To study the effect of polypropylene fibre in concrete to increase the strength of concrete structures.

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Abstract - The research project on the impact of polypropylene Fibercon on the strength of concrete structures will be beneficial in its potential application in conventional construction works as well as repair works, as the scarcity of conventional construction materials is causing many problems in construction practices like refurbishment or the construction of new structures.
In the proposed effort, the use of polypropylene fibers as a reinforcing material for concrete buildings will be thoroughly examined. Flexural strength, tensile strength, and compressive strength are the parameters that will be examined in order to analyze the performance.

***Key Words*: Compressive strength, Eco -friendly, Economical, Polypropylene fibre, seismic resistance.**

1. INTRODUCTION

Housing, clothing, and food are a man's three fundamental requirements. Directly or indirectly, civil engineers are relevant to all of humanity's essential necessities. Construction techniques have advanced significantly due to human advancement. The majority of us now live in RCC frame structures, while initially humans lived in huts. Over time, these evolved into load-bearing houses. Therefore, several cutting-edge methods and materials were used to build or remodel every part of this edifice.

Many reinforced concrete buildings and bridges that were constructed 20 to 60 years ago now require strengthening or maintenance. They may no longer serve the same purpose as before, or they may have been harmed by mishaps, chemical reactions, or other factors. These structures can be restored to help them regain their original strength and shield them from additional harm, or they can be strengthened to boost their initial strength.

Infrastructure construction is accelerating in today's expanding economy. Every year, a large number of masonry and reinforced concrete structures are built all over the world. As a result, many of them decay or become dangerous to use due to modifications in loads, use, or design configuration; other factors include the use of subpar building materials or natural disasters.

1.1 ABOUT THE POLYPROPLYENE

Two extremely sensitive topics have come to light as a result of the current global health emergency: safety and hygiene. It is crucial to meticulously adhere to all safety precautions when it comes to routine cleaning and thorough hygiene of our living spaces and the items we come into touch with.

In this case, the contemporary characteristics of polypropylene reappear in the present context when consumers place even more weight on the concept of "well-being" and health in addition to aesthetic taste and comfort.

The fact that polypropylene yarn can be easily sanitized with 70% hydroalcoholic solution or with sodium hypochlorite up to 0.5%, along with its ability to be completely recyclable and guarantee the highest level of sustainability among all natural and synthetic fibers (production requires lower temperatures than other polymers and reduced impact in terms of water, energy, and CO_2 emissions), makes it especially suitable for the current state of health. This is the required sanitization according to law, and following testing on fabrics in our lab that included bright and dark hues as well as intense colors, the color completely resisted washing and mechanical movements.

Fig -1: Polypropylene Fiber Composites

1.2 STORAGE CONDITIONS

For polypropylene, a maximum operating temperature of 180°F (82.2°C) is advised. The material's performance values could be jeopardized above this point. Temperature of Melting. The melting point of polypropylene is 327°F (163.8°C).

1.3 USE OF POLYPROPLYENE FIBRE

The cement matrix is frequently supplemented with polypropylene to increase concrete's resilience. In comparison to ordinary concrete, fiber-reinforced concrete has a substantially higher tensile strength and is less prone to fracture.

Some applications of polypropylene fibers can include:

- Roads
- Tunnels
- High-performance concrete
- Industrial pavements

fiber reinforced concrete can also present certain amazing benefits

- Can enhance the compressive strength of concrete
- Is a simple and rapid solution for reinforcement
- Can be easily combined with fresh concrete and then used immediately
- Plastic is non-corrosive and non-magnetic

2 LITERATURE REVIEW:

Studies conducted in the last few decades have concentrated on various techniques for Fiber Used Concrete. Researchers from all over the world have been working on various issues related to the production and application of Polypropylene Fiber, along with a large number of researchers and institutions actively trying to develop more viable and energy efficient products for civil infrastructure in order to use Glass Fiber in heavily loaded civil structures. The purpose of this chapter is to document earlier research in the area of polypropylene fiber's strengthening properties.

1. In 1951, Paul Hogan and Robert L. Banks from the Division of Structural Engineering tried to turn propylene into gasoline. Polypropylene is a high-melting, crystalline aliphatic hydrocarbon that was discovered by Paul Hogan and Robert L. Banks of the Phillips Petroleum Company. This finding resulted in the creation of a novel catalytic method for the production of high-density polyethylene.

2. Nowadays, billions of pounds of high-density polyethylene and polypropylene are used annually in water, sewer, and gas pipelines, vehicle parts, toys, tools, furniture, and packaging of all sizes, ranging from milk bottles to massive chemical drums. These polymers are now an essential component of daily life.

3. In 1954, Phillips launched HDPE under the Marlex polyethylene trademark. The marketing executives of the company were extremely hopeful. Project manager R. G. Rhodes recalled that at the time, he believed that the material was so good that we wouldn't need to sell it. The clients would arrive and seize it from us. However, the market had grown and become more varied, and Marlex—which was only available in one grade at the time—was no longer appropriate for all uses. Stock piling up in the storage facilities. The hula hoop, a big ring of plastic tubing, was an unexpected source of the turnaround. Marlex, a children's toy, became so popular that the facility had to produce all of it for almost six months due to the spike in demand. Phillips.

4. Paul Endecott, the president, was so happy that he kept a hoop in his office for spur-of-the-moment protests. The toy's success persisted long enough for Phillips to increase the number of product grades available and enhance the production process. The desire for hula hoops paved the door for other useful applications, like industrial and commercial tubing. Due to its resistance to high sterilizing temperatures, Marlex eventually gained popularity as the material of choice for infant bottles as well as secure, break-resistant food and domestic goods containers.

3 PROPOSED WORK:

Objectives:

1. Preparing a model of concrete cube and beam and circular column it with Polypropylene fibers.
2. Comparing the structural properties of Fiber mixed cubes, column and beams with simple concrete cubes, column and beams using different tests.
3. Comparison of cost of polypropylene Fiber.

4 PROPERTIES OF POLYPROPLYENE FIBER:

4.1 PHYSICAL PROPERTIES

There are several properties of polypropylene fiber which are given below:

- High Strength to weight ratio
- Good Rigidity
- Corrosion resistant

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- Fatigue Resistant
- Good tensile strength
- Fire Resistance/Not flammable
- High Thermal Conductivity
- Low coefficient of thermal expansion
- Non-poisonous biologically inert-Ray Permeable.

1) High Strength to weight ratio: -

Strength is resistance to breaking. Strength of a material is the force per unit area at failure, divided by its density. Any material that is strong and light has a favorable Strength/weight ratio.

2) Good Rigidity: -

Rigidity is resistance to bending or stretching. Rigidity or stiffness of a material is measured by its Young Modulus and measures how much a material deflects under stress.

3) Corrosion resistant: -

Polypropylene Fibers corrosion less as they are not affected by chemicals.

4) Fatigue Resistant: -

Resistance to Fatigue in Polypropylene Fiber Composites is good. However, when Polypropylene Fiber fails it usually fails catastrophically without significant exterior signs to announce its imminent failure.

5) Good tensile strength: -

Tensile strength or ultimate strength is the maximum stress that a material can withstand while being stretched or pulled before necking, or failing.

6) Fire Resistance/Non-Flammable: -

Polypropylene Fibers not susceptible to fire. Depending upon the manufacturing process and the precursor material, Polypropylene Fibercon is made to feel quite soft to the hand and can be made into or more often integrated into protective building for fire-fighting.

7) High Thermal Conductivity: -

Thermal Conductivity is the ability of a material to conduct heat. In SI units (International System of Units, Metric).

The Polypropylene Fiber has thermal conductivity ranging from 30-40 W

8) Low coefficient of thermal expansion: -

This is a measure of how much a material expands and contracts when the temperature goes up or down.

9) Non-poisonous, biologically inert, X-Ray Permeable: -

These qualities make Polypropylene Fiber useful in Medical applications.

4.2 FIBER ENGINEERING PROPERTIES

The values for various engineering properties of Polypropylene Fiber and are given below.

Polypropylene Fiber Properties	**SI unit**
Tensile Strength	50-600 Map
Tensile Modulus	3,000 MPa
Ultimate Elongation	25%-100%
Density	0.93 g/cm3

Table -1: Polypropylene Fiber Properties

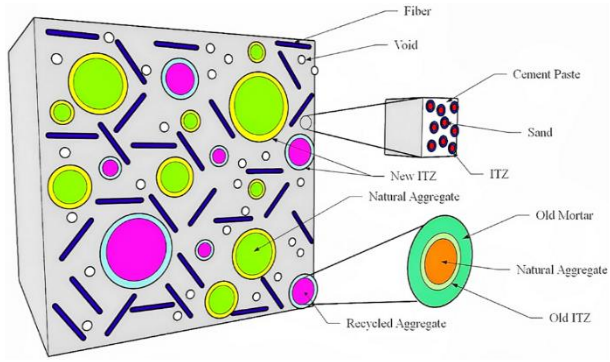

Fig -2: Different kinds of Polypropylene Fiber strengthening

5 METHODOLOGIES

5.1 Situations when the Polypropylene Fiber strengthening is possible

The main use of Polypropylene Fibers to strengthen structures against bending Moments and shear forces. The figure below describes the situations were Polypropylene Fiber strengthening is possible.

5.2 Requirements of Strengthening composites: -

For selection of material for any kind of work to be carried out the properties of material is to be studied.

The requirements for strengthening of any structure various aspects are seen as given below.

5.2.1 Compatibility: -

Durable strengthening requires that the reinforcing materials and the existing concrete be compatible. It has a significant impact on the structural performance as well. The reinforcing material's and the existing concrete's physical, chemical, and electrochemical qualities must work in harmony for there to be compatibility. It guarantees that for the course of its design life, the resultant composite system can withstand the stresses brought on by loads, volume changes, and chemical and electrochemical impacts without experiencing distress or degeneration.

Dimensional compatibility.

Dimensional compatibility, or the phenomena of volume instability, is one of the main issues. These variations in volume might happen in a number of ways. Consideration must be given to drying shrinkage if cement-based materials are chosen for the strengthening process. The contraction of the material upon removal of its moisture content is known as drying shrinkage. Internal tension is produced, perhaps leading to shrinkage cracks. It is necessary to determine whether the material is shrink-resistant, what occurs when it shrinks, whether it is hazardous, and—above all—whether the shrinkage is controlled. Thin fibers that do not shrink on their own may curl as a result of the matrix contracting. Therefore, a matrix material that does not shrink nor has a minimal shrinkage value is desirable.

Chemical and Electrochemical Compatibility.

Alkali, C3A, and chloride contents are a few examples of chemical compatibility characteristics to take into account. For example, if the previous concrete has re-active aggregates, a low-alkalinity strengthening material ought to be selected. Electrical resistivity, pH, and other characteristics are examples of electrochemical compatibility. For instance, if the strengthening is intended to preserve the steel reinforcement in the current structure, the pH value is crucial. Regarding the best materials, there is disagreement in this field across researchers.

Permeability Compatibility.

A substance that is permeable is concrete. This indicates that the material's vapor migrates. Consequently, attempting to reinforce materials with limited permeability may result in incompatibilities and even failure. At the vapor barrier's boundary, freeze-thaw damage may occur if the concrete is enclosed.

5.2.2 Durability

A long-lasting strengthening should continue to function as intended for the duration of its intended life. As mentioned previously, achieving material compatibility is crucial to achieving a long-lasting strengthening. But this is not the sole requirement. Important roles are also played by production, method selection, and design elements. Regarding manufacture, the craftsmanship merits recognition. The smallest carelessness in construction methods will result in a less durable strengthening, even if all other requirements are met. As a result, it's critical to make sure the design makes it reasonably simple to implement the strengthening.

5.2. 3 Special demands

A strengthening may also come with certain unique requirements that change depending on the circumstances. As an illustration: All interior structural concrete is subject to fire regulations. Numerous constructions must withstand unintentional loads from collisions, earthquakes, etc. The requirement for environmental acceptability is equally crucial. Lastly, and regrettably, graffiti is a factor in most urban areas.

5.2.4 Desirable mechanical properties of the composite

The relationship between stress and strain in an elastic material, or the stiffness of the material, is described by the modulus of elasticity (E). When tension is uniaxial, Hooke's law changes to $\sigma = \varepsilon E$. The reinforcing material must be strong enough to support the load on the structure. Steel reinforcement with a modulus of elasticity of 210 GPa is used in the current concrete. It is determined that there is a limited amount of strain remaining for the strengthening material to employ when taking into account that yielding in the steel is not acceptable under service circumstances and that the structure can be loaded during the strengthening process with, for example, its own weight. In order to support the weight, the strengthening must be stiff. However, since the steel reinforcement already in place requires a specific amount of strain in order to support additional weight, it runs the risk of becoming inactive if the stiffness of the composite is too high. The composite would therefore have to support greater weight than was necessary, which is not cost-effective. Using this logic, we may conclude that the composite material's modulus of elasticity should ideally be more than 210 GPa, but not significantly higher.

5.2.5 Requirements for the fibers

The fibers in a cementation strengthening composite should fulfill the following requirements.

- Alkali resistant.

- Not a corroding material.
- High strength.
- At least as stiff as steel (E = 210 GPa).

5.2.6 Configuration of the fibers

Given that fibers are easier to handle and that concrete and fibers connect better when used in weaves, using fibers in this way appears to be advantageous. Because of a weave's curved geometry, mechanical bonding is the reason weaves bond better than straight threads. If the fibers are woven, they must be dense to achieve a high volume fraction of reinforcing material in the composite; however, in order to achieve the desired monolithic behavior of the composite and the chemical bond between the fibers and matrix, the weaves must be as deeply penetrated by the matrix material as feasible. Chemical bond between cement and Polypropylene fibers is not possible unless the fibers have a special surface treatment.

6 PROCEDURE: -

The execution of strengthening should be carried out according to the following steps. Special care should always be taken to ensure the high quality of work.

Tensile bond strength of concrete is to be measured: It is generally accepted that it should reach at least 1.5 N/mm^2.

Taking a required material:

Take a required material like cement, sand and aggregate. In Proper Proportion.

Measuring the water content of the concrete surface before gluing:

Water content of the concrete is not allowed to exceed 4% (owing to the appropriate bonding of the glue).

Add the Polypropylene Fiber with respect to cement.

The Polypropylene fiber should be properly mixed.

7 TESTS ON CONCRETE: -

For evaluation of the engineering properties three tests were conducted viz. Compression test, split tensile test and Flexural test as described below.

7.1 COMPRESSION TEST: -

A compression test is a method for determining the behavior of materials under a compressive load. Compression tests are conducted by loading the test specimen between two plates and then applying a force to the specimen by moving the crossheads together. The compression test is used to determine elastic limit, proportionality limit, yield point, yield strength and compressive strength.

7. 2 SPLIT TENSILE TEST: -

The splitting tests are well known indirect tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens.

8 RESULTS AND DISCUSSION

This section deals with the results from the different tests done. The results are plotted as load displacement graphs.

8.1 COMPRESSION TEST

The compression test was done on cube of dimensions 15cm X 15cm X 15cm.The tests on three cubes of Polypropylene Fiber and three cubes of without mixed was done on universal testing machine. The table below shows the obtained results;

	c/s Area (mm2)	**Maximum Force (KN)**	**Compressive strength (N/mm2)**
CUBE 1	3375	344	15.28
CUBE 2	3375	348	14.02
CUBE 3	3375	454.6	13.99

Table -2: Test results of cubes before using of Fiber.

	c/s Area (mm2)	**Maximum Force (KN)**	**Compressive strength (N/mm2)**
CUBE 1	3375	584.3	25.96
CUBE 2	3375	528	23.11
CUBE 3	3375	718	31.17

Table -3: Test results of cubes after Using of fiber.

The compressive strength was increased by about 40% after Polypropylene Fiber mixed which is not more but the maximum displacement of fiber used cube is much less than conventional cubes.

The failure of conventional cube was complete at its maximum load whereas the fiber used cubes were still serviceable at its maximum load.

8.2 SPLIT TENSILE TEST

This test was done on circular column of diameter 15cm and height 30cm. In this test one column with Polypropylene Fiber mixed and one without mixed was tested on universal testing machine. The table below shows the obtained results;

	c/s Area (mm 2)	Maximum Force (KN)	Maximum Displacement	Compressive strength (KN/mm 2)
CIRCULAR COLUMN	17678.5	418.8	7.80 mm	0.024

Table -4: Test results of Column before

	c/s Area (mm 2)	Maximum Force (KN)	Maximum Displacement	Compressive strength (KN/mm 2)
CIRCULAR COLUMN	17678.5	921.750	5.60 mm	0.052

Table -5: Test results of Column after

The tensile strength of column was increased after Polypropylene Fiber. The load carrying capacity of conventional column was only 418.8 KN whereas load carrying capacity of fiber mixed column was 921.75 KN. which is much greater than conventional column. The decrease in maximum displacement of conventional column is about 28% than that of fiber used columns.

The failure pattern is as shown in figure below. The conventional column is still serviceable at the maximum force given to it.

9 COST COMPARISON OF POLYPROPLYENE FIBRE

For comparison of cost of Polypropylene Fiber mixed with conventional Concrete, the column of size 900mm x 900mm and height having 3.3m was considered.

9.1 Cost required for casting with fiber

Cost of M15 Grade of concrete for 1cu.m = Rs.3200.

Cost of M25 Grade of concrete for 1cu.m = Rs.5000.

Fiber required for casting of 1 cu. m concrete (using 25% of fiber by weight of cement) = 175 g

Cost required for casting of 1 cu. m concrete with M15 grade using fiber (using 25% of fiber by weight of cement) = Rs.3375.

9.2 Cost required for casting without fiber.

Cost of M15 Grade of concrete for 1cu.m = Rs.3200.

Cost of M25 Grade of concrete for 1cu.m = Rs.5000.

Therefore, the cost involved for Polypropylene Fiber is only 20 to 25 % that of using conventional concrete.

10 CONCLUSIONS

To achieve the decided objective various tests had been made, from which the conclusion was made as follows: -

- The compressive strength of the Polypropylene Fiber 40% more as compared to conventional cubes. The tensile strength of Polypropylene Fiber to column is 55% more as compared to conventional column. The flexural strength of Polypropylene Fiber made to beam is 55% more as compared to conventional beam.
- The Polypropylene Fiber increases compressive strength then that of tensile & Flexural strength.
- The maximum displacement of Polypropylene Fiber is about 30 to 50 % less than that of conventional concrete cube, column and beam.
- The use of Polypropylene Fiber saves 32% cost associated with using conventional concrete.
- Further investigation should be carried out to check the use of Polypropylene Fibers partial replacement for steel.

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