# A detailed review on Potential of Nano Filler &Natural Fibre Filled Polymer Green Composites

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***Abstract: Natural fibre-reinforced polymer composite materials are rapidly gaining popularity due to their industrial applications and fundamental research as they are renewable, low, completely or partially recyclable and biodegradable. To produce cost-effective polymer reinforced composites and to reduce the destruction of ecosystem, green composites using natural fibres which are partially biodegradable, for which plants such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, banana, wood etc., used from time immemorial as a rich source of lignocellulosic fibres, are more often applied as the reinforcement of composites. The increasing demand for greener and biodegradable materials leading to the satisfaction of society requires a compelling towards the advancement of nano-materials science. Nanocomposite shows considerable applications in different fields because of larger surface area, and greater aspect ratio, with fascinating properties over green composites. Hybrid bio-based composites that exploit the synergy between natural fibres in a nano-reinforced bio-based polymer can lead to improved properties along with maintaining environmental appeal. Applications of composites/nanocomposites offer new technology and business opportunities for several sectors, such as aerospace, automotive, electronics, biotechnology, building and construction industries (ceiling panelling, partition boards), packaging and consumer products, etc., industries. This review article presents information about diverse classes of green natural fibres, nanofiller, cellulosic fibre-based composite, nanocomposite, and natural fibre/nanofiller-based hybrid composite with specific concern to their applications. It will also provide summary of the emerging new aspects of nanotechnology for the development of hybrid composites for the sustainable and greener environment.***

**Index terms-** *Natural fibres, Nanofibres, Composites, Nano composites, Polymer*

## I. INTRODUCTION:

Natural fibre reinforced composites have been used during from earl ages and the demand and attention on natural fibre reinforced polymer composites and Nano-composites material has been growing day by day. Moreover, in early ancient Egypt, where straw and clay were mixed together to build walls. The interest in natural fibre reinforced polymer composite material is growing day by day. There is wide classification on natural fibres which are applied for reinforcement of composites. The most widely used natural fibres for the reinforcement fibre reinforced polymer composites materials include flax, hemp, jute, kenaf, and sisal due to their properties and easy availability as shown table 1.

Further process such that it provides environment suitability to that composite material along with the increased properties and this can be achieved by using post-consumer recycled plastic in place of virgin polymer matrices. As everything the polymer composites also has been classified into two classes, thermoplastics and thermosetting. Thermoplastic materials currently dominate as matrices for biofibres; the most commonly used thermoplastics for this purpose are polypropylene, polyethylene, polyvinyl chloride (PVC); while phenolic, epoxy and polyester resins are the most commonly used thermosetting matrices. Due to their classified properties they are in use for the application of transport systems such as in in railway coaches, automobile and aerospace sectors. They have adequate use of applications, building and construction and tiles as well as in packaging, sport and consumer products. The major problem arises with the composites is that their incorporation as hydrophilic natural fibres and hydrophilic thermoplastic matrices which leads to introduction of undesirable properties in resulting which leads to the destruction in desired properties and life of the materials. It is therefore necessary to alleviate this problem by various fibre-polymer interface modification to improve the adhesion between fibre and matrix, which results in an improvement of performance of the resulting composite. Considering the ecological aspects in material selection, replacing synthetic fibres with natural ones is only a first step. Restricting the emission of greenhouse effect caused by gases such as $CO_2$ into the atmosphere and an increasing awareness of the finiteness of fossil energy resources are paving the way for developing new materials that are entirely based on renewable resources.

## II. BIODEGRADABLE FIBRE RELATED LITERATURE SURVEY:

### *A. Begum K. and Islam studied natural fibre as a substitute for synthetic fibre in polymer composites.*

The unique advantages in natural fibre reinforced polymer composites is that they are renewable and recyclable over synthetic fibre reinforced polymer composites. The best and developmental idea which is also cost-effective is that the replacement of synthetic fibre reinforced composites by natural fibre reinforced composite which also been used for the improvement of tensile, flexural, mechanical and structural properties. The better improved properties can be achieved with epoxy resin which also provides excellent adhesion for the matrices between large number of materials and can be further increased by increasing the fibre content. The tensile strength and flexural strength are much higher as compared with glass fibre reinforced composites with increased fibre content. But the glass fibre reinforced composite with polypropylene matrix yields much higher tensile strength due to molecular mass distribution as compared to all-natural fibre reinforced composites. The light weight property along with other properties can be implemented in both thermoplastics and thermosets due to their various applications in automobile, industries, transportation, etc. As compared with natural fibres the polypropylene composite requires 20 times energy for production and emissions are also higher. So, the manufacturing of natural fibres will show superiority in regard to environmental performance over glass and synthetic fibre reinforced composites. Even though the natural fibres dhows major advantages there brings a major crisis such that the high moisture uptake which could break interface bonding between the matrices and the reinforcement polymer material.

### *B. Savita Dixit et al., investigated into Natural fibre reinforced polymer composite materials.*

The combination of two materials which brings about the constituent combined different material property. The major property of natural fibre reinforced polymer composites is that their biodegradability. As such to happen they have been treated with chemicals for the improvement of life-time and betterment of desired properties. The most commonly used chemical for treatment of composite materials is pyrolysis. Pyrolysis will contribute a layer, namely "charred layer", which will insulate lingo-cellulose from further thermal degradation. The layer of natural fibres is not even so during manufacturing Nano-clay is used to arrest cracks so that it transforms the composite's nature from brittle to ductile. The natural composites show poor property in wettability as they are compared with dry and wet conditions. Moreover, the plant wide which is a wide applicant subjected to chemical treatment before reinforcement for the betterment of properties. Composites which are chemical modified

is required to enhance its properties and workability. Thus, they are being implemented in many applications with some reinforcements.

*Reinforcing Fibres:* There is an increasing awareness of non-renewable resources becoming scarce and our inevitable dependence on renewable resources has increased. This century can be called the cellulosic century, because more renewable plant resources for products are being discovered. The living plants are renewable and sustainable from which the natural fibres are taken, but not the fibres themselves.
*Fibre Types:* There are six basic types of natural fibres. They are classified as follows: bast fibres (jute, flax, hemp, ramie, and kenaf), leaf fibres (abaca, sisal, and pineapple) seed fibres (Coir, cotton, and kapok), core fibres (kenaf, hemp, and jute), grass and reed fibres (wheat, corn, and rice) and all other types (wood and roots).

**Properties of Green fibres:**

| Fibre | Density g/cm$^3$ | Tensile Strength (MPa) | Elastic Modulus (MPa) | Elongation |
|---|---|---|---|---|
| Jute | 1.3 | 390-770 | 27 | 1.5 – 1.8 |
| Flax | 1.5 | 500-1500 | 28 | 2.6.3.3 |
| Hemp | 1.48 | 690 | 70 | 2-4 |
| Sisal | 1.5 | 510-635 | 9.5 - 22 | 1.5 |
| Cotton | 1.5 – 1.6 | 400 | 5.5 – 12.5 | 7.0 – 8.0 |
| Coir | 1.2 | 592 | 4.0 – 6.0 | 30 |
| Kenaf | 1.45 | 930 | 52 | 1.55 |

### *C. Kiran Rohit investigated into future aspect of natural fibre reinforced composite.*

There are many fibres which are in application for the reinforcement of composites but they cannot be readily used in application especially the manmade natural fibres which undergoes many modifications for the betterment of improved properties and materials. They are low cost, high compatibility, no-toxic and renewable; however, they have disadvantages such as high water and moisture absorbent, low durability, and low energy absorption. To overcome these disadvantages, they are chemically treated to improve specific properties for specific application besides overall mechanical and structural properties. Inclusion of wood flour and addition of fibres increase the tensile strength, flexural strength and bending modulus but this also increases the water absorption. Moreover, research programmes have been going on to increase the inadequate toughness and reduced long term stability so that they can be used in applications with load bearing capabilities under high temperature working capacity.

*D. M. R. Sanjay studied Applications of natural fibres and their composites.*

The production and cultivation on natural fs have an immense growth has they have not only used in the application of medical but also, they have been used for the engineering applications because of their improved light weight property they are used in conventional applications such as automobile parts. The abundance and cultivation of natural fibres have been upgraded to next level as hybrid natural composites as they can be used to overcome the thermal problems.

*E. Naheed Saba conducted a study titled "A Review on Potentiality of Nano Filler/Natural Fibre Filled Polymer Hybrid Composites"*

The natural fibre reinforced polymer composites show comparatively poor fibre/matrix interactions, water resistance, and relatively lower durability. The weaker interfacial or adhesion bonds between highly hydrophilic natural fibres and non-polar organophilic polymer matrix, leads to considerable decrease in the properties of the composites. Due to which lead to the development and research on Nano-composites which brings about advancement and improved desired properties on application. To overcome the crisis faced on natural fibre reinforced polymer composites nano-particles are used as fillers which are free from defects and they are used in the field of polymer composites applications. This provides better adhesion between the interfacial matrix and reinforcing materials. They can be both organic and inorganic in nature. The additive nanofillers can also be used in the next level of hybridization. Hybridization is the process in which the obstacles can be overcome such as water absorption, interaction on bonding of matrices and increase in mechanical properties. Hybridization is the process which involves the combination of Nano filler and natural fibre in the matrix which results in improved properties. Thermal degradation, moisture absorption, and biodegradation of natural fibres can be reduced to a great extent such that they have reached excellence. The nanofillers can also use aquatic plants which provide necessary stiffness and strength to fibres. Fibre variability, crystallinity, strength, dimensions, defects, and structure are the important factors governing the properties of different natural fibres. The diverse nanofillers that are used in nano composites include Nano clays, nano-oxides, carbon nanotubes, and organic nanofillers. A great possibility has been indicated broadly by the incorporations of nanoparticle as the reinforcement of composites.

*F. A.S. SINGHA investigated into the mechanical properties of natural fibre reinforced polymer composite.*

The replacement of natural fibres provided the way of manufacturing in a cost-effective manner and improved mechanical properties. For instance, the natural fibre is Hibiscus sabdariffa which has replaced the synthetic fibre with urea–formaldehyde which is a resin, and it is a resin-based polymer composite. The natural fibre and the reinforcing matrix urea-formaldehyde is chemically treated with NaOH solution to have better adhesion property between the matrix and the reinforcing materials. The tensile property of the composite shows that the particle reinforced composite can bear a load of 332·8 N at an extension of 2·2 mm. The research analysis based on the test results provide information that they can be applied in manufacturing of vest and industrial applications. The tensile strength, flexural strength, compressive and the bonding nature of atoms have shown that they exhibit better improved mechanical properties.

## III APPLICATION OF COMPOSITES

*A. Application of Natural Fibre Composites:*

Their improved mechanical properties due to various treatments and processes led to application on automotive and transportation industrial applications mainly due to their low density and cost-effective properties. The first car maker to use polymers filled with natural fibre was Mercedes-Benz in the 90s, by manufacturing door panels containing jute fibres. Its industrial applications include furniture, railroad sleepers, automotive panels and gardening items, packaging, shelves and in general those applications which do not require very high mechanical resistance but instead low purchasing and maintenance costs. Applications can also be easily found in the related technical literature and on the internet; these include, for instance, indoor furniture panels, footboards and platforms, automotive panels and noise insulating panels etc. The role of automotive industry in this respect is of primary importance. Bulletproof panels have been made from ramie fibre reinforced composites by hand lay-up process with epoxy as a matrix. These bullet proof type vest found to be more cost-efficient and lighter when compared to metals. Furthermore, it is possible and can be assured that it is recyclable and also it is assured that it doesn't affect green ecosystem.

*B. Application of Polymer Nano Composites:*

Polymer nanocomposites a large variability of diversity in industrial applications that include automotive industry, construction industry, aerospace (flame retardant panels and high-performance components), electrical and electronics (printed circuit boards and variety of electrical components), in food packaging (containers and wrapping films) and in the cosmetics industry. This is the most interesting application area, which relates to enhancing the functional properties of concrete, steel, wood, and glass, as the primary construction

materials. Specifically, the inclusion of nanoparticles in the micro-matrices, or through coatings on the surface areas of these materials can improve their strength, stress tolerance, and durability. Nanotechnology addresses environmental concerns in construction through many routes. The enabling nature of nanotechnology implies that it can endow traditional construction materials with completely new and eco-efficient functionalities and capabilities.

## IV. SURVEY RESULTS AND DISCUSSION:

As there are classifications in natural fibre composites there is high variability between their properties. Their disadvantages can be overcome with different process to obtain specific properties. The exploitation of natural fibre composites in various applications has opened new avenues for both academicians as well as industries to manufacture a sustainable module for future application of natural fibre composites. The replacement of synthetic fibres by natural fibres has turned a spot light in this 21$^{st}$ century on every environmental aspect. A hybrid composite is a combination of two or more different types of fibre in which one type of fibre makes up the deficiency of another fibre. Natural fibre reinforced polymer composites have been proven alternative to Synthetic fibre reinforced polymer composites in many applications. Many composites are developed and brought to market in application and these are possible with processing the material with different processes and the developed are applicable in automobile include parcel shelves, door panels, instrument panels, armrests, headrests and seat shells. Plastic/wood fibre composites are being used in many applications in decks, docks, window frames and molded panel components. The passenger car bumper beam is manufactured by kenaf/glass epoxy composite material. Recently, banana fibre reinforced composites are coming into the picture due to the innovative application of banana fibre in under-floor protection for passenger cars. Automobile parts such as rear-view mirror, visor in two-wheeler, pillion seat cover, indicator cover, cover L-side, name plate have been fabricated using sisal and roselle fibres hybrid composites. Nanotechnologies are estimated to impact and influence at least $3 trillion in the worldwide economy by 2020. It's the estimation says that industries based on nanotechnology are considering nano particles and might require at least 6 million workers to sustain them by the end of decade. Nanocomposites proposed perfections over conventional composites in terms of mechanical, electrical, thermal, and resistance (barrier) properties. A great possibility has been assured by the incorporations of nanoparticle as the reinforcement of composites.

## CONCLUSION:

The above summary is about the major attributes of natural fibre reinforced composite materials and developed nano composites. These include: good specific – but variable – mechanical properties,
environmental credentials (renewable, biodegradable, low embodied energy, non-toxic), Low cost, high water absorption, low durability and biocompatibility. Nowadays, a lot of attention is paid to environmental-friendly materials. This has resulted in a growing interest in natural lignocellulosic materials and composites based on them. Inclusion of wood flour in polyester has improved the load bearing capacity (tensile strength) and the ability to withstand bending (flexural strength and modulus) but the incorporation of metakaolin in wood flour polyester composite has drastically decreased the tensile, flexural modulus, and strength and has increased the water absorption. Polymer nanocomposites have acquired much significance as the most encouraging and promising family of materials science since the last decades and consequently drawn much attention due to their unique characteristics of enhancing the mechanical and barrier properties and have found applications construction, cosmetics, medical sciences, food packaging and many other composite-based

industries. Nanocomposites obtained from polymeric matrix (thermoplastics or thermosets) reinforced with nano-sized fillers, such as nano-size particles, carbon nano-tubes or intercalated layers are designated as a dynamic and active area of research.

Future research on natural fibre/nano filler-based hybrid composites will not only be driven by its automotive and construction applications, but it will be required to explore further on hybrid for aircraft components, rural areas and biomedical applications. However, more study and research remain to be achieved in order to recognize the possible ways of nano-reinforcement leading to major changes in material properties and their subsequent potential future applications in several composite based industries.

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