Research Paper Engineering

Effect of Hook Ended Steel Fibre on Workability and Strength of High Strength Concrete with Marble Powder Admixture

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ABSTRACT

This paper deals with experimental investigation of M50 grade High strength concrete with hook ended steel fibre and marble powder admixture to study strength characteristics (compressive strength and split tensile strength). The present work is carried out with M50 grade concrete with partial replacement of cement by 0%, 5%, 10%, 15%, 20% &25% marble powder and also addition of 0%, 0.5%, 1.0%, and 1.5% by hook end steel Fibre volume fraction of concrete. The cubes and cylinders are cured for 7 and 28 days. The results are presented graphically. The results indicate the optimum dosage of 10% marble powder and 1% hook ended steel Fibre improves strength characteristics.

KEYWORDS High strength concrete, Marble powder, hook ended steel Fibre, compressive strength, split tensile strength

1. INTRODUCTION

Cement concrete is most extensively used construction material in the world. To effective use of waste materials, cost concern of cement production, this paper presents an option of using marble powder as mineral admixture and steel Fibres as supplementary materials. Indian marble industry annual output is 68 million tones. Marble Powder in large quantity is generated during marble cutting, sawing, shaping, processing and grinding in marble industries, this is around 40% of marble stone mined and handled usually rejects at the mine sites or at processing units in the range of 250-400 tones. Leaving the waste materials to the environment can cause environmental problem [P.A.Shirule 2012]. Hence reuse of marble waste material in the building industry itself is recommended. [Baboo Rai 2011]. Dr. A.M. Shende (2012) stated that even such properly designed and prepared cement concrete mixes have some limitations like (i) low tensile strength (ii) Brittleness and low ductility (iii) low post cracking capacity (iv) Incapable accommodating large deformations. Generally concrete is strong in compression but it is very weak in tension even it is just 1/10th of its compressive stresses makes micro cracks under smaller load at tensile end, as the time elapses these cracks increase their magnitude and gradually propagate to the compression end of the member, finally the member breaks. So, to improve tensile strength to prevent crack propagation steel Fibres are randomly arranged and uniformly distributed in concrete matrix.

Valeria et al (2005) stated that marble powder had very high Blaine fineness value of about 1.5 m^2/g and 90% of particles passing through 50µm sieve (d_{90}=50µm) and 50% passing through 7 µm sieve (d_{50} = 7µm). Hanifi Binci et al (2007) found that marble dust concrete has higher compressive strength than that of the corresponding limestone dust concrete having equal w/c and mix proportion. Dr. A.M. Shende et al (2012) in their investigation the experimental results of split tensile strength for M_{40} grade concrete containing 0% 1% 2% 3%, hook ended steel Fibre with 50,60,67 aspect ratio were compared with mathematical model developed was found to be valid over 85% confidence limit.

The present paper aim to potential use of marble powder and steel Fibre and to do parametric study on compressive and split tensile strength with variable of grade of concrete, percentage of marble powder and steel Fibres.

2. Materials and Methods

(i) Cement: - Ordinary Portland cement of 53 grade ACC brand is used in experiment. And tested as per IS:8112-1989 the properties are specific gravity 3.02, normal consistency 32%, fineness of 2%, initial setting time 40 minutes and final setting time 390 minutes.

(ii) Fine aggregate: - The locally available natural river sand is used as fine aggregate and tested as per IS: 383-1970 Its specific gravity 2.60, grade Zone II, fineness modulus 2.96.

(iii) Coarse aggregate: - Crushed granite aggregate with 60% of aggregate are 20mm and remaining 40% are 12mm size. Its specific gravity 20mm is 2.44 and 12mm is 2.50 and fineness modulus 3.75.

(iv) Water: - Portable water is used for the experimentation.

(v) Marble Powder: - Marble Powder which is used in laboratory investigation is obtained from dressing polishing, cutting and processing unit in Industrial estate, Anantapur. Its specific gravity is 2.667, passing through 90µsieve.

(vi) Hook Ended Steel Fibre :- The hook ended steel Fibre are used in this study having diameter 0.5mm, length 25mm with aspect ratio 50.

(vii) Super Plasticizer: - Sulphonated Naphthalene polymer based Fosroc conplast SP430 is used as super Plasticizers. The dosage is 0.5% by weight of cement.

Variables Studied

(i) Concrete Mix: - The mix ratio of cement: sand: coarse aggregate is **1:1.572:2.408** and w/c ratio is 0.36.

(ii) Test Program for Casting: -.

a) First group is the control mix with 0% marble powder and 0% steel Fibre (PCC)
b) The second group consists of concrete in which cement is replaced 5%, 10%, 15%, 20%, and 25% by weight of cementitious material with marble powder.
c) The third group consists of concrete with 0.5%, 1%, 1.5% by volume fraction of concrete addition of hook ended steel Fibre.
d) The fourth group consists of concrete in which cement is replaced 5% to 25% with marble powder and addition of 0.5% to 1.5% by volume fraction of hook ended steel Fibre.

(iii) Size of specimen: - 150mmx150mmx150mm size of cubes for compressive strength test and 150mm diameter and 300mm height of cylinder for split tensile strength test.

(iv) Curing period: - Specimens are cured in curing tank for 7 and 28 days.

(v) Compressive Strength test: - After 7 and 28 days curing

period, the cubes are tested on digital compression testing machine as per IS 516-1959. In each category three cubes are tested and their average value is reported. The compressive strength is calculated as follows

$$\text{Compressive strength (N/mm}^2\text{)} = \frac{\text{load}}{\text{Area}}$$

(vi) Split tensile strength test: - After 7 and 28 days curing period the cylinders are tested under compression testing machine. In each category three cylinders are tested and their average value is reported. Split tensile strength is calculated as follows.

$$\text{Split tensile strength (N/mm}^2\text{)} = \frac{2P}{\pi DL}$$

Where P is load, D and L are diameter and length of cylinder

3. Results and Discussion

Table 1 and figure 1.A, 1.B represents 7 and 28 days compressive strength.

Table 2 and figure 2.A, 2.B represents 7 and 28 days split tensile strength.

The results indicate that the compressive strength of cubes and split tensile strength of cylinders after 7 and 28 days testing are

(i) With the inclusion of marble powder the strength of concrete gradually increase upto certain limit 10% cement replaced by marble powder then gradually decrease. 7 and 28 days compressive and split tensile strength values are increased by +17.91%, +20.69% and 25.39%, 25.52%respectively compared to initial values.

(ii) With the inclusion of steel fibre the strength of concrete marginally increase upto 1% addition of Fibre then with the increase in percentage of Fibre the strength values decreases. These strength values are more compared to only marble powder replacement. 7 and 28 days compressive and split tensile strength values are increased by +21.69%, +24.63% and +41.41%,+41.67% respectively compared to initial values.

(iii) With the inclusion of both marble powder content and steel Fibre the strength of concrete gradually increase upto optimum percentage i.e. 10% cement replaced by marble powder and addition of 1% steel fibre, then gradually decreases. The increase in strength values are more compared to only marble powder content and only steel fibre content mixes. 7 and 28 days compressive and split tensile strength values are increased by +30.10%, 29.97% and+47.27%, +46.35% compared to initial values respectively.

TABLE 1 : Results of Compressive strength in N/mm²

Mix Id	%MP	%SF	7 days Compressive strength N/mm²	% Change in Strength	28 days Compressive strength N/mm²	% Change in Strength
A	0	0	42.33	-	62.00	-
B	5	0	45.23	+6.85	67.77	+9.31
C	10	0	49.91	+17.91	74.83	+20.69
D	15	0	42.73	+0.94	65.60	+5.81
E	20	0	36.74	-13.21	58.89	-5.02
F	25	0	32.61	-22.96	51.14	-17.52
G	0	0.5	49.42	+16.75	73.17	+18.02
H	0	1.0	51.51	+21.69	77.27	+24.63
I	0	1.5	45.41	+7.28	71.59	+15.47
J	5	0.5	51.85	+22.49	76.65	+23.63
K	5	1.0	52.70	+24.50	77.70	+25.32
L	5	1.5	51.65	+22.2	76.24	+22.97
M	10	0.5	53.33	+25.99	78.40	+26.45
N	10	1.0	55.07	+30.10	80.58	+29.97
O	10	1.5	52.89	+24.95	78.19	+26.11
P	15	0.5	48.31	+14.13	72.86	+17.52
Q	15	1.0	48.89	+15.50	73.32	+18.26
R	15	1.5	47.60	+12.45	72.44	+16.84
S	20	0.5	41.50	-1.96	62.39	+0.63
T	20	1.0	44.18	+4.37	64.55	+4.11
U	20	1.5	38.84	-8.24	58.15	-6.21
V	25	0.5	35.75	-15.54	52.19	-15.82
W	25	1.0	35.05	-17.20	59.54	-3.97
X	25	1.5	32.90	-22.28	49.75	-19.76

TABLE 2: Results of Split tensile strength in N/mm²

Mix Id	%MP	%SF	7 days Split Tensile Strength N/ mm²	% Change in Strength	28 days Split Tensile Strength N/ mm²	% Change in Strength
A	0	0	2.56	-	3.84	-
B	5	0	2.85	+11.33	4.24	+10.42
C	10	0	3.21	+25.39	4.82	+25.52
D	15	0	2.71	+5.86	4.06	+5.73
E	20	0	2.36	-7.81	3.69	-3.91
F	25	0	2.05	-19.92	3.35	-12.76
G	0	0.5	3.40	+32.81	5.09	+32.55
H	0	1.0	3.62	+41.41	5.44	+41.67
I	0	1.5	3.28	+28.13	4.91	+27.86
J	5	0.5	3.45	+34.77	5.18	+34.90
K	5	1.0	3.56	+39.06	5.26	+36.98
L	5	1.5	3.32	+29.69	5.02	+36.98
M	10	0.5	3.66	+42.97	5.47	+42.45
N	10	1.0	3.77	+47.27	5.62	+46.35
O	10	1.5	3.44	+34.38	5.33	+38.80
P	15	0.5	2.95	+15.28	4.57	+19.01
Q	15	1.0	3.07	+19.22	4.62	+20.31
R	15	1.5	2.83	+10.55	4.42	+15.10
S	20	0.5	2.67	+4.3	3.98	+3.65
T	20	1.0	2.78	+8.59	4.04	+5.21
U	20	1.5	2.61	+1.95	3.88	+1.04
V	25	0.5	2.40	-6.25	3.62	-5.73
W	25	1.0	2.48	-3.13	3.70	-3.65
X	25	1.5	2.37	-7.42	3.54	-7.81

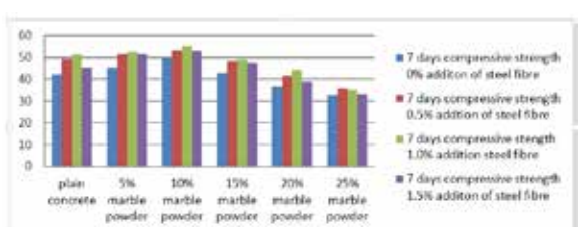

FIGURE 1.A: 7 days compressive strength values

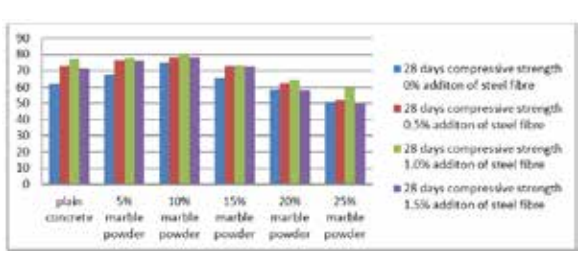

FIGURE 1.B: 28 days compressive strength values

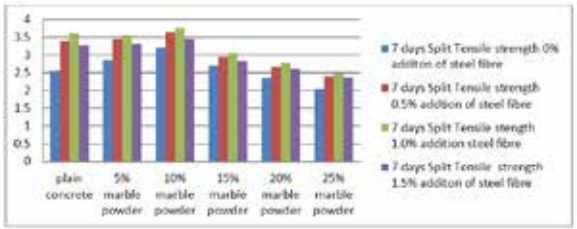

FIGURE 2.A: 7 days split tensile strength values

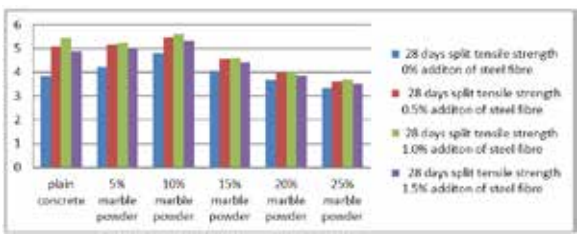

FIGURE 2.B: 28 days split tensile strength values

4. Conclusions

1. The compressive strength of cubes and split tensile strength of cylinders are increased upto optimum percentage limit then with the increase in marble powder content and steel fibres the strength values decrease.
2. Considering the strength criteria, the recommended optimum dosage is 10% marble powder and 1% hook ended steel fibre as supplementary materials. This dosage exhibited better reactivity with cement hydration products and showed improvement in strength properties compared to controlled concrete.
3. The use of marble powder in construction might be cost effective because this material is cheaply available and also eradicates disposal problem and keep environment green.

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