Engineering Department of Mechanical Engineering

Banana peels for hybrid composite materials

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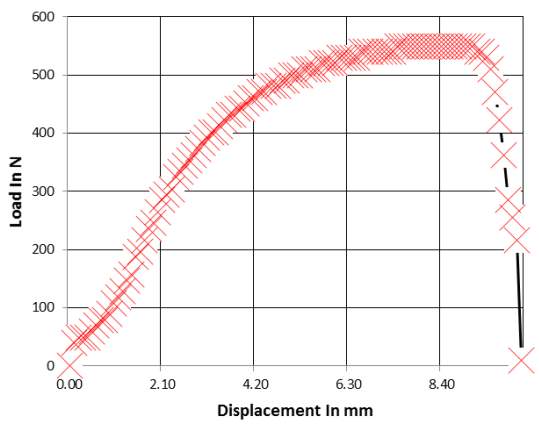
GRAPHICAL ABSTRACT



ABSTRACT

Hybrid nanocomposites have been prepared using the waste banana peels, copper Nanoparticles as reinforcements and high-density polyethene (HDPE) as a matrix by hand layout and casting methods. Washed banana fibres and different at. % of copper Nanoparticles were properly mixed in HDPE via thorough stirring. After that, the resultant solution has been cast and dried to result in the hybrid Nanocomposites. Their mechanical properties have been studied in details and compared with the conventional composite made from the waste banana peel used as reinforcement and high-density polyethene (HDPE) as a matrix. The material can be used in the applications of Aerospace and Automobile etc.

Keywords: *Banana peel powder, Polyethylene matrix composite, Mechanical properties and copper particles.*

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1. INTRODUCTION

Banana fruit contains lots of proteins in it, after consuming the peel is left out as a waste. These banana peels contain natural fibres and which are eco-friendly. These have a property which supports in composites for improving its mechanical properties. India in the top 3 producers of banana, states include in are Maharashtra, Tamilnadu, Gujarat, Karnataka and Andhra Pradesh.

The composition of material includes HDPE (high-density polyethene), copper and banana peel fibre. High-density polyethene is from the family of

polyethene with a change in its physical states such as in molecular weight, molecular weight distribution and density. By which physical properties of HDPE changes in flowability, rigidity, surface hardness, transparency and melt tension. As compared with the low-density polyethene, high-density polyethene (HDPE) only chosen.

In the present work the banana fibre with high-density polyethene and copper incorporation in the composite. The composite was analysed by evaluating through undergoing tests on its mechanical properties. There are many applications after the properties were known, in the fields of aerospace and automobile, etc. It serves with low cost and high performance comparatively.

Materials and Techniques

Materials required for this composite are banana peel powder, copper nanoparticles and high-density polyethene. The cleaned banana peels dried in open air, the dried banana peels are made into powder. High-density polyethene, the only type of polyethene produced was low-density polyethene. Low-Density polyethene was produced at extremely high pressures. This high-pressure polymerization created polyethene with many

Experimental system

The banana peel powder was collected from dried banana peels by grinding them. The collected powder was sieved from different mesh sizes. The banana shell powder and copper particles are incorporated with high-density polyethene with the help of injection moulding and casting technique with respective percentages of banana peel powder and copper particles. The ambient temperature of the high-density polyethene is 200°C.The mixture was prepared into the required shape and size with the help of moulds of injection moulding. All the specimens are to be undergone through above mentioned tests, hence a total of 15 branches; these branches are created due to intermolecular and intermolecular chain transfer during polymerization. The mechanism involved in the polymerization of low-density polyethene is free radical polymerization. The uses of low-density polyethene are limited due to a high number of branches. Because of the extreme pressure needed to create low-density polyethene and its limited uses, Karl Ziegler tried in creating polyethene at atmospheric pressure. Were copper nanoparticles are prepared from copper strips by using ball milling machine.

Banana peel powder, copper microparticles and HDPE was used in ratios of, 5%-1%-94%, 10%-1%-8% and 15-1%-84% respectively. The various methods used in testing of composite materials are a tensile test, bending test and impact test. The pieces were prepared in different concentrations and in different shapes by the process of injection moulding and casting technique for testing. These prepared pieces were subjected to various mechanical tests like a tensile test, bending test and impact test.

pieces are required, The dimensions and shapes of those pieces are in fig1, fig2, fig3, The pieces are tested for the mechanical properties, the piece which is compared with the standard, the one which matches with the standard it is acceptable for application in various mechanical fields.

Fig 1: 5% Coconut shell powder and High-density polyethene (specimen for tensile test)

Fig 2: 10% Coconut shell powder and High-density polyethene (Specimen for impact test)

Fig 3: 15% Coconut shell powder and High-density polyethene (specimen for bending test)

Results and discussions

The experimental curves for tensile strength from tensometer testing machine of pure HDPE, 5% BPP (Banana peel powder) filled, 10% BPP filled and 15% BPP filled composites are shown in Fig-1, Fig-2, Fig-3, and Fig-4 respectively.

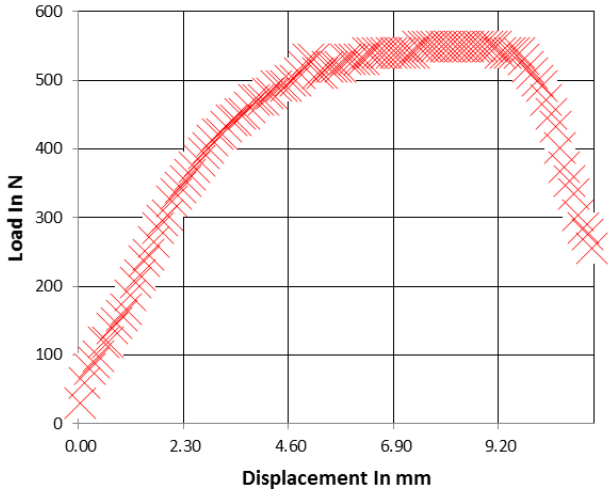
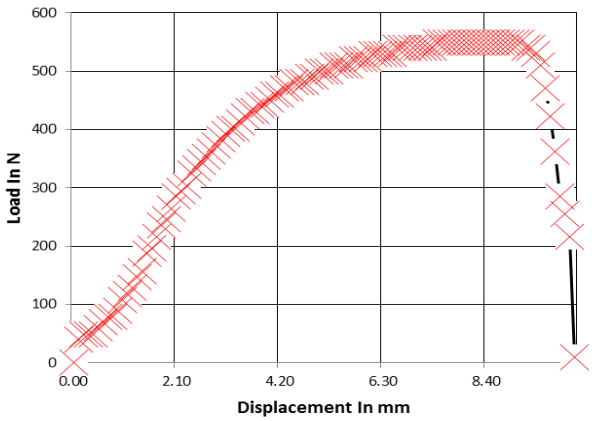


Figure 1. Load versus displacement curve of pure HDPE for tensile strength

The above graph indicates the sample with pure HDPE for tensile strength. The brake load and peak load was obtained at 246N length 11.2MM and 550 N at length 9.1 MM



Peak Load : 550 N At Length : 9.0 MM
Break Load : 128 N At Length : 10.2 MM

Figure 2. Load versus displacement curve of 5% BPP composite for tensile strength

The above graph indicates the sample with 5% banana peel powder and the remaining percentage is HDPE for tensile strength. The brake load and peak load was obtained at 128 N length 10.2 mm and 550 Natlength9.0MM

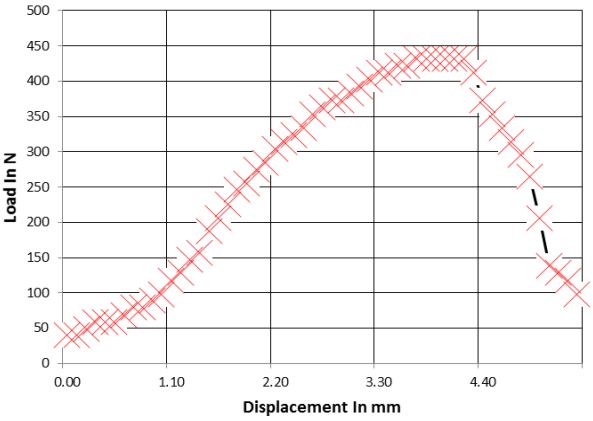
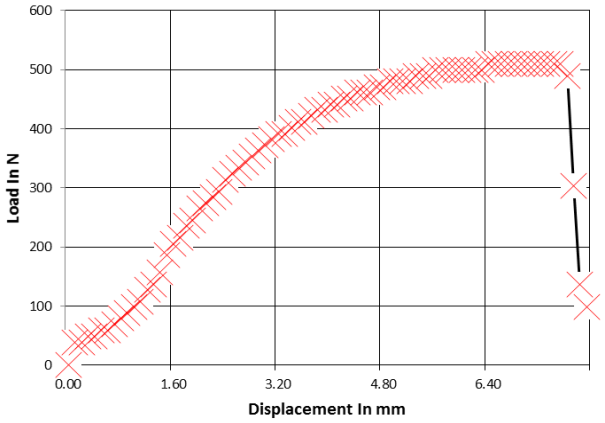


Figure 3. Load versus displacement curve of 10% BPP composite for tensile strength

The above graph indicates the sample with 10% banana peel powder and the remaining percentage is HDPE for tensile strength. The brake load and

peak load was obtained at 108 N length 5.4 MM and 432 N at length 4.2 MM respectively.



Peak Load: 510 N at Length: 7.5 MM
Break Load: 108 N at Length: 7.9 MM

Figure 4. Load versus displacement curve of 15% BPP composite for tensile strength

The above graph indicates the sample with 15% banana peel powder and the remaining percentage is HDPE for tensile strength. The brake load and peak load was obtained at 108 N length 7.9 MM and 510 N at length 7.5 MM respectively.

Table 1. Load and displacement of tensile test

S No	**Composite sample**	**Peak load**	**Break load**	**Peak load**	**Break load**
1	Pure HDOE	550	246	9.1	11.1
2	5% BPP filled	550	128	9.0	10.2
3	10% BPP filled	432	108	4.2	5.4
4	15% BPP filled	510	108	7.5	7.9

The tensile strength results in table 3 for composite sample which are prepared with BPP filler in different volumes fraction the load versus displacement curve illustrate that the maximum tensile strength is obtained for the composite prepared with 5% volume fraction. Banana peel powder HDPE composite with the higher fraction of filler 15% has the lowest strength this may be due to imperfect interfacial bonding between BPP and HDPE to transfer tensile strength.

The experimental curves for bending strength from tensometer testing machine of 5% BPP filled, 10% BPP filled and 15 % BPP filled composites are shown in Fig-5, Fig-6, Fig-7 and Fig-8 respectively.

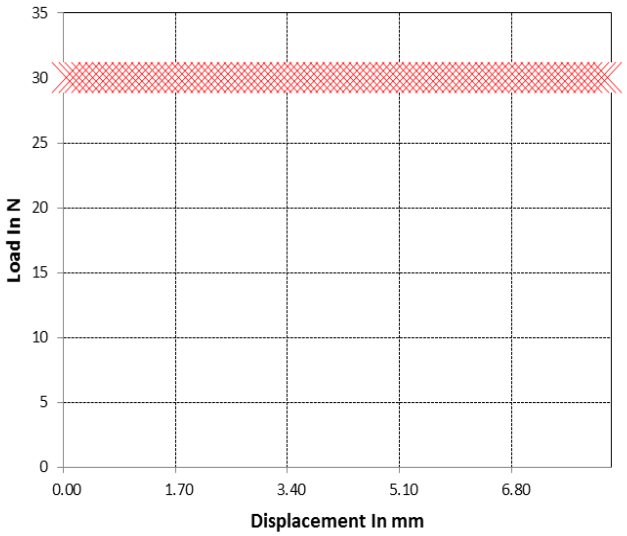


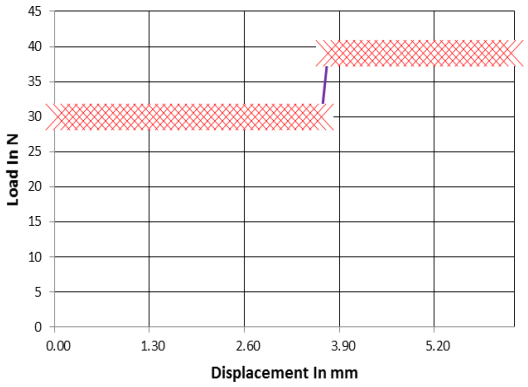
Figure 5. Load versus displacement curve of pure HDPE for bending strength

Sl no	**Composite sample**	**Tensile strength in N/SQ MM**
1	Pure HDOE	13.1
2	5% BPP filled	13.8
3	10% BPP filled	10.8
4	15% BPP filled	12.8

The above graph indicates the sample with pure HDPE for bending strength. The brake load and

peak load was obtained at 216N length 10.6MM and 608N at length 9.3 MM respectively.

Table 2. Tensile strength of composite sample



Peak Load : 30 N At Length : 3.9 MM
Break Load : 0 N At Length : 0.0 MM

Figure 6. Load versus displacement curve of 5% BPP composite for bending strength

The above graph indicates the sample with 5% banana peel powder and the remaining percentage is HDPE for bending strength. The brake load and peak load was obtained at 0 N length 0.0 MM and 39 N at length 6.2 MM respectively.

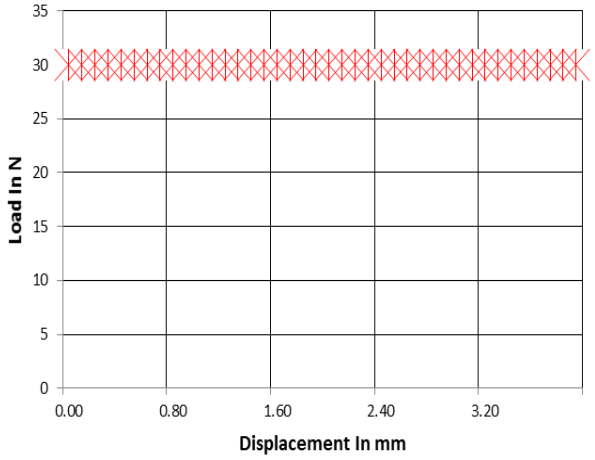
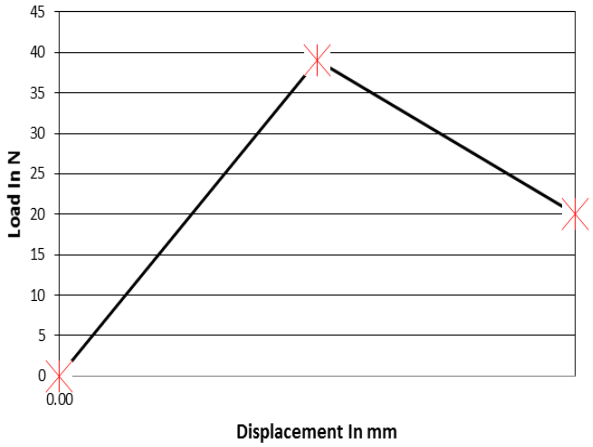


Figure 7. Load versus displacement curve of 10% BPP composite for bending strength

The above graph indicates the sample with 10% banana peel powder and the remaining percentage is HDPE for bending strength. The brake load and peak load was obtained at 0 N length 0.0 MM and 30 N at length 3.9 MM respectively.



Peak Load : 39 N At Length : 0.1 MM
Break Load : 39 N At Length : 0.1 MM

Figure 8. Load versus displacement curve of 15% BPP composite for bending strength

The above graph indicates the sample with 10% banana peel powder and the remaining percentage is HDPE for bending strength. The brake load and peak load was obtained at 39 N length 0.1 MM and 39 N at length 0.1 MM respectively.

Table 4. Load and displacement of bending test Composites

Sl No	Composite sample	Peak load	Break load	Peak load	Break load
1	0%	30	0	8.2	0.0
2	5%	39	0	6.2	0.0
3	10%	30	0	3.9	0.0
4	15%	39	39	0.1	0.1

Table 4. Bending strength of composite sample

Sl No	Composite sample	Bending strength in N/SQ MM
1	Pure HDOE	0.8
2	5% BPP filled	1.0
3	10% BPP filled	0.8
4	15% BPP filled	12.8

The bending strength results in table 3 for composite sample which are prepared with BPP filler in different volumes fraction the load versus displacement curve illustrate that the maximum bending strength is obtained for the composite prepared with 15% volume fraction. Banana peel powder HDPE composite with the higher fraction of filler 5% has the lowest strength this may be due to imperfect interfacial bonding between BPP and HDPE to transfer tensile strength.

The impact strength of 5% BPP filled, 10% BPP filled and 15 % BPP filled composites of its strengths are shown in the following table 6. The impact strength results in table 6 for composite sample which are prepared with BPP filler in different volumes fraction the load versus displacement curve illustrate that the maximum impact strength is obtained for the composite prepared with 10% BPP volume fraction. The banana peel powder HDPE, composite with the higher fraction of filler 15% has the lowest strength this may be due to imperfect interfacial bonding between BPP and HDPE to transfer tensile strength. Therefore it is common for impact strength to be higher than the tensile strength of the same composite sample.

Table 5. Impact strength of composite sample

The above table indicates the Impact strength of the composite sample. The maximum impact strength obtained was at 10% composite.

Sl No	Composite sample	Impact strength
1	Pure HDOE	0.32
2	5% BPP filled	0.33
3	10% BPP filled	0.34
4	15% BPP filled	0.31

Conclusion

The experimental characterization of banana peel powder for composite leads to the maximum tensile strength is obtained for the composite prepared with 5% BPP volume fraction and lower strength is obtained for the composite prepared with 10% volume fraction of BPP, the maximum bending strength is obtained for the composite prepared with 15% BPP volume fraction and lower strength is obtained for the composite prepared with 10% volume fraction of BPP, the maximum impact strength is obtained for the composite prepared with 10% BPP volume fraction and lower strength is obtained for the composite prepared with 15% volume fraction. The composite is prepared with 5% BPP is good for tensile applications, 10% BPP is good for impact

applications and 15% BPP is good for bending applications. Banana peel powder for hybrid composite can be used as an alternative material for the interiors of aircraft, spacecraft, ships, electronics and automobiles.

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