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Study on Impact of Marble Dust on a Cement Concrete as a Partial Replacement

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ABSTRACT- A product of the marble-making process is marble dust. The cutting process produces a significant amount of powder. Consequently, about 25% of the original marble mass is lost to dust. Directly discharging these waste products into the environment could lead to environmental issues including increased soil alkalinity, negative impacts on plants and people's health, etc. Concrete can be strengthened by adding marble powder as an addition. It is a stable byproduct of the manufacture of marble that can be used as a cement filler or as fine aggregates in concrete. Concrete that is built using this debris is more affordable and long-lasting, which can assist to address a number of ecological and environmental problems. This study explores the practicality of using marble waste in place of cement to conserve resources and the environment. This study examines the substitution of fine aggregate in concrete with marble dust particles. At content levels of 0, 4, 8, 12, and 16, marble has taken the place of fine aggregate in concrete. Five different series of concrete mixtures were made in order to evaluate the various characteristics of marble dust concrete. Controlled concrete's workability, compressive strength, water absorption, specific gravity, and other characteristics have all been compared.

KEYWORDS- Sieve Analysis, Marble Dust, Slump Cone Test, Compressive Strength Test, Split Tensile Strength Test.

I. INTRODUCTION

For long term development recycling trash into useable material is crucial environmental management strategy.

One of the global environmental issues today is how the marble powder material, which is made up of very fine powder, is disposed of by the business. Particularly if these wastes are left to nature, there may be ecological problems for example top soil porosity and permeability are decreased and due to tiny particles soil fertility is also decreased. Reusing these waste materials is therefore essential for the environment[1]. The use of marble in architectural construction is one of the logical ways to reduce the waste marble masses. It is possible to employ leftover marble powder to enhance the mechanical and physical qualities of regular concrete[2]. Additionally, due to the rapid development of their infrastructure, developing nations have a strong demand for cement, which drives up the price of the material and causes a shortage of supplies. Therefore, employing these waste products to make concrete lowers the cost of building[3][12].

II. LITERATURE REVIEW

According to test results from Ali Ergun's study on diatomite, cement samples containing 10% diatomite and 5% WMP and 5% WMP + 10% diatomite exhibited greater compressive and bending strengths. To improve the mechanical qualities of the normal concrete combination of mixtures, concrete can be replaced with diatomite and WMP separately as well as in combination with a strong plasticizing additive[4].

The likelihood of employing marble wastes as an alternative to natural aggregates in the making of cement is demonstrated by H. Hebhoub et al[5]. Three categories of concrete mixtures—fine sand substitution, gravel substitution, and a combination of each aggregate—were the subject of experimental investigation. The results demonstrate that concrete samples' mechanical characteristics were good, and it was discovered that using marble wastes allowed for concrete production standards to be met.

Manju Pawar et al [6]., A. Periodic Research, The Importance of Partial Cement Replacement, was the subject of a study with Powdered Waste Marble. They discovered that the relative compressive, tensile, and flexural strengths have been investigated in relation to the use of marble powder as constituents of fines in mortar or concrete by partially lowering quantities of cement. Higher waste marble powder (WMP) ratio results in increased strengths of the mortar and concrete, according to partial replacement of cement with varied percentages of marble powder. Directly releasing garbage into the environment might have negative effects on the environment. As a result, adding discarded marble powder and replacing it with cement increases the concrete's compressive strength by up to 12.5%. The compressive strength decreases with cement weight and any additional WMP. The use of waste marble powder can boost concrete's tensile strength by up to 12.5% of the weight of cement, but any additional WMP reduces that strength.

Thus, they discovered the ideal replacement rate for MDP, which is close to 12.5% cement for both compressive and tensile strength.

III. EXPERIMENTAL INVESTIGATION

A. *Materials Used*

i. *Cement*

Ambuja Cement's regular Portland cement that complied with IS 269-1976 and IS 4031-1968 was utilised in this project. The used cement is grade 5 3 m. A paste of cement can be made by combining it with water. Cement is a fine, grey powder. More than 90% of Portland cement clinker, a little amount of calcium sulphate (to control the set time), and up to 5% minor ingredients are ground into a fine powder. To create concrete, it is mixed with water and materials like coarse and fine particles[7]. The cement and water create a paste that binds the other components together as the concrete dries and hardens. Argillaceous and calcareous are the two major ingredients that make up cement. Ordinary Portland cement is the most popular type of cement (OPC). The low cost and wide availability of its components, its adaptability and diversity, as seen by the various building types in which it is used, and the minimal maintenance requirements during operation are just a few of the factors that contribute to its widespread use.
Ambuja OPC-43 grade cement was used in this experiment. It had no lumps and was crisp.

ii. *Fine Aggregate*

The project used natural sand since it is easily available and affordable. It has a cubical or spherical form with a smooth surface texture. Because of its cubical, rounded, and smooth texture, it is very workable. This project uses sand that is obtained from a stone crushing operation. The particles of this sand are smooth and brownish in colour. Through the use of sieve analysis, the fineness modulus was discovered to be 3.29 percent, which is within the limits of the IS 383-1970 standard[8].
A 4.75 mm IS sieve is used to filter the majority of the aggregate. The typical size limit for sand is considered to be 0.07 mm. The grading zones increase finer from grading zone I to grading zone IV confirming sand from zone II was used in this experiment. Properties of fine aggregates are described in (table 1).

Table 1: Properties of fine aggregates

S. No.	Characteristics	Value
1.	Type	Crushed
2.	Specific gravity	2.70

iii. *Coarse Aggregate*

The majority of the material used in this project is basalt rock, which is categorised as normal weight. The aggregates are offered nearby. 50 percent of the aggregate used has a size of 10 to 12 mm, while the other 50 percent has a size of 20 mm. During the experimental[9] examination, locally accessible, 50:50 crushed stone aggregate with nominal sizes of 20 mm and 10 mm was used. After being washed to get rid of dirt and grime, the aggregates were cleaned and dried until they were surface dry Properties are described in (table 2) given below.

Table 2: Properties of fresh coarse aggregates are reported

S. No.	Characteristics	20 mm aggregate	10 mm aggregate
1.	Type	Crushed	Crushed
2.	Maximum size	20 mm	10 mm
3.	Specific gravity	2.74	2.74

iv. *Marble Dust*

Marble dust is created by crushing marble, which itself is created by crystallising limestone or dolostone. The crystals appear to be calcite because of various atmospheric and temperature changes. The pressure required to make marble removes any superfluous components from the rock, leaving behind a thick, polished rock. Coloured marble is produced when different ratios of silt, clay, and other materials are mixed with limestone[10].
Marble dust is made of crushed or powdered marble that can still be shaped into a solid object. Waste marble powder is created as a by-product of cutting marble. 20% or more of the total marble handled is rubbish, on average. Between 250 and 400 tonnes of waste marble powder are produced annually at the research facility, which is a large quantity. Marble dust is used in many more applications than actual marble due to its lower cost and versatility. Cement or resins are mixed with marble dust to produce cultured marble, which has a similar appearance to natural marble[11].

B. *Methodology*

In this experiment, different percentages of marble dust were utilised as a partial replacement for building aggregates. The experiment's main objective was to observe how Marble Dust responded to the replacement of fine aggregate. The primary properties examined were those related to the slump test, compressive strength, and split tensile strength. The tests done on material used and concrete are given below.

i. *Following tests were conducted with proper procedure on the cement concrete and material used*
   - Slump cone test
   - Compressive strength test
   - Split tensile strength test
   - specific gravity test
   - standard consistency of cement
   - seive analysis of aggregates

IV. RESULT AND DISCUSSION

To find out how Marble Dust impacted the strength and workability of concrete, various mixes were developed. Among these were the slump test, split tensile strength, and compressive strength. The outcomes of each test were discussed independently.

A. *Slump Test*

To determine whether new concrete is workable, the slump test is performed. It employs the Slump Test (IS: 1199-1959). The diagram below displays the findings of the slump test. The findings show that there was no appreciable increase in slump value following the addition of Marble aggregates. The variation in slump value is shown in the below (figure 1).

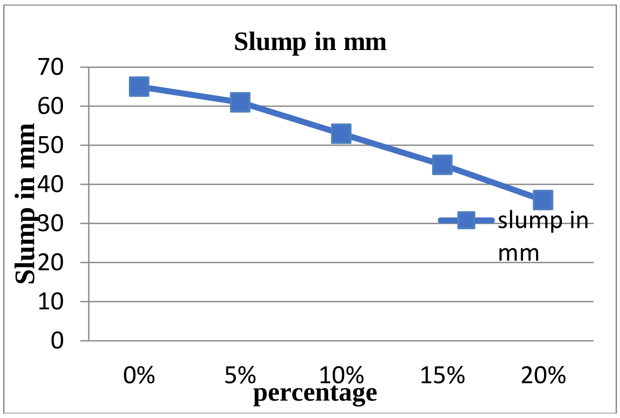

Figure 1: slump tensile strength

B. *Compressive strength test*

Three 150*150*150 mm cubes were tested for compressive strength in a compression testing apparatus for each mix on the seventh and the 28th days after cure. The difference in compressive strength (7 days) brought on by the addition of marble dust aggregates is shown in graph 2 depicts the variation in compressive strength caused by the addition of marble dust aggregate. (Figure 2) depicts the variation in compressive strength (28 days) caused by the addition of marble aggregate. The compressive strength gradually decreased as a result of the addition of used marble dust aggregate. This study suggests that up to 12% marble dust can be added to concrete mixtures without significantly reducing strength.

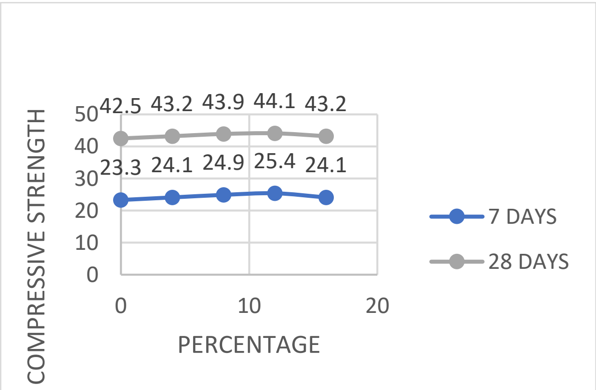

Figure 2: compressive strength test

C. *Split Tensile Strength Test*

The test procedure is used to figure out a cylindrical concrete specimen's splitting tensile strength. In this way, the diametric compressive force is applied along the entire length of the cylindrical specimen. Tensile strains are caused by this loading on the plane that is carrying the imposed load. There is tensile failure rather than compressive failure. The variation in split tensile strength is shown below in (figure 3).

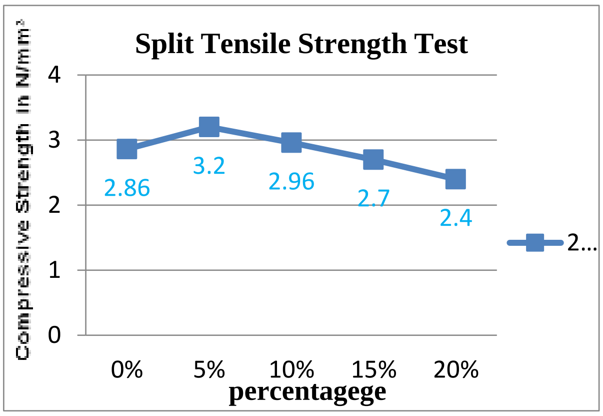

Figure 3: Split Tensile Strength

V. CONCLUSION

Marble dust's fineness helps to ensure good concrete cohesiveness when a super-plasticizing additive is present.It would help to lessen environmental issues brought on by the careless disposal of large amounts of waste produced by marble makers.Due to the fact that this garbage is offered without charge, it will aid in enhancing cost effectiveness.The addition of marble wastes has no impact on the mechanical properties throughout the entire process, indicating no expensive adjustments to the industrial production line.It would be easier to dispose of waste if marble scraps could be used as an alternate raw material when creating clay-based products. The concrete series that employed WMD as a stand-in for extremely fine aggregate that had passed through a 0.25 mm sieve outperformed the series without marble dust in terms of compressive strength. In reality, marble dust had a filler effect (which was notably noticeable in young ages) and was significantly involved in the process of hydration.The filler effect of marble dust on cement hydration is associated with the reduction in porosity. We can infer that marble dust usage lessens the porosity of cured concrete.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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