AN EXPERIMENTAL STUDY ON FLEXURAL STRENGTH OF CONCRETE USING STEEL AND GLASS FIBER

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SUBMITTED BY

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DECLARATION

I declare that the research thesis entitled “**AN EXPERIMENTAL STUDY ON FLEXURAL STRENGTH OF CONCRETE USING STEEL AND GLASS FIBRE** ” is the bonafide research work carried out by me, under the guidance of **Dr. SABIH AHMAD** , Associate Professor , Department of Civil Engineering , Integral University, Lucknow. Further I declare that this work has not previously formed the basis award of any degree, diploma, associate-ship or other similar degree or diplomas, and has not been submitted anywhere else.

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Certified that the thesis entitled "**AN EXPERIMENTAL STUDY ON FLEXURAL STRENGTH OF CONCRETE USING STEEL AND GLASS FIBRE** "is being submitted by **MEHTAB ALAM** (1901431014) in partial fulfillment of the requirement for the award of degree of Master of Technology in Structural Engineering at Integral University, Lucknow, is a record of candidate's own work carried by him under my supervision and guidance.

The results presented in the thesis have not been submitted to any other University or Institute for the award of any other degree or diploma.

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INTRODUCTION

1.1 GENERAL

Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. The concept of using fibers in a brittle matrix was first recorded with the ancient Egyptian who used the hair of animals and straw as reinforcement for mud bricks and walls in housing. This dates back to 1500 B.C.

But those researches are completely different from the current study, since they have concentrated along the material strength properties not on their structural behavior. According to the terminology adopted by American Concrete Institute (ACI) Committee 544, there are four catagories of Fibre Reinforced Concrete namely 1) SFRC (Steel Fibre Reinforced Concrete), 2) GFRC (Glass Fibre Reinforced concrete), 3) SNFRC (Synthetic Fibre Reinforced Concrete) and 4) NFRC (Natural Fibre Reinforced Concrete). It also provides the information about various mechanical properties and design applications.

Cost effective improvement of the mechanical performances of structural materials is an important goal in construction industry. To improve the flexural strength of plain concrete so as to reduce construction costs, the addition of fibers to the concrete mixture can be adopted. The addition of small steel fibers with different lengths and proportion have experimentally been analyzed in terms of concrete flexural strength enhancement.

Flexural strength and time to failure of fiber reinforce concrete could be further enhanced if, instead of smooth steel fibers, corrugated fibers were used.

1.2 Necessity of FRC

The use of concrete as a structural material is limited to certain extent by deficiencies like brittleness, poor tensile strength and poor resistance to impact strength, fatigue, low ductility and low durability. It is also very much limited to receive dynamic stresses caused due to explosions. The brittleness is compensated in structural member by the introduction of reinforcement (or) pre-stressing steel in the tensile zone. However it does not improve the basic property of concrete. It is merely a method of using two materials for the required performance. The main problem of low tensile strength and the requirements of high strength still remain and it is to be improved by different types of reinforcing materials.

Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion, and shatter resistance in concrete.

Fiber reinforced concrete (FRC) is **concrete** containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers.

Fiber is a small piece of reinforcing material possessing certain characteristics properties. They can be circular or flat. The fiber is often described by a convenient parameter called "aspect ratio". The aspect ratio of the fiber is the ratio of its length to its diameter. Typical aspect ratio ranges from 30 to 150.

Fibre-reinforcement is mainly used in concrete, but can also be used in normal concrete. Fibre-reinforced normal concrete are mostly used for on-ground floors and pavements. Concrete reinforced with fibres is less expensive than conventional reinforcements, while still increasing the tensile strength many times. Shape, dimension and length of fibre is important. A thin and short fibre, for example short hair-shaped glass fibre, will only be effective the first hours after pouring the concrete (reduces cracking while the concrete is stiffening) but will not increase the concrete tensile strength.

Following are the benefits one can obtain of a fibre reinforced concrete:

1. It increases the tensile strength of the concrete.
2. It reduces the air voids and water voids the inherent porosity of gel.
3. It increases the durability of the concrete.
4. Fibers such as graphite and glass have excellent resistance to creep. Therefore, the orientation and volume of fibers have a significant influence on the creep performance of reinforcement.
5. It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties.

1.3 Materials and Mix Proportions

Steel and Glass fiber concrete primarily consist of cement, fine aggregate, coarse aggregate, steel fiber, glass fiber, admixture and water.

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1.3.1 Coarse Aggregate

Coarse aggregates are an essential construction constituents made of rock quarried from ground deposits. It reduces shrinkage and effect economy. The mere fact that the aggregates occupy 70-80 percent of the volume of concrete with their various properties.
Angular aggregates exhibit a better interlocking effect in concrete, which property makes it superior in concrete. The size range between 4.75mm and 80mm falls in coarse aggregate but most preferable for concrete is 10mm and 20mm range aggregate size having angular shape.

‘Aggregate’ is a term for any particulate material. It includes gravel, crushed stone, sand, slag, and recycled concrete and geosynthetic aggregates. Aggregate may be natural, manufactured or recycled.

Consider concrete as a matter containing different particles (aggregates of different sizes) joined together by binder Material I.e. cement, flash etc. our priority is that voids in final concrete should be least...aggregates help in filling those voids...preference for aggregates is always such that one must be getting uniformly graded aggregates I.e. of various sizes and in good proportion.. That's why sieve analysis is done for aggregates...what happens is that 10 mm aggregates fill the voids left by 20 mm aggregates, sand fill the void left by 10 mm aggregates..to determine that whether aggregates of all sizes are there in good proportion combined all in one grading is done, whose range is given in IS 383...one can say more denser the concrete is packed more would be the strength...therefore...on moving to higher grades of concrete one need to think of remaining voids that are left even after adding everything in good proportion..For that micro silica/alccofine (extremely fine material) is added to the existing mix..Resulting in concrete with higher compaction and greater density. ..

Also, aggregates also takes some load that's why we have impact, crushing test etc..but one need not worry about these with the strength as long as they are coming within the limit of 30% as specified by IS code..but again beyond certain grades one would have to think about these values as the concrete will not be able to take loads if aggregates are not up to the mark...because in these cases whiles taking load aggregates will start breaking first which will ultimately result in concrete failure. .

• Aggregates make up some 60 -80% of the concrete mix. They provide compressive strength and bulk to concrete.

• Aggregates in any particular mix of concrete are selected for their durability, strength, workability and ability to receive finishes.

• For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

• Aggregates are divided into either '**coarse**' or '**fine**' categories.

- Coarse aggregates are particulates that are greater than 4.75mm. The usual range employed is between 9.5mm and 37.5mm in diameter.

- **Fine** aggregates are usually sand or crushed stone that are less than 9.55mm in diameter.

• Typically the most common size of aggregate used in construction is 20mm. A larger size, 40mm, is more common in mass concrete.

• Larger aggregate diameters reduce the quantity of cement and water needed.

Fig.1.3.1 coarse aggregate

1.3.2 Fine Aggregate

Fine aggregates are essentially any natural sand particles won from the land through the mining process. Fine aggregates consist of natural sand or any crushed stone particles that are ¼" or smaller. This product is often referred to as 1/4'" minus as it refers to the size, or grading, of this particular aggregate.

Or

Fine aggregate (Sand) Fills voids between aggregates. It forms the bulk and makes mortar or concrete economical. It provides resistance against shrinking and cracking. It is naturally available.

Fine aggregates are small size filler materials in construction. When the particles of the granular material are so fine that they pass through a 4.75mm and get retained on 0.075 mm sieve, it is called fine aggregates, used to produce concrete or mortar. Fine aggregate can be natural or crushed depending upon the local availability.

“Fine aggregate” means sand which is a mixture of small particles of grains & minerals which passes under 9 mm sieve & it is used for construction purposes like mixing in concrete & farming works etc. There are two types of sand like river sand & M sand , river sand means which i have mentioned above M sand(manufactured sand) which is crushed from coarse aggregates through crushing machines, nowadays M sand is rocking in the city because its eco friendly & low in cost.

Reduce using river sand because it is very useful for our nature & go with M sand.

“Coarse aggregate” means which is breaked from rocks using explosives & crushed into pieces using machines & coarse aggregate sizes 6mm,12mm,20mm,40mm,60mm are divided using big sieves in machines & coarse aggregate like 6,12,20mm is used to mix in concrete for construction purposes & 40mm is used for railroads.

Fig.1.3.2 fine, coarse aggregates

1.3.3 Cement (Binder Materials)

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. First ordinary Portland cement invented by Joseph Aspdin , England. Apart from OPC, PPC can be also used as a binder material having fly based up to 35% .The raw material required for the manufacture of Portland cement are calcareous materials such as limestone or chalk , and argillaceous material such as shale or clay with addition of 3-5% of gypsum (retarder).

Different Types of Cement

- Ordinary Portland **Cement** (OPC) ...
- Portland Pozzolana **Cement** (PPC) ...
- Rapid Hardening **Cement**. ...
- Extra Rapid Hardening **Cement**. ...
- Low Heat **Cement**. ...
- Sulfates Resisting **Cement**. ...

- Quick Setting **Cement**. ...
- Blast Furnace Slag **Cement**.
- **Ordinary Portland Cement (OPC)**
- **Portland cement** is the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and non-specialty grout. It was developed from other types of hydraulic lime in England in the early 19th century by Joseph Aspdin, and is usually made from limestone. It is a fine powder, produced by heating limestone and clay minerals in a kiln to form clinker, grinding the clinker, and adding 2 to 3 percent of gypsum. Several types of portland cement are available. The most common, called ordinary portland cement (OPC), is grey, but white portland cement is also available. Its name is derived from its resemblance to Portland stone which was quarried on the Isle of Portland in Dorset, England. It was named by Joseph Aspdin who obtained a patent for it in 1824. However, his son William Aspdin is regarded as the inventor of "modern" portland cement due to his developments in the 1840s.[1]
- Portland cement is caustic, so it can cause chemical burns.[2] The powder can cause irritation or, with severe exposure, lung cancer, and can contain a number of hazardous components, including crystalline silica and hexavalent chromium. Environmental concerns are the high energy consumption required to mine, manufacture, and transport the cement, and the related air pollution, including the release of the greenhouse gas carbon dioxide, dioxin,[NO_x, SO_2, and particulates. Production of portland cement contributes about 10% of world carbon dioxide emissions.[3] The International Energy Agency has estimated that cement production will increase by between 12 and 23% by 2050 to meet the needs of the world's growing population.[4] There are several ongoing researches targeting a suitable replacement of Portland cement by supplementary cementitious materials.[5]
- The low cost and widespread availability of the limestone, shales, and other naturally-occurring materials used in Portland cement make it one of the lowest-cost materials widely used over the last century. Concrete produced from Portland cement is one of the world's most versatile construction materials.

Portland Pozzolana Cement (PPC)

The Portland Pozzolana Cement is a kind of Blended Cement which is produced by either inter grinding of OPC clinker along with gypsum and pozzolanic materials in certain proportions or grinding the OPC clinker, gypsum and Pozzolanic materials separately and thoroughly blending them in certain proportions.

Portland Pozzolana *Cement* also commonly known as *PPC cement*. These types of *cement* are manufactured by using pozzolanic materials as one of the main ingredient. The percentage of pozzolanic material used in the preparation should be between 10 to 30. If the percentage is exceeded, the strength of *cement* is reduced.

Pozzolana is a natural or artificial material containing silica in a reactive form. It may be further discussed as siliceous or siliceous and aluminous material which in itself possesses little, or no cementitious properties but will in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties. It is essential that pozzolana be in a finely divided state as it is only then that silica can combine with calcium hydroxide (liberated by the hydrating Portland Cement) in the presence of water to form stable calcium silicates which have cementitious properties.

The pozzolanic materials commonly used are:

- Volcanic ash
- Calcined clay
- Fly ash
- Lica fumes

In Indian retail market PPC cement is available in bags of 50 kg.

Typical constituents of portland clinker plus gypsum showing Cement chemist notation (CCN)		
Clinker	**CCN**	**Mass (%)**
Tricalcium silicate $(CaO)_3 \cdot SiO_2$	C_3S	25-50%
Dicalcium silicate $(CaO)_2 \cdot SiO_2$	C_2S	20–45%
Tricalcium aluminate $(CaO)_3 \cdot Al_2O_3$	C_3A	5–12%
Tetra calcium aluminoferrite $(CaO)_4 \cdot Al_2O_3 \cdot Fe_2O_3$	C_4AF	6–12%
Gypsum $CaSO_4 \cdot 2\ H_2O$	$C\overline{S}H_2$	2–10%

Typical constituents of portland cement showing Cement chemist notation		
Cement	**CCN**	**Mass (%)**
Calcium oxide, CaO	C	61–67%
Silicon dioxide, SiO_2	S	19–23%

Aluminum oxide, Al_2O_3	A	2.5–6%
Ferric oxide, Fe_2O_3	F	0–6%
Sulfur (VI) oxide, SO_3	$\bar{S}$	1.5–4.5%

1.3.4 Glass Fiber

Glass fiber is made up (or glass fibre) of consisting of several extremely fine fibers of glass. The first commercial production of glass fiber was in 1936. In 1938 Owens-Illinois Glass Company and Corning Glass Works joined to form the Owens-Corning Fiberglas Corporation. It has **high tensile strength**. Glass has greater **tensile strength** than steel wire of the same diameter, at a lower weight. Glass has an amorphous structure by which its properties are same along and across the fiber.

An individual structural glass fiber is both stiff and strong in tension and compression that is, *along* its axis. Although it might be assumed that the fiber is weak in compression, it is actually only the long aspect ratio of the fiber which makes it seem so; i.e., because a typical fiber is long and narrow, it buckles easily. On the other hand, the glass fiber is weak in shear—that is, *across* its axis. Therefore, if a collection of fibers can be arranged permanently in a preferred direction within a material, and if they can be prevented from buckling in compression, the material will be preferentially strong in that direction.

- Improve concrete strength at low cost.
- Adds tensile reinforcement in all directions, unlike rebar.
- Add a decorative look as they are visible in the finished concrete surface.

Fig.1.3.4 glass fiber

1.3.5 Steel Fiber

Historically, horsehair was used in mortar and straw in mud bricks by the 1960s, **steel**, glass (GFRC), and synthetic (such as polypropylene) **fibers** were used in concrete. **Fibers** have been used as reinforcement since ancient times.

Steel fiber is a **metal** reinforcement. A certain amount of **steel fiber** in concrete can cause qualitative changes in concrete's physical property **Steel fibers strengthen concrete by resisting tensile** cracking. **Fiber** reinforced **concrete** has a higher flexural strength than that of unreinforced **concrete**.

Glass fiber-reinforced concrete consists of high-strength, alkali-resistant glass fiber embedded in a concrete matrix.[1] In this form, both fibers and matrix retain their physical and chemical identities, while offering a synergistic combination of properties that cannot be achieved with either of the components acting alone. In general, fibers are the principal load-carrying members, while the surrounding matrix keeps them in the desired locations and orientation, acting as a load transfer medium between the fibers and protecting them from environmental damage. The fibers provide reinforcement for the matrix and other useful functions in fiber-reinforced composite materials. Glass fibers can be incorporated into a matrix either in continuous or discontinuous (chopped) lengths.

Durability was poor with the original type of glass fibers since the alkalinity of cement reacts with its silica. In the 1970s alkali-resistant glass fibers were commercialized.[2] Alkali resistance is achieved by adding zirconia to the glass. The higher the zirconia content the better the resistance to alkali attack. AR glass fibers should have a Zirconia content of more than 16% to be in compliance with internationally recognized specifications

GFRC is incredibly versatile and has a large number of use cases due to its strength, weight, and design. The most common place you will see this material is in the construction industry. It's used in very demanding cases such as architectural cladding that's hanging several stories above sidewalks or even more for aesthetics such as interior furniture pieces like GFRC coffee tables.

- Improve structural strength
- Reduce steel reinforcement requirements
- Reduce crack widths and control the crack widths tightly, thus improving durability
- Improve impact– and abrasion–resistance
- Improve freeze-thaw resistance

Fig.1.3.5 steel fiber

1.3.6 Admixture

Admixtures are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes. Admixture is defined as a material, other than cement water and aggregates that is used as an ingredient of concrete and is added to the batch immediately before or during mixing to modify its freshly mixed, setting, or hardened properties.

They are:

- **Type** A: Water-reducing **admixtures**.
- **Type** B: Retarding **admixtures**.
- **Type** C: Accelerating **admixtures**.
- **Type** D: Water-reducing and retarding **admixtures**.

- **Type** E: Water-reducing and accelerating **admixtures**.
- **Type** F: Water-reducing, high range **admixtures**.
- **Type** G: Water-reducing, high range, and retarding **admixtures**.

Chemical admixtures reduce the cost of construction, modify properties of hardened concrete, ensure quality of concrete during mixing/transporting/placing/curing and overcome certain emergencies during concrete operations. Chemical admixtures are used to improve the quality of concrete during mixing, transporting, placement and curing.

Water Reduction in the Mix

Water reducers have become so important in concrete, that they could be considered the "fifth" ingredient.

They can be used to: (1) increase slump, (2) lower the water-cement ratio, or (3) reduce cement content.

Water reducers come as Low Range, Mid Range, and High Range Superplasticizers. There are enough different admixtures available that it is possible to select one that meets the need of a particular project whether it is tall columns that need a mix that pumps easily, or an easy-to-finish durable floor slab.

In general, they provide the required slump with less water in the mix, and may provide higher strength concrete without increasing the amount of cement.

Fig.1.3.6 admixture

1.3.7 Water

The amount of **water in concrete** controls many fresh and hardened properties in **concrete** including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking. Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quality and quantity of water is required to be looked very carefully. Water should be free from all contaminated particles and should be potable.

1.3.8 Mix proportions

In Indian standards, the **mixes** of grades M10, M15, M20 and M25 correspond approximately to the **mix proportions** (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively. Design **mix ratios** are decided by an engineer after analyzing the properties of the specific ingredients being used. The mixture proportioning of the concrete mix is done as per the latest IS codal provision IS-10262-2019, IS-383-2016 and with reference of IS-456:2000. The steel and glass fibers are uniformly mixed with concrete as per percentage ratio.

Mix proportion denotes the quantity of materials taken to prepare concrete of required strength relatively (with cement).

For example: M20, M30 and so on.

In this designation the letter M refers to the **mix** and the number to the specified 28 day cube strength of **mix** in N/mm^2. The **mixes** of grades M10, M15, M20 and M25 correspond approximately to the **mix proportions** (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively.

M10 mix proportion contains 1 part cement, 3 parts fine aggregate, 6 parts coarse aggregate.

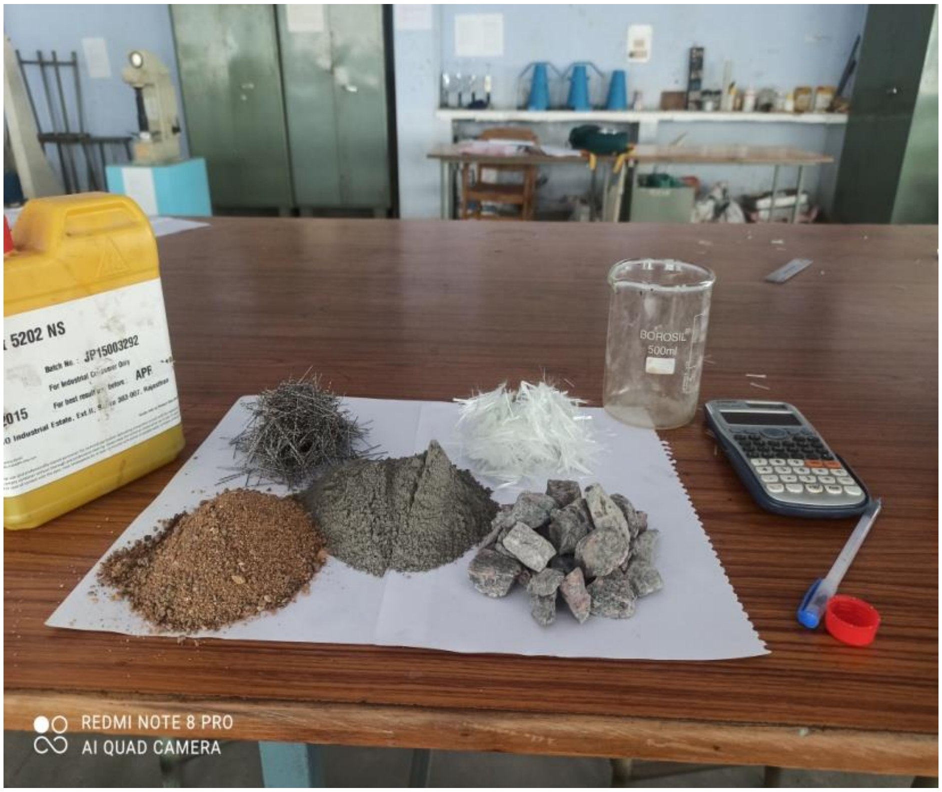


Fig.1.3.8 all ingredients

CHAPTER 02

LITERATURE REVIE

CHAPTER -2 LITERATURE REVIEW

LITERATURE REVIEW

2.1 General

This section presents a literature review on steel and glass fibre concrete. A number of experiments have been previously conducted throughout past few decades by variety of researchers for improving the flexural strength of concrete. Current literature review survey focus on the flexural strength of concrete enhancement using steel and glass fiber.

2.2 Review of studies on flexural strength of concrete using fibers

Rami H. Haddad and Ahmed M. Asteyate (2001)[1] A numerical approach for the evaluation of the flexural response of Steel Fibrous Concrete (SFC) cross-sections with arbitrary geometry, with or without conventional steel longitudinal reinforcing bars is proposed. Resisting bending moment versus curvature curves are calculated using verified non-linear constitutive stress-strain relationships for the SFC under compression and tension which include post-peak and post-cracking softening parts. A new compressive stress-strain model for SFC is employed that has been derived from test data of 125 stress-strain curves and 257 strength values providing the overall compressive behavior of various SFC mixtures. The proposed sectional analysis is verified using existing experimental data of 42 SFC beams, and it predicts the flexural capacity and the curvature ductility of SFC members reasonably well. The developed approach also provides rational and more accurate compressive and tensile stress-strain curves along with bending moment versus curvature curves with regards to the predictions of relevant existing models.

CB Kukreja and sanjeev chawla [I989][2] Present study is to investigate the behavior of composite beams of M20 Grade of concrete mix having size of 100 mm x 100 mm x 500 mm with varying percentages of fibre content under a combined state of flexure and direct compression. Straight cylindrical fibers of length 28 mm and diameter of 0.28 mm with aspect ratio of 100 were used. Twelve beam specimens each with 0, 0.5, 0.75 and 1% fibre percentages by weight were cast. Therefore in total forty eight beams were cast. These beams were tested as simply supported beams in flexure along with direct compression of 0, 50, 100, and 125 kN. The beams were tested such that for each percentage of fibre content, all the four values of direct compression were applied for each set of three beams. From the experimental study, it has been observed that the value of ultimate bending strength and deflection increases with the increase in the value of compression for a particular percentage of fibre content. The ductility increases as the value of compression increases for a particular percentage of fibers.

(Shende.A.M.1, Pande.A.M.2)[3] Fiber reinforced concrete, a composition of concrete and fibers is being prominently used for various important applications. The hook taint steel fibers assist in controlling the propagation of micro-cracks present in the matrix, first by improving the overall cracking resistance the matrix and later by bridging across even smaller cracks formed after the application of load on to the member thereby preventing there widening into major cracks. In the present paper, the effect of steel fibre reinforcement with different percentage of fibre 0, 1%, 2% and 3% by volume for M-40 grade of concrete with aspect ratio 50, 60 and 67 are studied. The beam is tested for flexural strength. The percentage increase through utilization of steel fibers is reported. A relationship between aspect ratio vs. flexural strength represented graphically.

HA Abadalla (2002)[4] The use of fibre reinforced polymer (FRP) reinforcements in concrete structures has increased rapidly in the last 10 years due to their excellent corrosion resistance, high tensile strength, and good non-magnetization properties. However, the low modulus of elasticity of the FRP materials and their non-yielding characteristics results in large deflection and wide cracks in FRP reinforced concrete members. Consequently, in many cases, serviceability requirements may govern the design of such members. This paper describes the development of simple approaches in estimating the deflection of FRP reinforced concrete members subjected to flexural stresses. The predictions of these approaches are compared with the experimental results obtained by testing seven prototype concrete beams reinforced with glass fibre reinforced polymer, GFRP, and carbon fibre reinforced polymer, CFRP, bars. The proposed analytical methods are also substantiated by test results available in the literature from eight concrete slabs reinforced with conventional steel, GFRP, and CFRP bars. Good agreement was shown between the theoretical and the experimental results.

(Carlos G.Berrocal[ab]IngemarLöfgren[ab]KarinLundgren 2018)[5] this paper reports the results of an experimental programme aimed at investigating the influence of fibre reinforcement on the corrosion process of conventional steel rebar embedded in cracked concrete and on the flexural behavior of reinforced concrete beams. Un- and pre-cracked reinforced concrete beams were subjected to natural corrosion through cyclic exposure to a 10% chloride solution for a period of three years. Subsequently, flexural tests were carried out under three-point bending configuration. Gravimetric measurements showed higher corrosion levels for bars in plain concrete compared to fibre reinforced concrete, and visual inspection of the bars revealed that fibers promoted a more distributed corrosion pattern. From detailed examination of the bars through 3D laser scanning technique, the main parameter controlling the local corrosion level of individual pits appears to be the local interfacial conditions; grater loads during pre-cracking and repeated load cycles yielded greater cross-sectional losses. Moreover, there was a tendency for more localized corrosion in beams with open cracks, indicating a possible impact of crack width on the extension of corrosion. The results from the flexural tests showed a consistent increase of load capacity for fibre reinforced beams compared to their plain concrete counterparts but only a marginal influence of the fibers on the rotation capacity. Furthermore, the rotation capacity of the beams was found to decrease several times faster than the load capacity with increasing loss of rebar cross-sectional area.

(Soon Pohyap U, Johnson Alengaram , Kim Hung Mo & Mohd Zamin Jumaat)[6] This paper presents the results of an experimental impact test conducted using drop hammer on the plain and the fibre reinforced oil palm shell concrete (FROPSC) panels. The variables investigated are different contents of steel (0.75%, 0.9%, 1%) and polypropylene fibers (0.1%, 0.25%, 1%), with uncrushed and crushed OPS. The FROPSC with uncrushed OPS developed higher initial and final impact resistance compared to specimens with crushed OPS. The specimen with 0.9% steel + 0.1% polypropylene (PP) hybrid-FROPSC, developed excellent impact energy of about 17 kJ that was 60 times higher than the plain OPSC. Its impact ductility index (μ_i) of 42 is double the value compared to other specimens. It also showed excellent crack growth resistance due to secondary cracks formation. Final crack widths of FROPSC ranged between 0.079 and

0.507 mm. Further, the compressive energy of 785 J was found for specimen with 1% steel fibers.

Chalioris, Constantin E. Panagiotopoulos, Thomas A. (2018)[7] A numerical approach for the evaluation of the flexural response of Steel Fibrous Concrete (SFC) cross-sections with arbitrary geometry, with or without conventional steel longitudinal reinforcing bars is proposed. Resisting bending moment versus curvature curves are calculated using verified non-linear constitutive stress-strain relationships for the SFC under compression and tension which include post-peak and post-cracking softening parts. A new compressive stress-strain model for SFC is employed that has been derived from test data of 125 stress-strain curves and 257 strength values providing the overall compressive behavior of various SFC mixtures. The proposed sectional analysis is verified using existing experimental data of 42 SFC beams, and it predicts the flexural capacity and the curvature ductility of SFC members reasonably well. The developed approach also provides rational and more accurate compressive and tensile stress-strain curves along with bending moment versus curvature curves with regards to the predictions of relevant existing models.

Aoude, Hassan; Belghiti, Mehdi; Cook, William D.; Mitchell, Denis (2012)[8] A series of nine full-scale reinforced concrete (RC) and steel fiber-reinforced concrete (SFRC) beams were tested to study the effects of steel fibers on shear capacity, failure mechanism, and crack control. Six of the specimens were constructed without shear reinforcement. In addition, three specimens were detailed in accordance with the minimum shear reinforcement requirements of CSA A23.3-04 to examine the influence of fibers on ductility. The results demonstrate that the addition of fibers leads to improved shear resistance in shear-deficient beams. Furthermore, the addition of fibers in beams that contain minimum shear reinforcement results in improved ductility and crack control. A procedure for predicting the shear resistance of SFRC beams is also presented.

Mohammed HaloobAl-Majidi[ab]Andreas P.Lampropoulos[a]Andrew B.Cundy[c]Ourania T.Tsioulou[a]SalamAlrekabi (2019)[9] The use of additional Reinforced Concrete (RC) layers or jackets is one of the most commonly used techniques for the strengthening of existing structural elements. A crucial parameter for these applications is the durability and the corrosion resistance of the RC layers. However, to date there are not any published studies on the use of novel cementitious materials for the improvement of the durability of the strengthened elements. In this study, a novel strengthening technique is proposed using additional high performance Fiber Reinforced Geopolymer Concrete (FRGC) layers and jackets reinforced with steel bars. The main goal of this technique is the improvement of the structural performance of the existing elements and at the same time the improvement of the durability and corrosion resistance of the strengthening layers. RC beams strengthened with reinforced FRGC layers were examined under standard and accelerated corrosion conditions. Accelerated corrosion tests were performed using the induced current technique followed by flexural tests. The results indicate superior performance for beams strengthened with FRGC and improved performance of the interface between the additional layer and the initial RC beam.

Alberto Meda, Fausto Minelli, Giovann APlizzari(2012)[10] Even though a number of research studies have demonstrated the effectiveness of Fiber Reinforced Concrete (FRC) in improving the structural response of RC members under different loading conditions, some concerns recently arose on the sectional ductility under flexure which can be reduced under specific conditions. In fact, fibers do not significantly increase the ultimate moment of RC members and, with rather tough FRC and low strain-hardening ratio of the longitudinal rebar, the rotation capacity can substantially decrease owing to a cracking localization at ultimate limit state.

This paper focuses on this topic with a number of experimental results on full-scale FRC beams tested under flexure.

Experimental results evidence that fibers, when provided in sufficient amount, are able to move the beam failure from concrete crushing to steel rupture. Under certain circumstances, the overall ductility, measured in terms of displacements, may decrease.

On the other hand, in all cases the addition of fibers determines a stiffer and in general enhanced post-cracking behavior in service conditions.

Xie Jianha , Guo young chang , Liuli sha , Xiezhi-hong (2015)[11] Using recycled concrete and crumb rubber as aggregates to produce green concrete is a promising technology toward sustainability in the construction industry. In this study, the compressive and flexural behaviors of a new type of concrete material, rubber crumb and steel-fibre-reinforced recycled aggregate concrete (RSRAC), are investigated. To popularize the application of this new type of green building material, an experimental study was conducted to investigate the effect of the rubber content on the compressive and flexural behaviors of RSRAC. A total of 18 cubes (150 mm) and 18 cylinders (150 mm × 200 mm) were tested under axial compressive loading, and 18 prisms of 150 × 150 × 550 mm were tested subjected to three-point bending. The crumb rubber content was varied in the investigation at levels of 0%, 4%, 8%, 12% and 16% by volume substitution of sand. Recycled concrete aggregate (RCA) was introduced into the concrete mixture by 100% volume substitution of natural coarse aggregate (NCA), and 1% volumetric quantity of steel fibre was added to the concrete mixture. The effect of the rubber content on the compressive and flexural strength, failure mode, and modulus of elasticity and toughness of RSRAC was analyzed. The results indicate that RSRAC with optimal rubber content displays good compressive behavior compared with normal NCA concrete. RSRAC is also a more environmentally friendly alternative to normal rubber concrete for use in the flexural members of concrete structures.

Cheng Yuan, WensuChen, Thong M, Pham Hong Hao (2018)[12] bonding behavior between FRP and Steel fibre reinforced concrete is not well studied. This study experimentally investigates the interfacial bond behavior between basalt fibre reinforced polymer sheet (BFRP) and steel fibre reinforced concrete (SFRC). Short steel fibers with four volume fractions were used to investigate the interfacial bond behavior of BFRP-SFRC as the mechanical properties of the concrete substrate (i.e. compressive strength and tensile strength) can be improved by adding steel fibers. The effects of volume fraction on the bond strength, effective bond length, local slip at the peak shear stress, and interfacial bond-slip relationship are evaluated and discussed. The experimental results showed that the debonding process becomes more ductile as the debonding plateau in the load and displacement curves has been significantly extended. Findings from the present tests show that the specimens with steel fibers of 0.25%, 0.50% and 1.0% experienced significant increase in the peak interfacial shear stress up to 31%, 53%, and 76% over the control specimen without steel fibers, respectively. In addition, the analytical bond strength models and interfacial bond-slip models, incorporating the effect of short steel fibers, are proposed.

H.V Dwarkanath and T.S. Nagaraj (1992)[13] An experimental study aimed at understanding the deformational behavior of conventionally reinforced steel fiber concrete beams in pure bending is reported in this paper. One group of beams has steel fibers dispersed in the entire volume of the beam and the second has fibers dispersed over half the depth of the beam on the tension side. A comparative study of the deformational characteristics of these beams has been made. Half-depth fiber inclusion, requiring only half the quantity of fibers of full-depth inclusion, is found to be equally effective in improving the deformational behavior of beams. Thus, by such modes of inclusion of fibers, an economical and efficient use of expensive steel fibers can be realized.

(K Bilba M-AArseneAO Uensanga2003)[14] various bagasse fibre/cement composites have been prepared, the fibers having a random distribution in the composites. The influence of different parameters on the setting of the composite material has been studied: (1) botanical components of the fibre, (2) thermal or chemical treatment of the fibre, (3) bagasse fibre content and (4) added water percentage. This study shows a retarding effect of lignin on the setting of the composite, for small amount of heat-treated bagasse (200 °C) the behavior of the composite is closely the same as the classical cement or cellulose/cement composite.

Romildo D Tolêdo Filho, Karen Scrivener, George L England, Khosrow Ghavami (2000)[15] This paper presents the results of an experimental program designed to assess the durability of sisal and coconut fibers exposed to alkaline solutions of calcium and sodium hydroxide. In addition, the durability and microstructure of the cement mortar composites reinforced with these fibers aged under tap water, exposed to controlled cycles of wetting and drying, as well as to the open air weathering have been studied. The possibility of biological attack of fibers was investigated by conditioning them in tap water for 420 days. It was found that sisal and coconut fibers kept in a calcium hydroxide solution of pH 12 completely lost their flexibility and strength after 300 days. The composites manufactured with short sisal or short coconut fibers and ordinary Portland cement “OPC” matrix presented a significant reduction in toughness after six months of exposure to the open air weathering or after being submitted to cycles of wetting and drying. The embrittlement of the composites can be mainly associated with the mineralization of the fibers due to the migration of hydration products, especially calcium hydroxide, to the fibre lumen, walls and voids.

Piti Sukontasukkul (2004)[16] Generally, the performance of most materials is characterized by parameters based on the mechanical properties such as strength, strain, or stiffness etc. However, in fibre reinforced concrete (FRC), unlike other materials, strength or stiffrress alone is not sufficient to characterize its behavior, and the value of toughness is often used instead. In this study, two different methods (ASTM C1018 and JSCE SF-4) are used to measure the toughness of steel and polypropylene fibre reinforced concrete subjected to bending. Results indicated that in the JSCE method, the information obtained by only one specified deflection toughness seemed to be insufficient in reflecting the characteristics of the load-deflection curves of both FRCs. On the other hand, in the ASTM method, the obtained information using the four toughness values at different deflections appeared to better clariff the characteristics of both FRCs.

(lian jie yang yongxin yang meng, zhao yan 2006)[17] More attention is focused on experimental research on basalt fiber in home and abroad. Strength and crack resistance capability of concrete will be improved after being reinforced by chopped basalt continuous fiber hundred and ninety-four test pieces are tested which involved six kinds of slenderness ratios and five cubic contents, and studies are done on the influence of cubic content and slenderness ratio to compressive strength, split strength and flexural strength of concrete, which lays the foundation of further study.

(Gang SHEN, Fa-qin DONG 2004)[18] The carbon fiber conductive concrete is prepared in CF elementary material of function. The changes of the resistivity and 28 days compressive strength with carbon fiber contents and the resistivity variation with the voltage of AC power are analyzed. The electro-thermal efficiency is analyzed under the different voltages and accounted approximately by a trend numeration. The experimental results show that the critical content in volume of CF is 1.0%. The resistivity decreases with the increasing of voltage. The thermal energy produced in CFRC connected to AC power source is enough for deicing and snow melting purpose. Thermal transformation efficiency of CFRC is up to 99.5% by the trend numeration.

Han Aylie1 , Buntara Sthenly Gan2,* , Sholihin As’ad3 , M. Mirza Abdillah Pratama4 (2015)[19] Steel reinforced concrete members in bending acquire their load carrying capacity from the integration between concrete compression and steel tensile strength. The codes neglect the concrete tensile capacity since it is relatively small compared to the compressive strength. Hypothetically, if a low concrete strength is assigned to the layers in tension, it leads to economical and environmental advantages. A method for producing functionally graded concrete (FGC) having a gradation in compressive strength and stiffness throughout the depth of a member was developed. Uniaxial compression tests on cylindrical FGC specimens were conducted and verified numerically using finite element models. We suggest that the compressive strength of FGC approaches the lower grade concrete layers while the stiffness properties follow the higher grade concrete layers. This potential could be exploited for the flexural member, through optimizing of material use while improving the serviceability of the member.

Mostafa EI Mogy , Amr EI- Ragaby and EI-Salakawy 2010[20] Continuous concrete beams are commonly used elements in structures such as parking garages and overpasses, which might be exposed to extreme weather conditions and the application of deicing salts. The use of the fiber-reinforced polymers (FRP) bars having no expansive corrosion product in these types of structures has become a viable alternative to steel bars to overcome the steel-corrosion problems. However, the ability of FRP materials to redistribute loads and moments in continuous beams is questionable due to the linear-elastic behavior of such materials up to failure. This paper presents the experimental results of four reinforced concrete beams with rectangular cross section of 200×300 mm200×300 mm continuous over two spans of 2,800 mm each. The material and the amount of longitudinal reinforcement were the main investigated parameters in this study. Two beams were reinforced with glass FRP (GFRP) bars in to different configurations while one beam was reinforced with carbon FRP bars. A steel-reinforced continuous concrete beam was also tested to compare the results. The experimental results showed that moment redistribution in FRP-reinforced continuous concrete beams is possible if the reinforcement configuration is chosen properly. Increasing the GFRP reinforcement at the midspan section compared to middle support section had positive effects on reducing midspan deflections and improving load capacity. The test results were compared to the available design models and FRP codes. It was concluded that the Canadian Standards Association Code (CSA/S806-02) could reasonably predict the failure load of the tested beams; however, it fails to predict the failure location.

(J.P. FirmoM, R.T. , Arruda . J.R. CorreiaC. Tiago2015)[21] Recent fire resistance tests on reinforced concrete (RC) beams strengthened with carbon fibre reinforced polymers (CFRP) laminates showed that it is possible to attain considerable fire endurance provided that thermal insulation is applied at the anchorage zones of the strengthening system. With such protection, although the CFRP laminate prematurely debonds in the central part of the beam, it transforms into a cable fixed at the extremities until one of the anchorage zones loses its bond strength. The main objective of this paper is to propose a simplified methodology for the design of fire protection systems for CFRP strengthened-RC beams, which is based on applying thicker insulation at the anchorage zones (promoting the above mentioned “cable behavior”) and a thinner one at the current zone (avoiding tensile rupture of the carbon fibers). As a first step towards the validation of this methodology, finite element (FE) models were developed to simulate the flexural behavior at ambient temperature of full-scale RC beams strengthened with CFRP laminates according to the externally bonded reinforcement (EBR) and near surface mounted (NSM) techniques, in both cases fully or partially bonded (the latter simulating the cable). The FE models were calibrated with results of 4-point bending tests on small-scale beams and then extended for different beam geometries, with spans (L) varying from 2 m to 5 m, in which the influence of the CFRP bonded length (l_b) and the loading type (point or uniformly distributed) on the strength reduction was evaluated. The results obtained show that the strength reduction decreases when the ratio l_b/L increases; the loading type does not present a relevant influence on the strength reduction; and, for similar l_b/L ratios, the strength reduction suffered by NSM-strengthened beams is lower than that of EBR-strengthened beams. Relations between the strength reduction due to the partial bonding and the l_b/L ratio were defined for both loading cases and strengthening techniques. These results, obtained at ambient temperature, were then incorporated in a simplified procedure that is proposed for the design of fire protection systems of CFRP-strengthened RC flexural members.

Bruhwiler, Eugen(2012) London, CRC Press/ Balkema[22] An original concept is presented for the durable rehabilitation and strengthening of concrete structures. The main idea is to use ultra-high performance fibre reinforced concrete (UHPFRC) complemented with steel reinforcing bars to protect and strengthen those zones of the structure that are exposed to severe environmental influences and high mechanical loading. This concept efficiently combines the protection and resistance properties of UHPFRC and significantly improves the structural performance of the rehabilitated concrete structure in terms of durability. The concept has been validated by means of field applications, demonstrating that the technology of UHPFRC is now well developed for cast *in situ* and prefabrication using standard equipment for concrete manufacturing. This novel technology is a step forward towards more sustainable structures.

(M. Singh A.H, Sheikh M.S. Mohamed AliP. Visintin M.C.Giriffith2017)[23] The development of standard analytical procedures and design guidelines for concrete requires extensive tests at material and structural level. For ultra-high performance fibre reinforced concrete (UHPFRC) this task is even more complicated than that of conventional concrete due to the potential range of fibre types and volume fractions. The experimental task of large scale structural members to develop the design procedures can be reduced by adopting an alternative way in which the concrete material model available in finite element packages are validated with the limited number of tests conducted on material and structural members. The validated numerical models can further used to study the effect on the structural behavior due to change in geometry, loading conditions and reinforcement. Therefore the objective of the present study is to investigate the efficacy of the hybrid approach of validating the existing concrete model to study the behavior of large-scale structural members made up of UHPFRC. For this four full-scale beams with varied spans and cross-sections were fabricated with the indigenously developed UHPFRC using conventional materials and mixing methods and tested under different loading conditions until failure. Numerical models were developed and validated with the test results of the beams for which the concrete damaged plasticity (CDP) model was adopted to characterize the behaviour of UHPFRC material. The material parameters required to define the constitutive model were identified by conducting direct/uniaxial tension and compression tests. The results obtained from the numerical models shows that the CDP model can accurately predict the load/moment carrying capacities of the UHPFRC beams. The results also show a good capability of the numerical models to predict the overall load deflection behavior of the UHPFRC beams.

(K.Holschemacher[a]T.Mueller[a]Y.Ribakov 2010)[24] Steel fibre reinforced concrete (SFRC) became in the recent decades a very popular and attractive material in structural engineering because of its good mechanical performance. The most important advantages are hindrance of macro cracks' development, delay in micro cracks' propagation to macroscopic level and the improved ductility after micro cracks' formation. SFRC is also tough and demonstrates high residual strengths after appearing of the first crack. This paper deals with a role of steel fibers having different configuration in combination with steel bar reinforcement. It reports on results of an experimental research program that was focused on the influence of steel fibre types and amounts on flexural tensile strength, fracture behavior and workability of steel bar reinforced high-strength concrete beams. In the frame of the research different bar reinforcements (2Ø6 mm and 2Ø12 mm) and three types of fibers' configurations (two straight with end hooks with different ultimate tensile strength and one corrugated) were used. Three different fibre contents were applied. Experiments show that for all selected fibre contents a more ductile behavior and higher load levels in the post-cracking range were obtained. The study forms a basis for selection of suitable fibre types and contents for their most efficient combination with regular steel bar reinforcement.

(H.M.Tanarslan2017)[25]The aim of this experimental study is to investigate the behavior of reinforced concrete (RC) beams that were strengthened with prefabricated ultra-high performance fibre reinforced concrete (UHPFRC) laminates. In order to receive consistent results while using UHPRFC and enhance the effectiveness of its usage on site applications, it has been considered to apply UHFRPC as a laminated plate. Furthermore, differently applied UHPFRC laminates were tested to determine which method is more effective for flexural strengthening of RC beams. Accordingly, each application method was evaluated by its own benefits and the subsequent application procedure was determined after seeing the deficiencies and the positive state of previous application. In view of that, seven specimens, one of which was the control specimen and six of which were the under-reinforced test specimens, were strengthened with 50 mm thick UHPFRC laminates. A minimum increase of 32% and a maximum of 208% at load carrying capacity were obtained from the UHPFRC strengthened specimens. Consequently, UHPFRC laminate usage is an effective technique to enhance the behavior and the load carrying capacity of RC beams and can be preferred to strengthen deteriorated structures.

(Chandramouli K.1 , Srinivasa Rao P.2 , Pannirselvam N.3 , Seshadri Sekhar T.4 and Sravana P.2)[26] The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using fibers and other admixtures in concrete up to certain proportions. In the view of the global sustainable developments, it is imperative that fibers like glass, carbon, polypropylene and aramid fibers provide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitations, erosion resistance and serviceability of concrete. Fibers impart energy absorption, toughness and impact resistance properties to fibre reinforced concrete material and these characteristics in turn improve the fracture and fatigue properties of fibre reinforced concrete research in glass fibre reinforced concrete resulted in the development of an alkali resistance fibers high dispersion that improved long term durability. This system was named alkali resistance glass fibre reinforced concrete. In the present experimental investigation the alkali resistance glass fibers has been used to study the effect on compressive, split tensile and flexural strength on M20, M30, M40 and M50 grades of concrete.

2.3 Inferences

Flexural behavior of fiber concrete was observed by different researchers.

- The flexural strength of concrete beam is increased by utilization of 1% steel fibers flexural strength increases from 13.35 to 23.35%.
- The flexural, compressive and split values varied after using glass fibre 0.3% with different grade of concrete on 28, 56, 90,180 days .The increase in compressive strength for all the grades of concrete mixes at 56, 90, 180 days are observed to be 20 to 25% when compared with 28 days strength. The flexural values of ordinary concrete and glass fibre concrete mixes are observed to be varied from 3.52 to 5.42 N/mm^2 ; 4.08 to 6.23 N/mm^2 for 28 days.
- The influence of fibers shape on flexural strength was studied. In this 3 different shape namely straight, bent and crimped was used varying volume percentages.0.5, 1, 1.5.

It is observed that research work is available in steel and glass fibre and there is a scope of work in this area.

2.4 Research Gap

As per inferences of literature review it is found that there exist a research gap in steel and glass fiber concrete and flexural behavior of concrete may be studied by mixing steel and glass fiber in different percentage.

2.5 Objectives

- The evaluation of the influence of steel and Glass fibre of concrete flexural characteristics using M25 design mix based concrete.
- The addition steel and Glass fibers in different proportion have to experimentally analyzed in terms of concrete flexural strength enhancement.

CHAPTER 03

EXPERIMENTAL WORK AND METHODOLOGY

CHAPTER -3 EXPERIMENTAL WORKS AND METHODOLOGY

INTRODUCTION

Beams of size 100mmX100mmX500mm were casted with the mix proportions of steel and glass fiber M25. The beams were tested after 28 days. Cubes and beams are casted to conduct compressive strength and flexural strength test; Cubes are casted as control cubes. The cubes and beams were casted with plain concrete and later adding fibers only in beam specimen 0.5%, 1.5%and 2% to total volume of cement .On each percentage of fibers 3 beams were casted having same percentage ratio of both steel and glass fibers and the total number of beams were 12. Compressive strength is tested on 7 days and 28 days, and beams are tested on 28 days complete curing.

3.1 Material Testing

Before starting any research work some preliminary test or work has to be done in lab or at site. The detailed experimental procedure is discussed below:

- Collecting all the basic materials like cement, sand and aggregate as per Indian Standard Specification.
- Finding all the basic properties of cement, sand and aggregate by performing basic tests on it.
- Getting cement: sand: aggregate ratio by defining w/c ratio by IS 10262-2019 mix design procedure.
- Casting of concrete cubes without addition of fibers of size 150mm×150mm×150mm for performing different tests of 7 and 28 days.

TEST ON CEMENT

Portland Pozzolana cement (PPC) IS 1489 fly ash based is used for the present investigation. The cement is of uniform color i.e. grey with a light greenish shade and is free from any hard lumps.

PRELIMINARY TEST

TEST ON FINE AGGREGATE

SIEVE TEST

Sieve Analysis of the fine aggregate is carried out in the laboratory as per IS 383-1870. The sand is first sieved through 4.75mm sieve to remove any particle greater than 4.75 mm sieve and then washed to remove the dust. For performing the sieve test 1kg of fine aggregate is taken. The fine aggregates used for the experimental work is locally procured and comply with grading zone II.

GRADING OF FINE AGGREGATE

S.No	IS sieve size	Weight retained	% weight retained	Cumulative % of weight retained	% of passing
1	4.75	13.5	1.35	1.35	98.65
2	2.36	45.5	4.55	5.9	94.1
3	1.18	161	16.1	22	78
4	600µ	290	29	51	49
5	300µ	400	40	91	9
6	150µ	50	5	100	_

Graph .3.1

SPECIFIC GRAVITY

Specific gravity is defined as the ratio of unit weight of substance to the standard substance at standard temperature i.e. 4^{o}C. This test is performed with the help of pycnometer.

1. Empty wt. of pycnometer (W_1)= gm
2. wt. of pycnometer + wt. of fine aggregate (W_2)= gm
3. wt. of pycnometer + wt. of fine aggregate + wt. of water (W_3)= gm
4. wt. of water filled in pycnometer up to full level (W_4)=gm

Specific gravity = $\frac{D}{A-(B-C)}$

Where,

A = weight in g of saturated surface dry sample

B = weight in g of pycnometer containing sample and filled with distilled water

C = weight in g of pycnometer is filled with distilled water only

D = weight in g of oven – dried sample

Specific gravity = = 2.63

WATER ABSORPTION OF FINE AGGREGATE

$= \frac{100(A-D)}{D}$

$= \frac{100(610-602)}{602} = 1.32\%$

PRELIMINARY TEST

TEST ON COARSE AGGREGATE

Specific gravity = $\frac{C}{B-A}$

Where,

C = the weight in g of the oven dried aggregate in air

B = the weight in g of the saturated surface dry aggregate in air

A = the weight in g of the saturated aggregate in water (A_1- A_2)

A_1= mass of aggregate + basket in water

A_2= mass of wire basket suspended in water.

Specific gravity = $\frac{203}{2010-1246.5}$

= 2.62

WATER ABSORPTION OF FINE AGGREGATE

$$= \frac{100(B-C)}{C}$$

$$= \frac{100(2010-2003)}{2003}$$

= 0.34%

FINENESS MODULOUS OF COARSE AGGREGATE AS PER IS 383 2016

3.1.4 Glass Fiber

Glass fiber having length of **1.5cm** which is made up (or glass fibre) of consisting of several extremely fine fibers of glass.

3.1.5 Steel Fiber

Steel fiber having length of 3cm and .75mm dia well crimped is used.

3.1.6 Water

pH Test of Tap Water

pH is defined as the negative logarithm of hydrogen ion concentration. pH test is performed by pH meter. Fresh and clean tap water is used for casting the specimens in the present study. The water is relatively free from organic matter, silt, oil, sugar, chloride and acidic material as per Indian standard. pH of **tap water =** 8.08.

3.1.7 Admixture

For the enhancement of workability reducing w/c ratio admixture is used.

3.1.8 CONCRETE SLUMP TEST

The concrete slump test is used for the measurement of a property of fresh concrete. The test is an empirical test that measures the workability of fresh concrete. More specially, it measures consistency between batches. The test is popular due to the simplicity of apparatus used and simple procedure.

Principle

The slump result is a measure of the behavior of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.

Apparatus

- Slump cone ,
- Scale for measurement
- Tamping rod

Procedure of Concrete Slump Test

1. The mould for the slump test is a frustum of a cone 300mm of height, 200mm base and 100mm top.
2. The base is placed on a smooth surface and the container I filled with concrete in three layers, whose workability is to be tested.
3. Each layer is temped 25 times with a standard 16mm dia steel rod , rounded at the end
4. When the mould is completely filled with concrete , top surface is struck off (leveled with mould top opening)by means of screening and rolling motion of the tamping rod
5. The mould must be firmly held against its base during the entire operation so that it could not move due to the pouring of concrete and this can be done by means of handles or root – rests brazed to the mould
6. Immediately after filing the is completed and the concrete is leveled , the cone is slowly and carefully lifted vertically , an unsupported concrete will now slump
7. The decrease in the height of the center of the slumped concrete is called slump
8. The slump is measured by placing the cone just besides the slump concrete and the tamping rod is placed over the cone so that it should also come over the area of slumped concrete.
9. The decrease in height of concrete tp that of mould is noted with scale.

3.2 **Mix Proportions**

f'ck = fck + 1.65 S

Where,

f'ck = target mean compressive strength at 28 days in 2lidays in N/mm^2

Fck = characteristic compressive strength at 28 days,

S = standard deviation.

f'ck = fck + 1.65 S

=25 +1.65 x 4 = 31.6 N/mm^2

From Table No 2 IS 10262: 2019 Standard deviation is taken, S = 4

MIX CALCULATIONS FOR 1 M^3

SELECTION OF WATER CONTENT

From Table No7IS 10262, 2019 water content for 20mm aggregate

= 186 kg/m^3

Assumed water cement ratio 0.47 and slump having 75mm

Estimated water content for 75mm slump (after each 25mm slump increase 3 % water)

186+3x186/100

= 191.58 kg/m^3

0.4% admixture added

Water reduced 10%

Hence, water content = 191.58x10/100

=19.158

=172.5 kg/m^3

Volume of water 172.5x1/1000 = 0.1725 m^3 (specific gravity of water 1000)

CALCULATION OF CEMENT CONTENT

Water – cement ratio = 0.47

Water content = 172.5 kg/m^3

Cement content = 172.5/.47 = 367kg/m^3

Volume of cement = mass of cement/specific gravity of cement x1/1000

Volume of cement = 367/3.15 x 1/1000 = 0.116 m^3 (specific gravity of cement 3.15)

Volume of admixture = 367x .4/1.08 x1/1000

=0.001359

CALCULATION OF AGGREGATES

Volume of all aggregates = 1- (volume of water + volume of cement + volume of admixture)

= 1-(0.172 + 0.116 + .001359)

=0.710 m^3

Volume of coarse aggregate = 0.710 x 0.626 zoneII (0.626) From Table No 5 IS 10262: 2019

= 0.44

Volume of fine aggregate = 0.374 x 0.710

= 0.266 m^3

Mass of cement = 367 kg

Mass of coarse aggregate = volume of all aggregates x volume of coarse aggregate x specific gravity x 1000

Mass coarse aggregate = 0.170 x 0.44 x 2.62 1000 = 819 kg

Mass of fine aggregate = volume of all aggregates x volume of fine aggregate x specific gravity x 1000

Mass of fine aggregate = 0.170 x 0.266 x 2.63 x 1000 = 497kg

DESIGN MIX PROPORTION FOR M25

1:2.23: 1.35 (CEMENT: COARSE AGGREGATE: FINE AGGREGATE).

Cement = 367 kg/m^3

Water = 172.5 kg/m^3

Admixture = 1.35 kg/m^3

Coarse aggregate = 819 kg/m^3

Fine aggregate = 497 kg/m^3

3.3 Mixing of Concrete

First of all, wet the inner surfaces of the drum of **concrete mixer**. Coarse aggregates are placed in the **mixer** first followed by sand and then **cement**. **Mix** the materials in the dry state in the **mixing machine**. Normally it should be 1.5 to 3 minutes.

After the compilation of all required tests on ingredients cement aggregates water and when they found suitable to be used mix design was done. The guidelines of IS 10262: 2019 were followed in the process of mixing, coarse aggregate were washed a day before casting to make them silt free and laid dry. On the day of casting coarse aggregate were moist to avoid absorption of water from mix i.e. to maintain water cement ratio. The moulds used for casting were of steel having internal dimension of 150mm X 150mm X 150mm for cube and 500mm X 100mm X 100mm for beam. During the process of mixing cement, fine aggregate, coarse aggregate were mixed in dry state by mixer, then water is added in rotating mixer and admixture was added mixing in water. Fibers were mixed in different % during the mixing of concrete. Percentage of fibers was mixed 0%, 0.5%, 1.5% and 2% respectively. in the process of mixing concrete , tilting type rotatory drum mixer having capacity of 100 kg is used and the process of rotating is carried out for at least 3-4 minutes .

Fig.3.3 Mixing Concrete

Fig.3.3.1 Fiber based concrete

PREPERATION OF SPECIMEN

The quantities of constituents of concrete were obtained by help of mix design which was done by guidelines given in IS 10262: 2019. The moulds are cleaned and screwed tightly to avoid leakage. Oil was applied in inner surface of the moulds.

Casting and Curing

The concrete after mixing was filled into moulds in three layers, each layer tamped well 25 times the cast specimens were removed from moulds after 24 hours and the specimens were immersed in a clean water tank. After curing the specimens for a period of 7 days and 28 days, the specimen were removed from the tank water and allowed to dry.

Fig.3.3.2 Casting Beam

Fig3.3.3 curing of beam

3.4.1 Specimen for Compressive Strength

This test gives us an idea about all the characteristics of concrete. With the help of this test we can check that whether Concreting has been done properly or not and compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates

Procedure of Test

For this test mainly 150mm * 150 mm * 150 mm cubes are used

- Clean the mounds properly and apply oil inside the cube frame
- Fill the concrete in the molds in layers approximately 50mm thick
- Compact each layer with not less than 35 strokes per layer using a tamping rod (steel bar 16mm diameter and 600 mm long,)
- Level the top surface and smoothen it with a trowel

- The concrete cubes are removed from the moulds between 16 to 72 hours, usually this done after 24 hours. Remove the specimen from water after specified curing time and wipe out excess water from the surface. Take the dimension of the specimen to the nearest 0.2mm and then place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
- Apply the load gradually without shock and continuously at the rate of 140 kg/cm^2/min. till the specimen fails
- Record the maximum load and note it.

Fig.3.3.4 cube testing

3.4.2 Specimen for Flexural Strength

Flexural strength is one measure of the tensile **strength of concrete**. It is a measure of an unreinforced con- Crete beam or slab to resist failure in bending.

EQUIPMENT & APPARATUS

- **Beam mould** of size 15 x 15x 70 cm (when size of aggregate is less than 38 mm) or of size 10 x 10 x 50 cm (when size of aggregate is less than 19 mm)

- **Tamping bar** (40 cm long, weighing 2 kg and tamping section having size of 25 mm x 25 mm)

- **Flexural test machine**– The bed of the testing machine shall be provided with two steel rollers, 38 mm in diameter, on which the specimen is to be supported, and these rollers shall be so mounted that the distance from centre to centre is 60 cm for 15.0 cm specimens or 40 cm for 10.0 cm specimens. The load shall be applied through two similar rollers mounted at the third points of the supporting span that is, spaced at 20 or 13.3 cm centre to centre. The load shall be divided equally between the two loading rollers, and all rollers shall be mounted in such a manner that the load is applied axially and without subjecting the specimen to any tensional stresses or restraints.

PROCEDURE

1. Prepare the test specimen by filling the concrete into the mould in 3 layers of approximately equal thickness. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire crossection of the beam mould and throughout the depth of each layer.
2. Clean the bearing surfaces of the supporting and loading rollers, and remove any loose sand or other material from the surfaces of the specimen where they are to make contact with the rollers.
3. Circular rollers manufactured out of steel having cross section with diameter 38 mm will be used for providing support and loading points to the specimens. The length of the rollers

shall be at least 10 mm more than the width of the test specimen. A total of four rollers shall be used, three out of which shall be capable of rotating along their own axes. The distance between the outer rollers (i.e. span) shall be **3d** and the distance between the inner rollers shall be **d**. The inner rollers shall be equally spaced between the outer rollers, such that the entire system is systematic.

4. The specimen stored in water shall be tested immediately on removal from water; whilst they are still wet. The test specimen shall be placed in the machine correctly centered with the longitudinal axis of the specimen at right angles to the rollers. For molded specimens, the mould filling direction shall be normal to the direction of loading.

5. The load shall be applied at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens.

Fig.3.3.5 Beam testing

Fig3.3.6 Flexural strength testing

CHAPTER 04

RESULTS AND DISCUSSION

CHAPTER - 4 RESULTS AND DISCUSSION

CALCULATIONS

Beams having dimension 100 mm X100 mm X 500mm tested on 28 days in different ratio with and without fibers.

3 beams with 0% fibers tested

$$F/y = M/I$$

Where,

F = stress in N/mm^2

y = Neutral axis d/2

M = bending moment WxL/4

I = moment of inertia $bd^3/12$

Beam having 2% fibers (13.5 KN , 13.7 KN , 13.9 KN)

Sample -01

$W = 13.5KN$ or $13.5x10^3N$

$M = WxL/4$

$= 13500x400/4$

$= 135x\ 10^4$ Nmm

$F/y = M/I$

$F/50 = 135x10^4/100^4/12$

$= 8.1$ N/mm^2

Sample -02

$W = 13.7KN$ or $13.7x10^3N$

$M = WxL/4$

$= 13700x400/4$

$= 137x\ 10^4$ Nmm

$F/y = M/I$

$F/50 = 137x10^4/100^4/12$

$= 8.22$ N/mm^2

Sample -03

$W = 13.9$ KN or 13.9×10^3 N

$M = W \times L/4$

$= 13900 \times 400/4$

$= 139 \times 10^4$ Nmm

$F/y = M/I$

$F/50 = 139 \times 10^4/100^4/12$

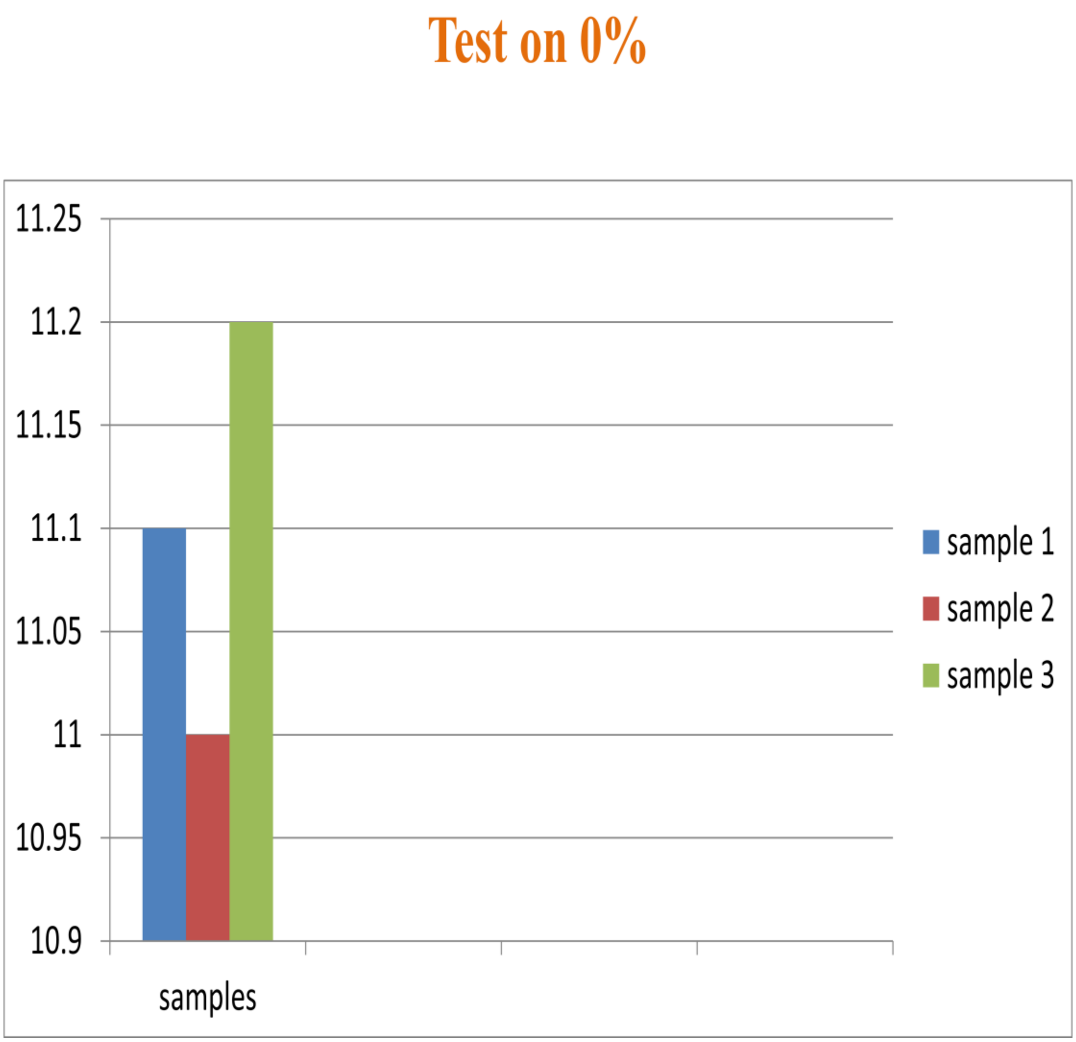
$= 8.34$ N/mm^2

STRESS ON DIFFERENT BEAM USING DIFFERENT % OF FIBERS

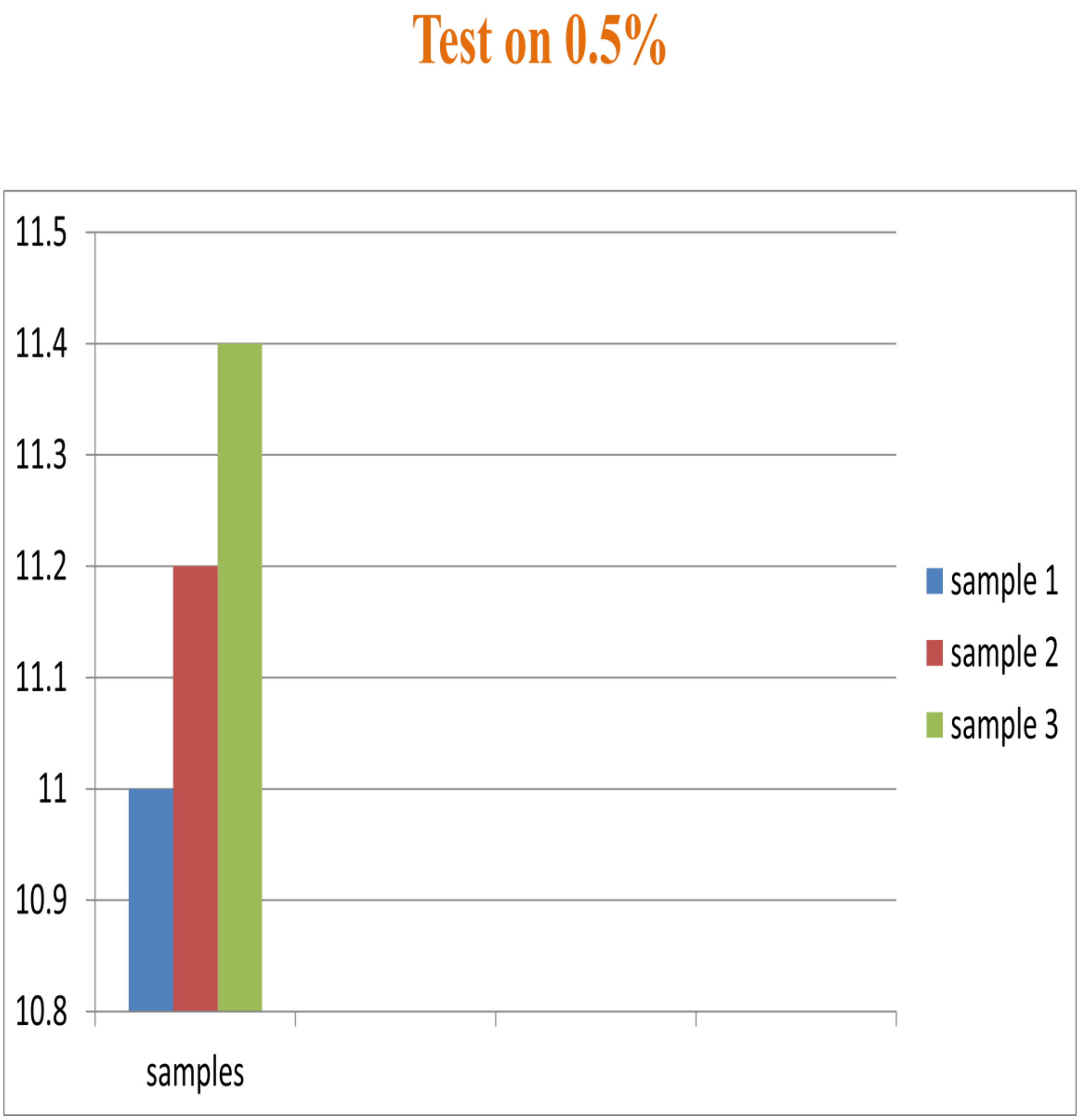
S.No.	**BEAM**	**% of fibers(Steel and Glass)**	**F(Stress) in N/mm^2**
1	B1	0%	**6.64**
2	B2	0.5%	**6.72**
3	B3	1.5%	**7.68**
4	B4	2%	**8.22**

Table-4.1

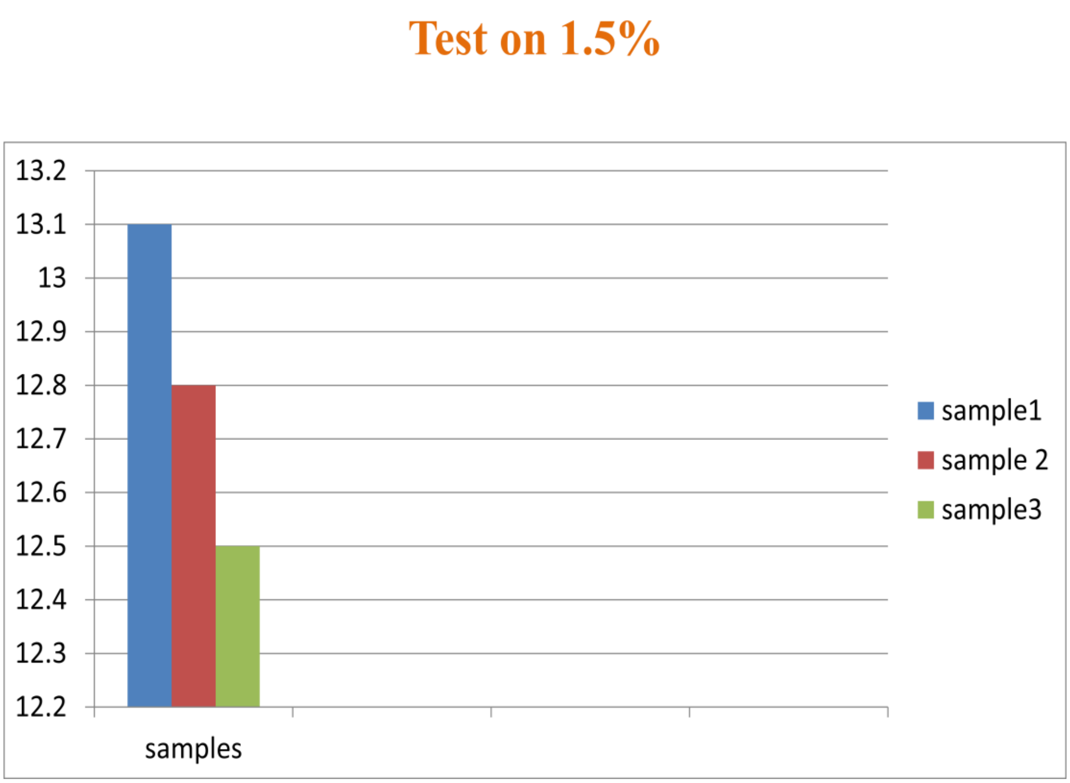
TEST ON 0% FIBERS



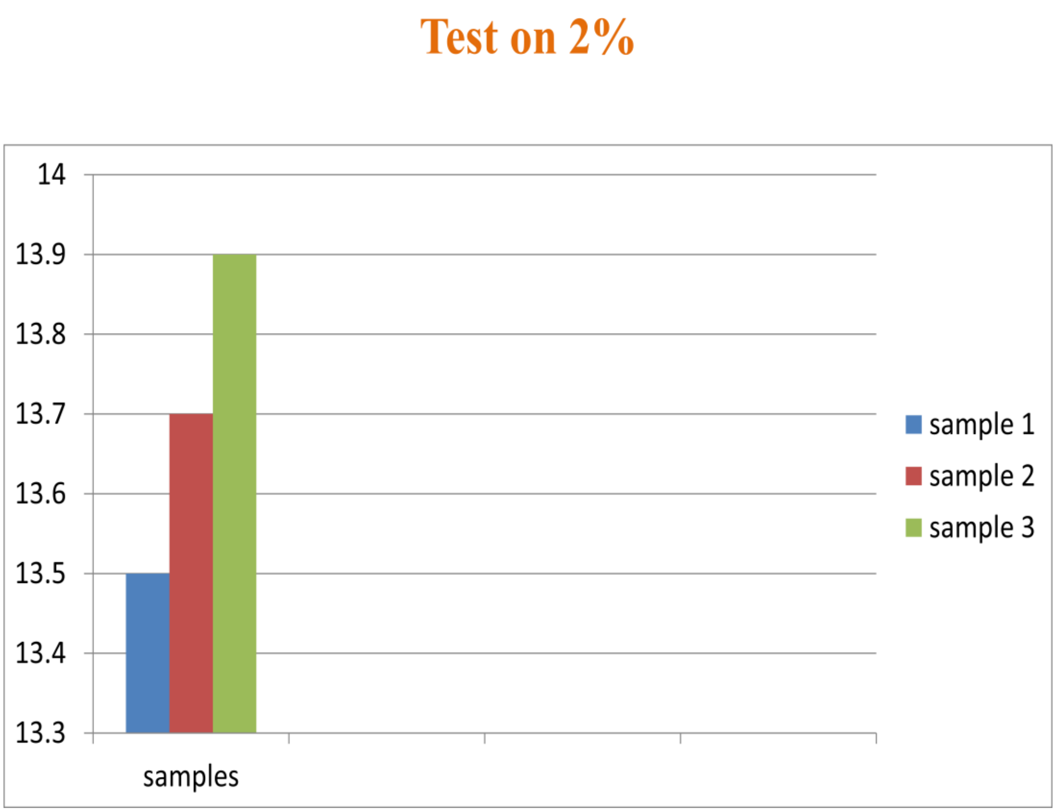
TEST ON 0.5% FIBERS



TEST ON 1.5% FIBERS

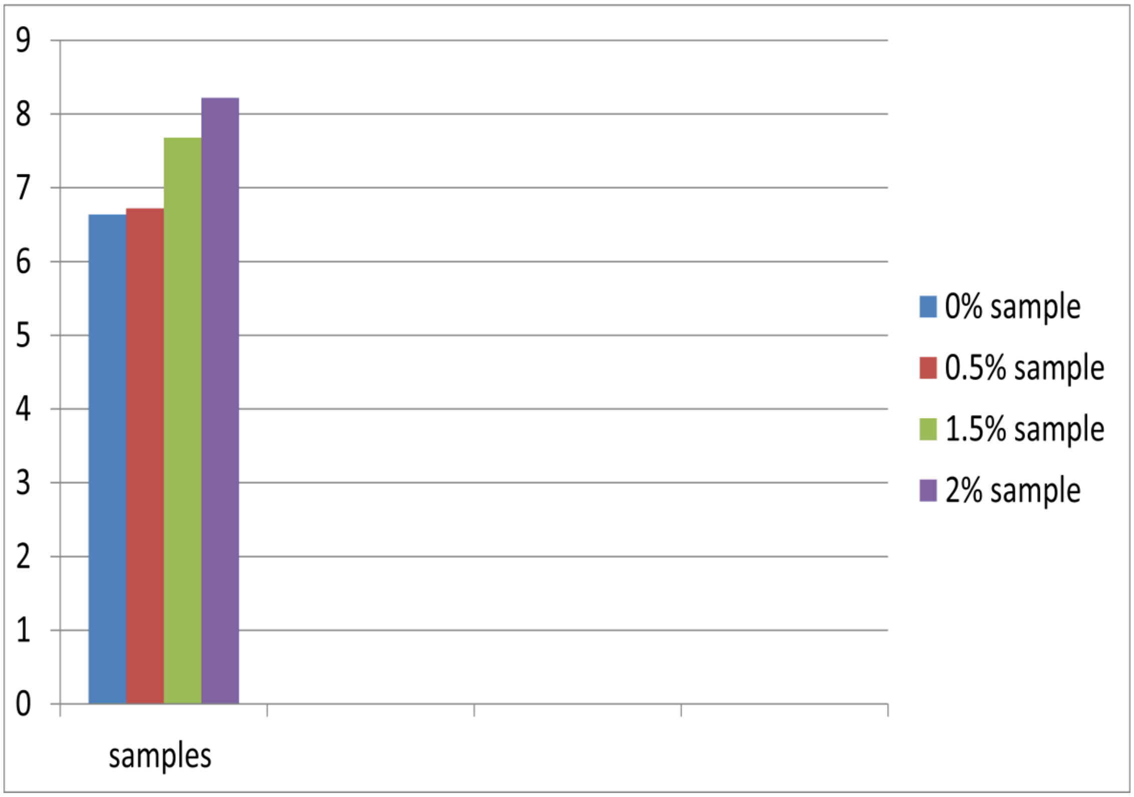


TEST ON 2% FIBERS



RESULT

Result



CHAPTER 05

CONCLUSIONS

CHAPTER - 5 CONCLUSIONS

It is observed that addition of fibers enhanced the flexural property at different percentage ratio of fibers on 0% average of all 3 specimens is observed stress 6.64 N/mm2 , fibers on 0.5% average of all 3 specimens is observed stress 6.72 N/mm2, fibers on 1.5% average of all 3 specimens is observed stress 7.68 N/mm2 , fibers on 2% average of all 3 specimens is observed stress 8.22 N/mm2 .

- The use of fibers help in modifying properties both in the plastic as well as hardened stage of concrete, thus making concrete a more versatile material to be used for variety of applications.
- Fibers control cracking due to plastic shrinkage and drying shrinkage.
- It reduces the permeability of concrete and thus reduces bleeding of water.
- The flexural strength of horizontal member of a structure can be enhanced using one or more fiber material in different ratio.
- Fibers concrete technology has proved to be better than conventional technologies and it enhance the life time of a structure by more than the expected value.

CHAPTER 06

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