Physical and Mechanical Properties of Novel Layered Composites of Lignocellulosic filler/Recycled HDPE

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INTRODUCTION

Generally, Wood plastic composites (WPCs) are defined as composite materials containing natural lignocellolusic filler or fibers (such as wood fiber and/or flour, some agriculture residual, kenaf fiber, hemp, sisal, rice hull, etc) and thermoplastic materials (PE, PP, PVC,PS, etc). As for virgin plastics, any recycled plastic that melts and can be processed below the degradation temperature of wood and/or lignocellolusic fillers (around 200 ?C) is usually suitable for manufacturing WPCs [1, 2]. At present, WPCs are mainly manufactured by extrusion and injection molding methods. It is difficult to produce large panels by these processes. The hot press method can be used to produce large panels of WPCs. However, in hot press method simply mixing lignocellolusic dried fillers with plastic have to do. Lack of sufficient strength and appearance beauty of the WPCs have caused that in this study, the effect of layering on properties of WPCs were studied.

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MATERIALS AND METHODS

Novel wood-plastic panels were manufactured using a dry blend/hot press method. Powder of recycled High Density Polyethylene (HDPE) as plastic, flour of wood (beech) and flour of rice hull (as filler), 4 per hundred compound (constant value) of Maleic Anhydride Polyethylene (MAPE) as coupling agent, and beech layer were used to produce the composites in a two-step conventional hot press system. At first, a forming mold frame (measuring 35×35×1cm) was placed on a stainless steel caul plate. A beech layer was set on the plate. Powder of recycled HDPE, MAPE and oven-dried filler with a moisture content of less than 3% were mixed in a high speed mixer at 1500 rpm for 5 minutes (according to Table 1). The compounded materials were poured into the frame on the beech layer and spread to fill the frame evenly. And then another beech layer was flattened on mixed materials. When the forming was complete, the top caul plate was placed on the top of the mat, and the entire assembly was placed into an oil-heated press that was used for compression molding. The press platens temperature was maintained at 170 ?C and the press cycle consisted of two phases. The first phase involved closing of the press for 5 min. In first phase the press was no completely closed and was stopped near the top of mat. In the second phase, the press was closed completely for 10 additional minutes. Then, the caul plate assembly containing the molten wood-plastic was removed from the hot press and placed in a cold press to allow the composites to harden under pressure. According table 1, manufactured composites including, WPCs with a thickness of 6 mm containing 50, 60 and 70% of filler loadings and two beech layers with a thickness of 4 mm, were produced, so the thickness of manufactured composites were 10 mm (Figure 1).

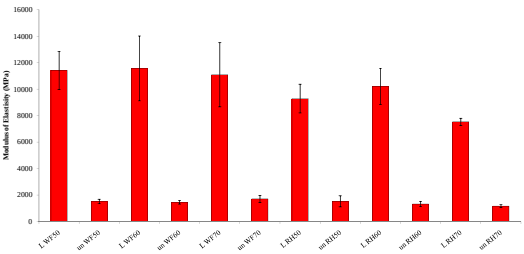

Figure 2. MOE of studied composites

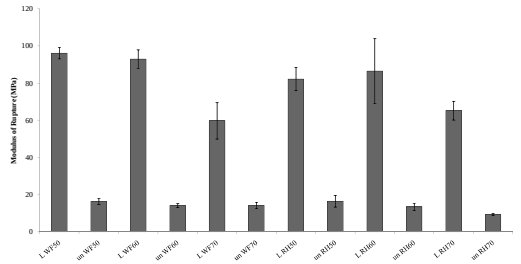

Figure 3. MOR of studied composites

Table 1. Composition of the Studied Formulations.

code	Filler loading(%)	Filler type	layering
L WF50	50	Wood flour	layered
L WF60	60		
L WF70	70		
unL WF50	50		unlayered
unL WF60	60		
unL WF70	70		
L RH50	50	flour of Rice Hull	layered
L RH60	60		
L RH70	70		
unL RH50	50		unlayered
unL RH60	60		
unL RH70	70		

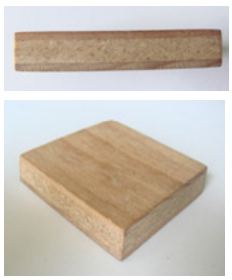

Figure 1. Layered composite manufactured

Table 2. physical and mechanical properties of the Studied Formulations.

Code	Water absorption (%)	Thickness swelling (%)	Screw withdrawal strength on face (N/mm)	Screw withdrawal strength on edge (N/mm)
L WF50	9.3	2.0	137.1 ± 18.8	109.0 ± 7.9
L WF60	12.7	2.2	128.0 ± 4.1	80.0 ± 8.4
L WF70	16.8	2.4	87.6 ± 3.0	53.7 ± 7.2
unLWF50	1.8	0.3	116.0 ± 2.8	80.0 ± 2.0
unLWF60	2.3	0.6	95.7 ± 7.2	74.4 ± 8.4
unL F70	2.8	0.8	55.7 ± 15.0	44.2 ± 4.1
L RH50	9.7	1.9	106.8 ± 3.1	95.2 ± 2.9
L RH60	9.8	2.2	82.4 ± 14.6	71.9 ± 16.4
L RH70	14.1	2.8	84.7 ± 17.4	58.4 ± 4.9
unL RH50	1.4	0.4	86.9 ± 8.9	66.9 ± 7.9
unLRH60	1.9	0.6	74.3 ± 8.2	50.2 ± 7.4
unL RH70	3.3	1.0	49.9 ± 2.7	41.0 ± 1.9

RESULTS AND DISCUSION

Results of flexural properties show that layered WPCs had higher values of MOE and MOR (Figures 2 and 3) than unlayered WPCs. According to Figures, the MOE and MOR of WPCs can be increased up 8 times by adding layers on WPCs. Also, it is observed that composites including flour of wood show higher values of MOR and MOE than rice hull composites. The water absorption and thickness swelling of composites after 2 hours immersed in water are given in Table 2. As it is clearly seen, generally water absorption and thickness swelling increase in layered composites. It can be seen that layer as hydrophilic material has a significant effect on water absorption and thickness swelling of composites [3]. Also, Table 2 indicates that by increasing in filler loading from 50 to 70% water absorption and thickness swelling increased. Also, results of screw withdrawal strength are presented in Table 2. Results of layering revealed that it caused a increase in the screw withdrawal strength [3]. Consequences of screw withdrawal strength in face and edge indicate that layering has positive effect in composites. Also results show that the effect of filer loading (from 50 to 70) on screw withdrawal strength of composites is negative. It was observes that Screw withdrawal strength on face in all WPCs was found to be slightly higher than on the edge. Flour of wood as filer in layered and unlayered WPCs has positive impact than flour of rice hull.

CONCLUSION

- MOE and MOR of layered WPCs increased up to 8 times than unlayered WPCs. WPCs including flour of wood showed high values of MOE and MOR.
- The composites containing wood layer exhibited higher water absorption and thickness swelling. By increasing in filler loading water absorption and thickness swelling increased.
- The layered WPCs indicated high values screw withdrawal strength.
- Screw withdrawal strength on face of all WPCs indicated higher values than edge of WPCs.
- Filler loading from 50 to 70% indicates negative impact on Screw withdrawal strength.

REFERENCES

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