

# Strength and Durability Properties of Concrete with Partial Replacement of Cement with Marble Dust

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## ABSTRACT

One of the most active research topics is marble powder, which covers a wide range of goods including those used in civil engineering and design. Despite the advancements made in the manufacturing process, the marble sector remains unquestionably a waste generator. Between 30 and 40 percent of the production is lost in the marble market. These wastes contribute significantly to environmental contamination in modern society. In order to achieve the requisite strength, one part marble powder is substituted for one part concrete in this operation. Marble powder is substituted in concrete in various percentages of 5%, 10%, 15%, 20%, and 25% for grade M40 concrete. This hypothetical study will provide a response to the issue of wasteful production in agricultural waste management. It assessed the compressive strength research after 7 and 28 days. According to the experimental findings, the strength of concrete grade M40 is unaffected by the compressive strength attained when 15% to 20% of concrete is replaced with marble powder. We can lessen concrete's durability by utilizing this marble powder in place of some of the concrete. We used grade 53 OPC concrete and 20 mm heavy aggregate for this project. By substituting one 15% marble powder concrete portion for ordinary concrete, we were able to attain better compressive strength.

**Keywords :** Marble Dust, Cement, Fine Aggregate, Coarse Aggregate.

## I. INTRODUCTION

Concrete is a major contribution to the globe in the current stage of development. Many magnificent buildings have been made with the use of this concrete from antiquity to the present

(1) With the aid of this concrete, constructions such as buildings, old buildings, roads, bridges, highways, dams, and others are erected

(2) Cement is the primary constituent in each of the several primary components that make up concrete.

Cement is being used up quickly in concrete as a result of the expanding demands brought on by industrialization. Cement use is relatively high, and this has a negative impact on the environment. The gas released by cement, such as CO<sub>2</sub>, is the primary cause of the environment's negative consequences.

Concrete is a composite material comprised of weak, loose pieces called aggregates that are combined with water and a cement-based binder to create a homogeneous slurry that can withstand a range of loads. The ability to make concrete from recycled waste material gives construction a new dimension and improves the sustainability of the built environment. In the construction of infrastructure for housing, transportation, and energy, Portland cement is widely employed. Together, business and academia have developed filler, admixture, and aggregate raw materials that are stronger than concrete. Each component of concrete serves to provide the necessary strength and maintain favorable design characteristics during the course of the material's lifespan. River sand is used for fine aggregates in PCC, whereas granite stones are used for coarse aggregates. All of these raw materials are in short supply due to their widespread use in construction. New building methods must be developed as a result of the overexploitation of various resources and the resultant lack of replenishment. By utilising more affordable and recyclable materials, the building industry hopes to cut costs and lower disposal costs for used garbage from other industries. Certain components that are used in concrete produce greater results than traditional concrete while having less of an adverse effect on the environment and the economy. To help meet the rising demand, cementous ingredients are added.

The focus of this work is on the potential for employing leftover materials from various industrial operations in preliminary mortar and concrete preparation. Stone mortar and solid waste are both produced by the marble industry. Environmental

issues may result from the atmospheric emission of waste materials. By encouraging particular breakthroughs, we can consume less natural resources and energy sources and worry less about air pollution. We discuss the viability of partially substituting marble mortar for concrete in the manufacturing of concrete. The structure and microstructure of the wetted object are greatly improved by these products' involvement in hydraulic reactions. Natural stone cleaning facilities currently produce a lot of marble dust, which has an impact on both the environment and individuals.

This study illustrates the viability of partially substituting concrete in the manufacturing of concrete with marble mortar. Processing marble and granite is one of the most lucrative industries in INDIA. Investigations have been done into how various marble slurry compositions affect the physical and mechanical performance of residential and commercial structures composed of freshly-poured and hardened concrete. Utilizing alternative products results in lower energy expenses, electricity cost savings, potential special considerations, and reduced atmospheric concerns. Our main goal in this experiment was to examine the compressibility of marble powder and study the effects of replacing some of the concrete with it.

## II. LITERATURE REVIEW

Amitkumar D. Rawal, Dr. Indrajit N. Patel and Prof. Jayeshkumar Pitroda (2013) The use of waste ceramic powder in various industries, especially construction, agriculture, glass and paper industry, will help to protect the environment. In this study, cement (OPC) was replaced by ceramic waste at the rates of 0%, 10%, 20%, 30%, 40% and 50% by weight for concrete grade M-30. Concrete samples are tested and compared for compressive strength with conventional concrete. These tests are performed to evaluate compression resistance for 7, 14 and 28 days. The test results show that the compressive strength achieved when replacing

cement with ceramic waste up to 30% is optimal without affecting the properties of fresh concrete and hardened concrete.

Monogna and M. Sri Lakshmi (2015) partial replacement of tile powder in cement in the range of 0%, 10%, 20%, 30%, 40% and 50% by weight respectively for M30 grade of concrete. For this, samples of tile concrete are tested and compared with ordinary concrete. The following tests are carried out i.e. compressive strength, tensile strength and flexural strength for 7, 28 and 56 days. Test results show that compressive strength, splitting strength and flexural strength can be achieved by replacing cement with tile powder by 30% without affecting the strength characteristics of M30 concrete.

Kutegeza and Alexander (2004) from the standpoint of sustainability, use of recycled materials as aggregates provides several advantages. Landfill space used for disposal is decreased, and existing natural aggregate sources are not as quickly depleted.

Leonard John Murdock 1991 Clean broken brick of good quality can provide satisfactory aggregates, the strength and density of concrete depending on the type of brick; engineering and allied bricks when crushed make quite good concrete of medium strength.

### III. RESULTS AND CONVERSATION

#### Slump Cone Test

Table.No. 4.2 compares slump for various marble powder concentration percentages. It has been shown that when marble powder content in concrete increases, slump decreases and workability decreases as a result. Therefore, the workability of concrete with 0% marble powder is the greatest, while that with 25% marble powder is the worst.

Table.No.3.1.1 : Slump Values of Concrete

Type of Mix	% of Marble Powder	Slump Values (mm)
Normal Concrete	0%	72
Mix 1	5%	69
Mix 2	10%	62
Mix 3	15%	55
Mix 4	20%	43
Mix 5	25%	38

Graph.No.3.1.1 : Slump Values of Concrete

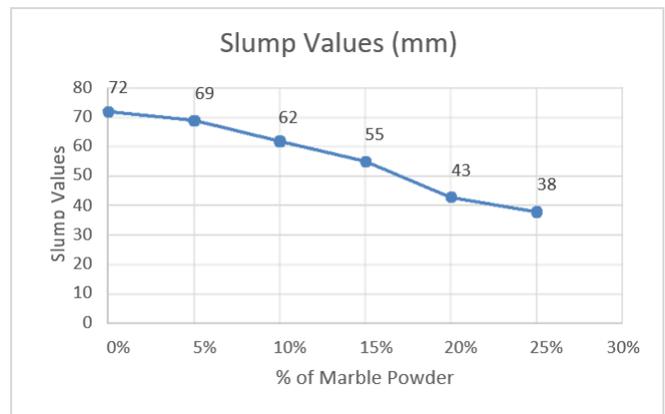


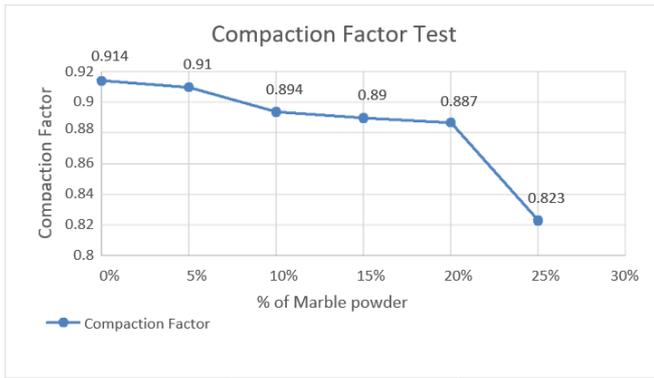
Chart 1 : showing the compressive strength of cube with AGE 1 recycled aggregate by replacing it with 30%, 60% and 100.

#### Compaction Factor Test

The compaction factor test is a standardized laboratory test used to assess the workability of fresh concrete.

Table.No.3.1.2 : Compaction Factor Values of Concrete

Type of Mix	% of Marble Powder	Compaction Factor
Normal Concrete	0%	0.914
Mix 1	5%	0.91
Mix 2	10%	0.894
Mix 3	15%	0.89
Mix 4	20%	0.887
Mix 5	25%	0.823



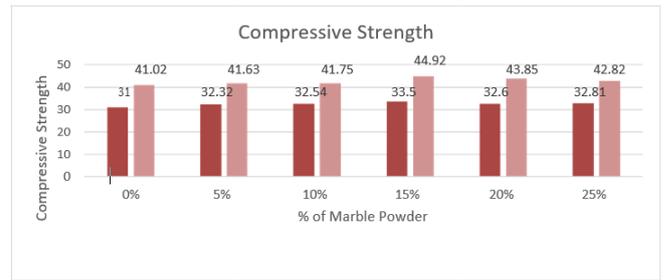
**Graph.No.3.1.2 :** Compaction Factor Values of Concrete

**Compressive strength test**

Three cubes of same mix proportion but different % variation of Marble powder. These are kept at a temperature of 27±2°C for 24 hours. At the end of the period cubes are immersed in clean fresh water. The cubes are kept in water until time of testing. These cubes are tested for their compressive strength after 7 and 28 days curing in compression testing machine. The load at failure is noted and compressive strength is calculated. For 7 days and 28 days are as follows.

**Table.No.3.1.3 :** Compressive strength of concrete for 7 days and 28 days

Compressive Strength (N/mm <sup>2</sup> )			
Type of Mix	%of Marble Powder	7 Days	28 Days
Normal Concrete	0%	31	41.02
Mix 1	5%	32.32	41.63
Mix 2	10%	32.54	41.75
Mix 3	15%	33.5	44.92
Mix 4	20%	32.6	43.85
Mix 5	25%	32.81	42.82



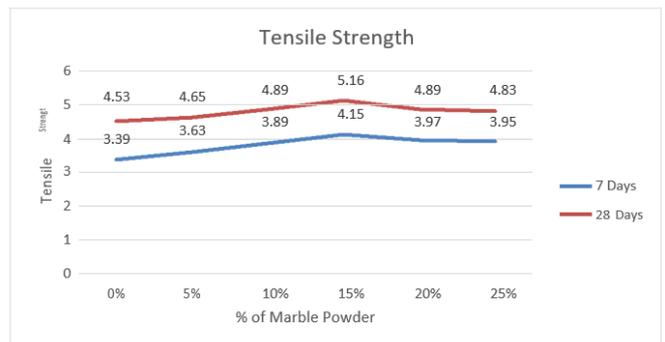
**Graph.No.3.1.3:** Compressive Strength of Concrete For 7 Days And 28 Days

**Split Tensile Strength Test**

Because concrete is weak in tension, tensile strength testing of cylinder specimens is essential. On universal testing equipment, cylinders with dimensions of 150mm in diameter and 300mm in length were cast and tested for split tensile strength.

**Table.No.3.1.4 :** Split tensile strength of concrete for 7 days and 28 days

Split Tensile test(N/mm <sup>2</sup> )			
Type of Mix	% of Marble Powder	7 Days	28 Days
Normal Concrete	0%	3.39	4.53
Mix 1	5%	3.63	4.65
Mix 2	10%	3.89	4.89
Mix 3	15%	4.15	5.16
Mix 4	20%	3.97	4.89
Mix 5	25%	3.95	4.83



**Graph.No.3.1.4 :** Split Tensile Strength of Concrete for 7 Days And 28 Days

### Flexural Tensile Strength Test

The tensile strength of concrete is measured in several ways, one of which is flexural strength. It is the ability of an unreinforced concrete beam or slab to withstand bending failure. For the flexural strength test, 150x150x500 mm beams were cast and tested on a flexural testing equipment.

**Table.No.3.1.5 :** Flexural strength of concrete for 7 days and 28 days

Flexural Strength (MPa)			
Type of Mix	% of Marble Powder	7 Days	28 Days
Normal Concrete	0%	3.07	5.68
Mix 1	5%	3.17	5.56
Mix 2	10%	3.2	5.92
Mix 3	15%	3.3	6.28
Mix 4	20%	2.7	5.83
Mix 5	25%	2.65	5.14

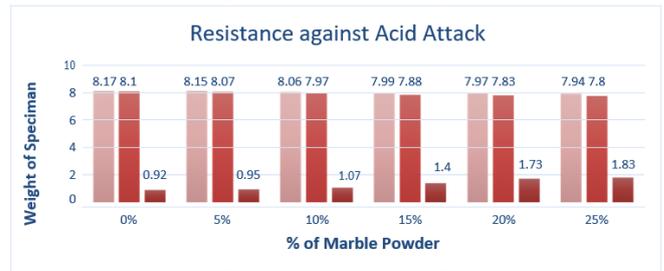
**Graph.No.3.1.5 :** Flexural Strength of Concrete for 7 days and 28 days

### Durability Tests

#### Observations and Calculations (Resistance against Acid Attack)

**Table.No.3.1.6 :** Resistance against Acid Attack

Mix Combination Designation	Dry weight of cube specimen (W1) in kg	Weight of cube specimen after immersed in solution (W2) in kg	Percent weight loss in kg $\frac{W1-W2}{W1} \times 100 = \%$
0%	8.17	8.1	0.92
5%	8.15	8.07	0.95
10%	8.06	7.97	1.07
15%	7.99	7.88	1.4
20%	7.97	7.83	1.73
25%	7.94	7.8	1.83



**Graph.No.3.1.6:** Resistance against Acid Attack

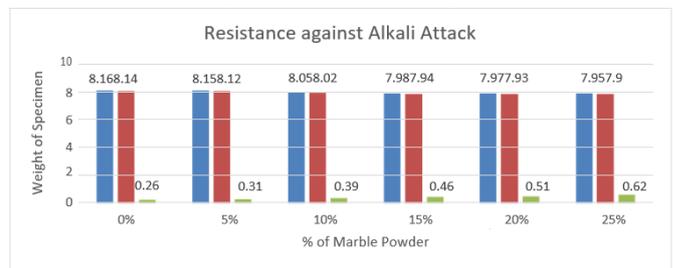
#### Resistance against Alkali Attack

#### Observations and Calculations (Resistance against Alkali Attack)

**Table.No.3.1.7 :** Resistance against Alkali Attack

Mix Combination Designation	Dry weight of cube specimen (W1) in kg	Weight of cube specimen after immersed in solution (W2) in kg	Percent weight loss in kg $\frac{W1-W2}{W1} \times 100 = \%$
0%	8.16	8.14	0.26
5%	8.15	8.12	0.31
10%	8.05	8.02	0.39
15%	7.98	7.94	0.46
20%	7.97	7.93	0.51
25%	7.95	7.9	0.62

**Graph.No.3.1.7 :** Resistance against Alkali Attack



Based on experimental investigation the following conclusion are done

- Addition of Marble Powder to the concrete mix decreases the workability as compared to normal concrete mix.
- When marble powder is substituted for 15% of the concrete mix, the compressive strength of the concrete increases; however, when marble powder is substituted for 20% of the concrete mix, the compressive strength of the concrete decreases.

- Up to 15% of marble powder can be replaced for the concrete mix without affecting the concrete's tensile strength; however, at 20% more marble powder, the tensile strength of the concrete is reduced.
- Adding Marble Powder is added to the concrete mix as a partial substitute. When compared to regular concrete, the work is less expensive.

Due to marble dust, it proved to be very effective in assuring very good cohesiveness of mortar and concrete. From the above study, it is concluded that the marble dust can be used as a replacement material for cement and 15 to 20% replacement of marble dust gives an excellent result in strength aspect and quality aspect. The results showed that the substitution of 15 to 20% of the cement content by marble stone dust induced higher compressive strength. Test results show that this industrial waste is capable of improving hardened concrete performance up to 20%, enhancing fresh concrete behavior and can be used in plain concrete.

#### IV. Future Scope of Work

It is recommended for future studies that the research on use of marble powder as to require to extend to a wider perspective in order to know the actual behavior and effective utilization of marble powder which gives an idea to study more parameters and different governing effect of marble powder had engineering properties of fresh and hardened concrete. This study can show an alternative way of use of industrial wastes by incorporating them into concrete construction of course; the concept that the problem emerges from urbanization and the solution goes along with it can also be appreciated.

- Therefore, the aim of this study is introduction of an environmental friendly technology that can benefit the society and the nation.
- Through this study, it is intended to arrive at a suitable mix proportion and percent replacement

using industrial wastes locally available by partial replacement of the cement with marble powder.

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