# EFFECT OF STEEL FIBRES AND MARBLE DUST ON COMPRESSIVE STRENGTH OF CONCRETE

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**ABSTRACT**

Fibers are generally added to concrete as a resistance to cracking and it causes strengthening of concrete. In this project, various tests are carried out on steel fiber reinforced concrete with the addition of different percentages of marble dust to check the influence of fibers on compressive strength of concrete and the optimum amount of marble dust that can safely replace the cement content in concrete. According to various research papers, it has been found that steel fibers give the maximum compressive strength in comparison to glass and polypropylene fibers. An experimental investigation was carried out on the behavior of concrete specimens reinforced with steel fibers and subjected to compressive loading is presented. Tests were conducted on specimens with four different fiber volume fractions. It was observed that Steel fibre reinforced concrete specimens showed enhanced properties compared to that of normal specimens.

The present study aims at, developing pavement quality concrete mixtures incorporating marble dust as partial replacement of cement and the use of steel fibres for strengthening of concrete. In this study, the compressive strength for pavement quality concrete mixtures for different percentage of steel fibres and replacement of cement with marble dust are reported. It is found that the maximum increase in compressive strength is for 1% Steel fibre. The savings in the cement can be achieved by replacing some amount of it with the cheaper material like marble dust and the strength decreased is compensated by adding steel fibres. Hence the replacement of cement by marble dust is more economical and the compressive strength is increased by addition of steel fibres.

Key words : Concrete , steel fibres, marble dust, compressive strength, flexural strength, split tensile strength.

## 1. INTRODUCTION

There is an increase demand for utilization of industrial waste and by products in road pavements. It has become very important to use these waste products in productive works. A contribution to enhance this demand and utilization is put forth by the government policies and public awareness. Marble dust is also one of the industrial wastes that creates environmental pollution on large scale. Therefore an attempt to use it in pavement quality concrete can prevent the environmental pollution and lead to use of fewer natural resources.

Fibre reinforced concrete is represented by combination of four different phases, i.e., cement, water, coarse aggregate, fine aggregate and a dispersion of discontinuous, steel fibre. It can also contain admixtures and pozzolans which are commonly used to improve the properties of conventional concrete. All admixtures under the ASTM specifications for use in concrete can be efficiently used in Steel Fibre Reinforced Concrete(SFRC).

Marble dust is a product that is obtained from sawing and shaping during marble production and the material faces disposal problem and poses serious environmental threats. Therefore, for sustainable development, efforts are made to analyze the effects of marble dust when used as partial replacement to cement in concrete mix.

## 2. METHODOLOGY AND MATERIALS

The various compressive strength tests were performed on the concrete specimens mixed with different percentages of marble dust and steel fibres. The cube specimens of size 150 mm x 150 mm x 150 mm were made of concrete and cured properly in the curing tank and then taken out form the curing tank at the ages of 28 days and tested immediately on removal from the water. Surface water was wiped off and the specimens were tested. The position of cube when tested was kept at right angle to that as cast. The load was applied gradually without shock by compression testing machine till the failure of the specimen occurs and thus the compressive strength was found.The quantities of various material used such as cement, coarse aggregate (20 mm and 10 mm), fine aggregate, marble dust and water for each batch was weighed separately. The cement and marble dust were mixed dry to a required proportion. The coarse aggregates were mixed properly to get uniform distribution throughout the batch. Water was added to the mix to get the required workability. Firstly, 50 to 70% of water was added to the mix and then mixed thoroughly for 3 to 4 minutes in mixer. Then the concrete was filled into the cube moulds and then get vibrated to ensure proper compaction. The specimens were removed from the moulds after 24 hours of casting and were placed in the water tank, filled with potable water in the laboratory. After removal of specimen from the curing tank, compressive strength tests were done on these cube using compression testing machine.

## 3. RESULTS AND DISCUSSION

In order to achieve the objectives of present study, an experimental program was planned to investigate the effect of marble dust and steel fibre on compressive strength of concrete so as to assess its feasibility for use in highway pavement. The experimental program consists of casting, curing and testing of controlled and marble dust-steel fibre concrete specimens.
The properties of cement sample, coarse aggregates, fine aggregates and steel fibres used in the present research work are obtained from various tests and are tabulated in table 1, table 2, table 3 and table 4.

**Table 1 : Properties of cement sample**

| S.NO. | Properties | Value |
|---|---|---|
| 1. | Consistency | 25% |
| 2. | Specific gravity | 3.2 |
| 3. | Initial setting time | 82 minutes |
| 4. | Final setting time | 200 minutes |
| 5. | Fineness | 7% |
| 6. | Soundness | 2.3 mm |
| 7. | Compressive strength<br>3 days<br>7 days<br>28 days | <br>29 MPa<br>40 MPa<br>51 MPa |

**Table 2 : Properties of coarse aggregates.**

| S.No | Properties | Value |
|---|---|---|
| 1. | Specific gravity | 2.7 |
| 2. | Fineness modulus | 6.2 |
| 3. | Bulk density(loose) | 1200 kg/m$^3$ |
| 4. | Bulk density (compacted) | 1620 kg/m$^3$ |
| 5. | Maximum size | 20 mm |

**Table 3 : Properties of fine aggregates.**

| S.No | Properties | Value |
|---|---|---|
| 1. | Specific gravity | 2.7 |
| 2. | Fineness Modulus | 2.05 |
| 3. | Bulk density (loose) | 1420 kg/m$^3$ |
| 4. | Bulk density (compacted) | 1660 kg/m$^3$ |

**Table 4 : Properties of Steel fibres.**

| S.No | Properties | Value |
|---|---|---|
| 1. | Length of fibre | 40mm |
| 2. | Thickness of fibre | 20mm |
| 3. | Density | 7540 $kg/m^3$ |
| 4. | Tensile strength | 8250 $kg/m^3$ |

The sieve analysis of marble dust and fine aggregates is done to obtain the fineness modulus of fine aggregates and marble dust used in the present study. The results of sieve analysis are given in table 5 and table 6.

**Table 5 : Sieve analysis of marble dust.**

| **Weight of sample taken = 200 gm.** | | | | | |
|---|---|---|---|---|---|
| **S.No** | **IS Sieve size** | **Weight retained (gm)** | **% weight retained** | **% passing** | **Cumulative % passing** |
| 1. | 4.75 mm | 0 | 0 | 100 | 0 |
| 2. | 2.36 mm | 0 | 0 | 100 | 0 |
| 3. | 1.18 mm | 0 | 0 | 100 | 0 |
| 4. | 600 micron | 22 | 11 | 89 | 11 |
| 5. | 300 micron | 41 | 20.5 | 79.5 | 31.5 |
| 6. | 150 micron | 115 | 57.5 | 42.5 | 89 |
| 7. | Pan | 22 | 11 | 89 | 100 |
| | | | **SUM = 231.5** | | |
| **Fineness modulus =2.31** | | | | | |

**Table 6 : Sieve Analysis of Fine Aggregate**

| **Weight of sample taken =1000 gm.** | | | | | |
|---|---|---|---|---|---|
| **Sr. No.** | **IS-Sieve (mm)** | **Wt. Retained (gm)** | **%age retained** | **%age passing** | **Cumulative % retained** |
| 1 | 4.75 | 6 | 0.6 | 99.4 | 0.6 |
| 2 | 2.36 | 59 | 5.9 | 93.5 | 6.5 |
| 3 | 1.18 | 220 | 22 | 71.5 | 28.5 |
| 4 | 600 μ | 159 | 15.9 | 55.6 | 44.4 |
| 5 | 300 μ | 316.5 | 31.65 | 23.95 | 76.05 |
| 6 | 150 μ | 196.5 | 19.65 | 4.3 | 95.70 |
| 7 | Pan | 43 | 4.3 | 0.0 | |
| | **Total** | **1000.00** | | **SUM** | **251.75** |
| **Fineness modulus =2.51** | | | | | |

The compressive strength results of concrete mixed with different percentages of steel fibre and marble dust are shown graphically from figure 1 to figure 8.

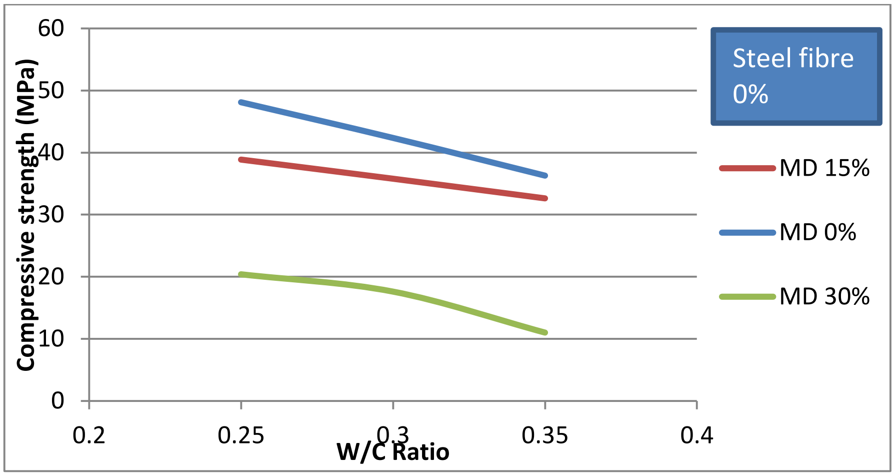


Figure 1 : Variation of Compressive strength of concrete with different W/C for 0% steel fibre and different percentages of marble dust.

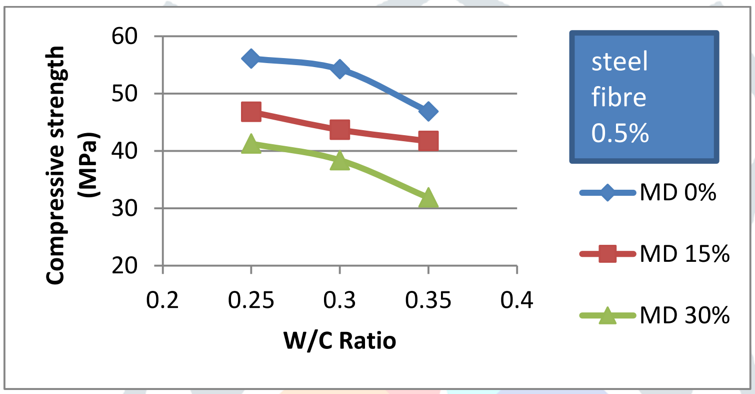


Figure 2: Variation of Compressive strength of concrete with different W/C for 0.5 % steel fibre and different percentage of marble dust.

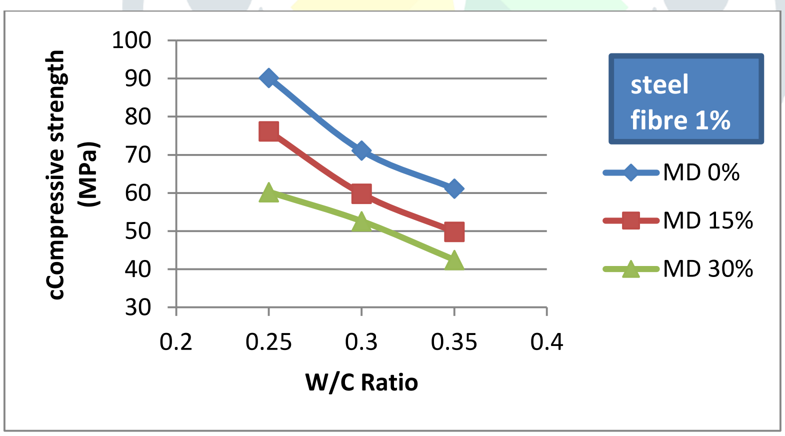


Figure 3: Variation of Compressive strength of concrete with different W/C for 1% steel fibre and different percentage of marble dust.

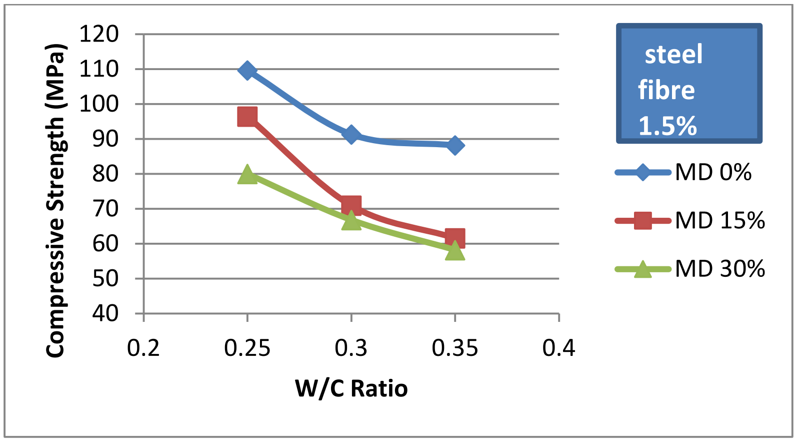


Figure 4: Variation of Compressive strength of concrete with different W/C for 1.5% steel fibre and different percentage of marble dust.

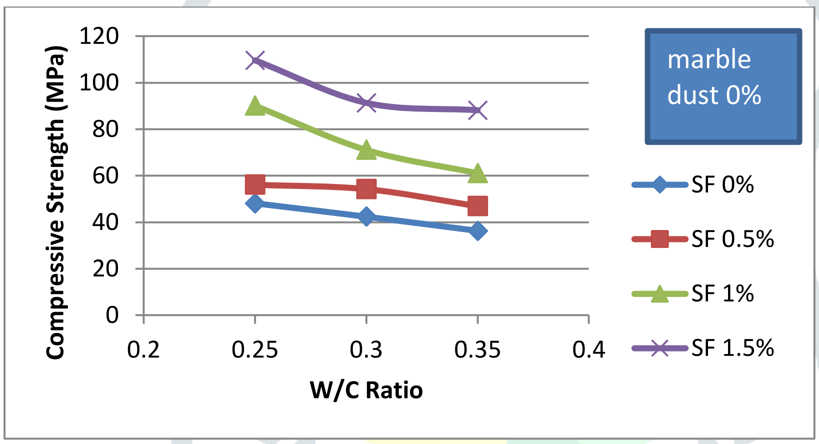


Figure 5: Variation of Compressive strength of concrete with different W/C for 0 % marble dust and different percentages of steel fibres.

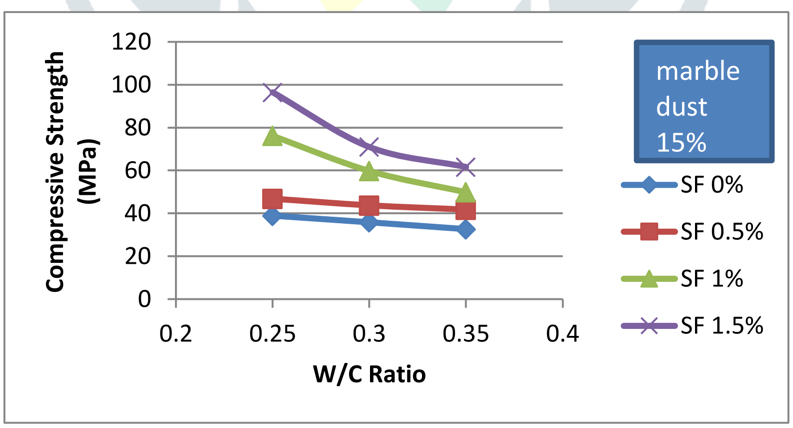


Figure 6: Variation of Compressive strength of concrete with different W/C for 15% marble dust and different percentage of steel fibres.

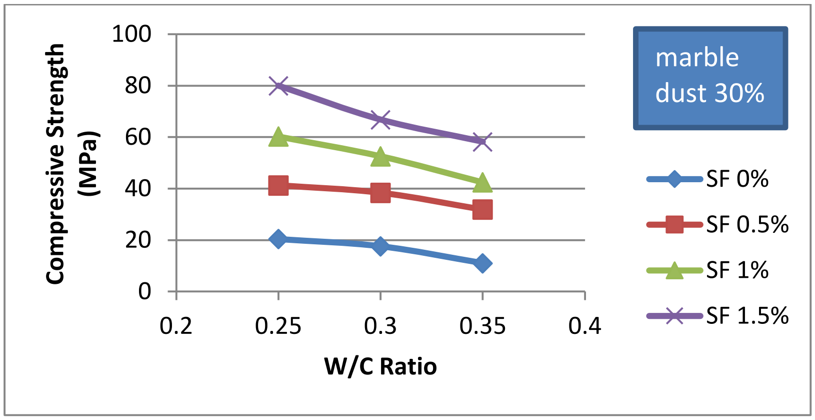


Figure 7: Variation of Compressive strength of concrete with different W/C for 30% marble dust and different percentage of steel fibres.

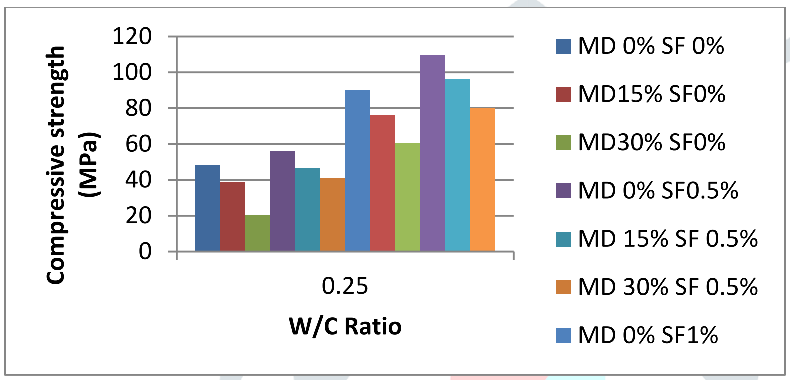


Figure 8: Variation of compressive strength of concrete at 0.25 W/C with different percentages of steel fibre and different percentage of Marble dust.

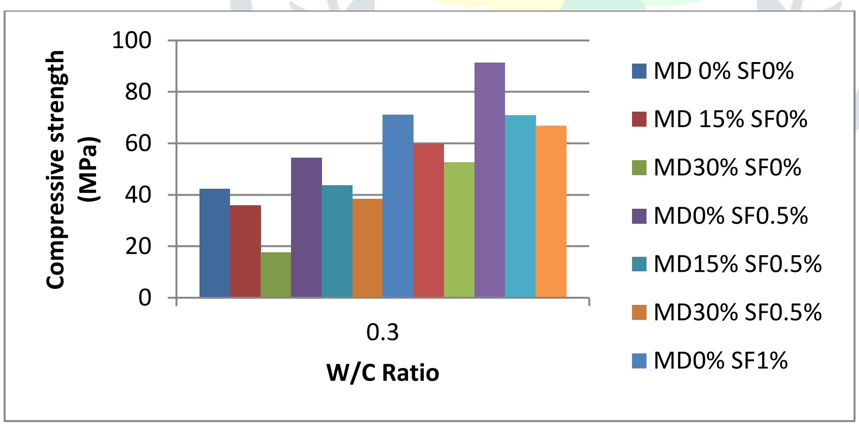


Figure 9 : Variation of compressive strength of concrete at 0.3 W/C with different percentages of Steel fibre and different percentage of Marble dust.

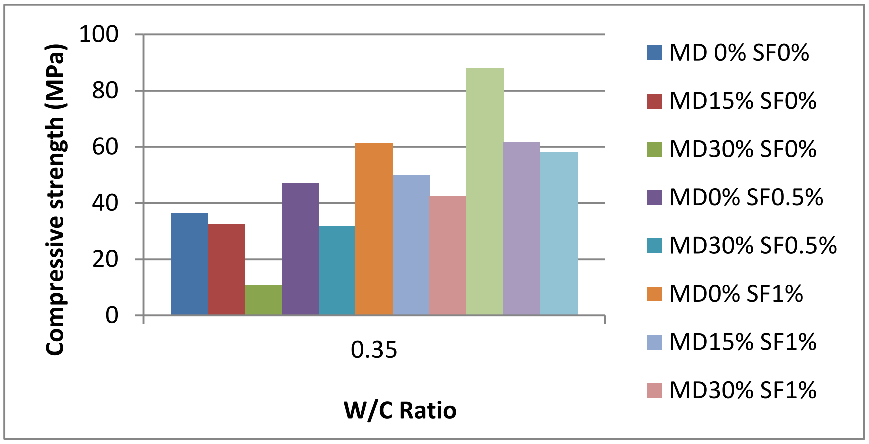


Figure 10 : Variation of compressive strength of concrete at 0.35 W/C with different percentages of Steel fibre and different percentage of Marble dust.

### 3.1 Effect of Steel Fibres on compressive strength of concrete

The various graphs plotted above show the effect of addition of steel fibres and marble dust on compressive strength of pavement quality concrete. The Figures 1 to 8, show the variation of compressive strength with water cement ratios at varying percentages of marble dust and steel fibres. It is observed that as the percentage of steel fibre in concrete is increased, the compressive strength increases. This is attributed to the propagation of cracks that are restrained due to the bonding of fibres into the concrete i.e., ductile failure is restrained due to addition of steel fibres to the concrete. Referring to graph above shown, it is observed that for addition of 1% steel fibre and replacement of cement with marble dust, the increase in compressive strength is the maximum when compared to nominal mix.

## 4. CONCLUSIONS

From the experimental results, the following conclusion can be drawn:

- Concrete mix with 15 percent marble dust as replacement of cement is the optimum level as it has been observed to show a significant increase in compressive strength at 28 days when compared with nominal mix.
- The compressive strength of concrete mixes increases on addition of steel fibres as compared to the nominal mixes.
- Maximum compressive strength of pavement quality concrete incorporating marble dust and steel fibres, both, is achieved for 15% marble dust replacement and 1% steel fibres

**REFERENCE0053**

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