Evaluation of Properties of Concrete by Adding Different Proportion of Cellulose Fiber

A

PROJECT REPORT

Submitted in partial fulfillment of the requirement for the degree of

BACHELOR IN TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

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And

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MAY, 2020

Student's Declaration

We hereby certify that the work which is being presented in the thesis entitled "**Evaluation of Properties of Concrete by Adding Different Proportion of Cellulose Fiber**" in fulfillment of the requirements for the award of the degree of Bachelor of Technology under Jaypee University of information Technology, Waknaghat is an authentic record of our own work carried out during the session 2018-19 under the supervision of Mr. Abhilash Shukla and Dr. Tanmay Gupta. The matter embodied in this thesis has not been submitted by us for the award of any degree of this or any other University/Institute.

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Certificate

We hereby declare that the work presented in this report entitled **“Evaluation of Properties of Concrete by Adding Different Proportion of Cellulose Fiber”** in fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Civil Engineering** submitted in the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of my own work under the supervision of **Mr. Abhilash Shukla** and **Dr. Tanmay Gupta, Assistant Professor,** Department of Civil Engineering. The matter embodied in the report has not been submitted for the award of any other degree ordiploma.

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This is to certify that the above statement made by the candidates is true to the best of my knowledge.

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Abstract

The current work examines tentatively the improvement of some mechanical properties of cement by including cellulose as fiber. Every one of them can be added through various rates to new concrete. The cellulose may function as super plasticizer which acts to bring down the pace of water assimilation and impact decidedly the quality and the versatility. The level of the added substance was 0, 0.5, 1, 1.5, 2%. It was discovered that the best rate was found as 1.5% following 28 days of wet relieved. The test examples was of standard cubic, the level of the improvement for the solid when it was assessed by the standard cement was 1.27 % for cellulose fiber, and because of the improvement in the versatility for fiber added substance, it might work appropriately under the stacking condition contrasting with solid standard example.

***Key words**: Cellulose, Strength, Elasticity, super plasticizer, damp relieved*

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List of Abbreviations

CF	Cellulose Fiber
GM	Genetically Modified
AGU	Anhydroglucose Unit
ACI	American Concrete Institute
ACS	Actividades de Construcción y Servicios
CP	Cryoporometry
MIP	Mercury Intrusion Porosimetry
DSC	Differential Scanning Calorimeter
EC	Ethyl Cellulose
OSEHEC	Organic-Soluble Ethyl Hydroxy Ethyl Cellulose
CMC	Carboxy Methyl Cellulose
HPFRCC	High Performance Fiber Reinforced Concrete Composites
FRC	Fiber Reinforced Concrete
CE	Cellulose Ethers
BASF	Badische Anilin & Soda-Fabric AG
PPC	Portland Pozzolona Cement
IST & FST	Initial & Final Setting Time
IS	Indian Standards
CS & FS	Compressive & Flexural Strength

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Chapter 1
Introduction

1.1 General

Concrete based materials which are permeable like solid; pore structures on one hand can assume a fundamental job in controlling physical and concoction properties and on other turn in administering the drawn out strength. Understanding the pore size conveyance is consequently, significant for assessing the presentation of such materials. In solid, pore systems give transport courses to unfavorable synthetic compounds, and shortening such systems through pore refinement and modification a perceived method of improving its strength. The straightforwardness with which synthetic substances are to be shipped inside the group of cement is regularly controlled by its porousness. Lower the porousness, increasingly sturdy will be the solid.

Top notch, quality, solidness and insignificant value make concrete a most used material in the development business. Regardless of whether cement is solid in pressure and can contradict high loads, it has the lower elasticity. This decrease of solidarity in strain makes concrete in danger to breaking under elastic pressure induced as a result of malleable burdens, plastic shrinkage, broad synthetic responses, and so forth. (Mehta and Monteiro, 2006). As the greater breaks impact the quality and quality of basic solid part, littler scope parts hamper the quality of solid structures.

The splits open the solid to the impeding substances present in nature. The water and distinctive compound substances passageway may bring about the rot of the solid cross section and consume the support (Reinhardt and Jooss, 2003). These splits require suitable and snappy treatment; regardless they will when all is said in done develop and over the long haul degenerate the auxiliary execution.

In the previous hardly any years, the three principle issues that would keep on amazing the advancement of the paper business are the absence of assets, pollution of environs and the degree of specialized apparatuses. The significant driving element among the three is the absence of crude material assets, which is because of the logical inconsistency among the structure of crude material and the structure of fiber assets. Because of that, non-wood filaments have a rich assortment of amazing properties in physical and optical methods, which could be utilized to improve their items. Albeit, everywhere throughout the world, non-wood fiber represents just a little division of the crude materials of paper. Be that as it may, in not many of the advancing nations, about 60% of the cellulose fiber comes straightforwardly from the non-wood materials, similar to bagasse, corn straw, bamboo, reed, grass, jute, flax, sisal, and so forth. Particularly, in India and China, 70% of the crude materials utilized in the mash business originate from non-wood herb just as oat straw and bagasse, and these two nations own 80% of the whole non-wood mash fabricating.

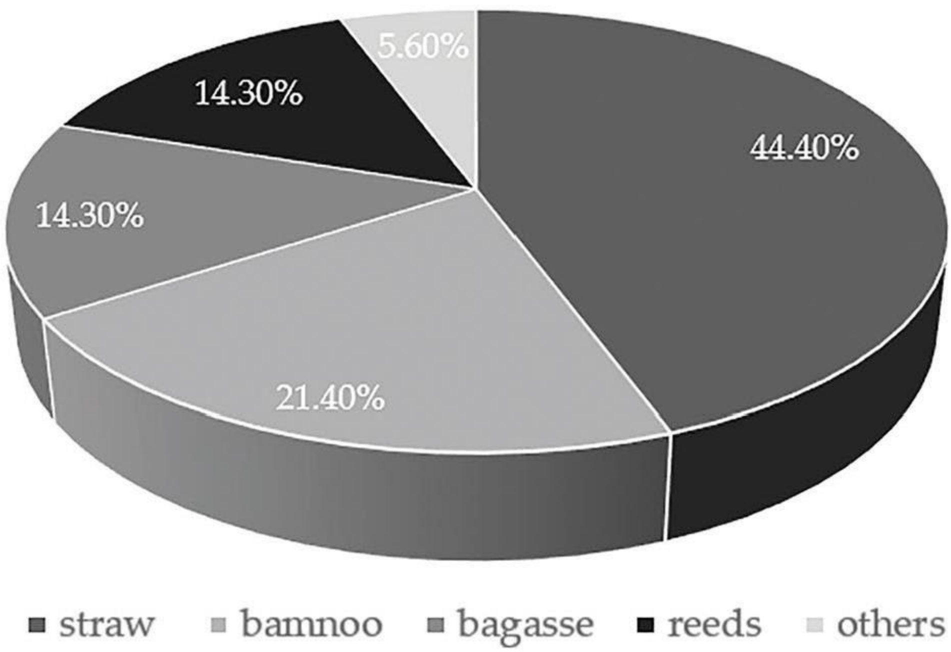


Figure 1.1 Proportion of different non wood pulps used in paper industry

Everywhere throughout the world, enormous number of non-wood filaments is utilized in the field of mash and papermaking, which comprise of yearly horticultural waste and fake development grass or characteristic development and so forth. In China, because of increment underway of wastepaper mash and wood mash, the structure of non-wood mash had changed in the previous barely any years, which brought about defeat in the level of straw mash from 77.2% in 2004 to 44.4% in 2015. In any case, the bamboo mash indicated a sensational upward pattern from 2.7% in 2000 to 21.4% in 2015. Proportion of the non-wood mash in paper creation is appeared in Figure 1.

1.2 Pulp of Wood

The lumbers assets which are utilized to make wood mash are known as pulpwood. While in writing coniferous trees are generally favored for the mash making in light of the fact that the cellulose fiber in the mash of these trees are longer, and subsequently make more grounded paper. A portion of the broadly utilized softwood trees for paper making are tidy, pine, fir, larch and hemlock, and hardwoods for instance Eucalyptus, aspen and birch. Likewise an expanding interest is found in hereditarily altered tree species, (for example, GM eucalyptus and GM poplar), in light of a few pivotal advantages these can give, for example, increment in the simplicityof separating lignin and expanded development rate.

Figure 1.2 Wood Pulp

Cellulose strands are produced using dissolving mash which are of two sorts, altered cellulose, for example, the cellulose acetic acid derivations and recovered or unadulterated cellulose like from the cupro-ammonium process. Both rayon and acetic acid derivation are counterfeit filaments, however not genuinely engineered, being prepared from wood.

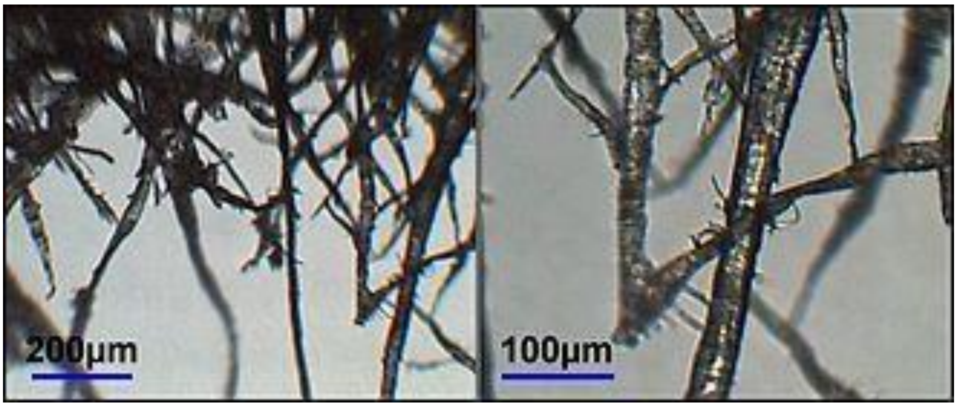


Figure 1.3 Fibers in wood pulp

1.3 Cellulose

Cellulose is the essential constituent of wood, cotton and paper. It is a starch comprised of glucose units. These have an exact recipe, C6H12O6, and can be given a cyclic structure, here and there assigned as an anhydroglucose unit (AGU) or beta-D-glucopyranose:

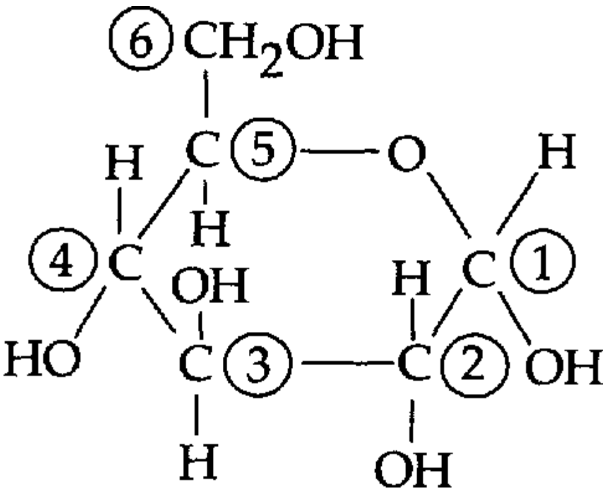


Figure 1.4 Glucose Structure

At the point when these units are snared together through a "buildup response" in which an atom of water is lost in framing each connection, the structure of cellulose becomes:

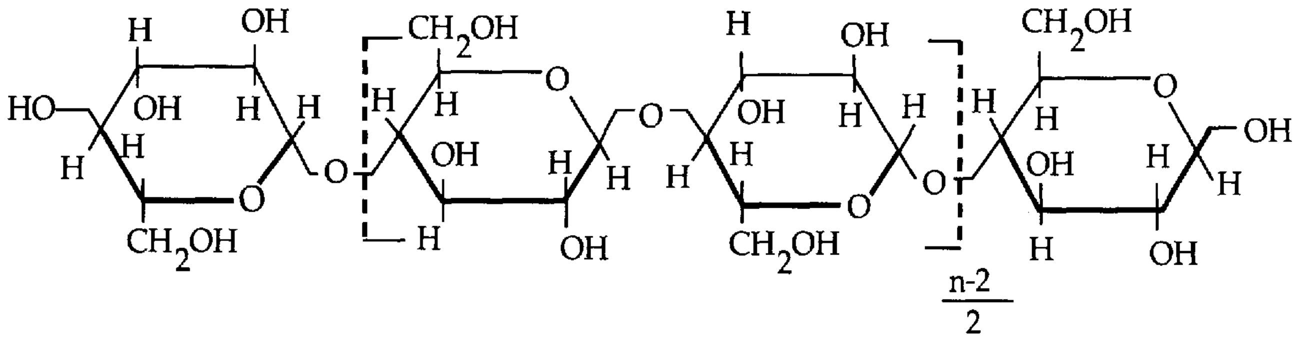


Figure 1.5 N number of An hydro Glucose units to form cellulose

1.4 Cellulose Fibers

Cellulose filaments are fundamentally produced using the esters of cellulose or ethers, and can likewise be gotten from the bark, leaves of the plants, or woods and from different materials which are plant-based. Notwithstanding cellulose, the filaments could likewise contain lignin and hemicellulose, with various rates of these components changing the mechanical properties of strands. The primary utilization of cellulose strands in the material business are as fiber-support composites, as compound channels, and furthermore because of their vague properties to built filaments, being one progressively elective for polymer composites and bio composites.

Cellulose is a polymer made of rehashing units of glucose atoms connected start to finish. A cellulose atom might be from hundred to more than 10,000 glucose units long. These polysaccharides are additionally acquired from various subunits of glucose. Cellulose is a straight chain polymer, and every cellulose particle is long bar like structure. This contrasts from starch, which is an adjusted particle. Because of these distinctions in structure, contrasted with starch furthermore, different starches, cellulose can't be broken into its glucose subunits by any of the chemicals handled by creatures.

Figure 1.6 Paste form of Cellulose Fiber

1.5 Fiber Mechanism

Cellulose filaments have an exceptionally high-water ingestion limit of 85%, in this way improving the interior restoring. Since cellulose strands have high soluble base obstruction and can fill in as a water repository prompting the crystallization of concrete hydration items because of persistent hydration.

Besides, cellulose filaments in concrete give a pleasant completed surface by expanding the freeze-defrost strength. What's more, they are appropriate for prepared blend plant which makes them simple to use in all size of solid development.

The primary motivation behind this paper is to tentatively research oneself recuperating, quality and sturdiness properties of fiber-based and typical solid composites. Pressure and flexural tests were likewise performed to analyze the mechanical properties of cement.

1.6 Advantages of using Cellulose Fiber

ACI 302 distinguishes the advantages of utilizing a characteristic cellulose smaller scale fiber to diminish early age plastic shrinkage and give long haul power over breaks. Likewise, this fiber mix improves the rigidity or limit of the solid. For e.g., Ultra Fiber 500, utilized in this investigation, is the fiber of decision for alluring cement and is a demonstrated entertainer, doesn't erode, improves solid quality, sturdiness, porousness, freeze-defrost properties, decline the warm conductivity and improve the sound-related execution, expands the sound retention, thickness of the composite and diminishes the plastic drying shrinkage in private, light business and basically strengthened cement. Additionally, Ultra Fiber 302 Blend is the auxiliary fortification that really decreases breaks maintenance and plastic drying shrinkage. It won't supplant load-bearing or basic support. It isn't expected to be utilized in slight chunk segments or to build the joint dispersing past that which is suggested by ACI.

Chapter 2

Literature Review

2.1 General

In this part, a point by point examination has been made about works done till now in this field as writing audit. The fiber strengthened cement with various measure of filaments and their conduct examination are talked about. Chipping away at the tests is talked about in the later piece of the part

2.2 Cellulose Fiber History

Cellulose was found in 1838 by the French scientific expert Anselme Payen. He disengaged it from plant matter and acquired its synthetic equation. Cellulose was utilized in effectively delivering the principal thermoplastic polymer, named celluloid, by Hyatt Manufacturing Company, 1870. Creation of rayon (fake silk) from cellulose started in 1890s, and cellophane was likewise designed in 1912. In 1893, Arthur D. Little from Boston, created another cellulosic item, acetic acid derivation, and refined it like a film. The principal business material that utilized the acetic acid derivation in the fiber structure was created by the Celanese Company in 1924. Hermann Staudinger set on the polymer structure of the cellulose in 1920. The compound was artificially orchestrated first (without utilization of any naturally determined chemicals) by Shoda and Kobayashi, in 1992.

The origination of CF amalgamated by living life forms returns to the times of Adrian J. Earthy colored (1886) who composed with respect to "an acidic mature which structures cellulose", alluding to the age of cellulose by the gram negative bar named Acetobacter xylinum. Throughout the years, this organism prompted the comprehension of the structure and biosynthesis of cellulose.

In 1922, when the ACS Division of Cellulose Chemistry was built up, crucial research on cellulose was in transit of entering the exceptionally gainful period that has proceeded till date. A significant advance taken in 1920 with the revelation that celluloses in de-lignified wood mash, flax, ramie, and cotton indicated nearly a similar x-beam design. Such examinations would do much so as to characterize the structure of cellulose, the mechanical properties of filaments, and their physical reason for the properties of polymeric frameworks shaping fiber. A subsequent significant advance came was the "essential valence chain" idea of cellulose polymers.

2.3 Mechanical Properties

Huda Nema Khalifa (2015) examined tentatively the improvement of a portion of the mechanical properties of cement by including various extents of cellulose as gem or fiber. Every one of them was added through three rates to new concrete. The centralization of the added substance was 2%, 5% and 7.5 % and was discovered that the best rate was at 5% following 28 days of wet restored. The test example was of standard shape and the level of progress for the solid when it was surveyed by the standard cement was 14% for cellulose fiber and 6.5% for cellulose gem.

Neeraj Buch, Owais M. Rehman, Jacob E. Hiller (1999) tried the Impact of Processed Cellulose Fibers on the Portland Cement Concrete Properties and found that prepared cellulose strands gives an alluring harmony between mechanical, physical, and solidness attributes when got set in a concrete framework. The impact of prepared cellulose strands on the dimensional and mechanical steadiness properties of Portland concrete cement and its progressive use in the clearing business are concentrated in this paper.

N. Banthia et al. (2012) conducted a test on penetrable porosity in bio-motivated fiber fortified cementitious composites and found that porousness assumes a significant job in administering the solidness of cement in adverse conditions. Beforehand, penetrability tests utilizing water as the pervading medium have delineated that the expansion of cellulose fiber is satisfactory in diminishing the water porousness in the nearness and nonattendance of stress and along these lines making a solid progressively tough. In this paper, additional evidence was looked for of pore-refinement in concrete having strengthened with cellulose fiber utilizing cryoporometry (CP) and mercury interruption porosimetry (MIP) strategies. Cryoporometry was finished utilizing a differential examining calorimeter (DSC). Two volume parts with 0.1% and 0.3% of a treated cellulose fiber were explored. The outcomes discovered that a clear pore refinement because of a cellulose fiber expansion and a related improvement in the sturdiness.

Romildo Dias Toledo Filho (2015) researched on Cellulosic fiber reinforced cement-based composites. The filaments utilized diverse preparing techniques; mechanical conduct and strength are introduced. The fundamental achievements discovered were the advancement of the solid concrete composites with improved fiber-network grip. Also, the as of late created material mixes will permit getting elite materials strengthened with vegetable strands.

Various medicines can be utilized to improve the strength of a cellulose concrete composites in two different ways: (a) by refining the pulps with hornification medications or concoction surface medications, as silanes. (b) by pozzolanic increases, either straightforwardly blended in with the mass of the concrete or by being applied to the filaments, as well as through restoring under CO2 air.x

Rao Arsalan Khushnood (2018) tested the Bio-inspired self-healing cementitious mortar using Bacillus subtilis immobilized on nano and micro-additives.

Zhong Liu (2018) researched on Pulping and Papermaking of Non-Wood Fibers. The significant crude materials of the mash and papermaking industry can be ordered into three classes: non-wood, wood and non-plant (for the most part the wastepaper), among which non-wood fiber materials are one of the most significant fiber source in the piece of zones where woodland assets are restricted. Nowadays, in the all out utilization of mash on the planet, the extents of wood mash, wastepaper mash, and non-wood mash are 63, 34, and 3%, individually. Additionally, there are non-wood strands, for example, flax, hemp, jute, kenaf, cotton, sisal, and abaca having properties in the same class as or obviously superior to those of softwood materials.

Obinna Onuaguluchi, Nemkumar Banthia (2016) analyzed Plant-based natural fiber reinforced cement composites. In this paper, Fiber types, fiber attributes and their consequences for the properties of concrete based materials are looked into. Variables that influence the solidified and new properties of the concrete composites strengthened with plant-based normal fiber are talked about in detail besides, measures to upgrade the solidness properties of the concrete composites containing plant-based regular filaments are additionally assessed.

Arvind Kumar Sharma (2014) published an article which reports pilot scale soft drink anthraquinone pulping of palm oil void natural product packs and essential sans chlorine dying of the subsequent mash. The pilot scale unbleached mash showed splendor 31.4%, kappa number 18, consistency 845 mL/g, elastic record 59 Nm/g with a yield of 48% and blanched mash brought about the brilliance 85%, thickness 650 mL/g, malleable file 48 Nm/g. Contrasting these qualities and those got in lab by different specialists through various procedures uncovered that the working conditions embraced in this investigation can be effectively applied at a paper plant for business creation of mash and paper from the palm oil void organic product packs.

R. L. Feller, M. Wilt (1990) did a research on Assessment of Cellulose Ethers for Conservation. He found that the utilization of natural dissolvable solvent cellulose ethers, ethyl cellulose (EC), and natural dissolvable sort of ethylhydroxyethylcellulose (OSEHEC), can't be supported for long haul applications in protection. The end depends on the watched quick drop in the inherent viscosities of polymers as granular-powder after maturing at 90 °C and furthermore on their propensity to frame the powders or movies peroxides at 90 °C or during presentation to bright lights.

He orchestrated some tentatively arranged cellulose ethers in following request of oxidation powerlessness: allyl cellulose > carboxymethylcellulose (CMC) > benzyl cellulose > ethyl cellulose > cyano ethyl cellulose. This appears to put CMC more handily oxidized than ethyl cellulose. The consequences of the current tests, in any case, recommend that the CMC items as a rule have great soundness.

Surendra P. Shah (2010) evaluated how the early-age shrinkage behaviors of cementitious materials are affected by the addition of the saturated cellulose fibers under sealed and unsealed conditions. The sealed condition simulates autogenously shrinkage exclusively on the other hand the unsealed condition introduces drying shrinkage.

The consequences of the autogenously shrinkage tests indicated that the cellulose filaments have inner restoring capacities. Albeit, because of their moderately low retention limit, high measure of strands are fundamental, to give enough inward restoring water to show a generous decrease in autogenously shrinkage (for w/c = 0.28, hypothetically 4.5% by mass of concrete).

The cellulose fiber was not found to influence drying shrinkage however they are compelling in lessening drying shrinkage-prompted splitting when sufficient scattering is accomplished. The outcomes show that the improved functionality prompts improved fiber scattering. Besides, the best scattering was accomplished in solid (v/s glue or mortar) because of the nearness of bigger totals.

JIAN Shouwei, XU Rulin (2010) researched on the Influence of Cellulose Ethers on Hydration Products of Portland Cement and found that:

a) The hydration items in both changed concrete glues are at long last indistinguishable with in perfect concrete glue.
b) The time of development is diverse for significant hydration items in unmodified and adjusted concrete glues. The hydration items, for example, CH, ettringite and C-S-H, show up later in the adjusted concrete glues than in the unmodified ones.
c) Cellulose ethers decline the external items and increment inward results of C-S-H gels.

Abdelkarim Ait-Mokhtar (2012) presented a paper paper distinguishing the outcomes of the carbonation marvel if there should arise an occurrence of mortar with cellulose ether as admixture on its mechanical properties, microstructure and length varieties. Carbonation was found to improve the mechanical qualities and lessening the worldwide porosity with alteration in pore size circulation. Despite the fact that, carbonation additionally prompted an expansion of shrinkage, and subsequently to a plausible increment of splitting. Carbonation and shrinkage energy can be eased back somewhere near shielding the material from carbonation at the hour of solidifying.

The restoring span predominantly impacts the shrinkage energy. Shrinkage and last weight variety the two amplitudes due to drying and carbonation were seen as minimal influenced by the relieving time frame.

Eventually, the change of the cellulose ether extent in mortar doesn't influence the absolute carbonation time. Despite the fact that, the expansion of this polymer extent in the mortar brings about deferring the carbonation energy during the initial scarcely any long periods of quickened carbonation tests.

Laetitia Patural (2010) analyzed the cellulose ether impact on water maintenance and consistency in concrete based mortars. CE is regularly utilized as added substances to improve the nature of concrete based materials. As admixtures, they reinforce the properties of mortars, for example, functionality, open time and water maintenance. Besides, polysaccharides, for example, starch subsidiaries are utilized to improve the consistency of new material.

It very well may be reasoned that steady impact on mortar water maintenance was unmistakably seen as an element of cellulose ether science. One of the principle finishes of this examination was that the basic parameters are fundamental. The outcomes clarified that the sub-atomic weight is critical to control water maintenance and mortar consistency. It was noticed that, as sub-atomic weight expanded, the yield pressure continued decreasing, the consistency got expanded and the water maintenance was improved.

A significant end, identified with the water maintenance components, is made that the rheological property of mortar is one of the key elements. Consistency of new material isn't the main parameter dependable to have great water maintenance limit.

2.4 Importance of theStudy

Concrete, having a heterogeneous organization and inelastic conduct, carries on very unique in relation to different materials, similar to metals. The dissemination of fine totals and coarse totals molecule all through the extreme concrete grid and nonlinear conduct under stacking, separate cement from the different homogeneous metals. It is the very structure and creation of solid which bestows its pace of stacking touchy qualities

Moreover, different type fibers are added into the cementitious matrix that helps in improving the low tensile strength, low strain ability at fracture, elastic modulus, fracture toughness, fatigue, shrinkage, and durability. These fibers have been categorized into four major categories as per ACI 544.1R and include steel fiber, synthetic fibers, glass fibers, and natural fibers. Fibers from any of the four major categories are used in short and discrete form and are randomly distributed throughout the matrix. Volume fraction of the fibers directly jolt the post crack behavior as more percentage tend to increase the ductility but at the expense of workability.

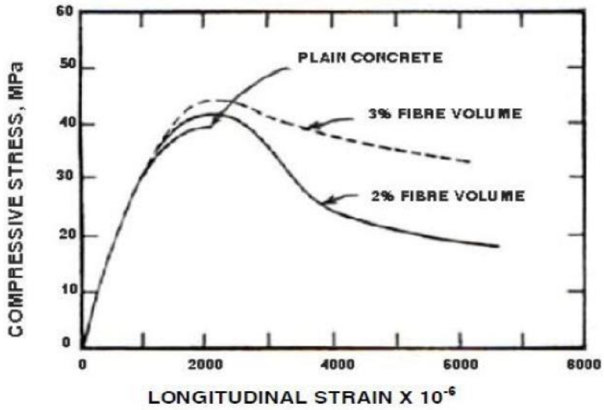


Figure 2.1 Effect of fibers addition on plain concrete

In addition, the actual effect of these fiber additions depends on various factors that include fibers type, geometry, size, distribution and volume fraction.

Failure of FRCs starts from tensile cracking of the matrix on planes where the normal tensile strain surpasses the allowed values. If the fibers are sufficiently long or having high performances, immense cracking normally occurs in the matrix prior to complete failure of composite.

Though, in the case of short and discrete fibers like steel, polypropylene, glass, or natural fibers once the matrix is cracked, following type of failure may occur;

a) After matrix cracking, composite fracture may immediately occur due to;

i. Inadequate fibers quantity at the critical section

ii. Insufficient fiber L_c that could not transfer the tensile stress all over the matrix

b) After matrix cracking, FRCs continues to carry the load but at a decreasing rate, also called strain softening. Resulting in increase in toughness but tensile strength remains the same.

c) After matrix cracking, FRCs continues to carry a increasing load hence resulting in the peak stress and the corresponding deformation is greater than that of the matrix alone.

By looking on to the above failure modes, (c) is desirable as it leads to increase in tensile strength and toughness of the concrete both. This failure mode is characteristic behavior of high performance fiber reinforced concrete composites (HPFRCC). Looking into these failure modes is also important as it gives the indication of the FRC limitations.

2.5 Objectives

- To check the optimum strength of concrete by adding different proportion of fibers
- To check the mechanical properties of concrete
- To check the impact loading of concrete

Chapter 3

Materials and Methodology

3.1 Materials

The vital materials for the solid blend proportioning are concrete, fine and coarse totals, water, and super plasticizer. Their physical and mechanical properties of these materials are examined underneath.

3.1.1 Cement

We utilized Portland Pozzolona Cement (PPC) with 31% consistency. The underlying and last setting time for separate is an hour and a half and 250 minutes. The particular gravity was seen as 3.15.

3.1.2 Aggregates

The coarse totals of size under 20 mm and fine total named zone II sand were utilized in this task. Different tests were led to get the physical and mechanical properties and their outcomes are examined in Section 3.2.

3.1.3 Water

Typical faucet water was utilized for every single test reason.

3.1.4 Super plasticizer

Because of functionality issues, we utilized a BASF item: Masterglenium 51. It was included as 0.8 % of the folio weight. Further the physical and substance properties of the super plasticizer are referenced in Table 3.1.

Table 3.1 Masterglenium 51 Properties

Formation	Polycarboxyl Ether
Colour	Amber
Mass/Volume	1.082-1.142 kg/l
Cl^- % (EN 480-10)	Less than 0.1
Alkali% (EN 480-12)	Less than 3

3.1.5 Cellulose Fiber

Filaments utilized in this undertaking were acquired from Solomon hues, INC. These filaments are really an uncommon sort of characteristic cellulose strands otherwise called Ultra Fiber 500 which is created utilizing the Slash pines and Loblolly in the North America. As said by producer, Ultra Fiber 500 is soluble base safe cellulose-based smaller scale filaments utilized for auxiliary support, controls break and have better hydration and holding properties. A nearby perspective on fabricated cellulose strands is appeared in Fig. 3.1. Figure 3.2 and Figure 3.3 shows the slurry structure and the infinitesimal perspective on fiber.

Fiber when blended in with concrete likewise bolsters the reason for astonishingly from normally sustainable assets. Aside from this, high surface territory and close dividing of cellulose strands make them very powerful in the concealment and support of small scale breaks in the solid grid. Physical and mechanical properties of the fiber are introduced in Table 1.

Figure 3.1 Ultra Fiber 500 solid pieces

Table 3.2 General Properties of Ultra Fiber 500

Name of Fiber	Ultra Fiber 500
Material Type	High Alkali Resistant, natural cellulose
Average Length [20]	2.1 mm
Average Denier	2.5 g/9,000m
Average Diameter	0.00063 inch
Count, fiber/lb.	720,000,000
Density	1.10 g/cm^3
Surface Area	25,000 cm^2/g
Tensile Strength	750 N/mm^2
Average Elastic Modulus	8500 N/mm^2
Water Absorption	About 85% of fiber wt.

Figure 3.2 Cellulose fibers in Slurry form

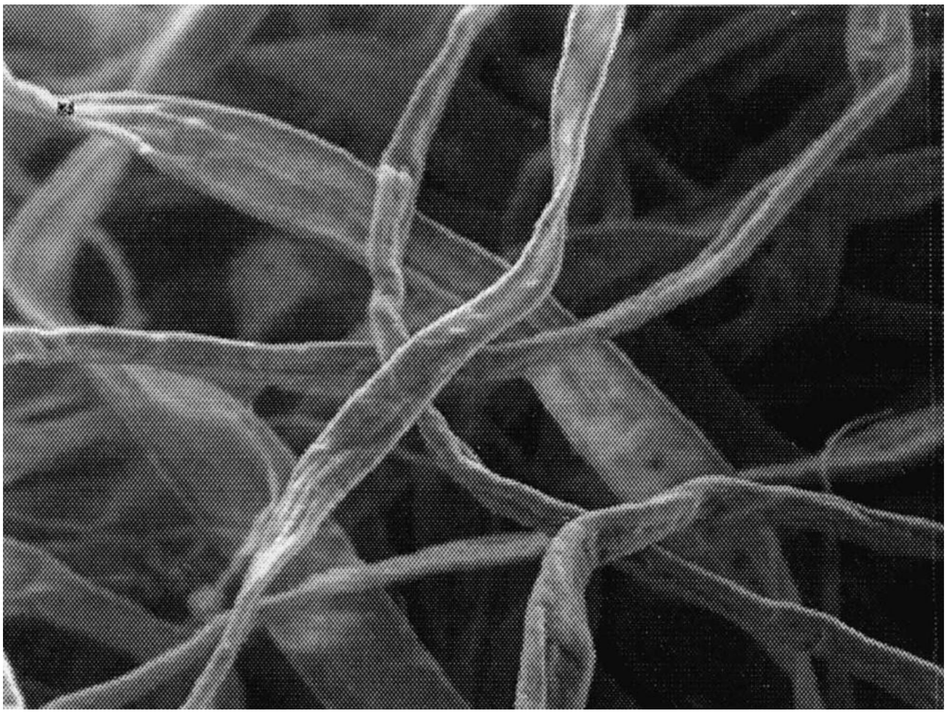


Figure 3.3 Microscopic view of cellulose fiber

3.2 Result of Materials Tested

Different tests were performed for testing the PPC and the outcomes got from these tests were contrasted with structured estimation of PPC alongside testing of fine total and coarse total. The outcomes are remembered for the Table 3.3. The mechanical assembly utilized for fine total strainer examination is appeared in Figure 3.4. Table 3.4 speaks to the strainer examination consequences of fine totals and Table 3.5 is the structured rate passing outcomes in as indicated by IS Code-383:2016. The graphical portrayal of strainer examination is appeared in Figure 3.5. Further, Table 3.6 shows the rundown of various devices used to perform mechanical and physical properties tests on Concrete Matrix.

Table 3.3 Materials property used in matrix

Experiments Performed	Value of Experiments
Test on Consistency	31 %
Initial setting Time	90 min
Final Setting Time	250 min
Test on Soundness	0.3 cm
Test on SG	3.14
• Test on SG of FA • Water Absorption Test • Zone of Fine Aggregate	2.51 1% II
• Test on SG of CA • Impact Test • Crushing Test • Los Angeles Test • Water Absorption Test	2.60 21% 24% 26%(B Grade) 0.5%

Figure 3.4 SA of Fine Aggregates

Table 3.4 Fine aggregate SA

Size (mm)	Wt. Retaining (gram)	Wt. Passing (gram)	Passed %age (%)
4.75	12.0	1980.5	99.11
2.36	418.9	1572.2	78.68
1.18	515.2	1100.5	55.08
0.6	298.3	699.8	35.02
0.3	199.6	498.5	24.94
0.15	450.9	120.9	6.05
PAN	66.5	-	-
TOTAL	1998.2	-	-

Table 3.5 Fine aggregates SA according to ***IS code-383:2016***

Size (mm)	Passed %age (%)	Passed %age range (%)	Remarks
4.5	99.11	90-100	
2.6	78.68	75-100	
1.8	55.08	55-90	IInd Zone
0.6	35.02	33-59	
0.3	24.94	8-30	
0.15	6.05	0-20	

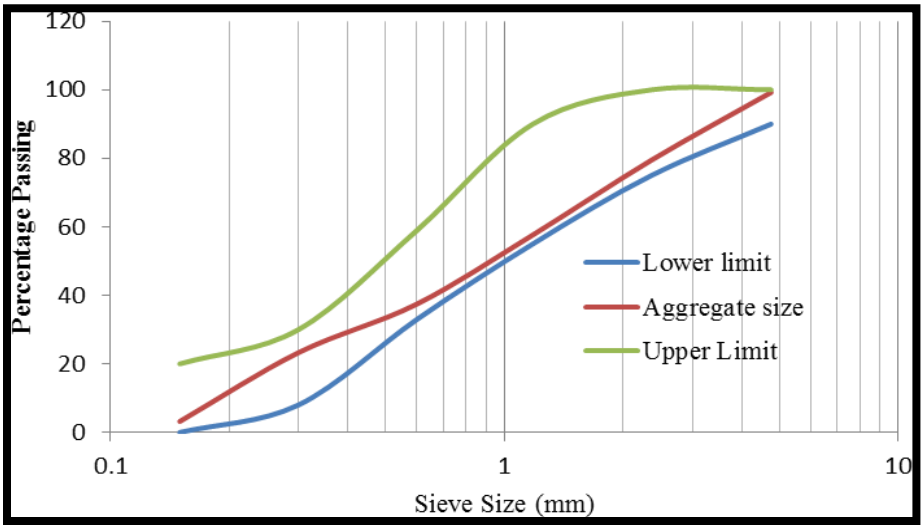


Figure 3.5 Logarithmic graph showing Fine aggregates SA

Table 3.6 Various equipment's to test concrete mixture

Apparatus	Usefulness
Vicat's Equipment "IS: 4031(4)-1988" & "IS: 4031(5)-1988"	For consistency, Initial & Final Setting time
Sieve of size 90 micron "IS: 4031(1)-1996"	Test on Fineness
Le-Chatelier"s Apparatus "IS: 4031(3)-1988"	Test on Soundness
SG Bottle	Test on SG
Pycnometer	SG of FA
Wire Mesh	SG of CA

3.3 Preparation and Casting Procedure

3.3.1 Methodology used in Mixing, Casting and Curing

Segments were weighed freely as indicated by the blend captions. Blending of solid parts was done in solid blender to cast 8 strong 3D squares for the given extents. To perform blend proportioning, inclining blend was utilized. The inclining blend hardware is appeared in Figure 3.6. After this point, cellulose filaments were blended in with hand. The consistency of concrete and fitting scattering of the strands essentially depends on the mixing system. Both concrete and segments of totals are mixed totally and along these lines cellulose strands are incorporated truly. While the blending action is in headway, around 75% of water is incorporated first and mixed for around 5 min and afterward rest of the water was incorporated and blended altogether. For each mix, a total for 8 3D squares of volume 150 mm3 were casted. Figures 3.7 and 3.8 show cast pillar and 3D shape examples, separately. After 24hr the examples are demoulded, put in faucet water for relieving and reestablished until testing. The demoulded solid 3D shapes with 0.5% of cellulose fiber are appeared in Figures 3.9.

Restoring is a path towards keeping up attractive moistness on examples and temperature on newly arranged cement for a positive time allotment instantly following game plan.

The technique satisfies two significant needs:

•It keeps away from or restores the loss of sogginess from the strong.

•It keeps up perfect temperature for the hydration to occur for a known timeframe.

We fix new solid examples to upgrade its nature of solidarity for example to helper quality factor and abatement parts. Figure 3.10 shows the restoring system of solid block when set under ordinary faucet water in the wake of throwing.

3.3.2 Final Casting

At the point when proper blend configuration was found, through the arrangement of preliminary blends, which invigorated wanted at 7 days. That preliminary blend was settled. Eight Cubes, Four bars and Five round and hollow examples were then casted with the settled blend Proportioning.

Table 3.7 Ratio containing different proportions of ingredients

Ingredients	Ratio (kg)
Water	172.0
Cement	430.0
FA	670.0
CA	1120.0
Admixture	1.387

This blend extent invigorated the compressive value of 27.50 MPa which was by our Design Strength.

Figure 3.6 Concrete Grinder Machine

Figure 3.7 Beam of concrete to test flexural strength

Figure 3.8 Cube of Concrete to test compressive strength

Figure 3.9 Concrete cubes casted with 0.5% of cellulose fiber

Figure 3.10 Curing of cubes

3.4 Experimental Procedures

As outlined before, one of the objectives of this project was to test the Impact loading test of concrete. However, owing to the unavailability of certain resources this test could not be performed in the laboratory and hence only CS and FS was done. The mechanical properties of cement have been found to rely upon the geometry of the example, solidness, kind of testing machine, stacking setup, dampness substance, temperature, and pace of stacking.

The cellulose fiber added to the concrete through mixing process gradually for the following percentage 0, 0.5, 1, 1.5 and 2% of which 8 moulds for the given percentages were made and cured in water until testing was carried out at 7 and 28 days age. The cubic were cured by immersing them in tap water until the age of 28 days.

3.5 Procedure of Testing

The essential point of the testing methodology was to build up a legitimate testing strategy to test concrete under various burden varieties, and to quantify the contrast between pressure rates on the presentation of plain and fiber containing concrete.

3.5.1 Compressive Strength

Concrete is viewed as a heterogeneous blend. A solid example contains some smaller scale level breaks. These miniaturized scale level increment under compressive stacking and in this way lead to greater split which in term brings about the structure disappointment. After a definitive quality is accomplished there is a reduction in stress yet the strain keeps on expanding, this is known as the conditioning stage. The uniaxial compressive loadings show the auxiliary part of the conditioning.

The solid proportioning blend was casted in 3D squares of measurement (150 mm x 150 mm x 150mm). Eight shapes were casted for 0%, 0.5%, 1%, 1.5%, and 2% of cellulose strands individually. The molds were demoulded and were saved for restoring for 7 and 28 days. The compressive tests for 3D squares were completed with the assistance of pressure testing machine of limit 2000KN at a steady stacking. The machine schematic is appeared in Figure 3.11.

Figure 3.11 CTM with 2000KN capacity

3.5.2 Flexure strength

Flexural quality is characterized as the most extreme worry at the peripheral fiber on either the pressure or strain side of the example. Flexure quality is the property of a material to check its flexure capacity for example modulus of flexibility or modulus of break in bowing. Its outcome is indicated in MPa. On the off chance that an example is anticipated under pliable pressure it extends. In the event that the extraordinary fiber is free or the throwing isn't top notch, at that point flexural test esteem diminishes. Computation of flexural quality is considered as essential in basic mechanics.

For this test 4 light emissions rates of cellulose fiber for example 0%, 0.5%, 1%, 1.5%, and 2.0% were casted having measurements 100mm×100mm×500mm. The machine utilized is flexural trying machine. The heap continued expanding till the pillars demonstrated disappointment. The contraption utilized in this investigation is appeared in Figure 3.12.

Figure 3.12 Machines to test Flexural strength

Chapter 4
Results and Discussions

4.1 Results on Concrete Tests

4.1.1 Compression Testing Results

4.1.1.1 7 days curing

We watch a progressive increment in compressive quality following 7 days. In spite of the fact that, the augmentation of solidarity gain isn't so high, this recommends expansion of cellulose strands does less addition in compressive quality of cement. The solid picked up around 73% of solidarity in 7 days. The readings of which are given in table 4.1. Most extreme augmentation of 1.27% was recorded for 1.5% of fiber as increment over the regular plain concrete. An itemized correlation between the compressive qualities at various volume parts of fiber is given in figure 4.1. Additionally, we see a decline in the compressive quality for 2%, which can be because of numerous reasons like inappropriate compaction, usefulness issue or ill-advised blending for example, or because of increment in fiber content more water is required.

4.1.1.2 28 days curing

Here likewise, compressive quality continued expanding till this age. Notwithstanding, the augmentation of solidarity gain is again less, which recommends that expansion of cellulose filaments does exceptionally less addition in compressive quality of cement. The solid picked up around 99% of solidarity in 28 days. The readings are given in table 4.1 underneath. Most extreme augmentation of 2.40% was recorded for 1.5% of fiber as increment over the customary plain concrete. An itemized examination between the compressive quality at various volume divisions is given in figure 4.2.

Additionally, we likewise observe a reduction in the compressive quality for 2%, which can be because of numerous reasons like inappropriate compaction, functionality issue or ill-advised blending for example or because of increment in fiber content more water is required. The disappointment of solid block under compressive stacking is appeared in figure 4.3.

Table 4.1 Compression Testing Results

Fiber Volume, V_f %	**Compression Strength, Mpa**	
	Day 7	**Day 28**
0.0	27.50	37.93
0.5	27.55	38.04
1.0	27.66	38.27
1.5	27.88	38.85
2.0	27.23	37.40

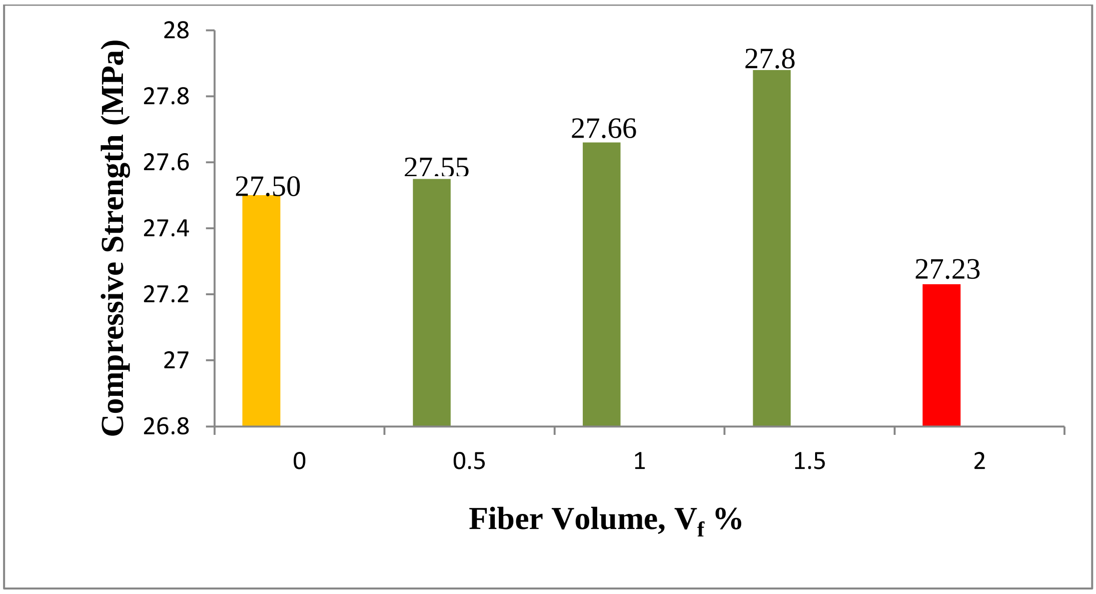
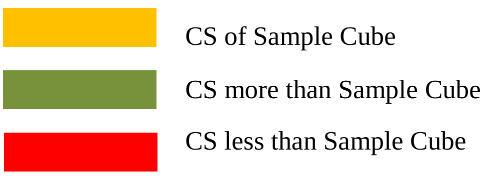


Figure 4.1 CS graph after 7 days



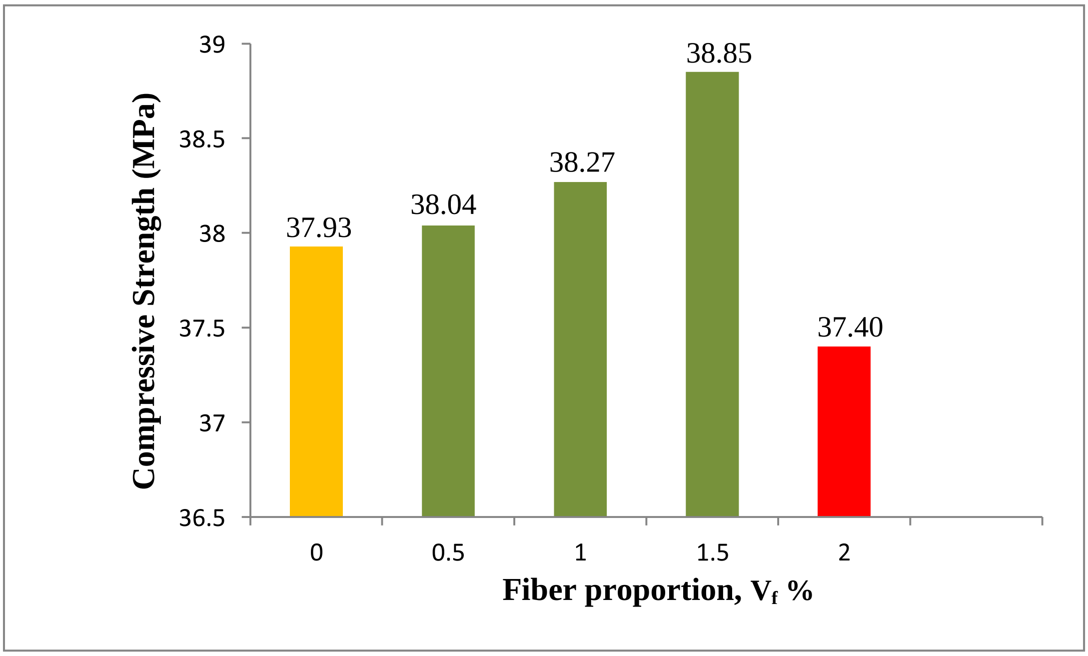


Figure 4.2 CS graph after 28 days

CS of Sample Cube

CS more than Sample Cube

CS less than Sample Cube

Figure 4.3 Cube failed while testing under CTM

4.1.1 Flexural Testing Results

4.1.1.1 7 days curing

We see a steady increment in flexural quality incentive following 7 days. The solid picked up around 71% of solidarity in 7 days and table 4.2 portrays it. Most extreme augmentation of 9.71% was recorded for 2% of fiber volume as increment over the ordinary plain concrete. A graphical correlation of the flexural quality at various volume portions is spoken to in figure 4.4.

4.1.1.2 28 days curing

Here additionally we see a steady increment of flexural quality at 28 days. The readings for which are expounded in table 4.2. Most extreme addition of 13.80% was recorded for 2% of fiber volume as increment over the traditional plain concrete. A graphical examination of the equivalent is given in figure 4.5. A bombed shaft example under flexural stacking is appeared in figure 4.6.

Table 4.2 Flexural Testing Results

Fiber Volume, V_f %	**Flexural Strength, Mpa**	
	Day 7	**Day 28**
0.0	2.75	3.81
0.5	2.88	4.05
1.0	2.91	4.16
1.5	3.05	4.29
2.0	3.09	4.39

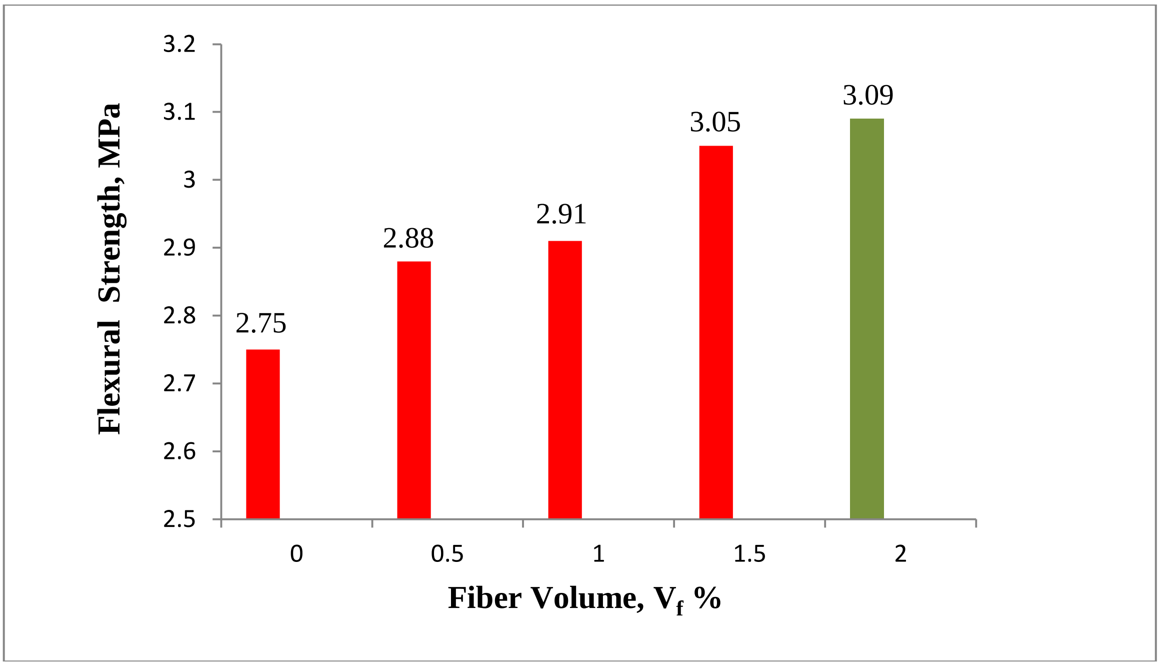


Figure 4.4 FS graph after 7 Days

FS of Sample Cube

FS more than Sample Cube

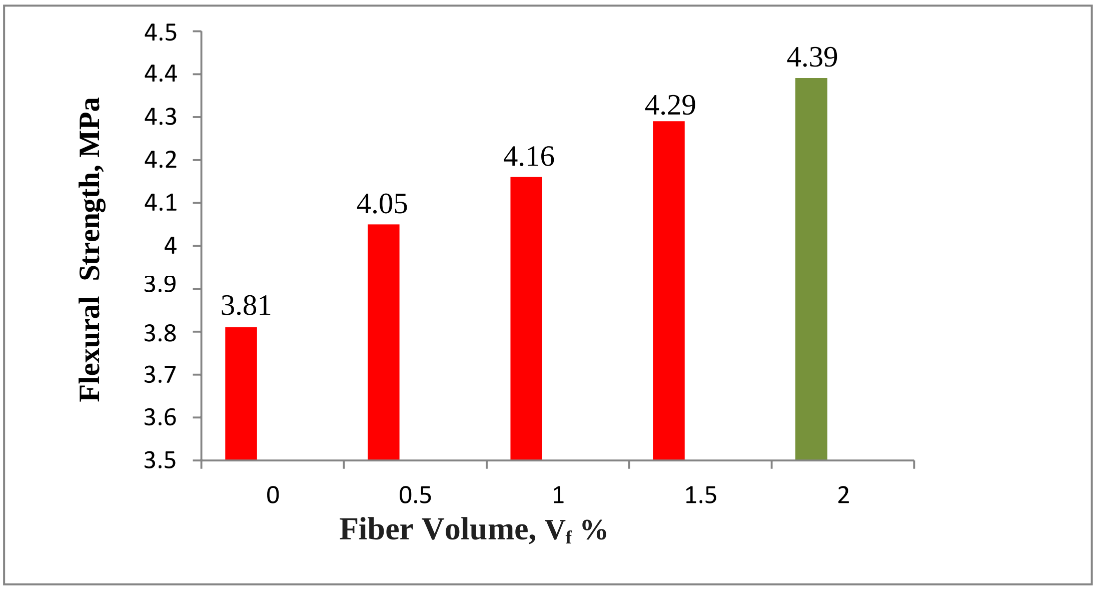


Figure 4.5 FS graph after 28 Days

FS of Sample Cube

FS more than Sample Cube

Figure 4.6 Beam Failures under FTM

Chapter 5
Conclusion

The following conclusions were made:

- Cellulose fiber fortified solid shows more prominent compressive quality when contrasted with plain concrete. The limit of which was seen as 38.85 MPa at a volume Fraction of 1.5% following 28 days.
- Cellulose fiber fortified cement indicated a more noteworthy flexural quality when contrasted with plain concrete. The limit of which was seen as 4.39 MPa at a volume division of 2% following 28 days.
- The examples containing no cellulose strands for example plain concrete, bombed in a weak way which proposes that plain concrete don't display malleable conduct while the examples containing filaments demonstrated a flexible disappointment.
- Three volume divisions which contain 0.5%, 1.0% and 1.5% of cellulose fiber demonstrates that there is an improvement in the pore structure because of expansion of cellulose fiber as pore refinement and decrease in porosity.
- Processed cellulose strands give an alluring harmony between mechanical properties when blended in with a concrete framework. Enormous surface zone and high modulus of versatility just as high fiber tally of the prepared cellulose filaments are the perfect explanations behind fortification effectiveness.
- Viscosity Test showed 20Pa.s which was according to the designed value.
- As referenced before, because of inaccessibility of specific assets Impact stacking trial of cement couldn't be performed.

Mix proportioning as per IS Code-10262:2019 guidelines:

M 30 = 30 N/mm^2
Formula Used = Target Strength
F = 30 + (S×1.65)
= 30 + (5+1.65)
= 38.25 MPa

Water/cement ratio = 0.39 (to be used) for 20mm coarse aggregate
Max. Water content
= 186 h (Reduction of 10% plasticizer)
= 172.0 kg/m^3

Cement
W/C = 0.4 [C=172.0/0.42]
Cement(c) = 429.23 kg/m^3
= 430.00 kg/m^3

Calculation of sand of course aggregate
Volume of concrete = 1m^3
= 430 / (3.14×1000)
=0.137m^3

Volume of water
= 172.0/1000
=0.1720

Course aggregate + Fine aggregate
= 1 - (0.1720 + 0.137)
=0.691m^3

Volume of course aggregate
= 0.62 × 0.6956
= 0.43 m^3

In the Fine types of Aggregates
= 1-0.62
= 0.38
= 0.38 × 0.691
=0.263 m^3

Coarse Aggregates mass
= Volume of coarse aggregate × Specific gravity ×1000
= 0.43 × 2.6 × 1000
=1118.0 kg/m^3

Mass of Fine aggregate
= Volume of fine aggregate × Specific gravity × 1000
= 0.263 × 2.51 × 1000
= 661.20 kg/m^3

Rounding off
Mass of cement = 430.00 kg/m^3
Mass of water = 172.00 kg/m^3
Coarse aggregate = 1120.00 kg/m^3
Fine aggregate = 670.00 kg/m^3

Water	Cement	Coarse	Fine
172 kg	430 kg	1120 kg	670 kg
0.4	1	2.60	1.56

Calculating the amount of material for each cube-

Cube casted of size = 150*150*150mm (i.e. 0.15*0.15*0.15m)
Total Volume of each cube = 0.15 x 0.15 x 0.15 = 0.003375m^3
Total Volume of all 3 cubes = 3 x 0.003375 = 0.010125m^3

Now,
Weight of Cement in each cube = Mass of Cement x Total Volume
= 430 x 0.010125
= **4.4kg**
Amount of water used in each cube = Mass of water x Total Volume
= 172 x 0.010125
= 1.742kg
Weight of CA in 1 cube = Mass of CA x Total Volume
= 1120 x 0.010125
= **11.34kg**
Weight of FA in 1 cube = Mass of FA x Total Volume
= 670 x 0.010125
= **6.784kg**

Weight of Cellulose Fiber for Different Volume Fraction (VF) = Total Volume x Weight of Cement in each cube x VF x 1000

For example,
Weight of fiber used for 0.5% VF is = 0.010125 x 4.4 x 0.5 x 1000
= **22.28gm**

Volume Fraction (V_f %)	**Weight for each fraction (gm.)**
0	44.55
0.5	22.28
1	44.55
1.5	66.83
2	89.10

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