Enhancement in Mechanical Properties on addition of Bamboo Powder in Wood Dust Powder filled Polyester Composites for Fbre Board Applications

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Abstract:

Bamboo is one of the fastest growing, least expensive, and widely available natural materials in the majority of developing countries. Bamboo, as an organic progressive genetic component, can provide excellent mechanical qualities along its fibre direction. Wood dust is also a waste generated during the fabrication of wood based items so it was utilized in the present research .The present investigation describes the addition of various quantities of bamboo powder addition on wood dust based polyester composites which improved the electrical properties, mechanical, and biodegradability of the hybrid composites. In this paper wood dust and bamboo powder was added in the polyester resin to prepare the hybrid composites.

Key words: Bamboo powder, Wood dust, Polyester, Composites

Introduction

Environmental contamination is currently one of the major challenges in human societies. The most essential technique for mitigating environmental pollution is the use of natural materials. Natural fibres and wood, both of which are renewable, can be used as biodegradable reinforcing elements for synthetic polymers. The incorporation of these elements to polymers is appealing because of their low density, high strength, wide availability, lack of abrasiveness, and inexpensive cost [1-4]. However, the hydrophilic character of wood fibres renders them incompatible with polymers, which is the primary cause of non-uniform dispersion and, as a result, poor stress transfer between wood particles and polymer matrix [5-7]. To address this issue and increase the performance, coupling agents such as silane coupling agents and maleic anhydride-grafted-polymer are added. Several scientists and academics are interested in natural fiber-based polymer composites, which represent a contemporary research trend. Many sorts of study have been conducted over the last few decades to generate a superior natural fiber-based polymer composite with improved material properties [1].Many researchers believe that natural fiber-reinforced composites can be used to replace synthetic materials [8-11].Polymer matrices reinforced with wood fillers have emerged as a study topic in recent years. Numerous research have found that adding fillers improves several characteristics of polymer composites [5, 6].

When compared to filers such as nano-clays, nanotubes, and many other inorganic fillers, the abundant availability of wood dust fillers makes it cost-effective in the use of polymer

matrices.when machinery or tools are used to cut or shape wood, wood dust is produced. Sawmills, as well as the furniture, cabinet, and carpentry sectors, generate a lot of wood dust.

Bamboo (subfamily Bambusoideae), a subfamily of tall tree like grasses in the Poaceae family with over 115 genera and 1,400 species. Bamboos are found in tropical and subtropical to mild temperate zones, with the greatest concentration and number of species in East and Southeast Asia and on Indian and Pacific ocean islands. Arundinaria species are native to the southern United States, where they create dense canebrakes along riverbanks and in swampy places. Bamboos are perennials that grow quickly, with some species reaching up to 30 cm (1 foot) per day. Culms are woody ringed stems that are hollow between the rings (nodes) and grow in branching clusters from a thick rhizome (underground stem) [7].

Bamboo fibre requires several treatments of the bamboo culm. Retting, alkali treatment, crushing, grinding, milling, and degumming are some of the extraction procedures used to get bamboo fibre from bamboo culm The process of extraction can have an impact on the quality and strength of the fibres. Alkali treatment of bamboo fibre has been the most widely utilised and cost-effective chemical treatment The purpose of the chemical treatment is to effectively change the surface of the fibre in order to improve interfacial adhesion between the fibre and the polymeric matrix

Nigrawal et al developed polymeric composites of bamboo and reported their electrical properties , it was found that bamboo addition improved the properties of the composites.

[10-12] various sorts of research have been conducted in order to create wood plastic composites for a variety of purposes[13-14] .Polyesters are a type of polymer in which the ester functionality repeats throughout the main chain. Polyesters are a classic step-growth polymer, formed by the reaction of a difunctional (or higher order) acid or acyl halide with a difunctional (or higher order) alcohol. Polyesters are commercially available in both saturated and unsaturated forms. Unsaturated are employed in a variety of industrially important markets, although they are most commonly used as the matrix material for various types of composites. The most common use for UPRs is glass fiber-reinforced composites, which can be processed using SMC, BMC, pultrusion, cured-in-place piping (known as relining in Europe), filament winding, hoover moulding, spray-up moulding, and resin transfer moulding (RTM). They are also used in wind turbine blades [9], as well as many other procedures. Gel coatings, shirt buttons, mine-bolts, bowling ball cores, polymer concrete, and engineered stone/cultured marble are all examples of non-reinforced applications that utilise polyester resins [15].

Materials and method:

In this research sodium hydroxide, unsaturated polyester resin with methyl ethyl ketone peroxide were obtained from sigma Aldrich. Bamboo fibre were grinded with a mechanical grinder and then rinsed in water to remove the impurities washed powder was then sun dried for five days then after it was chemically treated with sodium hydroxide and again rinsed with water and dried in an oven .Same process was done for wood dust powder then after these powders were removed after 48 hours and soaked in distilled water to minimise brittleness and diminish the alkaline content. The fibre is cleaned in flowing water until the pH of the fibre is neutral. Treated bamboo powder and wood dust powder was mixed with polyester at varied weights (after mixing with accelerator and catalyst at room temperature .Mixing was accomplished through dispersion and

hot pressing with a 100 ton hydraulic hot press. Samples were sliced in to desired shape for further testing

Nomenclature of the samples

Sample Designation	Wt% of Bamboo Powder	Wt% of Wood dust	Wt% of Polyester
WBP 1	**10**	**0**	**90**
WBP 2	**10**	**0**	**90**
WBP 3	**7**	**3**	**90**
WBP4	**6**	**4**	**90**

Mechanical Properties

The mechanical property like flexural strength, Tensile strength was measured with a Tinous Oleson Universal Tensile Machine.

Measurements of conductivity

Resistance (R) values of the produced composites were measured bymeans of an Electrometer device Keithely firm and model 610C at temperatures range from 30 °C to 150 °C at a continuous heating rate of 1 ° C/min.

The following relationship was used to compute D.C. conductivity (dc) values:

$= R*A/l$

Where R represents resistance.

The size of the electrodes is denoted by A (cm^2), while the width of the composite samples is denoted by l (cm).

The following formula was used to determine conductivity.

$\sigma_{dc} = 1/\rho$

Thermal Conductivity :

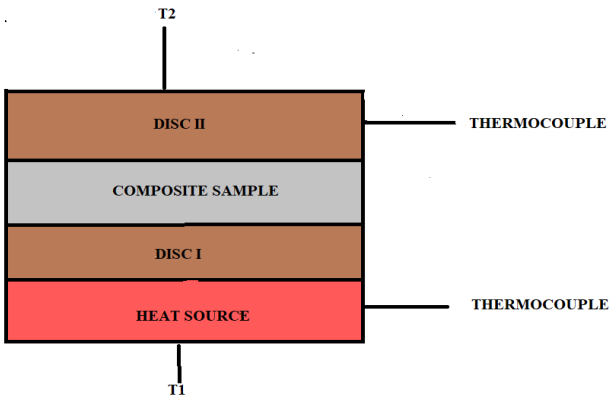
In this experiment thermal conductivity of the developed composites was recorded by LEE's Disc apparatus which is designed and used for thermal conductivity measurement . In the setup, a heat source is employed to keep the temperature constant. Two copper discs are put over the induction heater to hold the composite sample in place. The temperatures of the two copper discs are measured using thermocouples.

Thermal conductivity is a material attribute that specifies the rate at which heat travels within a body in response to a change in temperature. The heat transfer rate through the specimen or sample

is Where L is the sample thickness, A is the sample cross section area, K is the thermal conductivity,

$Q = K A (T_1-T_2)/L$

Q is the rate of heat transfer, and (T_1-T_2) is the difference in temperature .



SET UP OF THERMAL CONDUCTIVITY

Density

Density measurements were obtained using a balance (Mettler Toledo brand) on the generated com posite samples.

Results and Discussion

Density of the prepared samples varied according to the concentration of the bamboo and wood dust as shown in the graph (**Fig.1**)

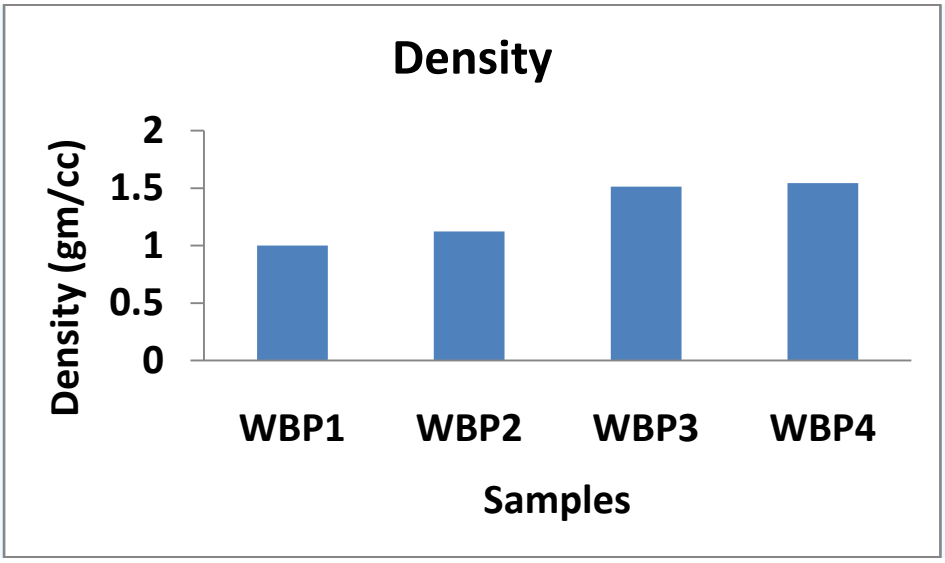


fig.1

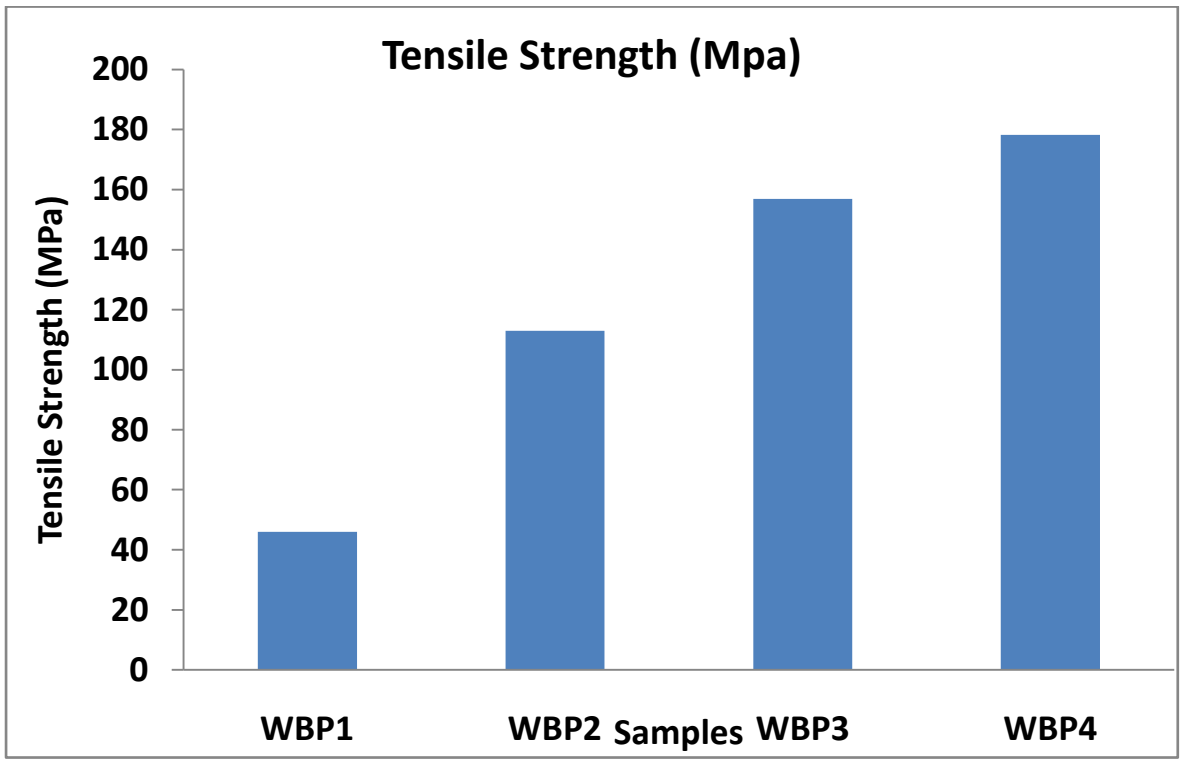


Fig. 2

Tensile strength is often determined by the weakest part of the composite, and it is possible that the interfacial interaction between polyester and bamboo powder is weak. As a result, the tensile strength decreased. Among other composites, the tensile strength is greatest at maximum fibre loading. The change in tensile strength based on the kind of fibre used and can also be driven by other factors such as fibre length, hydrophilicity, and the chemical composition of the fibre.

Mechanical performance of the samples in in wood dust bamboo powder composites is mostly determined by the matrix material, thus, when the amount of polyester in the composite material increases, mechanical characteristics of the composites increase as well.

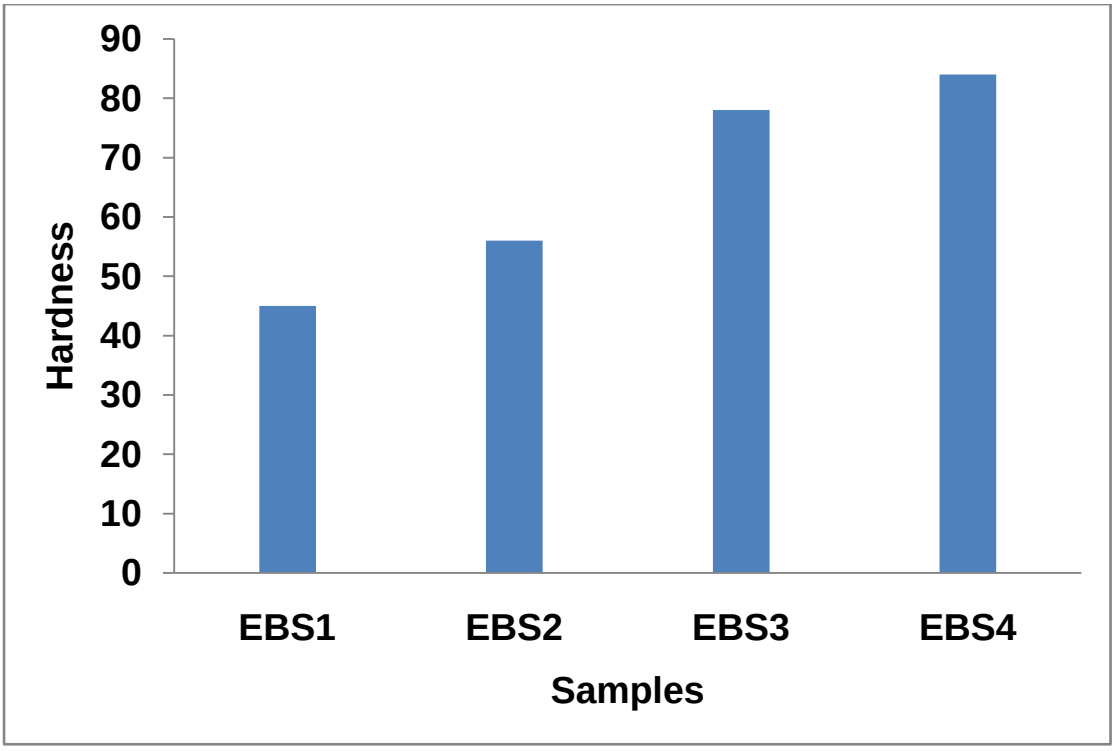


Fig. 3

The test findings demonstrate that increasing the fibre loading improves the hardness value of the composites addition of bamboo powder in the wood dust composites improved the toughness.

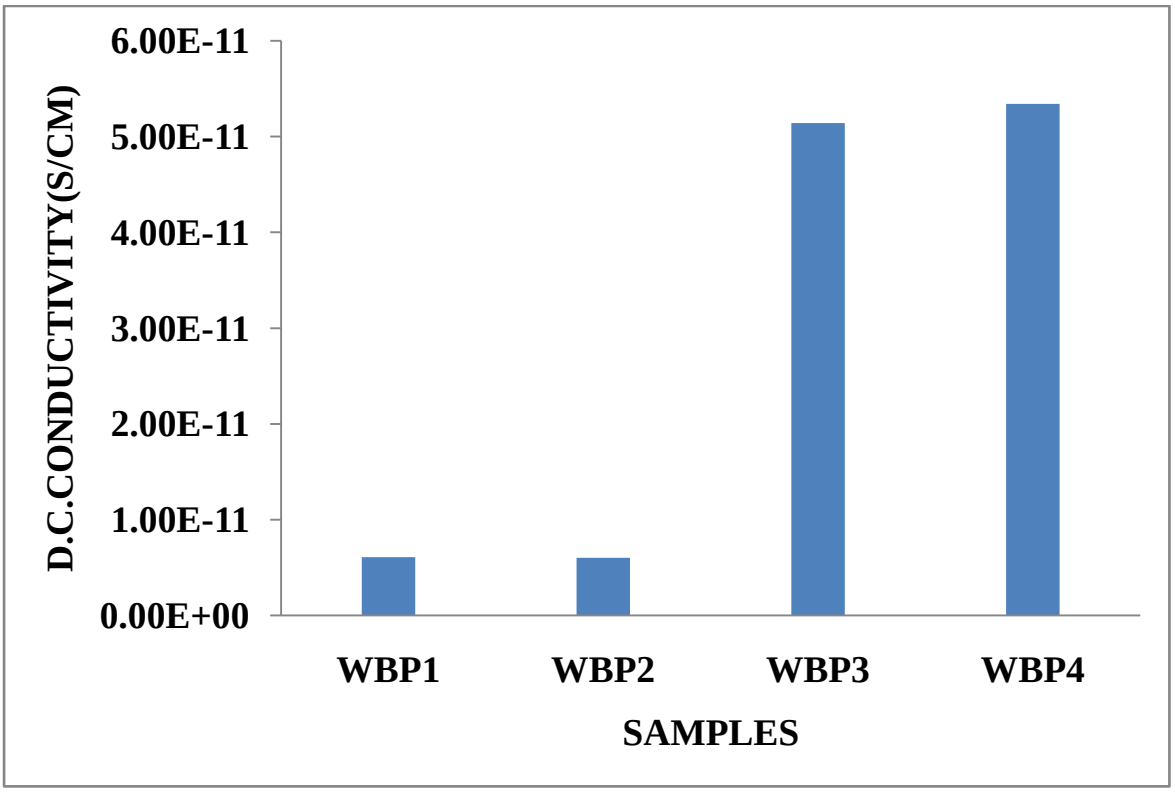


Fig.4

D.C.Conductivty of the samples was measured and it was found that D.C.conductivity of the sample WBP 4 was maximum because of the maximum concentration of the fillers in the developed composites

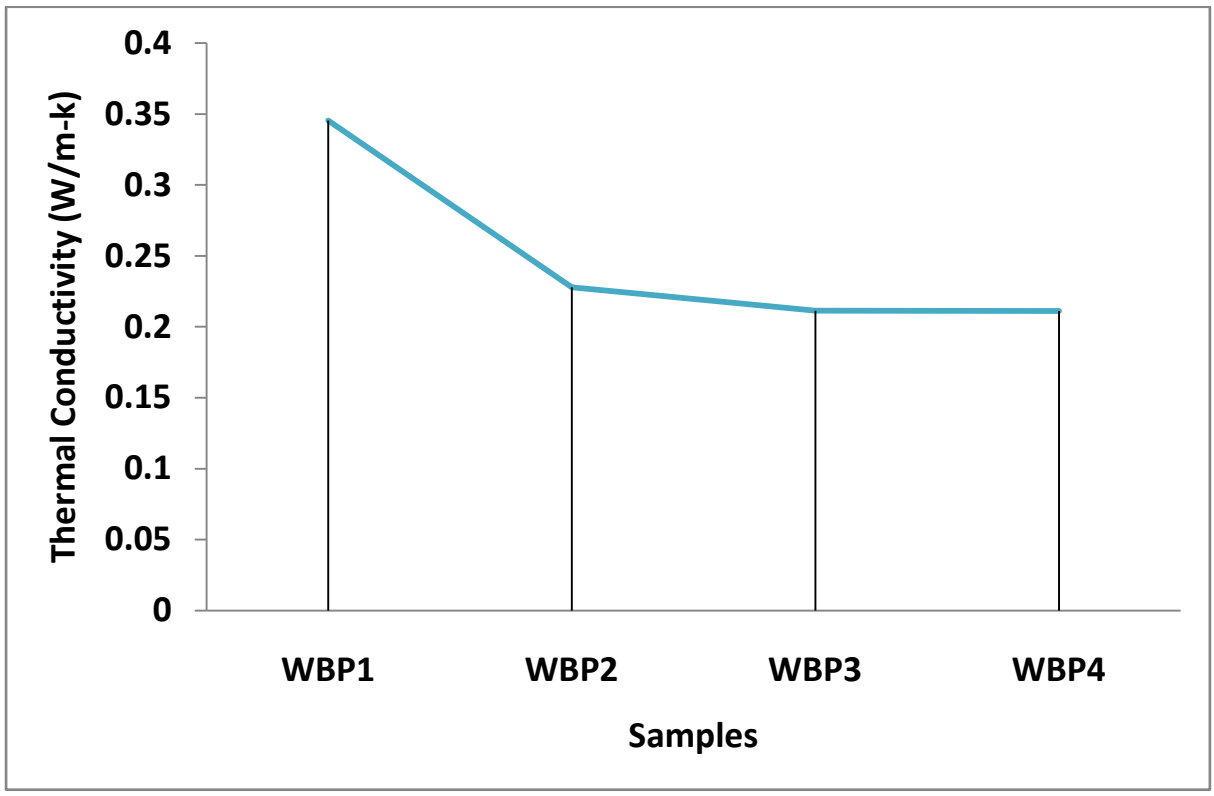


Fig. 5

Thermal conductivity of the developed composites

Thermal conductivity is a material attribute that specifies the rate at which heat travels within a body in response to a change in temperature. The heat transfer rate through the specimen or sample is Where L is the sample thickness, A is the sample cross section area, K is the thermal conductivity,

$Q = K A (T_1-T_2)/L$

Q is the rate of heat transfer, and (T_1-T_2) is the difference in temperature .

The improvement in thermal conductivity of wood dust and bamboo powder filed polyester based composites is due to the filler material including thermal releasing items that are thermally conductive, whilst used wood is thermally conductive when compared to polyester. Result shows that the coarse size of wood particles used in this study has no significant effect on the thermal conductivities of the produced composites.

Conclusions

- Composites made of bamboo powder and wood dust showed low thermal conductivity and can be utilised as insulators.
- It has been revealed that the thermal conductivity of composites made of bamboo powder and wood dust decrease as the stuffing concentration increased.
- The hydrophilic characteristic of natural fibres confines their applications as reinforcement for polymer composites. The interaction bonding between the fibre and matrix interface is affected by the poor moisture resistance and wet ability of natural fibres with hydrophobic polymers. As a result, chemical treatment of the fibre may greatly increase the mechanical characteristics when compared to untreated bamboo powder reinforced composites. Yet, fabrication techniques have also been influenced by advances in physical, mechanical properties.

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