Review Article

Application of Green Composite Material in Sustainable Architectural and Automotive Part Development - A Review

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ABSTRACT

In the current synerio, application of waste materials from various agricultural, livestock disposable elements are been highly appreciated. These discarded materials are been converted or reused to develop a new material which is cost effective, equally strengthened and ecofriendly too. A review based on the characterization, application and reusability of various green waste and biocomposite material development is done in order to generate various research gap and to pile up the clustered knowledge of developing green composite for various design applications. The use of green waste like almond shell particles, walnut, groundnut shell, cane residue, poultry waste and various livestock waste like cow dunk, chicken feather fiber, egg shell and so on are been reviewed for advance composite material development. The evaluation of Ecofriendly, Sustainable and cost effective material development is appreciated and piled up.

Keywords: Green Composite, Architecture, Biodegradable, Advance material, Characterization, chicken feather.

INTRODUCTION

Nature has always supported the man kind in providing all sorts of amenities and requirements. It helps in developing the closed cycle in order to maintain the balance between system and the surroundings. But the inclusion of artificial approach is the process development has always been a debating task with various loopholes. Currently, various applications of natural fibers and particulate material in composite material development are been reviewed. Large numbers of researchers are working in the field of advance composite material development in order to save the environment from pollution and waste disposal problem. Agricultural waste like almond shell particles, walnut and groundnut waste, sugarcane residue, cow dunk cake, chicken feather fiber, human hairs etc. are been inculcated as fiber or particulate in various matrices to generate ecofriendly, cost effective and highly strengthened materials.

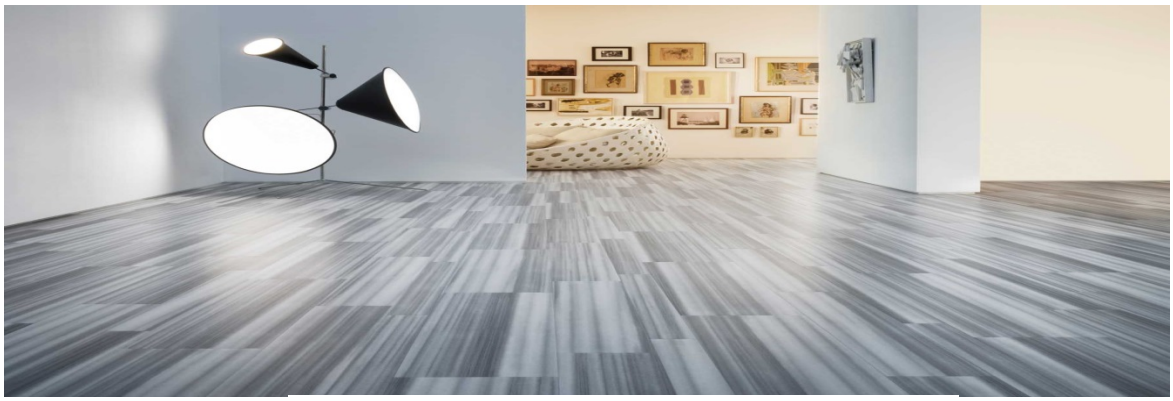

Figure 1. Flooring made using composite material1111

Also suggested the use of waste paper sludge in the development of composite [1]. Here, the prepared sludge can be used as a matrix as well as the reinforcing material with various matrices to prepare highly ecofriendly and dense composite material. Application of the waste is appreciated in flooring and fall ceiling as shown in figure 1 and figure 2. Testing and evaluation of many composites are been performed by various researchers and finally the application of the developed composites are been suggested which are been piled up in the current manuscript.

Materials and Methods

Application of Agricultural and Livestock waste

Various waste materials like almond shell particles, coconut shell particles, egg shell particles, chicken feather fiber, groundnut, walnut, Sugarcane residue etc. are been used as for the expansion of ecofriendly composite materials. These materials have appreciable contribution in the field of architectural, automotive, medical and other fields based on its characterizations and results. Some of the waste products used in the composites development are been discussed below.

Application of Almond Shell Particle

Application of Almond shell particle in the field of architectural design is enhanced because of its experimental characterizations. The thermal, mechanical and morphological outputs of the composites developed have shown the great extent of feasibility of almond shell particle with various matrices. Its Characterizations are been effectively determined by various researchers under different matrices. The reinforcement of almond shell particle is highly appreciable and it provides outputs which is cost effective, highly strengthened and eco-friendly [2]. The density, hardness, impact strength, ultimate tensile strength, percent elongation, ultimate compressive strength etc. has proved the high level of application of almond shell particles in architectural design applications [3]. The fall ceiling, the decorative eye catching wall hangings made of plastic, etc. can be made by almond shell particles reinforced plastic and ceramic composites. Waste almond shell particles is shown in figure 3.Compatibility of Almond Shell Particles is experimentally verified [4]. The use of almond shell is enhanced because of its hundred percent waste shell particle. There is no other use of almond shell except to burn it and dispose. Therefore utilizing it by recycling the waste in developing another useful material in the form of composites has enhanced the thought capability of various researchers. Also various automobile interior decorative parts have comparable strength as compared to the composites developed from waste, therefore its usage is appreciated in replacements [5].

Application of Sugarcane Residue

In the year 2011, Toyota, a leading automotive industry has claimed to adopt cent percent bio plastic in manufacturing the interior of the vehicle. The natural reinforced bio composite was used in RAUM 2003 model in the spare tire cover. One also had a great handon in the use of green composites for automotive applications [6].Long back one suggested the application of Plaster of Paris (POP), a ceramic material to fit defects in bone [7]. With the time the process of fitting and adjusting the defect in bone has only become light weightage and eye catching but could not replace POP completely. But after the advancement in materials technology various researchers have worked for developing the composite material which is light in weight and has strength and application similar to the POP. So the Sugarcane residue are been used as a fiber material along with POP to generate light weight material for medical purposes. The sugarcane bagasse for the development of anaerobically digested biochar [8]. The Isolation of nano cellulose from waste sugarcane bagasse (SCB) and its characterization [9]. Figure 4. Shows the sugarcane residue bagasse present in the villages after extraction of cane juice. It has experimentally characterized the fabrication of sugarcane and coconut fibers by thermal analysis and FTIR [10]. The output results were made compatible to construct RCC mixed roads and other paths. All the results obtained have appreciated the use of Sugarcane waste in various material developments. The major drawback with sugarcane residue reinforced composite is the least fire resistant ability.

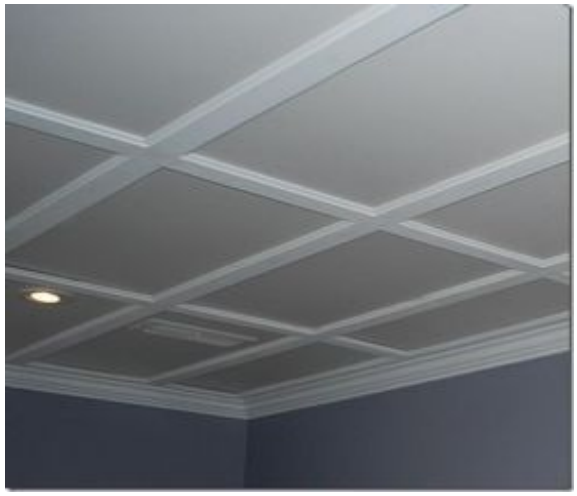

Figure 2. Fall ceiling made of Plaster of Paris

It has added a great awareness about the morphological and Thermo gravimetric study of kinetics of coal blends with corn and sugarcane residues [11]. The study revealed the high level of compatibility of sugarcane with various materials. It has served the cure to great disposal problem of Sugarcane residue. It has elaborately discussed the application of various green composites in automotive applications [12]. Here also the authors reviewed the use of sugarcane in ecofriendly material development which is highly strengthened and cost effective. Also it has performed various characterizations for developing automotive parts using different green composites [6]. Also the same compatibility of cane residue was used in various architectural applications where the pure POP was appreciable. It forms POP matrix with Cane residue as fiber and in some cases also as a grinded micro sized particulate material. Dried cane residue, after the removal of juicy liquid from it is used in making decorative items and also the cane residue fiber showed its application in making wooden dash

board of automobile, car fibered roof, fall ceiling in homes, restaurants etc., wall hangings, mats etc.

Application of Chicken Feather Fiber

It has described application of CFF in technical textiles. They added by interpreting that nonwoven which is prepared by CFF has wide application in the technical textiles [2]. There are multiple types of CFF present in India, some of them are shown in figure 5. It has performed various lab experiments to characterize the epoxy based biocomposite developed from amalgamation of chicken feather fiber (CFF) as reinforced fiber and extracted fish residue powder as particulate material [13]. The results obtained provide appreciable composite strength, water absorption and thickness swelling characteristics, thermal properties etc [14]. The developed material can be used to develop the new material based with Plaster of Paris and cement reinforced composite for application in architectural components. Multi colored feathers helps to make decorative items with palpable strength.

Figure 3. Almond Shell Particle

It is used the collagen from livestock and fish waste to develop the void free composites [15]. The use of fish residue as a powder was used to reduce the water absorption and thickness swelling characterization of the epoxy based composite, reinforced with CFF [14]. It is investigated mechanical and acoustical properties of composites from ground chicken quill and polypropylene (PP) and compared it with jute-PP composites [16]. The study about waste chicken feathers as reinforcement in cement bonded composites. Stiffness, flexural strength and dimensional stability of the feather–cement boards reduced as the proportion of feathers were increased above 10% [17]. Higher proportion of feather showed significant reduction in modulus of elasticity and modulus of rupture and boost in water absorption and thickness swelling after 24 hours in water. Later, the appreciable water absorption and thickness swelling characteristics were experimentally verified [18].

Figure 4. Sugarcane residue (Bagasse)

It has been studied the mechanical properties of composite made of CFF and glass fibers as reinforcing fibers, calcite powder as particulate and polyester as the base matrix [19]. Highest tensile strength was recorded to be at 10% CFF loading. It has been demonstrated that chicken feathers can be used as matrix with properties similar to that of composites having polypropylene (PP) as matrix and jute fiber as reinforcement, leading to a completely biodegradable composite [20].It investigated the mechanical properties of coconut coir fiber and chicken feather fiber reinforced polyester hybrid composite [21]. The tensile strength was obtained maximum at 26% coir and 4% CFF loading, which showed that coconut coir has more impact on tensile strength.

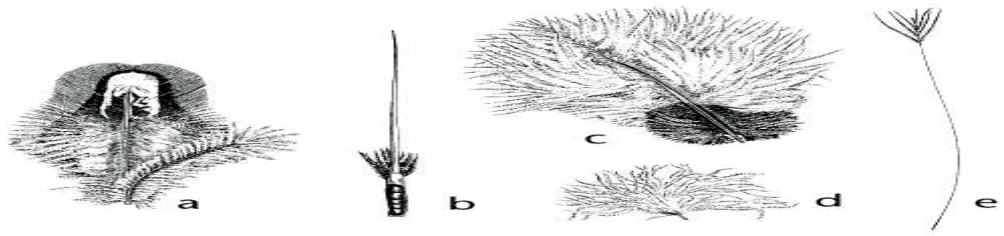

Figure 5. Types of Chicken Feathers (a) Contour (b) Bristle (c) Semi Plume (d) Down (e) Filo Plume (Bansal et al., 2016)

Figure 6. Conversion of Waste Egg Shell into fine powder (Buasri et al., 2013)

Application of Egg Shell Particles

Various parts of automobile require different properties based on the application and usage. The use of egg shell particle in composite development was characterized [22]. Here the mechanical behavior of composites developed from coconut coir and eggshell were diagnosed. Egg shell can be easily converted into fine powdered form as shown in figure 6. The experimental results were compared with the properties of various materials used in automobile industry. Parts like dashboard accessories, vehicle interior, plastic based components can be converted into composites reinforced with egg shell and coconut coir. The highly ecofriendly, cost effective and equally strengthened parts can be produced. Also the use of waste can be appreciated. It describes effects of eggshell on the microstructures and properties of Al–Cu–Mg/eggshell particulate composites [23]. The output characteristics provide the cost effective and light weight composite with highly varying properties. The improvement in the strength and other mechanical properties were diagnosed. The developed composite utilizes large percentage of eggshell and thus reduced the manufacturing cost of developing various light weight material used in automotive part manufacturing and also in the development of decorative wall hangings and aluminum wall coatings. It provides rust free, highly lustered, durable, light weighted, water proof and easily machinable properties. It is also used the egg shell waste in the production of biodiesel. Also they converted the egg shell into fine micro sized calcined Powder which was further used as particulate material in eggshell reinforced composites development [24].

Application of Groundnut shell

It is performed the Experimental Study on Optimization of Thermal Properties of Groundnut Shell Particle Reinforced Polymer Composites [25]. In the investigation the researcher focuses on the strength profile of the developed composite and finds great application in packaging, building and Civil Engineering fields. Taguchi L_9 orthogonal array was planned for experimentations. Results revealed that using groundnut shell particles as reinforcement for polymer matrix could successfully develop beneficial composites and can be used for thermal applications. Simple ground nut residue is shown in figure 7. It characterizes Mechanical Properties of Luffa Fiber and Ground nut (Shown in figure 8) Reinforced Epoxy Polymer Hybrid Composites [26]. Here the composites were developed using hand lay-up technique by using various volume fraction of fiber from 10% to 50%.

Figure 7. Groundnut Shell

The results showed remarkable rise in the flexural, compressive, tensile and impact strength of the final composites. SEM is also performed to diagnose the morphological characteristics of Epoxy based hybrid composite. The output strength relates to the development of improved automobile parts like dashboard, interior vehicle handles, wooden shelf, AC and Stereo casing, etc.

Figure 8. Ground nut Shell as Fiber (Panneerdhass et al., 2014)

Similar characterizations were obtained by using walnut reinforcement in epoxy resin [27]. Results

revealed that the percentage elongation of the developed composite was better than the control. But the tensile strength decreases after 20% inclusion of walnut particles epoxy resin matrix. The use of micro size powdered walnut particles in Plaster of Paris helps to recycle process.

Conclusion

Excellent attainment in terms of sustainable and ecofriendly material development is reviewed and the results obtained by various researchers has been piled up. Knowledge regarding the use of agricultural waste, livestock waste, natural waste etc. is monitored. Also the research gap can be identified for the further material development. The outcome also concludes the development of ecofriendly, cost effective, sustainable and highly strengthened material for architectural and automobiles applications. Disposable problem of waste also gets reduced by the recycling processes. Therefore, the efficiency of using such waste management approach is considered to be maximum.

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