INVESTIGATION FOR COMPRESSIVE STRENGTH OF STEEL-POLYPROPYLENE FIBER FOR PAVEMENT CONSTRUCTION

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Abstract: In this study, I have examined that the mechanical properties of concrete can be made better by the inclusion of a single type of fiber, but it is not so effective. The incorporating hybrid fiber of two fibers into concrete can lead to improvements and representation of their benefits. Here three types of fiber were examined: hooked-end steel fiber, crimped-end steel fiber and crimped polypropylene fiber. This paper presents compressive strength properties of steel-polypropylene fiber reinforced concrete compared to hybrid reinforced concrete and plain concrete. All these results were performed on normal concrete along with steel-fiber concrete, polypropylene concrete and hybrid concrete in 7 and 28 days by the universal testing machine. Various volume percentages of fibers are added i.e. steel (0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1.0%) and polypropylene (0.1%, 0.2%, 0.3%, 0.4%, 0.5%). From the investigation, it was found that steel and polypropylene (0.8% & 0.2%) gave the best result for all the three fibers used and out of the hooked-end and crimped-end steel fiber, hooked-end gave more compressive strength and it was also effective, so hooked-end steel fiber was used for hybrid reinforced fiber content. For the hybrid reinforced fiber content, same volume percentages were prepared for hooked steel and polypropylene (0.5%-0.5%), (0.6%-0.4%), (0.7%-0.3%), (0.8%-0.2%), (0.9%-0.1%), (1.0%-0.0%). Here, also the (0.8%-0.2%) of steel-polypropylene gave the highest compressive strength from all the volume percentages which is 59.65MPa.

Keywords - Concrete, Steel Fiber, Polypropylene Fiber, Hybrid Fibers, Fiber Reinforced Concrete, Compressive strength

I. INTRODUCTION

Concrete is a composite construction material which is mainly made of aggregate, cement and water. Concrete is hard and strong like stone, it is due to a chemical reaction between water and cement. The benefit of concrete is its most multipurpose use in the construction field. Concrete is the material that can be molded in some shapes and well-formed regular rectangular or circular structures such as dome or hemisphere. There are some special features of concrete made from Portland cement. Concrete is relatively strong in compression but weak in tension and becomes brittle. These two weaknesses have limited their use. Another basic weakness of concrete is that the cracks begin to form as soon as the concrete is placed before it is properly rigid. These cracks weaken the concrete, which is a major cause, especially in large onsite applications where there is a general lack of fracture, failure and stability. Use of traditional rod reinforcement and some quantity of fiber in adequate quantity can reduce the weakness of stress in some areas.

Fiber-reinforcement is mainly used for crack control and not for structural strengthening. Although the concept of strengthening brittle substances with fibers is quite old. Recent interest in strengthening cement-based materials with randomly distributed fibers based on the research that began in the 1960s. Since then, there have been substantial research and development activities around the world. It has been established that in addition to randomly distributed polypropylene fiber, plastic cracking has reduced and steel fibers increase their fracture toughness, flexibility and impact resistance. Since fiber can be traditionally premiered, the concept of polypropylene fiber concrete has added an additional dimension to concrete construction.

There is hardly any type of fiber that can improve all the desirable qualities of fresh and hardened concrete. In order to improve all the properties of concrete, a combination of two or more types of fiber is required and it is known as "hybrid fiber reinforced concrete". The basic purpose of using hybrid fiber is to increase the properties of concrete by mixing the benefits of concrete and controlling the crack at different size levels in different areas of concrete, which can provide each type of fiber. In this project, an experimental study will be conducted on the compressive behavior of hybrid-reinforced concrete using two fibers steel and polypropylene.

II. MATERIALS

Steel Fiber

Since the early 1900s, steel fiber is used in concrete. Steel fiber is a composite material that we can spray. It has a hydraulic cement with steel fibers which is randomly spaced and possesses a rectangular cross-section. Steel fiber is especially used to improve the properties of mechanical concrete, such as post-cracking tensile resistance. In addition, it has recently been used in short-term concrete slabs as an alternative engineering material rather than steel bars/steel strips. The construction of steel fiber is more economical than conventional construction. Besides the cost reduction, the SFRC has other beneficial properties such as high hardness, high flexibility, lightweight, low repair costs, and better post-cracking.

Steel fiber is used in steel-fiber reinforced applications, including highway pavement, airport runway, construction of industrial floors, refractory concrete, bridge deck, overlays, spillways, dams, slope stabilizations, and shotcrete tunnel lining by spraying fiber-reinforced concrete. Its potential improvement is to reduce the breakdown due to temperature, increase the hardness, resist effectiveness, friction, destroy and reduce fatigue In addition, steel fiber significantly reduces the strength of reinforced concrete fracture and spalling.

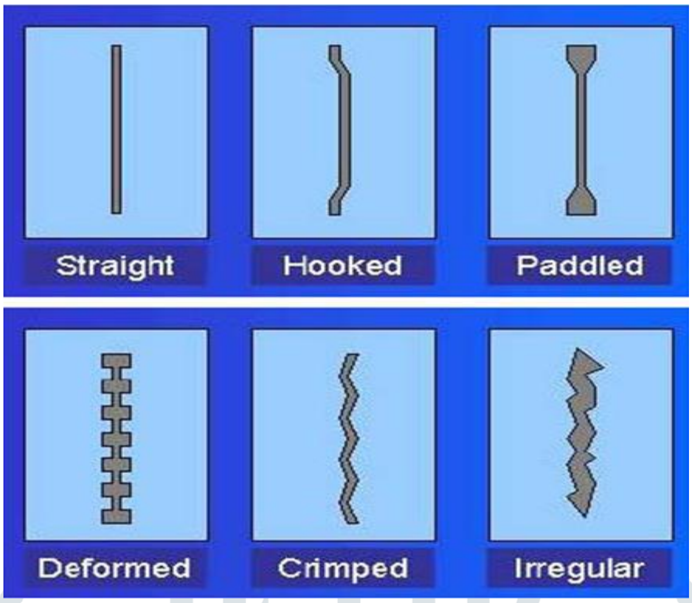


Fig. 1 Steel fiber shapes

Polypropylene

Polypropylene fiber was first used in the 1960s to strengthen concrete. In 1965, it was first suggested as a mixture of concrete for the US Corps Engineers for the construction of blast-resisted buildings. Fibre has been improved later and in the present, it is used as a brief dismantling material for the production of fiber concrete or a continuous mat of thin sheet components. These fibers have increased greatly in the construction of structures as in addition to these fibers in concrete, it improves toughness, flexural strength, tensile strength, and impact strength, and also improves concrete failure mode. Polypropylene twine is affordable, abundant and available in all man-made fiber of continuous quality

Fig. 2 Polypropylene Fiber

Polypropylene is a synthetic hydrocarbon polymer, whose fiber is made using hot-drawing material through a die by extrusion processes Polypropylene fibers are produced as continuous mono-filament circular cross-sections which are produced as required length or fibrillated films or tapes of rectangular cross-sections. Polypropylene fibers can increase concrete durability against fire, cold and chemical attacks. Its melting point is high (about 165 degrees centigrade). So that it can withstand a working temp, as (100 degree centigrade) for short periods without detriment to fiber properties. These fibers are specially used for concrete and mortar as a solid reinforcement system. They have very high tensile strength, but the lower modulus of their elasticity and high elongation do not contribute to flexible strength. These fibers are spread evenly in concrete, thus reducing plastic shrinkage and disposal cracks. They reduce permeability, increase the resistance of impact, friction and freeze/thaw. They reduce the corrosion of reinforcement, honeycombing, and segregation. Due to its benefits, polypropylene fiber reinforced concrete (PPFR) is used in pile foundations, holes, highways, industrial floors, bridge ornamentation, and others.

III. Experimental work

Table 1: Compressive strength of Plain Concrete

Sr. No.	DAYS	Plain concrete	
		Obtained Value	Minimum Value
1.	7 days	37.30	27.00
2.	28 days	48.50	40.00

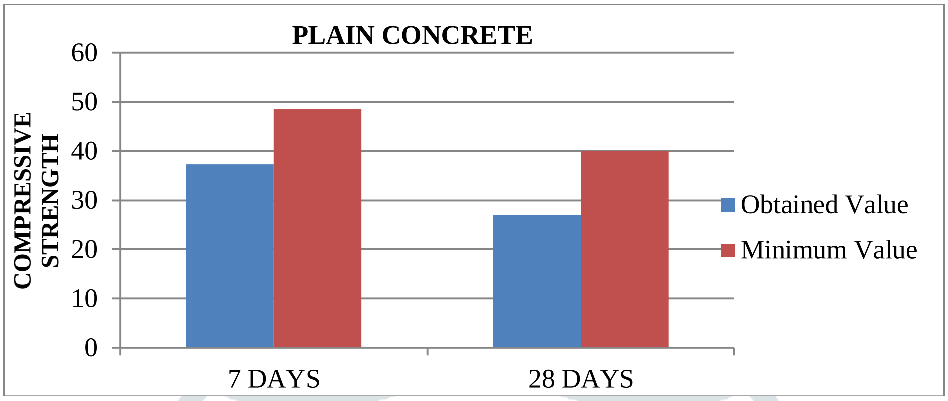


Table 2: Compressive strength of Polypropylene

Sr. No	Polypropylene Mix	Average Compressive Strength, MPa	
		7 days	28 days
1.	0.0%	37.30	48.50
2.	0.1%	34.63	42.14
3.	**0.2%**	**37.43**	**49.76**
4.	0.3%	36.32	47.83
5.	0.4%	34.16	46.30
6.	0.5%	32.93	42.90

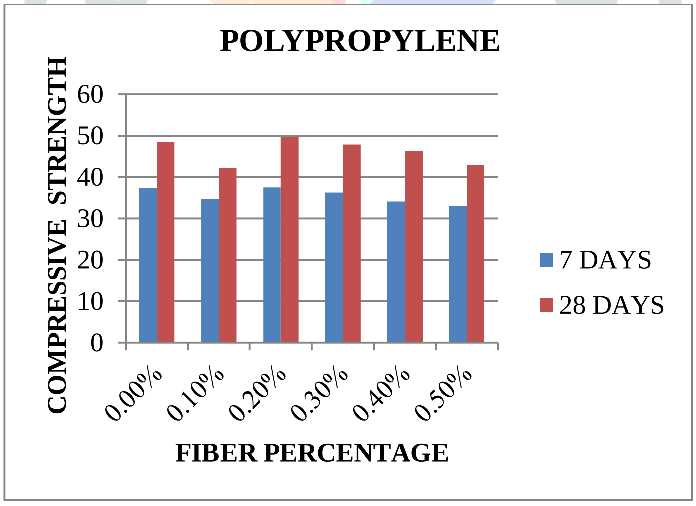
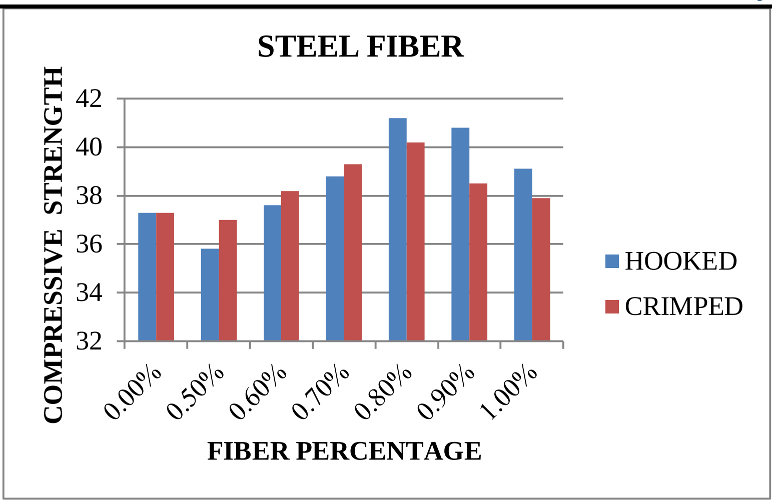


Table 3: Compressive strength of Steel

Sr. No.	Steel Mix	Compressive strength, MPa at 7 days	
		Hooked	Crimped
1.	0.0%	37.30	37.30
2.	0.5%	35.80	37.00
3.	0.6%	37.60	38.20
4.	0.7%	38.80	39.30
5.	**0.8%**	**41.20**	**40.20**
6.	0.9%	40.80	38.50
7.	1.0%	39.10	37.90



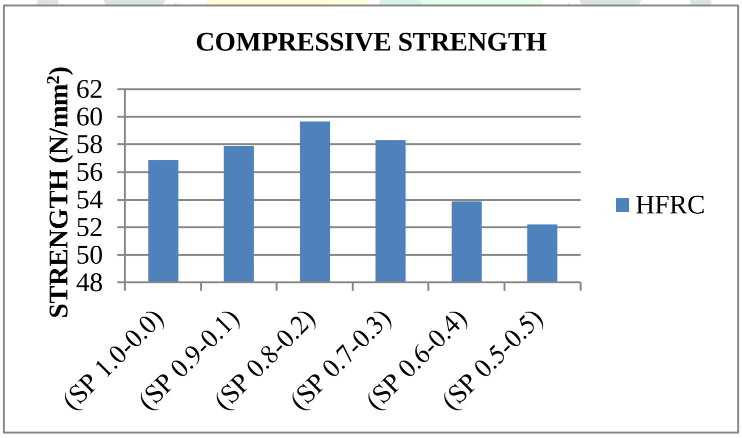
IV. RESULT AND DISCUSSION

Compressive strength test for HFRC:-

As from the above results, it was concluded that both the steel and polypropylene fibers have a higher compressive at 0.8% and 0.2% respectively. And now I have described the result by mixing steel and polypropylene. For the compressive strength test, both cubes of 150x150x150 mm dimensions were casted for concrete of M40 grade. The moulds were filled with 0% HFRC, Steel-Polypropylene (SP) (0.5%-0.5%), SP (0.6%-0.4%), SP (0.7%-0.3%), SP (0.8%-0.2%), SP (0.9%-0.1%), SP (1.0%-0.0%) fibers. The mould was vibrated using a vibrator. After 24 hours the samples were demolished and were transferred to the curing tank for curing. After 28 days, the wetted cubes were tested on compression testing machines and the cubes which are failed in the load test should be noted.

Table 4: Compressive strength of HFRC

Sr. No.	Specimen	Compressive Strength(N/mm2)
1.	Cube for HFRC (SP 1.0-0.0)	56.90
2.	Cube for HFRC (SP 0.9-0.1)	57.90
3.	**Cube for HFRC(SP 0.8-0.2)**	**59.65**
4.	Cube for HFRC (SP 0.7-0.3)	58.30
5.	Cube for HFRC (SP 0.6-0.4)	53.87
6.	Cube for HFRC (SP 0.5-0.5)	52.20



CONCLUSION

Based on the experimental investigation carried out, the following conclusions are made:

1. Maximum compressive strength of SFRC at Hooked steel is 41.20Mpa achieved at 0.8% adding of concrete by steel fibers (M40 grade) at 7 days. When compared to normal standard concrete 27Mpa, it increases by 52%

2. Maximum compressive strength of PPRC is 49.76Mpa achieved at 0.20% adding of concrete by polypropylene fibers (M40 grade) at 28 days. When compared to normal standard concrete 40Mpa, it increases by 24.4%

3. Compressive strength of HFRC is 59.65Mpa is achieved at (0.8%Steel & 0.2% Polypropylene) adding of concrete (M40 grade) when compared to normal concrete it increases by 49%. when compared to SFRC it increases by 45% at 7 days when compared to PPRC it increases by 20%

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