Fibre Reinforced Concrete

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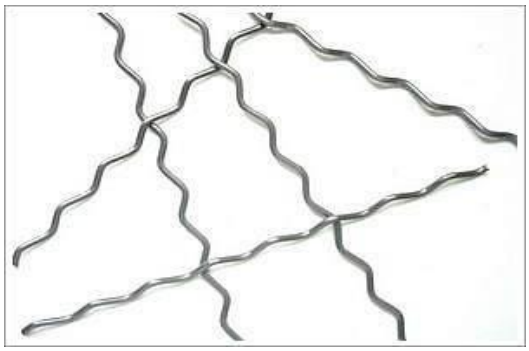
***Abstract*— Fibre Reinforced Concrete is a concrete which contains materials that increases its structural integrity such as steel, carbon or polymer. There are various types of fibers among which steel fibres is recommended by the researchers for its outstanding impact resistance, crack arresting and it is economically cheap. In order to improve the impact resistance of concrete, synthetic fibres such as polypropylene (PP) and nylon fibres are used. Comparing with steel fibres the synthetic fibre reinforced concrete provides lower impact resistance. These synthetic fibres are mainly used for its advantages like light and non-corrosive to cover the steel reinforcement, the fibre concrete is used as a tensile skin.**

Keywords— Frc, Synthetic Fibre, Steel Re4inforcement.

INTRODUCTION

1.1 GENERAL

Concrete are mostly applied in the construction of barriers and protective structures in places where there is an application of impact loads. Concrete is strong in compression but week in tension. The formation of crack is one of the main reasons for the failure of concrete. To arrest the the cracking the fibres are added to concrete mix. The properties of concrete such as strength, toughness, fatigue, ductility, durability, flexural strength etc. The fibre reinforced concrete is widely used in the bridges, harbor, railway tracks etc. These types of concrete are in great demand.



FIBRE

1. Characteristics

The geometric Characteristics of fibres include of length (L), equivalent diameter (d), and slenderness (λ)

2. Classification of fibres

The fibres are classified as steel fibres, polymer fibres and other organic fibres. Steel fibres

Depending upon the manufacturing process

- Cold drawn (Type 1)
- strip-cut (Type II)
- melt extracted (steel shavings) (Type III)
- others (for example, molten steel fibres (Type IV).

The fibre shape plays an important role on the bond characteristics, the shape of the fibre can be varied like straight , undulated , corrugated, shaped with different ends. The common usage length of 2.5-3 times the maximum largest aggregate. When there is an availability of fine shaped fibres the facing between them can be reduced according to their finess.

Advantages

- They are short when compared with continuous reinforcing bars of wires, they are closely spaced.
- These fibres are used in wide range of given cross sections, while reinforcing bars or wires are placed only in the required area.
- These are added in low volumes dosage to concrete (less than one persent) polypropylene,high density polyethylene,aramid,colyviney alcohol, acrylic, nylon, poly ester).
- (These fibres dimensions may vary according to their diameter and format.

Polymer fibres

Depending upon the manufacturing process

- Extruded monofilaments (Type 1)
- Fibrillated films (Type II)

These fibres are formed by an extrude and previously cut polymer material (polypropylene, high density polyethylene, aramid, colyviney alcohol, acrylic, nylon, poly ester). These fibres dimensions may vary according to their diameter and format.

fibres (less than 0.30 mm dia)

Inoder to reduce cracking of the concrete particularly in pavement and floors, microfibers are used. They are also used to improve fir resistance and in this case, the number of fibres per kg should be very high.

'Macro fibres(greater than or equal to 0.30 mm dia)
The structural length of the fibre may collaborate but this must be in proportion to the maximum aggregate.
Properties of fibre reinforced concrete Properties of cement, coarse aggregate, fine aggregate are the factors that affect the concrete properties
Also, factors that affect the fibre reinforced concrete are

Type of fibre
- Should posses variable elastic modulus
- Consistant with binder
- Being adequately short , fine and flexible to permit mixing , transporting and placing.

Aspect ratio
- The ratio of length to width of fibre is defined as aspect ratio
- The value of aspect ratio ranges between 30-150
- The increase in aspect ratio results in increase in strength and toughness
- The decrease in strength of concrete decrease the workability and reduced compaction

Fibre Quantity
- The fibre quantity is measured as percentage oiof cement content
- The increase in volume of fibre , results in increase in strength and toughness of concrete.

Orientation of fibre
- The determination of concrete capacity is the important role played by Orientation of fibre
- The fibres will be oriented in random direction
- The fibre reinforced concrete will have maximum resistance when fibres are oriented parallel to the load applied Fibre mechanism

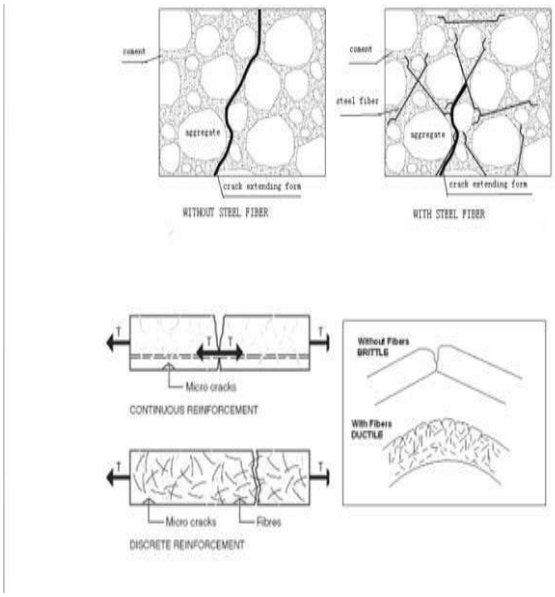
There are two mechanism which are utilized by fibre work along with concrete
- Spacing mechanism
- Crack bridging mechanism

Spacing mechanism
In order to arrest the existing micro crack that would expand into sound crack. In this mechanism, it requires large number of fibres which are well distributed within the concrete mix

Crack bridging mechanism
In this mechanism require straight fibres with adequate bond to concrete. This example for this fibre type that is commonly referred as large diameter fibres or micro fibres.

SI.No	Property	Experimental Value	Values by Indian Standards
1	Grade	53	-
2	Fineness of Cement	8%	<10% IS:4031(Part-2)2005
3	Initial Setting Time	45mins	Not < 30mins IS : 12269:2013
4	Final Setting Time	230mins	Not > 600mins IS : 12269:2013
5	Specific gravity	3.15	Range 3.15 IS:4031(Part-3)2005
6	Compressive Strength (N/mm^2)		
	3 Days	27.16	Not < 27N/mm ^{2} IS : 12269:2013
	7 Days	37.10	Not<37N/mm ^{2} IS : 12269:2013
	28 Days	53.00	53N/mm ^{2} IS : 12269:2013
7	Soundness Test (Le-Chatlier test)	2.1mm	Not >10mm IS:4031(Part-3)2005
8	Consistency of Cement	30%	Penetration 5-7mm IS:4031(Part-4)2005

SI.No	Property	Experimental Value	Values by Indian
1	Type	Graded(natural)	-
2	Specific Gravity	2.61	Range (2.6-2.7) IS: 2386(Part-3)2002.
3	Water Absorption	0.91%	IS: 2386(Part-3)2002.
4	Sieve Analysis	2.78	Medium sand 2.6-2.9
5	Moisture Content	Nil	-



Application of Fibre

- Agricultural application Short;
- thin section walling
- Water retainingstructure,
- marine application
- Roads, pavements, drive ways, kerbs.

Properties of materials
Properties of cement

As per IS 4031 and IS 12269, the experiments on the properties of cement were conducted. Commonly GPC 53 grade cement is used for the concrete mixes. The results have been experimentally proved

Properties of cement
Properties of aggregate
In order to find out the properties of fine and coarse aggregate as per IS2386

Properties of fine aggregate
Clean and Dry River sand will be used .IS 4.75 mm sieve is used for casting for all types of specimen
Properties of coarse aggregate
Crushed stone aggregate passing through 10mm sieve and retain on 4. 75 mm, were used for casting the specimens.

SI.No	Property	Experimental Value	Values by Indian Standards
1	Type	Crushed	-
2	Specific Gravity	2.7	Range 2.6-2.85 IS: 2386(Part-3)2002.
3	Water Absorption	0.4%	Range 0.4-0.5% IS: 2386(Part-
4	Sieve Analysis	7.5	IS: 2386(Part-1)2002.
5	Impact test	46.53%	IS:2386(Part-4)2002

Properties of coarse aggregate
Test on Concrete

There were various test conducted on fresh and hardened concrete

1. Slump test
2. Flexural strength test
3. Tensile test on cylinder
4. Compression strength on cube

There were different experimental values were obtained in these types of test mentioned above

Tests on Concrete

SI.No	Type of Test	Experimental value
1	Slump of Concrete	50mm
2	Flexural Strength	3.74Mpa
3	Split Tensile Test	30Mpa
4	Compressive Test on Concrete	25Mpa

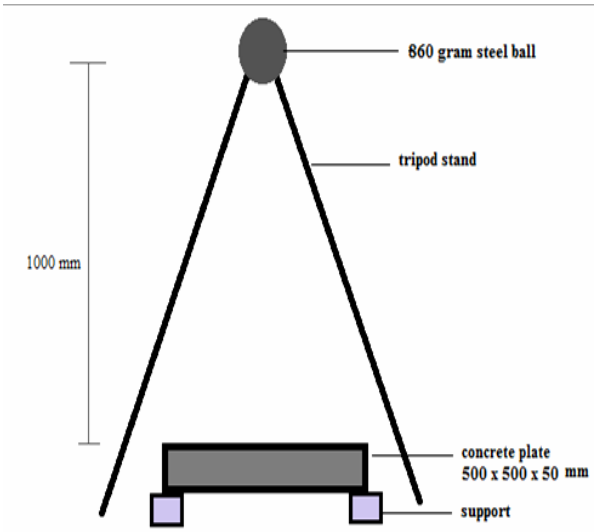
DESIGN MIX FOR M25 GRADE OF CONCRETE AS PER IS 10262 – 2009
Grade of concrete= M25 Max. Nominal size of aggregate = 10mm Characteristic strength(fc = 25MPa
Type of cement = (OPC) 53 grade Standard deviation = 4
Target mean strength = fck+1.65xS.D = 25+1.65x4 = 31.60 MPa.
Material Properties
Specific gravity of coarse aggregate = 2.70 Specific gravity of fine aggregate = 2.61 Specific gravity of cement= 3.15
Specific gravity of water = 1.00
Water absorption
Coarse aggregate = 0.96
Fine aggregate = 1.5
Mix design
Slump value = 25 to 50 mm
Water cement ratio = 0.42.
(From IS 10262-2009 for M25 grade)
Select water content for 10mm aggregate
=208 kg/m^3
Hence the volume of cement content
= 208/0.42
= 495 kg/m^3
Total volume of aggregate = vol. of concrete (vol. of cement + vol. of water + vol. of admixtures).
= 1-(0.15+0.208+0.0005) e = 0.636
Volume of coarse aggregate = vol. of coarse aggregate / total volume
Adopt volume of fine aggregate = 0.30
Total volume of fine aggregate = e x vol. of fine agg x specific gravity. = 0.636x.30x2.61
= 497.9 kg/m^3 Adopt volume of coarse aggregate = 0.46 (as per IS 10262)
Total volume of coarse aggregate = e x vol of coarse agg x specific gravity
= 0.636x0.46x2.70 = 789.91 kg/m^3
Cement content = 495 kg/m^3

Fine aggregate content = 497.9 kg/m^3
Coarse aggregate content = 789.91kg/m^3
Ratio of mix: 1: 1:1.6
Mixing of fibres
In accordance with the Indian standard code 10262–2009, M25 grade of concrete mix was adopted. Polypropylene fibres (PF) and hooked end steel fibres (SF) were added to the mixture in various proportions (Table 5.6). Water cement ratio of 0.42 was adopted for all the mixes. A total of 42 plates were prepared with 6 plates in each mix id in order to obtain accuracy. Dry hand mixing of the fibres were done before the addition of water . Once the water is added the mixture is stirred up thoroughly so that the fibre does not segregate.

Impact test
The drop hammer impact test was done based on modification of the recommendations by ACI Committee 544 in which an impact specimen is subjected to repeated blows on the same spot. The impact load was repeatedly applied at the mid ordinate of each plate using a 50.7 mm diameter iron ball with a weight of 860 grams falling from a height of 1000 mm.

The number of blows to cause the first visible crack and failure was observed and used to calculate the first crack and failure impact energy of the concrete, respectively .The schematic representation of the experimental setup is shown in Figure
Let N1 -Number of blows at which the first crack was visible
N2 -The blow which caused the specimen failure
The impact resistance of the specimen was determined after 28 days. The impact energy delivered to the specimen is calculated by IE = $Nmv^2/2$

IE - impact energy
N - number of blows
m - mass of the drop hammer (kg)
v - velocity of the hammer at impact (m/sec)
g - gravity acceleration (m/s^2)
h - height of drop hammer (m) : $h=gt^2/2$



CONCLUSION

The study indicates the average experimental test results of impact failure energy of fibre reinforced concrete. Hence it enables researchers to present the necessary impact strength. Therefore the hybrid reinforced concrete can also be used in hydraulic structures, airport runway pavements, industrial flooring, bridges , military building and railway traversers. It also plays an important role in place where the impact loads are heavier and therefore these types of concrete are in great demand in the construction. Furthermore, the impact resistance are also increased against the first visible crack, this means that the energy absorption capacity in concrete with fibres in increased stage.

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