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# AN EXPERIMENTAL STUDY ON NATURAL REINFORCED CONCRETE WITH MARBLE POWDER

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**Abstract** — *This study is Focused to improve the strength and durability of green concrete. For this project attempt made for the Study was to replace the cement by marble powder (0%, 5%, 10%, 15% & 20%) and banana fiber (0%, 0.25% & 0.5%) for M30 grade of concrete. Tests were conducted for workability of fresh concrete (Slump test) and strength of hardened concrete (Compressive strength, Split tensile strength and Flexural Strength) for 28 days. Compare the parameter of green Concrete with normal concrete. Also compare the cost of green concrete with normal concrete. Based on present study, definite conclusions have been arrived and suggestions for further works have also been given. In this Experiment study concluded that the use of 10% marble powder and 0.25% Banana Fiber as partial replacement of cement (Compressive & flexural strength) in concrete and 15% marble powder & 0.5% banana fiber in split tensile strength.*

***Keywords***-*Marble Powder, Banana Fiber, Compressive strength, Split tensile strength, Flexural strength.*

## I. INTRODUCTION

The Ordinary Portland Cement (OPC) is one of the major ingredients used for the preparation of concrete. Concrete is the most popular binding material that is being used from many years and is serving the purpose of binding very effectively. The manufacturing of cement on a big scale is increasing the environmental pollution. Similar is the case of aggregates, which may be replaced by using the alternate materials. The concrete industry is trying constantly to find the alternate materials for cement and also the aggregates. Fly-ash has been used as the alternate material for the replacement of cement since many years. Some of the replacement materials are the rice-husk ash, silica fume, Ground Granulated Blast furnace Slag (GGBS), Marble Powder etc.

Green concrete is concept of using eco-friendly material in concrete, to make the system more sustainable. Green concrete is very often and also cheap to produce, because for example, waste product are use as a partial substitute for cement, charges for the disposal of waste are avoided, energy consumption in production is lower, and durability is greater. The conventional concrete is one of the most widely used manmade building materials in the world.

Natural fiber have good mechanical strength, low weight and low cost. Natural fibers are classified into two types they are natural inorganic fibers like asbestos, shells etc. and natural organic fibers like jute, banana, hemp, sisal, etc. By adding banana fiber the strength of the concrete is increased and also it is economical when compare to steel fiber reinforced concrete or glass fiber.

Waste Marble Powder is the by-product of the marble industry which is generated during cutting and grinding of marble. The waste generation is approximately 40% of the total marble handled per annum. It makes relevance because annually about 68 million of marble is manufactured all over the world. Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased.

### 1.1 Need of the Study:-

- To determine an alternative for the ordinary Portland cement.
- To produce eco-friendly concrete and reduce CO2 emission.
- To develop a product which will be a cost efficient.
- To provide high strength concrete than ordinary Portland concrete

### 1.2 Objectives:-

The main Objective of this study is to make Eco-friendly Concrete using Natural Fibers and Marble Waste. Further Objectives are as under

- To study the Compressive strength of concrete with partial replacement of cement with Marble powder and Banana Fiber.
- To study the Split tensile Strength of concrete using Banana Fiber.
- To study the Flexural Strength of concrete with normal concrete.
- To find Optimum content of Marble powder and Banana fiber with gives best performance under loading.
- To analyze the cost comparison with normal concrete

**1.3 Scope of Work:-**

In this study focused on effect of partial replacement of cement by Marble Powder and to enhance the Tensile Strength by using Banana Fiber. The successful use of Marble Powder and Banana Fiber may be aid in reducing Environment effect due to dispose marble powder.

The Prospective of this research is preliminary focus on noticing change of various properties of concrete by Utilize of Marble Powder and Banana Fiber. The Various properties of Fresh and Hardened Concrete self be investigation to conclude the Effectiveness of this material in the concrete.

## II. MATERIAL AND METHODOLOGY

**2.1 Material Used:-**

**Cement:-** Generally three grade of OPC is available i.e. 33, 43 & 53. OPC 53 of grade ULTRATECH Cement is used throughout the project work. It is locally available in Rajkot city of Gujarat.

**Table:-1 Properties of Cement and Marble powder**

| Chemical composition | Cement (%) | Marble Powder (%) |
|---|---|---|
| Silica ($SiO_2$) | 34 | 13.8 |
| Alumina ($Al_2O3$) | 5.5 | 2.5 |
| Calcium Oxide (CaO) | 63 | 43.2 |
| Ferric Oxide Calcium Oxide ($Fe_2O_3$) | 4.4 | 1.9 |
| Magnesium Oxide (MgO) | 1.26 | 2.7 |
| Potassium Oxide ($K_2O$) | 0.48 | 0.6 |
| Sulphuric anhydride ($SO_4$) | 1.92 | 0.07 |
| Loss of ignition | 1.3 | 43.63 |
| Specific Gravity | 3.15 | 2.60 |
| Physical form | Fine Powder | Fine Powder |
| Colour | Gray | White |

**Fine Aggregate:-** Locally available fresh river sand, free from organic matter was used. The result of sieve analysis confirms to zone-I (according to IS: 383-1970). Specific Gravity is 2.70.

**Coarse Aggregate:-** The crushed stone is generally used as a coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 383-1970. Specific Gravity is 2.80.

**Marble Powder:-** This project describes the feasibility of using the marble dust in concrete production as partial replacement of cement. The waste marble powder was collected from the local market in Rajkot. Marble powder was collected from the deposits of marble factories during shaping and cutting. It was sieved by IS-90 micron sieve before mixing in concrete. Other Properties of marble Powder which are shown in table-1.

**Banana Fiber:-** The use of banana stem is very useful to produce paper, yarn, fabric etc. Banana Fiber of diameter 1mm and Length of 30-40 mm were used. The Banana Fiber collected from Vadodara by India-mart.

**Water:-** Potable tap water available in laboratory conforming to the requirement of IS: 456-2000 was used for mixing concrete and curing the specimen.

**2.2 Experimental Work:-**

**Table:-2 Experimental Work on Cubes, Cylinders and Beams**

| Sr. No. | Marble Powder + Banana Fiber (%) | Compressive Strength (150 X 150 X 150) mm | Split tensile Strength (150 dia. X 300 ht.) mm | Flexural Strength (100 X 100 X 500) mm |
|---|---|---|---|---|
| | | 28 Days | 28 Days | 28 Days |
| 1 | 0 + 0 | 3 | 3 | 3 |
| 2 | 5 + 0 | 3 | 3 | 3 |
| 3 | 10 + 0 | 3 | 3 | 3 |
| 4 | 15 + 0 | 3 | 3 | 3 |
| 5 | 20 + 0 | 3 | 3 | 3 |
| 6 | 0 + 0.25 | 3 | 3 | 3 |
| 7 | 5 + 0.25 | 3 | 3 | 3 |
| 8 | 10 + 0.25 | 3 | 3 | 3 |
| 9 | 15 + 0.25 | 3 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| 10 | 20 + 0.25 | 3 | 3 | 3 |
| 11 | 0 + 0.5 | 3 | 3 | 3 |
| 12 | 5 + 0.5 | 3 | 3 | 3 |
| 13 | 10 + 0.5 | 3 | 3 | 3 |
| 14 | 15 + 0.5 | 3 | 3 | 3 |
| 15 | 20 + 0.5 | 3 | 3 | 3 |
| Total | | 45 | 45 | 45 |

**2.3 Concrete Mix Design:-**

Cement Used = OPC 53 Grade Confirming to IS 12269
Specific Gravity of Cement = 3.15
Specific Gravity of Fine Aggregate (sand) = 2.70
Specific Gravity of Coarse Aggregate = 2.80
Sieve Analysis Fine aggregates = Confirming to Zone I of Table 4 IS – 383
Maximum water-cement ratio = 0.45(From Table 5 of IS 456)
Estimated water content for 100 Slump = 197 lit

**Mix Proportion:-**

Cement = 437 kg
Coarse Aggregate = 1117 Kg
Fine Aggregate = 718 kg
Water = 197 kg
W/C ratio = 0.45
Grade of Concrete M30 ratio = 1:1.64:2.55

**Table:-3 Mix Designation**

| Sr. No. | MP+BF (%) | Cement (Kg) | Marble Powder (Kg) | Banana Fiber (Kg) | Coarse Aggregate (Kg) | Fine Aggregate (Kg) | Water (Kg) |
|---|---|---|---|---|---|---|---|
| 1 | 0 + 0 | 437 | 0 | 0 | 1117 | 718 | 197 |
| 2 | 5 + 0 | 415 | 22 | 0 | 1117 | 718 | 197 |
| 3 | 10 + 0 | 393 | 44 | 0 | 1117 | 718 | 197 |
| 4 | 15 + 0 | 371 | 66 | 0 | 1117 | 718 | 197 |
| 5 | 20 + 0 | 349 | 88 | 0 | 1117 | 718 | 197 |
| 6 | 0 + 0.25 | 437 | 0 | 1 | 1117 | 718 | 197 |
| 7 | 5 + 0.25 | 415 | 22 | 1 | 1117 | 718 | 197 |
| 8 | 10 + 0.25 | 393 | 44 | 1 | 1117 | 718 | 197 |
| 9 | 15 + 0.25 | 371 | 66 | 1 | 1117 | 718 | 197 |
| 10 | 20 + 0.25 | 349 | 88 | 1 | 1117 | 718 | 197 |
| 11 | 0 + 0.5 | 437 | 0 | 2 | 1117 | 718 | 197 |
| 12 | 5 + 0.5 | 415 | 22 | 2 | 1117 | 718 | 197 |
| 13 | 10 + 0.5 | 393 | 44 | 2 | 1117 | 718 | 197 |
| 14 | 15 + 0.5 | 371 | 66 | 2 | 1117 | 718 | 197 |
| 15 | 20 + 0.5 | 349 | 88 | 2 | 1117 | 718 | 197 |

**2.4 Testing for properties of Fresh concrete (Slump test)**

Slump test is the most commonly use method of measuring consistency of concrete. It is very essential for concrete to have good workability so that entrapped air can be easily removed by minimum effort of compaction.
Slump flow test ASTMC 1611, to check flow property, the mixes are tested to flow intensity after mixing a slump flow between 20 to 35 mm should be obtained.

**2.5 Testing for properties of Hardened concrete**

**(1) Compressive Strength:-** The compressive testing machine generally used to find out the compressive strength of the concrete cubes. The Size of cube specimen is 150x150x150 mm. and this test performed 2000 KN capacity compression machine. The Compressive Strength is to be tested 28 days different percentage of Marble Powder and Banana Fiber.

To measure compressive strength of specimen following equation are,

$$\text{Compressive strength} = P / A \ (N/mm^2)$$

Where,
P = Maximum Load at Failure (N),
A = Cross Section Area ($mm^2$).

**(2) Split tensile Strength:-** Beams of size 100mm × 100mm × 500mm under two-point load were used to determine the flexural strength. The beams are casted with different percentage of Marble Powder and Banana Fiber content in concrete has been investigated. After curing, the specimens were tested 28 days.

To measure flexural strength of specimen following equation are,

Flexural strength = $PL / bd^2$ ($N/mm^2$)

Where,
P = Maximum Load at failure (N)
L = Length of beam (500 mm)
b = Width of beam (100 mm)
d = Depth of beam (100 mm)

**(3) Flexural Strength:-** In spilt tensile strength cylinder of size 150 mm Diameter and 300 mm Height is to be placed in compression testing machine. The Split Tensile Strength is to be tested 28 days different percentage of Marble Powder and Banana Fiber.

To measure split tensile strength of specimen following equation are,

Split tensile strength = $2P / \pi dh$ (N/mm2)

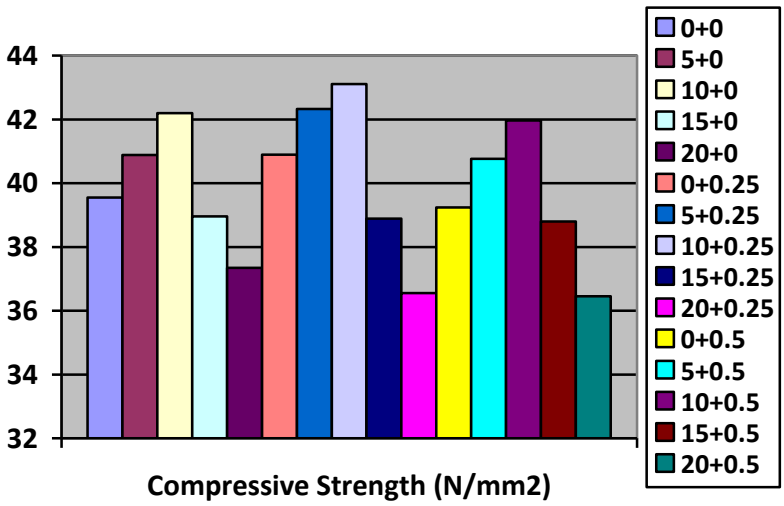
Where,
P = Maximum Load at failure (N)
d = Dia. of Cylinder (150 mm)
h = Ht. of Cylinder (300 mm)

## III. RESULT AND DISCUSSION

### 3.1 Result of Compressive strength of Concrete cubes

**Table:-4 Compressive strength Result of Cubes**

| Sr. No. | MP + BF (%) | Result ($N/mm^2$) |
|---|---|---|
| 1 | 0 + 0 | 39.55 |
| 2 | 5 + 0 | 40.88 |
| 3 | 10 + 0 | 42.20 |
| 4 | 15 + 00 | 38.96 |
| 5 | 20 + 0 | 37.34 |
| 6 | 0 + 0.25 | 40.89 |
| 7 | 5 + 0.25 | 42.33 |
| 8 | 10 + 0.25 | 43.11 |
| 9 | 15 + 0.25 | 38.89 |
| 10 | 20 + 0.25 | 36.55 |
| 11 | 0 + 0.5 | 39.24 |
| 12 | 5 + 0.5 | 40.76 |
| 13 | 10 + 0.5 | 41.96 |
| 14 | 15 + 0.5 | 38.80 |
| 15 | 20 + 0.5 | 36.45 |



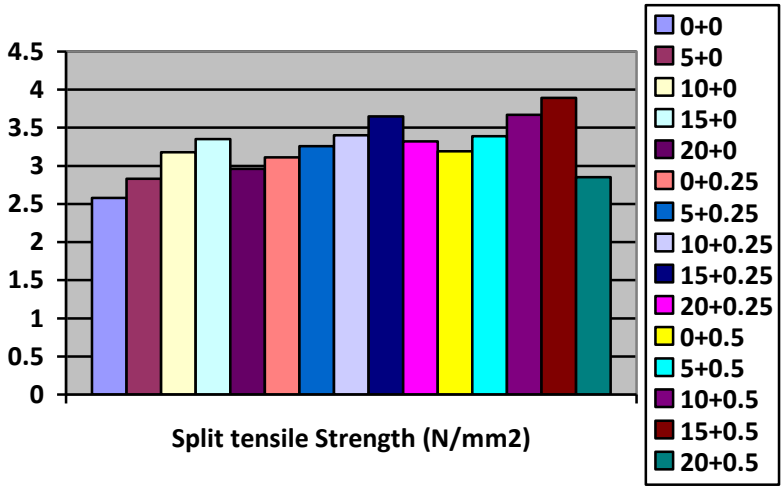

**Graph:-1 Compressive Strength Result**

### 3.2 Result of Split tensile strength of Concrete cylinders

**Table:-5 Split tensile strength Result of Cylinders**

| Sr. No. | MP + BF (%) | Result ($N/mm^2$) |
|---|---|---|
| 1 | 0 + 0 | 2.58 |
| 2 | 5 + 0 | 2.83 |
| 3 | 10 + 0 | 3.18 |
| 4 | 15 + 0 | 3.35 |
| 5 | 20 + 0 | 2.96 |
| 6 | 0 + 0.25 | 3.11 |
| 7 | 5 + 0.25 | 3.26 |
| 8 | 10 + 0.25 | 3.40 |
| 9 | 15 + 0.25 | 3.65 |
| 10 | 20 + 0.25 | 3.32 |
| 11 | 0 + 0.5 | 3.19 |
| 12 | 5 + 0.5 | 3.39 |
| 13 | 10 + 0.5 | 3.67 |
| 14 | 15 + 0.5 | 3.89 |
| 15 | 20 + 0.5 | 2.85 |



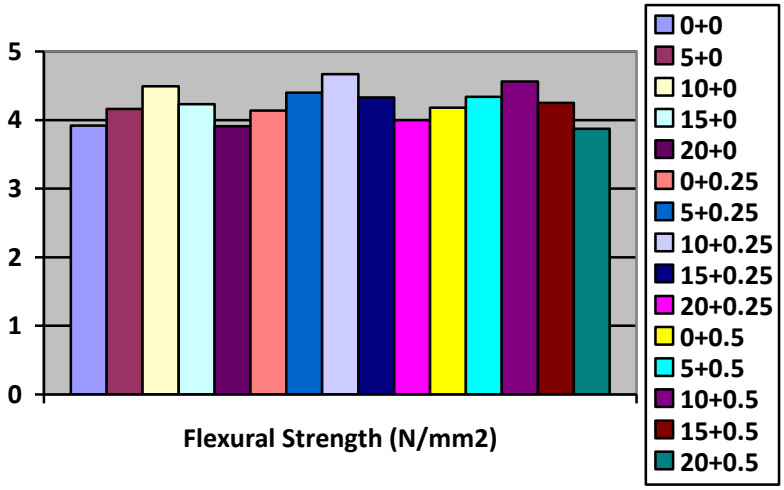

**Graph:-2 Split tensile Strength Result**

### 3.3 Result of Flexural strength of Concrete beams

**Table:-6 Flexural strength Result of Beams**

| Sr. No. | MP + BF (%) | Result ($N/mm^2$) |
|---|---|---|
| 1 | 0 + 0 | 3.92 |
| 2 | 5 + 0 | 4.16 |
| 3 | 10 + 0 | 4.49 |
| 4 | 15 + 0 | 4.23 |
| 5 | 20 + 0 | 3.91 |
| 6 | 0 + 0.25 | 4.14 |
| 7 | 5 + 0.25 | 4.40 |
| 8 | 10 + 0.25 | 4.67 |
| 9 | 15 + 0.25 | 4.33 |
| 10 | 20 + 0.25 | 4.00 |
| 11 | 0 + 0.5 | 4.18 |
| 12 | 5 + 0.5 | 4.34 |
| 13 | 10 + 0.5 | 4.56 |
| 14 | 15 + 0.5 | 4.25 |
| 15 | 20 + 0.5 | 3.87 |

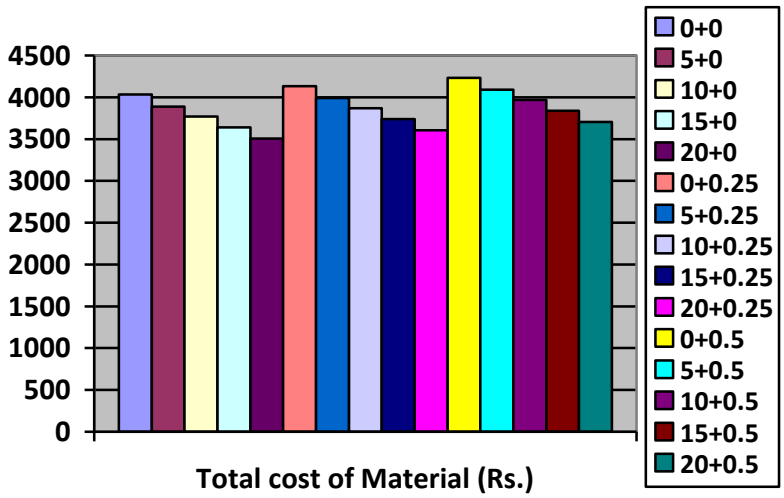



**Graph:-3 Flexural Strength Result**

### 3.4 Result of Cost comparison

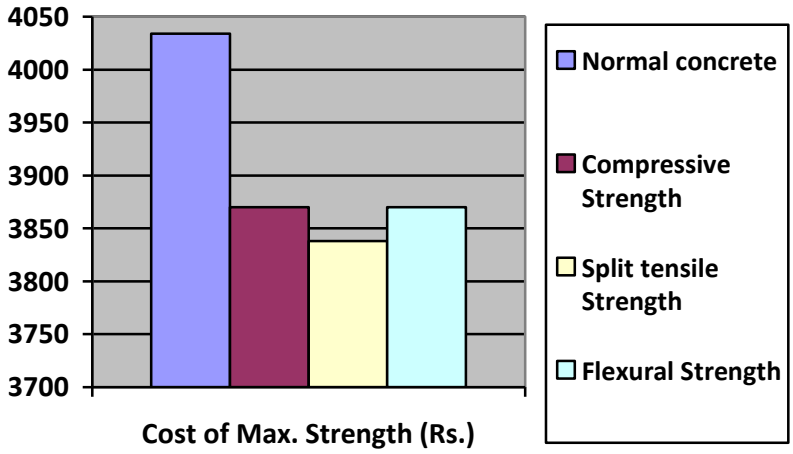
**Table:-7 Cost of material for 1 $m^3$ Volume of Concrete**

| Sr. No. | MP + BF (%) | Cement | Marble Powder | Banana Fiber | Coarse Aggregate | Fine Aggregate | Total (Rs.) |
|---|---|---|---|---|---|---|---|
| 1 | 0 + 0 | 2622 | 0 | 0 | 838 | 574 | 4034 |
| 2 | 5 + 0 | 2478 | 0 | 0 | 838 | 574 | 3890 |
| 3 | 10 + 0 | 2358 | 0 | 0 | 838 | 574 | 3770 |
| 4 | 15 + 0 | 2226 | 0 | 0 | 838 | 574 | 3638 |
| 5 | 20 + 0 | 2094 | 0 | 0 | 838 | 574 | 3506 |
| 6 | 0 + 0.25 | 2622 | 0 | 100 | 838 | 574 | 4134 |
| 7 | 5 + 0.25 | 2478 | 0 | 100 | 838 | 574 | 3990 |
| 8 | 10 + 0.25 | 2358 | 0 | 100 | 838 | 574 | 3870 |
| 9 | 15 + 0.25 | 2226 | 0 | 100 | 838 | 574 | 3738 |
| 10 | 20 + 0.25 | 2094 | 0 | 100 | 838 | 574 | 3606 |
| 11 | 0 + 0.5 | 2622 | 0 | 200 | 838 | 574 | 4234 |
| 12 | 5 + 0.5 | 2478 | 0 | 200 | 838 | 574 | 4090 |
| 13 | 10 + 0.5 | 2358 | 0 | 200 | 838 | 574 | 3970 |
| 14 | 15 + 0.5 | 2226 | 0 | 200 | 838 | 574 | 3838 |
| 15 | 20 + 0.5 | 2094 | 0 | 200 | 838 | 574 | 3706 |




**Graph:-4 Cost of 1$m^3$ Volume of concrete**




**Graph:-5 Cost comparison with Normal Concrete**

## IV. CONCLUSION

- The Marble powder can be used as an admixture in concrete, so that Compressive strength of the concrete can be increased.
- The Slump Value is between 20 to 25 mm from 10% MP & 0.25% BF.
- The Compressive Strength from the result obtain by Maximum Compressive strength is 43.11 MPa for 10% MP & 0.25% BF.
- The Split tensile Strength from the result obtain by Maximum Split tensile strength is 3.89 MPa for 15% MP & 0.50% BF.
- The Flexural Strength from the result obtain by Maximum Flexural strength is 4.76 MPa for 10 % MP & 0.25% BF.
- The Compressive Strength from the result obtain by 36.45 MPa for 20% MP & 0.5% BF was decreased.
- The Split tensile Strength from the result obtain by 2.58 MPa for 0% MP & 0% BF was decreased.
- The Flexural Strength from the result obtain by 3.87 MPa for 20% MP & 0.5% BF was decreased.
- The cost of green concrete is 4.23% decreased as compare to normal concrete so it's more effective.

## V. FUTURE SCOPE OF THE WORK

- The investigation can be further extended to more grade of concrete.
- The durability test should be included for further studies.
- The more ratio (upto 20%) of marble powder should be consider.
- There is scope of coarse aggregates replacement in concrete mix from different Recycle coarse aggregate by using different combination.

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