Performance Study on Polypropylene Fiber Reinforced Concrete Beams Using Foundry Sand

K. Shalini[1], Mrs. M. Saranya[2]
[1]Dept of Civil
[2]Assistant professor, Dept of Civil
[1, 2] N.S.N. College of Engineering and technology, Karur.

Abstract- *A rise in urbanization and industrialization has led to over utilisation of natural river sand, which affects environmental sustainability. Also, due to massive demand of river sand, industrial by-products can be utilized in concrete. Most metal casting sand foundry sand is high quality silica sand with uniform physical characteristics., Here an attempt has been made to partially replace river sand with an 20% waste foundry sand (WFS) in concrete. Foundry sand is a waste from ferrous and nonferrous metal industry and it is used for partially replacing fine aggregate. Polypropylene fiber are added to the concrete to forming fibre-reinforced concrete, to improve its ability to absorb energy and deformation before failure, and behave as a ductile material. Polypropylene fibers are thermo plastics produced from propylene gas. Propylene gas is obtained from the petroleum by products or cracking of natural gas feed stocks, Polypropylene fiber can be used to increase the mechanical properties of concrete. Polypropylene fiber is added in concrete for different volume fraction (0%, 0.15%, 0.25% and 0.35%) . The present work started by determining the basic properties of materials and mix design for M25.*

I. INTRODUCTION

1.1 GENERAL

Concrete has better resistance in compression while steel has more resistance in tension. Conventional concrete has limited ductility, low impact and abrasion resistance and little resistance to cracking. A good concrete must possess high strength and low permeability. Hence, alternative Composite materials are gaining popularity because of ductility and strain hardening. To improve the post cracking behaviour, short discontinuous and discrete fibers are added to the plain concrete. Addition of fibers improves the post peak ductility performance, pre-crack tensile strength, fracture strength, toughness, impact resistance, flexural Strength resistance, fatigue performance etc. The ductility of fiber reinforced concrete depends on the ability of the fibers to bridge cracks at high levels of strain. Addition of polypropylene fibers decreases the unit weight of concrete and increases its strength.

1.2 POLYPROPYLENE FIBER

Polypropylene fibers are new generation chemical fibers. They are manufactured in large scale and have fourth largest volume in production after polyesters, polyamides and acrylics. About 4 million tons of polypropylene fibers are produced in the world in a year.

Polypropylene fibers were first suggested for use in 1965 as an admixture in concrete for construction of blast resistant buildings meant for the US Corps of Engineers.

Subsequently, the polypropylene fiber has been improved further and is now used as short discontinuous fibrillated material for production of fiber reinforced concrete or as a continuous mat for production of thin sheet components. Further, the application of these fibers in construction increased largely because addition of fibers in concrete improves the tensile strength, flexural strength, toughness, impact strength and also failure mode of concrete

These fibers are manufactured using conventional melt spinning. Polypropylene fibers are thermo plastics produced from Propylene gas. Propylene gas is obtained from the petroleum by products or cracking of natural gas feed stocks. Propylene polymerizes to form long polymer chain under high temperature and pressure. However, polypropylene fibers with controlled configurations of molecules can be made only using special catalysts.

Polypropylene fibers were formerly known as Steal the. These are micro reinforcement fibers and are 100% virgin homo polymer polypropylene graded monofilament fibers. They contain no reprocessed Olefin materials. The raw material of polypropylene is derived from mono meric C_3H_6 which is purely a hydrocarbon.

Monofilament polypropylene fibers can be used in much lower content than steel fibers. The tensile strength and other mechanical properties are enhanced by subsequent multi stage drawing. These fibers have low density of 0.9 g/cc. They are highly crystalline, with high stiffness and excellent resistance to chemical and bacterial attack. The crystallinity of these fibers is about 70% while the molecular weight is 80,000 to 300,000 gm/mole.

Polypropylene fibers should not be used for structural reinforcement. These fibers should not be used to produce thinner sections and also to increase joint spacing than those suggested for unreinforced masonry.

Polypropylene when copolymerized with ethylene is generally tough and flexible, which allows polypropylene to be used as engineering plastic. Polypropylene is reasonably economical and when uncoloured appears translucent. It is generally not readily available transparent as acrylic, polystyrene or other plastics. It is often opaque or made coloured using colouring pigments. It has good resistance to fatigue. Perfectly isotactic Polypropylene has a melting point of 171 °C while Commercial isotactic Polypropylene has a melting point ranging from 160 to 166 °C. Polypropylene is used in hinges of flip flop bottles, piping, loud speaker units etc. Thin sheets of polypropylene are used as dielectric in capacitors

1.3 FOUNDRY SAND

Most metal casting sand Foundry Sand (FS) is high quality silica sand with uniform physical characteristics. It is a by-product of the ferrous and nonferrous metal casting industry, where sand has been used for centuries as a moulding material because of its unique engineering properties. In modern foundry practice, sand is typically recycled and reused through many production cycles. Industry estimates are that approximately 100 million tons of sand are used in production annually. Of that, four (4) to seven (7) million tons are discarded annually and are available to be recycled into other products and industries.

Sand used at foundries is of a high quality, much of it supplied by members of the Stringent physical and chemical properties must be met as poor quality sand can result in casting defects. Foundries and sand producers invest significant resources in quality control of their sand systems, with extensive testing done to maintain consistency. As a result, FS from an individual facility will generally be very consistent in composition, which is an advantage for most end use applications.

Although there are other casting methods including die casting, investment casting, and permanent mould casting, sand casting is by far the most prevalent casting technique. Sand is used in two different ways in metal casting: as a molding material, which forms the external shape of the cast part, and as cores, which form internal void spaces in products such as engine blocks. Since sand grains do not naturally adhere to each other, binders must be introduced to cause the sand to stick together and hold its shape during the introduction of the molten metal into the mould and the cooling of the casting.

1.4 ADVANTAGES OF POLYPROPYLENE FIBERS

1. PP is a light fiber, its density (0.91 gm/cm³) is the lowest of all synthetic fibers.
2. It does not absorb moisture. This means the wet and dry properties of the fiber are identical. Low moisture regain is not considered a disadvantage because it helps in quick transport of moisture as is required in special applications like babies' ever-dry nappies.
3. It has excellent chemical resistance. PP fibers are very resistant to most acids and alkalis.
4. The thermal conductivity of PP fiber is lower than that of other fibers and may be used in applications as thermal wear.

1.5 APPLICATIONS OF POLYPROPYLENE FIBER

1. Polypropylene is used in the manufacturing piping systems; both ones concerned with high-purity and ones designed for strength and rigidity (e.g. those intended for use in potable plumbing, hydronic heating and cooling, and reclaimed water). This material is often chosen for its resistance to corrosion and chemical leaching, its resilience against most forms of physical damage, including impact and freezing, its environmental benefits, and its ability to be joined by heat fusion rather than gluing.
2. Many plastic items for laboratory use can be made from polypropylene because it can withstand the heat in an autoclave. Its heat resistance also enables it to be used as the manufacturing material of consumer-grade kettles. Food containers made from it will not melt in the dishwasher, and do not melt during industrial hot filling processes. For this reason, most plastic tubs for dairy products are polypropylene sealed with aluminium foil (both heat-resistant materials). After the product has cooled, the tubs are often given lids made of a less heat-resistant material, such as LDPE or polystyrene. Such containers provide a good hands-on example of the difference in modulus, since the rubbery (softer, more flexible) feeling of LDPE with respect to polypropylene of the same thickness is readily apparent. Rugged, translucent, reusable plastic containers made in a wide variety of shapes and sizes for consumers from

various companies such as Rubbermaid and Sterilite are commonly made of polypropylene, although the lids are often made of somewhat more flexible LDPE so they can snap onto the container to close it. Polypropylene can also be made into disposable bottles to contain liquid, powdered, or similar consumer products, although HDPE and polyethylene terephthalate are commonly also used to make bottles. Plastic pails, car batteries, wastebaskets, pharmacy prescription bottles, cooler containers, dishes and pitchers are often made of polypropylene or HDPE, both of which commonly have rather similar appearance, feel, and properties at ambient temperature. A diversity of medical devices are made from PP.

3. Polypropylene is also used in particular roofing membranes as the waterproofing top layer of single-ply systems as opposed to modified-bit systems.
4. Polypropylene is most commonly used for plastic mouldings, wherein it is injected into a mould while molten, forming complex shapes at relatively low cost and high volume; examples include bottle tops, bottles, and fittings.
5. Polypropylene sheets are a popular choice for trading card collectors; these come with pockets (nine for standard-size cards) for the cards to be inserted and are used to protect their condition and are meant to be stored in a binder.

1.6 OBJECTIVES OF THE PROJECT

- To study the mechanical properties of Polypropylene fiber reinforced concrete combined with Foundry sand and to compare the result with the conventional one.
- To find out the optimum percentage of Polypropylene fiber required to get the maximum strength for M25 grade of concrete.
- To investigate the structural behaviour of PPFRC beam using waste foundry sand.

1.7 SCOPE OF THE PROJECT

- To select the foundry sand and polypropylene fiber can be utilized in concrete.
- To find the efficiency of the foundry sand and polypropylene fiber for civil construction.
- To study various properties foundry sand and polypropylene fibre
- To improve concrete strength & durability factors.

II. LITERATURE REVIEW

2.1 GENERAL

This chapter describe the review of literature on foundry sand &polypropylene fiber investigation carried by the researchers in the area of concrete.

2.2 LITERATURE REVIEW

Nithya et.al, Priya, Muthukumaran, Arunvivek(2017), discussed that Properties of concrete containing waste foundry sand for partial replacement of fine aggregate in concrete. Concrete is the second most consumed material after water, with nearly three tons used annually for each person on the planet reference. India consumes an approximate quantity of 450 million cubic meter of concrete per annum, which nearly transforms to 1 ton per Indian2.The foundry sand is recycled and again reused as the moulding material. The effect of using WFS as partial replacement of fine aggregate on mechanical and durability properties of concrete in various percentages was investigated.150 mm concrete cubes were cast for compressive strength and acid resistance, 150 × 300 mm cylinders for split tensile strength and samples of size 500 × 100×100mm. All the test specimens were stored at room temperature in the casting room. The specimens were immersed in water curing tank after 24 hours. After a required period of curing (28 days), the specimens were taken out of the curing tank, and their surfaces were wiped off. In the end results Concrete specimens produced with WFS suffered the similar loss in weight and compressive strength, as compared to ordinary concrete when subjected to sulphuric acid attack.

Nwofor and Ukpaka (2016), discussed that assessment of concrete produce with foundry sand waste as partial replacement for river sand and the result reveals that 15% of foundry sand is appropriate as partial replacement of fine aggregate for preparation of grade 20 concrete by application of compressive equation as targeted strength of concrete were established at 28 days .In this research selecting suitable in gradients of concrete and determining their relative proportions with object of producing concrete of certain minimum strength &durability as economically as possible based on specification of BS:1881:Part 125-1986,Hence 1:2:4 design mix was used where the river fine sand constant were partially replaced with foundry sand aggregate at a constant water cement ratio 0.5 fine aggregate were partially replaced with foundry sand at 5,10,15,20&25% replacement and specimen this research shows its increase compressive strength and the maximum compressive strength is achieved at 15% replacement lowed.

Badogiannis, Christidis, Tzanetatos (2018), discussed evaluation of the mechanical behaviour of light weight concrete enforced with steel and poly propylene fibers. An investigation of the mechanical properties of fiber reinforced punish light weight concrete is example of the volume of fiber 0.5% and 1.0% the effect of steel and poly propylene fiber has been widely research in respect to the mechanical properties of LWC the use of steel fibers in punice LWC reported the base compressive strength increase up to 60% comprise to the plain concrete the prismatic specimen has been used in this test size(100×100×500 mm) & (100×100×300 mm) ,the compressive and flexural strength has been conducted ,in this end result the both fiber types seemed to lead to a significant increase of the compressive strength measured from 16% up to 76% modulus of elasticit and persons ratio the fibers addition has proved to be refer negligible.

Biao Li, Yin Chi, LihuaXu, Yuhina Shi, Changning Li (2018), discussed Experimental investigation on the flexural behavior of steel-polypropylene hybrid fiber reinforced concrete. four volume fractions of 0.5%, 1.0%, 1.5% and 2.0% for corrugated steel fiber and three volume fractions of 0.1%, 0.15% and 0.2% for polypropylene fiber we readopted. The compressive and splitting tensile strengths, and three prismatic specimens, 100×100×400 mm in dimension, to explore the flexural behavior of concrete, were prepared. After a uniform mix, the fresh concrete was cast in plastic moulds, and then vibrated upon a vibrating table. The specimens were demolded24 h after casting and stored for an additional 27 days under controlled conditions at 20 ± 3 °C. Compressive and splitting tensile test and Four-point bending tests are conducted. it is also found that the synergy of hybrid fibers in the properties of pre-peak stage is higher than those of post-peak stage. In this end result Hybrid fibers are found to have synergetic effects on the flexural behavior of concrete for all the three steel fiber types. Increase in the volume fractions for both steel and polypropylene fibers leads to an increase in the flexural strengths and post-peak ductility of concrete.

KutalmısRecepAkca, OzgurCakır, MetinIpek (2015), discussed about the recycling of rubble obtained during urban transformation and manufacturing new concrete using this material was experimentally studied. Recycling has become prominent in construction industry in the last decades with the term of sustainable structural materials. Volume of 0%, 1% and 1.5% polypropylene fibers were used in mixtures for each series. Compressive strength test was carried out with cubic specimens of (150×150×150 mm) in accordance with the standard. Cylinder specimens (150/300 mm) were used in order to determine splitting tensile strength and static/dynamic modulus of elasticity, prism specimens (75×75×500 mm) were used in case of three point loading flexural tensile strength and toughness. replacement ratio is increased, splitting tensile strength decreases. In the end results of Although the workability of concrete decreases due to high water absorption tendency of RCA, it is possible to attain desired workability with proper superplasticizer admixture. Due to the fact that fiber content influencing gradation negatively, fiber reinforced concrete series exhibit heterogeneous behavior.

Sadiqul Islam, Sristi Das Gupta(2015), discussed that Evaluating plastic shrinkage and permeability of polypropylene fiber reinforced concrete. This study evaluated strength, plastic shrinkage and permeability (gas and water) of concrete incorporating ‘polypropylene’ fiber (aspect ratio 300) in various proportions (0.10%, 0.15%, 0.2%, 0.25% and 0.3%) by volume of concrete. A total of eighteen plains concrete (12 for compression) and split tensile strength test, 6 for gas and water permeability tests) and seventy-two fiber reinforced mixes were prepared. Concrete was mixed using a machine mixer. Size of slab mould 500×250×75 mm. The size of the cored sample wasØ25×75 mm. Using about 0.30% fiber (by volume) literally no plastic shrinkage cracks was observed. With the addition of 0.10–0.25% fibers, visiblyrestrained the crack width compared to control sample. The crack width reduced by 72–93% with the addition of fiber up to 0.25%. The shrinkage cracking is reduced by 50–99% by addition of fibers up to 0.30%. Shrinkage characteristics of 0.5% fiber (combination of steel and polypropylene) reinforced concrete and found reduction in plastic shrinkage crack ranging between 49% and 99%. In the end results polypropylene fiber addition was more effective than steel fiber against shrinkage cracking.

SaberFallah, Mahdi Nematzadeh (2016), discussed about the effects of different amounts of polypropylene (PP) and macro polymeric (MP) fibers on the mechanical properties and durability of high-strength concrete containing silica fume and nano-silica.1, 2, and 3% of the cement weight was replaced by nano-silica, and 8, 10, and 12% of that was replaced by silica fume. The fresh concrete was cast into the 100×200 mm cylindrical molds in 3 layers, each compacted via 25 strokes using a compacting rod. The concretes with the macro-polymeric and polypropylene fibers of 0.25 and 0.1% volume fraction demonstrated the maximum improving effects on the compressive strength with 8.0 and 11.5% increase, respectively. The increase in the compressive strength of the specimens with 1, 2, and 3% nano-silica compared to the plain concrete is 6.8, 14, and 8.6%, respectively, while the increase for the specimens containing 8, 10, and 12% silica fume compared to the plain concrete is 28.7, 37.9, and 41.1%, respectively. The tensile strength of the concrete specimens with 0.25, 0.5, 0.75, 1, and 1.25% macro polymericfibers exhibited an increase of 8.06, 8.44, 9.73, 18.66, and 27.45%, respectively. In this end result Increasing the level of PP and MP fibers in the high-strength concrete leads to a reduction in the compressive strength improvement trend to such an extent that using high volume fractions of these fibers even leads to a lower concrete compressive strength relative to the plain concrete.

Antonio Caggiano, Serena Gambarelli, EnzoMartinelli, Nicola Nistico, Marco Pepe(2016), discusses the results of experimental tests performed on concrete specimens internally reinforced with polypropylene and steel fibers. A total number of 18 prismatic (15 ×150×600 mm) specimens were prepared for the four-point bending tests. 21 (6 for the plain concrete and 3 for each FRC mixture) cylindrical specimens (300 mm in height and 150 mm in diameter) were realized for the uniaxial compressive tests. All specimens were tested at 28 days of curing. The 4PB tests were executed on three specimens for each mixture. The vertical load and the corresponding Crack Mouth Opening Displacement (CMOD) were monitored during each test. Combining steel and polypropylene fibers is an attractive solution for enhancing the post-cracking behaviour of cement-based matrices and possibly tailoring the material response to specific structural requirements. In this end result.

KamilBicer, HakanYalciner, AysePekriogluBalkıs, AtilaKumbasaroglu (2018), discussed that Effect of corrosion on flexural strength of reinforced concrete beams with polypropylene fibers. Corrosion of reinforcement in concrete is considered to be one of the most common reasons for the deterioration of reinforced concrete (RC). The test specimens were divided into four main groups: A, B, C, and D. Group A represents a 0% corrosion level, while groups B, C, and D, represent corrosion levels of approximately 5, 7, and 9%. Following three months of curing, the specimens were subjected to an accelerated corrosion method. The extended bars were surrounded with polyvinyl chloride pipes to prevent pitting corrosion on the concrete's top surface. The size of specimen 250×400×2500mm.In the end results show the uncorroded stirrups with corroded tensile reinforcement bars, and corroded stirrups with uncorroded tensile reinforcement bars at different corrosion levels, could be performed for improved prediction of the actual resisting capacities of corroded RC beams.

Yuan Qin, Xianwei Zhang, Junrui Chai, ZengguangXu, Shouyi Li (2018), discussed that experimental study of compressive behavior of poly propylene fiber reinforced and poly propylene fiber-fabric reinforced concrete was fabric fiber has already become an important pollutant source of the world's environmental problems waste fabric fiber accumulating forming approximately 30% of the total quantity of garbage. plain concrete mix, poly propylene fiber reinforced concrete and polypropylene fiber fabric reinforced concrete test are conducted. These studies have analysed that tensile strength, flexural strength toughness and energy absorption of the concrete mix. In this end result shows the addition waste fiber can improve the compression performance of concrete.

III. METHODOLOGY

3.1 GENERAL

This methodology clearly shows the processes which have been carried out in this work. The step-by-step process of this project is explained in the flow chart.

3.2 METHODOLOGY DESCRIPTION

In this project, an experimental study will be carried out on PPFRC concrete using waste foundry sand. Material properties like specific gravity, fineness modulus, setting time will be studied for cement, river sand, waste foundry sand and coarse aggregate.

According to Indian standards, cubes (150 mm x 150 mm x 150mm), cylinders (150mm diameter and 300mm height) and prisms (100 mm x 100 mm x 500mm) respectively will be prepared for polypropylene fiber reinforced concrete mix (M25) with 20% replacement of fine aggregate with WFS. Project methodology and Experimental methodology are given in figure.

IV. MIX DESIGN OF CONCRETE

Concrete mix design is the process of finding right proportions of cement, sand and aggregates for concrete to achieve target strength in structures and mix ratio achieved is given in Table 4.7. The mix proportion for M25 grade of concrete given in Table 4.8 has been designed as per IS 10262-2019.

Mix Ratio

Cement	Fine aggregate	Coarse aggregate	Water/Cement ratio

1	1.79	3.26	0.4

Mix Proportion of Concrete

S. No	Cement (kg/m³)	Water (kg/ m³)	River sand (kg/ m³)	WFS (kg/ m³)	CA (kg/ m³)	PP fiber (%)
1	380	152	679	-	1238	0
2	380	152	543	136	1238	0.15
3	380	152	543	136	1238	0.25
4	380	152	543	136	1238	0.35

MIX DESIGN FOR M25 GRADE OF CONCRETE

1. Stipulations for Proportioning

a. Grade designation = M25
b. Type of cement =OPC 53 grade
c. Maximum nominal size of aggregate = 20 mm
d. Minimum cement content =300 kg/m^3
e. Maximum water-cement ratio =0.4
f. Workability =100 mm (slump)
g. Exposure condition =Moderate
h. Degree of site control =Good
i. Type of aggregate =Crushed angular
Maximum cement content not including fly ash =450 kg/m^3
j. Chemical admixture type =Superplasticizer

2. Test data for materials

a. Cement used =OPC 53
b. Specific gravity of cement =3.15
c. Specific gravity of fine aggregate =2.64
d. Specific gravity of coarse aggregate =2.71
e. Specific gravity of chemical admixture =1.18
f. Water absorption of
    - Coarse aggregate =0.5 %
    - Fine aggregate =1.0 %

3. Target strength for mix proportioning

$$f'_{ck} = f_{ck} + 1.65S \text{ (or) } f'_{ck} = f_{ck} + X$$

From Table 2, standard deviation, S = 4 N/mm^2.

From Table 1, X = 5.5
Therefore, target strength using both equations, that is,

a) $f'_{ck} = f_{ck} + 1.65S = 40 + 1.65 \times 5 = 31.6$ N/mm^2
b) $f'_{ck} = f_{ck} + 5.5 = 40 + 6.5$
=30.5 N/mm^2

The higher value is to be adopted. Therefore, target strength will be **31.6 N/mm^2**where 31.6 N/mm^2> 30.5 N/mm^2.

4. Approximate air content

From Table 3, the approximate amount of entrapped air to be expected in normal (non-air-entrained) concrete is 1.0percent for 20 mm nominal maximum size of aggregate.

5. Selection of Water-cement ratio

From Fig. 1, the free water-cement ratio required for the target strength of 31.6 N/mm^2 is 0.558 for OPC 53 grade curve. This is higher than the maximum value of 0.45 prescribed for 'moderate' exposure for reinforced concrete as per Table 5 of IS 456. Therefore, take 0.4 as maximum water-cement ratio.

6. Selection of water content

From Table 4, water content = 186 kg (for 50 mm slump)
Estimated water content for 100 mm = 186 + (6x186) / 100
= **197.16 kg**

As super plasticizer is used, the water content may be reduced. Based on trial data, the water content reduction of 23 percent is considered while using super plasticizer at the rate 1.0 percent by weight of cement.

Hence the water content = 197.16 × 0.77

Calculation of cement content

Water-cement ratio = 0.4
Cement content = 152 / 0.4
From table for moderate exposure condition =300 kg/m^3
380 kg/m^3 > 300 kg/m^3, Hence OK.

7. Proportion of volume of Coarse aggregate and fine aggregate content

From Table 5, the proportionate volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.4 0.62+0.02 =**0.64**
Volume of fine aggregate content = 1 – 0.64 =**0.36**

8. Mix proportions

The mix calculations per unit volume of concrete shall be as follows:

a. Total volume = 1 m^3
b. Volume of entrapped air in wet concrete = 0.01 m^3
c. Volume of cement =(380/3.15)x (1/1000)0.121 m^3
d. Volume of water =(152/1)x (1/1000=)0.152m^3
e. Volume of chemical admixture (Super plasticizer) (@1.0 percent by mass of cementitious material) = (3.8/1.18) x (1/1000) =0.0032m^3
f. Volume of all in aggregate = [(1-0.01) – 0.714m^3
g. Mass of coarse aggregate =0.714x0.64x2.71x1000=8kg

9. Mix proportions for trial section

- Cement = 380 kg/m^3
- Water = 152 kg/m^3
- Fine aggregate (SSD) = 679 kg/m^3
- Coarse aggregate (SSD) = 1238 kg/m^3

- Chemical admixture = 3.8 kg/m^3
- Free water-cement ratio = 0.4

V. EXPERIMENTAL PROGRAM

5.1 GENERAL

This chapter deals with the casting and testing of the specimens.

5.2 CASTING OF SPECIMENS

Concrete specimens of cube (150x150x150mm), cylinder (150x300 mm) and prism (100x100x500 mm) were cast by partially replacing 20% sand with foundry sand. Polypropylene fibers were used in different volume fraction (0%, 0.15%, 0.25% and 0.35%). Specimens were cured for 7 days and 28 days.

5.3 TESTING OF SPECIMENS

Specimens were tested in Compression testing machine of 1000 kN capacity and flexural testing machine. Two-point loading method was used for determining the flexural strength of the specimen. Three test to be conducted there are

- Compressive strength
- Split tensile strength
- Flexural strength

5.3.1 Compressive Strength

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. Fig.6.1 shows the testing of cube & Fig.6.2 shows the crack pattern of cube.

Formula

Compressive strength formula for any material is the load applied at the point of failure to the cross-section area of the face on which load was applied.

Compressive Strength = Load / Cross-sectional Area

5.3.2 Split Tensile Strength

A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete. Fig 6.3 shows the testing of cylinder & Fig.6.4 shows the crack pattern of cylinder.

Formula

Calculate the splitting tensile strength of the specimen as follows:

$$T = 2P/\pi LD$$

Where:
T = splitting tensile strength, MPa
P = maximum applied load indicated by the testing machine, N
D = diameter of the specimen, mm
L: length of the specimen, mm

5.3.3 Flexural strength

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an un-reinforced concrete beam or slab to resist failure in bending. It is measured by (150 x 150 mm) concrete beams with a span length of at least three times the depth. Fig 6.5 shows the testing of prism & Fig.6.6 shows the crack pattern of prism.

Formula

$$F = PL/(bd^2)$$

VI. RESULTS AND DISCUSSION

6.1 GENERAL

This chapter deals with results of the tests conducted for compressive strength, split tensile strength & flexural strength. And the results were interpreted.

6.2 TEST ON SPECIMEN

6.2.1 Compressive strength

The test result of compressive strength is given in Table .

Table 6.1 Compressive Strength

S. No	% Of foundry sand	% Of Polypropylene	Compressive strength -7 days MPa	Compressive strength - 28 days Mpa
1	0	0	14.1	26
2	20	0.15	17.27	30.6
3	**20**	**0.25**	**22.07**	**32.1**
4	20	0.35	19.10	30.8

6.2.2 Split Tensile strength

The test result of split tensile strength is given in Table

S. No	% Of Foundry Sand	% Of Polypropylene	Split tensile strength -7 days MPa	Split tensile strength -28 days MPa
1	0	0	1.47	2.07
2	20	0.15	1.81	2.87
3	**20**	**0.25**	**2.02**	**3.12**
4	20	0.35	1.90	3.02

6.2.3 Flexural strength

The test result of flexural strength is given in Table 5. Flexural strength increases by 30% for the combination of foundry sand (20%) & polypropylene fiber (0.15%) when compared to conventional concrete. 0.25% volume fraction of fibers records higher flexural strength values than any other combinations as seen in figure 7.3. The test result of flexural strength is given in Table

S. No	% Of Foundry	% Of Polypropylene	Flexural strength	Flexural strength

	Sand		**-7 days MPa**	**-28 days MPa**
1	0	0	2.7	3.65
2	20	0.15	3.5	4.75
3	**20**	**0.25**	**4.2**	**5.1**
4	20	0.35	3.88	4.7

6.2.4 Energy absorption capacity

VII. CONCLUSION

From results and discussion, following conclusion can be drawn.

- 20% foundry sand and 0.25% volume fraction of polypropylene fibers is found to be optimum.
- For 0.25% volume fraction of fibres,23% increase is observed in compressive strength when compared to cosssnventional specimens.
- When compared to conventional specimens, 0.25% volume fraction of fibers recorded 50% increase in split tensile strength

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