STUDY ON STRENGTH PARAMETERS OF TEXTILE REINFORCED CONCRETE

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Abstract -*This paper deals with the study of the strength parameters of textile reinforced concrete. The mix design of concrete is M30 grade of concrete with water cement ratio 0.40. An experimental program consisting of two point loading tests on textile reinforced concrete and ordinary conventional concrete beams was conducted under cyclic loading to obtain stability points. The present investigation is an attempt made to evaluate the mechanical properties of textile reinforced concrete. Standard cubes of 150× 150× 150mm has been cast and tested for obtaining 28 days compressive strength. Flexural strength is checked by testing beams of size 1200 ×100 ×150 mm. The analytical studies carried out by finite element models using ANSYS.*

Key Words: Textile reinforced concrete, cyclic loading, compressive strength, flexural strength, finite element models.

1. INTRODUCTION

Textile reinforced concrete offers innovative technology to strengthen or repair concrete structures with thin layers of textile fibres. Textile reinforced concrete is a type of reinforced concrete in which the usual steel reinforcing bars are replaced by textile materials. Textile fibre are mesh like structures made up of steel, polypropylene and jute, which are used in concrete. The use of textile fibre mineral matrix composites, improve the shear behaviour of the beam. The aim of this project to is to find the mechanical properties of the beam under cyclic loading condition. Therefore this study deals about the properties and behaviour of the textile reinforced concrete, to act as a primary structural member for futuristic technology applications. The textile reinforcement provides enhanced textile strength, ductility and other features to the finished textile reinforced concrete composites. The choice of fibre material used in textile reinforced concrete is based on various factors such as material properties, corrosion, temperature resistance, bond quality and environmental impact. Polypropylene fibres have capacity to absorb large amount of energy, to moderate strength improvement, resistance to impact and explosive loading. Material characteristics are most important for the building trade. The steel fibre is used to improve strength, corrosion and stiffness of the concrete. Steel fiber are fast and perfect mixable high performance fibers and crack resistance. Steel fibers reinforce concrete against impact forces, thereby improving the toughness characteristics of hardened concrete. Steel fibres reduce the permeability and water migration in concrete, which ensures protection of concrete due to the ill effects of moisture.

2. RESEARCH SIGNIFICANCE

a) Concrete is most widely used construction material in the world. Textile reinforced concrete (TRC) is a concrete in which small and discontinuous fibres are dispersed uniformly.

b) The fibres used in TRC is of different materials like steel, G.I., carbon, glass, asbestos, polypropylene, jute etc.

c) The addition of these fibres into concrete mass can dramatically increase the compressive strength, tensile strength, flexural strength and impact strength of concrete. The important factor consider in textile reinforced concrete is "Aspect Ratio". It has been used upto aspect ratio of 75, increase in the aspect ratio increases the ultimate strength of concrete linearly. Beyond 75, relative strength and toughness is reduced.

d) Use of higher percentage of fibre is likely to cause segregation and harshness of concrete and mortar.

e) The addition of these fibres into concrete mass can dramatically increase the compressive strength, tensile strength, flexural strength and impact strength of concrete.

f) Incorporation of steel fibre decreases the workability, this situation adversely affects consolidation of fresh mix.

g) Steel fibre content in excess of 2% by volume and an aspect ratio of more than 100 are difficult to mix.

h) This research is aimed - studying the mechanical properties of textile reinforced concrete like compressive strength and flexural strength with different types of textile fibers.

3. MATERIAL AND METHODS

The materials used in the experimental work listed below were used preparation of the specimens

3.1 Mix Proportion

The mix design of concrete is M30 grade with water cement ratio 0.40. The four different fibres, namely crimped steel fibre, hooked steel fibre, polypropylene fibre and jute fibre were added to the concrete in 1% and 1.5% mix proportions respectively, with the water cement ratio of 0.40. The use of higher fibre volume fraction above 1.5% leads to fibre balling and irregular distribution of the fibers within the mix and thus reduces the strength of the matrix.

a.Crimped Fibre

b. Hooked End Fibre

c. Jute Fibre

d.Polypropylene Fibre

Fig -1 Textile Fibres

3.2 Cement

The cement used in this experimental work is OPC43 Grade. All properties of cement are tested by referring IS12269-1987 specification for OPC 43 grade.

3.3 Water

Portable water used for the experimentation. Water is an important ingredient of concrete as it activity participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Depending upon the specification of the acceptable water pH for making concrete is between the ranges of 6 to 8.

3.4 Fine Aggregate

Locally available river sand is used. The size of sand particle should be less than or equal to 4.75mm(passing through 4.75mm IS sieve). The specific gravity of sand is 2.77.

3.5 Coarse Aggregate

Aggregates are the important constituents in concrete. They give body to concrete, reduces shrinkage and effect of economy. Generally the maximum size of aggregate should be as large as possible within the limits specified, but in any case not greater than one- fourth of the minimum thickness of the member. Crushed aggregate available from local sources has been used. The coarse aggregate with a maximum size of 20mm having specific gravity of 2.78 is used.

3.6 Steel Fibers

Steel fibers are widely used in textile concrete. Steel fibres have a flexural strength three times greater than conventional concrete. The material is less porous.

3.6.1 Crimped Steel Fibre

Crimped steel fibre is low carbon fibre, the cold drawn steel wire fibers designed to provide concrete with temperature and shrinkage crack, enhanced flexural reinforcement, improved shear strength and increase the crack resistance of concrete.

3.6.2 Hooked End Steel Fibre

Cold-drawn hooked end steel fiber is manufactured by quality base steel bar, which has excellent mechanical properties including high tensile strength. Hence, the average tensile strength of the reinforced fibre surpasses 1100MPa. Owing to high strength and uniform distribution of fibers, stresses can be fully dispersed and cracking propagation be effectively controlled.

Table -1: Properties of Steel Fibre

Description	Hooked End Steel Fibre	Crimped Steel Fibre
Length	70mm	50mm
Diameter	1mm	1mm
Aspect ratio	1mm	50
Tensile strength	1186 Mpa	345 to 3000Mpa
Young's modulus	210 Gpa	200Gpa
Ultimate elongation (%)	4 to10	4 to 10

3.7 Jute Fibre

Jute is a long, soft, shiny natural fibre that can be spun into coarse, strong threads. Jute is one of the most affordable natural fibres. The most important types of natural fibres used in composite materials are flax, hemp, jute, and sisal due to their properties and availability. Using jute fibre for composites has many advantages like low cost, biodegradability, better thermal and insulating properties, and low energy consumption during processing.

3.8 Polypropylene Fibre

Polypropylene is the most widely used in ready mixed concrete. Polypropylene fibres are hydrophobic, so they don't absorb water and have no effect on concrete mixing water requirements. They come as monofilaments.

a) Polypropylene also known as a thermoplastic polymer used in a wide variety of applications including package and labelling textiles (e.g., ropes thermal under ware and carpets).

b) Polypropylene is in many aspects similar to polyethylene, especially in solution behaviour and electrical properties.

c) The properties depends on the molecular weight, molecular weight distribution and type.

d) Polypropylene and nylon fibres are found to be suitable to increase the impact strength.

e) They possess very high tensile strength, but their low modulus of elasticity and higher elongation do not contribute to the flexural strength.

Table -2: Properties of Polypropylene Fibre

Descriptions	Polypropylene Fibre
Tensile strength	360Mpa
Poisson's ratio	0.45
Young's modulus	3.45Gpa
Shear modulus	1127.4 Mpa
Cut length	6 and 12mm

4. ANALYTICAL INVESTIGATION

The test conducted was a cyclic loading test on Reinforced Concrete and textile reinforced concrete beams to find stability points in which the loading started at zero loads and increased to point coinciding approximately with envelope load- deflection curve. The incremental load and deflection were chosen so that the loading curve, in each cycle attained the envelope curve. This is monitoring the incremental load up to yield and incremental deflection after yield in each cycle. The analytical study on the beam is carried out by the application of lateral force. The finite element model is analyzed and the displacement results are observed under half cyclic loading. In the finite element modeling, defining the property is an important process. Defining the property means, defining the material and section properties. Under this section the various fibre properties are applied.

The various properties of fibres like Density, Young's Modulus, Shear Modulus, Bulk Modulus, Tensile Strength and Poisson's Ratio are assigned in this module. These properties are arrived based on the test results of ultrasonic pulse velocity test.

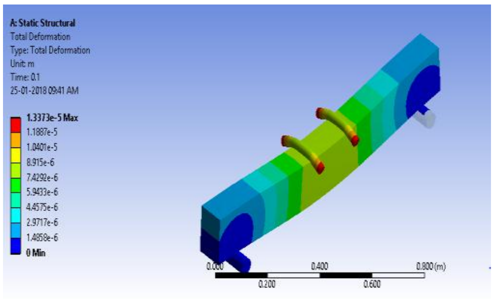

Fig -2 Deformation of conventional Beam

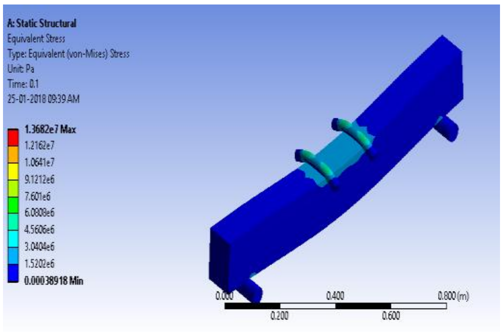

Fig -3 Equivalent Stress Of Conventional Beam

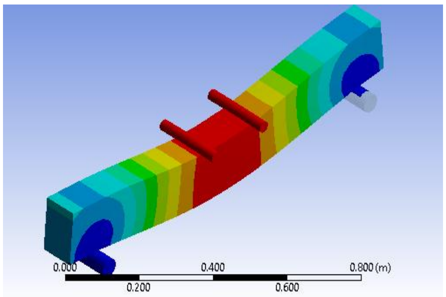

Fig -4 Deformation of hooked end steel fibre Beam

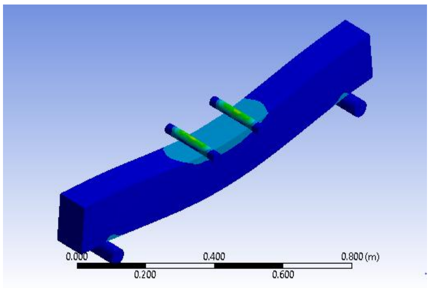

Fig -5 Equivalent Stress for hooked end steel fibre

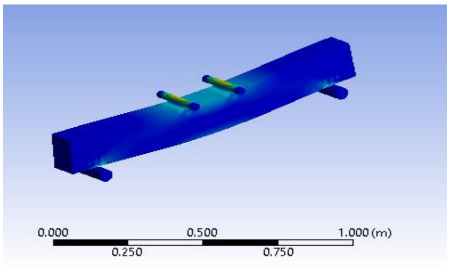

Fig -6 Equivalent stress for crimped fibre

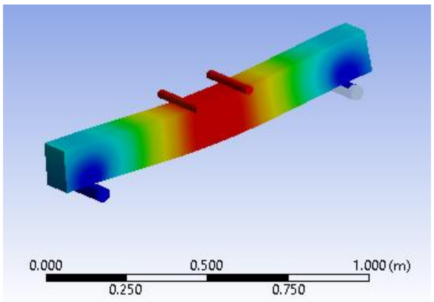

Fig -7 Deformation of crimped fibre

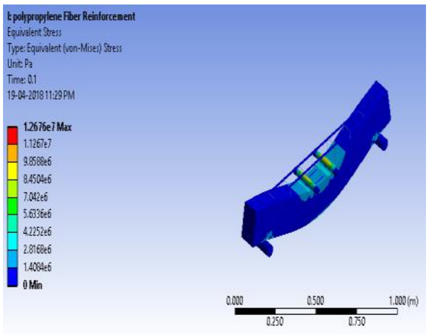

Fig -8 Equivalent stress of polypropylene fibre

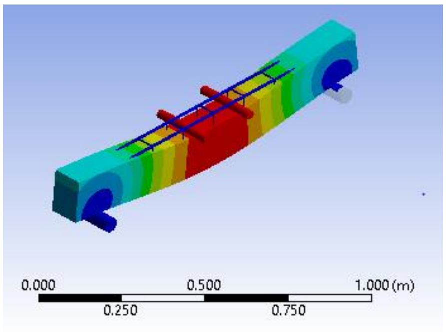

Fig -9 Deformation of Polypropylene Fibre

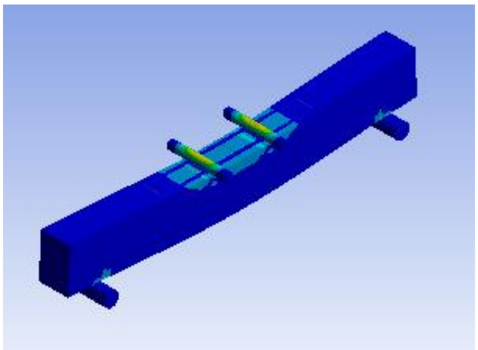

Fig -10 Equivalent Stress for Jute Fibre

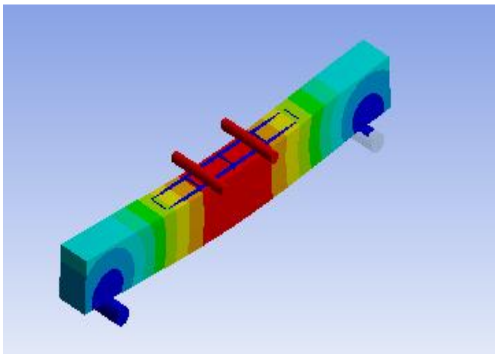

Fig -11 Deformation of Jute Fibre Beam

5. RESULTS AND DISCUSSION

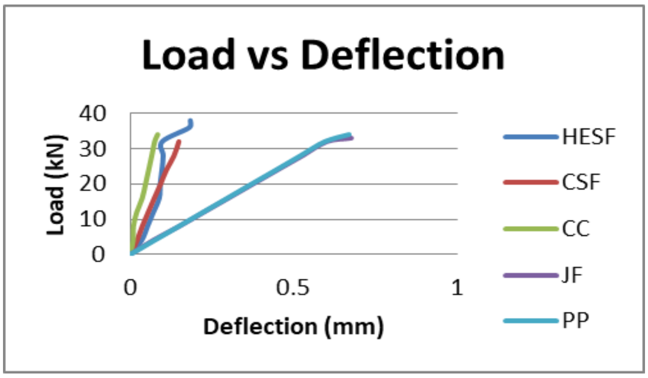

Chart -1 load vs deflection graph

- Based on the analytical method the obtained results are shown in above chart 1
- Reinforced concrete yields at 29kN with a deflection of 0.13mm and the ultimate load of 34kN with deflection of 0.84mm.
- Crimped steel fibre yields at 27kN with a deflection of 0.12mm and fails at 32kN with deflection of 0.149 mm.
- Hooked end steel fibre yields at 28.3kN with a deflection of 0.10mm and fails at 38kN with deflection of 0.184mm.
- Jute fibre yields at 24kN with a deflection of 0.11mm and fails at 33kN with deflection of 0.677mm.
- Polypropylene fibre yields at 26kN with a deflection of 0.12mm and fails at 34kN with deflection of 0.670mm.
- Compared to conventional concrete, the textile reinforced concrete eliminates the shrinkage cracks.
- The self-weight of textile reinforced concrete is lower than conventional concrete and it increases the compressive and flexural strength.
- Textile reinforced concrete improves ductility and impact resistance and also reduces the crack width. Among all the textile fibres, steel fibre is exhibits better strength than other fibres.

6. CONCLUSION

- Compared to conventional concrete, strength of hooked end steel fibre is greater than conventional concrete by 10%.
- Among the textile fibres used, hooked end steel fibre gives more strength. (i.e) the strength of hooked end fibre is greater by 10%, 13% and 15%, to polypropylene fibre, jute fibre and crimped steel fibre.

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