

Study on Polyvinyl Alcoholic Fiber Reinforced Concrete

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Civil Engineering

by

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

**SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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APRIL 2021



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DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that the Project Report is the bonafide work of **YUVARAJ.G** (Reg. No. 37200909) and **VISHWAKKUMAR.R** (Reg. No. 37200911) who carried out the project entitled “**Study on Polyvinyl Alcoholic Fiber Reinforced Concrete**” under my supervision from October 2020 to April 2021.

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Submitted for Viva voce Examination held on_____

Internal Examiner

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DECLARATION

We YUVARAJ.G (Reg. No. 37200909) and VISHWAKKUMAR.R (Reg. No. 37200911) hereby declare that the Project entitled “**Study on Polyvinyl Alcoholic Fiber Reinforced Concrete**” done by us under the guidance of Mrs. B.PRIYADHARSHINI M.E, at Sathyabama Institute of Science and Technology, Chennai is submitted in partial fulfilment of the requirement for the award of Bachelor of Engineering Degree in Civil Engineering.

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Abstract:

The benefits of fiber supported cement (FRC) in different structural designing applications are undisputed. Up until this point, fiber supported cement has been utilized effectively in chunks, short concrete, engineering pieces, precast items, seaward development, structures in seismic areas, flimsy and thick fixes, guardrails, establishments, water powered developments and numerous other applications. This report contains a short record of the solidness investigations of polyvinyl liquor fiber-built up concrete. The issue with common foundation all throughout the planet lies in the evident absence of toughness of our structure materials, the proprietors' powerlessness to give ideal support, the absence of cutting edge condition appraisal instruments, and the absence of innovation and modest and economical sturdy fix materials. Present information to help the contention that polyvinyl liquor fiber-built up concrete was a only product to accomplish these objectives. The report additionally talks about the properties of polyvinyl liquor fiber-supported solid materials and blend plan. PVA strands are added to regular cement at 0%, 0.1%, 0.2%, 0.3% and 0.4% of their concrete weight. Compressive strength the partitioned rigidity and the modulus of crack of the solid were found and the ideal level was found by looking at the solid qualities. made of PVA fiber. The timeframe of realistic usability of PVA fiber concrete is controlled by submerging the solid shapes in sodium chloride (NaCl), sodium sulfate (Na₂SO₄) and magnesium sulfate (MgSO₄) for 7 and 28 days.

Catchphrases – Sodium Sulfate, Magnesium Sulfate Polyvinyl Alcohol Fiber, Durability, Sodium Chloride,.

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CHAPTER-1

INTRODUCTION

1.1 GENERAL

Fibre Reinforced Concrete (FRC) is done via way of means of integrally including and combining broken small fibre inside concrete. Incorporation of polyvinyl alcohol fibres in concrete are used to controlling and mitigating prone to plastic shrinkage cracking. In the position of intrinsic reinforcement, those fibres make contributions to enhancing the behavior of the ductile and damping of the concrete.

In fact, restricted investigations executed to this point on the flighty incorporation of polyvinyl alcohol fibre (PVA) strands in designed cementitious composites has affirmed that pliability and submit stature conduct can be improved. Filaments are respected to development power ingestion potential and life span while conveyed to concrete. Concrete is contemplated to be a fragile material this is defenseless in nervousness and, accordingly, demonstrates no submit tallness conduct. The flexibility of cement can be ventured forward through method of methods for the use of strands to enrich the tractable and flexural power properties. Past investigations has approved that supporting cement with miniature strands does now no longer to the essential break pressure as pleasantly on the grounds that the most pressing factor and its comparing pressure.

Creators of past examinations research have demonstrated that filaments assist with developing the solid's volumetric pressing factor potential in the wake of breaking through method of methods for spanning breaks and, in this way, changing over the submit stature conduct of FRC. In straightforward solid, disappointment usually impacts all of unexpected after the most pressing factor degree has been reached, while in FRC this crossing over sway allows the load to switch all through the break halting astounding disappointment. Depending at the type of fiber utilized and content material of fiber conveyed to the blend, the conduct of FRC will differ.

1.2 CONCRETE

Concrete is material in which a binding material mixed with water on solidification binds the inert particles of well graded fine and coarse aggregate.

1.3 CLASSIFICATION OF CONCRETE

Concrete are broadly divided into different types:

- Based on their binding materials used in concrete
- Design of the concrete

1.3.1 CLASSIFICATION ACCORDING TO BINDING MATERIAL

Concrete are two types based on binding material:

- Cement concrete
- Lime concrete

1.3.1.1 CEMENT CONCRETE

Concrete, which consists of cement, coarse aggregates and sand mixed in respective proportions in adding a water in the mixture, named as cement concrete. In concrete, binding agent is cement, fine aggregate was sand and gravel is crushed stone as coarse aggregate. Cement Concrete is normally used in buildings and other major engineering work where strength and durability are of the utmost importance.

1.3.1.2 LIME CONCRETE

Concrete produced using lime, fine total and coarse total in reasonable extents with water is called lime concrete. Water driven lime is for the most part utilized as a fastener in this sort of cement. Debris and Sand are utilized as fine totals and crushed blocks, rock can be used as coarse aggregate. The utilization of lime concrete is by and large utilized in establishment work and deck for reasons of economy. On the rooftop and where the concrete isn't modest and simple to get in the important amounts.

1.3.2 CLASSIFICATION OF CONCRETE BASED ON DESIGN

- Pre-stressed concrete
- Reinforced cement concrete
- Plain cement concrete

1.3.2.1 PLAIN CEMENT CONCRETE

Cement concrete that does not provide reinforcement is called ordinary cement concrete. These type of concrete has high strength and can withstand compressive stress, while low strength can withstand tensile stress. Flat concrete is often used for foundation work and building panels.

1.3.2.2 REINFORCED CEMENT CONCRETE

The concrete cement is fortified as installed for getting malleable pressing factor is alluded to as reinforced concrete cement. In this type of cement the metal support is to be utilized regularly concrete with inside the state of round bars, 8mm to 32mm dia. This solid is similarly high strength in facing ductile, shear stresses and compressive stresses . The usage of RCC is by and large utilized for production of pieces, radiates, sections, premise and precast cement.

1.3.2.3 PRE-STRESSED CEMENT CONCRETE

Concrete, in which falsely high compressive anxieties are initiated before it is really utilized, is alluded to as prestressed concrete cement. In this sort of concrete cement, prestressing initiates high compressive burdens and the support is delivered when the solid at last sets. Cement can withstand high tractable and compressive anxieties without cracking.significantly diminished by utilizing this solid.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

In this chapter, it has been describing about the literature studies of polyvinyl alcoholic fiber reinforced concrete.

2.2 LITERATURE STUDY

Effect of polyvinyl alcohol (PVA) fibre on dynamic and material properties of fibre reinforced concrete - Amin Noushini, Bijan Samali, Kirk Vessalas (September 2013). The impact of adding uncoated polyvinyl liquor fiber (PVA) on the powerful attributes of fiber concrete (FRC) was examined. In this examination, PVA strands with two mathematical lengths (6 and 12)(Mm) The perspective proportion is 428 and 857, and fly debris is likewise utilized as a halfway substitute for Portland concrete altogether blends. The recurrence, dynamic modulus and damping coefficient of the static mechanical properties of the 28-day FRC were additionally estimated. The little volume division utilized in this examination can altogether improve the mechanical properties of FRC without essentially impeding the damping properties of solid materials.

Static mechanical properties of polyvinyl alcohol fibre reinforced concrete (PVA-FRC) - Amin Noushini, Bijan Samali, Kirk Vessalas (March 2014). This exploration surveyed the general execution of polyvinyl liquor (PVA) filaments of 6 mm and 12 mm term in concrete. Based on by and large solid volume, 4 fiber divisions (0.125, 0.25, 0.375 and 0.5%) have been assessed for their effect on shining and solidified homes of PVA fiber supported cements (PVA-FRCs). Fly debris changed into moreover utilized as incomplete option of Portland concrete taking all things together of the blends. By donning out a total arrangement of analyses (compressive strength, parting rigidity, modulus of versatility, modulus of burst and lingering flexural strength), it changed into saw that PVA fiber widely

supplements the static mechanical homes of cement as well as upgrading its post-top response and malleable conduct.

A novel corrosion resistant repair technique for existing reinforced concrete (RC) elements using polyvinyl alcohol fibre reinforced geopolymer concrete (PVAFRGC)-Mohammed Haloub Al-Majidi, Andreas P. Lampropoulos, Andrew B. Kandy, Urania T. This examination assessed the counter consumption execution of geopolymer solid utilizing polyvinyl liquor as a maintenance material. Tests of mimicked surface coatings were tried as fix materials to forestall consumption of steel. Large-scale bar fixes were performed utilizing radiates, and polyvinyl liquor supported geopolymer concrete was utilized to supplant incomplete solid coatings of various profundities (12.5% and 25% of the complete pillar profundity, individually). The ostensible nonstop anode current is 300 mA/cm² for around 90 days. The consequences of the bowing strength test show that the underlying exhibition of supported solid shafts fixed with polyvinyl liquor strands has been fundamentally improved. The results can be summed up as follows: Coating the surface with polyvinyl liquor built up geopolymer can essentially decrease consumption harm as far as weight reduction, break dissemination and primary execution, and the distinction in surface covering thickness additionally altogether influences Corrosion obstruction fixed bar.

Drying Shrinkage Behaviour of Fibre Reinforced Concrete Incorporating Polyvinyl Alcohol Fibres and Fly Ash - Amin Noushini, Kirk Vesalas, Garo Arabian and Bijan Samali (May 2014). Uncoated PVA monofilament long (6 mm) and long length (12 mm) at 0.125%, 25%, 0.375% and 0°C.5% (volume). Fly debris is likewise utilized taking all things together combinations as a halfway substitute for Portland concrete. The PVA-FRC blend was contrasted and the adjustment long of the control concrete (no fiber) at three time spans: early age (0-7 days), momentary stretch (0-28 days) and long haul (28 days) days). - 112 days). The consequences of the shrinkage pace of FRC and the control concrete for as long as 112 days showed that all PVA-FRC combinations showed a more prominent dry shrinkage rate than the

control. PVA-FRC blend. The range is from 449 to 480 micro-elongation, and on account of the control, the worth is just 427 micro-elongation. Also, longer filaments have more noteworthy weight reduction, which may cause more prominent shrinkage.

Flexural and tensile characteristics of polyvinyl alcohol fibre reinforced concrete (pva-frc) - A. Nushini, K. Vesalas and B. Samali (May 2015). The effect of the consequences of test considers (PVA). The presentation of the fiber to the supported solid PVA fiber of variable length 612mm and 12mm with measurement and angle proportion (l/d) of 430 and 860, separately, are utilized in volume proportions of 0.125%, 0.25%, and 5%. Furthermore, altogether fiber-supported cement (FRC) blends, 30% fly debris is utilized as a halfway substitute for Portland concrete. As indicated by the Australian norm for assessing mechanical strength, the uniaxial pressure, split rigidity, modulus of break (MOR) and modulus of flexibility (MOE) were tried. PVA-FRC credits. A straight factor differential sensor (LVDT) at the focal point of each example is utilized to quantify the redirection of the adaptable example at the focal point of the range and record the heap diversion bend. The outcomes show that the expansion of PVA filaments to the mix can by and large improve mechanical properties. All things considered, the ideal fiber content is 0.25%. For fiber length and durability and last redirection, 0.5% shows the most elevated worth.

Modelling of the pre and post-cracking response of the PVA fibre reinforced concrete subjected to direct tension - Sadaqat Ullah Khan, Tehmina Ayub (May 2016). In any case, the utilization of a higher folio content, generally minimal effort, and a higher modulus of flexibility restricts their underlying application. Elite fiber supported cement (HPFRC) with coarse totals containing polyvinyl liquor (PVA) filaments under direct pressure was noticed. Models have been proposed and checked dependent on trial research. Metakaolin and silica seethe were utilized as substitutes in both blends to limit cement. Content and improvement of restricting fiber power with a lower interesting bond. The fiber exhaust test was likewise performed to build up the response report as indicated by the breaks and filaments.

The filaments have shown that the solid within the sight of PVA strands has gotten a hardener response with a lessening of the heap of up to half of the most extreme burden and capacitance of about 2% as a feature of the DC voltage relates to the consequences of direct tractable tests.

Polyvinyl alcohol fiber reinforced engineered cementitious composites: material design and performances - shuxin wang and victor c. Li. Polyvinyl liquor (PVA) strands are viewed as perhaps the most reasonable polymer filaments for use as support in designing support composites (ECCs), albeit the extraordinary microstructural properties of PVA filaments present a test to material plan. PVA-ECC reasonable for underlying applications is depicted and useful plan contemplations are portrayed, including interfacial holding, dimensional security, and framework disappointment necessities to accomplish a decent composite. The properties of a praise worthy PVA-ECC model have been summed up, including tractable conduct and improvement of compressive strength, flexural conduct, versatile modulus, autogenous and desiccant shrinkage, and freeze-defrost soundness.

Strain hardening behavior of lightweight hybrid polyvinyl alcohol (PVA) fiber reinforced cement composites -Shaikh Faiz, Uddin Ahmed, Hirozo Mihashi (November 2010). This article presents exploratory outcomes on pressure solidifying and various twisting of polyvinyl liquor (PVA) fiber-supported concrete composites. contains 2% thicker PVA fibers with a length of 12 mm and 1% more slender PVA6mm fibers and a composite with 2% thicker 24mm PVA fibers and 1% more slender 6mm PVA fibers showed the best exhibition as far as better quality burden, CMOD (crack dislodging) in addition to high top burden and numerous disappointments . W The examination additionally assessed the impact of four sorts of light sand on extension and numerous breaking of cross breed composites. It was seen that the most extreme burden and CMODA top burdens, they are practically something very similar for all light cross breed fiber composites, paying little heed to the volume part of the sand with low mass. Composite materials containing better light sands showed a higher extreme burden than those containing coarser light

sands. It was likewise seen that half breed fiber composites containing customary quartz sand displayed a higher extreme burden than light sand composites.

Properties of Polyvinyl Alcohol-Steel Hybrid Fiber-Reinforced Composite with High-Strength Cement Matrix-Jun Zhang, Qing Wang, Zhenbo Wang (March 2017). This paper contemplates the mechanical properties of PVA built up steel fiber blended concrete composite (HCC) with a high-strength concrete lattice. Check the tractable properties. Two kinds of concrete were utilized in the test, Ordinary Portland Cement (OPC) and Calcium Sulpho-aluminate Cement (SAC), which have the test results show that with the expansion of steel strands, the elasticity and rigidity of the composite material are altogether improved. Extra steel filaments can likewise expand the rigidity of the composite material. An appropriate measure of steel fiber (around 1% in the current test) is needed to deliver a positive reaction to the last pliable pressure of the composite material. By adding steel fiber, the phase of different break arrangement is enormously diminished. The base pliable break width is roughly 25 μm . The most noteworthy to least compressive strength and flexural strength, rigidity and elasticity, just as the biggest and littlest normal break width of the association acquired following 28 days of ordinary relieving for OPC and SAC arrangement are 99.4–105.37 MPa, 13.91–17.97 MPa, 5.04–8.10 MPa, 0.37–0.82%, 0.089–0.036 mm and 83.75–85.70 MPa, 9.81–15.95 MPa, 4.83–7.32 MPa, 0.51–1.00%, and 0.063–0.025 mm.

Experimental and numerical fracture analysis of the plain and polyvinyl alcohol fiber-reinforced ultra-high-performance concrete structures- Kun Zhanga, Tao Nib, Giulia Saregoc, Mirco Zaccariottoc, Qizhi Zhub, Ugo Galvanettoc, (March 2020). This article presents another interaction for delivering super superior cement from smooth cement (UHPC) and fiber-supported polyvinyl liquor (PVA) to improve its functionality and lessen its shrinkage properties. The test was performed on a furrowed bar structure produced using the created super high pressing factor. Likewise, as the interest for plan strategies that set aside time and cash proceeds to

grow. The innovative work of numerous modern materials, for example, UHPC plan, mathematical demonstrating and reproduction have become significant apparatuses. To anticipate the crack conduct of UHPC and UHPC-PVA structures, a discrete level mathematical reenactment strategy dependent on limited period elements is proposed. In the proposed technique, the construction is discretized by homogeneous non-matrix hubs associated by standard period dynamic bonds. At that point, as per the proposed strategy, these securities are arbitrarily identified with the mechanical boundaries and the obliteration boundaries of UHPC and PVA materials. In this technique, the support of PVA filaments in the UHPC material is addressed by the connection between the boundaries of the PVA material, which enormously improves on the displaying interaction of haphazardly conveyed UHPC structures built up with PVA strands. The legitimacy and precision of this system.

Mechanical properties of geopolymer concrete containing polyvinyl alcohol fiber exposed to high temperature -Harun Tanyildizi, Yavuz Yonar (September 2016). The point of the work is to test the high temperature obstruction of geopolymer concrete with polyvinyl liquor (PVA) fiber for the creation of geo-polymer, class F fly debris. Sodium silicate arrangement and sodium hydroxide were utilized as basic activators. The examples were made as 3D squares $100 \times 100 \times 100$ mm and pillars $75 \times 75 \times 300$ mm. Geopolymer concrete The set was made by restoring these examples at 60, 80 and 100°C and afterward air drying at $20 \pm 2^\circ\text{C}$ for 28 days toward the finish of the relieving time frame. The examples were presented to high temperatures at 20°C . The examples were exposed to pressure and flexural strength tests at 400°C , 600°C and 800°C , which showed The coefficient expanded, the compressive and flexural strength of the geopolymer concrete expanded, and the compressive and flexural strength of the examples presented to high temperatures showed a lessening in the examples.

CHAPTER-3

AIM AND SCOPE

3.1 AIM

- Determination of the influence of concrete reinforced with polyvinyl alcohol fibers.
- Evaluation of the influence of concrete reinforced with polyvinyl alcohol fibers on the experimentally tested mechanical properties.
- Reduction of water consumption for curing.

3.2 SCOPE

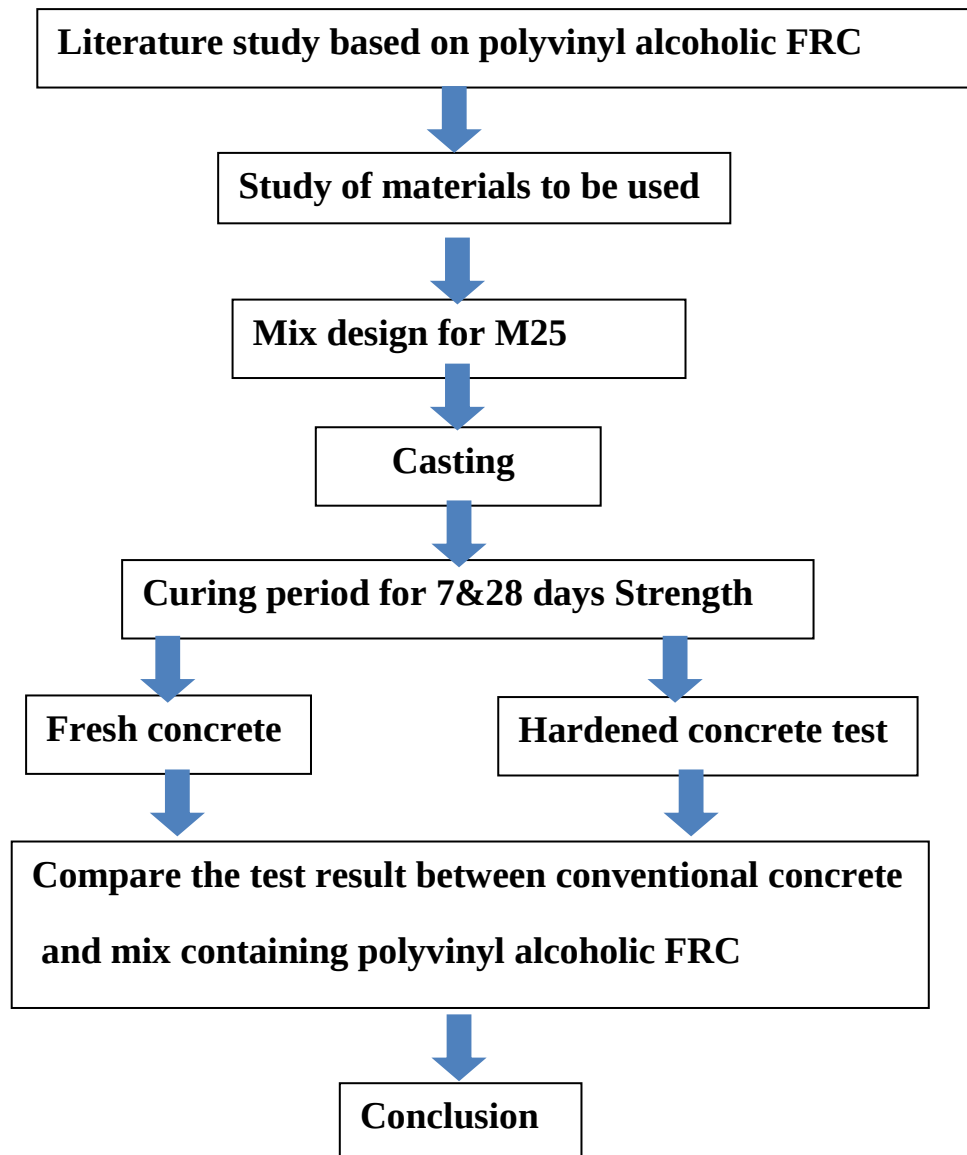
- For research, the experimental program consists of testing the strength of concrete reinforced with polyvinyl alcohol fibers.
- Concrete mixes are made from a different percentage of concrete reinforced with polyvinyl alcohol fibers.
- This concrete is compared with conventional concrete.
- Make the project economical.
- Investigation of the effect of different hardeners on the strength properties of concrete

CHAPTER-4

MATERIAL AND METHODOLOGY

4.1 METHODOLOGY

It describes about the workflow of the project as follows:



4.2 MIX DESIGN

4.2.1 STIPULATION FOR PROPORTIONING

Grade designation	: M25
Type of cement	: OPC 53 confirming IS 8112
Nominal size of aggregate	: 20mm
Max. Cement content	: 383.2 kg/m ³
Min. water content ratio	: 0.5
Workability	: 50-75 mm (slump)
Chemical admixture type	: polyvinyl alcoholic FRC
Type of aggregate	: Crushed angular

4.2.2 TEST DATA FOR MATERIALS

Cement used	: OPC53 grade confirming IS 8112
Specific gravity of cement	: 3.15
Specific gravity of	
Fine aggregate	: 2.65
Coarse aggregate	: 2.67
Free moisture	
Fine aggregate	: NIL
Coarse aggregate	: NIL

4.2.3 TARGET STRENGTH FOR PROPORTIONING

$$f_{ck}^* = f_{ck} + 1.65S$$

Where,

f_{ck}^* = Target Average Compressive Strength at 28days
 f_{ck} = Characteristic Compressive Strength at 28 days
S = Standard deviation

For table 1, standard deviation

$$S = 4 \text{ N/mm}^2$$

Therefore target strength = $25 + (1.65 \times 4)$

$$f_{ck} = 31.6 \text{ N/mm}^2$$

4.2.4 SELECTION OF WATER CONTENT

For table 2, Maximum Water content for 20mm aggregate = 186 litres

For 50mm slump add 3%

$$= 186 + (3/100 \times 186)$$

$$= 192 \text{ litres}$$

4.2.5 CALCULATION OF CEMENT CONTENT

Water cement ratio = 0.50

$$\begin{aligned} \text{Cement content} &= 192 / 0.50 \\ &= 383.2 \text{ Kg/m}^3 \end{aligned}$$

For table 5 IS 456 minimum cement content ever exposure condition

$$= 320 \text{ Kg/m}^3$$

$$383.2 \text{ Kg/m}^3 > 320 \text{ Kg/m}^3$$

4.2.6 MIX CALCULATION

Mix calculation per unit volume of concrete shall be follow.

$$\text{Volume of concrete} = 1 \text{ m}^3$$

$$\text{Volume of cement} = \text{mass of cement / SG of}$$

$$\text{Cement} \times 1/100$$

$$= 383.2 / 3.15 \times 1/1000$$

$$= 0.122 \text{ m}^3$$

$$\text{Volume of water} = \text{mass of water / SG of water} \times 1/1000$$

$$= 192 / 1 \times 1/1000$$

$$= 0.196 \text{ m}^3$$

$$\text{Volume of total aggregate} = (A - (B + C))$$

$$= 1 - (0.122 + 191)$$

$$= 0.6864 \text{ m}^3$$

Mass of coarse aggregate $= (0.6864 \times 0.62 \times 2.67 \times 1000)$

$$= 1136.26 \text{ kg/m}^3$$

Mass of fine aggregate $= (0.6864 \times 0.38 \times 2.65 \times 1000)$

$$= 691.2 \text{ kg/m}^3$$

Table 4.1 Mix Proportion

CEMENT	FINE AGGREGATE	COARSE AGGREGATE
383.2	691.2	1136.26
1	1.8	2.96

4.3 CEMENT

Cement is the main constituent of the concrete. Some important factors for selecting the cement are grade of the cement, type of the cement, color, finesses of cement, heat of hydration and alkali content of the cement. Most commonly using type of cement is the ordinary Portland cement, which is available in the grades of 33, 43 & 53. The grade numbers are indicating the compressive strength of the cement.

Table 4.2: Chemical composition of cement

S.NO	COMPOSITION	PERCENTAGE
1	Al_2O_3	6.6
2	SiO_2	21.8
3	Fe_2O_3	4.1

4	CaO	63.1
---	-----	------

Cement should be very cool and should be free from lumps. Color of the cement should be greenish grey and should be placed in dry place. Specific gravity of the cement is 3.15.

4.4 FINE AGGREGATE

River sand and crusher sand are used for fine aggregate. Fine aggregate should be well sieved through 2.36mm sieve before using. Fine aggregate is classified as zone I to zone IV based on the sieve size of the aggregate. Properties of the fine aggregates checked with the IS 393-1970 codal provision. Generally zone II aggregate is used for concrete, size of the zone II aggregate is used for the concrete and size of the zone II aggregate is 4.75 to 2.36 mm. Specific gravity of the fine aggregate is 2.65.

4.5 COARSE AGGREGATE

Coarse aggregate plays an important role in the strength of the concrete. It is chemically stable and least porous material. Coarse aggregate reduces the drying shrinkage and other dimensional changes the concrete. Properties of the coarse aggregate checked with IS 393- 1970 codal provision. Optimum size of the coarse aggregate is 20mm. Specific gravity is 2.65 to 2.7.

4.6 WATER

Water is the main constituent of the aggregate. Because, quality of the water influences the quality of the concrete. Water should be free from salts and other harmful components. Because the presence of salt in water, creates efflorescence as in the concrete after hardened. Portable water is used for the concrete works. Strength of the concrete is based on the water content of the concrete. Higher water content decreases the strength of the concrete, lower water content reduces the

workability of the concrete.

4.7 POLYVINYL ALCOHOLIC FRC

For this exploration work OPC 53 evaluation is used. Normally accessible fine and coarse total was utilized which has gravity of 2.75 and 2.8. The greatest size of coarse total was 12.5mm. The Poly vinyl Alcohol fiber was gotten from Spinning King (India) Limited, Gujarat, India, with following Properties.

TABLE 4.3 PROPERTIES OF POLY VINYL ALCOHOL FIBER

Test item	Tested value
Material	Polyvinyl alcoholic FRC
Density	1300 kg/m ³
Diameter	18 µm
Length	6mm
Modulus of rigidity	36000 N/mm ²
Tensile strength	1280 N/mm ²



Fig.4.1 Poly Vinyl Alcohol fiber

CHAPTER-5

MATERIAL AND CONCRETE TESTING

5.1 TEST ON FINE AGGREGATE

- Fineness modulus test
- Specific gravity test
- Moisture content test

5.1.1 FINENESS MODULUS TEST

Fineness modulus test was carried out to find the fineness of the aggregates. Sieve analysis is used for this test. 1 Kg sample of fine aggregate was taken. Sieve sets were kept in the order from 4.36mm to 75 micron with pan at the bottom. Aggregate sample was kept in 4.36mm sieve, closed with lid and the machine was run for 10 minutes. After 10 minutes weight of retained sample on each sieve was noted.

Table 5.1 Fineness modulus of fine aggregate

S.NO	Sieve size mm	Wt of sand retained(X) G in gram	Percentage weight retained $(X/W) \times 100$	Cumulative Percentage retained 'y'	Percentage finer $n=100-y$
1	4.750	25.3	2.53	25.3	
2	2.360	42.7	4.27	6.80	97.47
3	1.180	128.4	12.84	19.84	93.2
4	0.600	140.6	14.06	33.70	80.36
5	0.425	118.2	11.82	45.52	66.30
6	0.300	109.4	10.94	56.46	54.48
7	0.150	234.9	23.49	79.95	43.50
8	0.075	103.5	10.35	90.30	20.54
9	Pan	97	9.70	100	0

Weight of the sample taken = 1000Kg From the graph:

$$D_{10}=0.08, D_{30}= 0.30, D_{60}=0.52$$

$$\text{Coefficient of curvature } C_c = \frac{D_{30}^2}{D_{10} \times D_{60}} = \frac{(0.3)^2}{0.08 \times 0.52} = 2.16$$

$$\text{Uniformity coefficient } C_u = \frac{D_{60}}{D_{10}} = \frac{0.52}{0.08} = 6.5$$

Result:

Uniformity coefficient =6.5

Percentage of gravel (>4.75mm)= 2.53%

Percentage of sand (4.75-0.075mm)= 90.30%

Percentage of silt and clay = 9.7%



FIG 4.2 Concrete Cube

5.1.2 SPECIFIC GRAVITY TEST

Specific gravity test was conducted by using pycnometer. First the empty weight of the pycnometer with lid taken as w1. Then the weight of pycnometer filled with 400g of sand was noted as w2. After this water is filled in pycnometer up to the lid, weight was noted as w3. Then the pycnometer was washed well and filled with water was taken as w4. Specific gravity of fine aggregate was found by using the following calculations.

Table 5.2 Specific gravity of the fine aggregate

S.NO	w1(g)	w2(g)	w3(g)	w4(g)	G
1	684.5	1268.4	1860.5	1499.6	2.64
2	684.5	1303.6	1894.4	1501.9	2.73
3	684.5	1275.6	1846.5	1487.7	2.54

$$\text{Specific gravity } G = \frac{w_2 - w_1}{(w_2 - w_1) - (w_3 - w_4)}$$

w1- Empty weight of pycnometer w2- Weight of pycnometer with sand w3- Weight of pycnometer with sand and water w4- Weight of pycnometer with water Calculation

$$G = \frac{1268.4 - 684.5}{(1268.4 - 684.5) - (1860.5 - 1499.6)} = 2.65$$

Result:

Specific gravity of the fine aggregate = 2.65

5.1.3 MOISTURE CONTENT TEST

Empty weight of pan = 31.8g

Weight of sand with pan = 70.6g

Weight of sand w1 = 38.8g

Weight of dry sand with pan = 70.2g

Weight of dry sand w2 = 38.2g

$$\begin{aligned} \text{Moisture content of fine aggregate} &= \frac{w_1 - w_2}{w_2} \\ &= \frac{38.8 - 38.2}{38.2} = 0.015 \end{aligned}$$

Result:

Moisture content of fine aggregate = 0.01

5.2 TEST ON COARSE AGGREGATE

- Specific gravity test
- Fineness modulus test
- Water absorption test

5.2.1 SPECIFIC GRAVITY TEST

Specific gravity of coarse aggregate is also done by using pycnometer. Coarse aggregate which was sieved through 20mm sieve was filled in one by third of pycnometer.

Table 5.3 Specific gravity of coarse aggregate

S.NO	TRAIL	w1(g)	w2(g)	w3(g)	w4(g)	G
1	1	620	825	1640	1510	2.73
2	2	620	815	1630	1510	2.65

$$\text{Specific gravity } G = \frac{w_2 - w_1}{(w_2 - w_1) - (w_3 - w_4)}$$

Where,

w1-Empty weight of pycnometer

w2-weight of pycnometer

w3- weight of pycnometer

w4-weight of pycnometer with water



Calculation:

$$G = \frac{810 - 620}{(810 - 620) - (1630 - 1510)} = 2.67$$

Result:

Specific gravity of coarse aggregate = 2.67

5.2.2 FINENESS MODULUS TEST

As per IS 383- 1970 fine aggregate is classified in four grading zone from coarser and (zone1) to fines sand (zone 4)

FIG 4.3 Concrete Beam

Table 5.4 Sieve analysis of coarse aggregate

S.NO	Sieve size mm	Wt of particles	% of wt retained	Cumulative % of wt retained	% fineness
1	20	P1 0.385	19.25	19.25	80.75
2	16	0.780	39	58.25	41.75
3	12.5	0.630	31.50	89.75	50.25
4	10	0.155	7.75	97.50	2.50
5	6.3	0.050	2.50	100	0
6	4.75	-	-	-	-
7	Pan	-	-	-	-

Fineness modulus = ($\sum$ of cumulative % of weight retained)/100

$$= 364.75/100$$

$$= 3.64$$

5.2.3 WATER ABSORPTION TEST

Water absorption test is used for determine the water absorption value of coarse aggregate. Light weight aggregate has high absorption value than the normal weight aggregate. Absorption value of the aggregate is 5 to 20%. Hence it is

important to find the absorption value of aggregates. 2Kg of sample was taken for test and it was kept in the bucket mesh then immersed in water for 24 hours and the weight of oven dried sample was taken. Adsorption value was found by using the following formula,

Percentage of water absorption $= w_3/w_1 \times 100$

Table 5.5 Water absorption test of coarse aggregate

S.NO	Wt of saturated aggregate w_1 kg	Wt of oven dried aggregate w_2 kg	Wt o water absorbed aggregate $w_3=(w_2-w_1)$ kg	% of water absorption $w_3/w_1 \times 100$
1	2.090	1.970	0.120	6%
2	2.170	1.940	0.200	11.5%

Mean = 8.7%

Result:

Water absorption value of coarse aggregate = 8.7%

5.3 TEST ON CEMENT

- Consistency test
- Initial and final setting time

5.3.1 Consistency of cement

Standard consistency of the cement is defined as the amount of the water required to make the cement paste. This paste is used to find out the initial setting time, final setting time and soundness of cement. Standard consistency of the cement paste is determined by using Vicat apparatus. The following procedure had

followed for done this test. 500g of cement was taken and mixed with water for prepare the cement paste. This paste was filled in the Vicat mould within 3 minutes and shake the mould to expel the air. Then the mould is kept in position on the Vicat apparatus. Vicat plunger having 10mm diameter and 50mm length was brought down to touch the surface of the paste, quickly, released and allowed to penetrate into the cement paste by its own weight. Value of the depth of penetration was noted.

Table 5.6 Standard consistency test

S.NO	Water cement ratio	Water content (ml)	Depth of penetration (mm)
1	0.30	150	26.0
2	0.32	160	29.2
3	0.34	170	31.5
4	0.36	180	34.5

This test was conducted for various water cement ratio until the value had reached the 33-35mm depth from the top. Then the amount of water required to reach the 33-35mm depth was taken as the consistency of cement. 33-35mm depth was achieved in the water content of 180 ml. So the standard consistency of cement was 180ml.

Result:

Standard consistency value = 180ml.

5.3.2 INITIAL SETTING TIME

Initial setting time of cement was also determined by using vicat apparatus. 500g of cement and standard consistency water content was taken for making cement paste. Then the paste was filled in vicat mould and kept in position. Vicat needle was brought into touch on the surface of the cement paste and released. Time taken for achieving the depth of 33-35mm was noted.

Result:

Initial setting time of the cement was 35minute

5.4 TEST ON FRESH CONCRETE

5.4.1 SLUMP CONE TEST

Slump cone test is used to find the consistency of fresh concrete by using slump cone of height 30cm. Prepared fresh concrete was filled into the slump cone with 15 times tamping. After filling, slump cone is removed vertically, concrete is subjected to stand alone without any support. Then the concrete will subsided and the subsided height are measured. This procedure was repeated for various water cement ratios.

Table 5.7 Slump cone test

S.NO	Water cement ratio	Initial height of slump h1 in cm	Height of subsided h2 in cm	Slump h1-h2 in cm	Type of slump
1	0.40	30	30	0	Zero
2	0.50	30	28	2	True
3	0.55	30	24	6	Shear
4	0.60	30	21	9	Shear
5	0.65	30	18	12	Shear
			Average	5.8	Shear

Result:

Slump cone test of the concrete = 5.8cm

5.4.2 COMPACTION FACTOR TEST

Compaction factor is used to find the workability of the fresh concrete. Compaction factor machine is used for this test. First the fresh concrete was prepared with lower water cement ratio. Compaction factor machine consists of upper hopper, lower hopper and cylinder. Hoppers provided with trap doors at bottom. Empty weight of the cylinder was taken. Concrete is filled first in upper hopper without any compaction. Then the trap door of upper hopper was opened and concrete is allowed to fall on the lower hopper. Then the trap door of the lower was opened and the concrete is allowed to fall on the cylinder. Surface of the cylinder was wiped and the weight was taken. After this, concrete is filled on the upper hopper with compaction then the procedure was repeated. This procedure was

repeated for various water cement ratios and the readings were noted.

Table 5.8 Compaction factor test

S.NO	Water cement ratio	Wt of concrete with partial compacted w1 kg	Wt of concrete with fully compacted w2 kg	Compaction factor $(w1/w2) \times 100$
1	0.40	10.99	12.32	89
2	0.50	12.10	12.46	97
3	0.55	12.50	13.49	92
4	0.60	12.92	13.78	93
5	0.65	13.25	14.01	94
			Average	93

Result:

Compaction factor of concrete = 93%

5.4.3 FLOW TABLE TEST

Flow table test is conducted for find out the workability of the concrete. Same slump cone mould was used for this test. Slump cone was kept on the flow table and fresh concrete was filled. Then the mould was removed vertically initial diameter of the concrete was measured. Machine was started and the concrete was allowed to vibration for 5 minutes. After vibration final diameter of the concrete was measured.

This procedure was repeated for various water cement ratios and reading were noted.

Table 5.9 Flow table test

S.NO	Water cement ratio	Initial diameter in cm	Spread diameter in cm	Percentage of flow
1	0.40	19	38	52
2	0.50	19	39	56
3	0.55	20	41	64
4	0.60	20	42	68
5	0.65	20	43	74
			Average	62.8

Calculation

$$\text{Flow percentage} = \frac{\text{spread diameter in cm} - 25}{25} \times 100$$

$$= \frac{38 - 25}{25} \times 100 = 52$$

Result:

Flow percentage of the concrete = 62.8%

5.5 TEST ON HARDENED CONCRETE

5.5.1 COMPRESSIVE STRENGTH

The compressive strength test shows the compressive strength of hardened concrete. The compressive strength test shows the best possible concrete strength that can be achieved under optimal conditions. The compressive strength is a measure of the strength of concrete in the hardened state. 140 kg / cm² / minute after centering the sample Charging continued until the face of the dial simply changed direction. Reversing the needle direction indicates that the sample has been damaged. The comparator value was the last load at this point. The maximum load divided by the cross-section of the sample corresponds to the final compressive strength of the cube. The compressive strength of the concrete gives an impression of the quality of the concrete. are manufactured at a recognized age of the samples, preferably from different batches that have been manufactured for testing at a selected age. All cubes were tested under saturated conditions after moisture was removed from the surface. Each mixture of traces, three cubic associations was tested at the age of 7 days and 28 days of self-curing using a compression testing machine with a load capacity of 2000 kN according to the per IS 516-1959 standard.

Table 5.10 Compression Strength on cubes

S.NO	MIX	MATERIAL USED	STRENGTH ON 7 th DAY (N/mm ²)	STRENGTH ON 28 th DAY (N/mm ²)
1	M25	Conventional concrete	17.1	26.6
2	M25	polyvinyl alcoholic FRC	22.9	41.7

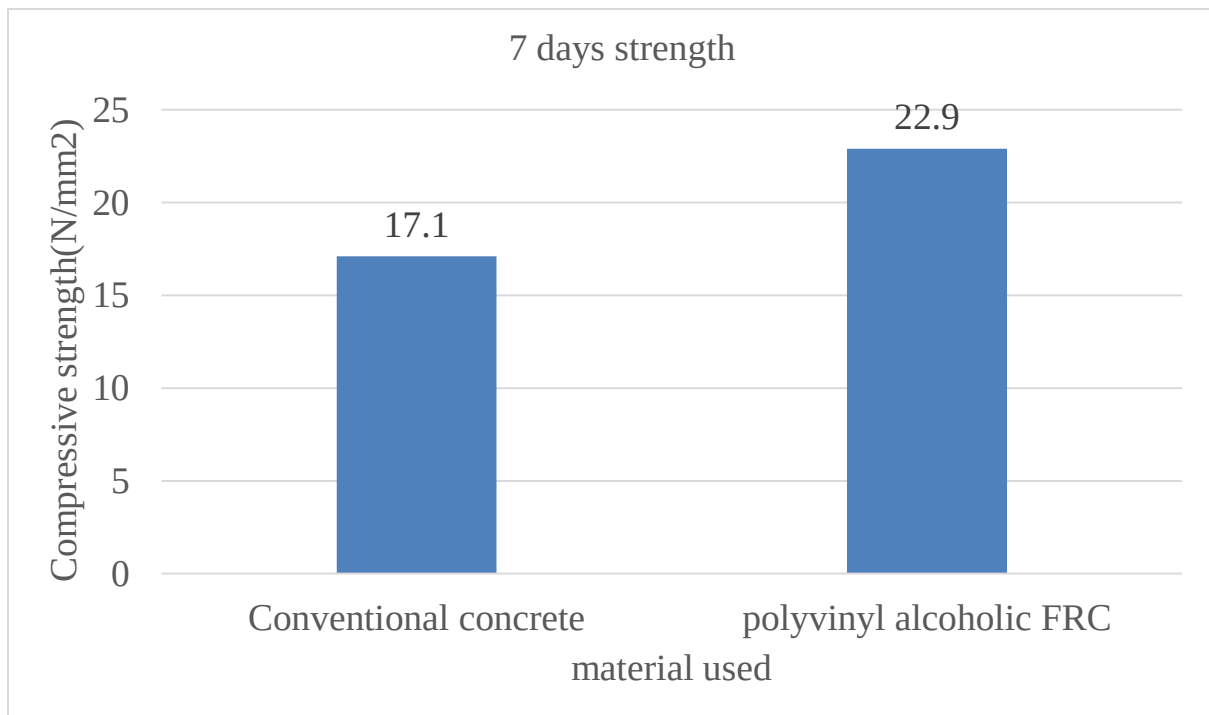


FIGURE 5.1 Compressive Strength for 7days



FIGURE 5.2 Compressive Strength for 28 days

5.5.2 SPLIT TENSILE STRENGTH OF CONCRETE

Tensile strength is one of the fundamental and important properties of concrete. Concrete generally resists direct tensile strength due to its low tensile strength and brittleness, but is a load that can cause concrete elements to break. To determine the tensile strength of concrete, it can be roughly classified as (a) direct method (b) indirect method encounters a number of difficulties in properly holding the specimen in the testing machine without introducing a stress concentration and applying a uniaxial tensile load to the specimen that is free of eccentricity. Cylinder diameter 150 mm and height 300 mm. is used to determine the strength of concrete, sometimes called the tensile strength of concrete. A genuinely uniform rigidity is accomplished because of the pressing factor load near the stacked distance across acquired from versatile investigation. The size of this elastic pressure is given by the recipe (IS 5816-1970).

Table 5.11 Split tensile strength on the cylinder

S.NO	MIX	MATERIAL USED	STRENGTH ON 7 th DAY (N/mm ²)	STRENGTH ON 28 th DAY (N/mm ²)
1	M25	Conventional concrete	5.2	6.9
3	M25	polyvinyl alcoholic FRC	5.15	9.9

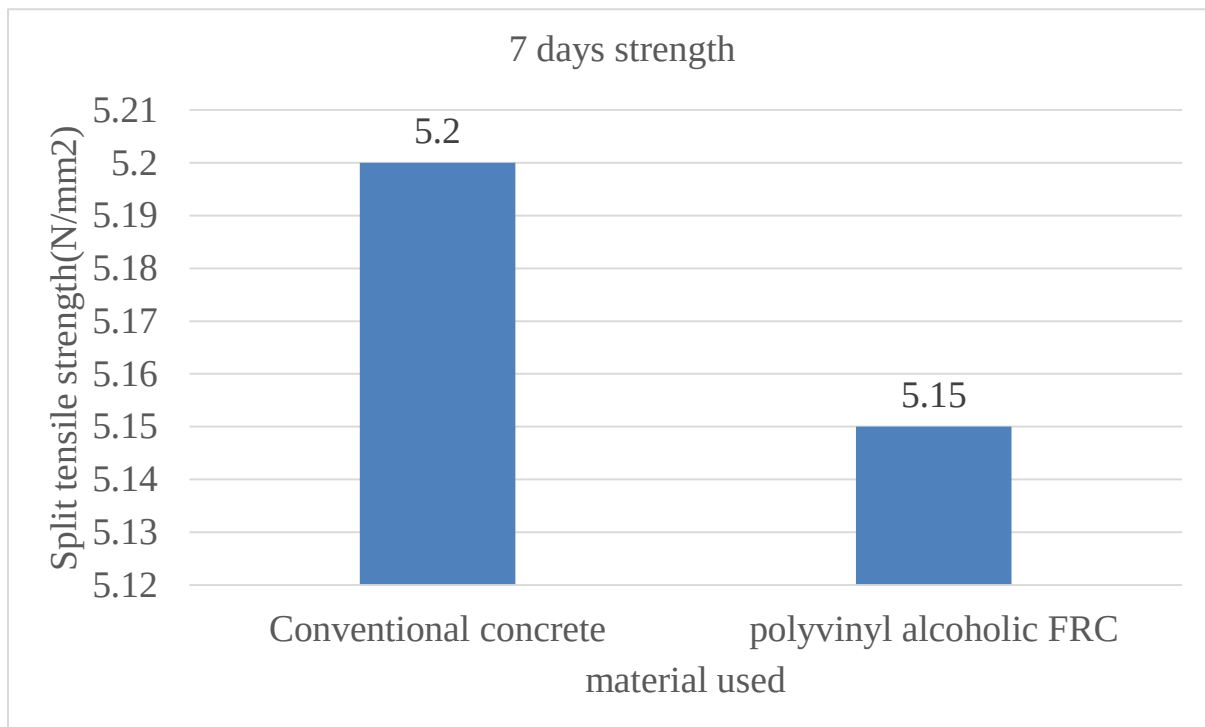


FIGURE 5.3 Split Tensile Strength for 7days

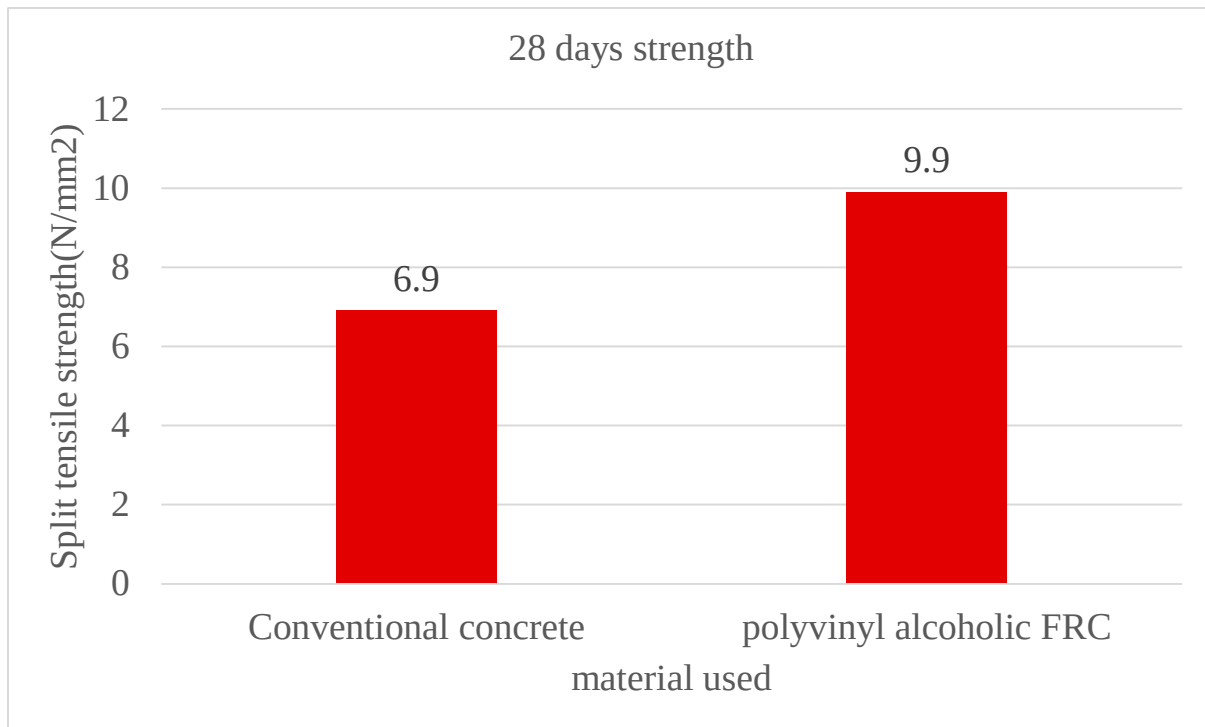


FIGURE 5.4 Split Tensile Strength for 28days

5.5.3 FLEXURAL STRENGTH

The flexural strength is a proportion of the elasticity of cement. This is a proportion of an unreinforced solid shaft or chunk that will oppose twisting. It is estimated by stacking solid pillars estimating 100 x 100 x 500 mm (6 x 6 inches) with at any rate multiple times the range. The flexural strength is communicated as the modulus of disappointment (MR) in psi (MPa) and is resolved by ASTM C293 Standard Test Methods (medium burden). The MR flexural strength is around 10 to 20 percent of the compressive strength, contingent upon the size and volume of the coarse total utilized. The best connection for singular materials is accomplished dependent on lab tests for explicit materials and the blend plan upto 15%.

Table 5.12 Flexural Strength on prism

S.NO	MIX	MATERIAL USED	STRENGTH ON 7 th DAY (N/mm ²)	STRENGTH ON 28 th DAY (N/mm ²)
1	M25	Conventional concrete	2.24	3.86
2	M25	polyvinyl alcoholic FRC	2.65	4.65

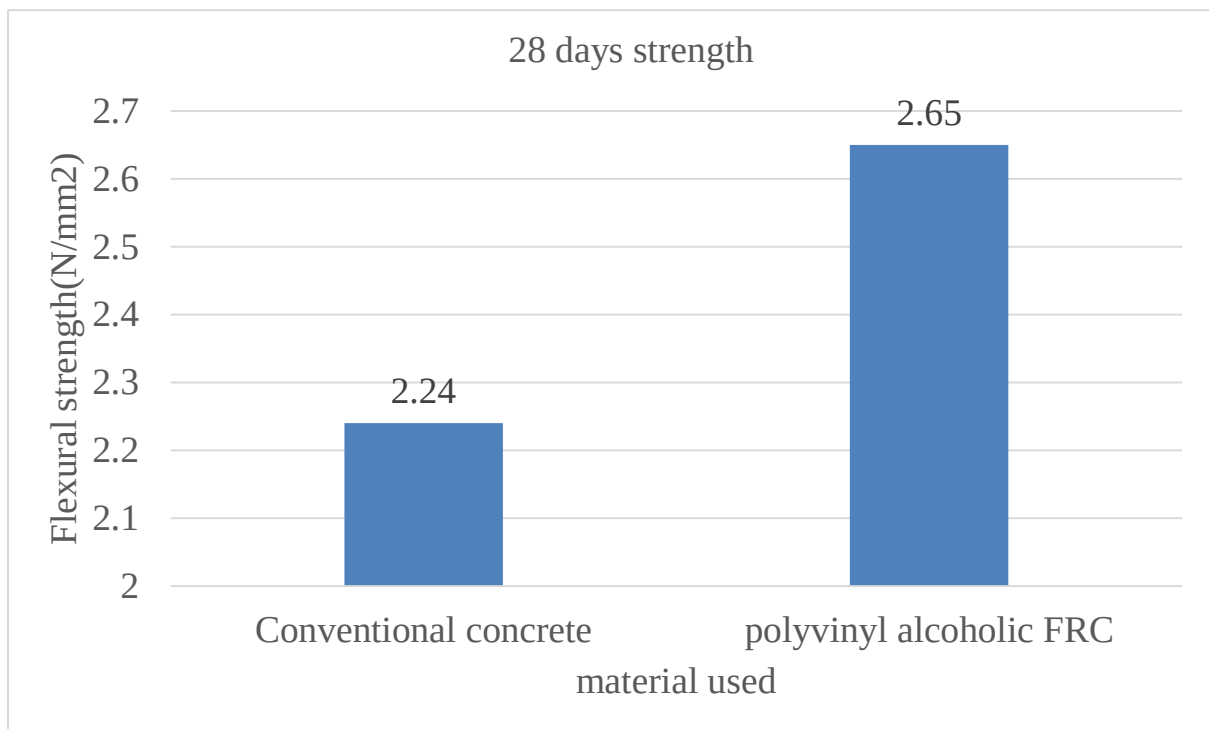


FIGURE 5.5 Flexural Strength for 7 days

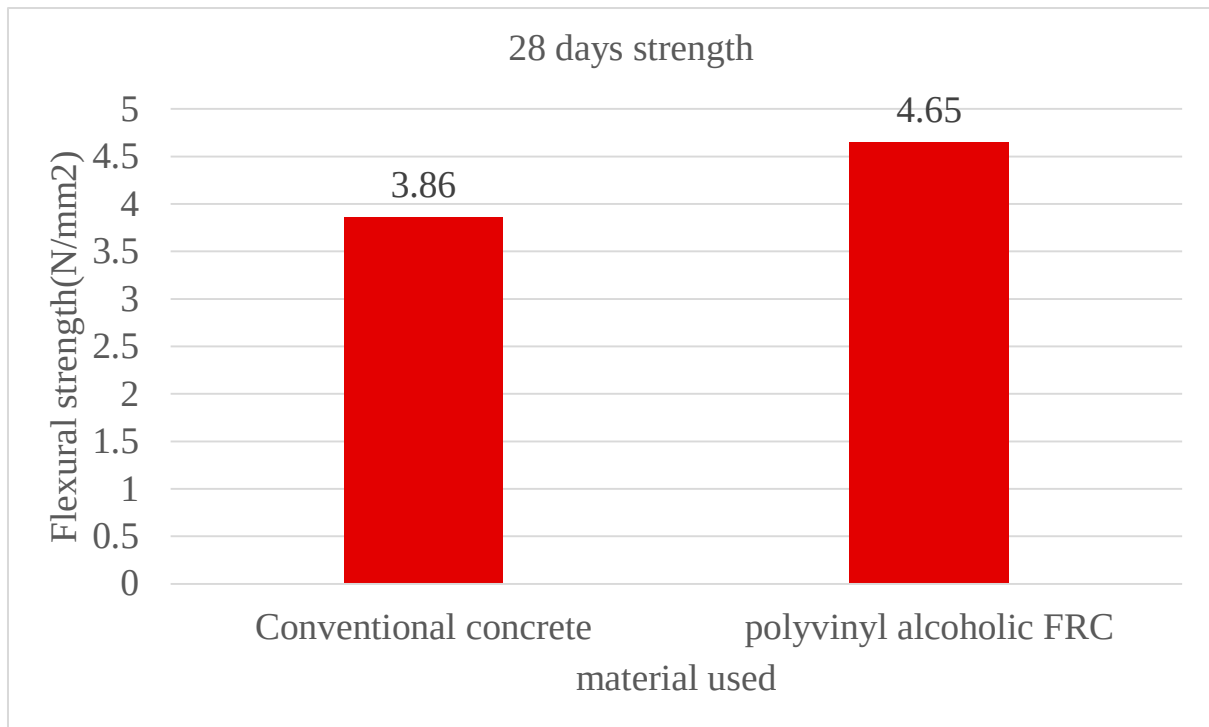


FIGURE 5.6 Flexural Strength for 28 days

CHAPTER- 6

RESULT AND CONCLUSION

6.1 Compressive strength

For this study, M25 grade mix proportion is used and the mix ratio is 1:1.8:2.96. To find out compressive strength, 16 cubes were cast. The average compressive strength was calculated at 150mm x 150mm x 150mm size cubes by taking the average of 3 specimens for 7 and 28 days. The compressive strength of plain concrete and self-curing concrete is 26.7 and 41.7 MPa for 28 days. Thus, the compressive strength of the self-curing concrete is much greater than the conventional concrete. The optimum dosage of POLYVINYL ALCOHOLIC FRC was found to be 1% for compressive strength. As the percentage of POLYVINYL ALCOHOLIC FRC increase to more than 1%, the strength of concrete tends to decrease. We also found that at 1.5% dosage of POLYVINYL ALCOHOLIC FRC, reaches the target strength of 35 Mpa

6.2 Split Tensile strength

For finding split tensile strength, totally 16 cylinders were cast. The average split tensile strength was calculated on 300mm X 150mm size cylinder by taking the average of three specimens for 7 and 28 days. The split tensile strength of the plain concrete for 28 days is 6.9 Mpa whereas the split tensile strength of the self-curing concrete for 28 days is 17.1 Mpa which much greater than the conventional concrete. The optimum dosage for the occurring maximum split tensile strength was found to be 1%. If the POLYVINYL ALCOHOLIC FRC adding more than 1%, the concrete tends to a reduction in strength and also we found that at POLYVINYL ALCOHOLIC FRC 1.5% split tensile strength is 9.9 Mpa which greater than the conventional concrete 6.9 Mpa.

6.3 Flexural strength

For finding flexural strength, totally 16 prisms were cast. The average flexural strength was calculated on 500mm X 100mm X 100mm size prisms by taking the average of 3 specimens for 7 and 28 days. The flexural strength of the conventional concrete for 28 days 3.8 Mpa whereas the flexural strength of the self-curing concrete for 28 days is 4.65 Mpa which much greater than the conventional concrete. The optimum dosage for the occurring maximum flexural strength was found to be 1%. If the percentage of POLYVINYL ALCOHOLIC FRC increases, the flexural strength of the concrete decreases. By adding POLYVINYL ALCOHOLIC FRC 1.5% flexural strength values are 4.10 Mpa which is lower than the conventional concrete 3.28 Mpa.

6.4 CONCLUSION

- The compressive strength value gets increased by adding 1% of POLYVINYL ALCOHOLIC FRC and strength decreases by adding more than 1% of POLYVINYL ALCOHOLIC FRC.
- The split tensile strength value gets increased by adding 1% of POLYVINYL ALCOHOLIC FRC and strength decreases by adding the more than 1% of POLYVINYL ALCOHOLIC FRC.
- The Flexural strength value gets increased by adding 1.5% of POLYVINYL ALCOHOLIC FRC and strength decreases by adding more than 1.5% of PEG.
- It was observed 1% of the POLYVINYL ALCOHOLIC FRC optimum ideal dosage of maximum compressive strength and split tensile strength.
- As the percentage of POLYVINYL ALCOHOLIC FRC increase, the workability of concrete also increases and it was found by workability test.
- Self-curing concrete is the answer to where the scarcity of water is more.
- In the study cast cubes, cylinders and prisms were kept for curing at room temperature.

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