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Application of Polypropylene Fibre as a Reinforced Concrete

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Abstract:- **The Polypropylene fibre reinforced concrete (PPFRC) contains very short discrete Polypropylene fibres which act as an internal reinforcement so as to enhance the properties of the concrete. Addition of discrete fibres into a cement mix reduces the cracking in elastic range, increases tensile strength, deformation capacity and toughness of the composite. These properties of PPFRC primarily depend upon length and volume of propylene fibres (PPF) used in the concrete mixture. In India the polypropylene fibre reinforced concrete has limited applications in several structures. The applications are mainly to inhibit the cracking. However due to the lack of awareness, proper design guidelines specifications, its uses are very limited. Therefore there is a need to upgrade information on the properties of Polypropylene Fibre Reinforced Concrete (PPFRC). For the study, polypropylene fibres of lengths 6 mm with 0.1 %, 0.2%, 0.5 %, 1%, 1.25%, 1.5% and 2% volume fractions are used. The result reported includes an experimental investigation for measurement of workability of PPFRC using standard test method and a selected mechanical property of PPFRC to study the effect of volume fraction of (PPF) for predicting PPFRC in compression.**

Keyword: PFRC, conventional concrete, workability, slump test, compressive strength

1. INTRODUCTION

Polypropylene is a synthetic hydrocarbon polymer material. Currently polypropylene is the widely used for paving applications. Polypropylene has a melting point of 1650 C and can withstand temperatures of over 1000 C for short periods of time before softening. Monofilament fibres were the first type of polypropylene fibre introduced as an additive in PFRC. Polypropylene fibres are hydrophobic. Therefore, when placed in a concrete matrix they need to be mixed for a longer time so to insure proper dispersion of fibre in the concrete mixture. As far as possible the mixing time of fibres should be kept to a minimum so as to avoid possible shredding of the fibres. The majority of the PFRC is used for paving operations in residential and commercial driveways, for parking lots construction. Polypropylene fibres act to absorb energy. So when the volume of fibres increase, the amount of compactive energy required in achieving a desired consolidation will also increase. Polypropylene fibres are much easier to handle than steel fibres. The light weight and ease of handling help to reduce the costs involved in adding the fibres to the concrete mixture.

II. EXPERIMENTAL DETAILS

To test the suitability of PRFC for construction of pavements, the general tests for cement, sand and aggregates must be performed. The experiment mainly focuses on testing and finding the compressive strength of the concrete containing different percentages of fibers and also to check whether it is better than conventional concrete in terms of compressive strength.

The grade of concrete used is M20. In the experiment a total of 32 cubes have been casted, out of which 4 are of conventional blocks and remaining 28 cubes contain fibres of

0.1%, 0.2%, 0.5%, 1%, 1.25%, 1.5% and 2% of 4 cubes of each percentage of fibre. The strengths of the cubes are measured after 7 days and 28 days of curing. The fibre used in the experiment is Aqua polyfibers (virgin PP fibers) from Aquatek™ Conchem. A proper mix design is carried out to find the amount of cement, sand and aggregate to be used in the experiment. The following tables show the amount of materials and the percentage of fiber to be required for casting four cubes at each trial.

Table I:- Details of quantities of material used for casting four cubes at each trial.

Materials	Quantity (in kg.)
Cement	4.4
Sand	15.35
Course Aggregate (20 mm)	18.45
Total	**38.2 kg.**

Table II:- List showing quantity of PPF used for making the sample tests cubes

Percentage of fibers used	Quantity in gms.
0.1% PP fiber	(0.1x38.2) / 100 = 38.2 gms.
0.2% PP fiber	(0.2x38.2) / 100 = 76.4 gms.
0.5% PP fiber	(0.5x38.2) / 100 = 191 gms.
1% PP fiber	(1x38.2) / 100 = 382 gms.
1.25% PP fiber	(1.25x38.2) / 100 = 477.5 gms

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1.5% PP fiber	(1.5x38.2) / 100 = 573 gms.
2% PP fiber	(2x38.2) / 100 = 764 gms.

Now, the moulds are filled fully with the materials. Cement and sand are mixed thoroughly and to it aggregates are added for making of conventional sample cubes. When PP fibers are used then cement, sand and PP fibers are mixed thoroughly and then CA is added to the mixture. The PP fibers are added in percent by the volume of concrete used. The following table shows the details of materials used in making the concrete. The concrete is now ready for casting but prior to casting the workability of concrete is measured by the slump test. The slump value obtained is noted and recorded for different mixes of concrete.

Table III:- Table showing slump test values of the concrete

Concrete Type	Slump Value in cm
Conventional concrete	10.5
Concrete containing 0.1% of PP fiber	7.8
Concrete containing 0.2% of PP fiber	7.2
Concrete containing 0.5% of PP fiber	6.5
Concrete containing 1% of PP fiber	5.7
Concrete containing 1.25% of PP fiber	5.2
Concrete containing 1.5% of PP fiber	5
Concrete containing 2% of PP fiber	4.8

For measuring the compressive strengths of the different types of cubes casted, some of the cubes are taken out from the curing tank after 7 and 28 days to measure 7 days and 28 days compressive strength.

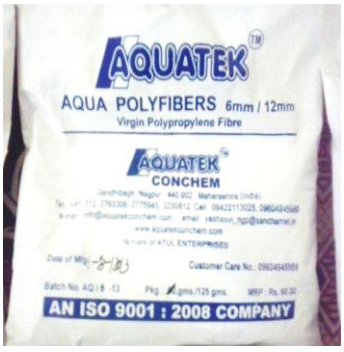
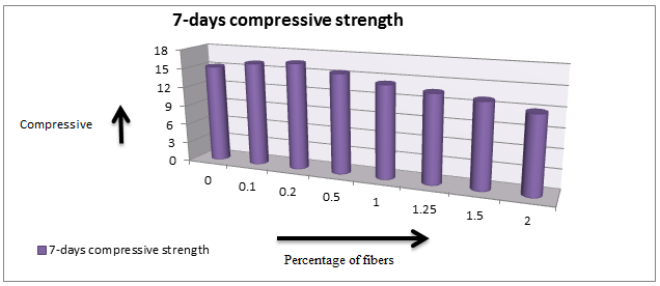


Fig:(a) Polypropylene Fibre

Table IV:- 7 days compressive strength of conventional and PRFC blocks

S.L. No.	Type of concrete used	Load (in tonnes)			Compressive Strength (N / mm2) 7 days
		Trial I	Trial II	Average	
1	Conventional concrete (0% fiber)	34.1	34.2	34.15	15.17
2	Concrete containing 0.1% of PP fiber	36.0	36.1	36.5	16.08
3	Concrete containing 0.2% of PP fiber	37.3	37.1	37.2	16.53
4	Concrete containing 0.5% of PP fiber	35.21	34.09	35.0	15.45
5	Concrete containing 1% of PP fiber	32.13	32.02	32.1	14.31
6	Concrete containing 1.25% of PP fiber	30.5	30.6	30.55	13.58
7	Concrete containing 1.5% of PP fiber	29.6	29.14	29.01	13.00
8	Concrete containing 2% of PP fiber	26.7	26.8	26.75	11.89



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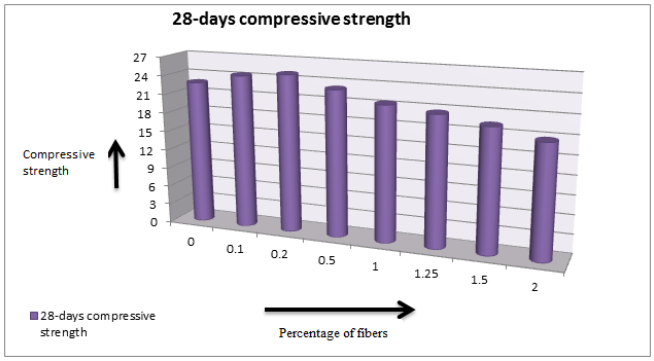

Table V:- 28 days compressive strength of conventional and PRFC blocks

S.L. No.	Type of concrete used	Load (in tonnes)			Compressive Strength (N / mm2) 28 days
		Trial I	Trial II	Average	
1	Conventional concrete (0% fiber)	51.2	51.5	51.35	22.82
2	Concrete containing 0.1% of PP fiber	55.0	54.8	54.55	24.35
3	Concrete containing 0.2% of PP fiber	56.3	56.1	56.25	25.0
4	Concrete containing 0.5% of PP fiber	52.8	51.5	52.16	23.18
5	Concrete containing 1% of PP fiber	48.64	48.18	47.8	21.43
6	Concrete containing 1.25% of PP fiber	46.2	46.5	46.35	20.6
7	Concrete containing 1.5% of PP fiber	43.53	43.8	43.6	19.4
8	Concrete containing 2% of PP fiber	40.1	40.3	40.2	17.8

Fig (b) PFRC specimen under compression

Fig (c) Conventional specimen under compression

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III. RESULT

From table IV and V, it is observed that due to the addition of fiber as reinforcement there is a slight increase in the compressive strength. However when the percentage of fiber is kept between 0.1% to 0.5%, it is considered good whereas if the percentage of fiber is increased above 1% it tends to decrease the strength of the concrete as compared to conventional concrete. When polypropylene fibers are added to concrete it tries to absorb energy. So when the volume of fiber is increased, the amount of energy required to achieve the desired consolidation will also increase. From figure (b) and (c), it is seen that the fiber binds the cement with the aggregates strongly which increases the bond strength of the concrete. Because of this the PRFC does not break apart easily as compared to conventional concrete when subjected under compression. The fiber also resists the formation of multiple cracks from the stress on the concrete.

IV. CONCLUSION

At optimum percentage, fiber concrete can be used over normal concrete. The fibers can be used as a replacement for steel reinforcement and have various advantages such as- light weight, tight cracks, ease of use, safe handling, rapid dispersion and no corrosion. However specific design considerations and construction procedures should be adopted in order to obtain optimum performance. In earthquake prone areas, the use of fiber reinforced concrete would certainly minimize the human casualties. The PPFRC can extensively be used in slabs, beams, balconies, overhangs, driveways, sidewalks, water storage tanks (both overhead and underground), basements, foundations, drainage etc. As these are synthetic fibres so there is no risk of corrosion to occur.

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