East Asian Journal of Multidisciplinary Research (EAJMR)
Vol. 1, No. 11, 2022 : 2521-2530

# Strength Properties of Concrete Using Marble Dust Powder

A. Dhanalakshmi[1*], M. Shahul Hameed[2]
Department of Civil Engineering, P.S.R. Engineering College
**Corresponding Author:** A. Dhanalakshmi dhanalakshmicvl@psr.edu.in

A R T I C L E I N F O

*Keywords:* Marble Dust Powder, Compressive Strength, Split Tensile Strength, Young's Modulus

*Received: 09 October*
*Revised: 10 November*
*Accepted: 11 December*



A B S T R A C T

Construction expenses have mostly grown unaffordable in recent years. Civil engineering institutes and stakeholders throughout the world have worked to develop recyclable and resource-saving concrete for building applications in order to reduce these expenses. The majority of environmental issues arise from the disposal of trash in areas where marble sculpting takes place. The marble stone slurry generates both stone slurry and solid wastes, and with the massive discharge of marble trash locally, emphasis has been focused on the utilisation of waste material. This study looked into the use of marble dust powder in concrete, with varied percentages of marble dust (0%, 5%, 10%, 15% & 20%) replaced by sharp sand in M20 grade concrete mixes, while the water cement ratio was kept constant at 0.45. The compressive and split tensile strength of the concrete were evaluated after 7 and 28 days of curing time to determine its quality, performance, and dependability. The laboratory findings revealed that replacing marble dust powder with cement boosted concrete strength by up to 10% in terms of compressive load resistance and tensile strength.

DOI: https://10.55927/eajmr.v1i11.1785
ISSN-E: 2828-1519

## INTRODUCTION

Concrete is a composite material made up of loose components called aggregates that offer strength and are mixed together with water and a binder in the form of cement to make a homogeneous slurry that can sustain a variety of stresses. The capacity to create concrete out of recycled waste material adds a new dimension to building and contributes to the built environment's sustainability. Portland cement is an extensively used building material in housing, transportation, and energy infrastructure. Industry and academics have collaborated to build stronger concrete, as well as raw materials used as filler, admixture, and aggregate. The purpose of each of concrete's elements is to provide appropriate strength and preserve favourable design attributes throughout its life cycle. PCC is made up of raw resources such as limestone, shale, and clay for cement manufacturing, river sand for fine aggregates, and granite stones for coarse aggregates, all of which are depleting due to their extensive use in building. Due to exploitation of diverse resources and a lack of subsequent replenishment, new construction techniques must be established. The construction industry aspires to save expenses and reduce disposal costs of used wastes from other sectors by using more cost-effective and recyclable materials in construction. When certain elements are employed in concrete, they yield better outcomes than conventional concrete while reducing environmental and economic impacts. Cementous materials are supplemented to assist fulfil the increased demand.

## THEORETICAL REVIEW

Huseyin Yilmaz Arunta et al investigated the waste marble dust is used in cement production as an additive material. It was found that 10% of leftover marble dust can be added as a cement addition. The period for setting is unaffected by waste marble dust. In comparison to regular concrete, waste marble dust concrete has a higher compressive strength. Ali A Aliabdo et al investigated waste marble dust was utilized in cement and concrete production. Marble dust has favourable impacts on steel concrete bond strength up to 15% as cement substitute, with a maximum of 10%. Additionally, it was noted that the addition of marble dust to concrete reduces porosity. Marble dust use in concrete resulted in a negligible modification in ultrasonic pulse velocity. Ankita Khatri, Abhishek Kanoungo et al investigated paper the focus is feasibility of the substitution of marble waste for cement to attain economy and environmental saving. Additionally, it was found that marble dust reduces the porosity of the concrete after it has hardened.

S.Suresh, J. Revathi investigated the objective of research was to examine the possibility of utilizing marble powder in concrete production. When 10% marble powder was substituted for them, it was found that the compressive strength and flexural strength improved to 23%, 24% and 17.82%, respectively. Additionally, a decline in chloride penetrations was noted. Mes Belouadah saouda et al investigated the mable and glass powder used as alternates for cement and their effect on physical and mechanical properties were tested. It was found that using up to 10% marble powder increased compressive strength. Compressive strength for glass powder increases by 5% to 10% at

most, with 10% being the maximum. Therefore, up to 10% is the ideal percentage for waste class and marble.

## METHODOLOGY

*Materials Used*

The basic materials used in this experimental study are:

1. Ordinary Portland Cement of grade 53
2. Sand
3. Marble Dust Powder
4. Water

*Concrete Proportions*

A concrete mix ratio of 1:2:4 was used and was achieved during the experiment through the Weight method. For each mix, a total of twelve concrete specimens were produced with three concrete pieces being taken per curing age (7 and 28 days). A total of twelve cubic specimens (150 x 150 x 150) mm were cast in order to determine the compressive strength, split tensile strength and Young's modulus of the concrete.

Table 1: Mix Proportion

| S.NO | MIX | Cement | Marble Dust Powder | Fine Aggregate | Coarse Aggregate | w/c Ratio |
|---|---|---|---|---|---|---|
| 1 | Mix 1 | 100 | 0 | 100 | 100 | 0.45 |
| 2 | Mix 2 | 100 | 5 | 100 | 100 | 0.45 |
| 3 | Mix 3 | 100 | 10 | 100 | 100 | 0.45 |
| 4 | Mix 4 | 100 | 15 | 100 | 100 | 0.45 |
| 5 | Mix 5 | 100 | 20 | 100 | 100 | 0.45 |

*Moulding and Curing*

For the compressive test, the specimen was cubical in shape and size of 150 x150 x 150 mm and for the Split tensile test the specimen was cylindrical in shape and diameter of 150 mm by 300 mm height. The concrete cubes were demoulded and placed in curing ponds filled with potable water. Curing was made to last for 7, 21, 28 and 56 days after which the cubes were dried and tested.

## RESULTS AND DISCUSSIONS

*Work Ability*

The workability of the concrete produced using three different replacement percentages 0%, 5%, 10%, 15% and 20% of Waste marble dust concrete was tested using the slump test. An arbitrary water-cement ratio of 0.45 was used. Table 2 presents the recorded slump values of the investigation conducted.

Table 2. Slump Values for the Resulting Concrete Mixes

| S.No | Mix | Slump Value(mm) | Slump Type |
|---|---|---|---|
| 1 | Mix 1 | 15 | True |
| 2 | Mix 2 | 16 | True |
| 3 | Mix 3 | 19 | True |
| 4 | Mix 4 | 25 | True |
| 5 | Mix 5 | 20 | True |

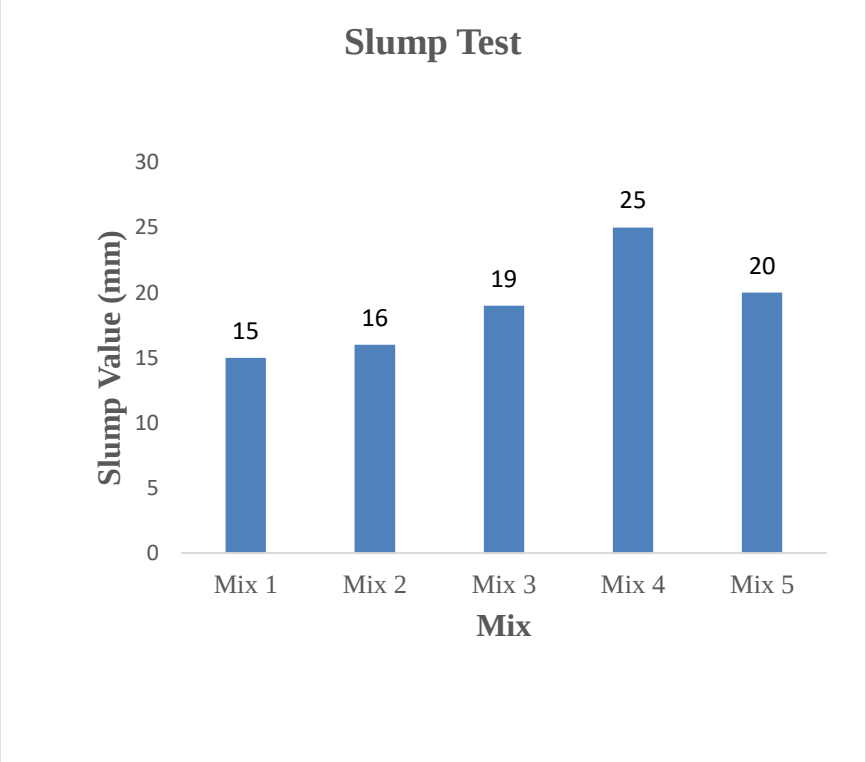


Figure 1. Slump Value of Concrete Samples for aach Percentage Mix

*Compressive Strength*

The compressive strength test was performed on the cubes after they had been removed from the curing pond and allowed to dry for about one hour. The compressive strength test was done with an compression Testing machine at a fixed rate. Each specimen was crush to failure with the failure load recorded in kN. The samples were placed in the compressive strength testing machine with the smooth surface of the cubes in contact with the plates of the machine.


Figure 2. Testing of Compressive Strength

Table 3. Compressive Strengths of Various Mix of Marble Dust Concrete Cubes

| S.No | Mix | Compression Strength (MPa) | |
|---|---|---|---|
| | | 7 Days | 28 Days |
| 1 | Mix 1 | 13 | 22 |
| 2 | Mix 2 | 14 | 26 |
| 3 | Mix 3 | 17 | 29 |
| 4 | Mix 4 | 19 | 34 |
| 5 | Mix 5 | 16 | 28 |

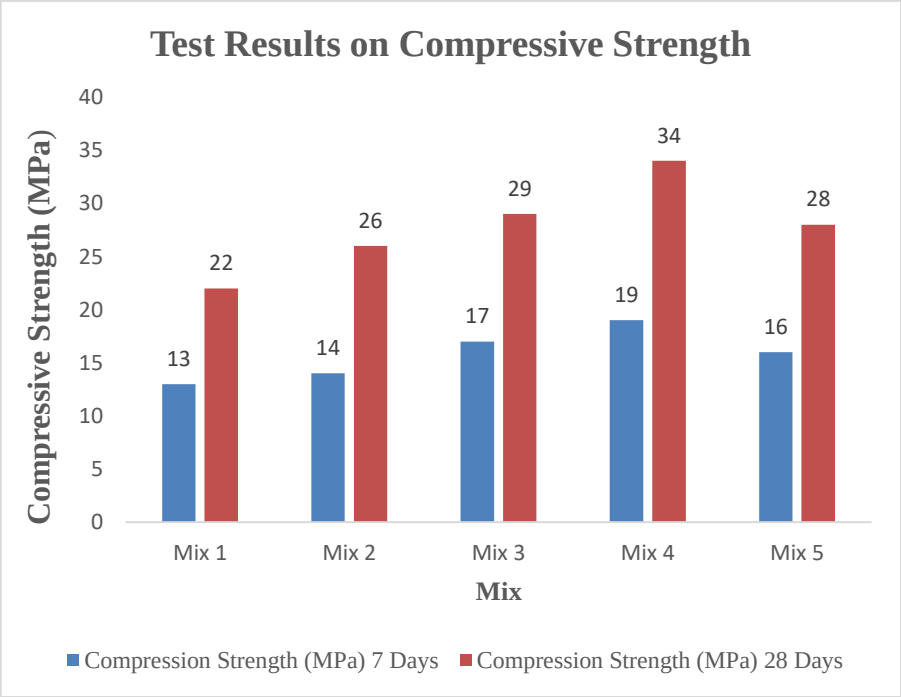


Figure 3. Compressive Strengths of Various Mix

From the above result Mix 4 which is having 15% of Marble Dust powder shows higher compressive strength of the concrete.

*Split Tensile Strength*

This determines the tensile strength of concrete using a concrete specimen of 0.15 m by 0.30 m concrete cylinder is subjected to a load at a constant rate which increases continuously until it splits across the vertical diameter. After failure due to tension developed in the transverse direction the maximum applied load indicated at the testing machine is noted and appearance of fracture.


Figure 4. Testing of Split Tensile Strength

Table 4. Split Tensile Strength of Various Mix of Marble Dust Concrete Cylinders

| S.No | Mix | Split Tensile Strength (MPa) | |
|---|---|---|---|
| | | 7 Days | 28 Days |
| 1 | Mix 1 | 2.21 | 3.54 |
| 2 | Mix 2 | 2.38 | 3.59 |
| 3 | Mix 3 | 2.45 | 3.71 |
| 4 | Mix 4 | 3.02 | 3.97 |
| 5 | Mix 5 | 2.27 | 3.71 |

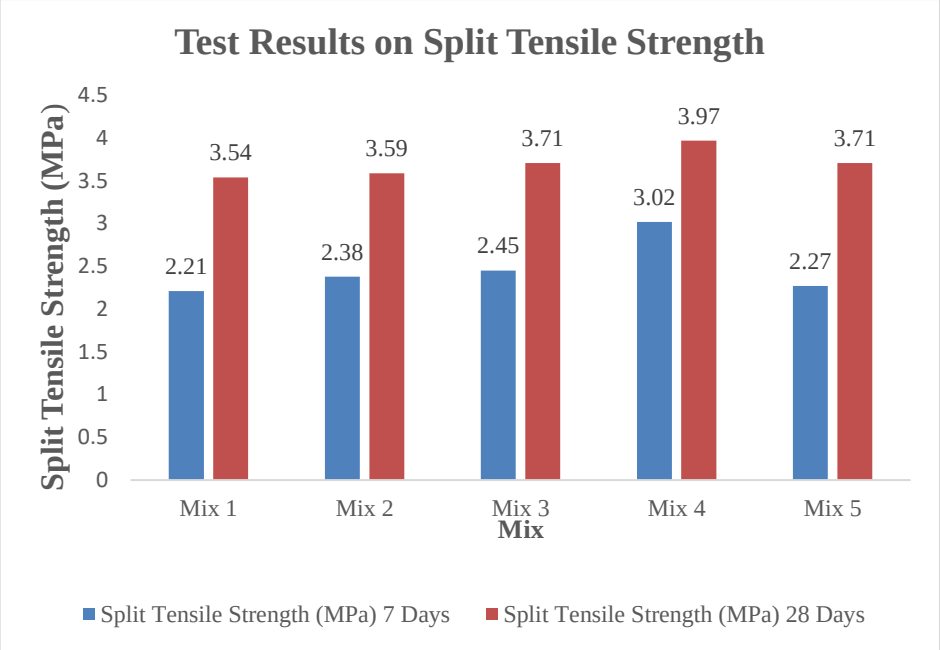


Figure 5. Split Tensile Strengths of Various Mix

From the above result Mix 4 which is having 15% of Marble Dust powder shows higher split tensile strength of the concrete.

*Modulus of Elasticity*

Young's modulus (E) E is defined as the stress required to produce unit strain. As per IS: 456-2000 code, the E of concrete depends on the grade of the concrete characteristic compressive strength of the con crete. Modulus of elasticity of concrete can be determined by compressometer and test procedure is specified under Indian standard code IS:516-1959.

Table 5. Modulus of Elasticity of Concrete

| S.No | Mix | Split Tensile Strength (GPa) |
|---|---|---|
| | | 28 Days |
| 1 | Mix 1 | 23.45 |
| 2 | Mix 2 | 25.49 |
| 3 | Mix 3 | 26.93 |
| 4 | Mix 4 | 29.15 |
| 5 | Mix 5 | 26.46 |

Figure 6. Testing of Modulus of Rigidity

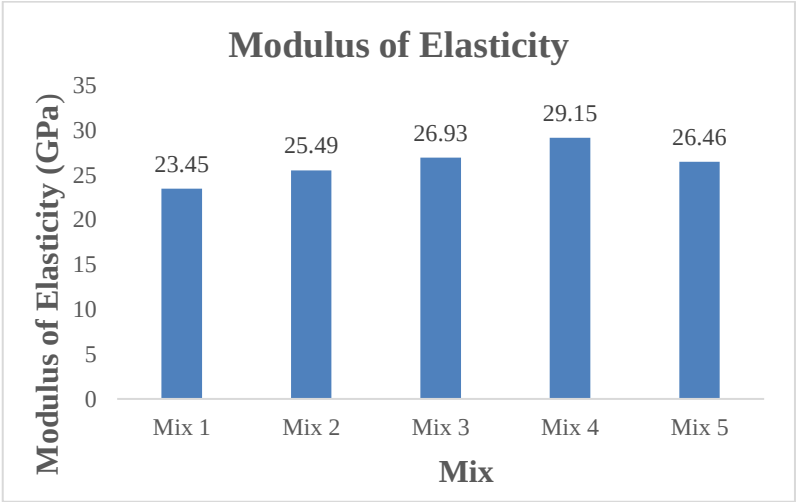


Figure 7. Test Results on Modulus of Elasticity of Concrete

## CONCLUSIONS AND RECOMMENDATIONS

The use of leftover marble dust powder as a concrete constituent resulted in a satisfactory slump of fresh concrete. Marble dust had a strength of 15% larger than the control after 28 days. The addition of marble dust powder, on the other hand, enhanced the tensile strength by 15%. By adding 15% marble dust powder to concrete, the compressive strength of the concrete was improved. For both cubes and cylinders, the optimal percentage for replacing sand with Marble waste is 15%. Because Marble Dust powder is inexpensive, this study proposed a simple and practical method for reducing concrete manufacturing costs.

Based on the findings of the test results and analyses of marble dust powder concrete, including marble dust powder into the production of green concrete might be a potential method for improving concrete performance. The effect of marble dust powder is responsible for enhancing compressive strength.

Because the MDP present in the concrete reacts with cement gradually, it contributes to the overall strength of the concrete mix design. Furthermore, MDP aids in the reduction of the pore structure of concrete, which in turn aids in enhancing the material's strength. Because of the large increase in toughness, Marble dust powder concrete can withstand a greater level of stress, and as a result, concrete buildings built of Marble dust powder concrete can hold more weight.

**FURTHER STUDY**

Construction expenses have mostly grown unaffordable in recent years. Civil engineering institutes and stakeholders throughout the world have worked to develop recyclable and resource-saving concrete for building applications in order to reduce these expenses. The majority of environmental issues arise from the disposal of trash in areas where marble sculpting takes place.

**REFERENCES**

Aruntas H.Y., Guru M., Dayı, M. and Tekin, I., (2010), Utilization of waste marble dust as an additive in cement production. Materials & Design, 31(8), pp.4039-4042.

Aliabdo, A.A., Abd Elmoaty, M. and Auda, E.M., (2014), Re-use of waste marble dust in the production of cement and concrete, Construction and building materials, 50, pp.28-41.

Suresh, S. and Revathi, J., (2019), An Experimental Examination on Mechanical and Durability Properties of Cement Replacing with Marble Powder. International Journal of Innovative Technology and Exploring Engineering.

Belouadah, M., Rahmouni, Z.E.A. and Tebbal, N., (2019), Influence of the addition of glass powder and marble powder on the physical and mechanical behavior of composite cement. Procedia Computer Science, 158, pp.366-375.

Rajni, V.R. and Guleria, H., (2019), Experimental Approach on Strength Characteristics of Concrete on Partially Replacing Sand with Waste Foundry Sand and Cement with Marble Dust Powder. International Journal of Innovative Technology and Exploring Engineering.

Pereira, T.G.T., Silva, D.W., Eugenio, T.M.C., Scatolino, M.V., de Carvalho Terra, I.C., Fonseca, C.S., Bufalino, L., Mendes, R.F. and Mendes, L.M., (2020), Coconut fibers and quartzite wastes for fiber-cement production by extrusion. Materials Today: Proceedings.

Saketh (2021), Statistical Analysis of Polypropylene Fibre Reinforced Concrete. International Journal of Advance Research, Ideas and Innovations in Technology.

Pansuriya, Use of polypropylene fiber in rigid pavement. Development, International Journal of Advance Engineering and Research Development, 2016.

A.P.Sathe, A.V.Patil, Experimental Investigation on Polypropylene Fibre Reinforced concrete with Artificial, International Journal of Science and Research, 2015.

Khan, S, (2019), Mechanical Properties of Polypropylene fibre reinforced concrete for M25 and M 30 mixes: A Comparative Study. International Journal of Scientific Engineering and Applied Sciences.

Swathi, J, (2021), Strength Characteristics on Partial Replacement of fine Aggregate by Ceramic Waste in Concrete to avoid Land Pollution, Journal of Ceramics and Concrete Sciences.

Kavitha, K., Cheela, V.S. and Raju, G., (2015), Utilization of Quartzite as Fine Aggregate in Concrete, E-Journal of Science and Technology, 10, pp.45-53.

Shalaka S. Utkar., (2016), Use of Marble Powder as a Partial Replacement of Cement, International Journal of Advance Research in Science and Engineering, vol. no. 5, issue no. 12.

Gopi, R., (2020), Study on Marble Powder as Partial Replacement of Cement in Concrete. Global Resey and Development Journal for Engineering.

Tayeh, B.A., (2018), Effects of marble, timber, and glass powder as partial replacements for cement. Journal of Civil Engineering and Construction, 7(2), pp.63-71.