

# Investigative Study on Hybrid Fiber Reinforced Concrete using a Combination of Steel and Polypropylene (PP) Fibers

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## ABSTRACT

The objective of the current project is to conduct an investigative study of the high-strength hybrid fibre reinforced concrete, i.e., the mixture of steel and polypropylene fibres. The compressive strength and a flexural strength of hybrid fibre-reinforced concrete with various percentages of fibres were tested using M30 grade concrete. Normal concrete of M30 grade was taken as the control specimen. The specimens of hybrid fibre-reinforced concrete cubes and flexural beam were casted with a different proportion of the fibres, i.e., with 0.0, 1.0, 2.0, per cent fibre contents. Specimens are put to test on compression, and flexural strength. Physical and chemical properties of the two steel fibres and the polypropylene fibres were examined. A concrete mixture was prepared to achieve the grade of M30 needed in IS 10262-2019. The investigation was done in two phases. The first stage is research and the identification of the Physical characteristics of the fiber materials. Concrete specimen containing 1% of steel fiber and 0.30% of polypropylene fiber were tested under the various aggressive environment including air, water, sodium chloride over the duration of 28 days. The results demonstrated significant improvement in compressive strength, tensile and flexural strength. And the second stage contains the mix proportions of 2% of steel fibers and 0.30% of the Polypropylene fibers that gives absolutely high strength in the duration period of 7 days, 14 days and 28 days. The improvement in the toughness, crack resistance and better resistance to chloride penetration and chemical attack. The synergy between Steel and polypropylene fibers improved resistance to RCPT and reduced Permeability range and exhibits the best performance and contributing to enhanced long-term durability. These findings give the Hybrid fiber reinforced concrete can be substantially extend the service life of structure exposed to harsh environment by simultaneously improving mechanical properties and durability.

**Keywords:** Steel fibres, Polypropylene fibres, and Hybrid fibres.

## I. INTRODUCTION

Concrete is a construction material. When the concrete is combined with certain types of fibres, it becomes hard and smooth. It is observed that ordinary concrete is gradually taking the place of reinforced concrete, which, though brittle, has a longer life, and is considered to be an improvement. Fibre is added to concrete to make sure that problems associated with contraction and cracks are eliminated. Fibre-reinforced concrete (FRC) is primarily a two-component mechanism, i.e., the matrix and the inclusion mechanism. By another definition, the fibres are made with the help of steel, polypropylene, and glass, synthetic or natural materials.

Fibre-reinforced concrete is referred to as reinforced concrete. These fibres are significant in the development and design of modern concrete technology. The mixing of two or more types of fibres is known as hybridization. The fibre only the material used are what define environment performance. It's the type of concrete reinforced with fibres, which makes it stronger. These fibres are casually distributed all over the concrete structure and are evenly distributed. The fibres can be steel fibres, polypropylene fibres, glass fibres, synthetic fibres, and natural fibres, and they possess different properties in the concrete. The concrete composition can be changed considering the

construction, type of fibre, shape, distribution, inclination, and density. The conceptualization of hybrid fibre-reinforced concrete (HFRC) has achieved considerable popularity over the previous years.

The method in which two or more types of fibre are mixed in a concrete mix. In this technique, the special properties of each fibre are exploited. Large cracks are well managed by steel fibres, which increase load-bearing capacity, whereas small cracks are better handled by polypropylene (PP) fibres, which increase ductile behavior after cracking. A combination of kinds of fibres ought to perform better than an individual fibre.

### 1.1 Fibre-Reinforced Concrete (FRC):

The advantages of FRC over ordinary concrete are its capacity to retain flexural strength following the crack, greater toughness in bending and tension, improved distribution of stress, and control of cracks. These characteristics enable the use of FRC in reinforced concrete elements to decrease the quantity of conventional reinforcement in the element, and beneath reliable condition, this procedure although avoid the reinforcement. FRC is usually used in left-in-situ floor slabs or as precast earth retaining units. It is being actively helpful in the construction industry, not as widely as it could be. Steel fibres (crimped or hooked ends) and macro-synthetic fibres are the most popular fibre types in the industry. The reason hooked-end the Steel fibres were frequently used is that they provide superior anchorage in the concrete itself and are known to enhance shear in beam members as high. Flexural performance of FRC is also dependent on the tensile strength of a steel fibre. Macro-synthetic fibres composed of polypropylene or polyolefin are favoured over steel fibres in certain applications since they have a smaller impact on concrete workability. Consequently, steel fibres are typically favoured in circumstances where flexural and shear characteristics matter, whereas macro-synthetic fibres are more likely to be used in lower performance cases where workability is an issue. The use of FRC have introduced many investigations are effective in reducing both shrinkage and flexural cracking as opposed to normal concrete. This shrinkage and cracking reduction contribute to what makes FRC more watertight and can be used in water retaining structures (WRSs). Also, more and more applications where FRC is being applied have become more difficult and unconventional. Examples of projects they are made to more useful of macro-synthetic FRC in the control of cracking in WRSs would include the lagoon in Universal Studios in Osaka and the Oslo swimming pool complex.

### 1.2 History of Use of Fibres

Fibre reinforcement of brittle materials has been in operation since the days of the Bible, when straw was employed to make bricks. A pueblo house constructed of sun-baked adobe blocks and reinforced with straw, about 1540, is said to be the oldest structure in the United States. It was soon discovered that the alkalis of the cement paste attack and ultimately damage ordinary glass fibres, even borosilicate E-glass fibres. Nonetheless, as more information is available on fibre reinforcement, manufacturing, and new organic fibres, researchers have concluded that natural and synthetic fibres can be used to reinforce concrete. Carbon fibre reinforced concrete studies started in the early 1970's. First, the expensive continuous carbon fibres of polyacrylonitrile. Pitch-based carbon fibres were invented in the 1980s, and were cheap, low-modulus carbon fibres composed of coal and petroleum pitches. When used in large-scale applications such as highway pavements, slabs, and foundations, they may be incorporated into ready-mix concrete in a truck and poured conventionally. They may also be sprayed to produce thin pre-cast mortar slurry panels. The findings of these experiments are provided, as well as the different varieties of hybrid fibres that have been utilised by various researchers.

## II. LITERATURE SURVEY

Wang Li (2024): Examined hybrid Steel-Polyethylene Fiber-Reinforced Iron Ore Tailing Concrete, and quantified the mechanical performance, sulphate freeze-thaw strength, and microscopic character of the iron ore tailings concrete improved with steel-PE composite (fibrils).

Caggiano et al. (2023): The authors built an experiment to reveal what impact, exactly, the deep beam concrete actually has on the steel and the polypropylene fibers. They were exploring how the materials behave and how they can be modelled. Combining the two types of fibers has increased their power and longevity and made them useful in a variety of situations.

Luo et al. (2020): The research aimed to the difference between the advantages of the hybrid steel fibre and pp fibers on the questioned concrete throughout the freezing and thawing of the questioned concrete. They tested the various concentrations of steel (SF)-polypropylene (PF) fibres. This is because they discovered that low steel mixed with high polypropylene or high polypropylene mixed with low steel was better at reinforcing the frost of

concrete. The most appropriate mix was 1.5 per cent steel and 0.1 per cent polypropylene fibres, i.e., S1.5P0.1. Wiley Online Library.

Maruthachalam et al. (2019): The authors experimented with the potential effect of adding Polyethene Terephthalate (PET) and steel fibres on the concrete-on-concrete strength. Compressive strength and flexural strength rendered the mixture containing either one of the two fibres superior to the mixtures containing either of the two kinds of fibres. The ideal concentration of the fibre was identified.

Yoo, Kim, and Kim (2018) researched the polymers in ultra-high performance cementitious composites. They discovered that when twisted steel was reinforced with PE fibres in direct tension, a special effect was produced. Enhanced tensile strength through twisted steel, reduction in drop to the point of load through PE fibre, and strain capacity and energy absorption through PE fibre.

Lakshmi and Madhavi (2016). The mixtures of steel fibre and polypropylene fibre concrete cast bean specimens, and covered in sheets of fibre-reinforced polymer, where the flexural strength was established, and the character of the hybrid fibre-reinforced concrete beam was investigated.

Manisha and Karjinni (2016), the mechanical properties, including the strength and the workability of the concrete with steel fibres, and with polypropylene fibres, were investigated. Preeti and Titiksh (2016) used some new types of hybrid fibre in self-compacting concrete. The man-made steel fibres were mixed with natural banana fibres to produce these fibres. They concluded that the performance of the self-compacting concrete would greatly improve when the right amount of these hybrid fibres is applied.

Malgorzata Pajak (2016): Did research on the combined effects of SF and PP fibre on a Compressive strength of hybrid fibre reinforced self-consolidating concrete. The compressive strength shows lower with the higher in the content of the fibre, and a maximum reduction was observed in the mix with 7% polypropylene fibre. But the mix of two kinds of fibres did not affect a compressive strength of the hybrid mix since fibres have little to do with how the material performs once it cracks. Flexural strength was greater in mixes containing steel fibre, whereas in mixes containing polypropylene fibres, it was harder to predict.

Aminuddin Jameran *et al.* (2015): Used in the experiment because the researchers wanted to study the behaviour of high-temperature steel and propylene hybrid fibre-reinforced concrete. Experiment samples were vulnerable to three temperature values: 27 °C, 200 °C, and 400 °C. The cube strength declined greatly at 400 °C. High temperatures also reduced the flexural strength of prism, and there was only a small effect on the mixing of a more propylene fibre to the mix.

Pargana. N. Javali S. Elavenil (2015): This thesis studies a mechanical property of reinforced concrete that consists of a mixture of steel and polypropylene fibres, which is known as M40 grade barrier concrete. Steel fibres are crimped, and the steel fibres and a polypropylene fibre varies. Tensile tests were the first to be affected in determining the strength of these fibers. Then a compressive test was performed to measure the strength of the fibres in every mix. According to the laboratory works performed, it is discovered that the lowest strength is obtained when the hybrid fibre concrete is created using the 2% steel fibre and 0.50 per cent polypropylene fibre.

Banthia N et al. (2014): Examined the chances of enhancing the strength of FRC by using various types of fibre in mixing. They established in this study that two or more fibres in the right combination can enhance the physical properties of a concrete. The interaction between cellulose fibres and steel was positive in all cases when considering the bending strength of the hybrid composites.

### III. PROBLEM STATEMENT AND OBJECTIVES

#### 3.1 Problem Statement

The characteristics of conventional reinforced concrete are good, particularly when used in structures, the material has a few limitations, like low tensile strength, brittle failure, and low crack resistance. Manipulation of steel reinforcement and steel fibres has improved a mechanical behaviour of the concrete, especially the strength and toughness. Corrosion has been a problem increased with the usage of SF fibers, and increase of weight to the material, and an increase the cost. Synthetic fibres reduce enhance the durability, but do not contribute much to the load-bearing capacity of concrete, including polypropylene (PP). The various demands of the new construction, particularly the structural strength and durability, a single type of fiber reinforcement is not enough to achieve the strength. By mixing steel and PP fibre, it is possible to achieve a synergistic effect and strengthen, enhance ductility, crack resistance, and durability of hybrid reinforcement. However, nearly nothing has so far

been done regarding the mechanical and durability performance of hybrid fibre-reinforced concrete to accommodate a blend of steel and PP fibre. Consequently, the characters of the HFRC containing steel and PP fibres should be investigated and examined the structural behaviour, the control of the crack control, and durability. This type of research can also come in handy in the construction of high-performance concrete which is capable to use in coarse infrastructure.

### 3.2 Objectives

1. Mechanical properties (compressive strength) were to be determine a concrete reinforced with a hybrid mixture of steel and PP fiber.
2. To investigate the influence of different ratios of SF and PP fibres on the enhancement of the structure as a whole and determine the dosage of fibres to achieve the highest strength and durability.
3. To determine the durability properties of hybrid reinforced concrete, such as its ability to resist shrinkage, permeability, and corrosion effects that may result.
4. To compare the performance and efficiency of hybrid fibre-reinforced concrete and conventional reinforced concrete, to determine whether it is appropriate to use it in structural and infrastructure applications

## IV. METHODOLOGY AND MATERIALS

### 4.1 Steel Fibre

Steel fiber is widely utilised fibre material because steel possesses desirable tensile strength properties. The motive of the paper is to reduce the fibre to steel and explain the SFs in concrete structure.



**Figure No. 1:** *Steel Fibre was used in present investigation*

**Table No. 1:** *Physical behaviour of SF (Steel Fiber)*

| Property               | Value    |
|------------------------|----------|
| Type of SF             | Crimped  |
| length of fibre        | 30mm     |
| Diameter               | 0.5      |
| Aspect ratio           | 60       |
| Tensile strength (MPa) | 280-2800 |
| Young's modulus (GPa)  | 203      |
| Ultimate elongation    | 0.5-3.5% |
| Specific gravity       | 7.8      |

### Steel fibres applications

- Maintaining and fixing of marines.
- These include work on highways and their maintenance.
- Precast panels.
- Dam construction and repair.
- Taxiways, runways, and aprons at the airport and Cast-in-place tunnel lining by slip forming.

**Table No. 2:** *Physical properties of Polypropylene Fibre*

| Property         | Value               |
|------------------|---------------------|
| Appearance       | Crimped white fibre |
| length of fibre  | 48mm                |
| Diameter         | 18-micron nominal   |
| Thickness        | 0.6mm               |
| Width            | 1.1mm               |
| Tensile strength | 450Mpa              |
| Failure strain   | 15%                 |
| Young modulus    | 5500-7000 MPa       |

#### 4.2 Polypropylene Fibre:

Polypropylene Fibres in Concrete Polypropylene (PP) fibres are artificial polymer fibres that can be incorporated into concrete to improve concrete performance in many ways, such as crack resistance, toughness, and durability. PP fibres are cherished by comparison with steel fibres, which, in their pure nature, constitute an element of strength, and which consist of bending easily, and having cleavages in a mode adequate to the performance of their functions. These fibres are extremely lightweight, resistant to corrosion, and chemically stable, which renders them very uncorrupted even in a rough atmosphere.



**Figure No. 2:** *Polypropylene Fibre*

The benefact polypropylene fibres is also effective in helping to enhance a strength of concrete. They are not corrosive and thus suited to application in marine buildings, water-retaining buildings, and in areas where chemicals or de-icing salts are present.

PP fibres are less expensive, lighter than steel fibres, and easier to play with. But they are lower in stiffness than steel and, therefore, they do not add to the load-carrying capacity of concrete as much as that of steel. Because of this, the kind of two fibers with other fibres such as steel to make hybrid fibre reinforced concrete so that high strength crack management.

#### Polypropylene fiber application

- as flexibility.
- A luxury apartment, including reinforced cement concrete houses, plane cement concrete houses.
- Foundation ponds. large concrete blocks make business areas downtown more attractive.
- pavement roads.

#### 4.3 Hybrid Fibres Reinforced Concrete (HFRC)

The steel fibres are super strong, tough, impact-resistant, and fatigue-resistant. The avoidance of plastic shrinkage cracks, greater variations in crack distributions, and greater durability are achieved by synthetic fibres (such as Polyethene, Polypropylene, Glass, or Nylon). Put together, they become a balanced composite.

#### Applications

- Pavements and runways (to resist break-up and load impact)
- Precast elements and industrial floors.
- Tunnel lining and shotcrete.
- Seismic-resistant structures
- Marine and hydraulic structures (as a result of increased longevity)

## V. EXPERIMENTAL INVESTIGATION

### 5.1 Method of Mix Design:

Concrete mix-design. The objective of concrete mix design is to identify the use of appropriate ingredients in the correct proportions, by weight, of cement, sand, and water, to produce concrete with the required strength and sustainability at the minimum allowable cost. Two sets of test equipment shall be deployed, and the validation of every mixture shall be done according to the IS 10262-2019 approach. A normal M30 concrete is prepared by combining the mix consists of sand Portland cement, and water in the proportion of 1:1: 2.the ratio of steel fibers and polypropylene fibers in the hybrid mix is varied to determine their effect by making them to a cement with fibers, different mix proportions of steel-polypropylene hybrid fibers are mixed with varying percentages.

### 5.2 Mix combinations:

Mix A [Control]: No fibres

Mix B [Steel only]: 2.0% steel fibres

Mix C [PE Fibers]: 0.30% PP fibers

Mix D [Hybrid Fibers 1]: 2% Steel + 0.30% PP

**Table No. 3:** *Fresh properties of different mixes of steel fibres*

| Mix % of Steel fibers | Slump (mm) | Compaction factor |
|-----------------------|------------|-------------------|
| M1 (0% S)             | 40         | 0.90              |
| M2(1.0% S)            | 50         | 0.92              |
| M3 (2.0%S)            | 60         | 0.94              |

**Table No. 4:** *Workability and consistency of different polypropylene fibre-reinforced mixes.*

| Mix % of PP fibers | Slump test (mm) | Compaction factor of mix |
|--------------------|-----------------|--------------------------|
| M1 (0% PP)         | 40              | 0.89                     |
| M2(0.20% PP)       | 48              | 0.91                     |
| M3(0.30% PP)       | 64              | 0.95                     |

**Table No. 5:** *Fresh state behaviour of concrete with Hybrid fibres*

| Mix of hybrid fibers | Slump (mm) | Compaction factor |
|----------------------|------------|-------------------|
| M1 (0% S&PP)         | 40         | 0.91              |
| M2(2.0%S &0.30%PP)   | 60         | 0.95              |

## VI. TEST RESULTS AND DISCUSSIONS

### 5.1 Test for Workability

#### 5.1.1 Slump Cone Test:

Slump cone or (Abram's cone) test is performed on concrete samples to evaluate their workability and verify the right composition to be put to use. In this study, the concrete mix was suited in the laboratory, designed with M30 grade concrete.

The steel fibres are super strong, tough, impact-resistant, and fatigue-resistant. The avoidance of plastic shrinkage cracks, greater variations in crack distributions, and greater durability are achieved by synthetic fibres (such as Polyethylene, Polypropylene, Glass, or Nylon). Put together, they become a balanced composite as lower workability increases porosity within the concrete. Additionally, it has been observed that increasing fiber content tends to reduce the slump flow value, slightly affecting the free-flowing characteristic of the mix.

### 5.1.2 Compaction Factor Test:

It provides more reliable determine of the workability of concrete compared to conventional slump cone test, and it does not assess the actual workability of the cement mortar fraction. This is done as per the requirements of IS 1199-1959. The updated characteristics of the plane concrete is also carried the evaluation of slump and concrete compaction and compaction. The S-F and P table 5.4.1, 5.4.2 & 5.4.3 below gives observed slump and compaction factor measurements of different composite mixtures with SF (Steel fibers) (i.e., 0. percent, 1percent, 2percent), polypropylene fibre (0.0percent, 0.20percent, 0.30percent) and together with hybrid fibre composites (2percent S, 0.30percent P).

## 5.2 Durability Test:

### 5.2.1 Rapid Chloride Penetration Test Method ASTM C-1202:2017 (RCPT):

This Test expresses the chloride ions permeability, less the charge passed, -the less permeability and greater its resistance to chloride – induced corrosion of the embedded steel. The casted cylinders are size of 100mmdia x 200mm height the samples are normal concrete and the hybrid fiber reinforced concrete. the cutting of the specimen in slice of 50mm thickness from middle of cylinders. The DC voltage is applied is 60 v across the cell and the cells contains one side is 3% NaCl solution and other side contains NaOH solution the DC voltage applied for 6 hours and reading taken in every 30 min from the machine. And the HFRC (1200 C) is located in between the lower permeability range (compared to control (2500 C)) once again their both steel and PP fibers reduce the permeability relative to Normal concrete but again their combination (HFRC) improves pore blockage and crack bridging and inhibits the compromise of solution ingress.

The formula is  $Q = 900 \times (I_0 + 2I_{30} + 2I_{60} + \dots + 2I_{330} + I_{360})$

Were

Q = Total charge passed in Coulombs

$I_0, 2I_{30}, 2I_{60}, 2I_{330}, I_{360}$  = Current (in Amperes) measured at 30 min

900 = Conversion factor= (time interval in seconds /2) = (1800/2)

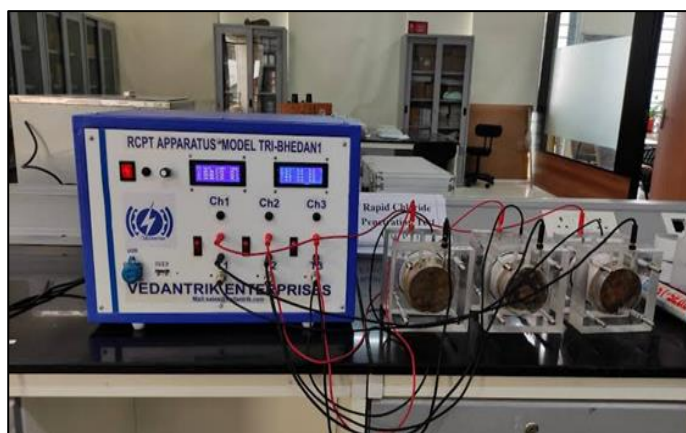
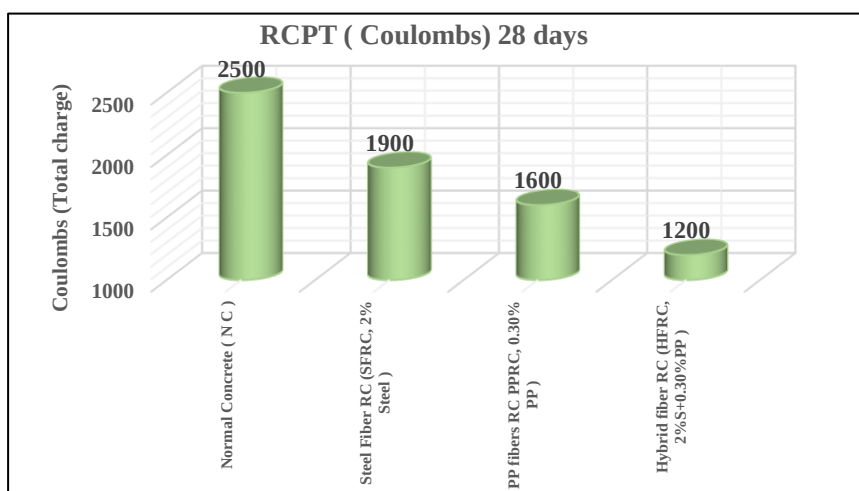


Figure No. 4: Rapid chloride penetration Test

According to ASTM C1202 as per the procedures and the NaCL solution on one side and other side NaOH solution to note down the reading in every 30 minutes up to 6 hours.

Table No 6. RCPT Test samples

| Sample of Mix                          | RCPT<br>(Coulombs) |
|----------------------------------------|--------------------|
| Normal Concrete (NC)                   | 2500               |
| Steel Fiber RC (SFRC, 2% Steel)        | 1900               |
| PP fibers RC PPRC, 0.30% PP)           | 1600               |
| Hybrid fiber RC<br>(HFRC, 2%S+0.30%PP) | 1200               |



**Graph No 1.** Results of Rapid chloride Permeability Test at a Duration of 28 days

**Durability Test Results Discussion:** The Durability experiment Concentrated on RCPT according to the methodology. Consequently, this represents Hybrid fiber reinforced concrete (HFRC 2% steel 0.30) has the lowest RCPT charge is (1200 C) out of all samples. It was the cumulative effect of the micro-fibers PP) which decreases the chloride permeability in the hybrid fibers. The control mix exhibits the normal charge id 2500C and the HFRC is 1200C and the Steel and PP passed the charge is 1800C and 1600C both falling within in permeability range. The PPRC shoed the improved resistance, this demonstration that the hybridization of fibers enhances the pore blocking and crack-bridging effects, and improves the durability performance of the concrete structure and increases the postulated service of the severe environment.

**5.2. Compressive Strength:** IS Code: IS 516:1959, IS 456:2000, Specimens are 150x150 x150 mm cube size. The compressive strength can be calculated as follows:



**Figure No. 4:** Compressive Strength Testing Machine



5 a. Before test

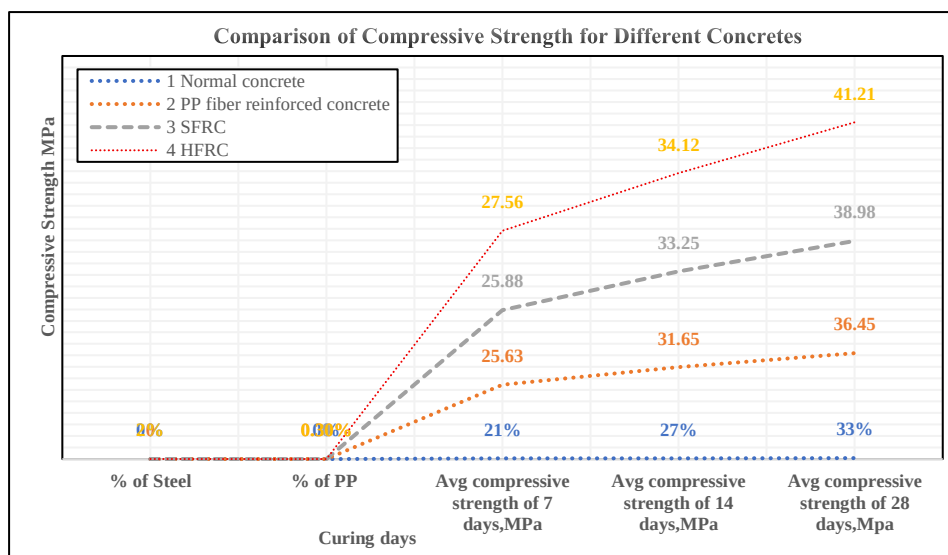
5 b. after test

Figure No. 5: Compressive Testing of Cubes

Once the specimens have been cast in the testing facility, they are stored in an air-filtered room for a duration of 24 hours. After this period, the specimens are demoulded and arranged in the curing tank. To ensure the curing conditions, the tank is loaded with fresh and clean water. The specimen is cured for the duration of 7 days, 14 days, and even 28 days are chosen in concrete testing as per IS standard.

Table No. 7 Hybrid Concrete vs. Concrete Comparison Compressive Strength

| SL No | Concrete name                           | Steel % | % of Polypropylene | No of Days MPa |         |         |
|-------|-----------------------------------------|---------|--------------------|----------------|---------|---------|
|       |                                         |         |                    | 7 Days         | 14 Days | 28 Days |
| 1     | Normal Concrete (NC)                    | 0%      | 0%                 | 21.33          | 27.27   | 33.31   |
| 2     | PP Fiber Reinforced Concrete (PPFC)     | -       | 0.30%              | 25.63          | 31.65   | 36.45   |
| 3     | Steel fibre Reinforced concrete (SFRC)  | 2%      | -                  | 25.88          | 33.25   | 38.98   |
| 4     | Hybrid fibre Reinforced Concrete (HFRC) | 2%      | 0.30%              | 27.56          | 34.12   | 41.21   |



Graph No 2. Hybrid Concrete vs. Concrete Comparison Compressive Strength

In this test, the compressive strength is checked with reference cubes having sides measuring 150mm each. Testing was designed to be conducted on normal concrete (NC), steel fibre-reinforced concrete (SFRC), polymer powder-reinforced concrete (PPRC), and high fibre-reinforced concrete (HFRC). The curing times were 7<sup>th</sup>, 14<sup>th</sup>, and 28<sup>th</sup> days. Compressive strength of average concrete was studied, and findings will be 21.33 MPa 7<sup>th</sup> days after, 27.27 MPa 14<sup>th</sup> days after and 33.31 MPa 28<sup>th</sup> days after. The SFRC, comprising two per cent of fibre, displayed the value 25.88 MPa after 7<sup>th</sup> days, 33.25 MPa after the 14<sup>th</sup> day, and a 38.98 MPa after 28<sup>th</sup> days. The PPRC of the 0.30% polymer powder after 7<sup>th</sup> days, 14<sup>th</sup> days and 28<sup>th</sup> days was 25.63 MPa, 31.65 MPa and 36.45

MPa, respectively. The HFRC after a 7<sup>th</sup> day, 14<sup>th</sup> day, and 28<sup>th</sup> days is 27.56 MPa, 34.12 MPa, and 41.21 MPa, respectively.

## CONCLUSIONS

1. Based on the examination, these specimens have been tested, and below is the investigation. The highest compressive strength of a Steel fibre reinforced concrete (SFRC) is 38.98 MPa, achieved using 2% of the Steel fibres in a M30 grade of the concrete. This is 17.19% higher than normal concrete.
2. The highest compressive strength of PP fibre reinforced concrete (PPRC) is 36.45 MPa, achieved with 0.30% polypropylene fibres in M30 grade concrete, which is 12% higher than normal concrete. The strength Compressive of hybrid fibre reinforced concrete (HFRC), which uses 2% of the Steel fibres and 0.40% polypropylene fibres in M30 grade concrete, is 41.21 MPa, an increase of 22.7% compared to normal concrete.
3. The highest flexural strength of SFRC is 3.58 MPa, achieved with 2% steel fibres in M30 grade concrete, which is 39.29% higher than normal concrete. The flexural strength is highest in PPRC is 3.52 MPa, reached with 0.30% polypropylene fibres in M30 grade concrete, showing an increase of 38.2% compared to conventional concrete. The Strength of flexural of HFRC is 3.62 MPa, achieved with 2% steel fibres and 0.40% polypropylene fibres in M30 grade concrete, an increase of 40.8% compared to conventional concrete.
4. This is 0.62% higher than SFRC and 2. % higher than PPRC. When compared to normal concrete, hybrid fibres give the best results. However, when matched with mono fibres, hybrid fibres give the best results.
5. RCPT test of samples have been tested for various durations to the HFRC passes the charge 120<sup>0</sup>C and PPRC is 160<sup>0</sup>C and the SFRC is 180<sup>0</sup>C the hybridization of the fibers can be lower charge passed and its durable, exhibits the best performance with lower charge passed, failing in the lower permeability range.

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