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Improving Some Mechanical Properties of Concrete by Using Hyper-Plasticizer (HP-580) and Steel Fibers

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Abstract. This research aims to study the effects of high performance superplasticizer or hyper superplasticizer on mechanical properties of concrete include compressive , tensile and flexural strength. Superplasticizers in general are a water reducer admixtures that give concrete high workability and higher strength , but the use of superplasticizers must done with care ,because higher dosages ratio lead to segregation and lower ratios not have significant effects ,so for these reasons this research include the use of different dosages of HP and studying the ratios effect on mechanical properties and taking the optimum ratio of HP that use with steel fibers mixes .study show 1liter for each 100 kg cement leads to give optimum mechanical properties of concrete . Steel fibers increase slightly compressive strength but flexural strength is highly increased by adding fibers , mixes with both HP super plasticizer and steel fibers give best results . compressive strength increased from 34.6MPa for reference mixes to 49.90 MPa for mixes with 2% steel fibers and HP with 1 liter for each 100 kg cement . flexural strength increase also from 2.3 to 13.28 MPa by using both steel fiber and HP-superplasticizer.

Keywords— Steel Fiber, Superplasticizer, Compressive Strength, Tensile Strength, Flexural Strength.

INTRODUCTION

Concrete is a brittle construction material and have low ductility. concrete structures subjected to high loads, earthquake forces ,severe conditions like impacts loads need to improve ductility and toughness of concrete by using fibers [1]. Fibers like steel fibers or polypropylene fibers improve ductility , toughness and mechanical properties of concrete [2 ,3]. Superplasticizers used in concrete also to reduce water/cement ratio and that give very low porosity to concrete and higher values of strength [4] and that give a durable concrete. This research aim to study the mechanical properties of concrete by using the effect of high performance superplasticizer and steel fibers both individually effects on concrete ,and also study properties of concrete with both superplasticizer and steel fibers together.

EXPERIMENTAL WORK

A. Materials and Mix Proportions

Using reference mix of concrete with ingredients shown in table 1, ordinary Portland cement used in all mixes , coarse and fine aggregate grading were confirming Indian standards IS-383 [5], table 2 show the grading of coarse aggregate used in study , table 3 show the grading of fine aggregate confirming zone 1 . hyper super plasticizer type HP-580 (High performance liquid admixture) was used individually in concrete with different percentages to find optimum dosage. HP – 580 properties shown in table 4. Steel fiber used individually in mix with different percentages also . and then study include both effects of HP and steel fiber on reference mix of concrete. Steel fiber used in study is from type micro steel fiber coated with brass with 13 mm length and 0.2 mm diameter , table 5 show the properties of micro steel fiber .

B. Molds and Tests

Cubes with 10cm*10 cm *10 cm used in study to find compressive strength , cylinders with 10 cm diameter and 20cm height used for finding tensile strength , and flexural strength done by using beams with 10*10*40 cm dimensions. Third point loading test done to find flexural strength according to British Standards 1881 [6]. Flexural strength can be found from equation 1.

Fb = PL/b.d^2 ----------

---------- (1)

Where :

Fb : is the maximum flexural strength of concrete beam.

P :maximum load applied from machine.

L : Is the distance between supports of beam.

b and d : is width and depth of beam.

Figure1 show steel fiber used in study , the steel fiber used as percentages by volume of concrete with different ratios. figure 2 show some specimens under testing for compressive and flexural strength in study.

Table 1: Ingredients of reference mix used in study

	Cement	Sand	Gravel	Water
Concrete ingredients for each 1 cubic concrete , kg	490	670	1000	220

Table 2: Grading of coarse aggregate with 16mm maximum size confirming Indian standards

Sieve size , mm	% passing by weight	% passing by weight according to Indian standards IS-383.
20 mm	100	100
16 mm	94.6	90 - 100
10 mm	37.5	30 – 70
4.75	7.4	0 – 10

Table 3: Grading of fine aggregate confirming zone 1 according to Indian standards.

Sieve size , mm, micron	% passing by weight	% passing by weight according to Indian standards IS-383.zone 1
10 mm	100	100
4.75	93.2	90 - 100
1.18	44.1	30 - 70
600 micron	25.5	15 -34
300 micron	13.4	5- 20
150 micron	2.5	0 - 10

Table 4: Hyper superplasticizers HP-580 properties, used in study.

Hyper superplasticizer properties	Type	Specific Gravity	Colour	Chemical composition
HP-580-Liquid ADMIX.	HP-580-Liquid ADMIX	1.10	Light brown	MultiCarboxylate Chains

Table 5: Some properties of micro steel fiber used in research

Steel fiber type	Tensile strength	length	diameter	Aspect ratio	Production country
Micro steel fiber	2850 MPa	13 mm	0.20 mm	65	China

Figure 1: Micro steel fiber used in study

Figure 2: Beam and cube specimens under testing for flexural and compressive strength

RESULTS DISCUSSION

Table 6 show the effect of hyper superplasticizer (HP) on concrete, adding this superplasticizer lead to increase the mechanical properties values but dosage exceed 1 liter per 100kg cement lead to reduce mechanical properties of concrete because of high fluidity of concrete and segregation effects. The optimum dosage of HP is found to be equal to 1 liter for each 100 kg cement , and this ratio used for fiber reinforced concrete mixes as shown in table 3. Table 7 show the effect of increasing ratios of steel fibers on mechanical properties of concrete , compressive strength increased slightly by adding fibers , tensile and flexural strength increased highly by adding steel fibers in concrete, the compressive strength increased from 34.6 MPa for reference mix to 40.5 MPa for steel fiber concrete without HP plasticizer , flexural strength increased from 2.3 to 11.49 MPa and that can be attributed to the action of fibers that reduce propagation of cracks under loading [7 ,8] and that leads to give much time to absorb additional load from testing machine before failure. Table 8 show the mechanical properties of concrete improved with both HP and steel fibers , compressive ,tensile and flexural strength are highly increased compared with ordinary concrete modified with HP only and steel fiber concrete without HP, because of the double effect of HP and steel fiber. Flexural strength increased here to 13.28 MPa , while for fiber concrete without HP , was 11.49 MPa , and that attributed by action of HP admixture that greatly improve the dispersion of cement particles an reducing water content in concrete. Figures 3 , 4 ,and 5 , show the double effect of HPsuper plasticizer and steel fibers on compressive, tensile and flexural strength of concrete.

CONCLUSIONS

1- Hyper superplasticizer increased compressive, tensile and flexural strength of ordinary concrete, and the optimum dosage was 1 liter for each 100 kg cement, higher dosages more than 1 liter can cause problems and lead to decrease the strength of concrete.
2- micro steel fibers increase slightly the compressive strength, but flexural strength increased highly (about 5 times) compared with ordinary mixes.
3- using both HP superplasticizer and steel fiber give highly improving in mechanical properties of concrete, the flexural strength increased from 2.3 MPa for reference mix to 13.28 MPa for 2% steel fiber by volume of concrete and optimum dosage of HP superplasticizer.

Table 6: Effect of HP-Superplasticizer on mechanical properties of concrete

Mix type	Compressive strength	Tensile strength	Flexural strength
M1 reference	34.67	1.57	2.34
M2 (WITH 0.5 L/100 KG CEMENT)	36.80	1.93	2.78

M3 (with 0.75 L/100 kg cement)	40.31	2.54	3.87
M4 (with 0.75 L/100kg cement)	42.50	3.12	4.90
M5 (with 1 L/100kg cement)	44.35	3.54	5.32
M6(with 1.25 L/100kg cement)	42.17	3.18	5.11

Table 7: Effect of steel fiber percentages on concrete mechanical properties without HP-Super plasticizer

Mix Type	Compressive strength	Tensile strength	Flexural strength
0.5% Steel fiber	35.92	2.10	4.28
1% steel Fiber	38.30	3.86	7.33
1.5% Steel fiber	39.25	4.34	10.56
2% steel fiber	40.56	4.70	11.49

Table 8: Effect of steel fiber percentages on concrete mechanical properties (with HP-Super plasticizer)

Mix type	Compressive strength	Tensile strength	Flexural strength
Steel fiber 0.5% with optimum HP Superplasticizer(1L/100 Kg cement)	45.34	2.43	5.16
Steel fiber 1% with optimum HP Superplasticizer(1L/100 Kg cement)	47.18	4.24	8.40
Steel fiber 1.5% with optimum HP Superplasticizer(1L/100 Kg cement)	49.05	4.92	12.36
Steel fiber2% with optimum HP Superplasticizer(1L/100cement)	49.90	5.47	13.28

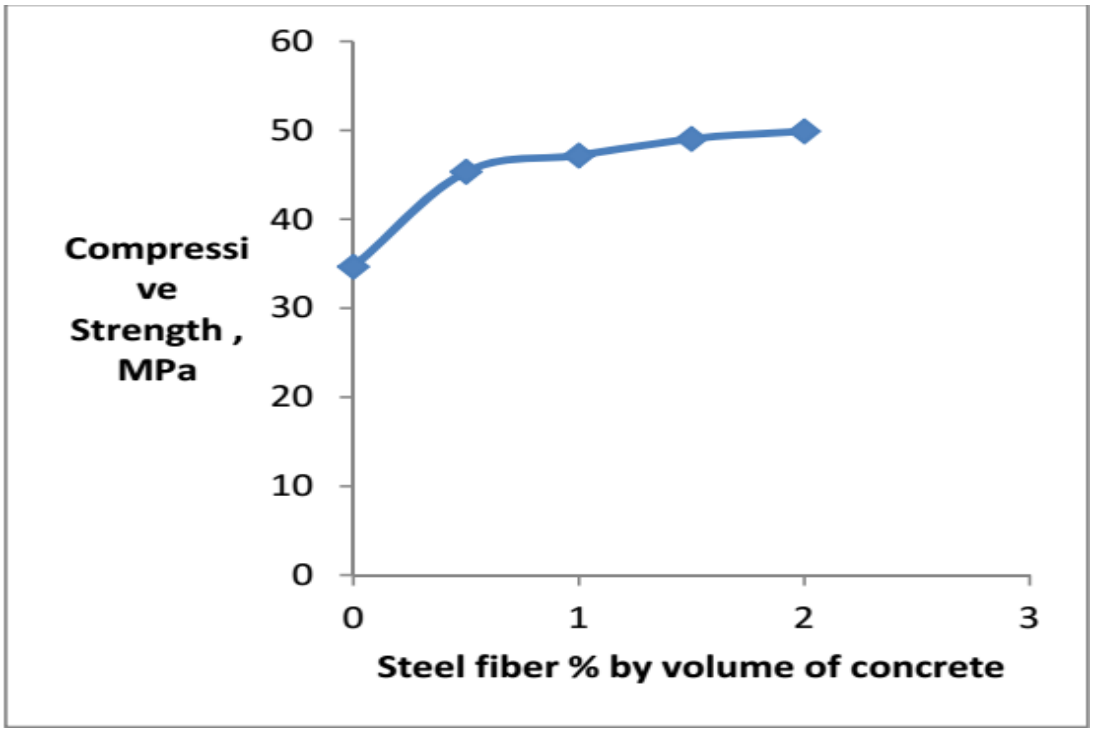

Figure 3: Effect of steel fiber (%) on compressive strength of concrete contain HP-super plasticizer

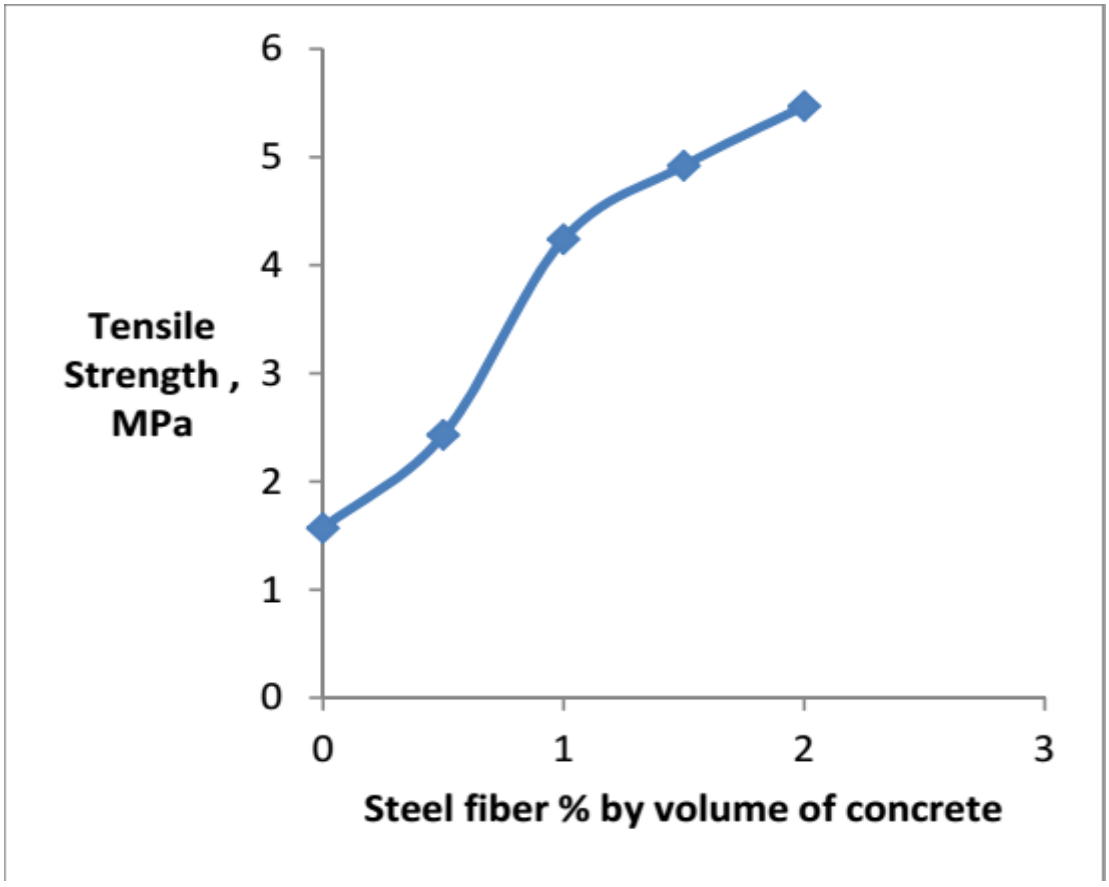

Figure 4: Effect of steel fiber (%) on tensile strength of concrete contain HP-super plasticizer

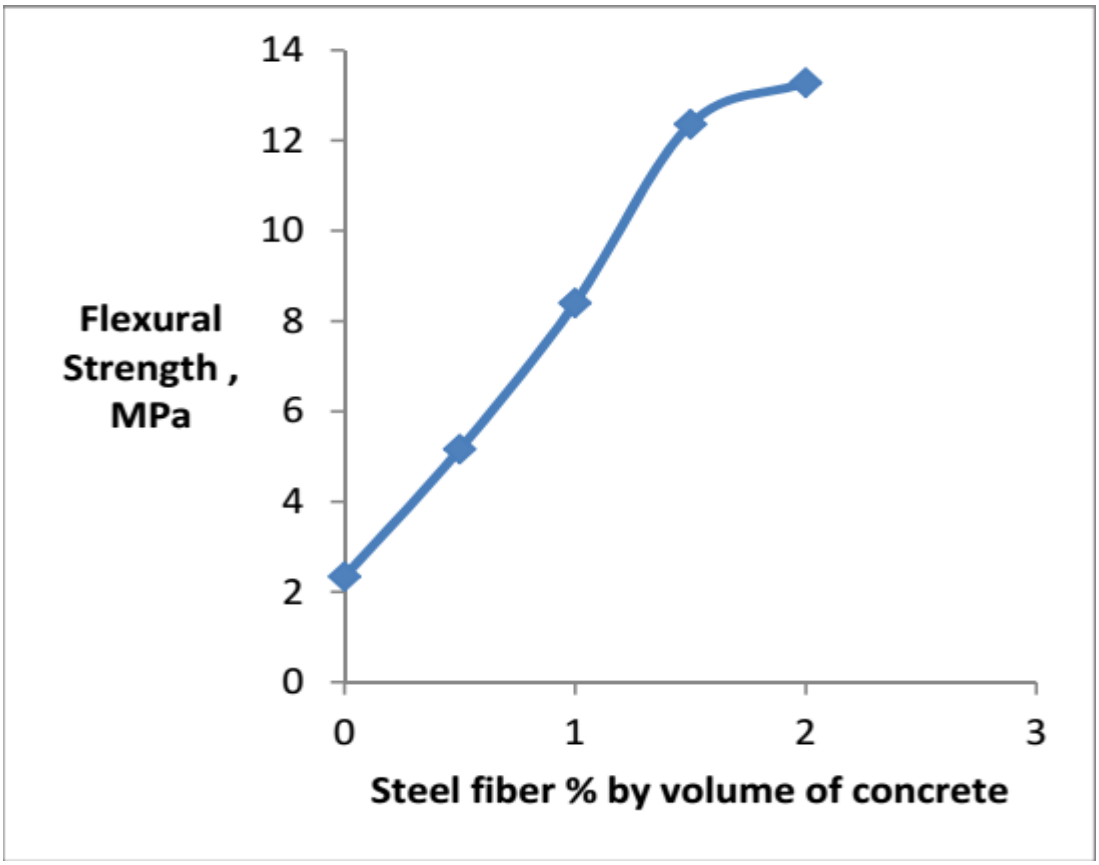

Figure 5: Effect of steel fiber (%) on flexural strength of concrete contain HP-super plasticizer

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