**"An İnvestigation of the mechanical properties of Marble Dust and Silica Fume substituted Ordinary Portland Cement"**

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**ABSTRACT**

The use of Marble powder and silica fume in concrete is abounded with data from mechanical and chemical strengths to assess the material parameters. Studies focusing on material properties with different replacement of cement with Marble powder and silica fume are presented and on structural component with use of multi blend concrete and fiber concrete composites. It has been found the workability of concrete has increased and the amount of cube compressive strength has been decreased and on significant effect has been noted on impact strength of plain concrete. M30 grade of concrete is used in this experiment and O%,5%,10%,15%, 20%,25%, 30%,35% and 40% of Marble powder and silica fume were used as a cement replacement (by weight). The specimens for testing were prepared, the cube, Beams are cured for 7 & 28 days. All the properties were determined by performing different tests like flexural strength and compressive strength and. At last, workability, setting time, compressive strength is investigated. The results of the Compressive Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete 24.22 N/mm2 -26.44 N/mm2 in 9.18 % ,24.27 N/mm2-26.49 N/mm2 in 9.14 %, 24.36 N/mm2-26.76 N/mm2 in 9.83 % at 7 days. The results of the Compressive Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete 38.67 N/mm2- 41.78 N/mm2 in 8.04 %, 38.44 N/mm2- 41.56 N/mm2 in 8.10 %, 38.89 N/mm2- 42.44 N/mm2 in 9.15 % at 28 days. The results of the Flexural Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete 4.83 N/mm2 - 5.29 N/mm2 in 9.27 % ,4.86 N/mm2 -5.27 N/mm2 in 8.46 % ,4.89 N/mm2-5.25 N/mm2 in 7.43 % at 28 days.

**Keywords:**

Marble powder , silica fume, Nominal Concrete , Fiber Concrete, Compressive Strength, Cubes, Splitting Tensile Strength , Cylinders ,Flexural Tensile Strength, Beams.

1. **INTRODUCTION**

With almost six billion tons produced annually, concrete is arguably the material used in construction most widely in the world. Our country's structural requirements are growing steadily, and as concrete is a vital component of many of the infrastructure projects that support it, it is critical to improve its strength and solidity. The substance concrete is somewhat brittle. When strands are expanded to significant lengths, the material becomes more malleable. Some of the limitations of plain concrete cement are as follows: low elastic, limited pliability, minimal protection against breakage, high fragility, and helpless sturdiness. On the basis of exploratory analyses, strands enhance cement's mechanical qualities, such as its stiffness, sturdiness, flexural strength, compressive strength, and resistance to creep. Among these, steel strands and polymer filaments are particularly common in the cement industry. Only water is consumed per capita more than it is. Concrete is the largest single material element in the built environment. Reduced embodied energy in concrete could have significant positive effects on the environment and the economy without compromising performance or raising costs.

Concrete is a widely used construction material known for its strength and durability. Researchers have been exploring the effects of various additives on concrete properties to enhance its performance. Two common additives studied extensively are marble powder and silica fume.

**1.1 Ordinary port land cement (OPC)**

Ordinary port land cement (OPC) is the basic Portland cement and is best suited for use in general concrete construction. It is of three types, 33 grades, 43 grades, 53 grades. One of the important benefits is the faster rate of development of strength. Portland slag cement is obtained by mixing Portland cement clinker, gypsum and granulated blast furnace slag in suitable proportion and grinding the mixture to get a thorough and intimate mixture between the constituents. This type of cement can be used for all purposes just like OPC. It has lower heat of evolution and is more durable and can be used in mass concrete production.

**1.2 Fine Aggregate**

Fine aggregate most of which passes through a 4.75 mm. IS sieve and contains only that much coarser material as is permitted by the specifications. Sand is generally considered to have a lower size limit of about 0.07 mm. Material between 0.06 mm and 0.002 mm is classified as silt, and still smaller particles are called clay. The soft deposit consisting of sand, silt and clay in about equal proportions is termed loam.

**1.3 Coarse Aggregates**

In this study, coarse aggregates of size 40 mm and 20 mm conforming to specifications as given in IS: 383- 1970 is used. Pycnometer test is carried out to find the specific gravity of aggregates. Sieve analysis has been done to find the fineness modulus of aggregate.

**1.4 Marble Powder**

Marble powder is a fine, white powder obtained from grinding marble. Marble powder obtained from grinding marble has a wide range of uses. Marble powder is also known as limestone and calcium carbonate. In nature, marble powder is mainly found in old rocks and seashells. Marble powder, which is used intensively in industry, can also be used in paint making, ceramic making, and as a filler additive.

**1.5 Silica fume**

Silica fume is a by-product from the production of elemental silicon or alloys containing silicon in electric arc furnaces. At a temperature of approximately 2000°C the reduction of high-purity quartz to silicon produces silicon dioxide vapor, which oxidizes and condenses at low temperatures to produce silica fume.

**1.6 Water**

Concrete is a composite material made primarily of four key ingredients: cementitious material, fine aggregates, coarse aggregates, and water. Among these components, water plays a crucial role in the formation and strength of concrete. The following sections will detail the importance of water in concrete, the effects of excess water, and considerations regarding water quality.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Concrete : Aggregates in Concrete | What Is Coarse Aggregate | Requirements ... | What is silica fume? | Elkem.com | Marble Powder/Marble Dust Used In Art or Painting Works, Loose Packed  (900g) : Amazon.in: Home & Kitchen |  |
| **Cement (OPC)** | **Fine Aggregate** | **Coarse Agg.** | **Silica fume** | **Marble powder** | **Water** |

**Figure no 1; Ingredients of Mix Concrete**

1. **OBJECTIVE OF THE STUDY**

The main objective of the study is to investigate the change in characteristics strength properties and workability of concrete mixed with different percentage of Marble powder and Silica fume with concrete. Following are objectives of the study.

1. To find out the effect of Marble powder and Silica fume on strength when mixed with concrete sample in partially replacement of cement.
2. To study the workability of concrete on variation in different percentage of Marble powder and Silica fume on strength when mixed with concrete sample in partially replacement of cement.
3. To perform the sieve analysis and specific gravity of Marble powder and Silica fume and Cement used Reduce the maintenance cost.
4. Increase the economy of the construction with using the cheaper material as a replacement of the cement.
5. Compare the result with conventional normal concrete.
6. To find out the compressive strength of hardened concrete after 7 and 28 days of curing, and to compare different concrete cube mixes that substitute some of the cement with a mixture of marble powder and silica fume.
7. To find out the flexural strength of hardened concrete after 7 and 28 days of curing, and to compare different concrete cube mixes that substitute some of the cement with a mixture of marble powder and silica fume.
8. Check the feasibility of Marble powder as a replacement of Cement in the construction of concrete.
9. To provide economical construction cost.
10. **METHODOLOGY**

Concrete for M30 grade were prepared as per I.S.- 10262: 2009. Water cement ratio to get a characteristic strength of M30 was considered for this study. The exact quantity of materials for each mix was calculated.

In this experimental study Cement, sand, coarse aggregate, water, Marble powder, and silica fume were used

1. Cement :- Ordinary Portland cement of 43 grade From Jabalpur M.P.

2. Sand (Fine Aggregate) :- Locally available river sand From Jabalpur M.P.

3. Coarse Aggregate : Jabalpur M.P.

4. Water :- Potable water was used for the experimentation.

5. Marble powder - Marble powder is available in dry powder form M.P.

6. Silica fume :- Silica fume is available from DCW engineering Jabalpur.

The use of Marble powder and silica fume in concrete is abounded with data from mechanical and chemical strengths to assess the material parameters. Studies focusing on material properties with different replacement of cement with Marble powder and silica fume are presented and on structural component with use of multi blend concrete and fiber concrete composites. It has been found the workability of concrete has increased and the amount of cube compressive strength has been decreased and on significant effect has been noted on impact strength of plain concrete.

M30 grade of concrete is used in this experiment and O%,5%,10%,15%, 20%,25%, 30%,35% and 40% of Marble powder and silica fume were used as a cement replacement (by weight). The specimens for testing were prepared, the cube, Beams are cured for 7 & 28 days. All the properties were determined by performing different tests like flexural strength and compressive strength and. At last, workability, setting time, compressive strength is investigated. The maximum strength for the concrete specimen is obtained when 30% of Marble powder and silica fume are replaced of cement.

1. **OBSERVATIONS & RESULT DISCUSSION**

|  |  |  |  |
| --- | --- | --- | --- |
| **Table no.1; Mix proportion by(Saturated surface dry) mass** | | | |
| **Cement** | **Water** | **Fine aggregate** | **Coarse aggregate** |
| **414** | **186** | **711** | **1141** |
| **1** | **0.45** | **7.72** | **2.76** |

**Table no.2; The Final Batches percentages with Silica Fume of Concrete M30 (in kg/m3)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mix Code** | **Cement** | **Silica Fume** | **Fine Aggregate** | **Coarse Aggregate** |
|  | kg/m3 | kg/m3 | kg/m3 | kg/m3 |
| M-1 | 414.00 | 0.00 | 697.88 | 1128.06 |
| M-2 | 393.30 | 20.70 | 697.88 | 1105.50 |
| M-3 | 372.60 | 41.40 | 697.88 | 1105.50 |
| M-4 | 351.90 | 62.10 | 697.88 | 1105.50 |
| M-5 | 331.20 | 82.80 | 697.88 | 1105.50 |
| M-6 | 310.50 | 103.50 | 697.88 | 1105.50 |
| M-7 | 289.80 | 124.20 | 697.88 | 1105.50 |
| M-8 | 269.10 | 144.90 | 697.88 | 1105.50 |
| M-9 | 248.40 | 165.60 | 697.88 | 1105.50 |

**Table no.3 ; The Final Trial Batches percentages with Marble Powder of Concrete M30 (in kg/m3)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mix Code** | **Cement** | **Marble Powder** | **Fine Aggregate** | **Coarse Aggregate** |
|  | kg/m3 | kg/m3 | kg/m3 | kg/m3 |
| M-10 | 414.00 | 0.00 | 697.88 | 1128.06 |
| M-11 | 393.30 | 20.70 | 697.88 | 1105.50 |
| M-12 | 372.60 | 41.40 | 697.88 | 1105.50 |
| M-13 | 351.90 | 62.10 | 697.88 | 1105.50 |
| M-14 | 331.20 | 82.80 | 697.88 | 1105.50 |
| M-15 | 310.50 | 103.50 | 697.88 | 1105.50 |
| M-16 | 289.80 | 124.20 | 697.88 | 1105.50 |
| M-17 | 269.10 | 144.90 | 697.88 | 1105.50 |
| M-18 | 248.40 | 165.60 | 697.88 | 1105.50 |

**Table no.4; The Final Trial Batches percentages with Silica Fume and Marble Powder of Concrete M30 (in kg/m3)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Mix Code** | **Cement** | **Silica Fume** | **Marble Powder** | **Fine Aggregate** | **Coarse Aggregate** |
|  | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 |
| M-19 | 414.00 | 0.00 | 0.00 | 697.88 | 1128.06 |
| M-20 | 248.40 | 0.00 | 165.60 | 697.88 | 1105.50 |
| M-21 | 248.40 | 20.70 | 144.90 | 697.88 | 1082.94 |
| M-22 | 248.40 | 41.40 | 124.20 | 697.88 | 1060.38 |
| M-23 | 248.40 | 62.10 | 103.50 | 697.88 | 1037.82 |
| M-24 | 248.40 | 82.80 | 82.80 | 697.88 | 1015.26 |
| M-25 | 248.40 | 103.50 | 62.10 | 697.88 | 992.70 |
| M-26 | 248.40 | 124.20 | 41.40 | 697.88 | 970.14 |
| M-27 | 248.40 | 144.90 | 20.70 | 697.88 | 947.58 |
| M-28 | 248.40 | 165.60 | 0.00 | 697.88 | 925.02 |

**4.1 Workability of various concrete mixes design for slump cone test**

**Graph no. 1; The results of the slump cone test show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete.**

**4.2 Compressive Strength**

**Graph no. 2; The results of the Compressive Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete at 7 days**

**Graph no. 3; The results of the Compressive Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete at 28 days**

**4.3 Flexural Strength(fb)N/mm2**

**Graph no. 4; The results of the Flexural Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete at 28 days**

1. **CONCLUSION**

The following conclusions could be drawn from the present investigation.

1. The flexural & compressive strength of Marble powder and silica fume based multi blended concrete were improved when compared with conventional concrete mix design M30.
2. Super plasticizer agent is required to produce workable mix.
3. Slump Cone test results workability of

* fresh M30 grade concrete with Silica Fume M-24 Slump value 91mm.
* fresh M30 grade concrete with Marble Powder M-15 Slump value 91mm.
* fresh M30 grade concrete with Silica Fume and Marble Powder M-24 Slump value 91mm.

1. The results of Compressive strength for cube (N/mm2) show the partial replacement with Silica Fume for cement in the concrete at 7 Days

Mix design loads strength (N/mm2) % Increase in strength

M-1 545.00 KN 24.22 N/mm2 0.00 %

M-7 595.00 KN 26.44 N/mm2 9.18 %

1. The results of Compressive strength for cube (N/mm2) show the partial replacement with Marble Powder for cement in the concrete at 7 Days

Mix design loads strength (N/mm2) % Increase in strength

M-10 546.00 KN 24.27 N/mm2 0.00 %

M-16 596.00 KN 26.49 N/mm2 9.14 %

1. The results of Compressive strength for cube (N/mm2) show the partial replacement with Silica Fume and Marble Powder for cement in the concrete at 7 Days

Mix design loads strength (N/mm2) % Increase in strength

M-19 548.00 KN 24.36 N/mm2 0.00 %

M-24 602.00 KN 26.76 N/mm2 9.83 %

1. The results of Compressive strength for cube (N/mm2) show the partial replacement with Silica Fume for cement in the concrete at 28 Days

Mix design loads strength (N/mm2) % Increase in strength

M-29 870.00 KN 38.67 N/mm2  0.00 %

M-35 940.00 KN 41.78 N/mm2  8.04 %

1. The results of Compressive strength for cube (N/mm2) show the partial replacement with Marble Powder for cement in the concrete at 28 Days

Mix design loads strength (N/mm2) % Increase in strength

M-38 865.00 KN 38.44 N/mm2 0.00 %

M-44 935.00 KN 41.56 N/mm2 8.10 %

1. The results of Compressive strength for cube (N/mm2) show the partial replacement with Silica Fume and Marble Powder for cement in the concrete at 28 Days

Mix design loads strength (N/mm2) % Increase in strength

M-47 875.00 KN 38.89 N/mm2  0.00 %

M-53 955.00 KN 42.44 N/mm2  9.15 %

1. The results of Flexural strength for Beams (N/mm2) show the partial replacement with Silica Fume for cement in the concrete at 28 Days

Mix design Strength (N/mm2) % Increase in strength

Mix-B1 4.83 N/mm2  0.00 %

Mix-B7 5.29 N/mm2  9.27 %

1. The results of Flexural strength for Beams (N/mm2) show the partial replacement with Marble Powder for cement in the concrete at 28 Days

Mix design Strength (N/mm2) % Increase in strength

Mix-B17 4.86 N/mm2  0.00 %

Mix-B11 5.27 N/mm2  8.46 %

1. The results of Flexural strength for Beams (N/mm2) show the partial replacement with Silica Fume and Marble Powder for cement in the concrete at 28 Days

Mix design Strength (N/mm2) % Increase in strength

Mix-B27 4.89 N/mm2  0.00 %

Mix-B21 5.25 N/mm2  7.43 %

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