INFLUENCE OF POLYPROPYLENE STRAPPING ROLL FIBERS ON TENSILE STRENGTH OF CONCRETE

Pratik Patel [1], Asst. Prof. Shaishav Viradiya [2]
[1]PG Student, Structural Engineering, Marwadi Education Foundation Group of Institutions
[2]Assistant Professor, Marwadi Education Foundation Group of Institutions

Abstract -This paper approaches the effects on addition of numerous proportions of polypropylene (PP) strapping roll fibers on the split tensile strength and workability of M25 grade concrete. An experimental initiative was accomplished to explore the effect of PP strapping roll fibers on tensile strength of concrete at 7 and 28 days of curing. The main intend of the investigation program is to study the effect of PP strapping roll fibers on concrete by varying aspect ratio of fibers by 10, 20, 30, 40, 50 and also varying fiber content by 0%, 0.5%, 1%, 1.5%, 2% & 2.5% by replacing the total volume of concrete and finding the optimum aspect ratio and fiber content. Concrete specimens were tested for the split cylinder test. This test results exhibit that the optimum aspect ratio for the particular type of fiber was found to be 50 and optimum fiber content 1.5% by total volume of concrete. The influence of such type of fiber was found to drop its workability with subsequent rise in fiber content and its aspect ratio. However, further investigations are highly endorsed and should be carried out to understand more mechanical and durability attributes of PP strapping roll fiber reinforced concrete.

Keywords—Polypropylene Strapping Roll, Fibers, Tensile strength, fiber content, aspect ratio, workability.

I. INTRODUCTION

Concrete by its attribute is robust in compression but is brittle and feeble in tension. Another fundamental frailty of concrete made with Portland cement is that evolution of cracks starts as soon as concrete is placed and before it has befittingly hardened. These cracks are crucial cause of shortcoming in concrete particularly in large onsite applications causing subsequent fracture and failure and also deficiency of durability [1]. The feebleness in tension can be overcome by the use of conventional rod reinforcement and to some extent by the introduction of a sufficient volume of short, discrete, and randomly oriented fibers. In this investigation Polypropylene (PP) strapping roll fibers which are formed from strapping rolls used for carton packaging have been introduced in conventional concrete with M25 grade to increase and perceive its tensile properties.

Figure 1: PP Strapping Roll Fibers

Table 1: Properties of PP strapping roll fibers

Chemical inertness
Density 930 kg/m³
0% water appetite
Tough and flexible
Melting point ranges from 160 to 166 °C
Due to regular atomic arrangement there is very less alteration in its density
Tensile breaking load is 86kg
Elongation at break is 40%

Here the mechanism is that when concrete starts to crack the randomly oriented fibers starts to function and act as a bridge between these cracks and doesn't enable cracks to widen. This way Polypropylene fiber reinforced concrete gives superior results compared to conventional concrete. The below given figure 2 shows how the fibers have started to function on gradual increment of load after the occurrence on first crack.

Figure 2: Ductile behavior of concrete cylinder with PP fibers

II. MATERIALS

The materials used for the concrete mixture consist of the normal portland pozzolana cement confining to IS 1489 (Part 1): 1991 was used with standard consistency 32.5%, fly ash 28%, the gravel and sand having a maximum size and fineness modulus 2.54 cm and 2.9.the type and properties of fibers used here are as discussed above.

III. EXPERIMENTAL PROGRAM

Experimental work was carried out to achieve the objectives of the study. At first by laboratory testing the density for the particular type of fiber was found 930kg/$m^{3.}$ Then after in the experimental work overall 48 cylinders were casted and tested for split cylinder and slump test. In which at first for decision of optimum aspect ratio M25 grade concrete and 1% volume of fibers (by overall volume of concrete) was fixed. But the aspect ratio of fibers was varying from 10, 20, 30, 40, 50 and the specimens were tested after 28 days of curing. The results were compared to conventional concrete. Each batch of concrete was casted with 3 cylinders. The results for fibers with aspect ratio 50 were found to be optimum .Now after decision of optimum aspect ratio of fiber the second step was finding optimum fiber content. Again by keeping the grade of concrete as M25 and aspect ratio of fibers as 50 fiber content had been varied by 0.5%, 1%,1.5%, 2% and 2.5%.Again the specimens were been tested after 7 and 28 days of curing. Results were compared to conventional concrete specimens. Test results showed specimens with 1.5% of fibers to be optimum.

SPLIT TENSILE TEST

The most commonly used tests for estimating the tensile strength of concrete are the split tensile test according to Indian Standard 5816-1999 where a 150 mm x 300 mm concrete cylinder is subjected to compression loads along the two axial lines which are diametrically opposite. The load is applied continuously at a constant rate within the splitting tension stress until the specimen fails. The compressive stress produces a transverse tensile stress, which is uniform along the vertical diameter. Split tensile strength of concrete cylinder is measured in N/mm2.The split tensile strength of the cylinder specimen is calculated using the following formula:

$$\text{Split Tensile Strength} = \frac{2P}{\pi dL}$$

Split tensile strength fsp = N/mm^2 Where,

P = Load at failure in N
L = Length of the Specimen in mm (300 mm)
d = Diameter of the Specimen in mm (150mm)

Figure 3: Split Tensile Test

SLUMP TEST

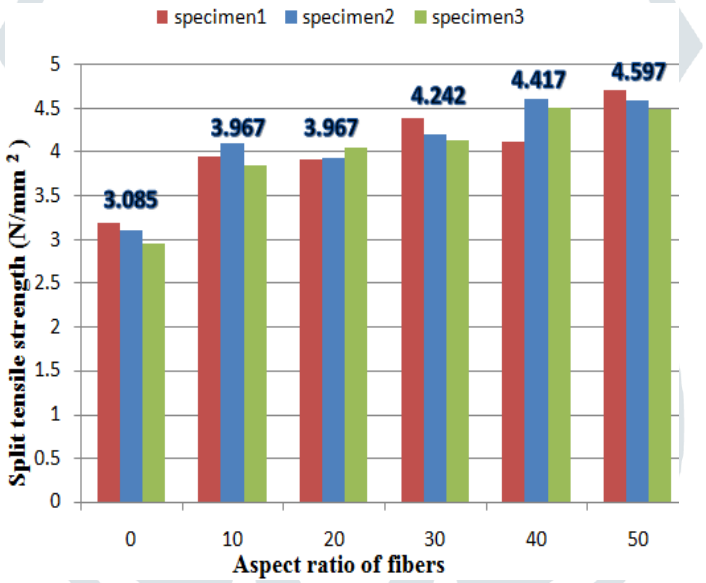
Slump test is used for determining workability of fresh concrete. Workability may be explained as the easy with which concrete is workable that is transported, placed and compacted. It mainly depends on its materials, mix proportion and environmental condition. In this research work workability of fresh concrete was determined according to IS 1199:1959 [12].

IV. RESULTS AND DISCUSSIONS

In graph 1 the average results for 3 specimens for split tensile strength of different aspect ratio is shown as discussed earlier. It is observed that the specimens with aspect ratio 50 gives the optimum results that is 4.597 N/mm^2 at 28 days of curing keeping 1% fiber content and concrete grade M25.

Table 2: Test results for Optimum Aspect Ratio

Aspect Ratio of Fibers	Tensile strength of specimen no 1 (N/mm^2)	Tensile strength of specimen no 2 (N/mm^2)	Tensile strength of specimen no 3 (N/mm^2)	Average Results (N/mm^2)
0	3.200	3.105	2.950	3.085
10	3.953	4.100	3.850	3.967
20	3.918	3.935	4.050	3.967
30	4.390	4.203	4.133	4.242
40	4.125	4.612	4.515	4.417
50	4.705	4.603	4.485	4.597

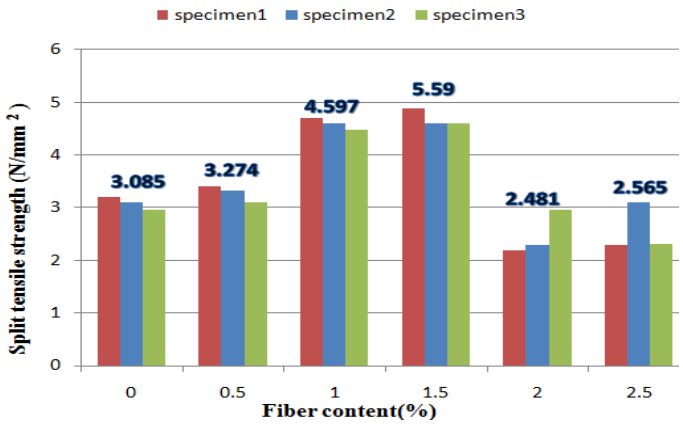


Graph 1: Test results for optimum aspect ratio

After decision of optimum aspect ratio as discussed earlier average results for 3 specimens for split tensile strength of different fiber content are show in graph 2 and 3 where it is observed that the value of specimens with fiber content of 1.5% gives the optimum result at 7 and 28 days of curing for M25 grade concrete and aspect ratio 50.

Table 3: Test results for Optimum Fiber Content at 28 days curing

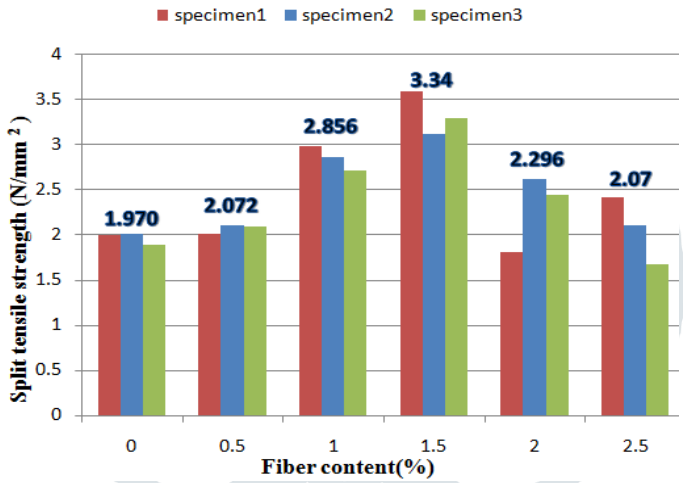
Fiber Content (%)	Tensile strength of specimen no 1 (N/mm^2)	Tensile strength of specimen no 2 (N/mm^2)	Tensile strength of specimen no 3 (N/mm^2)	Average Results (N/mm^2)
0	3.200	3.105	2.950	3.085
0.5	3.401	3.319	3.103	3.274
1	4.705	4.603	4.485	4.597
1.5	4.895	4.596	4.608	5.590
2	2.192	2.295	2.956	2.481
2.5	2.282	3.105	2.310	2.565



Graph 2: Test results for optimum fiber content at 28 days curing

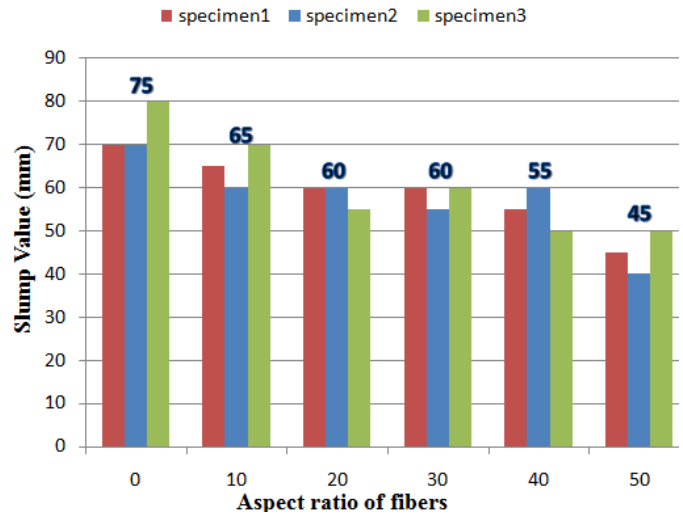
Table 4: Test results for Optimum Fiber Content at 7 days curing

Fiber Content (%)	Tensile strength of specimen no 1 (N/mm^2)	Tensile strength of specimen no 2 (N/mm^2)	Tensile strength of specimen no 3 (N/mm^2)	Average Results (N/mm^2)
0	2.005	2.011	1.895	3.085
0.5	2.007	2.11	2.101	3.274
1	2.988	2.859	2.721	4.597
1.5	3.6	3.125	3.295	5.590
2	1.812	2.625	2.451	2.481
2.5	2.421	2.109	1.68	2.565

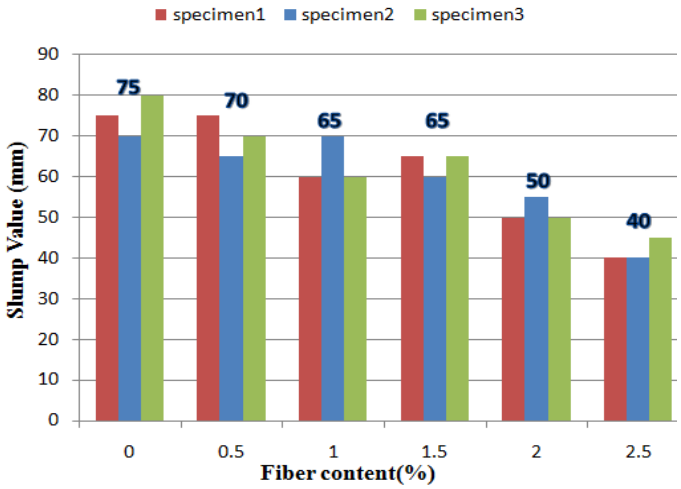


Graph 3: Test results for optimum fiber content at 7 days curing

Now for slump test an average of three slump specimens were taken. The proportions and mix design was kept similar as taken in split cylinder test and the results are shown accordingly as explained graph 4 and 5.It is observed that increase in aspect ratio and fiber content simultaneously decreases its workability.



Graph 4: Average slump values for different aspect ratio



Graph 5: Average slump values for different fiber contents

V. CONCLUSION

In summary the following points were concluded from this study:

1. The tensile strength of concrete with PP strapping roll fibers yields better result compared to conventional concrete.
2. Optimum aspect ratio and fiber content for the split tensile strength found were 50 and 1.5% at 7 and 28 days of curing by total volume of concrete.
3. Using this type of fibers in concrete not only enhances its tensile properties but also solves disposal problem of PP up to some extent if its scrap is used.
4. Increasing aspect ratio and fiber content gradually decreases workability of concrete.

VI. ACKNOWLEDGMENTS

The authors gratefully acknowledge Marwadi Education Foundation Group of Institutions for supporting and facilitating this research work.

VII. REFERENCE

[1] Ahmed, Saeed, et al. "A study on properties of polypropylene fiber reinforced concrete." 31st conference on our world in concrete & structures, Singapore. 2006.

[2] Mohod, Milind V. "Performance of Polypropylene Fibre Reinforced Concrete." IOSR-JMCE) e-ISSN: 2278-1684.

[3] Kolli.Ramujee. "Strength properties of polypropylene fiber reinforced concrete." International Journal of Innovative Research in Science, Engineering and Technology 2.8 (2013): ISSN: 2319-8753

[4] Kakooei, Saeid, et al. "The effects of polypropylene fibers on the properties of reinforced concrete structures." Construction and Building Materials 27.1 (2012): 73-77.

[5] Hsie, Machine, Chijen Tu, and P. S. Song. "Mechanical properties of polypropylene hybrid fiber-reinforced concrete." Materials Science and Engineering: A 494.1 (2008): 153-157.

[6] Yao, Wu, Jie Li, and Keru Wu. "Mechanical properties of hybrid fiber-reinforced concrete at low fiber volume fraction." Cement and concrete research 33.1 (2003): 27-30.

[7] Song, P. S., S. Hwang, and B. C. Sheu. "Strength properties of nylon-and polypropylene-fiber-reinforced concretes." Cement and Concrete Research 35.8 (2005): 1546-1550.

[8] Soroushian, Parviz, et al. "Mixed-mode fracture properties of concrete reinforced with low volume fractions of steel and polypropylene fibers." Cement and Concrete Composites 20.1 (1998): 67-78.

[9] Yao, Wu, Jie Li, and Keru Wu. "Mechanical properties of hybrid fiber-reinforced concrete at low fiber volume fraction." Cement and concrete research 33.1 (2003): 27-30.

[10] Zeiml, Matthias, et al. "How do polypropylene fibers improve the spalling behavior of in-situ concrete?." Cement and concrete research 36.5 (2006): 929-942.

[11] IS 5816:1999 “Splitting tensile strength of concrete – method of test”.

[12] IS 1999:1959 “Methods of sampling and analysis of concrete”.