EFFECT OF STEEL FIBRES AND MARBLE DUST ON STRENGTH CHARACTERISTICS OF PAVEMENT QUALITY CONCRETE

[1]Syed Haamid Ali Andrabi,[2]Ankaj Minhas
[1]M.Tech Scholar,[2]Assistant professor, GGGI
[1]Department of civil engineering,
[1]Galaxy Global Group of institutions, dinarpur, Ambala,Haryana, India.

Abstract : Steel fibers generally provide adequate resistance to cracking and strengthening of concrete. In this project various tests are being carried out on steel fiber reinforced concrete to check the influence of fibers on tensile strength and flexural strength of concrete and the partial replacement of cement with marble dust is done to make it economical as marble dust is a waste product . Various research papers show that the steel fibers impart the maximum strength to concrete in comparison to glass and polypropylene fibers. Hence, in this project the effect of addition of steel fibers and marble dust to the pavement quality concrete is observed. An experimental investigation on the behavior of concrete specimens reinforced with steel fibers and partial replacement of cement with marble dust and subjected to tensile and flexural loading is presented. Tests were conducted on specimens with four different percentages of steel fibres added (0%, 0.5%, 1% and 1.5%).Also the cement in concrete was replaced by different amounts of marble dust (0%, 15% and 30%). It was observed that Steel fibre reinforced conrete specimens showed enhanced strength properties compared to that of normal specimens. The tensile strength and flexural strength of the specimen increased indefinitely on addition of more percentage of steel fibres. The decrease in strength of concrete due to replacement of cement by a waste product i.e., marble dust is compensated by the enhancement in strength due to addition of steel fibres. So the optimum amount of steel fibres used is 1% by volume and 15% marble dust can be used effectively without any compromise with the strength of concrete.

Keywords: Tensile strength, flexural strength, steel fibres, marble dust, concrete.

1. Introduction

Concrete is a versatile construction material used in almost every modern constructions . Earlier it was being used as a protective cover of steel members, but now a day's concrete is used as a structural member along with steel to modify its properties and give better strength to the concrete. Marble is a metamorphic rock that is composed of re-crystallized carbonate minerals, usually calcite or dolomite. Marble is a rock resulting from the transformation of a pure limestone. The purity of the marble decides its color and appearance. It is white in color if the limestone is solely composed of calcite (100% $CaCO_3$).

The steel fibre reinforced concrete is made up of cement concrete and uniformly dispersed steel fibres. The steel fibres in concrete provide the structural improvement. Plain cement concrete pavements have low tensile and flexural strengths and strain capacity, however these structural characteristics are improved by addition of steel fibres allowing simplification of the pavement layer thickness. The most substantial act of using fibre reinforcement in concrete is to retard and control the tensile cracking of concrete. Comparing with the life cycle of an asphalt road, the steel fibre reinforced concrete pavements have been described to last twice as long.

2. Methodology

The properties of materials used for manufacturing concrete mix are found out in the laboratory as per relevant codes of practice. The various materials used in the present study are cement, coarse aggregates, fine aggregates, marble dust and steel fibres.

2.1 Split tensile strength

The split tensile strength of all the mixes was determined at the ages 28 days for various replacement levels of marble dust and additional percentages of steel fibres in concrete mix. The results of split tensile strength of concrete are reported in figure 4.3. The maximum values of split tensile strength of concrete with addition of 1% steel fibre and 0% marble dust replacement for pavement quality concrete

From the results, it is observed that the optimum value of split tensile strength is achieved with addition of 1% of steel fibre in controlled concrete mix.

2.2 Flexural strength

The most common concrete structure subjected to flexure is a highway or airway pavement and strength of concrete for pavements is commonly evaluated by means of bending tests. When concrete is subjected to bending, then tensile and compressive stresses and in many cases direct shear stresses are developed.

When fibre reinforced concrete and composite beams are loaded in pure bending, then the tensile strains develop. The load at first crack would increase with respect to steel fibre reinforced concrete due to crack arresting mechanism of the closely spaced fibres. After the concrete matrix cracks, the fibres continue to take higher load which is provided. Thus the ultimate flexural strength is increased.

3. Results

4. The properties of various materials which were used in this study are given in table 1 to 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 3 days 7 days 28 days	 29 MPa 40 MPa 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					

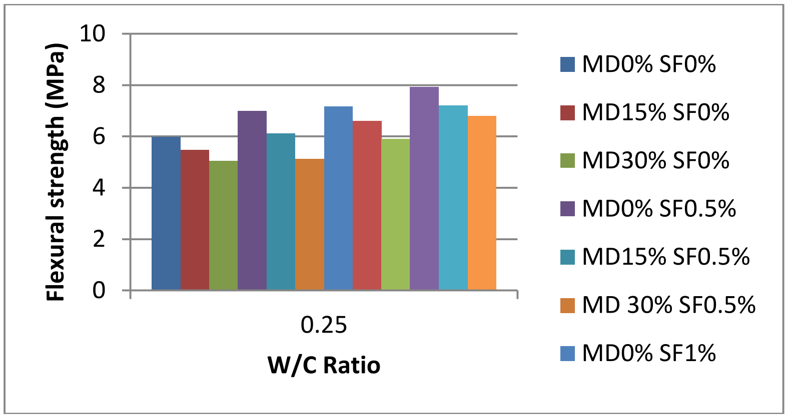

Figure 1 : Variation of flexural strength of concrete at 0.25 W/C with different percentages of Steel fibre and different percentage of Marble dust

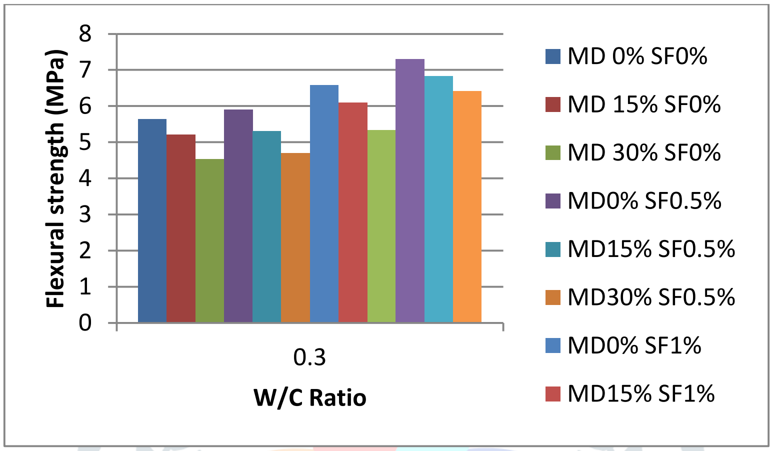

Figure 2 : Variation of flexural strength of concrete at 0.3 W/C with different percentages of Steel fibre and different percentage of Marble dust

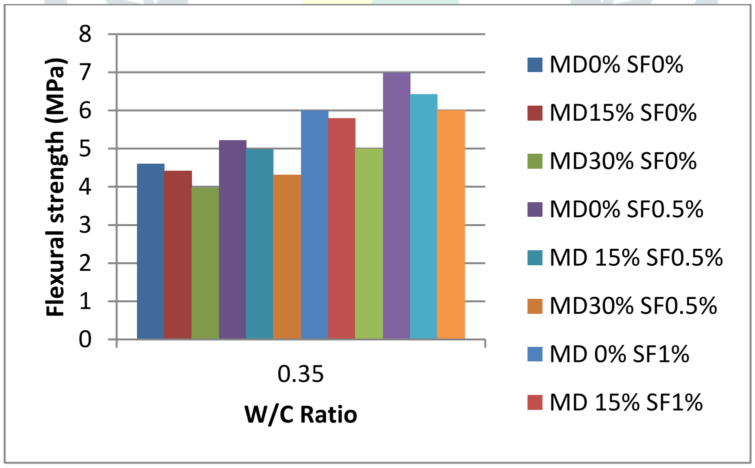

Figure 3 : Variation of flexural strength of concrete at 0.35 W/C with different percentages of Steel fibre and different percentage of Marble dust

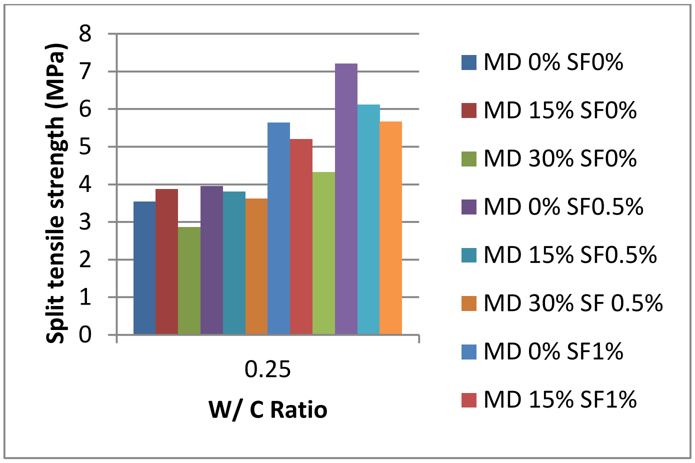

Figure 4 : Variation of Split tensile strength of concrete at 0.25 W/C with different percentages of Steel fibre and different percentage of Marble dust

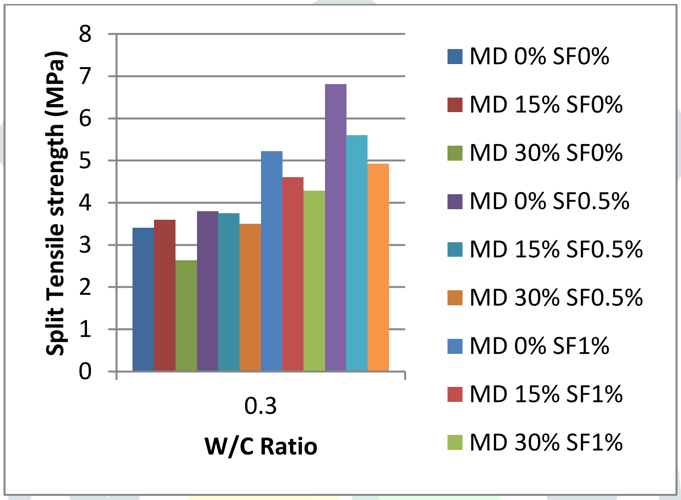

Figure 5: Variation of Split tensile strength of concrete at 0.3 W/C with different percentages of Steel fibre and different percentage of Marble dust

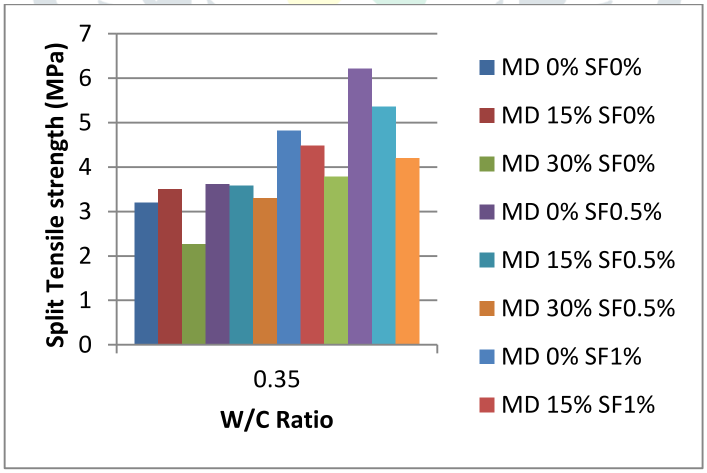

Figure 6: Variation of Split tensile strength of concrete at 0.35 W/C with different percentages of Steel fibre and different percentage of Marble dust.

3.1 Effect on split tensilestrength:

The Figures 1 to 3, show the variation of split tensile strength with water cement ratios by varying the percentage of marble dust added at different amount of steel fibres. It is observed here that with the increase in percentage of steel fibre there is an increase in split tensile strength similar to that of compressive strength. This trend due to the addition of steel fibre in concrete is caused by the same reason, as for compressive strength increase. When the cement is replaced with 15% marble dust, there is a slight increase in split tensile strength as observed from the graphs for higher w/c ratios. This trend, as described earlier, can be attributed to the fact that marble granules do possess cementing properties. However, on increasing the replacement of marble beyond 15%, there is a slight reduction in the tensile strength value. On the other hand, when the steel fibre is added to the concrete mix, there is significant increase in tensile strength as compared to controlled mix.

3.2 Effect on flexural strength:

The Figures 4 to 6, have been plotted between flexure strength and water cement ratios for each specimen. It is observed that with the increase percentage of steel fibre at varying percentages of marble dust as replacement of cement, the flexure strength follows a pattern similar to that of compressive strength and split tensile strength. This happens because when the steel fibre was added to the concrete, the propagation of cracks was restrained due to the bonding of fibres into the concrete (ductile failure).However, on increasing the percentage replacementof marble dust beyond 15%, the value of flexure strength is decreased. On the other hand, when the steel fibre is added in the concrete mix, there is significant increase in flexure strength, as well, when compared to controlled mix

5. 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.
- Concrete mixes when reinforced with steel fibre show an increased compressive strength as compared to nominal mix.
- The splittensile strength also tends to increase withincreasedpercentagesofsteelfibres in themix.
- On increasing the percentage replacement of cement with marble dust beyond 15%, there is a slight reduction in the tensile strength value.
- The flexure strength also tends to increase with the increase percentages of steel fibres, a trend similar to increase in split tensile strength and compressive strength.
- On increasing the percentage replacement of cement with marble dust beyond 15%, there is decrease in the flexure strength value.

Maximum strength (flexure, compressive as well as split tensile) of pavement quality concrete incorporating marble dust and steel fibres, both, is achieved for 15% marble dust replacement and 1% steel fibres. However, if the marble dust content is increased to 20%, even with 1% steel fibre, the increase is not very significant.

References

1. Elavarasi.D (2014), *"Structural behaviour of High Strength Steel Fibre Reinforced Concrete (HS-SFRC) block pavement"*, International Journal of ChemTech Research, Vol.7, No.4, pp 1790-1794, 2014-201.

2. Majid Jaral, Er Suhaib Firdous (april 2018) *''A review study on the steel fiber reinforced concrete pavement*'' IJSDR | Volume 3, Issue 4
3. Soulioti, D. V., et al. *"Effects of Fibre Geometry and Volume Fraction on the Flexural Behaviour of Steel-Fibre Reinforced Concrete."* Strain 47.s1 (2011): e535-e541.
4. Wang Nianzhi, Sidney Mindess, and Keith Ko. *"Fibre reinforced concrete beams under impact loading."* Cement and concrete research 26.3 (1996): 363-376.
5. Wegian, Falah M., A. Alanki, and A. Alotaibi. *"Influence of Fly Ash on Behavior of Fibres Reinforced Concrete Structures."*Journal of Applied Sciences 11.17 (2011): 31853191.
6. Aquib Sultan Mir,O.P Mittal "*A Study on Strength Properties of Rigid Pavement Concrete with Use of Steel Fibers and Marble Dust".* International Journal of Advanced Research in Education & Technology (IJARET) Vol. 3, Issue 2 (April - June 2016).
7. Veera reddy.M."*investigations on stone dust and ceramic scrap as aggregate replacement in concrete".* International journal of civil and structural engineering volume 1, No 3, 2010.
8. Devesh Meena, "*A study on behavior of marble dust in concrete pavement".* International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 05 | Aug-2015.