INFLUENCE OF FIBRE REINFORCEMENT ON STRENGTH AND TOUGHNESS OF LIGHT WEIGHT CONCRETE

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Abstract: **The usefulness of fiber reinforced concrete (FRC) in various civil engineering applications in indisputable. FRC has so far been successfully used in construction of structure like slab on grade, bridge, industrial structure and many other applications. In this work partially replacement of pumice light weight aggregate is carried out. The light weight materials such as light weight aggregate concrete can increase economic efficiency by reducing the self weight and dimensions of the structure. In this work the polypropylene fibers are added with concrete with different ratio (0.5 % ,1% , 1.5% , 2%) to identify the splitting tensile strength of concrete , compressive strength, flexural strength, toughness and ductility behavior of concrete.**

Keywords: **polypropylene fibers, splitting tensile strength of concrete, compressive strength, Flexural strength.**

I. INTRODUCTION

Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the aggregate particles and glues them together. Concrete as a composite material that consists of a binding medium within which are embedded particles or fragments of aggregates. concrete is strong in compression but weak in tension.

The simplest representation of concrete is:

Concrete = Filler + Binder.

According to the type of binder used, there are many different kinds of concrete. For instance, Portland cement concrete, asphalt concrete, and epoxy concrete. In concrete construction, the Portland cement concrete is utilized the most.

1.1 Polypropylene Fibres:

Polypropylene (PP) is a thermoplastic polymer used in a wide variety of applications such as textiles (rope and carpets) , packaging, labeling , stationary , containers , automotive parts and banknotes. Its structure is based on CnH2n monomer. Polypropylene fibres derive from synthetic hydrocarbon polymer through extrusion processes of hot drawing the material through a die .In the production process and based on the properties required , copolymerization among the monomers is necessary for the desired properties to be achieved. It is adopted because of its tensile and flextural strength capability of arresting plastic shrinkage cracks. It has been established that the addition of randomly distributed polypropylene fibres to brittle cement based materials can increases their fracture toughness, ductility and impact resistance. polypropylene twine is cheap ,abundantly available , and like all manmade fibers of a consistant quality.

Fig 1: Polypropylene Fiber

1.2 Light Weight Aggregate (Pumice Stone):

Pumice called pumicite in its powdered or dust form is a volcanic rock that consists of highly vesicular rough textured volcanic glass,which may or may not contain crystals.

Fig 2: Light Weight Aggregate Pumice

1.3 Polypropylene Fiber Reinforced Concrete:

Concrete modification by using polymeric materials has been studied for the past four decades. In general, the reinforcement of brittle building materials with fibres has been known from ancient period such as putting straw into the mud for housing walls or reinforcing mortar using hair etc. Many materials like jute , bamboo ,coconut , rice husk , cane biogases , and sawdust as well as synthetic materials such as polyvinyl alcohol , polypropylene (pp) etc. Its use enables reliable and effective utilization of intrinsic tensile and flexural strength of the material along with significant reduction of plastic shrinkage cracking and minimizing of thermal cracking. Since then the use of these fibres has increased tremendously in construction of structures because addition of fibres in concrete improves the toughness, flexural strength , tensile strength and impact strength as well as failure mode of concrete.

II. MATERIAL PROPERTIES

Portland pozzolanic cement:

Cement is a fine grey powder .It is mixed with water and materials such as sand , gravel and other crushed stone to make concrete. The cement and water from a paste that binds the other materials together as the concrete hardens. Standard consistency , initial setting time tests were done for this cement.

Table 1: Physical properties of cement

S. no	Physical properties of cement	Result	Requirements as per is :8112 - 1989
1	Specific gravity	3.15	3 – 3.15
2	Standard consistency	28%	27 - 33
3	Initial setting time	35 min	Minimum 30 min
4	Final setting time	492 min	Maximum 600 min

Fine aggregate:

Fine aggregate used in this investigation is clear river sand without impurities like clay , shell and organic matters.It is passing through 4.75mm sieve.The fine aggregate were tested,as per Indian specifications IS 383-1970.Thefine aggregate used in this investigation was clean river sand and the following tests were carried out on sand as IS:2386-1968

(I & III).

Table 2: Physical properties of Fine aggregate

S. no	Property	Fine aggregate
1	Fineness modulus	3.47
2	Specific gravity	2.62

Coarse aggregate:

The aggregate size bigger than 4.75 mm, is considered as coarse aggregate.coarse aggregate are available in different shapes like rounded , irregular or partly rounded , angular ,flaky. It should be free from any organic impurities and the dirt content was negligible. Aggregates passing through 20 mm sieve have been used in the present study.

Table 3: Physical properties of Coarse aggregate

S. no	property	Value
1	Type	Crushed
2	Maximum size	20mm
3	Specific gravity	2.66
4	Fineness modulus	8.28

Light weight aggregate (pumice):

Table 4: Physical properties of light weight aggregate (pumice)

S. no	Property	Value
1	Type	Crushed
2	Maximum size	12.5 mm
3	Specific gravity	1.11

III. MIX DESIGN

Mix Proportioning:

Portland pozzolana cement and M_{30} grade .The natural river sand passing through IS 4.75mm sieve .then natural coarse aggregate passing through IS 20mm sieve.cubes of 150mm*150mm*150mm,cylinders of 300*150mm were cast cured and tested for 7&28 days.

Using the conventional mix proportion = 1:1.36:2.15:0.4

Table 5: Mix proportion for control mix

S.No	Materials	Quantity
1	Cement	492.5 (kg/m^3)
2	Fine Aggregate	669 (kg/m^3)
3	Coarse Aggregate	1058 (kg/m^3)
4	Water	197 lit

IV. EXPERIMENTAL RESULTS

4.1 Tests Conducted On Fresh Cconcrete:

Table 6: Slump cone test Results for controlled concrete.

Mix type	W/C ratio	Slump in mm
M1	0.4	100mm

4.2 Hardened State Properties:

Compressive strength:

In this study hardened state properties considered are compressive strength of cubes for 7 and 28 days. compressive strength of cubes are tabulated below.

Table 7: Compressive strength of M30 grade concrete

Mix Type	pp fibre+light weight aggregate (pumice) (%)	Average Compressive Strength, N/mm^2	
		7Days	28 Days
A1	Nominal concrete	20.74	30.22
M1	0.5 + 50	25.04	34.65
M2	1+50	26.14	37.93
M3	1.5+50	31.40	39.99
M4	2+50	27.11	35.57

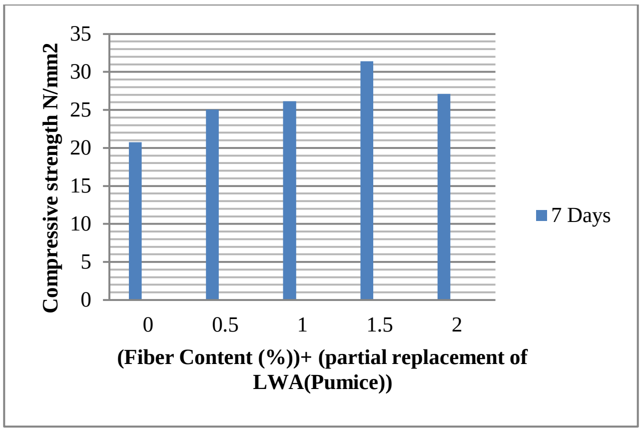

Fig 3: Fiber vs compressive strength at 7 days

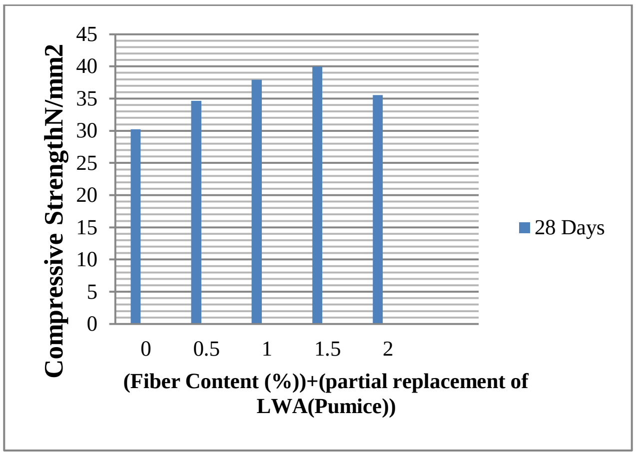

Fig 4: Fiber vs compressive strength at 28 days

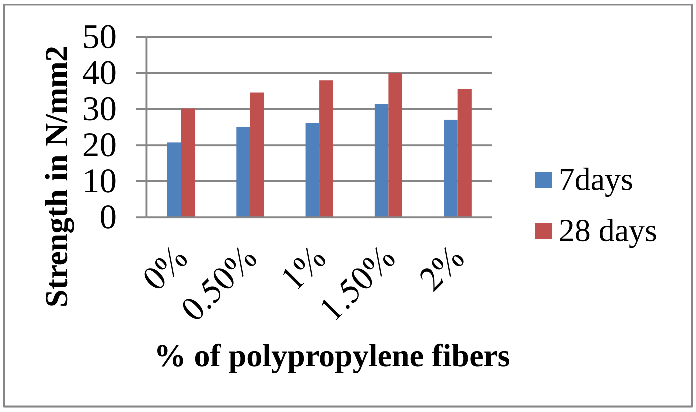

Fig 5: Fiber vs compressive strength at 7& 28 days

Split tensile strength: In this study hardened state properties considered are Split tensile strength of cylinder for 7 and 28 days. Split tensile strength of cylinder are tabulated below.

Table 8: split tensile strength of M30 grade concrete

Mix Type	**pp fibre+light weight aggregate (pumice) (%)**	**Average split tensile Strength, N/mm^2**	
		7Days	28 Days
A1	Nominal concrete	2.83	3.30
M1	0.5 + 50	3.25	4.15
M2	1+50	3.49	4.29
M3	1.5+50	3.87	4.44
M4	2+50	3.11	4.19

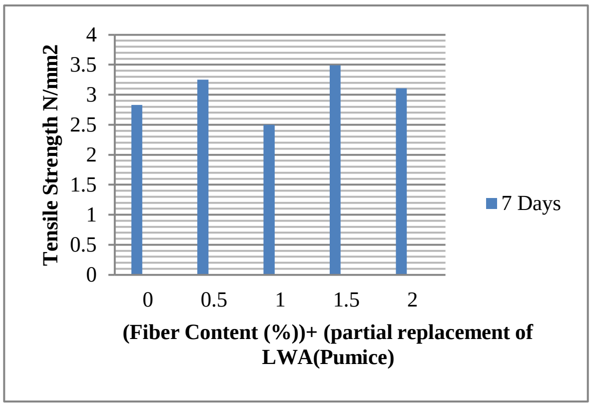

Fig 6: Fiber vs Split tensile strength at 7 days

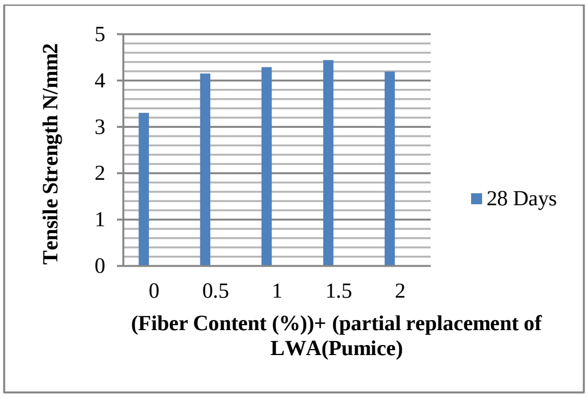

Fig 7: Fiber vs Split tensile strength at 28 days

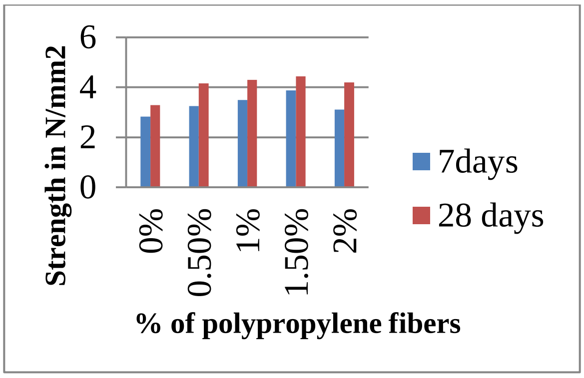

Fig 8: Fiber vs Split tensile strength at 7& 28 days .

Flexural strength:

In this study hardened state properties considered are flexural strength of prism for 7 and 28 days. Split tensile strength of prism are tabulated below.

Table 9: Flexural strength of M30 grade concrete

Mix Type	**pp fibre+light weight aggregate (pumice) (%)**	**Average flexural Strength, N/mm²**	
		7Days	28 Days
A1	Nominal concrete	1.56	3.51
M1	0.5 + 50	1.69	3.84
M2	1+50	2.06	3.93
M3	1.5+50	2.12	4.14
M4	2+50	1.82	3.81

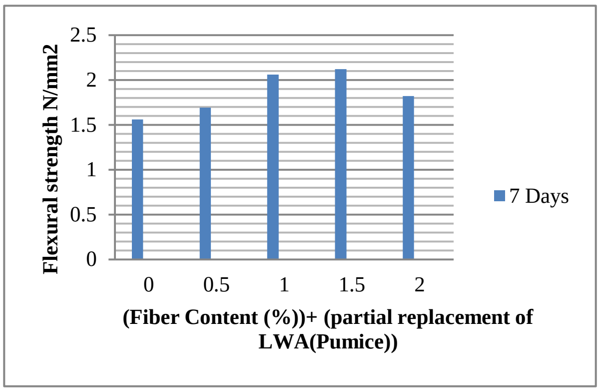

Fig 9: Fiber vs flexural strength at 7 days

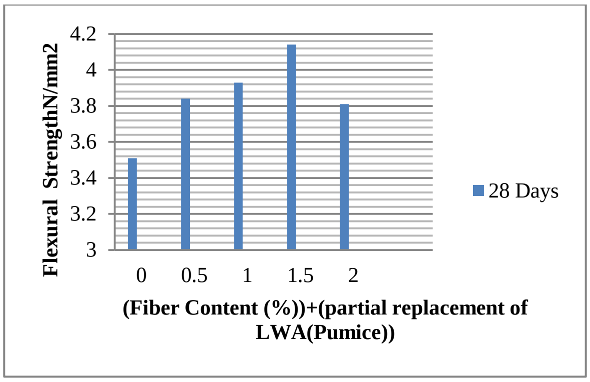

Fig10: Fiber vs flexural strength at 28 days

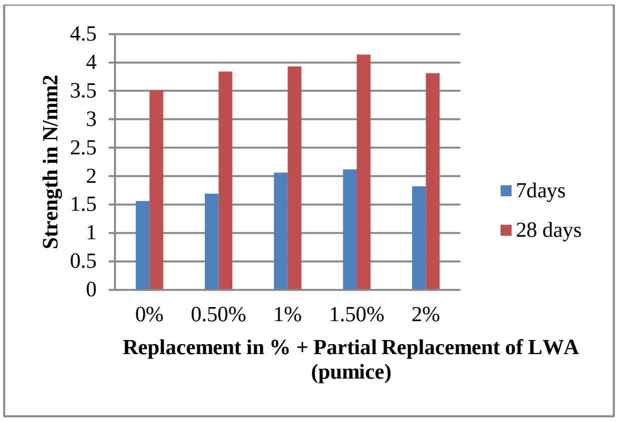

Fig 11: Fiber vs flexural strength at 7& 28 days.

V. CONCLUSIONS

After studying the results following conclusions are made:

- In the hardened state of concrete there is an overall increase in strength of concrete both in compressive strength ,split tensile strength and flexural for the 1.5% addition polypropylene fibers.
- Polypropylene fibers reduce the water permeability, plastic shrinkage an settlement.
- The compressive strength, split tensile strength & flexural strength increase with the addition of fiber content as compared with conventional concrete.

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