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FIBER REINFORCED CONCRETE BY USING CARPET INDUSTERIAL WASTE

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ABSTRACT

The carpet industry consumes million tons of fibers annually and about 70% of the carpet produced is for replacement. The replacement carpets are treated a waste and useless material. Now we are tired to fiber in fiber reinforced concrete (FRC). A carpet fiber is used as reinforcement in concrete to improve their properties. Besides performance enhancement, the use of recycled fiber for concrete offers additional benefits such as low cost raw materials, resource utilization, and reduced needs for land fillings. Compressive and flexural tests for strength and toughness were conducted, and significant increase in shatter resistance, energy absorption, and ductility were observed with a fiber volume fraction range 0.5%-2%. The project also discusses the general advantages of fiber reinforcement and reviews some studies on the use of carpet waste fibers for concrete. However the addition of carpet fiber leads to enhance the split tensile strength, flexural strength and reducing crack size and a smoother mode of failure, unlike the brittle failure behavior of plain concrete.

INTRODUCTION

Concrete is weak in tension and has a brittle character. The concept of using fibers to improve the characteristics of construction materials is very old. Early applications include addition of straw to mud bricks horse hair to reinforce plaster and asbestos to reinforce pottery. Use of continuous reinforcement in concrete increases strength and ductility, but requires careful placement and labor skill. Alternatively, introduction of fibers in discrete in from in plain or reinforced concrete may provide a better solution. Concrete is durable, inexpensive, readily molded into complicated shapes, and has adequate compressive strength and stiffness. However, tensile strength, low ductility, and low energy absorption. Due to its lack of tensile strength, concrete is often reinforced with steel reinforcing bars structural applications. However, steel re-bar corrosion has contributed to the decay of reinforced concrete structures. Fiber reinforced concrete is often made by adding a small fraction of short fibers to the concrete mix during mixing. After extensive studies in the last three decades, it is now beyond doubt that such fiber reinforcement can significantly improve tensile properties of the concrete. Orders of magnitude increases in toughness over plain cement are commonly observed. Fiber reinforcement can also improve the fatigue strength and reduce the drying shrinkage of concrete.

This project reports on an experimental program to evaluate the effectiveness of using recycled fiber from carpet waste for concrete reinforcement. The results suggest that using such recycled fiber in highway construction would not only improve the reliability and life of the highways, it but also could reduce the land fill spaces needed to

dispose the waste material. The different types of fibers which are used in concrete are steel fibers, glass fibers, natural fibers, synthetic fibers (carbon and polypropylene), recycled fibers (carpet fibers, soft drink can fibers and steel fibers from the tire). Most of the fibrous waste is composed of natural and synthetic polymeric materials such as cotton, wool, silk, polyester, nylon, polypropylene, etc. These fibers are consumed and discarded in large quantities. Industrial waste refers to that generated in the manufacturing process of fiber products. The carpet industry is one of them which produced a large amount of waste materials and major part of these waste materials is fiber. These fibers are mainly 50%-70% nylon and 15%-25% polypropylene

A brief review is provided in this article on the advantages of fiber reinforcement of concrete and soil. Laboratory and field studies using carpet waste fibers for concrete and soil reinforcement are described. The carpet waste generated each year and accumulated in landfills represents an abundance of useful resources, as it may be converted into various useful products the rate of carpet disposal is about 2-3 million tons per year in the U.S. and about 4-6 million tons per year worldwide. A carpet typically consists of two layers of backing (usually fabrics from polypropylene tape yarns), joined by $CaCO_3$ filled styrene-butadiene latex rubber (SBR), and face fibers (majority being nylon 6 and nylon 66 textured yarns) tufted into the primary backing. To use post-consumer carpet as concrete or soil reinforcement, the carpet is shredded to recover fibers. It is generally not necessary to disassemble yarns in the carpet into individual fibers. The size-reduction process yields the following from post-consumer carpet:

- Discontinuous face yarns, which are fiber bundles with a low twist,
- Individual fibers from face yarn and backing fabrics,
- Powder-like substances from filled latex adhesive and soil trapped in the used carpet

In the size-reduction process, some adhesive is removed and some still remains on the fibers. For both concrete and soil reinforcement, it is not necessary to completely remove the adhesive, avoiding the process of cleaning and separation. Therefore carpet can be converted to fibers at very low cost for concrete and soil reinforcement.

EXPERIMENTAL PROGRAM

2.1 MATERIALS

2.1.1. Cement: Ordinary Portland land cement is used in this experiment .the properties of cement are as follows:

Table 1: properties of cement

property	Specific gravity	fineness	Initial setting time	Final setting time	Standard consistency	Compressive strength
value	3.00	97.80	1hr min	9hr 30 min	30.00%	54.28N/mm^2

2.1.2 Fine aggregate:

Clean river sand is used as fine aggregate. The specific gravity and fineness modulus were found to be 2.652.54 respectively. The properties are tested as per IS 383:1970.

2.1.3 Coarse aggregate:

Machine crushed granite obtained from a local quarry was used as coarse aggregate. Its properties are tested as per tested as per IS 383:1970 and are given in table.2

Table 2: properties of coarse aggregate

property	Specific gravity	Fineness modulus	Impact value	Water absorption
value	2.7	97.80	33.46	1.52

2.1.4 Carpet fibers

The fiber as mentioned before is the product cutting carpets in industries either from back or face yarns of carpet during the mixing process. It consists typically of two yarns. The face yarn is most usually made of either polypropylene or nylon and most of industrial wastes are of these materials. The back they held together by adhesives with $CaCo_3$ as filler. In the present study, polypropylene carpet fiber was collected from hardware shops in villupuram. The fiber was according the standard codes of practice. The fiber were 0.45mm in diameter and the optimum length of 50mm used in this study carried out by conducting a trail test.

LABORATORY WORK AND TEST PROCEDURE

The manufactures of concrete were specimens and all the tests on the fiber and concrete were carried out in the structure and materials laboratory of the faculty of civil engineering IFET COLLEGE OF ENGINEERING Villupuram. Ordinary Portland cement was used in through the experimental program. Natural and crushed granite of 10mm size were used as fine and coarse aggregate respectively. Plain concrete was made to have a target mean strength of 30 MPa at 28 days with 30- 60mm slump. In this study, cylindrical specimens 150mm diameter and 300 mm length, cube specimens (150 mm x150 mm x 150 mm) and prism specimens (150mm x 150mm x 700mm) were prepared for splitting tensile strength, compressive strength and flexural strength respectively.

Concrete containing carpet fibers were prepared in the same way as plain concrete and fiber volume fraction of 0.5%, 1% and 2% without any additional admixtures. Carpet fiber was added to the concrete mixture uniformly throughout the mixing period. After casting, the specimens were de-molded at 24 hours and then put into the water tank for curing until testing. Compressive, splitting tensile and flexural strength tests at the ages of 7, 28 days were conducted

3. TEST RESULTS AND DISCUSSION

3.1 Fresh Properties

Workability is a property of concrete which investigate at fresh stage. Slump and density tests were carried out on the fresh concrete containing carpet fiber and plain concrete. It is important to note that slump value significantly reduced by adding carpet fiber into the concrete mix. For example, the slump value of plain concrete was obtained at 55 mm. A slightly lower value of 40 mm was measured for 0.5% of the carpet fiber content. The addition of more fiber content reduced the slump value up to 10 mm for 2% carpet fiber. The wet density of concrete was also reduced by the addition of carpet fiber. This is to be expected, because of the low density of carpet fibers (945 kg/m3) as compared to the OPC.

Table -3: Test results for plain and carpet fiber reinforced concrete

Type of concrete	Slump value	Compressive strength		Splitting tensile strength (MPa)		Flexural strength (MPa)	
		7 days	28 days	7 days	28 days	7 days	28 days
PC	51	21	31	3.75	4.10	2.2	2.7
FRC 0.5%	42	23.2	32.2	4.87	5.15	2.6	3
FRC 1.0%	23	24.8	37.1	5.15	5.35	2.8	3.1
FRC 1.5%	10	27.6	39	5.2	5.5	2.9	3.3
FRC 2.0%	7	29.8	42.5	5.35	6.25	3	3.5

Fig -1: Slump values vs fiber volume fraction

3.2 Mechanical Properties

Mechanical properties obtained from compressive, splitting tensile and flexural strength tests at the age of 1, 7 and 28 days are presented in the table-3. The result displayed in the table 3, show that the compressive strength of concrete containing carpet fibers decreases with the addition and increasing the fiber volume fraction. The compressive strength decreases 8% for 0.5% carpet fiber content and about 45% for 2% carpet fiber content when compared to plain concrete. Figure 6 reveals the effect of fiber content on compressive strength of concrete. A similar trend has been reported by Vilkner, et al. Who observed, the lower value in a slump and compressive strength containing carpet fibers compared to the plain concrete. It can be seen from the data presented in table 3 that after adding the carpet fiber, concrete splitting tensile strength is obviously better than the plain concrete at all ages and fiber volume fractions. Compared the concrete containing carpet fiber with the plain concrete, when the volume of fiber was 0.5%, the splitting tensile strength increased by about 14.7% and the splitting tensile strength was increased by about 30.4% for 1.5% carpet fiber. According to the data collected from this study, it is observed that the addition of carpet volume fraction improves the splitting tensile strength of concrete. The effects of the carpet fiber on the splitting tensile strength of concrete is clearly shown in the figure 2.

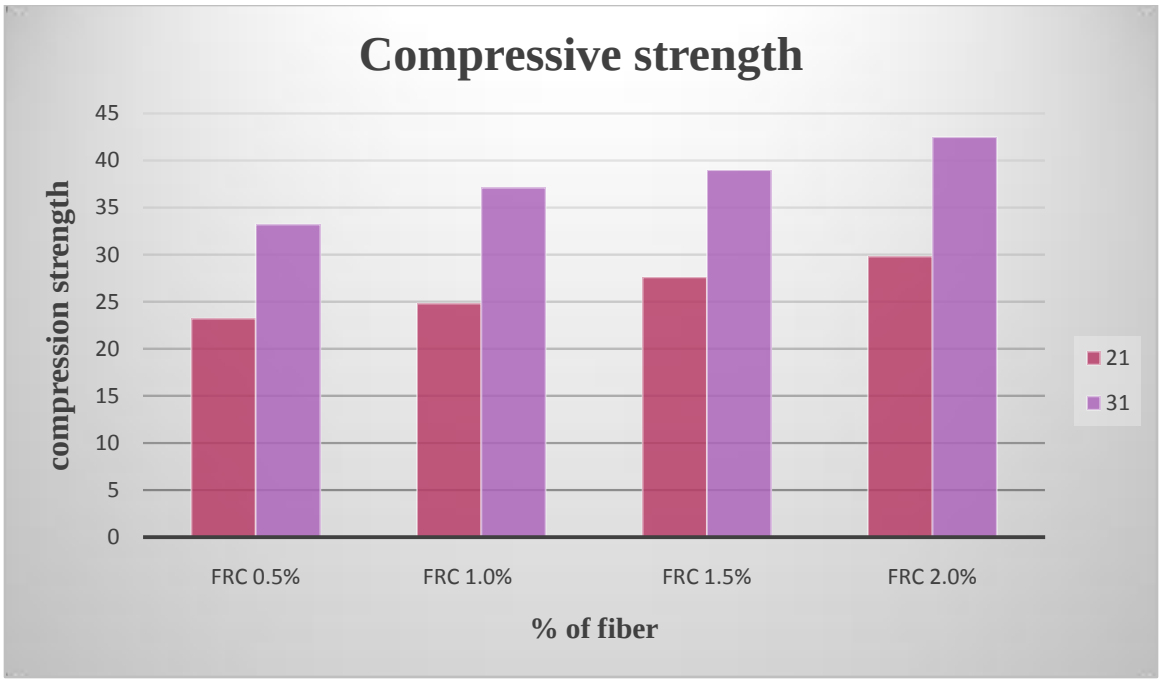

Fig -2: compressive strength vs concrete age

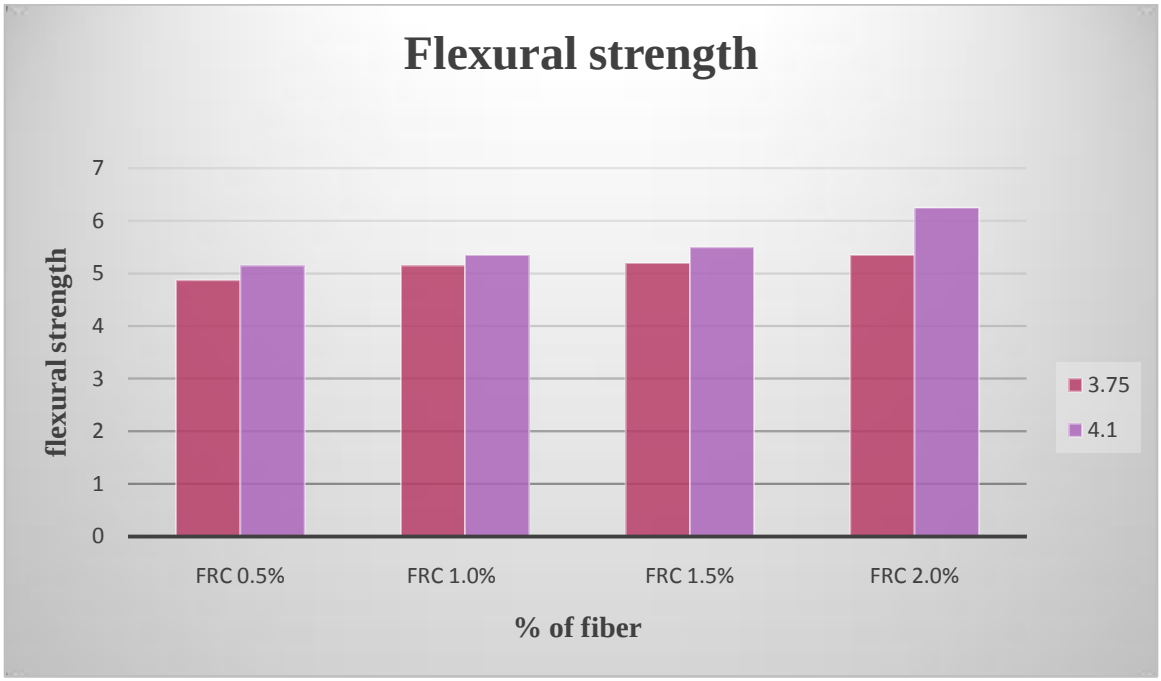

Fig -3: flexural strength vs age of concrete

Split tensile strength

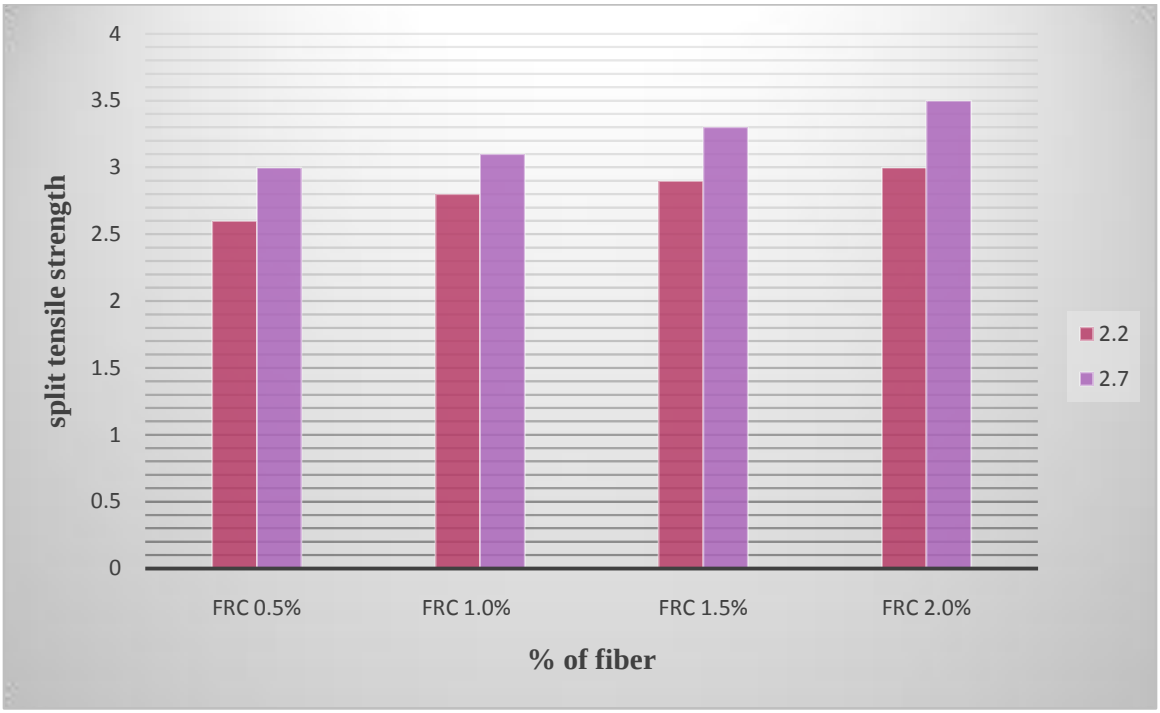

Fig -4: split tensile strength vs age of concrete

The results presented in table-3 show that the flexural strength of concrete containing 0.5% carpet fibers at age 28 days increased by about 18.5% and 1.71% for 1% fiber. Further increase in the fiber content however, reduced the flexural strength. During the flexural strength test it has been observed that, by adding and increasing fiber volume fraction the mode of failure was smoother and the size of cracks was reduced. This is to be expected, due to bridging action provided by fibers which absorbed more energy and prevent the sudden failure of the specimen. Similar results have been reported by Marciano, who observed a lower value in flexural strength in concrete with textile fibers than in the plain concrete.

CONCLUSIONS

Fiber reinforced concrete using carpet fiber has been studied, and found to be effective in improving the mechanical properties of concrete. The use of industrial waste carpet fiber offers the additional advantages of waste reduction and resource conservation. This paper reports experimental results on fresh and hardened properties such as workability and density and compressive, splitting tensile and flexural strength of concrete incorporating carpet fiber. Laboratory test data revealed that the workability and density were reduced with

function of fiber volume fraction and compressive strength of concrete. Containing carpet fiber was somewhat lower than that of plain concrete. Concrete with carpet fiber like concrete made with other fibers, significantly increased in the splitting tensile and also flexural strength. The bridging action of carpet fibers caused smoother mode of failure and also reduced the size of cracks during bending load.

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