Study Of Mechanical and Physical Properties of Wood Plastic Composite, Polypropylene, Rose, Teak and Neem Wood

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Abstract— various mechanical and physical tests are conducted on fabricated wood plastic composite according to standards. In order to show how wood plastic composite is better for some applications, tests are also conducted on polypropylene, rose, teak and neem wood. In this study, mechanical and physical characteristics of wood plastic composite have been compared with polypropylene, rose, teak and neem wood. Finally results are analyzed.

Key words: Extrusion, Neem, Polypropylene, Rose, Teak and Wood Plastic Composite

I. INTRODUCTION

Wood plastic composite (WPC) is a combination of wood flour, polymer and small percentage of additives. The concept of wood plastic composite was originated in Italy in 1970. Later it was popularized in North America in 1990s and spreading to Asian countries in the early 21st century. Today WPC is a fast growing sector of the polymer industry. WPCs are used for wide variety of applications such as; automotives, building & construction and for industrial or infrastructure purposes. The application of different woods is well-known.

II. PREPARATION OF WOOD PLASTIC COMPOSITE

The following raw materials are used in the preparation of wood plastic composite: wood flours (50%), polymer (40%) and additives (10%).

A. Wood Flours

Wood flours are the attractive fillers for the wood plastic composite. They are the main ingredients. The commonly used wood flours are the mixtures of teak, neem and some other varieties.

B. Polymer

The polymer used here is polypropylene in powder form.

C. Additives

The commonly used additives are mentioned below.

- Lubricants; Helps in easy movement of wood plastic composite mixture through the processing equipment.
- Coupling agents; improve the interaction of wood and polymer.
- Pigments; provide a desired color to the product.
- Biocides; protect the wood plastic composite from the attacks of insects and fungi.

III. FABRICATION PROCESS

Wood plastic composites are fabricated by Extrusion Technique. The wood flour, polypropylene and additives mixture is poured into the extruder through the hopper (Fig.2). As this mixture of materials enter the extruder, the heated screw and barrel soften/melt the materials. This molten material is then forced through a die to make continuous profile of desired shape. After coming out from the die opening of the extruder machine, WPC material cooled in a water bath and then cut to a final length with desired pattern.

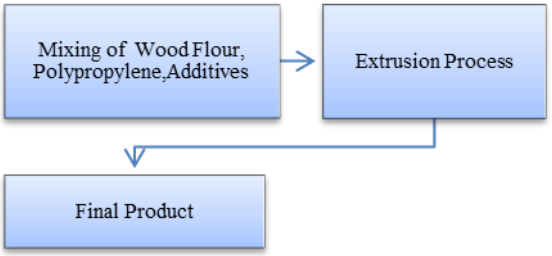

Fig. 1: A typical production flowchart of wood plastic composite

Fig. 2: Co-rotating twin screw extruder machine

IV. EXPERIMENTATION

A. Izod Impact Test

Izod impact test is performed according to ISO 180 to determine the izod impact strength using pendulum impact tester. Izod impact strength is the material ability to capture energy when an object fractures or breaks under a high speed collision. Five specimens of each wood plastic composite, polypropylene (PP), rose, teak and neem woods are used.

1) Specimens Dimensions:

Length: 80mm; Width: 10mm; Thickness: 4mm; Depth below the notch: 8mm.

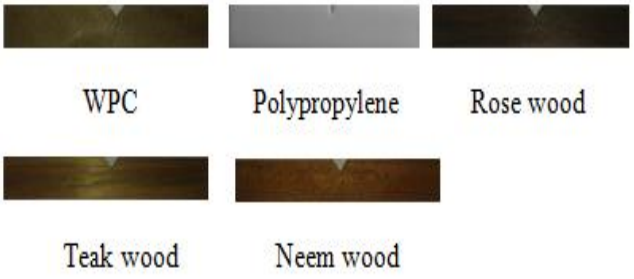

Fig. 3: Specimens used for izod impact test

B. Tensile Test

Tensile test is performed according to ISO 527 to determine tensile strength using universal testing machine. Dumbbell shaped five specimens each of wood plastic composite, polypropylene (PP), rose, teak and neem woods are used.

1) Specimens Dimensions:

Width of Narrow section: 10mm; Length of narrow section: 60mm; Thickness: 4mm; Overall length: 155mm; Overall width: 20mm; Radius of fillet: 60mm.

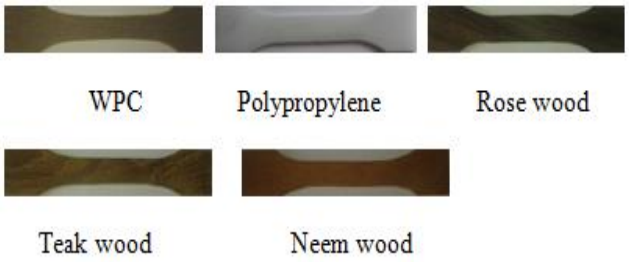

Fig. 4: Specimens used for tensile test

C. Flexural Test

Flexural test is performed according to ISO 178 to determine the flexural strength using universal testing machine. Five specimens each of wood plastic composite, polypropylene (PP), rose, teak and neem woods are used.

1) Specimens Dimensions:

Length: 80mm; Width: 10mm; Thickness: 4mm.

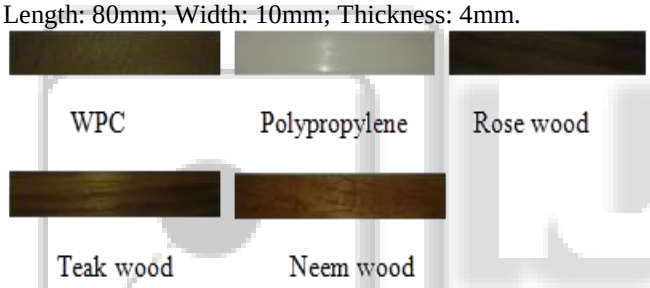

Fig. 5: Specimens used for flexural test

D. Specific Gravity Test

Specific gravity test is performed according to ISO 1183 to determine the specific gravity of the samples using mettler balance equipment. Five specimens of wood plastic composite, polypropylene (PP), rose, teak and neem wood, each weighing 5gms are used.

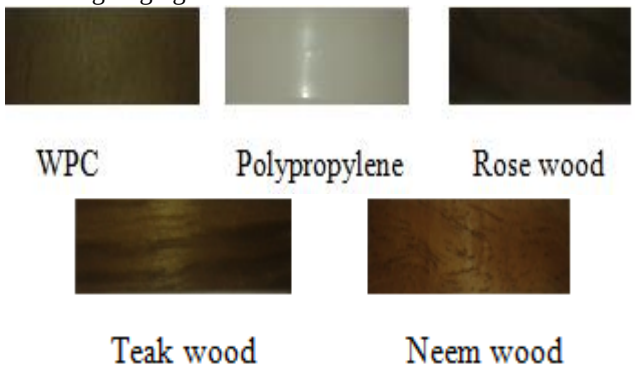

Fig. 6: Specimens used for specific gravity test

E. Moisture Content Test

Moisture content test is performed to determine how much percentage of moisture content occurred in the specimen using moisture analyzer equipment. Five specimens of wood plastic composite, polypropylene (PP), rose, teak and neem wood, each weighing 8gms are used.

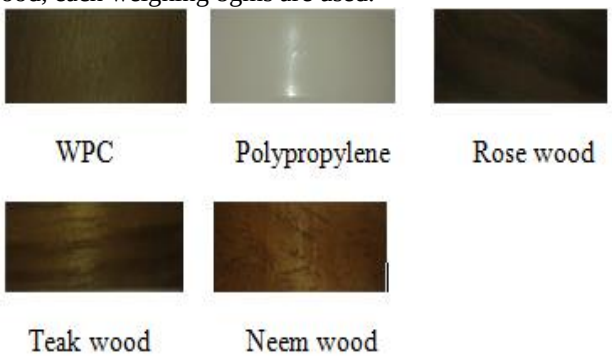

Fig. 7: Specimens used for moisture content test

F. Water Absorption Test

It is performed according to ASTM D570 to determine how much percentage of water absorbed by the specimen. Firstly, all the dried specimens were weighed using weighing machine. Then, each specimen was immersed in separate boxes containing salt water for 24 hrs at room temperature 23.4^{o}C (density of salt water is 10.725kg/m^{3}). After this all the wetted specimens are weighed. Finally water absorption rate is calculated by using the formula, WA (%) = $W_1 - W_0 / W_0 * 100$. Five specimens of wood plastic composite, polypropylene (PP), rose, teak and neem wood are used.

1) Specimens Dimensions:

Length: 50mm; Width: 50mm; Thickness: 3mm.

Fig. 8: Specimens used for water absorption test

G. Heat Resisting Test

This test is carried out to know how much heat is resisted by the specimen by knowing its change of color. It is performed by heating the specimens of wood plastic composite, polypropylene (PP), rose, teak and neem wood with the help of sunlight using straight-shank glass lens. Digital thermometer is used to determine the temperature. Specimens are heated by two ranges of temperatures one is up to 90^{o}C and other one is 120^{o}C.

1) Specimens Dimensions:

Length: 50mm; Width: 50mm; Thickness: 4mm.

Fig. 9: Specimens used for heat resisting test

V. RESULTS AND DISCUSSION

A. *Izod Impact Test: ISO 180*

Specimen material	Izod impact strength (KJ/m^2)
Wood plastic composite	3.38
Polypropylene	3.62
Rose wood	27.53
Teak wood	26.54
Neem wood	16.38

Table 1: Izod impact strength results

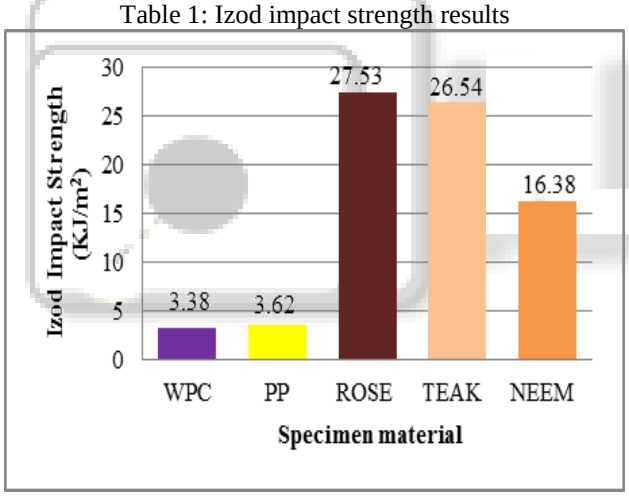

Fig. 10: Izod Impact Strength Chart

From the results, it is seen that the highest value of the izod impact strength is 27.53 KJ/m2 for rose wood and the lowest value is 3.38 KJ/m2 for wood plastic composite.

B. *Tensile Test: ISO 527*

Specimen material	Tensile strength (MPa)
Wood plastic composite	11.42
Polypropylene	31.99
Rose wood	132.23
Teak wood	126.14
Neem wood	66.19

Table 2: Tensile test results

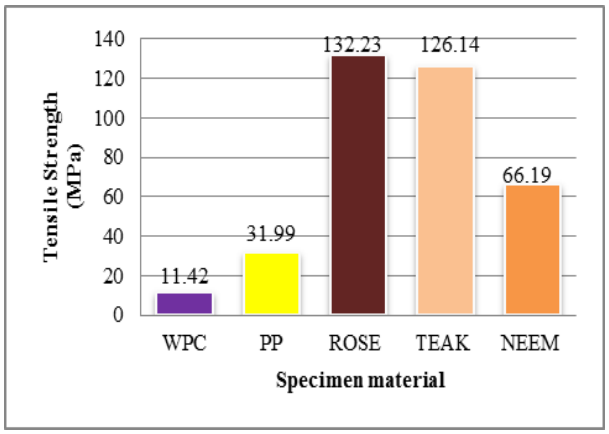

Fig. 11: Tensile Strength Chart

From the results, it is seen that the highest value of the tensile strength is 132.23 MPa for rose wood and the lowest value of the tensile strength is 11.42 MPa for wood plastic composite.

C. *Flexural Test: ISO 178*

Specimen material	Flexural strength (MPa)
Wood plastic composite	25.82
Polypropylene	62.21
Rose wood	203.43
Teak wood	193.29
Neem wood	157.34

Table 3: Flexural test results

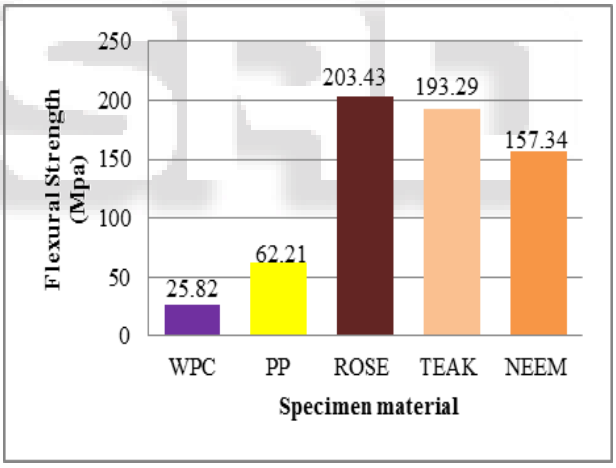

Fig. 12: Flexural Strength Chart

From the results, it is seen that the highest value of the flexural strength is 203.43 MPa for rose wood and the lowest value of the flexural strength is 25.82 MPa for wood plastic composite.

D. *Specific Gravity Test: ISO 1183*

Specimen material	Specific gravity
Wood plastic composite	1.10
Polypropylene	0.89
Rose wood	0.91
Teak wood	0.71
Neem wood	0.68

Table 4: Specific gravity test results

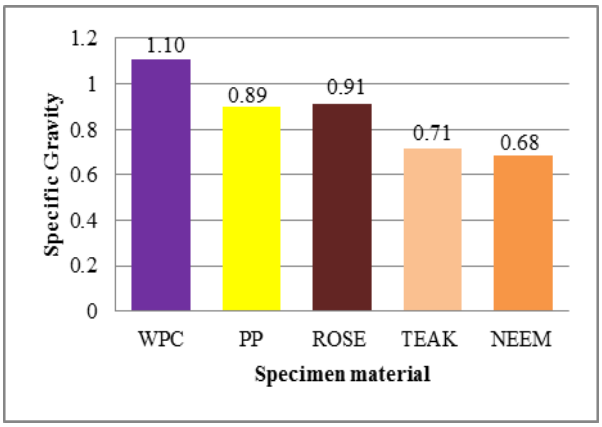

Fig. 13: Specific Gravity Chart

In specific gravity test, it is seen that the highest value of the specific gravity is 1.10 for wood plastic composite and the lowest value is 0.68 for neem wood.

Wood plastic composite's specific gravity is higher than the polypropylene, rose, teak, and neem wood.

E. Moisture Content Test

Specimen material	Moisture content (%)
Wood plastic composite	2.73
Polypropylene	-
Rose wood	2.80
Teak wood	2.65
Neem wood	2.53

Table 5: Moisture content test results

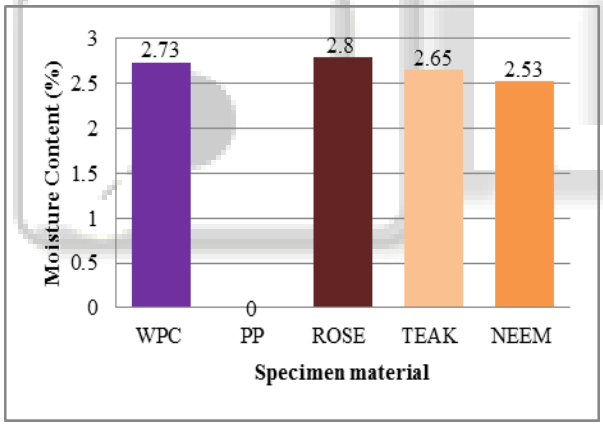

Fig. 14: Moisture Content Chart

In moisture content test, it is seen that the value of the moisture content is 2.73% in wood plastic composite which is less than rose wood and higher than teak and neem wood. But there is no moisture content in polypropylene.

F. Water Absorption Test: ASTM D570

Specimen material	W_0 (gm)	W_1 (gm)	WA (%)
WPC	13.2	13.4	1.51
Polypropylene	5.5	5.5	-
Rose wood	9.6	10.6	10.41
Teak wood	6.9	7.9	14.49
Neem wood	8.4	9.4	11.90

Table 6: Water absorption test results

$WA\ (\%) = W_1 - W_0 / W_0 * 100.$

WA = Water Absorption (%).

W_0 = Specimen weight before immersion (gm).

W_1 = Specimen weight after immersion (gm).

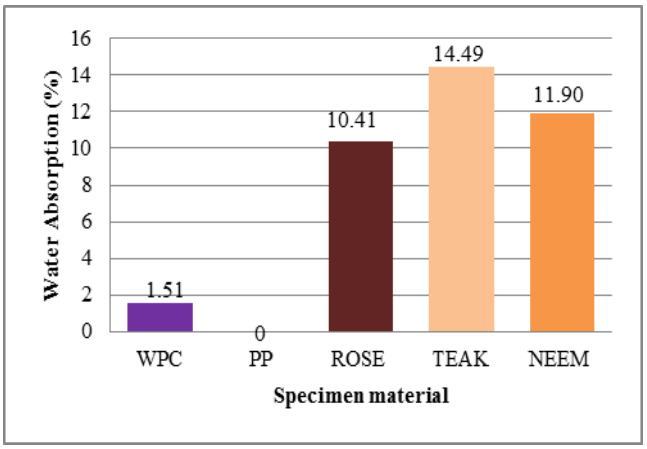

Fig. 15: Water Absorption Chart

In water absorption test, it is seen that the highest value of the water absorption rate is 14.49 % for teak wood and the lowest value is 1.51 % for wood plastic composite.

Wood plastic composite absorbed little percentage of water compared to rose, teak & neem wood, but polypropylene did not absorb any water. From the initial weight, water absorption rate of WPC increased by 0.2% and for rose, teak & neem wood water absorption rate was increased by 1% from the initial weight.

G. Heat Resisting Test

Specimen material	Color change
WPC	Brown
Polypropylene	No
Rose wood	Black
Teak wood	Black
Neem wood	Black

Table 7: Heating the specimens at 90°C

By heating the specimens at 90°C, WPC turns to brown whereas rose, teak & neem wood turn to black. But there is no change of color for polypropylene. This means WPC resist more heat than the rose, teak and neem wood.

Specimen material	Color change
WPC	Black
Polypropylene	No
Rose wood	Dark black
Teak wood	Dark black
Neem wood	Dark black

Table 8: Heating the specimens at 120°C

By heating the specimens at 120°C, WPC turns to black whereas rose, teak & neem wood turns to dark black. But there is no change of color for polypropylene. This means WPC resist more heat than the rose, teak and neem wood.

VI. Conclusion

Mechanical properties viz. Izod impact strength, tensile strength and flexural strength of the wood plastic composite show minimum value compared to polypropylene, rose, teak and neem wood, because some of the raw materials used for WPC are in powder form.

Physical properties such as specific gravity, moisture content, water absorption and heat resisting capacity of wood plastic composite show better results compared to rose, teak and neem wood. Polypropylene

showed better result than the WPC for moisture content, water absorption and heat resisting test except specific gravity test.

It is concluded that wood plastic composite is best suitable for all weather conditions. Moreover wood plastic composite is comparatively cheaper.

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