To Study the Effect of Polypropylene Fiber, Fly Ash and Rice Husk on Concrete Properties

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ABSTRACT: India is now one of the world's developing nations. Concrete with exceptional strength and performance will be needed in the future to build projects. Concrete that has fibrous material added to it to strengthen its structural integrity is known as fibre concrete. With different concrete fibre materials, geometries, distributions, orientations, and densities, fibre concrete takes on different characteristics. One synthetic fibre that is lightweight is polypropylene. It gives the concrete construction strength and prevents cracks from forming. In this project, we're adding various percentages of polypropylene fibres, such 0%, 0.5%, 1%, 1.5%, and 2%, and we're replacing the cement with 10% each of fly ash and rice husk. Specimens underwent tests for flexural resistance, split tensile strength, compressive strength, and workability.

I. INTRODUCTION

1.1 GENERAL

Concrete is the most appropriate and extensively utilized construction material now a days. Until recently, this building material underwent numerous changes. Cement is the most significant component of concrete. This raw material's manufacturing process emits a significant amount of CO_2. The most efficient technique to reduce CO_2 emissions from the cement business is to replace a portion of cement with another material these materials is called as a supplementary cementing materials.

It is the most widely used construction material because its principal components are easily available everywhere, relatively simple production and its wide application to various civil infrastructure works. However, the main drawback of using concrete is its brittleness and susceptibility to crack openings and their propagations, thereby creating many problems in its application. Cracks in a concrete structure leaves a negative impression on the strength, toughness and serviceability of the structures. One of the solutions to this problem is the inclusion of small fibers in the concrete matrix. The concrete containing fibers is also known as Polypropylene Fiber Concrete (PPC). In Polypropylene Fiber Concrete (PPC), thousands of small fibrous particles are dispersed and distributed randomly in the concrete mixture during mixing, therefore improving its properties in all directions. The fibers act as stress- transfer bridges in concrete and abate the nucleation and also the propagation of cracks in concrete . Moreover, the addition of fibers to concrete modifies its properties both in plastic and hardened state and therefore results into a more sturdy concrete.

1.2 OBJECTIVE OF THE WORK

- To study the fibers that are being used in concrete matrix and the various factors contributing to the selection of fibers in concrete.
- To investigate the impact of polypropylene fibre on concrete properties.
- The replacement of cement by flyash and rice husk and the effect on concrete strength.

II.MATERIALS USED

2.1 CEMENT:

A cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource.

Cements used in construction are usually inorganic, often lime or calcium silicate based, which can be characterized as non-hydraulic or hydraulic respectively, depending on the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).

Non-hydraulic cement does not set in wet conditions or under water. Rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting.

Hydraulic cements (e.g., Portland cement) set and become adhesive due to a chemical reaction between the dry ingredients and water. The chemical reaction results in mineral hydrates that are not very water-soluble and so are quite durable in water and safe from chemical attack. This allows setting in wet conditions or under water and further protects the hardened material from chemical attack. The chemical process for hydraulic cement was found by ancient Romans who used volcanic ash (pozzolana) with added lime (calcium oxide).

2.1.1Ordinary Portland cement (OPC)

Ordinary Portland cement is a controlled blend of calcium silicates, aluminates and ferrate which is ground to a fine powder with gypsum and other materials. After 1987, OPC was divided is three types based on the strength obtained by 28 days. The types are as follows:

•OPC 33 grade – strength not less than 33N/mm^2 at 28 days

•OPC 43 grade – strength not less than 43N/mm^2 at 28 days

•OPC 53 grade – strength not less than 53N/mm^2 at 28 days

Portland cement obtains its strength as a result of chemical reactions between cement and water. The process is known as hydration. This is a complex process that is best understood by elucidating the chemical composition of cement.

Table 2.1.Chemical composition of cement

Compound	**Formula**	**Mass%**
Calcium oxide	CaO	61-67%
Silicon dioxide	SiO_2	19-23%
Aluminum oxide	Al_2O_3	2.5-6%
Iron oxide	Fe_2O_3	0-6%
Sulphate	SO_3	1.5-4.5%

Table 2.2 Chemical composition of Clinker

Compound	**Formula**	**Mass%**
Tricalcium silicate	$(CaO)_3.SiO_2$	45-75%
Dicalcium silicate	$(CaO)_2.SiO_2$	7-32%
Tri calcium aluminate	$(CaO)_3.Al_2O_3$	0-13%
Tetra calcium alumino ferrite	$(CaO)_4.Al_2O_3.Fe_2O_3$	0-18%
Gypsum	$CaSO_4.2H_2O$	2-10%

2.2. Construction Aggregate

Is a broad category of coarse- to medium-grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and roadside edge drains. Aggregates are also used as base material under foundations, roads, and railroads. In other words, aggregates are used as a stable foundation or road/rail base with predictable, uniform properties (e.g. to help prevent differential settling under the road or building), or as a low-cost extender that binds with more expensive cement or asphalt to form concrete.

Sources for these basic materials can be grouped into three main areas: Mining of mineral aggregate deposits, including sand, gravel, and stone; use of waste slag from the manufacture of iron and steel; and recycling of concrete, which is itself chiefly manufactured from mineral aggregates. In addition, there are some (minor) materials that are used as specialty lightweight aggregates: clay, pumice, perlite, and vermiculite.

2.3. Sand

Sand is a granular material composed of finely divided rock and mineral particles. Sand has various compositions but is defined by its grain size. Sand grains are smaller than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass.

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz.

Calcium carbonate is the second most common type of sand, for example, aragonite, which has mostly been created, over the past 500 million years, by various forms of life, like coral and shel. F lfish or example, it is the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years like the Caribbean. Somewhat more rarely, sand may be composed of calcium sulfate, such as gypsum and selenite, as is found in places like White Sands National Park and Salt Plains National Wildlife Refuge in the U.S.Sand is a non-renewable resource over human timescales, and sand suitable for making concrete is in high demand. Desert sand, although plentiful, is not suitable for concrete. 50 billion tons of beach sand and fossil sand is used each year for construction.

2.4 Fly ash

Fly ash or coal ash, and also known as pulverized fuel ash in the United Kingdom, or coal combustion residuals (CCRs), is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler's combustion chamber (commonly called a firebox) is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and composition of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon (SiO_2) (both amorphous and crystalline), aluminium oxide (Al_2O_3) and calcium oxidedioxide (CaO), the main mineral compounds in coal-bearing rock strata.

The minor constituents of fly ash depend upon the spe but may include one or more of the followicific coal bed compositing elements or compounds found in trace concentrations (up to hundred ppm): arsenic, beryllium, boron, cadmium, chromium, hexavalent chromium, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium, along with very small concentrations of dioxins and PAH compounds. It also has unburnt carbon.

In the past, fly ash was generally released into the atmosphere, but air pollution control standards now require that it be captured prior to release by fitting pollution control equipment. In the United States, fly ash is generally stored at coal power plants or placed in landfills. About 43% is recycled, often used as a pozzolan to produce hydraulic cement or hydraulic plaster and a replacement or partial replacement for Portland cement in concrete production. Pozzolans ensure the setting of concrete and plaster and provide concrete with more protection from wet conditions and chemical attack.

Table 2.3: CHEMICAL COMPOSTION OF FLY ASH (MASS %)

S.No	Major Components	Formula	Fly Ash
1	Silicon Dioxide	SiO_2	60.54%
2	Aluminium Oxide	Al_2O_3	26.20%
3	Ferric Oxide	Fe_2O_3 CaO	5.87%
4	Calcium Oxide	MgO	1.91%
5	Magnesium Oxide	Na_2O_3	0.38%

Fly Ash

2.5 RICE HUSK

Due to the increasing rate of environmental pollution and the consideration of sustainability factor have made the idea of utilizing rice husk. The reasons behind the usage of rice husk as an alternative for cement in concrete manufacturing are explained in the following sections. To have a proper idea on the performance of rice husk in concrete, a detailed study on its properties must be done. About 100 million tons of rice paddy manufacture by-products are obtained around the world. They have a very low bulk density of 90 to 150kg/m^3. This results in a greater value of dry volume. The rice husk itself has a very rough surface which is abrasive in nature. These are hence resistant to natural degradation. This would result in improper disposal problems. So, a way to use these by-products to make a new product is the best sustainable idea. Among all industries to reuse this product, cement, and concrete manufacturing industries are the ones who can use rice husk in a better way.

2.6.1Rice Husk Ash as a Supplementary Binder

The rice husk ash has good reactivity when used as a partial substitute for cement. These are prominent in countries where the rice production is abundant. The properly rice husk ashes are found to be active within the cement paste. So, the use and practical application of rice husk ash for concrete manufacturing are important

2.6.1Rice Husk Ash Classification and Chemical Composition

The rice husk ash possesses a chemical composition similar to many of the organic fibers. Rice husk ash consists of the following:

- Cellulose ($C_5H_{10}O_5$)
- Lignin ($C_7H_{10}O_3$)
- Hemicellulose
- SiO_2
- Holocellulose

These are compounds within them in common. The rice husk ash may vary depending upon the source as well as the type of treatment. Treatment in the sense the rice husk is burned to have proper properties. So, the method of heating can also bring changes in the overall chemical composition of the ash. The silicates are one of the primary components of the rice husk ash. During the burning process, the components that can evaporate are evaporated and the only component left are the silicates. The rice husk ash to be more precise have characteristics based on the components, the temperature of burning and the time of burning. The silicates are the component that gives the pozzolanic reactivity capacity for rice husk ash. So to gain this, the silica must remain in its non-crystalline form. They should gain a highly porous structure within their microstructure. So, this makes it clear that a proper quality burning of rice husk to get rice husk ash would remove the cellulose and rice husk components preserving the original cellular structure of the rice husk particles.

Rice Husk Ash

2.7. FIBERS

DIFFERENT TYPES OF FIBERS

2.7.1. Steel Fibers

Steel fibers are a type of metal reinforcement. These steel fibers are relatively short and firmly spaced as compared to the conventional continuous reinforcing bars. They are added to improve the structural properties i.e. tensile strength and flexural strength, and durability. Steel fibers also found to contribute to post-cracking strength due to their crack bridging mechanism and thereby, they help in restraining the cracks in concrete . The research studies carried out by Narayanan and Darwish concluded that addition of steel fibers increases shear strength of the concrete due to their crack- arresting mechanism . Nowadays, steel fibers are being used as main and secondary reinforcement in a number of applications such as highway and air-field pavements, hydraulic structures, refractory concrete, and precast applications .

2.7.2 Polypropylene Fibers

Polypropylene fibers are synthetic fibers and are generally hydrophobic in nature. The research conducted by Alhozaimy et. al found no significant effects of polypropylene fibers on compressive and flexural strengths, while impact resistance and flexural toughness were found to increase in the presence of polypropylene fibers . Toutanji et al. established that the inclusion of polypropylene fibers increases the permeability of conventional concrete but addition of a cementitious material like silica fume can reduce the permeability caused by these fibers . The spalling behaviour of concrete can also be improved by using polypropylene fibers . Therefore, polypropylene fibers have many applications in conventional concrete, self- compacting concretes, high performance concretes, rigid pavements etc.

Polypropylene Fibers

2.7.3. 1Properties of Polypropylene Fiber

Fiber Structure and Characteristics

PP fibers are composed of crystalline and non-crystalline regions. Each crystal is surrounded by non-crystalline material. Fiber spinning and drawing may influence the orientation of both crystalline and amorphous regions.

The degree of crystalline of polypropylene fiber is between 50-65% in general, depending on the processing conditions. Crystallization occurs between glass transition temperature and the equilibrium melting point of PP. The crystallization rate is faster at low temperatures.

In general, polypropylene fiber has excellent chemical resistance to acids and alkalis, high abrasion resistance and resistance to insects and pests. PP fiber is also easy to process and inexpensive compared to other synthetic fibers. It also has low moisture absorption.

2.7.4Mechanical Properties

Polypropylene fibers are produced in a variety of types with different tenacities in order to suit varying market requirements. Fibers for general textile uses have tenacities in the range of 4.5-6.0 g/den. High tenacity yarns up to 9.0 g/den are produced for the use in ropes, nets and other similar products. High performance PP fibers have been made with high strength and high modulus. The techniques include ultra-drawing, solid state extrusion and crystal surface

Properties of polypropylene filaments. The higher the degree of stretch, the higher the tensile strength and the lower the elongation. Commercial monofilaments have an elongation at break in the region of 12-25%. Multifilament and staple fibers are in the range of 20-30% and 20-35%.

2.7.5. Thermal Properties

Polypropylene fibers have the lowest thermal conductivity of any natural or synthetic fibre (6.0 compared to 7.3 for wool, 11.2 for viscose and 17.5 for cotton). PP fibres retain more heat for a longer period of time, have excellent insulative properties in apparel, and, combined with its hydrophobic nature, keep wearer dry and warm.

Polypropylene fibers have a softening point around 150°C and a melting point at 160-170°C. At low temperatures of -70°C or lower, PP fibers keep their excellent flexibility. At high temperature (but below 120°C), PP fibers nearly keep all of their normal mechanical properties. PP fibers have the lowest thermal conductivity of all commercial fibers, and in this respect they are the warmest fibers of all, even warmer than wool.

When it comes to the effect of extreme cold, they remain flexible at temperatures in the region of -55°C.

2.7.6. How Is Polypropylene Fiber Made

Polypropylene chips can be converted to fiber/filament by standard melt spinning process, though the operating parameters can be adjusted depending on the final products.

The production of polypropylene fiber varies among the manufacturers. The manufacturing process differs, so that desirous properties can be achieved including dye ability, light stability, heat sensitivity etc.

The basic production procedure includes polymerizing propylene gas with the help of a metal compound like titanium chloride. The polymer formed from propylene is slurred in the diluents to decompose the catalyst, then it is filtered, purified and finally reduced to polypropylene resin.

The resin so formed is melted and extruded through a spinneret in a filament form. These filaments are then treated in order to get the desired properties.

2.7.7. How Is Polypropylene Fibre Used

Polypropylene fibre can be used in a wide range of applications. These are only some examples:

automotive industry, carpeting, packaging, fiber, filament, film, pipes, upholstery fabrics and bed covers, toys, bottle caps, disposables, hygiene, apparel, technical filters, woven bags, ropes and twins, tapes, construction fabrics, absorbent products (diapers),furniture industry, agriculture.

Because of its superior performance characteristics and comparatively low-cost, PP fiber finds extensive use in the nonwovens industry**,** and it dominates in many nonwoven markets. The main application areas include: nonwoven fabrics, absorbent product coverstock markets, home furnishings and automotive markets.

III. METHODOLOGY

3.1. Cement

Ordinary Portland cement (OPC) of 53 grades procured from a single batch was used for the entire work and care has been taken that it was stored in airtight containers to prevent it from being affected by the atmospheric moisture and humidity. The cement obtained was tested for satisfying the chemical requirements in accordance with IS: 4032-1977 and for physical requirements in accordance with IS: 12269-1987.

Table 3.1. Properties of cement

S.no	Property	Value
1	Normal Consistency	33mm
2	Fineness of cement	7%
3	Initial Setting Time(min)	85
4	Final Setting Time (min)	240

3.2. Fine aggregate

The sand of river that is passing through 4.75 mm sieve and retained on 600 μm sieve, conforming to Zone II as per IS 383-1970 was used as fine aggregate in the present study. The sand was free from silt, clay and organic impurities. The aggregate was then tested for its physical requirements like specific gravity, gradation, fineness modulus and bulk modulus in accordance with IS: 2386-1963.

Table 3.2. Properties of fine aggregate

S.no	Property	Value
1	Specific gravity	2.60
2	Bulk	1.542

	Density	
3	Fineness Modulus	2.74

3.3. Coarse aggregate

Crushed coarse aggregates of 20mm procured from the local crushing plants was used throughout the investigation. The aggregate was checked for its physical requirements like specific gravity, fineness modulus, gradation and bulk density.

Table 3.3 Properties of Coarse aggregate

S.No	Property	Value
1	Bulk Density	1.610
2	Specific Gravity	2.74
3	Fineness Modulus	7.17
4	Aggregate Impact Value	25.21
5	Aggregate crushing value	25.22

3.4. Fine aggregate

In this investigation natural river sand is used as fine aggregate. Sand was obtained from local sources. Fine aggregate which is passing through IS 4.75mm sieve and retained on IS 150 micron sieve is considered for the experimental program.

Table 3.4. Properties of fine aggregate

Specific gravity	2.78
Fineness modulus	3.12

3.5. Coarse aggregate

The aggregate consists of natural occurring crushed, uncrushed stones, gravel and sand. It should be strong, clear, hard, durable, dense, and free from adherent coating and free from disintegrate pieces, alkali, and other deleterious substances as far as possible. Flaky and elongation pieces should be avoided. In this investigation the locally available aggregates from crusher 20mm sieve passing and 12.5mm sieve retained is used. It should be angular in shape.

Table 3.5. Properties of coarse aggregate

Property	20mm	10mm
Fineness Modulus	7.32	7.32
Specific Gravity	2.89	2.89

3.6. Water

Fresh portable water that is free from organic matter and oil is used for mixing the concrete .Required quantities of water were measured in graduated jar and added to the concrete for mixing. The other materials in preparation of the concrete mix were taken by weigh batching. It should be noted that the pH value should not be less than 6.

3.7 Properties of materials

In this study we had performed tests on cement (OPC 53 grade), coarse aggregate, and fine aggregate.

1. Tests on cement:

• Standard consistency test

• Initial setting time

• Final setting time

• Specific gravity of Cement

2. Tests on fine aggregate and coarse aggregate

• Fineness modulus of fine aggregate and coarse aggregate.

• Specific gravity of fine aggregate and coarse aggregate.

3 Tests on workability

• Slump cone test.

• Compaction factor test.

Materials Used

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1. Cement In this experiment 53 grade ordinary Portland cement (OPC) with brand name ultra tech was used for all concrete mixes. The cement used was fresh and without any lumps IS 8112 the specific gravity of cement was found to be 3.15.

2.Fine Aggregate Fine aggregate was purchased which satisfied the required properties of fine aggregate required for experimental work and the sand conforms as per the specifications of IS 3812 (part I).the specific gravity of fine aggregate found to be 2.55

3. Coarse Aggregate

The aggregate which retained on 4.75mm size sieve are categorized in coarse aggregate. In this investigation we use two single sized aggregate 10mm (ranging from 12.5to 2.36) and 20mm (ranging from 20mm to 4.75mm).

Aggregate will consist of naturally occurring (crushed and uncrushed) stones, gravel and sand or combination thereof. The will be hard, strong, dense, durable, clear and free from veins and adherent coating and free from injurious amount of disintegrated pieces, alkali, vegetation matters and other deleterious substances. As for as possible flaky, coriaceous and elongated pieces should be avoided. The specific gravity of coarse aggregate found to be 2.68

IV. EXPERIMENTAL PROGRAMME

4.1 INTRODUCTION

Experimental investigation was planned to provide sufficient information about the strength and also chemical characteristics of G30 polypropylene concrete and tests were conducted on materials. Results were analyzed to derive useful conclusions regarding the strength and chemical characteristics of Polypropylene concrete that has been used as a reference mix. The design mix is presented in appendix– I.

4.2 PREPARATION OF SPECIMENS:

The cast iron moulds are cleaned of dust particles with mineral oil on all sides be for the concrete is poured into the moulds. The moulds are placed on a level platform. The well mixed concrete is filled into the moulds immediately after mixing, in three layer compacted with manual strokes. Excess concrete was removed with a trowel and the top surface level is finished and smooth as per IS 516- 1969.

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Cube Cylinder Prism

FIG 4.1: Moulds used for testing concrete

4.3 CURING OF THE SPECIMENS:

The specimens are left in the moulds undisturbed at room temperature for about 24 hours as it was polypropylene concrete after casting. The specimens are then removed from the moulds and they are exposed to sunlight and air for desired periods.

4.4 TESTING OF SPECIMENS

A time schedule for testing of specimens is maintained to ensure their proper testing on the due date and time. The cast specimens are tested as per standard procedures as they are exposed to sunlight and then they are tested.

4.5 TESTS CONDUCTED

Different investigations were done on the concrete, I divided this investigations as two depending on their properties such as physical properties and chemical properties.

4.5.1. Workability:

Workability is the most commonly used method and measuring consistency of concrete which is employed in laboratory or at the site work. For the present work, slump tests were conducted as per IS: 1199 – 1959 for all mixes. It is not suitable method for vary wet or dry concrete. This method is suitable for medium slump.

The apparatus for conducting the slump test essentially consists a metallic mould in the form of frustum of a cone having the internal dimensions as under:

Bottom diameter : 20 cm

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Top diameter : 10 cm

Height : 30 m

The thickness of the metallic sheet for the mould should not be thinner than 1.6mm.For tamping the concrete; a steel tamping rod is 16mm diameter 0.6m along with bulletis used. The mould is then filled in four layers, each approximately 1/4th of the height of the mould. Each layer is tamped 25 times by the tamping rod. Immediately after removal of the mould, the slump was measured and recorded by determining the difference between the height of the mould and that of the highest point of the slumped test specimen as shown in Fig. 3.5 The measure the slump values. The certain percentage of SP was added for all the mix combinations to get required amount of workability.

Fig 4.2: Slump Test in progress

4.5.2 COMPRESSIVE STRENGTH

The cube of sizes 150 x 150 x 150mm were cast. After 24 hours , the specimens are removed from the moulds and subjected to curing for 28 days exposed to sunlight. After curing, the specimens are tested for compressive strength using compression testing machine of 2000 KN capacity (IS: 516 - 1959). The machine maximum load at failure is taken. The average compressive strength of concrete specimens is calculated by using the following equation. The specimens were transferred on to the swiveling head of the machine such that the load was applied centrally. The smooth surfaces of the specimen are placed on the bearing surfaces in such a manner the load was applied to the opposite sides of the cubes. The top plate was brought in contact with the specimen by the power button. The oil pressure valve was closed and the machine was switched on.

In each case the cube was positioned in such a way that the load was applied perpendicularly to the direction of casting with a loading rate of 140 kg/cm2/min was maintained and it was continued till the specimen fails, i.e. with further increment of load, no resistance was offered by the specimen, that maximum load was recorded. The test was repeated for the three specimens and the average value was taken as the mean strength. The test set up is shown in Fig.

Fig 4.3: Compressive Testing machine

Compressive strength of concrete=$\frac{Ultimate\ load(N)}{Area\ of\ crosssection(mm^2)}$

4.5.3 SPLIT TENSILE STRENGTH

The cylinder mould shall is of metal 3mm thick. Each mould is capable of being opened longitudinally to facilitate the removal of the specimen and is provided with a means of keeping it closed while in use. The mean internal diameter of the mould is 15cm and the height is 30cm. Each mould is provided with a metal base plate. The mould should be coated with a thin film of mould oil before use, in order to prevent adhesion of concrete.

The cubes were cast and after 24 hours, the specimens are removed from the moulds and subjected to curing for 28 days by exposing to sunlight. After curing, the specimens are tested for split tensile strength using compression testing machine of 2000 KN capacity (IS: 5816 - 1999). The maximum load at failure is taken. The average split tensile strength of concrete specimens is calculated by using the following equation.

Fig 4.4: Sample testing on CTM for Split tensile Strength

Split tensile strength =$\frac{2p(N)}{\pi ld(mm^2)}$

Where p: maximum load applied on the specimen, l: length of the specimen, d: cross sectional diameter of the specimen. In this test, in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses developed in the specimen. The tensile stress at which the failure occurs is termed the tensile strength of concrete.

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 apposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. Due to the compression loading a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter as obtained from an elastic analysis. The advantages of the split tensile strength test are as follows,

i) The test is simple to perform and gives more uniform results than that given by other tests

ii) The strength determined is closer to the actual tensile strength of concrete than the modulus of rupture value.

iii) The same moulds and testing machine can be used for compression and tension tests

4.5.4 FLEXURAL STRENGTH:

The beams of sizes 500 x 100 x 100mm were casted. After 24 hours , the specimens are removed from the moulds and subjected to curing for 28 days exposed to sunlight. After curing, the specimens are tested for flexural strength using universal testing machine. The maximum load at failure is taken. The average flexural strength of concrete specimens is calculated by using the following equation.

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100 x 100 mm concrete beams with a span length at least three times the depth. The flexural strength is expressed as Modulus of Rupture (MR) in psi (MPa) and is determined by standard test method (center-point loading).

The bed of the testing machine shall be provided with two steel rollers, 38 mm in diameter, on which the specimen is to be supported, and these rollers shall be so mounted that the distance from centre to centre is 60 cm for 15.0 cm specimens or 40 cm for 10.0 cm specimens. The load shall be applied on the top through a similar roller mounted at the middle of the supporting span. The load shall be divided equally between all rollers, shall be mounted in such a manner that the load is applied axially and without subjecting the specimen to any torsional stresses or restraints.

Fig 4.5: Flexural strength testing machine

Flexural strength=$\frac{pl}{bd^2}$

Where p = Maximum load applied on the specimen, l = length of the span on which the specimen was supported, b = with of the specimen, d = depth of the specimen.

V. EXPERIMENTAL RESULTS AND DISCUSSION

5.1 Optimization of polypropylene fiber in concrete

In this section polypropylene fiber blended type- 24mm of different percentage added in concrete.

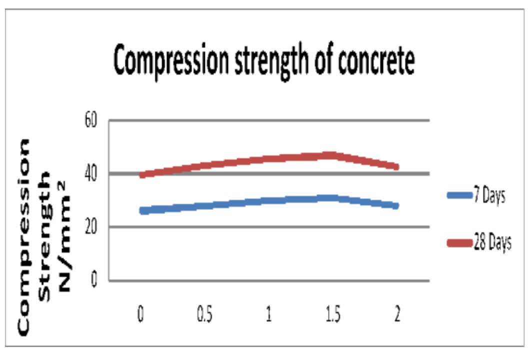
Slump value-75MM

Workability decreases due to more addition of fibers, there is increases in amount of entrapped air voids due to the presence of fibers and therefore increase in air content attributes in reducing workability.

Table 5.1: Compressive strength of the specimens

S.No	% of fibers	%Replacement of Fly ash in cement	%Replacement of rice husk in cement	7days Compressive strength	28days compressive strength

				(N/mm²)	(N/mm²)
1	0	10%	10%	26.25	39.50
2	0.5	10%	10%	27.90	43.14
3	1	10%	10%	29.91	45.61
4	1.5	10%	10%	30.91	47.00
5	2	10%	10%	28.12	42.72



% of Fibers

Compressive strength increases for all dosages of fibers due to confinement provided by fiber increases bonding characteristics of concrete.

Table 5.2: Split tensile strength of the specimens

S.No	% of fibers	%Replacement of Fly ash in cement	%Replacement of rice husk in cement	28days Split tensile strength (N/mm²)
1	0	10%	10%	3.52
2	0.5	10%	10%	3.96

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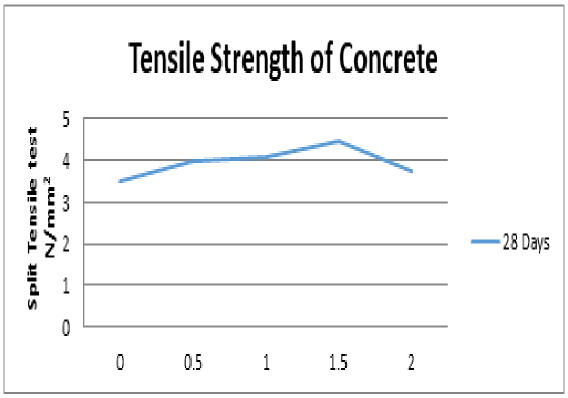
3	1	10%	10%	4.08
4	1.5	10%	10%	4.48
5	2	10%	10%	3.76



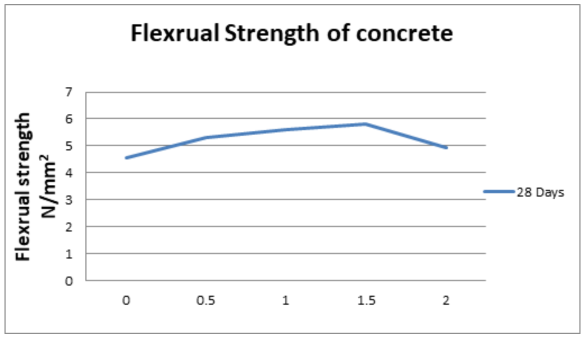
% of Fibers

Failure patterns of splitting tensile test indicate that specimens after first cracking do not separate unlike the concrete failure. Large damage zone is produced due to closely spaced micro cracks surrounding a splitting plane. Fiber bridging mechanism is responsible for such enhanced ductile failure pattern.

Table 5.3: Flexural strength of the specimens % of fibers

S.No	% of fibers	%Replacement of Fly ash in cement	%Replacement ofrice husk in cement	28days Flexural strength (N/mm^2)
1	0	10%	10%	4.54
2	0.5	10%	10%	5.31
3	1	10%	10%	5.58

4	1.5	10%	10%	5.81
5	2	10%	10%	4.92



VI. CONCLUSIONS

When compared to conventional concrete, the 1.5% blended length polypropylene fibre reinforced concrete's compressive strength showed a 17% improvement in strength. In comparison to conventional concrete, there is a 24% increase in flexural strength and a 22% increase in split tensile strength.The ideal technique for producing concrete that is both strong and long-lasting was found via experimental research.

In general, plain concrete has very little resistance to cracking, poor flexibility, and extremely low tensile strength. According to research investigations, concrete performs better when tiny, evenly dispersed fibres are added than when ordinary concrete is used. Concrete's tensile and compressive strengths are enhanced by these fibres, which also serve as crack-arresters. Concrete is made of a variety of fibres, including steel, glass, carbon, polypropylene, and natural fibres like bamboo, jute, and coconut fibres. Volume, aspect ratio, and fibre orientation are the main variables influencing the fibre selection into the concrete matrix. Therefore, depending on the qualities needed for the concrete building, a specific kind of fibre or a combination of two or more fibres might be included in the concrete mix.

India produces a significant quantity of fly ash globally. Replacing fly ash with this substance may potentially address a lot of issues. Cost and cement use will be decreased. Additionally, there will be less environmental contamination. The development of different mix designs and knowledge of fly ash concrete's additional qualities have been aided by the experimental work.

Using fly ash has the potential to produce PPC concrete.

- Concrete will become more workable.
- As fly ash content rises, concrete's compressive strength will decline.

- Concrete loses strength between seven and twenty-eight days before.
- As fly ash content rises, concrete's flexural strength falls.
- Using polypropylene fibre may improve concrete's serviceability by narrowing cracks, it can be established.
- It was discovered that the workability of concrete mix decreased as the amount of RHA added to the mixture increased in lieu of cement.
- When compared to the control mix, the addition of RHA to the concrete mix increased the compressive strength at 10% replacement; however, further addition decreased strength.
- The long-term compressive strength of all mixtures, both with and without fibres, is increased by adding RHA at a volume fraction of 0.5%. Conversely, the impact of polypropylene fibres on lowering compressive strength was greater than that of RHA.

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