Strength Characteristics of Concrete Produced by Replacing Fine Aggregates with Marble Powder and Basalt Fiber as Admixture

Athira Suresh[1], Ali Bhadhusha[2], Fathimathu Suhana[3], Shabana Shanavas[4], Sidharth S[5]

[1]*Assistant Professor, Department of Civil Engineering, Ilahia College of Engineering and Technology, Kerala*
[2,3,4,5]*Pursuing B. Tech in Civil Engineering from APJ Abdul Kalam Technical University, Kerala*

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Abstract - *The Concrete is the important construction material and it is used in the construction industry due to its high compressive strength and its durability. Now a day's various studies have been conducted to make concrete with waste material with the intention of reducing cost and unavailability of conventional materials. From the examination, it was discovered that the basalt fiber expanded the strength of concrete not withstanding when unprotected to sulphate attack bit by bit when compared with consistent concrete. the ideal strength of concrete was accomplished with an addition of 2% basalt fiber by the heaviness of cement. This paper investigates the strength properties of concrete specimens cast using 2% basalt fiber as optimum and waste marble powder as the partial replacement of fine aggregate. The marble pieces are finely crushed to powdered and the gradation is compared with conventional fine aggregate. The marble powder is added to M40 grade of concrete at 0%, 25%, 50% and 75% partial replacement by weight of fine aggregate. The results obtained from compressive strength test after 7 days and 28 days are then evaluated. And the split tensile strength and flexural strength after 28 days are also evaluated. Finally, the results obtained after partial replacement of fine aggregate by marble powder is compared graphically. The idea is to achieve higher strength of concrete at an economical rate. Moreover, the use of industrial wastes like marble powder would also help to solve various environmental problems.*

***Key Words*: Marble Powder, Basalt Fibre, Fine Aggregate**

1. INTRODUCTION

Concrete is an extensively used building item and consists of cement, coarse aggregate, fine aggregate and deliberate amount of water. Natural sand is usually used as fine aggregate. For appropriate rapid growth in structural activities, accessible natural sand supply is exhausting. In addition, there are times when it is necessary to transport high-class sand from a long distance, and because of the expense of construction, it is essential to partially or completely substitute the ordinary sand in the concrete with a substitute matter without weakening the superiority of the concrete. To substitute sand as fine aggregate, waste marble dust can be used. The project aims to exploit the usage of waste marble powder in concrete instead of sand as fine aggregate.

From the experiments it is known that 2% of basalt fiber by the total weight of cement shows the maximum strength in the concrete. therefore taking 2% of basalt fiber as optimum value and changing the proportion of marble powder from 0% to 75% with an increment of 25%, the optimum strength of concrete is determined.

2. MATERIALS USED

2.1 Marble Powder

Marble is one of the most extensively used types of rock/stone nowadays. It is the end-product of the metamorphism process of sedimentary carbonate rocks, most commonly limestone or dolomite rock. Marble has retained its importance over time, due to its attractive decorative purposes and its variety of appearances and colors. Like other waste materials, the disposal of the marble powder has become a serious environmental problem. So, to overcome this serious problem we can use several types of waste coming from the industry, e.g. by replacing or partially replacing the constituents of concrete (cement, sand or aggregates) thus conserving natural resources. Marble waste can be utilized in various ways and marble slurry can be used as fine aggregates in concrete replacing, at least partially, river sand. The utilization of marble dust powder (MDP) as cement replacement was studied. The fine aggregate was partially replaced with MP up to 75% by weight with an increment of 25%.

2.2 Basalt Fiber

Basalt is a natural, hard, dense, dark brown to black volcanic igneous rock originating at a depth of hundreds of kilometers beneath the earth and resulting the surface as molten magma. Basalt fiber is a typical ceramic fiber, it's easy to disperse when mixed with cement concrete and mortar. Therefore, basalt fiber reinforced concrete serves the functions of reinforcement, crack resistance, and can extend the life of construction in the fields of housing, bridges, Highways, railways, urban elevated roads, runways, ports, subway tunnels, the coastal Protection works, plant facilities. Performance of conventional Concrete is enhanced by the addition of fibers in concrete. The brittleness in concrete is reduced and the adequate ductility of concrete is ensured by the addition of fibers in concrete. Basalt fibers show comparable mechanical properties to glass fibers at lower cost and exhibit good resistance to chemical and high temperature exposure. The various strength properties studied consist of compressive strength, flexural strength and splitting tensile strength.

2.3 Cement

The cement exploited for the study is ULTRATECH of 43 grade Portland Pozzolana cement. The specific gravity of cement is 3.15, with a consistency of 33%. And the initial setting time is 50 min.

2.4 Fine Aggregate (sand)

The sand which was locally available and passing through 4.75mm IS sieve is used. Good quality river sand was used as a fine aggregate.

2.5 Coarse Aggregate

Locally available well graded aggregates larger than 4.75 mm and smaller than 12.5 mm are used as coarse aggregates. ACI Mix Design Procedure. Crushed stone of 10 mm and 20 mm size, taken from a local quarry.

2.6 Super plasticizer

Super plasticizers (SPs), also known as high range water reducers, are additives used in making high strength concrete. Plasticizers are chemical compounds that enable the production of concrete with approximately 15% less water content. Super plasticizers allow reduction in water content by 30% or more. Dr. Fixit was used for the experimental work.

2.7 Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. It should be free from organic matter and the pH value should be between 6 and 7.

3. METHODOLOGY

Based on the Indian Standard (IS: 10262 – 1982), design mix for M40 grade of concrete was prepared. And tests were conducted. By partially replacing fine aggregate with five different percentages by weight of marble powder (0%, 25%, 50%, 75%). The concrete cubes of size 150x150x150 mm, beams of size 100x100x500 mm and cylinder sample of diameter 150mm and height 300mm were casted. The six specimens of cube, three specimens of beam and three specimens of cylinder of each mix were prepared. After 24 hrs the specimens were removed from the mould subjected to water curing for 7 & 28 days. After curing the specimens were tested for compressive strength for 7 and 28 days, and flexural strength and split tensile strength for 28 days.

Figure 1: Images of specimen

Table -1: Details of Replaced Concrete Specimens

% replacement of Marble Powder	Quantity of materials (Kg)				
	Cement	Coarse aggregate	Fine aggregate	Marble powder	Basalt fiber
MP0	24	55	36	0	480
MP25	24	55	27	9	480
MP50	24	55	18	18	480
MP75	24	55	9	27	480

Figure 2: Water curing

4. TEST RESULTS

4.1 Compressive Strength

All cubes were tested in the ambient curing process. For the different proportions, cubes were tested using a 3000 KN volume compression tester 7 days and 28 days after curing. After placing the test piece in the center of the testing machine, the test was conducted with a uniform stress of 10 kg / cm 2 / min. Loading continued until the readings were reversed from the incremented value. Reversal of the reading indicates that the test piece has failed. The machine stopped, and it turned out that readingat that moment was the ultimate load. The value obtained by isolating the final load by the cross-sectional area of thesample is

equal to the final cubic compressive strength.

% replacement of Marble Dust	7days Compression test results (N/mm^2)	28days Compression test results (N/mm^2)
MP0	31.03	41.55
MP25	31.40	43.22
MP50	32.66	44.11
MP75	31.77	42.215

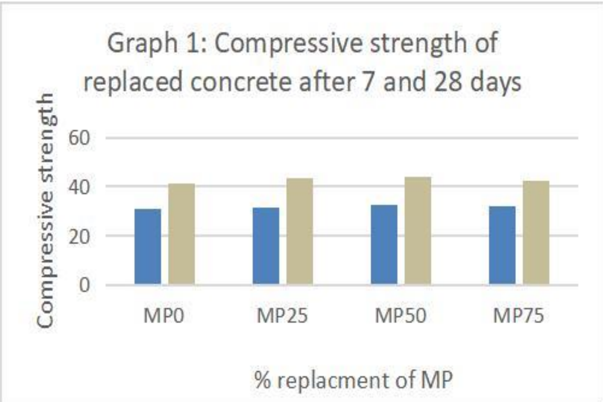


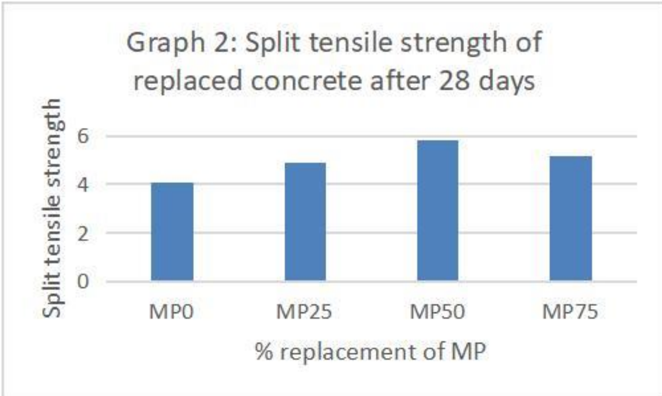
Figure 3: Compressive testing machine

4.2 Split Tensile Strength of Concrete

This is an indirect test to determine the tensile strength of a cylindrical specimen. In the divided tensile strength test, a cylinder test piece having a span of 100 mm and a length of 200 mm was subjected to curing for 28 days using a 3000KN capacity compression tester. To avoid direct loading on the test specimen, a cylindrical specimen was placed under the woody specimen. The test piece was cracked and the load was gradually added until the measured value was recorded.

Figure 4: Split tensile strength testing machine

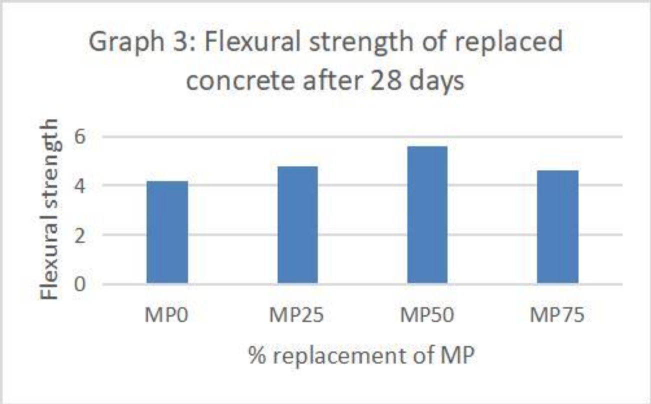
% replacement of MP	28 days split tensilestrength (N/mm^2)
MP0	4.10
MP25	4.9
MP50	5.8
MP75	5.16



4.3 Flexural Strength

Flexural strength familiarized as the modulus of rupture, or flexural strength or transverse breaking strength is a property of material identified as the stress of the material before the bending test. The transverse bending test is most commonly adopted and uses a three-point bending test technique to bend a specimen either rectangular or circular in cross section to rupture or yield. Flexural strength signifies the maximum stress experienced in the material in that instant. Four-point bending is considered. In rectangular sample below a load in a four-point bending setup where the loading span is one-third of the support span.

% replacement of MP	28 days flexural strength (N/mm^2)
MP0	4.2
MP25	4.8
MP50	5.6
MP75	4.6



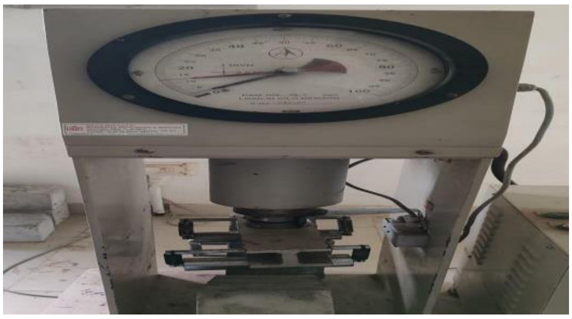


Figure 5: Flexural strength testing machine

5. CONCLUSIONS

- There is a possibility for the partial replacement of sand with marble powder in the production of concrete.
- The use of MP in concrete production would lead to improved environmental waste management and profitable utilization of industrial waste.
- Marble powder can be used for production of heavy weight concrete.
- Compared to the control mix, the compressive, tensile and flexural strengths of the replaced concrete shows an increase initially with increasing replacement percentage up to an optimum limit and from there it decreases.
- The compressive strength of concrete increased by 10.28% when the replacement becomes 50% and it then decreased by 4.3% when the replacement becomes 75%. So the optimum value of compression is 50%. The split tensile strength of concrete increased by 31.8% when the replacement becomes 50% and it then decreased by 4.3% when the replacement becomes 75%. So, the optimum value of compression is 50%.
- The split tensile strength of concrete increased by 31.8% when the replacement becomes 50% and it then decreased by 11.03% when the replacement becomes 75%. So the optimum value of tension is 50%.
- The flexural strength of concrete increased by 26.7% when the replacement becomes 50% and it then decreased by 17.85% when the replacement becomes 75%. So the optimum value of flexural is 50%.
- Thus, an optimum of 50% replacement by weight of sand with MP can be used in concrete.
- The basalt can be used as a new mineral admixture in concrete because it does not show negative effect on the strength of concrete.
- The strength gain of concrete when sand was partially replaced with MP showed that it can be effectively utilized in the manufacturing of concrete and thus contributes in the reduction of natural resource utilization in concrete.

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