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A Review Study of Strength Properties of Hybrid Fiber Reinforced Concrete Using PPC

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Abstract - *In recent year's fibers have been widely utilized for strengthening of concrete structures due to its high tensile and compressive properties. In this paper, an introduction is given on the properties of different fibers used for structural applications. Moreover, a brief review of the papers on different fibers and the use of natural and synthetic fibers on improvement in properties of concrete is also highlighted. This paper shall focus on strength properties of hybrid fiber Sisal/polypropylene reinforced concrete.*

Key Words: *polypropylene fiber, sisal fiber, Mechanical properties of concrete*.

1. INTRODUCTION

Concrete is made of a mixture of cement, sand, and aggregates, where aggregate is filler material like sand, stone chips, gravels etc. Concrete can be modified into any shape as it hardens to give a stable structure. Concrete is economical and can be easily manufactured. Concrete is weak in tension and good in compressive strength. To increase it's tensile as well as compressive properties different types of fibers are used. i.e. Natural fiber and synthetic fibers. The addition of fibers and pozzolanic materials improve the mechanical properties of concrete such as flexural, compressive, tensile strength besides creep behavior, impact resistance and toughness. Maximum studies have shown the use of OPC cement. The effect of fibers in this composite lead to an increase in the tension and impact strength of the material. The addition of fibers improves the mechanical properties of concrete.

1.1 Sisal Fiber

Sisal Fiber is one of the most widely used **natural fiber** and is very easily cultivated. It is obtained from sisal plant. the plant, known formally as Agave sisalana. It is very easily cultivated. Each leaf contains a number of long, straight fibers which can be removed in a process known as decortications.

1.2 Properties of Sisal Fibre

Sisal fibers are obtained from the outer leaf skin, removing the inner pulp.

- It is Recyclable.
- Sisal fibers are Anti-static, does not attract or trap dust particles and do not absorb moisture or water easily.
- It displays great sound and impact absorbing properties.

1.3 Sisal Fiber Reinforced Concrete

Studies of sisal fiber reinforced concrete started in Sweden in 1971 by Nilsson (1975). Cut fibers with a length of 10- 30 mm were cast into beams and an improvement in the tensile strength in bending was observed for fiber reinforced specimens. By the addition of sisal fiber in concrete higher strength is achieved. The effect of sisal fiber reduces the plastic shrinkage of green concrete.

1.4 Polypropylene Fiber

Polypropylene fiber also known as polypropylene is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textile (e.g., ropes and carpets), stationary plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components etc. An addition of polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases, and acids. Polypropylene has a relatively slippery "low energy surface" which means that many common types of glue will not form adequate joints.

1.5 Polypropylene Fiber Reinforced Concrete

The capability of durable structure to resist weathering action, chemical attack, abrasion and other degradation processes during its service life with the minimal maintenance is equally important as the capacity of a structure to resist loads applied on it. Although concrete offers many advantages regarding mechanical characteristics and economic aspects of the construction, the brittle behavior of the material remains a larger handicap for the seismic and other applications where flexible behavior is essentially required, however, the development of polypropylene fiber-reinforced concrete (PFRC) has provided a technical basis for improving these deficiencies. Polypropylene (PP) fibers improve various properties of concrete in fresh and hardened state such as compressive, flexural strength, workability, bond strength, fracture properties, creep strain, impact and chloride penetration.

1.6 Properties Of Polypropylene Fiber Reinforced Concrete

- Polypropylene fibers are used to resist shrinkage and cracking. Polypropylene fibers are commercially utilized low volume fractions to control plastic shrinkage of concrete.

- These fibers are not expected to increase the large strength of concrete, but to improve its ductility and toughness and impact resistance.
- These fibers have good ductility, fineness, and dispersion so they can restrain the plastic cracks in concrete.
- Workability decreases with increase in the percentage of sisal fiber.
- The Flexure strength of concrete increases with the optimum percentage of sisal fiber as compared to the strength of conventional concrete.

2. LITERATURE SURVEY

This part presents a survey of the literature to draw out the foundation of the study, to be carried out in the present work. Early reviews on the utilization of natural and glass fibers in concrete have shown positive results. From various studies, it has been found that artificial fiber is environment-friendly, non-economical, and derived from non-renewable sources which in turn affect the environment. Though properties of artificial fibers are better than natural fibers natural fibers being environment-friendly, cheap, easily available in local markets, low-cost production, derived from natural materials which are renewable sources.

1. Athiappan. K et al [1]., In his paper "Experimental Study on Flexural Behavior of Sisal Fiber in Reinforced Concrete Beam", published in International Journal of Engineering Research &Technology, 2014 the study carried out Research work on mechanical properties like compressive and split tensile strength. Dosage of fiber content used was 0.1%, 0.2%, 0.3%, 0.4% and 0.5% by volume of cement with optimum length 35mm and cement used was OPC 53 grade. Super plasticizer was used to increase the workability of concrete. M40 grade of concrete was prepared. Various results are found to increase the dosage of fiber.

- Workability decreases with increase in the percentage of sisal fiber.
- The Flexure strength of concrete increases with the optimum percentage of sisal fiber as compared to the strength of conventional concrete.

By the use of a plasticizer, workability increased in terms of slump increased. In this study, It was concluded that optimum dosage of sisal fiber 0.3%. It gave good results

2. M. Aruna [2], In her paper " Mechanical Behavior of Sisal Fiber Reinforced Cement Composites", published in International Journal of Mechanical, Aerospace, Industrial, Techtronic and Manufacturing Engineering, 2014 in this study the hardness and tensile strength of sisal reinforced cement composites with 6, 12, 18 and 24% by weight of cement had been used. The study shows improvement in tensile strength. With the increase in fiber volume fraction and length reduces the workability of the mix. The high energy absorption capacity of the composite gave increased toughness and tension values.

3. Apoorva Chandak et al. [3], In his paper "Analysis of Self Compacting Concrete Using Hybrid Fibers", published in International Journal of Trend in Research and Development, 2016 carried out a comparison between the conventional concrete and self-compacting fiber reinforced concrete in which sisal fiber and hybrid fiber of banana are used. The aim of this study creating a self-compacting concrete increasing coarse aggregate content and increasing the mechanical properties like tensile, flexural, and compressive strength. Compaction factor and slump values were also checked. M30 grade of concrete was prepared. PPC cement was used hybrid fiber kept 0.5% of the cement, water cement ratio kept as 0.45 and admixture (sikacim) as1%. SFRC gives lower slump which means lower workability. So, in order to increase workability plasticizer was used. The addition of fiber in concrete to increase compressive and flexure strength.

4. Abdul Rahuman et al [4]., In his paper "Study on properties of Sisal Fiber Reinforced Concrete with different mix proportions and different percentage of Fiber Addition", published in International Journal of Research in Engineering and Technology, 2015 tried to assess workability and strength properties of sisal fiber reinforced composite using OPC cement. The Super plasticizer was added at 0.2% by weight of the cement. Percentage of sisal fiber was kept 0.5, 1 and 1.5% by the weight of cement in different concrete mixes. The study has concluded that there was an increase in slump value 4mm to 53mm after addition of super plasticizer. Compressive strength increases by 50.53% after addition of 1.5% fiber for M20 mix design, where as the increase was up to 52.51% for the same percentage addition of fiber in M25. It was found that 1.5% addition of fiber will give better strength test results.

5. P. Sathish et al. [5], In this paper "Experimental Study on Sisal Fiber reinforced concrete with partial replacement of cement by Ground Granulated Blast furnace Slag", published in International Journal of Science and Research, 2016 carried out research on partial replacement of OPC cement with different percentage of slag and studying different mechanical properties. The material used was OPC cement of grade 53, slag was added at 10%, 20% & 30% by weight of cement and 1% of sisal fiber was added by weight of cement. M30 grade of concrete was prepared. The rate of increase of compressive strength of GGBS concrete was found to be slow in the initial stage. As the curing period increased strength also increased. With the increase in GGBS, the compressive, tensile and flexure strength increased but decreased at the dose of 30% replacement of cement by GGBS. Optimum dosage for partial replacement of cement by 20% ground granulated blast furnace slag and 1% of sisal fiber gave best results in enhancing mechanical properties of concrete.

6. A. M. Alhozaimy et al. [6], In his paper "Mechanical Properties of Polypropylene Fiber Reinforced Concrete and the effect of Pozzolanic Materials", published in Cement and Concrete Composites, 1995 studied the effect of collated fibrillated polypropylene fibers on compressive and flexural strength. The impact resistance of Polypropylene fiber was also assessed. The material used was Portland cement type I, coarse aggregate, fine aggregate, water and collated fibrillated polypropylene fibers. In this study, Polypropylene fiber has no significant effect on the compressive strength and toughness of conventional concrete. However, increase in

the compressive strength by 17% & 23% of plain and fibrous concrete. Polypropylene fiber was added at 0.1, 0.2 & 0.3%. Polypropylene fiber has no effects on flexural strength but the flexural toughness increased on adding Polypropylene fiber.

7. Milind V. Mohod. [7], In his paper "Performance of Polypropylene Fiber Reinforced Concrete", published in Journal of mechanical and civil Engineering, 2015 studied the effect of the addition of various properties of Polypropylene fibers on the properties of high strength concrete M30 and M40 mixes. Effect on properties such as compressive, tensile, and flexural strength under different curing condition was investigated. Polypropylene fiber was added at replacement percentages of 0.5%, 1%, 1.5% & 2% by weight of PPC cement. The addition of Polypropylene fiber in a concrete increased the compressive, tensile and flexural strength, but a decrease in workability was observed when fiber content was increased. Better results were obtained at 0.5% of Polypropylene fiber.

8. Kolli.Ramujee [8], In his paper "Strength Properties of Polypropylene Fiber Reinforced Concrete", published in International Journal of Innovative Research in Science, 2013 carried out the strength properties of Polypropylene fiber reinforced concrete. In this study different fiber dosage varies from 0.5%, 1%, 1.5% and 2.0% were used by weight of cement. Better results were obtained at 1.5% of polypropylene fibers. The compressive and split tensile strength were increased with increase in a volume ratio of polypropylene fibers with reference to the conventional concrete.

2.1 Physical properties of Sisal and Polypropylene fiber

Physical properties of a fiber play vital role in determining the overall strength of fiber reinforced concrete properties such as tensile strength, Young's modulus and elongation at break are some of the properties which should be taken into consideration while selecting the fiber. Fiber with better physical properties performs well in concrete. Comparison of Physical Properties of Sisal and Polypropylene fiber has been shown in Table 1.

Table-1: Physical properties of Sisal and Polypropylene fiber

PHYSICAL PROPERTIES	SISAL FIBER	POLYPROPYLENE FIBER
Tensile Strength (MPa)	610-720	500-700kg/cm^2
Young's modulus (GPa)	9-24	3.6-6.8
Elongation at Break (%)	2-3	21
Density (g/cm^3)	1.34	0.91g/cm^3

2.2 Comparison of properties of Sisal and Polypropylene Fiber

The investigation has been done in many countries on different mechanical properties, physical performance and durability of cement based matrices reinforced with the natural fiber like sisal, coconut, jute etc. These fibers are easily available and economical in cost. Fiber length used in concrete has been 10-40mm which is good for performance. The tensile strength of the fibers is developed by the molecular orientation obtained during the extrusion process. The draw ratio (final length/initial length), a measure of the extension applied to the fiber during the making of polypropylene fibers is generally about eight. It is chemically inert and any chemical that can harm these fibers will probably be much more detrimental to the concrete matrix. Comparison of properties of sisal and Polypropylene fiber has been shown in Table 2.

Table-2: Comparison of properties of Sisal and Polypropylene fiber.

SISAL FIBER	POLYPROPYLENE FIBER
Sisal fiber is biodegradable organic fiber.	Polypropylene fiber is non biodegradable fiber.
Sisal fibers enhance compressive, tensile and flexure strength.	Polypropylene fibers enhance flexural, tensile and impact strength.
Sisal fiber is not chemically inert.	Polypropylene fiber is chemically inert
Sisal fiber can be used in various lengths (10-40mm).	Polypropylene fiber can be used as 6mm for plastering and 12mm for concrete.

2.3 Effect of Sisal and Polypropylene fiber reinforced concrete

Based on the detailed survey of various studies on Sisal and Polypropylene fiber reinforced concrete, it was reserved that the 1) Workability decreases with the addition of Sisal and Polypropylene fiber. 2) Sisal fiber has a Positive effect on Compressive strength whereas no considerable effect on Compressive strength has been seen on using Polypropylene fiber and 3) Flexural strength increases with the use of Sisal and Polypropylene fiber. Effects of Polypropylene and Sisal fiber on the properties of concrete have been summarized in Table 3.

Table -3: Effect of Sisal and Polypropylene fiber reinforced concrete on the properties of fresh and hardened concrete.

PROPERTIES	SISAL FIBER REINFORCED CONCRETE	POLYPROPYLENE FIBER REINFORCED CONCRETE
Compressive strength	Results obtained from 7 & 28 days found that compressive strength increased at an optimum dose of sisal fiber. The fiber content used in various studies are (0.5, 1, 1.5 & 2%). The optimum dose of fiber content in which good results are obtained has been 1.5%. The compressive strength increased up to this percentage and decreased if the fiber content exceeds 1.5%.	No considerable effect on compressive strength but increases toughness, ductility & impact resistance. Polypropylene fiber has low volume fractions but the effect of fiber in concrete is small. Fiber content was used at (0-2%). Polypropylene fiber had less effect on compressive strength. The fiber length used in different studies (6-12mm).
Flexure Strength	Sisal fiber gave good results in flexural strength. Flexural strength increased with the optimum percentage of sisal fiber as compared to conventional concrete. The optimum percentages of sisal fiber which give good results were 1.5%.	Flexure strength was increased at the optimum percentage of sisal fiber. The optimum percentage of sisal fiber was 0.5%. At this percentage, polypropylene fibers gave best results in flexural strength.
Split Tensile Strength	Tensile strength increases at sufficient dose of sisal fiber. The optimum dose of sisal fiber was 1-1.5%.	Tensile strength increases at sufficient dose of polypropylene fiber. Tensile strength was obtained at 0.5% addition of polypropylene fiber.
Workability	Workability decreases with increase in the percentage of sisal fiber.	At addition of Polypropylene fiber workability decreases as compared to conventional concrete. With the increase in the percentage of fiber content workability continuously decreases.

3. CONCLUSIONS

The tensile and flexural strength of concrete increased with the addition of Sisal and Polypropylene fiber. The addition of Sisal fiber has enhanced the compressive strength properties, whereas polypropylene fiber showed the negligible effect on compressive strength. Both Sisal and Polypropylene fiber in concrete mix lead to decrease in the slump value, thus, having a negative impact on consistency. The optimum dosage of Sisal fiber to be used in concrete mix ranged from 1-1.5%, whereas Polypropylene fiber the optimum dosage ranged from 0-0.5%.

REFERENCES

[1] K. Athiappan and S. Vijaychandrakanth, "Experimental Study on Flexural Behavior of Sisal," Int. J. Eng. Res. Technol., vol. 3, no. 5, pp. 1500–1505, 2014.

[2] M. Aruna, "Mechanical Behaviour of Sisal Fibre Reinforced Cement Composites," World Acad. Sci. Eng., vol. 8, no. 4, pp. 650–653, 2014.

[3] A. Chandak, N. Agrawal, D. Thakur, and A. Titiksh, "Analysis of Self Compacting Concrete Using Hybrid Fibres," Int. J. Trend Res. Dev., vol. 3, no. 2, pp. 641–645, 2016.

[4] A. Rahuman and S. Yeshika, "Study on Properties of Sisal Fiber Reinforced Concrete With Different Mix Proportions and Different Percentage of Fiber Addition," Int. J. Res. Eng. Technol., pp. 2319–2322, 2015.

5] P. Sathish and V. Murugesh, "Experimental Study on Sisal Fibre Reinforced concrete With Partial Replacement of Cement by Ground Granulated Blast furnace Slag," vol. 5, no. 6, pp. 2013–2016, 2016.

[6] A. M. Alhozaimy, P. Soroushian, and F. Mirza, "Mechanical properties of polypropylene fiber reinforced concrete and the effects of pozzolanic materials," Cem. Concur. Compos., vol. 18, no. 2, pp. 85–92, 1996.

[7] Milind V. Mohod, "Performance of Polypropylene Fibre Reinforced Concrete\n," IOSR J. Mech. Civ. Eng., vol. 12, no. 1, pp. 28–36, 2015.

[8] Z. Bayasi and J. Zeng, "Properties of polypropylene fiber reinforced concrete," Mater. J., vol. 90, no. 6, pp. 605–610, 1993.