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STUDY ON CHARACTERISTICS OF TEXTILE FIBRE REINFORCED CONCRETE

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ABSTRACT

The Project work is on the study of characteristics of textile fiber reinforced concrete. The influence of type of fibers and their content on the characteristics of textile fiber reinforced concrete having different volume fractions are studied. The mechanical properties such as Compressive strength, Split tensile strength and Flexural strength are studied .The specimens are incorporated with 0.5, 1, 1.5, and 2% Volume fractions of Nylon, Woolen and Cotton in different proportions. The optimum percentage of suitable fiber is obtained structural behaviour is compared with the conventional concrete specimens.

Keywords— *Textile fiber reinforced concrete, Nylon, Woolen, Cotton.*

I. INTRODUCTION

1.1 GENERAL

This study demonstrates the chances of using Textile fibers as a reinforcing material in concrete with hand mould process for production of high performance fiber-cement composites. The primary component of this new construction technology is the development of a family of cement products as thin elements.

The main advantage of fibers as reinforcements in cement-based composites is the enhancement of mechanical behavior, especially when low modulus low cost yarns are used. In addition, modern textile technology offers a wide variety of fibers with great flexibility in fabric design and control of yarn geometry and orientation. This flexibility allows Engineering of composite performance for various cement products. Practical use of fiber-cement composites requires an industrial cost-effective production process.

1.2 FIBRE REINFORCED CONCRETE

Plain concrete possesses a very low tensile, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle fracture of the concrete.

- Randomly distributed short fibres in concrete
- Bridging the gaps between cracks
- Providing the resistance against crack propagation and opening

- Enhancing the Ductility and energy absorption
- Improves the durability
- Increasing tensile strength
- Reducing the shrinkage properties

1.2.1 Commonly Used Fibres

- CommercialFibers–Steel,Glass, Polypropylene, Glass, Carbon etc.,
- Rural Fibers
  - Waste Nylon, Plastic, Tyre
  - Natural Fibers like coir, sugarcane etc

1.3 TEXTILE FIBRES

Nylon

Nylon is a strong, light synthetic fiber. Nylon thread is made from the polymerization of an amine and an acid chloride. The thread is lifted from the interface of two immiscible liquids. It is strong and elastic.

Cotton

Cotton, as a natural cellulosic fiber, has a lot of characteristics, such as;

- Good absorbency
- Color retention
- Good strength

Woolen

The type of wool that a sheep produces varies by breed. For example, Merino sheep produce wool that is very fine. Merino wool is thus considered the most valuable of wools. Australia produces about 43 percent of the world's Merino wool.

1.4 TEXTILE FIBER REINFORCED CONCRETE

- Textile reinforced concrete is a special type of fiber reinforced concrete, which offers some obvious load-bearing capacity under tensile loading.
- Textile reinforced concrete (TRC) is a composite of textile structures made of multi-filament yarns (rovings) within a cementitious matrix.
- Commonly used Textile Fibers in Textile Fibers Reinforced Concrete are AR Glass, E-Glass, Polyester and Cotton etc.,
- One of the biggest advantages of TRC is the quasi-ductile behavior after matrix cracking, which is important for applications in civil engineering.
- This is due to the crack bridging of the textiles and the deboning of the textile-matrix interface.

1.5 PAST STUDY IN TRC

- TRC is not a new technique.
- There are lot of research works are going for last ten years
- In Arizona State University, Tempe, AZ, USA , lot of research works are undergoing in TRC
- They used monofilament and multi filament fibres.
- Pultrusion technique was introduced and used for making TRC Composites
- Modeling and testing works are going there.
- But they are using the new original textile fibres, which are costly and can be used by textile industries.

1.6 TEXTILE EXPORT IN INDIA

The Indian textile industry in the second largest in the world second only to China India's textile products, including handlooms and handicrafts, are exported to more than a hundred countries. However, the USA and the EU, account for about two-third of India's textiles exports Indian textiles also account for 38 percent of the country's total exports and is, therefore, a very important industry The textiles exports reached more than 16 billion USD during the year 2008

1.6 FABRIC TEXTILE YARN WAST

An increasing amount of waste is generated each year from textiles and their production.

- For economic and environmental reasons it is necessary that as much of this waste as possible is recycled instead of being disposed of in landfill sites.
- But the rate of textile recycling is still relatively low.
- On average, approximately ten million tonnes of textile waste is currently dumped in Europe and America each year.

1.7 NEED OF THE STUDY

- Hence it is planned to have a attempt to reuse such waste Textile yarns as construction materials in Building Industry
- One of the possibilities is using the waste textiles as Fiber Reinforced Composites in Cement and concrete members
- So, focus of this research is double prolonged
- Enhances the structural performance against unanticipated loading
- Solves tangible potential of reducing the waste disposal problem

1.9 OBJECTIVES

- To study the Workability of concrete with textile fibres.
- To study the strength and structural properties of concrete with textile fibres.
- To enhance the crack arresting capability of concrete using Textile fibres.

1.10 INGREDIENTS USED

- **Cement :** Ordinary Portland cement 53 grade (OPC)
- **Fine aggregate :** Natural river sand
- **Coarse aggregate :** Maximum stone size of 20 mm is used
- **Fibers:** Nylon, Cotton Woolen and Cotton
- **Water:** Ordinary portable water
- **Resin:** Polymer acrylic resin.

II. LITERATURE REVIEW

2.1 GENERAL

This chapter presents an overview of literatures collected from various journals. The most noteworthy of them which are relevant to the current study are being reviewed.

Catherine Papanicolaou, Thanasis Triantafillou, Ioannis Papantoniou and Christos Balioukos, "Strengthening of Two-Way Reinforced Concrete Slabs with Textile Reinforced Mortars (Trm)", 4th Colloquim on Textile Reinforced structures, pp 410- 420.

The textiles used in the experimental campaign comprised fabric meshes made of long stitch-bonded fibre roving's in two orthogonal directions. The specimens measured 2 x 2 m in plan and were supported on hinges at the corners. Three RC slabs strengthened by textile reinforced mortar (TRM) overlays and one control specimen were tested to failure. One specimen received one layer of carbon fibre textile, another one received two, whereas the third specimen was strengthened with three layers of glass fibre textile having the same axial rigidity (in both directions) with the single-layered carbon fibre textile. All specimens failed due to flexural punching. The predictions of ultimate strength from existing formulations based on yield line theory are very conservative for the unstrengthened slab on the contrary, they are unsafe for the strengthened specimens tested in this study.

Rostislav Rypl, MiroslaVořechovský, BrittaSköck-Hartmann,Rostislav Chudoba and Thomas Gries , "Effect of twist, fineness, loading rate and length on tensile behaviour of Multifilament Yarn".

The idea underlying the present study was to apply twisting in order to introduce different levels of transverse pressure. The modified structure affected both the bonding level and the evolution of the damage in the yarn. Most emphasis is put on alkali resistant (AR) glass fibers as they are comparatively cheap while having a high tenacity. The multivariate study of continuous AR-glass multifilament yarns brought about an evidence of interaction between filaments through increase of bundle strength for a certain range of bundle twist. In particular, the study has identified a significant effect of bond on the yarn performance for twist levels up to 20 turns/m. The increased filament-filament interaction can compensate for filament breaks during the loading and results in significantly higher bundle strength.

Suji.D, Natesan.S.C and Murugesan.R, "Experimental study on behaviours of Polypropylene fibrous concrete beams",Suji et al. / J Zhejiang Univ Sci A 2007 8(7):1101-1109, 5th March 2007.

The Synthetic fibers made from nylon or polypropylene have gained application when loose and woven into geo textile form although no information on the matrix's mechanical performance is obtained so that more understanding of their structural composition to resist cracking can be determined. This paper presents the results of an experimental investigation to determine the performance characteristics of concrete reinforced with a polypropylene structural fiber.

The addition of fibers does not change crack pattern as such but there were reduced crack widths, which were observed. The flexural rigidity of the fiber concrete beams is more than their companion beams except for a few cases and the increases are found to be higher for Beam. The contribution of the fibers to flexural strength is very minimal.

Jan Hausding, Thomas Engler, Gerd Franzke, Uwe Köckritz, Chokri Cherif, "Plain Stitch-Bonded Multi-Plies for Textile Reinforced Concrete", AUTEX Research Journal, Vol.6, June 2006.

This paper presents the research activities in the field of textile reinforced concrete carried out by the Institute of Textile and Clothing Technology (ITB) of the Technische Universitat Dresden, Germany. To achieve this, the textile machinery was adjusted and improved and new testing methods were developed. This research has resulted thus for in several innovative applications for the repair of existing buildings as well as the production of precast concrete parts.

The usage of Textiles for the reinforcement of concrete is a new, flexible and efficient technology. Based on its distinguished and versatile properties the textile reinforced concrete is suited for special as well as mass production. For the first time modern Textile production methods are used that insert the reinforcing fibers in the quantity and structure according to the load. It can be used for repairing and strengthening existing structures, as well as for the production of load- bearing or non- load bearing precast parts.

Barzin Mobasher , Alva Peled ,Jitendra Pahilajani -, "Distributed cracking and stiffness degradation in Fabric-Cement Composites", Materials and Structures (2006) 39:317- 331,6 May 2005.

The composites made from low modulus woven polyethylene fabric and bonded Alkali Resistant (AR) glass mesh was manufactured by means of Pultrusion Technique. The influence of fabric type, matrix modification and curing as well as the pressure applied after pultrusion were studied using tensile stress strain response. The evolution of crack spacing as a function of applied strain was correlated with the tensile response as well as with the stiffness degradation various composites.

The mechanical properties of high fly ash composites were highly influenced by the curing process used, perhaps due to the direct effect on the bond development. The transition from distributed cracking to fabric debonding is the secondary mode of response and takes place at the later loading stages. The main mechanism of loading in PE composite systems was crack widening due to fabric debonding and Pullout, whereas in the glass fabric composites, crack widening was not the governing mechanism until 80% of the strain capacity was reached. The intensity of the static pressure applied after casting affects the mechanical behaviour of the pultruded composites. Increasing the pressure improves the tensile strength.

III. STUDY OF INGREDIENT

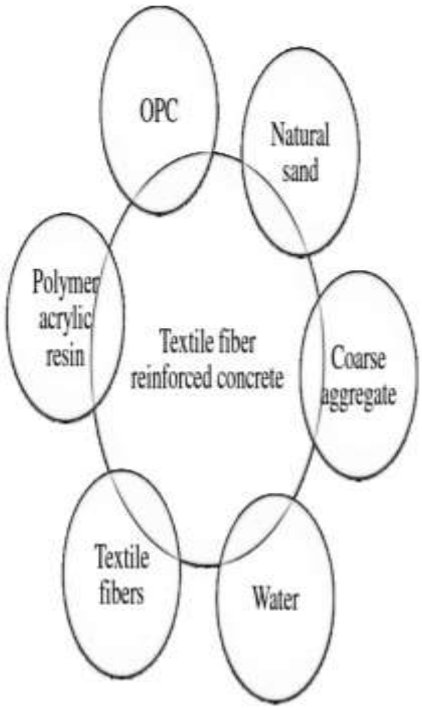
3.1 Ingredients

The TFRC considered here is prepared by the following ingred ients ASTM Type II Portland cement, fin e sand (approximately 150–500 µm) , Por table water,Coarse aggregate,Polymer Acrylic resin,and textile fibres(50mm in length) Fibres diameter determined from the mecruy displacement meter.

Table 3.1 Fibres diameter and aspect ratio

S.NO	FIBERS	LENGTH IN MM	DIAMETER IN MM	ASPECT RATIO [L/D]
1	NYLON	50	1.0178	49.13
2	WOOLEN	50	2.1074	23.73
3	COTTON	50	0.5398	92.63

3.1.1 INGREDIENTS



3.2 Cement

In the most general sense of the word, cement is a binder, a substance that sets and hardens independently, and can bind other materials together. The most important use of cement is the production of mortar and concrete to make bonding of natural or artificial aggregates to form a strong building material that is durable in the face of normal environmental effects.

3.2.1 Portland cement

Cement is made by heating limestone (calcium carbonate), with small quantities of other materials (such as clay) to 1450 °C in a kiln, in a process known as calcinations, whereby a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which is then blended with the other materials that have been included in the mix . The resulting hard substance, called 'clinker', is then ground with a small amount of gypsum into a powder to make 'Ordinary Portland Cement', the most commonly used type of cement (often referred to as OPC).

Portland cement is a basic ingredient of concrete, mortar and most non-specialty grout. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement, and water. As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural (load bearing) element. Portland cement may be gray or white.

3.3 Aggregates

Generally, aggregates occupy 70% to 80% of the volume of concrete and have an important influence on its properties. They are granular materials, derived for the most part from natural rock (crushed stone, or natural gravels) and sands, although synthetic materials such as slags and expanded clay or shale are used to some extent, mostly in lightweight concretes (Mindess et al., 2003). In addition to their use as economical filler, aggregates generally provide concrete with better dimensional stability and wear resistance. Although aggregate strength can play sometimes an important role, for example in high-strength concretes, for most applications the strength of concrete and mix design are essentially independent of the composition of aggregates. However, in other instances, a certain kind of rock may be required to attain certain concrete properties, e.g., high density or low coefficient of thermal expansion (Neville, 1993).

In order to obtain a good concrete quality, aggregates should be hard and strong, free of undesirable impurities, and chemically stable (Garber and Hoel, 1988). Soft and porous rock can limit strength and wear resistance, and sometimes it may also break down during mixing and adversely affect workability by increasing the amount of fines. Rocks that tend to fracture easily along specific planes can also limit strength and wear resistance (Neville, 1993). Aggregates should also be free of impurities like silt, clay, dirt, or organic matter. If these materials coat the surfaces of the aggregate, they will isolate the aggregate particles from the surrounding concrete, causing a reduction in strength. Silt, clay and other fine materials will increase the water requirements of the concrete, and the organic matter may interfere with the cement hydration. The properties of fine and coarse aggregate as follows.

Table 3.2 Properties of Fine Aggregates

Property	Results
Grade Limit	Zone II
Specific Gravity	2.65
Fineness	2.72

Table 3.3 Properties of Coarse Aggregates

Property	Results
Grade Limit	Single Sized Aggregate
Specific Gravity	2.75
Fineness	6.92

3.4 Polymer acrylic resin

Polymer acrylic resin is a bonding agent which is used to make bond between concrete and textile fibers.

3.5 Textile fibers

Properties of the nylon

Nylon is a strong, light synthetic fiber. Nylon thread is made from the polymerization of an amine and an acid chloride. The thread is lifted from the interface of two immiscible liquids.

- It is strong and elastic.
- It is easy to launder.
- It dries quickly.
- It retains its shape.

Properties of cotton

Cotton swells in a high humidity environment, in water and in concentrated solutions of certain acids, salts and bases. The swelling effect is usually attributed to the sorption of highly hydrated ions. The moisture regain for cotton is about 7.1~8.5% and the moisture absorption is 7~8%.

Properties of oolen

- Superior insulation
- Resilience
- Moisture absorption
- Moisture bufferin

IV. WORKING METHODOLOGY

4.1 METHODOLOGY

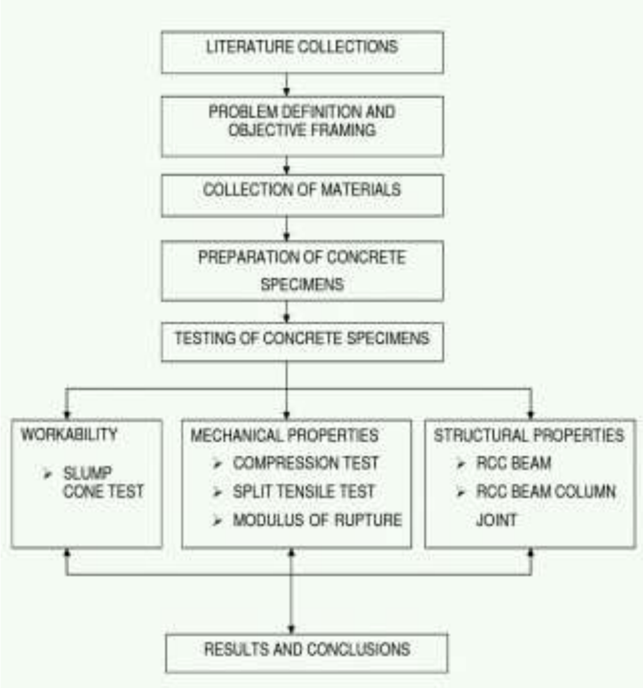
Step 1: Literature collections
Step 2: Problem definition and objective framing
Step 3: Collection of materials
Step 4: Preparation of Concrete specimens
Step 5: Testing of Concrete Specimens

1. Workability - Slump cone test
2. Mechanical Properties
   a) Compression test
   b) Split tensile test

c) Modulus of rupture test
3. Structural Properties
a) RCC beam
b)RCC Beam – Column joint

Step 6: Results and Conclusions

4.2METHODOLOGY CHART



4.3 MIX PROPORTIONS

The control mixture included only ordinary Portland cement as the binder while the remaining mixtures incorporated binary, ternary, quaternary cementitious blends in which a proportion of Portland cement was replaced with the mineral admixtures. Mixture proportions are summarized as follows.

MIX DESIGN

INDIAN STANDARD METHOD FOR USING MIX DESIGN

4.3.1 GENERAL:

This Method Is Recommended for designing Mixed for general Types of Construction, Using the ingredients of Concrete normally available .The Design Is carried out for specified Compressive Strength and Workability of Concrete Using Continuously graded aggregate. The method can be for both, reinforcedand Pre stressed concrete.

The Assumption Made In IS Method:

Compressive strength of Concrete Is based on the water cement ratio of the concrete mix .Further, for a given type, Shape, Size, and grading of aggregate, the amount of water determines the workability for normal concretes.

4.1 Design data for M20mix:

STIPULATIONS FOR PROPORTIONING:

Characteristic compressive strength Required at 28 Days	20mpa
Maximum Size Of Aggregate	20mm
Degree of Workability	50mm(slump)
Degree of quality Control	Good
Type of exposure	Moderate

DESIGN MIX FOR CONCRETE M20GRADE:

1. STIPULATIONS FOR PROPORTIONING:

Grade of designation : M20
Type of cement : OPC 53 grade conforming to IS12269
Maximum nominal size of aggregate: 20mm
Maximum water cement ratio : 0.55(From IS 456:2000,Table no.5)
Minimum cement content :300kg/M3(FromIS456:2000, Table no5)
Workability : 50mm (From IS 456:2000, Page no.17) Exposure condition : Mild (For reinforced concrete)
Method of concrete placing : Normal Degree of supervision : good
Type of aggregate : crushed angular aggregate
Maximum cement content : 450/kg/ m^3
Chemical admixture type : nil

2. FOR TEST DATA MATERIALS:

Cement used : OPC 53 grade conforming to IS 8112
Specific gravity of cement : 3.15
Chemical admixture : nil

3. SPECIFIC GRAVITY OF:

Coarse aggregate : 2.76
Fine aggregate : 2.68

4. WATER ABSORPTION:

Coarse aggregate : 0.90 percent
Fine aggregate : 0.42 percent

5. FREE (SURFACE) MOISTURE:

Coarse aggregate : Nil (absorbed moisture also nil)
Fine aggregate : Nil

6. SIEVE ANALYSIS:

Coarse aggregate : Conforming to grading Zone III of Table5 IS383
Fine aggregate : Conforming to grading Zone II of Table 4 IS 383

7. TARGET STRENGTH FOR MIX PRORTIONING:

F_{ck}' $=f_{ck}+1.65s$

Where,

F_{ck}'= target average compressive strength at 28 days,

F_{ck} = characteristic compressive strength at 28 days, and

S = standard deviation.

From Table 1, standard deviation S =4 N/ mm^2

Therefore, target strength =20+1.65*5 =26.60 N/mm^2

8. SELECTION OF WATER CEMENT RATIO:

From table5 of is 456, maximum water- cement ratio =0.55

Based on experience, adopt water- cement ratio as = 0.50

0.50<0.55, hence o.k.

9. SELECTION OF WATER CONTENT:

From table 2, maximum water content =186 liter (for 25to50mm

slump range) for 20mm aggregate

Estimate water content for 50mm slump = 186liters

10. **CALCULATION OF CEMENT CONTENT**:

Water- cement ratio = 0.50

Cement content =186/0.50 =372kg/M3

Minimum cement content : 300 kg/M3 (From table5 of is 456 'severe'

exposure condition

300kg/M3<372kg/M3, hence o.k.

PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT:

From table3 of IS 10262:2009Page no 3, Volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate(Zone II) for water cement ratio0.50=0.60

Therefore,

Volume of coarse aggregate =0.62

Volume of fine aggregate = 1-0.62 =0.38

MIX CALCULATION:

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1m^3

b) Volume of cement = $\frac{\text{mass of cement}}{\text{specific gravity of cement}} \times \frac{1}{1000}$

$= \frac{372}{3.15} \times \frac{1}{1000}$

= 338kg/m^3

C) Volume of water = $\frac{\text{mass of water}}{\text{specific gravity of water}} \times \frac{1}{1000}$

$= \frac{186}{1} \times \frac{1}{1000}$ = 192kg/ m^3

d) Volume of all in aggregate = [a-(b+c)]

=1-(0.118+0.1)

=0.696 m^3

e) Mass of coarse aggregate = $d \times$ volume of coarse aggregate $\times$ specific gravity of coarse aggregate $\times$ 1000= 0.696x0.62x2.76x1000

= 1188kg/ m^3

f) Mass of fine aggregate = $d \times$ volume of fine aggregate $\times$ specific gravity of fine aggregate $\times$ 1000

= 0.696x0.38x2.68x1000

= 546kg/ m^3

MIX PRORTIONING FOR TRIAL 1:

Cement =383 kg/ m^3

Water =192kg/ m^3

Fine aggregate =546 kg/ m^3

Coarse aggregate = 1188kg/ m^3

Watercement ratio =0.50

Mix ratio = 1 : 1.45 : 3.10

Table 4.2 Mix Proportions with volume fraction

Description	**W/C Ratio**	**W** (kg)	**C (kg)**	**FA (kg)**	**CA (kg)**	PA
Textile Fiber Reinforced Concrete	0.50	192	383	546	1188	(approx.)

DESCRIPTION

W/C - Water cement ratio

C - Cement

FA -Fine aggregate

CA - Coarse aggregate

PA - Polymer acrylic resin

Table.4.3 Fibre weight calculations for Workability (Slump cone test)

Fiber	Density(g/m3)	Volume of mould (m3)	Fiber weight (gm)			
			0.50%	1%	1.50%	2%
Nylon	958693.6	7.069×10^{-3}	33.89	67.77	101.66	135.54
Woolen	83140.79	7.069×10^{-3}	2.94	5.88	8.82	11.76
Cotton	131088.81	7.069×10^{-3}	4.63	9.26	13.89	18.52

Table.4.4 Fibre weight calculations for Compressive strength of Cube (150 mm)

Fiber	Density(g/m3)	Volume of mould (m3)	Fiber weight (gm)			
			0.50%	1%	1.50%	2%
Nylon	958693.6	3.375×10^{-3}	16.18	32.36	48.53	64.7
Woolen	83140.79	3.375×10^{-3}	1.4	2.81	4.21	5.61
Cotton	131088.81	3.375×10^{-3}	2.21	4.42	6.64	8.85

Table.4.5 Fibre weight calculations for Split tensile strength of Cylinder (150 mm x 300mm)

Fiber	Density(g/m3)	Volume of mould (m3)	Fiber weight (gm)			
			0.50%	1%	1.50%	2%
Nylon	958693.6	5.3014×10^{-3}	25.41	50.82	76.24	101.64
Woolen	83140.79	5.3014×10^{-3}	2.204	4.408	6.612	8.82
Cotton	131088.81	5.3014×10^{-3}	3.48	6.95	10.44	13.92

Table.4.6 Fibre weight calculations for conducting Flexural strength with prism (500 mm x 100mm x 100mm)

Fiber	Density(g/m3)	Volume of mould (m3)	Fiber weight (gm)			
			0.50%	1%	1.50%	2%
Nylon	958693.6	5×10^{-3}	25.415	50.82	76.24	101.64
Woolen	83140.79	5×10^{-3}	2.204	4.408	6.612	8.82

Table.4.7 Fibre weight calculations for conducting Flexural strength with prism (700 mm x 150mm x 150mm)

Fiber	Density(g/m3)	Volume of mould (m3)	Fiber weight (gm)			
			0.50%	1%	1.50%	2%
Nylon	958693.6	15.75×10^{-3}	23.97	47.93	71.9	95.87
Woolen	83140.79	15.75×10^{-3}	2.08	4.16	6.24	8.32

Table.4.8 Fibre weight calculations for conducting Woolen Beam (1800 mm x 100mm x 150mm)

Fiber	Density(g/m3)	Volume of mould (m3)	Beam Fiber Volume Fraction-1.5%	Fiber Weight (gm)
Woolen	83140.79	0.027	4.05×10^{-4}	33.67

Table.4.9 Fibre weight calculations for conducting Woolen Beam (600 mm x 150mm x 200mm) – Column (900 mm x 150mm x 200mm) joint

Fiber	Density(g/m3)	Volume of mould (m3)	Beam Fiber Volume Fraction-1.5%	Fiber Weight (gm)
Woolen	83140.79	0.045	6.75×10^{-4}	56.12

V. TESTS ON CONCRETE ELEMENTS

5.1 SLUMP CONE

Slump cone measuring the workability of conventional concrete and Textile fibre reinforced concrete. Slump cone test has been performed as per IS 7320: 1974

5.2 COMPRESSIVE STRENGTH OF CUBE

The Compression test is the most common test conducted on hardened concrete.The cube specimen is of the size 15 X 15 X 15 cm.

Compressive strength of cube test has been performed as per IS 10086: 1982

5.3 SPLIT TENSILE STRENGTH

Direct measurement of tensile strength of concrete is difficult. One of the indirect tension test methods is Split tension test. The Split tensile strength test was carried out on the Compression testing machine. The casting and testing of the specimens were done as per IS5816: 1999.

Split tensile strength=2P/ ld

Where, P = Load applied to the specimen in N
b = Breadth of the specimen in mm
d = depth of the specimen in mm

5.4 FLEXURAL STRENGTH

The extreme fibre stress calculated at the failure of specimen is called Modulus of rupture. It is also an indirect measure to predict the tensile strength of concrete. Flexural strength test was conducted as per recommendations IS: 516 – 1959. For flexural strength test, beams of size 15 x 15 x 70 cm, 10 X 10 X 50 cm were casted. The loading arrangement is done as shown in fig.

Flexural strength, fb = (Pxl)/(bxd^2)

Where, P = Load applied to the specimen in N
l = length of the specimen in mm
b = Breadth of the specimen in mm
d = depth of the specimen in mm

5.5 SPECIMEN DETAILS

This experimental programme consists of casting and testing of Two numbers of 1.8 m long reinforced concrete beams. All the beams were tested over a simply supported span of 1.5 m. The beam was designed as under reinforced section to sustain a minimum ultimate load of 25 kN. The details of reinforcements present in the test beam are shown in Fig4.1. The beam consists of two 8 mm diameter bars at bottom as tensile reinforcement. Another two numbers of 8 mm diameter bars were placed at top. To hold the reinforcements and to act as shear reinforcements, 6 mm diameter stirrups were used at 150 mm centre to centre. HYSD Fe 415 steel was
used as reinforcements. Totally 5 reinforced concrete beams were cast and tested..
The designation for each specimen is given as,

CC	-	Conventional Concrete Beam
WFRC	-	Woolen Fibre Reinforced Concrete Beam
V.F	-	Volume Fraction

5.6 SPECIMENS CASTING

All the beam specimens were cast in wooden moulds. First aggregate and cement were well mixed and then water is added to have an uniform mixture of concrete. All the specimens are filled with concrete and were well compacted. The specimens were demoulded after one day and then placed in a curing tank for 28 days of curing. For 12 hours prior to the testing, the specimens were allowed to air dry in the laboratory.

Tests were carried out at room temperature and as per the India n standards. Structural properties are ascertained by conducting middle third loadi ng test. The testing arrangement is shown in Fig4.3. Two point bending was applied o n reinforced concrete beams of beam spa n 1.5 m through hydraulic jack of capacity 100kN. The specimens were placed on a simply supported arrangement of 100 T Universal testing machine (UTM). Th e beams were suitably instrumented for measuring midspan deflection.

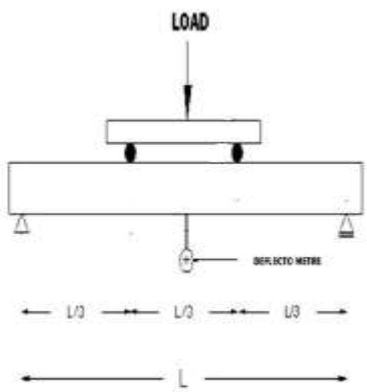


Fig.5.1 Loading Arrangement of Flexural Test

5.7 TESTS ON BEAM – C0LUMN JOINTS

5.7.1 SPECIMEN DETAILS

A total of six exterior beam – column joints were casted according to IS 456:2000 and tested under static loading in this investigation. The longitudinal steel reinforcing bars are deformed, hot rolled, high strength 10mm and 8mm bars. The stirrups (Traverse reinforcement) are made of mild steel bars with 6mm diameter. The yield strength of steel provided is 415N/mm^2 and 250N/mm^2 for 10mm, 8mm bars and 6mm bar respectively. The steel reinforcement used is free from rust.

- **BEAM**

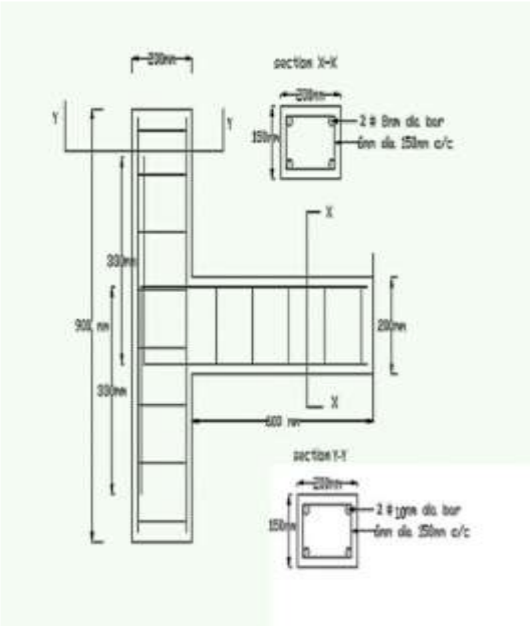
The cross section of the beam = 600 x 200 x 150m

Longitudinal reinforcement = 10 mm diabars
Traverse reinforcement= 6 mm dia bars
Spacing of stirrups = 150 mm c/c distance

- **COLUMN**

The cross section of the beam = 900 x 200 x 150mm
Longitudinal reinforcement = 8 mm dia bar
Traverse reinforcement = 6 mm dia bars Spacing of stirrups = 150 mm c/c distance

Fig 5.2 The reinforcement detailing of structural beam column joint section is shown in the figure



5.7.2 TESTING OF SPECIMENS

Tests were carried out at room temperature in a universal testing machine (UTM) of 100t capacity.A dial gauge was provided at the free end of the beam to measure deflection.The beam was loaded at free end through a hydraulic jack and corresponding deflection was taken.Load – deflection curves was plotted based on the experimental readings.

VI. TEST RESULTS FOR CONVENTIONAL AND TFRC

6.1 WORKABILITY

Conventional concrete Workability (Slump value) = 100 mm

Table 6.1 TFRC WORKABILITY WITH VOLUME FRACTION

SL. NO	FIBERS	V.F – 0.5%	V.F – 1%	V.F – 1.5%	V.F – 2%
1.	Nylon	75 mm	40 mm	30 mm	25 mm
2.	Cotton	20 mm	10 mm	5 mm	0 mm
3.	Woolen	125 mm	65 mm	55 mm	30 mm

6.2 COMPRESSIVE STRENGTH OF CUBE

Table.6.2.1 Nylon-Compressive strength of cubes Nylon-Compressive strength of cubes (Mpa)

Nylon-Compressive strength of cubes (Mpa)			
	No of days	7 days	28 days
	CC M20	17.50	25.00
TFRC M20	V.F 0.5%	24.84	28.22
	V.F 1.0%	27.50	28.36
	V.F 1.5%	12.79	18.29
	V.F 2.0 %	18.22	21.95

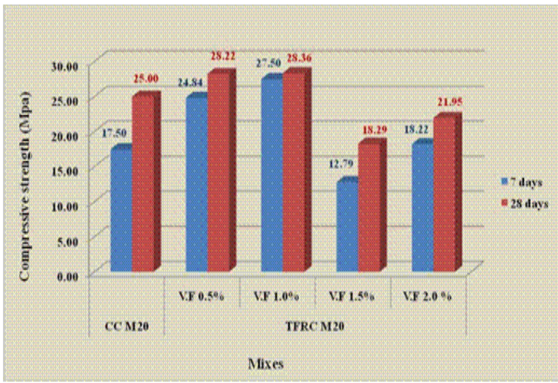
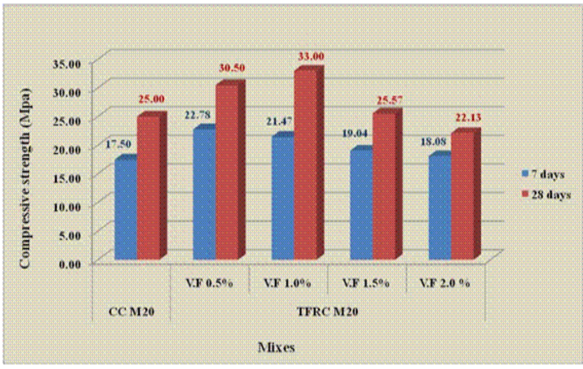


Fig 6.2.1 Comparison of compressive strength of nylon (7&28 days)

Table.6.2.2 cotton-Compressive strength of cubes Cotton-Compressive strength of cubes (Mpa)

Cotton-Compressive strength of cubes (Mpa)			
	No of days	7 days	28 days
	CC M20	17.50	25.00
TFRC M20	V.F 0.5%	22.78	30.50
	V.F 1.0%	21.47	33.00
	V.F 1.5%	19.04	25.57
	V.F 2.0 %	18.08	22.13



6.2.2 Comparison of compressive strength of Cotton (7&28 days)

Table.6.2.3 Woolen-Compressive strength of cubes Woolen-Compressive strength of cubes (Mpa)

Woolen-Compressive strength of cubes (Mpa)			
No of days		7 days	28 days
CC M20		17.50	25.00
TFRC M20	V.F 0.5%	16.19	21.05
	V.F 1.0%	15.78	27.78
	V.F 1.5%	17.56	21.33
	V.F 2.0 %	16.67	17.78

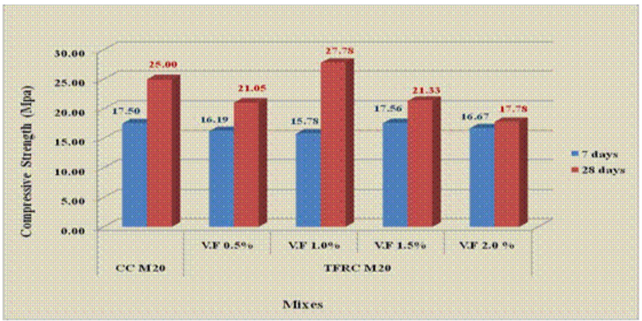


Fig 6.2.3 Comparison of compressive strength of Woolen (7&28 days)

6.3 SPLIT TENSILE STRENGTH OF CYLINDER

Table.6.3.1 Nylon-spilt tensile strength of cylinder Nylon- spilt tensile strength of cylinder (Mpa)

Nylon- spilt tensile strength of cylinder (Mpa)			
No of days		7 days	28 days
CC M20		2.20	2.81
TFRC M20	V.F 0.5%	1.94	2.77
	V.F 1.0%	1.27	2.34
	V.F 1.5%	1.20	1.77

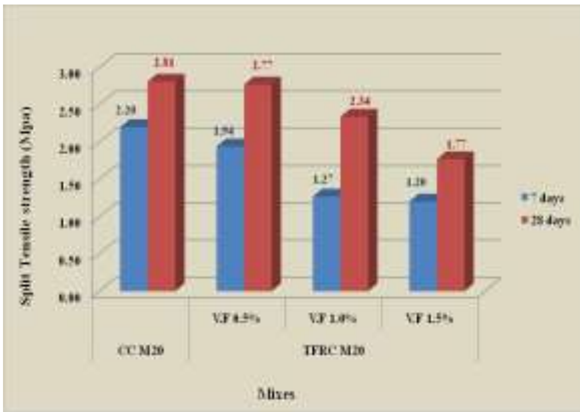


Fig. 6.3.1 Comparison of Split tensile strength of Conventional & Nylon concrete (7 Days & 28 Days - Cylinders)

Table.6.3.2 cotton-spilt tensile strength of cylinder cotton- spilt tensile strength of cylinder (Mpa)

cotton- spilt tensile strength of cylinder (Mpa)			
No of days		7 days	28 days
CC M20		2.20	2.81
TFRC M20	V.F 0.5%	0.80	1.04

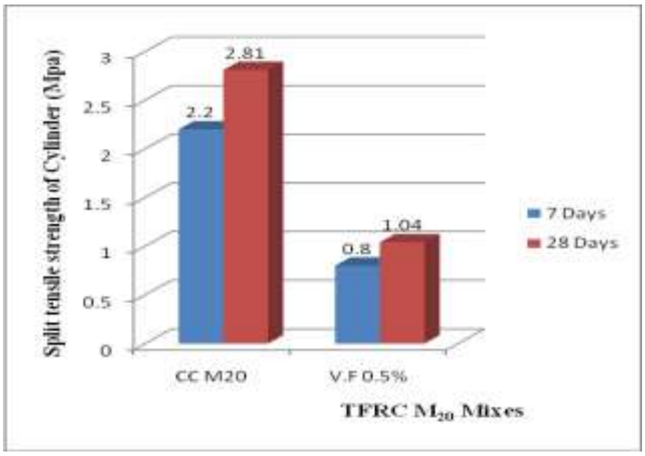


Fig. 6.3.2 Comparison of Split tensile strength of Conventional & Cotton concrete (7 Days & 28 Days - Cylinders)

Table.6.3.3 woolen-spilt tensile strength of cylinder woolen- spilt tensile strength of cylinder (Mpa)

woolen- spilt tensile strength of cylinder (Mpa)		
No of days	7 days	28 days
CC M20	2.20	2.81

TFRC M20	V.F 0.5%	1.20	1.55
	V.F 1.0%	1.42	1.83
	V.F 1.5%	1.49	1.93
	V.F 2.0 %	1.87	2.42

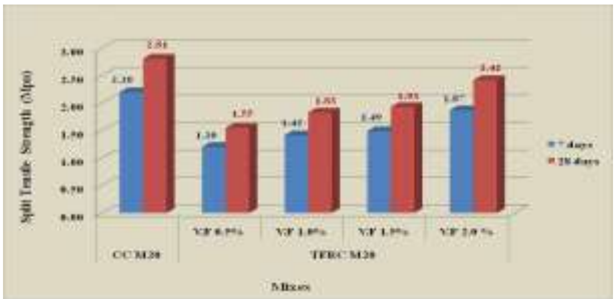


Fig. 6.3.3 Comparison of Split tensile strength of Conventional & Woolen concrete (7 Days & 28 Days - Cylinders)

6.4 FLEXURAL STRENGTH OF PRISMS

Table.6.4.1 Nylon-flexural strength of prism(500mm) Nylon-flexural strength of prism(500mm)

Nylon-flexural strength of prism(500mm x 100mm x100mm)Mpa			
	No of days	7 days	28 days
	CC M20	3.53	4.9
TFRC M20	V.F 0.5%	4.40	5.72
	V.F 1.0%	3.14	3.92
	V.F 1.5%	5.49	7.85
	V.F 2.0 %	3.14	4.32

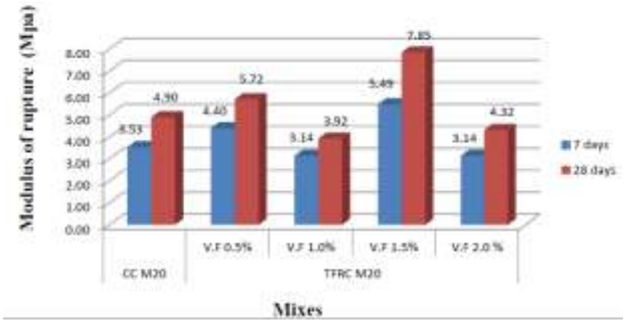


Fig. 6.4.1 Comparison of Flexural strength of Conventional & Nylon concrete (7 Days & 28 Days - Prisms)

Table.6.4.2 Woolen-flexural strength of prism(500mm)Woolen -flexural strength of prism(500mm)

Woolen -flexural strength of prism(500mm x 100mm x100mm)Mpa			
	No of days	7 days	28 days
	CC M20	3.53	4.9
TFRC M20	V.F 0.5%	4.71	6.25
	V.F 1.0%	3.924	7.07
	V.F 1.5%	3.924	7.07
	V.F 2.0 %	3.924	6.25

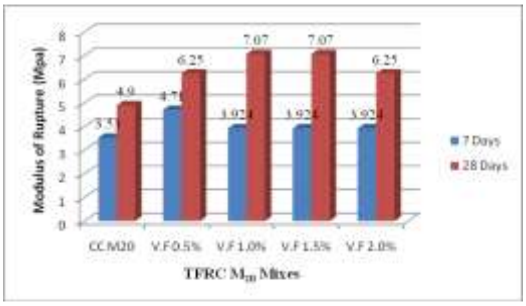


Fig. 6.4.2 Comparison of Flexural strength of Conventional & Woolen concrete (7 Days & 28 Days - Prisms)

Table.6.4.3 Nylon-flexural strength of prism(700mm) Nylon-flexural strength of prism(700mm)

Nylon-flexural strength of prism(700mm x 150mm x150mm)Mpa			
	No of days	7 days	28 days
	CC M20	2.52	3.60
TFRC M20	V.F 0.5%	2.93	3.81
	V.F 1.0%	2.74	3.91
	V.F 1.5%	3.60	4.46

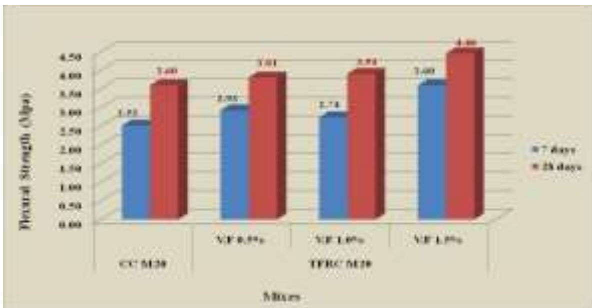


Fig. 6.4.3 Comparison of Flexural strength of Conventional & Nylon concrete (7 Days & 28 Days - Prisms)

Table.6.4.4 Woolen-flexural strength of prism(700mm) Woolen -flexural strength of prism(700mm)

Woolen -flexural strength of prism(700mm x 150mm x150mm)Mpa			
No of days		7 days	28 days
CC M20		2.52	3.60
TFRC M20	V.F 0.5%	3.26	4.25
	V.F 1.0%	3.58	4.65
	V.F 1.5%	2.93	3.81
	V.F 2.0 %	2.60	3.39

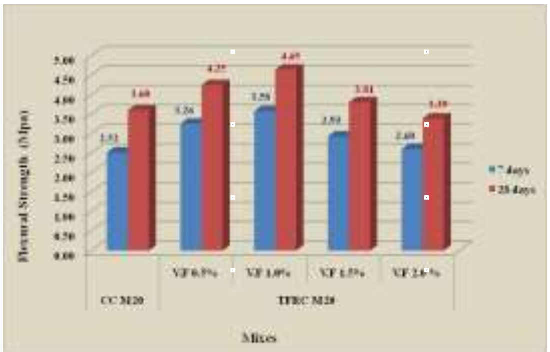


Fig. 6.4.4 Comparison of Flexural strength of Conventional & Woolen concrete (7 Days & 28 Days - Prisms)

6.5. RCC BEAM AND TFRC BEAM

Table 6.5.1 Load-Deflection Details (Conventional RCC Beam)

S.NO	LOAD X10^3 N	DEFLECTION (mm)
1	5	0.29
2	10	0.43
3	15	0.67
4	20	0.92
5	25	1.29
6	30	1.84
7	35	2.30
8	40	3
9	45	3.53
10	50	4.31
11	55	5.07
12	60	5.98
13	65	7.32
14	70	8.29
15	75	12.79
16	80	24.39

TABLE 6.5.2 LOAD-DEFLECTION DETAILS (WFRC Beam V.F – 1.5%)

S.NO	LOAD X10^3 N	DEFLECTION (mm)
0	0	0
1	5	0
2	10	0.1
3	15	0.55
4	20	1.02
5	25	1.3
6	30	1.53
7	35	1.77
8	40	2.23
9	45	2.67
10	50	3.1
11	55	4.0
12	60	4.6
13	65	5.1
14	70	5.6
15	75	5.8
16	80	6.0
17	85	6.5
18	90	7.4
19	95	8.1
20	100	11
21	105	15

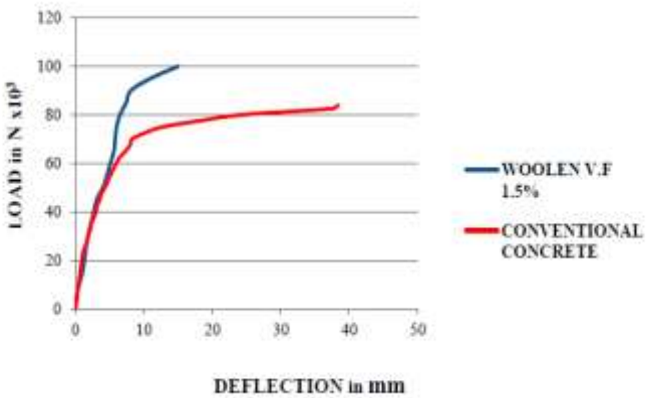


Fig. 6.5 Load- Deflection curve for (28 Conventional & woolen fibre

6.6 RCC BEAM – COLUMN JOINT SRUCTURAL RESULTS

TABLE 6.6.1 Load – Deflection Values For Rcc Beam – Column Joint

S.NO	LOAD X10^3 N	DEFLECTION (mm)
1	5	3.5
2	10	7.8
3	15	16.2
4	18	40.8

TABLE 6.6.2 Load – Deflection Values For WFRC Beam- Column joint

S.NO	LOAD X10^3 N	DEFLECTION (mm)
1	5	2.45
2	10	6.3
3	15	15
4	18	34
5	20	38
6	22	41

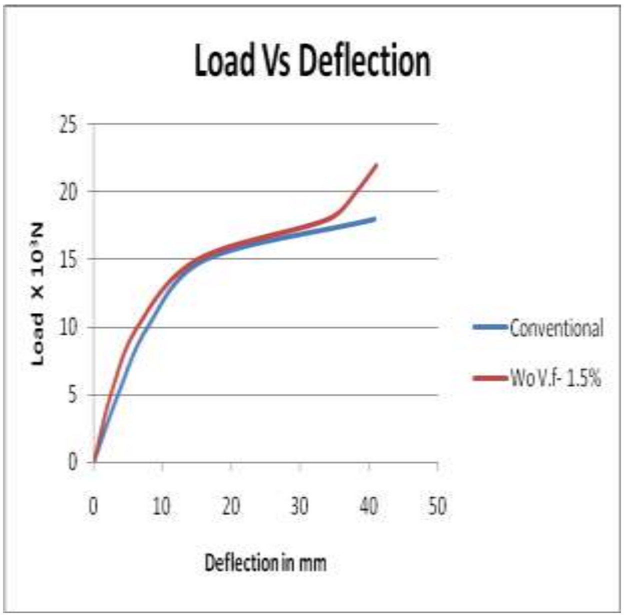


Fig. 6.6 Load- Deflection curve for Conventional & woolen Fibre R cc Beam –Column joint (28 Days)

VII. TEST PHOTOGRAPHS

7.1 TEXTILE FIBERS IN MARKET FORMS

7.2 TEXTILE FIBRE REINFORCED CONCRETE

7.2.1 NYLON MIXING WITH

7.2.2 TFRC CONCRETE

POLYMER ACRYLIC RESIN

7.2.3 WORKABILITY CONDUCTING IN TFRC

7.3 SPECIMENS

7.4 BEAM REINFORCEMENT ERECTION AND BEAM-COLUMN JOINT CAST

7.5 TESTING ON HARDEN CONCRET

VIII. CONCLUSIONS

Based on the workability test conducted for the fibers taken, better results in woolen and nylon than cotton. The compressive strength of cube and cylinder, textile fiber reinforced concrete decreases in strength while percentage of fiber increases.

Comparing the results of compressive strength, split textile strength and flexural strength for cotton, woolen and nylon. The woolen is very good is compression, tension and flexure.

- The compressive strength tested on cubes for different volume fraction of 0.5, 1, 1.5 and 2%, for M_{20} grade concrete is 33 N/mm^2 for cotton, 27.78 N/mm^2 for woolen and 28.36 N/mm^2 for nylon, for the best volume fraction 1% of nylon.
- The split tensile strength tested on cylindrical specimen for a volume fraction of 0.5, 1, 1.5 and 2% for M_{20} grade concrete is 1.04 N/mm^2 for cotton, 2.42N/mm^2 for woolen and 2.34 N/mm^2 for nylon, for the best volume fraction is 2% of woolen.
- The flexural strength of M_{20} grade concrete tested on prism is 4.65 N/mm^2 for woolen and 4.46 N/mm^2 for Nylon for the best volume fraction of 1% of woolen.

Thus comparing all the fibers, woolen is very good in compression, tension and flexural strength with a minimum volume fraction of 1% Compared to conventional M20 grade RCC beam and beam column joint WFRC beam and beam column joint with volume fraction 1.5% takes maximum load with minimum deflection.

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Figure 6.3.2, 6.4.1, 6.4.2 pg no 32,33 (bar chart back ground color must be added)

Two bar chart are added for nylon flexural strength 500*100 pg.no 33
Figure 6.5 load deflection curve (graph x and y axis no are not shown) pg no 34