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Distinct Fibers for Concrete Usage: Review

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ABSTRACT

The "Infrastructure/Construction Sector" has recently emerged as a significant driver of the country's rapid development. It is general knowledge that "Concrete Building" is the most effective and durable construction method owing to the fact that it can be retrofitted and recover strength. As a result, many investigations into concrete and its constituent parts have been conducted in order to add value. Concrete, a common building material, is made by mixing a range of ingredients with varying properties and structures to make a paste, which is then allowed to cure for a defined period of time before taking on the shape that is known as hardened concrete. With the increased utilization of valuable waste in eco-friendly concrete creation, environmental pollution has been reduced, while the strength and durability of the resulting material have been improved. Pozzolana and fiber waste have been the subject of several studies throughout the years. There has been a review in this publication of all previous research on reinforced fiber concrete. Fiber Reinforced Concrete is a term used to describe concrete that has been reinforced with fibers of varying properties and orientations. Justification is given in the study for the addition of fibers such as natural fiber, metallic fiber and organic fiber into concrete mix.

Keywords: *Concrete Construction; Retrofitting; Fiber; Fiber Reinforced Concrete; Durability.*

1.0 Introduction

Concrete, which is now the most widely used building material in the field of civil engineering construction, has room for development in terms of both the strength and the durability of its properties. Concrete is the name given to a material that does not exhibit ductile behaviour and is a collection of materials that each have their own unique qualities. It can be acknowledged that concrete is strong in compression phase in comparison to its tension phase (weak phase), and in order to improve the tensile property of concrete reinforcing steel bars are incorporated. This is because the mode of failure determines which phase the concrete is in when it fails. These integrated reinforcements have a lower propensity to stop fractures that form as a result of an increase in stress. Therefore, in order to improve the performance of concrete and make it more desirable and acceptable, it is necessary to strengthen concrete and make it capable of preventing cracking to a larger degree or at a level of higher pressures. As a result, the employment of fibre in the modern building of concrete is regarded as the method that is both the best and the most acceptable. Fiber Reinforced Concrete is a term used to describe concrete that contains fibres that are both randomly and evenly aligned (FRP). The preceding research on fibres serves as a foundation for

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this study, which is why it is a requirement. Fibers have been used as a form of reinforcement in concrete for a number of decades now due to the fact that in harsh environments, they have a higher level of durability than other materials, and their homogeneity in concrete increases the cracking strength of concrete that is reinforced with fibre (Sam, 2016). Natural fibres, metallic fibres, and mineral fibres are the three categories into which fibres that are utilised to improve the properties of concrete may be placed. In a more general sense, we may categorise them as steel fibres, glass fibres, coir fibres, jute fibres, wool fibres, wood fibres, polypropylene fibres, asbestos fibres, and many more types of fibres.

Figure 1: Fiber Reinforced Concrete

2.0 Material Reviewed

2.1 Metallic fiber

Figure 2: Carbon Steel Fiber

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Materials such as metal and plastic are used in the production of fibres like steel fibre, which may be further subdivided into carbon steel fibre and stainless steel fibre. Metal with a coating. Using steel fibre in traditional concrete is an easy way to get rid of problems like spalling damage, shrinkage-induced cracking, and corrosion. These problems may be prevented in the first place by using steel fibre (Hover, Eddie, & Psomas, 2017). When compared to the usage of steel rebar in concrete, the use of steel fibre is seen as being superior in terms of durability, cost effectiveness, and efficiency of time spent in harsh environmental circumstances (Hover, Eddie, & Psomas, 2017). In prior studies, it was shown that the load-carrying capability of ground slabs increased dramatically when between 0 and 30 kg/m3 of steel wire was inserted into the slabs. The slabs' strengths were between 30 and 40 MPa..

Figure 3: Chopped Carbon Fiber

Figure 4: Carbon-Structural Fiber

Figure 5: Chopped Glass Fiber

2.2 Mineral fiber

Mineral-Fiber is the name given to fibres that may be readily removed using an electro-thermal process (Larisa, Solbon, & Sergei, 2016). Glass Fiber and asbestos Fiber. It was discovered that the addition of glass fibre to concrete causes a significant reduction in ductility when the material is subjected to the natural conditions and elements of the environment (Shah, Ludirdja, Daniel, & Mobasher, 1988).

2.3 Natural fiber

The phrase "natural fibre" refers to a kind of fibre that has a high tensile strength but a low modulus of elasticity (TORGAL & JALALI, 2011). In addition to providing a reinforcement for concrete, natural fibres provide a number of other benefits, including the fact that they are renewable, inexpensive, nonabrasive, and do not have any adverse effects on health and safety throughout the processing and handling processes (Reis, 2006). According to (Ramakrishna & Sundararajan, 2005), the potential of Natural Fiber as reinforcement made it possible for the concrete to overcome the inert shortcomings caused by the cementing ingredient.

The following are the several categories of natural fibres:

Figure 6: Coir Fiber

Doi: 10.51976/jfsa.412107

Figure 7: Wood Fiber

Figure 8: Sisal Fiber

Figure 9: Jute Fiber

3.0 Literature Review

Reference	Fiber Category	Reviewed Conclusion
(Al-Oraimi & Seibi, 1995)	Natural Fiber	The investigation was carried out on concrete containing varying amounts of glass fibre and natural fiber. The author arrived at the conclusion that the incorporation of fibre led to an improvement in both the impact resistance and the toughness of the concrete. The observed results were such that the compressive strength of concrete with glass and natural fibre incorporation was relatively less as compared to conventional concrete, but both results were fair enough that they were indicating the importance of Fiber incorporation in concrete. The author explained in the introduction that thinking about high-strength concrete came first in the investigation before anything else was done. There is a possibility that the presence of fibre in normal concrete will not improve the pre-cracking behaviour of the concrete but will significantly improve the post-cracking behavior.
(Aziz, Paramasivam, & Lee, 1981)	Natural Fiber	Although adding fibre to concrete makes the concrete stronger, there are specific aspects that alter the qualities of the fibre and, in turn, how the fibre affects the concrete. The author comes to the conclusion in his work that some of the parameters, including geometry, form surface, and kind of Fiber, as well as the property, design, mixing, putting, casting, and curing of entire concrete, all play a role. The inclusion of fibre into concrete results in a reduction in the fresh concrete's workability. This reduction is related to the surface area of the fibre as well as the characteristics of the fibre. It has been observed that natural fibre is used in pre-cast goods in order to lessen the effect of unintentional damages. This is done in order to meet the requirements of the American National Standards Institute.
(SETHUNARAYAN AN, CHOCKALINGAM, & RAMANATHAN, 1989)	Natural Fiber	The usage of NFRC (Natural Fiber Reinforced Concrete), which is suggested by many researchers due to the ease with which natural fibres may be obtained and the fact that many of these natural fibres can be found locally in underdeveloped nations, is recommended. There have only been a few studies that have documented the long-term effects of fibre in concrete beams, and from those studies, the researchers came to the conclusion that an increase in the amount of cycle loads led to an increase in the lifetime of such beams. In their most basic form, natural fibres may be divided into two categories: those of vegetable and animal origin. The author came to the conclusion that the deterioration of fibre over time would cause a decrease in the strength of the composite. In order to improve the strength of the material throughout its service life and to increase its durability, pozzolans such as rice-husk ash and silica fumes should be used in place of cement in Fiber Reinforced concrete.
(Song & Hwang, 2004)	Steel Fiber	The author conducted research on the performance of high-strength concrete that included the addition of fibre. The hooked-end steel fibre was employed in the composite in the following percentage breakdown: 0.5 percent, 1 percent, 1.5 percent, and 2 percent. There was an increase in strength caused by the incorporation of fibre, and the maximum value was confirmed to be at 1.5 percent fraction. On the other hand, there was a slight drop in strength at 2 percent fraction, but it was still greater when compared to non-fibrous concrete. The research at last concludes that there was an increase in strength caused by the incorporation of fibre.

(Nataraja, Dhang, & Gupta, 1999)	Steel Fiber	Because of an increase in the production of steel fibre across a variety of sectors, there has been an uptick in the usage of steel fibre in concrete over the course of the last quarter century. At this time, steel fibres are most often used in concrete constructions including highways, airport pavements, hydraulic systems, and tunnel linings, amongst many other applications. According to the findings of a number of studies conducted in the past, the addition of steel fibre to concrete improves a variety of its properties, including its resistance to cracking, fatigue strength, impact strength, toughness, and sapling. Researchers also found that the addition of steel fibre increased sapling. The following observation was made about the experimental investigation: The properties of concrete, such as its toughness and compressive strength, were significantly improved, and the improvement in both was directly related to the reinforcing index.
(Banthia & Sappakittipakorn, 2007)	Steel Fiber	During the course of this study, experimental and analytical work was carried out using steel fibres of several sizes, such as 0.8 mm, 0.45 mm, and 0.4 mm. The design called for M-335 Grade concrete to be used. It was determined that the value of compressive strength was greater at increasing proportions of big diameter wire when there was a greater incorporation of steel. The trend of steel incorporation was 0.25 percent, 0.50 percent, and 0.75 percent across all three diameters.
(Ali, Liu, Sou, & Chouw, 2012)	Coir Fiber	The author mentioned in his abstract that among all the natural fibres, coir fibre have the highest toughness and should especially be used as reinforcement to maintain low cost of concrete, and the preferred region is region with tropical earthquakes. In addition, the author mentioned that the preferred region is region with tropical earthquakes. The amount of fibre that was mixed in with the concrete ranged from one percent to two percent, three percent to five percent of the total mass of the cement. According to him, the coir fibre that is available on the market may be purchased in one of three different forms, which he identifies as long fibre (bristle), relatively short fibre (mattress), and mixed fibres (decorated fibers). Taking into mind the findings of a physical evaluation of the study, it was hypothesised that the flexural toughness of CFRC (Coir Fiber Reinforced Concrete) rises significantly for all estimated proportions.
(Asasutjarit, Hirunlabh, Khedari, Charoenvai, Zeghmati, & Shin, 2007)	Coir Fiber	According to the findings of the study, the name "coir" refers to the fibre that is extracted from the thick mesocarp of coconuts. The boiling and rinsing of the fibre produces a cementing agent called lignin, and this lignin is what binds the cellulose fibres together. Lignin is found in fibres and serves as a cementing agent. Coir fibre is made more durable and rigid by the processes of boiling and washing. The purpose of this study is to investigate the possibility of producing lightweight cement board that contains coir made from coconut husks. In the course of this study, the fibre is subjected to a 24-hour boil followed by a washing in water with a pH of 7. After conducting the experiments and analysing the results, it was determined that the mechanical and physical properties of coir fibre could be improved by subjecting it to pretreatments such as washing and boiling.
(Silva, Mobasher, & Filho, 2009)	Sisal Fiber	Sisal is a fibre that is harvested from the sisal plant, and the sisal fibre that was harvested for this study came from a sisal plant that was located in the city of Valente in Brazil. The leaf of the sisal plant is made up of three distinct fibres that are called structural fibre, xylem fibre, and arch fibre, as seen in the image below. Because of this, the leaf is said to have a functionally graded composite structure.

		When sisal fibre was added to regular concrete, the resulting composite became visible. High modulus, and when subjected to loads of both bending and tension, it exhibits multiple fracture behaviour. The study also came to the conclusion that the integration of sisal fibre led to an improvement in the energy absorption capacity and mechanical performance of concrete, and that it acted actively by bridging and arresting fractures in the tension phase of the material.
(Silva, Filho, Filho, & Fairbairn, 2010)	Sisal Fiber	Sisal fibre was collected from the sisal plant using a semi-automatic decorticator in this study. Sisal leaves weighed 100 kilogrammes and yielded 3.5 kilogrammes of sisal fibre. Mid-span deflection occurred under bending of PC composite at roughly 13mm and CH free at 20mm, respectively, according to the author of the study on both materials. For the PC composite and CH-free composite, the Modulus of Rupture was measured at 21Mpa and 23Mpa, respectively.
(Kundu, Chakraborty, Roy, Adhikari, & Majumder, 2012)	Jute Fiber	The study centred on developing jute-reinforced concrete by chemically changing existing concrete, with the goal of using the material in NP3 concrete pipe construction. In order to chemically alter jute fibre, the author made use of two different chemicals, namely NaOH solution and carboxylated styrene butadiene copolymer emulsion. Following the application of these chemicals to the jute fibre, the fibre was baked at 105 degrees Celsius in a laboratory oven for twenty-four hours. In the article's conclusion, the author explained the point of the chemical modification, and he made the observation that making the fibre surface hydrophobic is necessary in order to ensure that the fibres are evenly dispersed throughout the concrete mixture. Tannin, which is a water retarder, is added to the concrete mix. It was noticed that there was a considerable increase in the strength of the concrete matrix after tannin was added. Jute, which is a fibre, needs more water than other materials.
(Zhou, Ghaffar, Dong, Oladiran, & Fan, 2013)	Jute Fiber	The experimental study was done comparing JFR Cementitious Composite, blended with GGBS and PFA (Pulverized Fly Ash), and the observation that was made was that with the addition of GGBS to JFRCC exhibited greater Compressive, Flexural, and Split tensile as compared to JFRCC with Pulverized Fly Ash. It was also noted that toughness, CSIF (Critical stress intensity factor), and CSER (Critical Strain Energy Rate) were greater for JFRCC with GGBS as compared to JFRCC with PFA and Plain concrete with Ground Granulated Furnace Slag. When compared to GGBS concrete matrix, the degradation factor of jute fibre was lower in PFA concrete matrix. This was the case because PFA concrete matrix contained less water.
(Dharan & Lal, 2016)	Polypropylene Fiber	The study investigated the possibility of including various diameters of polypropylene fibre into the concrete mixture. It is a form of synthetic fibre known as polypropylene fibre, and it is a waste product that is produced by the textile industry. After conducting the research on M30 and M40 grade concrete, it was discovered that the slump value has a tendency to decrease with an increase in the fibre content, whereas both CS and STS achieved a higher value at a fibre incorporation rate of 1.5 percent. The research was carried out on both grades.

4.0 Conclusion

With the knowledge of a wide variety of fibres, their characteristics, and the influence that they have on concrete composite, researchers have spent a significant amount of time and effort over the last many years looking for an appropriate fibre addition. Some of them had arrived at a conclusion, while others were still in the process of doing so. This review study is the result of my reading a large number of research papers on the workings and effects of various fibres. I have compiled the results of those papers as well as their discussions. It is possible to draw the following conclusion regarding the utilisation of fibres in concrete: the incorporation of fibres into concrete has resulted in concrete that is more cost effective, durable, waste-utilizing, and material with higher strength in comparison to concrete that does not contain fibre. When compared to plain concrete, it was discovered that the inclusion of fibre, of any kind, increased the material's strength in all three dimensions (compressive, split-tensile, and flexural). With many of the benefits, including fibre into concrete indicates a drop in slump value, which means that more super plasticizer must be added in order to make the concrete pumpable. Therefore, we may at long last presume that the integration of fibre is successful.

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