International Journal of Civil Engineering Research.
ISSN 2278-3652 Volume 5, Number 3 (2014), pp. 285-288

http://www.ripublication.com/ijcer.htm

The Performance of Natural Fiber Reinforced Polymer Composites: Review

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Abstract

During the latest decades fiber reinforced polymer composites (FRPC) have been proved as very valuable material and suitable to be a new construction material. While nowadays, natural fibers have received much more attention from the structural engineers all over the world and utilization of natural fibers as reinforcement in polymer composite for making low cost construction materials has been growing very wide interest. Natural fibers have served many useful purposes but the demand for utilization of it as reinforcement in polymer matrix is growing in recent years. These natural fibers offer a number of advantages over traditional synthetic fibers because of their superior corrosion resistance, excellent thermo-mechanical properties and high strength to weight ratio. So, the natural fibers present many advantages as compared to synthetic fibers which make them attractive as reinforcement in composite materials. This paper will provide a review on the different properties of natural FRP composites for various applications in the civil infrastructure.

Keywords: Natural fiber, reinforced polymer composites, reinforcement, FRP.

1. Introduction

Fiber Reinforced polymer (FRP) composite materials have developed into economically and structurally viable construction materials for load bearing elements in building and bridges over the last two decades. The use of FRP composites in civil infrastructures can improve innovation, increase productivity, enhance performance and provide longer service lives, i.e. reduced life cycle cost [3].

Fiber reinforced polymer composites are increasingly being used in civil infrastructures for various applications ranging from reinforcing rods and tendons, wraps for seismic retrofits for columns and externally bonded reinforcement for strengthening of walls, beams and slabs, to all-composite bridge decks, and even hybrid (FRP composites in combinations with conventional materials) and all composite structural systems [8]. The use of FRP composites in strengthening solutions has became an efficient alternative to some of the existing traditional methods due to some advantages such as their features in terms of strength, lightness, corrosion resistance and ease of application.

Reduced own weight (table 1), high strength to specific weight ratio, electromagnetic transparency, increased resistance to corrosive agents along with other structural and technological aspects recommend these materials as suitable for structural applications [3]. While, advantages of natural fibers over traditional reinforcing materials such as glass fibers, carbon fibers, etc are their specific strength properties, easy availability, light weight, ease of separation, enhanced energy recovery, high toughness, non corrosive nature, low density, low cost, good thermal properties, reduced tool wear and less abrasion to processing equipment [1].

Table 1: Properties of fibers [7]

Properties	Glass	Jute	Coir	Sisal	Cotton
Density (g/cm3)	2.567	1.47	1.25	1.34	1.51
Tensile Strength (N/mm2)	2450	400-800	220	600-700	400
Stiffness (KN/mm2)	72	10-30	7	38	12
Elongation at break (%)	3	1.8	15-25	2-3	3-10
Moisture Absorption	-	12	10	11	8-25

Cellulosic fibers like sisal, coconut and bamboo in their natural form as well as several waste cellulosic products such as shell flour, wood flour and pulp have been used as reinforcing agents of different thermosetting and thermoplastic composite [4]. Composites are material that comprise of strong load carrying material (known as reinforcement) embedded in weaker material (known as matrix). Reinforcement provides strength and rigidity, helping to support structural load. The matrix or binder (organic or in-organic) maintains the position and orientation of the reinforcement. [2].

2. Literature Review

Okra Fiber reinforced polymer composite [6] is useful for the preparation of doors for house hold purposes with light weight. Tensile modulus of okra woven chemical treatment fiber reinforced polymer composite shown linear increase in its value with increase in percentage volume fraction of fiber.

A study [1] on the synthesis and mechanical properties of new series of green composites involving Hibiscus sabdariffa fiber as a reinforcing material in urea-formaldehyde (UF) resin was carried out. It revealed that mechanical properties such

as tensile strength, compressive strength and wear resistance of the UF resin increased to considerable extent when reinforced with fiber.

Groundnut shell properties shell particles reinforced polymer composite (GSPC) were prepared [5] with different weight percentage of particles in polymer matrix. It was observed that the addition of particles improved the mechanical properties up to some weight % and further decreased with increased particle content in the sample. The sample with 40 weight % of groundnut shell particle reinforcement has maximum modulus of rupture and impact strength. The impact test result showed that a steady increase in impact strength up to 50 weight % of filler addition.

Natural fibrous material used as reinforcement in the polymer composite [9] was pine needles collected from local resource. It had been observed that polymer composite obtained by particle reinforcement exhibit better mechanical properties as compared to short and long fiber reinforcement. Also it had been observed that particle reinforced composites exhibit higher resistance to swelling, moisture absorption and chemical resistance behavior due to the hydrophilic nature of the lignocellulosic fiber. Excellent results were obtained when the pine needles were used in 'particle form'.

Starch [7] is a natural polymer which possesses many unique properties. By combining the individual advantage of starch and synthetic polymers, starch based biodegradable polymers found to be potential due to the wide variety of available manufacturing process; each resulted in their own characteristic products. Development in the field of biopolymer materials is promising because of its environmental friendly behavior.

3. Conclusion

Natural polymer composites are more environmental friendly. Ongoing researchers found varieties of natural fibers, which improved the mechanical strength of polymer composite. Natural fibers resulted in lighter composite materials. Also, due to the low density of the natural fibers used in the composites can be regarded as a useful light weight engineering material. From the above discussions it is quite evident that newer composites using abundantly available natural fibers are on the horizon, this brought new trends in composite materials.

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