Compressive strength

Cubical test specimens of size 150 mm x 150 mm x 150 mm were cast and tested for compressive strength in compliance to Indian standards. Twenty cubes with varying percentage of marble powder were tested to determine the strength after seven and twenty eight days of curing. The results are presented in Fig. 1.

The aggregate used in this investigation is 20mm down size crushed aggregate and angular in shape dressed thoroughly. As per IS Specifications [5] preliminary tests were done and results are tabulated in table 2

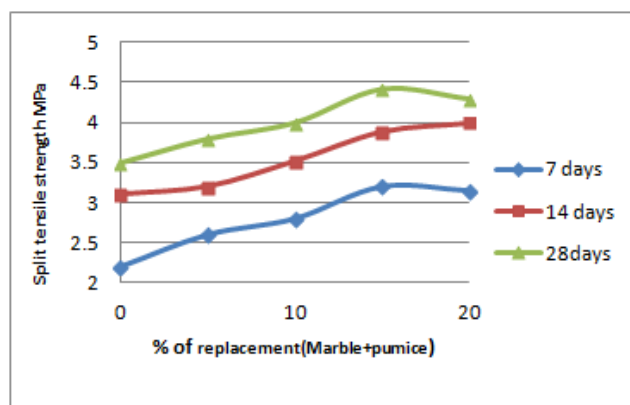
### C. Tests for Split tensile strength

Cylindrical test specimens of 150 mm diameter and 300 mm height were prepared to evaluate split tensile strength. Twenty cylinders with varying percentage of marble powder were tested to determine the strength after seven and twenty eight days of curing. The results are presented in Fig. 2.



**Fig.1 Results for compressive strength**

The tensile strength decreases with decrease in replacement percentage. At 15 % RMP, a 45.5% improvement in tensile strength is observed after 7 days of curing, when compared with conventional concrete. In case of RMP 10%, the 7 days strength is found to be 3.2 N/mm<sup>2</sup> which is 55.5% higher than conventional concrete strength after 28 days of curing.



**Fig.2 Split tensile strength results**

### D. Tests for Acid Attack test

To determine performance in corrosive environments, acid resistance test was performed. The study involves determination of compressive strength, after exposure of a sample of standard size to 5 % sulphuric acid for 15 days. The results are tabulated in Table 3.

**Table 3: Results on acid attack**

S.No	Replacement(marble waste+pumicite)%	Compressive strength MPa
1	0	22.00
2	5	22
3	10	23.5
4	15	27.8
5	20	26.25



**Fig.3 Testing on cylinders**



**Fig.4 Testing on cubes**

### E. Flexural Strength

Flexural strength of different concrete mixes were determined by testing 500x500x100 unreinforced prismatic specimens as per IS 456. The specimens were subjected to two point loading. Deflection was recorded in middle of the beam using a dial gauge. The specimens were tested after 7, 14 and 24 days of curing. Optimal percentage of pumicite and marble waste in concrete is obtained. The results are presented in table 4.

**Table 4 Flexural strength of prismatic specimens**

S. No	Replacement(marble waste+pumicite)%	7days(MPa)	14days(MPa)	28days(MPa)
1	0	2.94	3.65	4.32
2	5	3.05	4.17	5.05
3	10	3.2	4.23	5.10
4	15	3.67	4.38	5.59
5	20	3.56	4.25	5.41

### V. CONCLUSION

It can be seen from the results of this study that use of marble dust replacement of cement in the production of concrete for the construction industry should be encouraged

where there comparative cost advantage, the following conclusions can be made from this study

- Replacement of cement with marble powder and coarse aggregate with pumicite, is observed to improve the mechanical properties of concrete. This improvement is obtained upto 15 % of replacement after which there is marked deterioration in properties.
- The optimum percentage of replacement is determined to be 15 %.
- Thus we can conclude that At 7 and 28 days after testing 15% replacement of pumicite and marble there is 14% increment in compressive strength when compared with control concrete
- Pumicite absorbs more than 20 % water by weight, and this reduces workability of concrete with increasing percentage of replacement. At 15% the workability is 65, which can be practically used.
- Due to fineness and pozzolanic nature of marble powder, it behaves as mineral admixture thus improving concrete strength. Usage of pumicite stones results better strength to weight properties of concrete. Thus the concrete using marble powder as filler and pumicite as coarse aggregate will be useful high strength low weight applications such as prefabricated girders, dynamic structures

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