Enrichment of Strength Properties of Polypropylene Fiber Reinforced Concrete of Different Lengths And Densities

A. Kishore[1], D. Appanna[2]
[1]Dept of Civil Engineering
[2]Assistant Professor,Dept of Civil Engineering
[1, 2] Lenora College of Engineering, Rampachodavaram

Abstract- *The increasing amount of waste material from industry is a concerning reality that has began the sustainability issues of the environment and ecology of earth surface. The production of fibre in the industry accounts for the global warming by releasing the carbon dioxide and other harmful gases in the atmosphere during its manufacturing. Concrete is a substance, which has high strength in compression and less strength in tension, so far increasing the tensile strength of the concrete, reinforcements are added. To increase the tensile strength and to prevent the growth of micro cracks of concrete to the macroscopic level, fibres can be added. The presence of micro cracks at the mortar-aggregate interface is responsible for the inherent weakness of plain concrete. The weakness can be removed by inclusion of fibres in the mix. Such a concrete is called fibre reinforced concrete (FRC). In this study polypropylene fibre was used as an additional material of cement concrete. Polypropylene fibre (PPF) is a synthetic hydrocarbon polymer which was added to enhance the strength of the concrete i.e. compressive and split tensile strength. The present proposal involves a comprehensive laboratory study for the newer application of this waste material in the preparation of fibre reinforced concrete. The primary objective of investigation is to study the strength behaviour i.e. compressive strength, and impact resistance of concrete with different lengths and densities of polypropylene Fibre.*

Keywords- Polypropylene fibre, Fibre Reinforced Concrete, Fibre Reinforced Mortar, compressive strength, split tensile strength test, flexural strrngth test.

I. INTRODUCTION

The Fibre Reinforced Concrete (FRC) is a composite material essentially consisting of concrete reinforced by random placement of short discontinuous and discrete fine fibers of specific geometry. It is now well established that the addition of short, discontinuous fibers plays an important role in the improvement of the mechanical properties of concrete. In the FRC, the fibers help to transfer load to the internal micro cracks. In the recent past, many developments have been made in the fiber reinforced concrete. Also it has been recognized that addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve the properties and can cause a change in the failure mode under compressive deformation from brittle to pseudo-ductile, thereby imparting a degree of toughness to concrete. Concrete made with Portland cement has certain characteristics; it is relatively strong in compression but weak in tension and tends to be brittle. These two weaknesses have limited its use. Another fundamental weakness of concrete is that cracks start to form as soon as concrete is placed and before it has properly hardened. These cracks are major cause of weakness in concrete particularly in large onsite applications leading to subsequent fracture and failure and general lack of durability. The weakness in tension can be overcome by the use of conventional rod reinforcement and to some extent by the inclusion of a sufficient volume of certain fibers. Glass, fiber, carbon fibers are commonly used in manufacturing of reinforcing bars for concrete applications.

It is possible to make several classifications among fiber types. Fibers can be divided into two groups, Those with elastic moduli lower than the cement matrix, such as cellulose, nylon, and polypropylene and those with higher elastic moduli such as asbestos, glass, steel, and carbon.

Among all the fibers Steel fibers have been used in pavements, in shotcrete, and in a variety of other structures. Banana fibers are renewable and obtained from natural resources that present several advantages, including low density, acceptable specific strength properties, good sound abatement capability, low abrasivity, low cost, high biodegradability and existence of vaster sources. In addition, at the end of their life cycle these can be incinerated for energy recovery, because they have a good calorific value. New application areas become available as new fiber types and new FRC production techniques are developed.

Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. Within these different fibers that character of fiber reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation and densities.

This Study describes the influence of different lengths and densities of fibre on fiber reinforced concrete. In this project polypropylene fibre used to study the influence of fibre and detected the influence using workability, compressive strength, and tensile strength on comparison with conventional concrete.

II. REVIEW OF LITERATURE

Schneider and Chen (2005) reported on the influence of di erent concentrations of chemical solutions, the quality class of concretes, the load level of applied stress on the strengths of concrete, and the mechanism of steel reinforcement corrosion.

The research shows that performance needs to be divided into several phenomena: absorption and di usion of sulphate and the influence of environmental conditions (Ferraris et al. 2006). It increases the risk of corrosion of the embedded reinforcing steel, if the structure is to be exposed to air in service.

RaghatateAtul M. (2012) investigated the use of plastic bags in form of fiber in concrete and added fiber in proportion of 0.2%, 0.4%, 0.6%, 0.8% and 1% by weight of concrete. It was observed that there was reduction of compressive strength with the increase in plastic content, but there was increase in tensile strength with optimum strength at 0.8% addition. B Jaivignesh and A Sofi (2017) performed Study Properties of Concrete with Plastic Waste as Aggregate. The aim of this paper is to find out the effects of plastic waste on the mechanical properties of polymer concrete. They used the plastic place of fine aggregates as well as coarse aggregates in proportion of 10%, 15 % and 20% and further added steel fibre to the concrete and came to conclusion that the reduction in strength but suggested its use in favor of reduction of waste material and ecofriendly materials.

Elango A and Ashok Kumar A (2018) had done a study on concrete by using plastic in a proportion of 10%, 20% and 30% and tested mechanical and durability properties on their concrete samples and observed that the concrete shows prominent results against acid attacks and increase in elasticity but decrease in the strength of the concrete. Concluded that the plastic aggregate concrete can be used in place where we need less compressive strength but more durability.

Lhakpa Wangmo Thingh Tamanget. al. (2017) had done laboratory experiments on Plastics in Concrete as Coarse Aggregate in proportion of 10%, 15%, and 20%. They observed that marginal reduction in strength and suggested the optimum result as 15% replacement.

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H. Alperenbulut et al. (2017): - The research study shows the effects of electronic waste (e-plastic) on the strength properties of polymer concrete and done a laboratory experimentation on various fresh and hardened properties of concrete.

A.N.Dancygier and Z.Savir studied the influence of steel fiber on flexural performance of high strength concrete beam with low longitudinal reinforcement ratio, which proved that steel fiber enhance brittleness of beam compared to that of beam with minimum longitudinal reinforcement ratio. Compared to steel fiber reinforced concrete, the hybrid fiber with different type and size can improve effectively strength and toughness of concrete, form hybrid effect during different fiber, play respective beneficial influence from different level. However, few researches on flexural performance of hybrid fiber reinforced RC beam were studied.

Based on the investigation on the workability of hybrid fiber reinforced self-compacting concrete (HFRSCC)' a series of hybrid fiber reinforced SCC beams with low longitudinal reinforcement ratio are tested to evaluate the hybrid fiber influence on load-deflection curve, beam flexural ductility. Steel fiber reinforced SCC beams were made in order to compare the load, ductility with hybrid fiber reinforced SCC beams.

omualdi and Batson (1963) after conducting impact test on fibre reinforced concrete specimens, they concluded that first crack strength improved by addition of closely spaced continuous steel fibres in it. The steel fibres prevent the adverting of micro cracks by applying pinching forces at the crack tips and thus delaying the propagation of the cracks. Further, they established that the increase in strength of concrete is inversely proportional to the square root of the wire spacing.

Charles H.Henage (1976) developed an analytical method based on ultimate strength approach, which has taken into account of bond stress, fibres stress and volume fraction of fibres. After his investigations, he concluded that the incorporation of steel fibres significantly increases the ultimate flexural strength, reduces crack widths and first crack occurred at higher loads.

III. MATERIALS AND METHODS

The experimental investigation work is started with various tests on the constituent materials. The constituent materials are given below.

1. Cement
2. Coarse aggregate
3. Water
4. Polypropylene fiber

Cement

Ordinary Portland Cement (OPC) was used in the experimental work which is conforming to I.S 4031-1988.The O.P.C is classified into three grades, those are 33grade, 43grade and 53 grades, and depending upon the strength of the cement in this experiment 43grade cement is used.

Fine Aggregate

Fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate conforming to the requirements of IS 383:1970.

Coarse Aggregate

The crushed aggregates used were of 20mm nominal maximum size.Aggregate most of which is retained on 4.75-mmIS Sieve and containing only so much finer material as is permitted for the various types described in this standard.

Polypropylene fiber

Polypropylene fiber reinforced concrete is also known as polypropene or PP. It is a synthetic fiber, transformed from propylene, and used in a variety of applications. These fibers are usually used in concrete to control cracking due to plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete and thus reduce the bleeding of water.. Polypropylene fiber displays good heat-insulating properties and is highly resistant to acids, alkalis, and organic solvents.

IV. MIX DESIGN

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance. Percentage dosage of super plasticizer was fixed as per the mix design method described in IS 10262- 2009. Mix proportion was arrived through various trial mixes. The grade of concrete prepared for the experimental study was M40.

V. TESTS ON HARDENED CONCRETE

5.1 COMPRESSIVE STRENGTH

Compressive strength of concrete replaced with bagasse ash for curing period of 7-days, 14-days and 28-days respectively and fig shows the summarized Compressive strength Results for different curing periods– M40 grade.

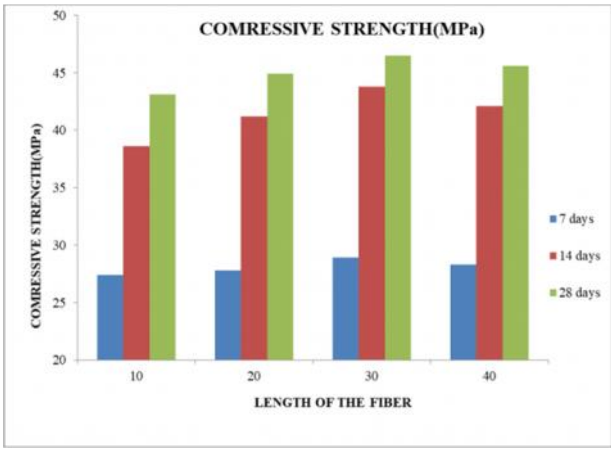

Fig shows the variation in compressive strength results with in length of fiber with density 2kg/m^3

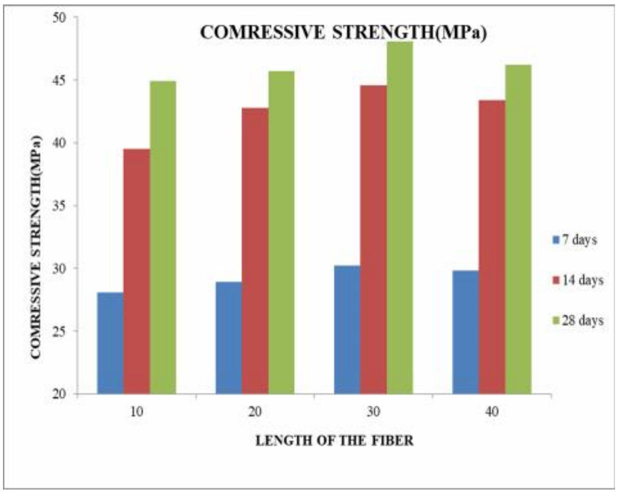

Fig shows the variation in compressive strength results with in length of fiber with density 4kg/m^3

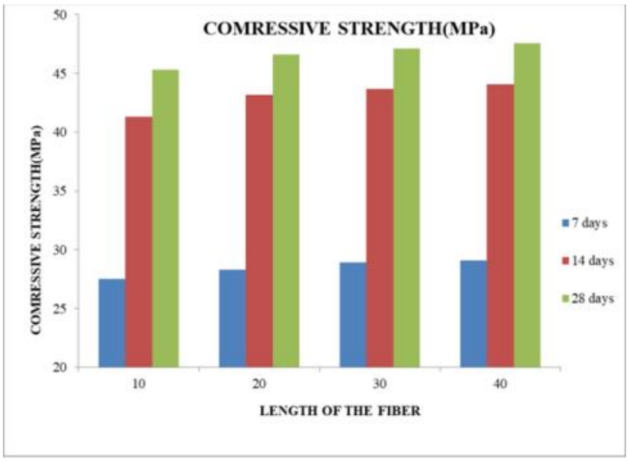

Fig shows the variation in compressive strength results with in length of fiber with density 6kg/m3

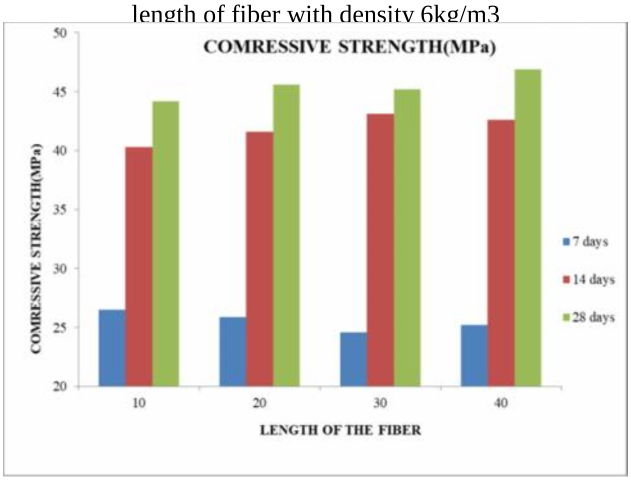

Fig shows the variation in compressive strength results with in length of fiber with density 8kg/m3

With increasing in length of the fiber and with the density there is an increase in compressive strength and it is observed that at 30mm length of polypropylene fiber addition and 4 kg/m3 density of fibre. However the further increase of length and density yield better comparative results with nominal concrete.

5.2 FLEXURAL STRENGTH OF FIBER REINFORCED CONCRETE

Direct measurement of tensile strength of concrete is difficult. Neither specimens nor testing apparatus have been designed which assure uniform distribution of pull applied to the concrete. In flexural test we find the modulus of rupture (extreme fibre stress in bending), this value depends up on the dimension of beam manner of loading. In the flexural test two types of loading conditions, there are central point loading, third point loading. In our experimentation I use third point loading with a size of beam is 70 x 15 x 15 cm. this test performed as per IS: 516 codes.

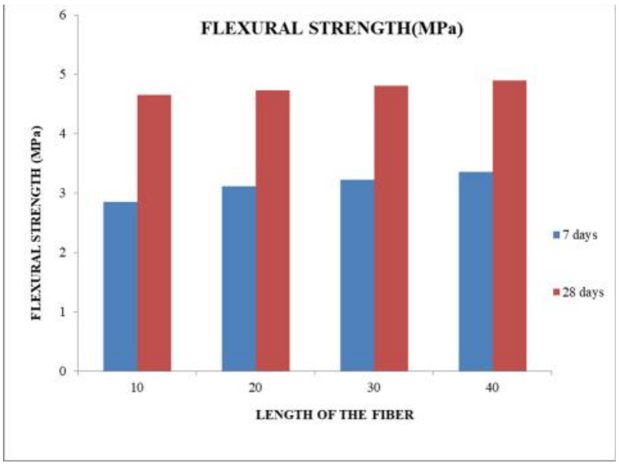

Fig shows the variation in flexural strength results with in length of fiber with density 2kg/m3

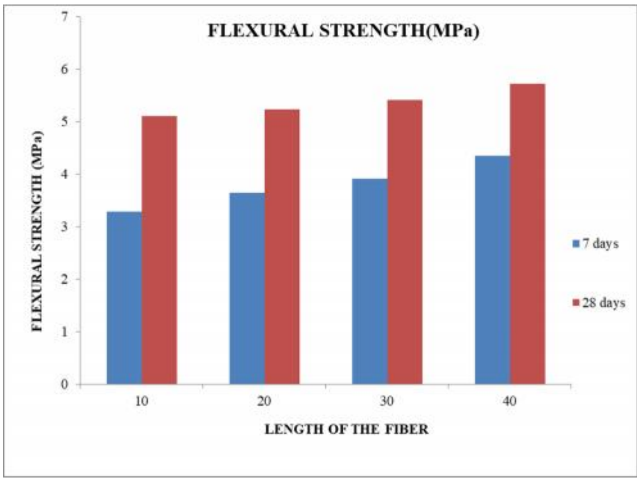

Fig shows the variation in flexural strength results with in length of fiber with density 4kg/m3

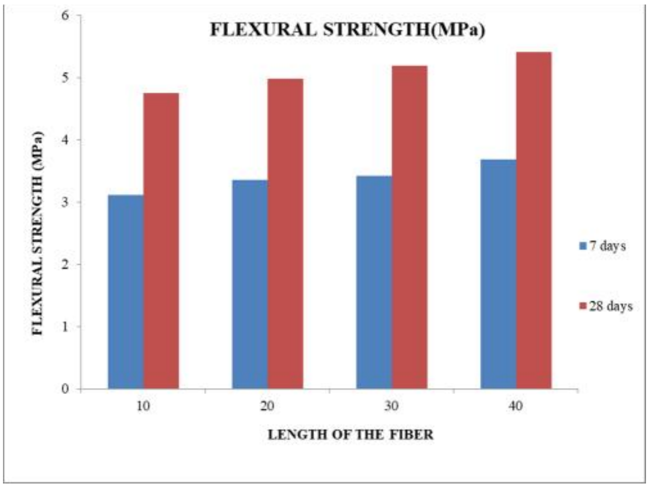

Fig shows the variation in flexural strength results with in length of fiber with density 6kg/m3

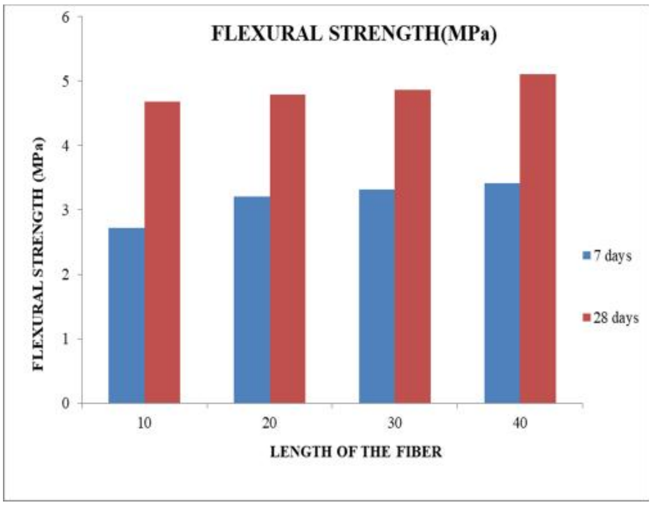

Fig shows the variation in flexural strength results with in length of fiber with density 8kg/m3

With increasing in length of the fiber and with the density there is an increase in flexural strength and it is observed that at 30mm length of polypropylene fiber addition and 4 kg/m3 density of fibre. However the further increase of length and density yield better comparative results with nominal concrete.

5.3 SPLIT TENSILE STRENGTH OF FIBER REINFORCED CONCRETE

Split tensile test is also used to determine the tensile stress in concrete; this method is also called as Brazilin test. In this we place the cylindrical specimen of size 300 mm height 150 mm diameter is placed in horizontal between the loading surfaces of compression test machine and load is applied until the failure of the specimen along the vertical diameter. This test is performed as per IS: 5816 code.

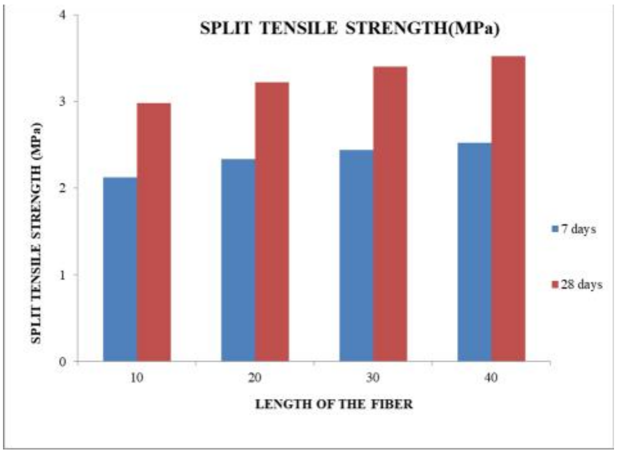

Fig shows the variation in split tensile strength results with inlength of fiber with density 2kg/m3

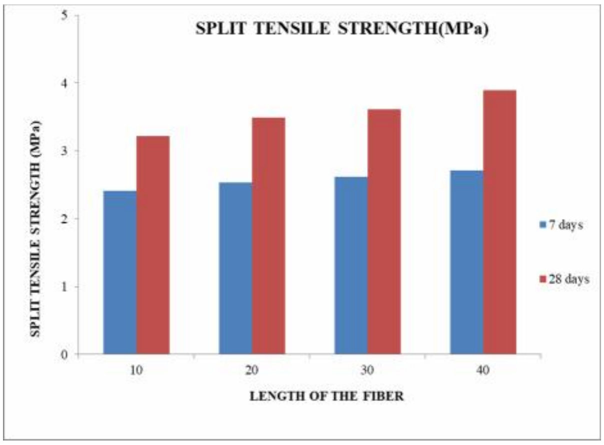

Fig shows the variation in split tensile strength results with in length of fiber with density 4kg/m^3

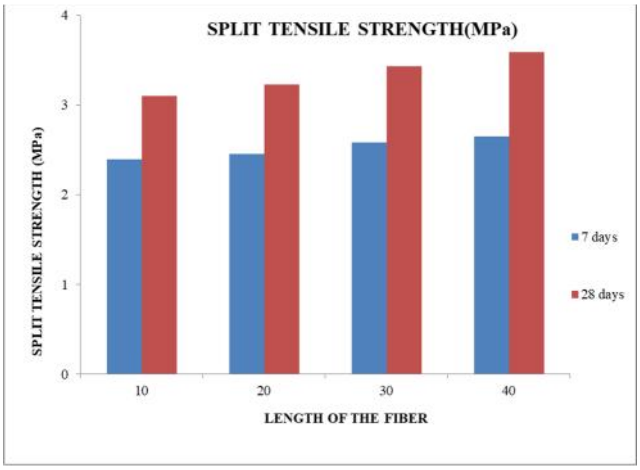

Fig shows the variation in split tensile strength results with in length of fiber with density 6kg/m3

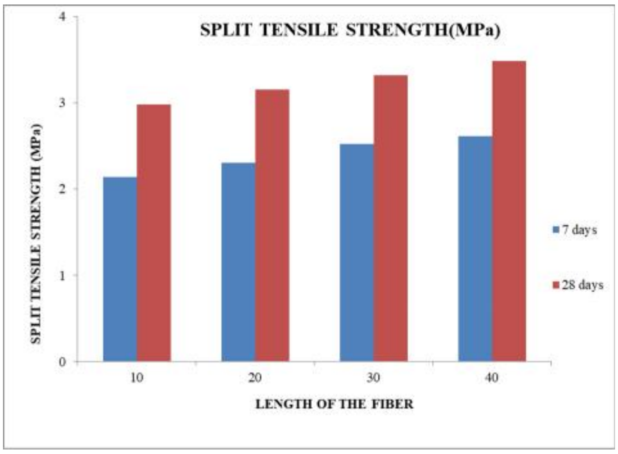

Fig shows the variation in split tensile strength results with in length of fiber with density 8kg/m3

With increasing in length of the fiber and with the density there is an increase in split tensile strength and it is observed that at 30mm length of polypropylene fiber addition and 4 kg/m3 density of fibre. However the further increase of length and density yield better comparative results with nominal concrete.

VI. CONCLUSIONS

From the present study the following conclusions can be drawn

- The workability of concrete reduces as the fiber length and fiber amount increase. Low slumps were recorded when a large amount (8 kg/m3) of fiber was added.
- Clumping or balling of fibers was visible in all mixes when the high fiber amount of 8 kg/m3 was added. This clumping of fibers became a severe problem when the fiber length was increased to 40 mm.
- Addition of fibers to concrete improves mechanical properties like compressive strength and flexural strength etc. of the mix.
- There was an optimum percentage of each type of fiber in terms of length and densities, provided maximum improvement in mechanical properties of the concrete resulting in polypropylene fibre reinforced concrete.
- The low fiber amount of 2 kg/m3 did show some improvement in both the compressive strength and flexural and tensile strengths. However, the improvements are not definite.
- However, the largest increase in the compressive strength was found at the small fiber amount (4 kg/m3) for the 30-mm-long fibers.
- This study found that the optimum length and optimum amount of polypropylene fiber are 30 mm and 4 kg/m3 if increases in compressive Strength, split tensile strength and flexural strength are required.
- In polypropylene fibre if the amount and length of polypropylene fibre are chosen to be 30 mm and 4 kg/m3 respectively. However the further increase of length and density yield better comparative results with nominal concrete.

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