STUDY OF MECHANICAL AND PHYSICAL PROPERTIES OF WOOD-PLASTIC COMPOSITES MADE OF LOW DENSITY POLYETHYLENE, WOOD FLOUR AND NANOCLAY

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***Abstract:** With growing accumulation of pastic waste over the decades has caused environmental awareness, ecological concerns and new legislations. Because of this wood fiber-reinforced plastic composites have received increasing attention during the recent decades. Here study is focused to evaluate the mechanical and physical properties of wood plastic composites made of low density polyethylene, wood flour and nanoclay.Interfacial strength of wood plastic composite is increased by treating teak wood fibers with NaOH solution. Low density polyethylene is melted in a graphite crucible by placing in an oven by maintaining temperature in the range of 110^0 C-120^0 C.Thorough mixing of treated teak wood fibers, nanoclay and melted thermoplastic is done. Then the mixture is transferred to the die and rammed by applying hand pressure to the rammer. After solidification of the mixture; the specimens were ejected from the die. Mechanical and physical tests were conducted to evaluate the results.*

***Index Terms-** Wood-Plastic Composites, Low Density Polyethylene (LDPE), Nanoclay, Wood fibers.*

I. Objectives of the project:

- Fabrication of wood-plastic composites made of low density polyethylene, wood flour and nanoclay.
- Evaluation of mechanical properties of the composites such as compressive and tensile strengths
- Chemical treatment for wood fibers to improve the interfacial strength between wood and matrix phase.
- Evaluation of water absorption for wood plastic composites.

II. INTRODUCTION

Accumulation of plastic over the decades has adversely affected wildlife and human habitat. It can favorably affect lands, waterways and oceans, particularly marine animals get affected by entanglement and direct ingestion of plastic waste. Plastic pollution has caused disruption of various hormonal mechanisms in human beings .A new study says that globally about 9 billion tons of plastic is produced since 1950 and only 9% of plastic waste produced ended up recycled.

In the recent years due to the improved methods of manufacturing has led to the development of wood plastic composites (WPC).Wood plastic composites are composite materials made of thermoplastic as matrix phase and wood flour/wood fiber as reinforcement phase. Wood plastic composites can be used for various applications such for railings, fences, park benches, landscaping timbers, window and door frames, indoor furniture, outdoor decking etc. Plastic composites are obtaining a great attention in the manufacturing sectors as well as in academics due to the following desirable properties;

- High strength to weight ratio and low cost.
- Can be manufactured using recycled plastics and the waste products of the wood industry.
- Better durability and favourable mechanical properties.

III.EXPERIMENTAL WORK

The teak wood fibres were treated with 3% solution of NaOH for one hour and then washed with distilled water containing a few percent of acetic acid to remove the alkali residue. The washed fibres were then dried under sunlight for a period of 100 hours in order to remove the moisture. The proposed reaction for this treatment is given in the following equation:

Teak wood fibre-OH +NaOH =Fibre-O- Na+ H2O

Low density polyethylene bags were melted in a graphite crucible by placing in an oven by maintaining temperature in the range of 110°C-120°C.Then thorough mixing of treated wood flour, nanoclay(Bentonite) and melted thermoplastic is done. Then the mixture is transferred to the die and rammed by applying hand pressure to the rammer. After solidification of the mixture; the specimen is ejected from the die.

Figure 1: Mould for tensile testing specimens.

Figure 2: Graphite crucible.

Figure 3: Semi solid polyethylene after melting of polyethylene bags in a graphite crucible.

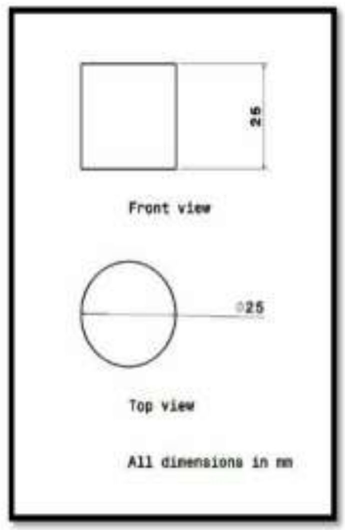

Figure 4: Specification of WPC specimens for compression (ASTM D3410).

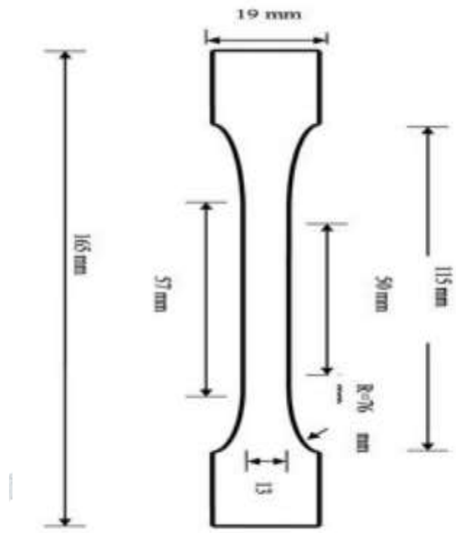

Figure 5: Specification of WPC specimens for tensile (ASTM D638).

Figure 6: Teak wood dust powder.

3.1 Mechanical properties of wood plastic composites:

The tensile and compression strengths of wood-plastic composites were determined by following the ASTM standards (ASTM D638 for tensile & ASTM D3410 for compression).An average of two trials for each composition is taken.Tests were conducted at RSM laboratory, Bangalore.

3.2 Water absorption test: Amount of water absorbed by each specimen is calculated by soaking with distilled water for a given period of time at room temperature. Then the samples were removed from the water, dried and then measured again. An average of two trials is taken for each composition. The amount of water absorbed by each specimen in percentage is calculated using the following equation:

$WA = (W_2 - W_1 / W_1) \times 100$

Where,

WA - water absorption in percentage for a period of 't'.

W_1 - oven dried weight

W_2 -weight of specimen at a given immersion period of 't'.

Figure 7: Prepared tensile and compression test specimens made of LDPE.

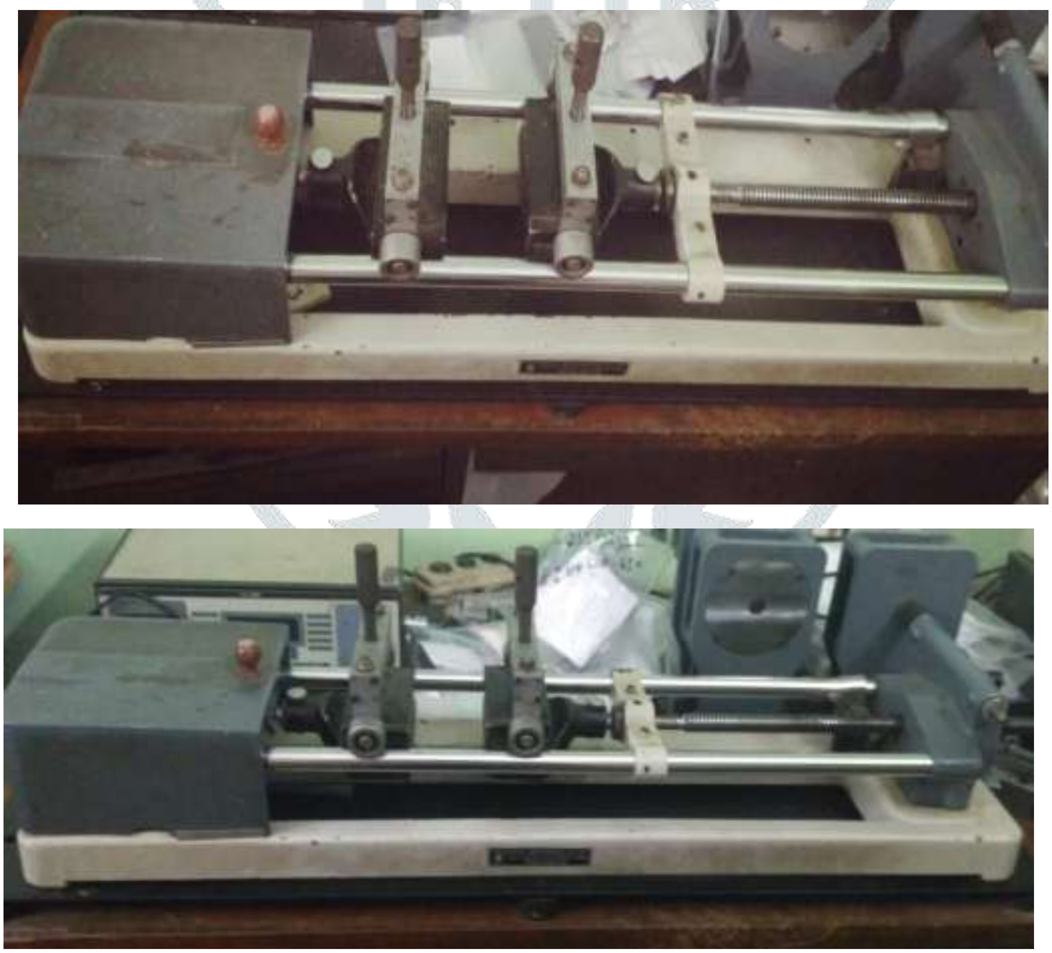

Figure 8: Tensile testing machine (Tensometer) used for testing WPC.

Figure 9: Universal testing machine used for testing of wood plastic composites.

3.3 RESULTS AND CONCLUSION: Table 1 shows composition and average compressive strength of various specimens. Table 2 shows composition and average tensile strength of various specimens.

Table 1: Comparison of compression test results.

Type of Plastic	**Composition of wood plastic composite**	**Average maximum load (kN)**	**Average Compressive Strength (N/mm^2)**
Low density polyethylene (Specimen 1= Specimen 4)	90% P+8% Wood fiber +2% Nanoclay	9.95	20.26
Low density polyethylene (Specimen 2 = Specimen 5)	80% P+18% Wood fiber +2% Nanoclay	12.5	25.46
Low density polyethylene (Specimen 3 = Specimen 6)	70% P+28% Wood fiber +2% Nanoclay	13.5	27.50

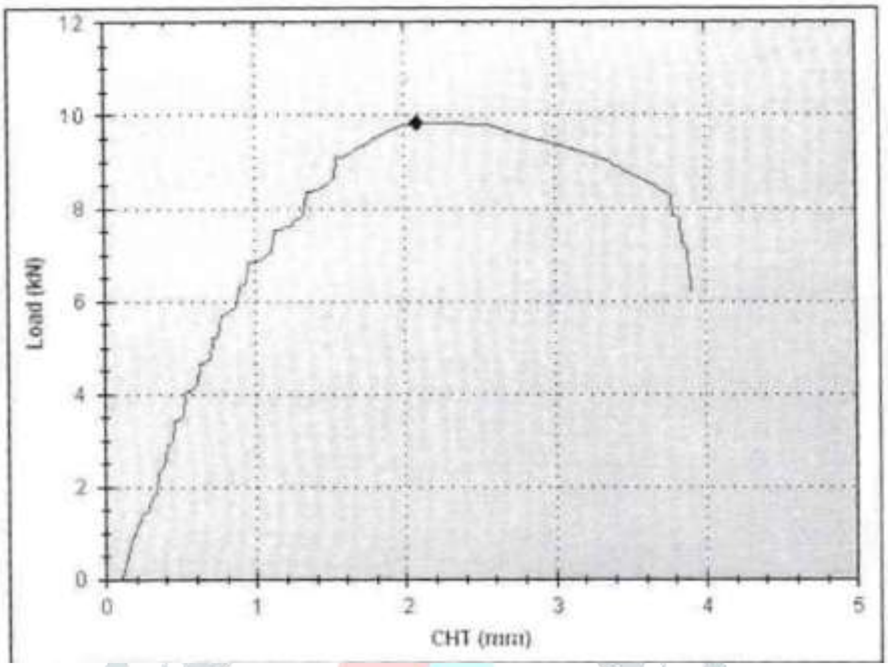

Figure 10: Compression Test for 90% P+8% Wood fiber+2% Nanoclay.

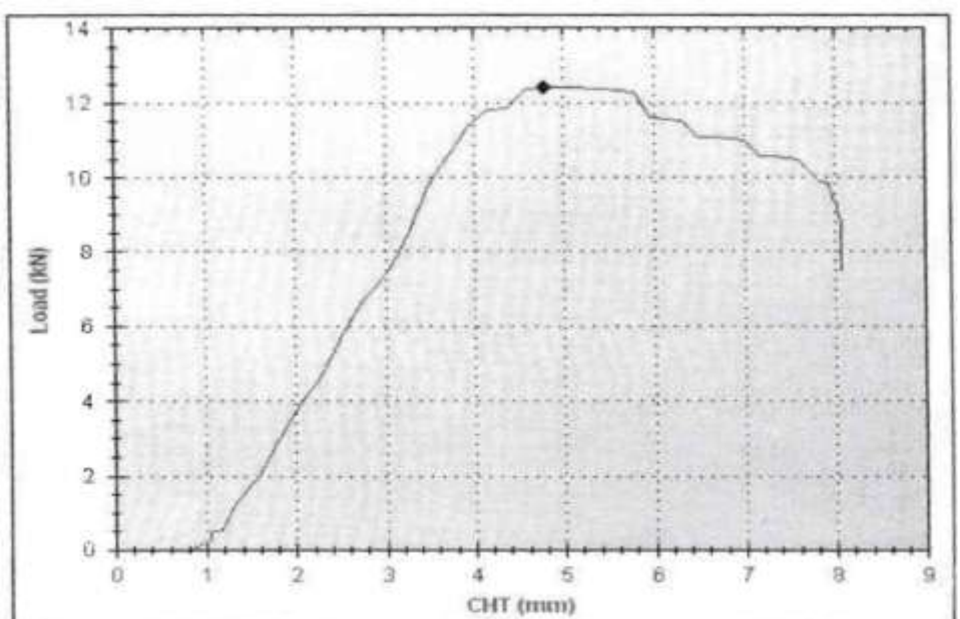

Figure 11: Compression Test for 80% P+18% Wood fiber+2% Nanoclay.

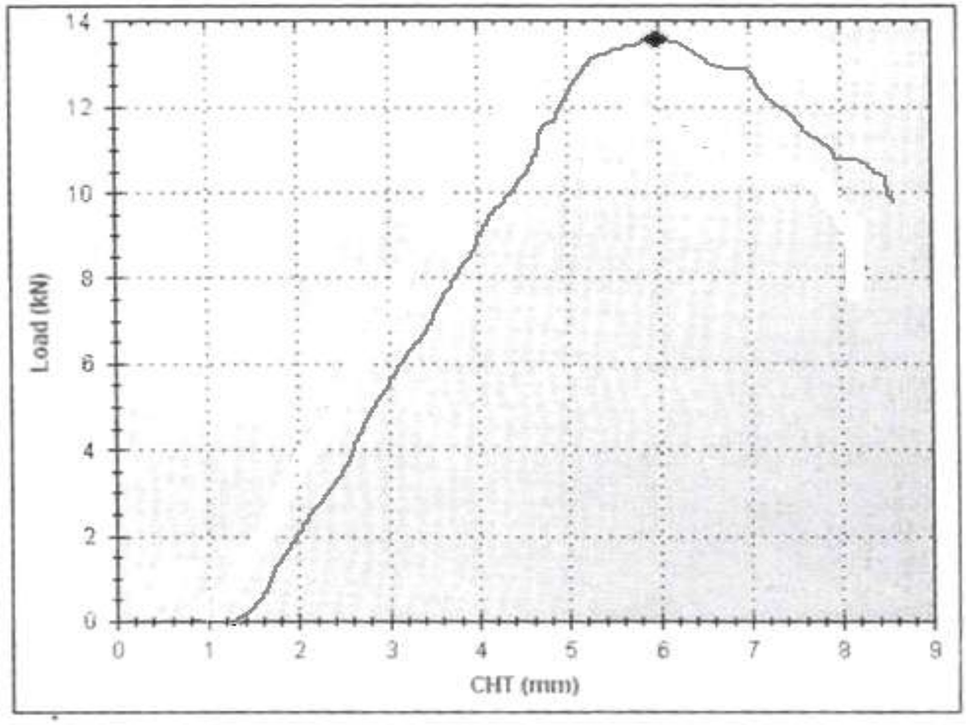

Figure 12: Compression Test for 70% P+28% Wood fiber +2% Nanoclay.

Table 2: comparison of tensile test results.

Type of Plastic	**Composition of wood plastic composite**	**Average maximum load (N)**	**Average Tensile Strength (N/mm^2)**
Low density polyethylene (Specimen 1= Specimen 4)	90% P+8% Wood fiber +2% Nanoclay	647.3	7.11
Low density polyethylene (Specimen 2 = Specimen 5)	80% P+18% Wood fiber +2% Nanoclay	853.2	9.37
Low density polyethylene (Specimen 3 = Specimen 6)	70% P+28% Wood fiber +2% Nanoclay	951.3	10.45

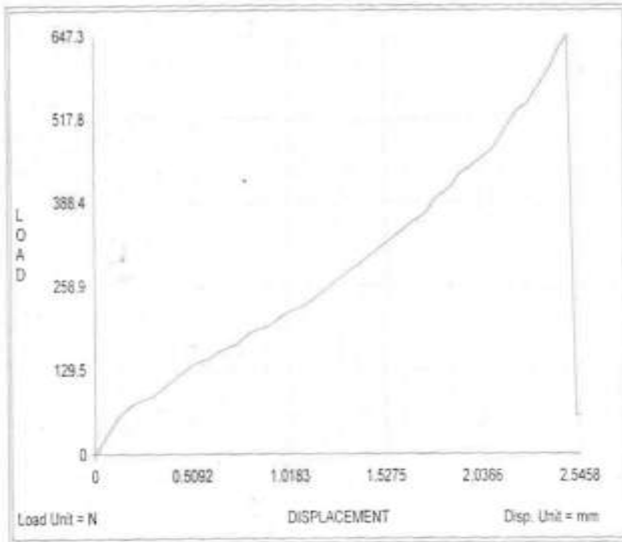

Figure 13: Tensile Test for 90% P+8% Wood fiber +2% Nanoclay.

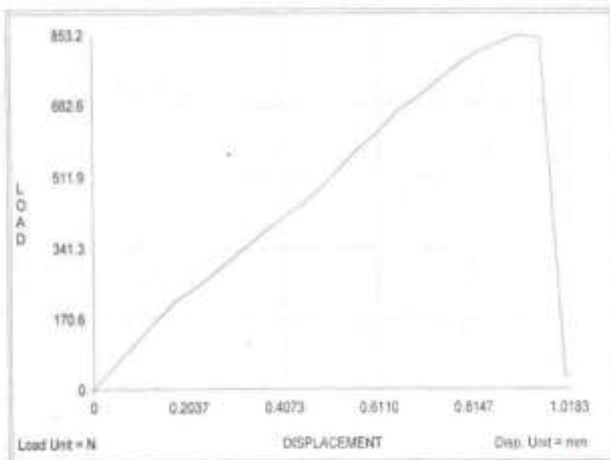

Figure 14: Tensile Test for 80% P+18% Wood fiber +2% Nanoclay.

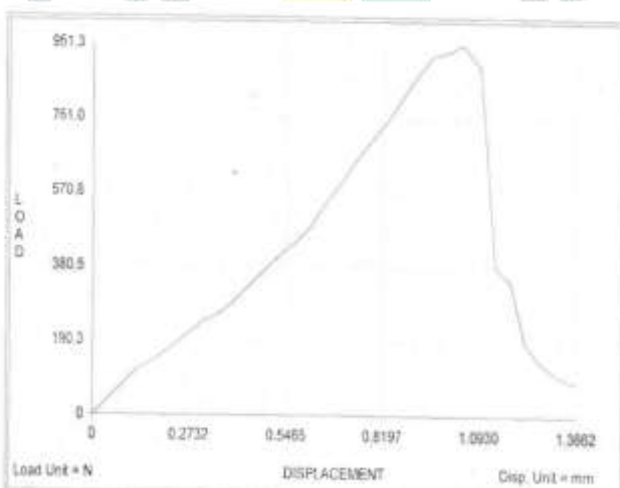

Figure 15: Tensile Test for 70% P+28% Wood fiber +2% Nanoclay.

Table 3.2: Water absorption test results

Type of plastic	**Composition of wood plastic composite**	**Weight of specimen W_2 in gm after immersion period of**		**Oven dried weight -W_1 in gm**	**WA in % for 30 Hours**	**WA in % for 50 Hours**
		30 hours	**50 hours**			
Low density polyethylene (Specimen 1= Specimen 4)	90% P+8% Wood fiber+2% Nanoclay	45.01	45.012	45	0.0222	0.0266
Low density polyethylene (Specimen 2 = Specimen 5)	80% P+18% Wood fiber +2% Nanoclay	45.020	45.029		0.044	0.0644
Low density polyethylene (Specimen 3 = Specimen 6)	70% P+28% Wood fiber +2% Nanoclay	45.028	45.031		0.0622	0.0688

3.4 CONLUSIONS:

From the experimental work conducted the following conclusions can be made

- As the percentage of wood fiber increases compressive strength of wood plastic composite increases.
- As the percentage of wood fiber increases tensile strength of wood plastic composite increases.
- As the percentage of wood fiber increases water absorption capacity of wood plastic composite increases.

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