POLYETHYLENE BONDED COMPOSITE CHIPBOARD
Part 2 Machining tests

Marcin Zbieć – Piotr Borysiuk – Andrzej Mazurek

Abstract
Paper deals with milling tests of chipboard bonded with polyethylene. Material made with parameters similar to regular chipboard, but with utilization of 30% of waste polyethylene. Wood-polyethylene boards were thoroughly tested machineability-wise, especially with machining surface temperature, wear ratio and forces in milling, and then compared to regular chipboard.

Key words: *polyethylene,WPC, particleboard, machining, milling*

INTRODUCTION

Particleboards use, especially chipboard show high usage increase year by year. Almost all furniture, home furnishings, and even latest building constructions such as of relatively inexpensive particleboard materials. In case of most popular product, regular chipboard, in most cases urea-formaldehyde resin is being used. This most popular bonding material, has some disadvantages, low environmental resistance, and what is most essential, harmful formaldehyde emission. Wood particles can be however cemented with other substances, such as thermoplasts. In fact, wood-plastic composites show lower mechanical properties than regular chipboard made of wood particles and urea-formaldehyde resin. These composites show also some advantages, higher environmental resistance and lack of harmful emissions, especially valuable in contemporary highly allergic dwelling environment. Usually, wood-plastic composites are made of fine wood fraction thru the extrusion process. This paper deals with machining tests of coarse grain wood-polyethylene composite, being fabricated as a test material from regular industry standard chips and polyethylene coming from waste wrappings, boxes and single-use goods. This type of material shows reasonable mechanical properties, allowing to use waste plastic instead of the regular urea-formaldehyde resin.

MATERIAL AND METHODS

During the experiment three types of the boards were used:

- Regular reference chipboard
- Chipboard bonded with 30% polyethylene

All boards were made of coniferous industrial chips in two variants, with classic urea-formaldehyde resin and with polyethelene recycled from waste wrappings, boxes and single-use goods. Density of all the boards equaled 750 kg/m^3
Boards showed similar density distribution, showed at fig.1

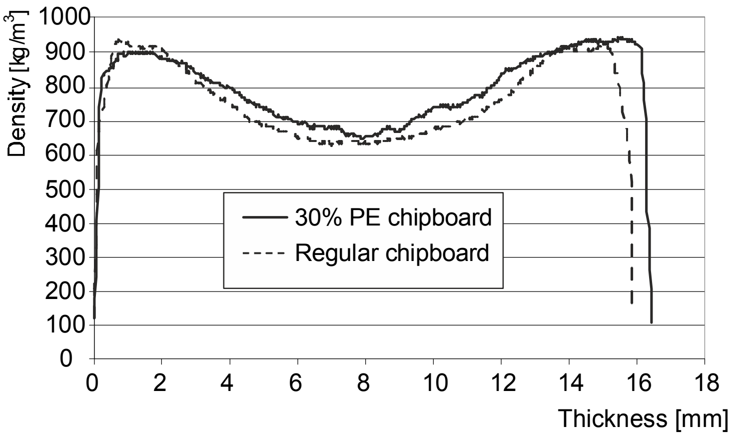


Fig.1 Density distribution of the machined boards

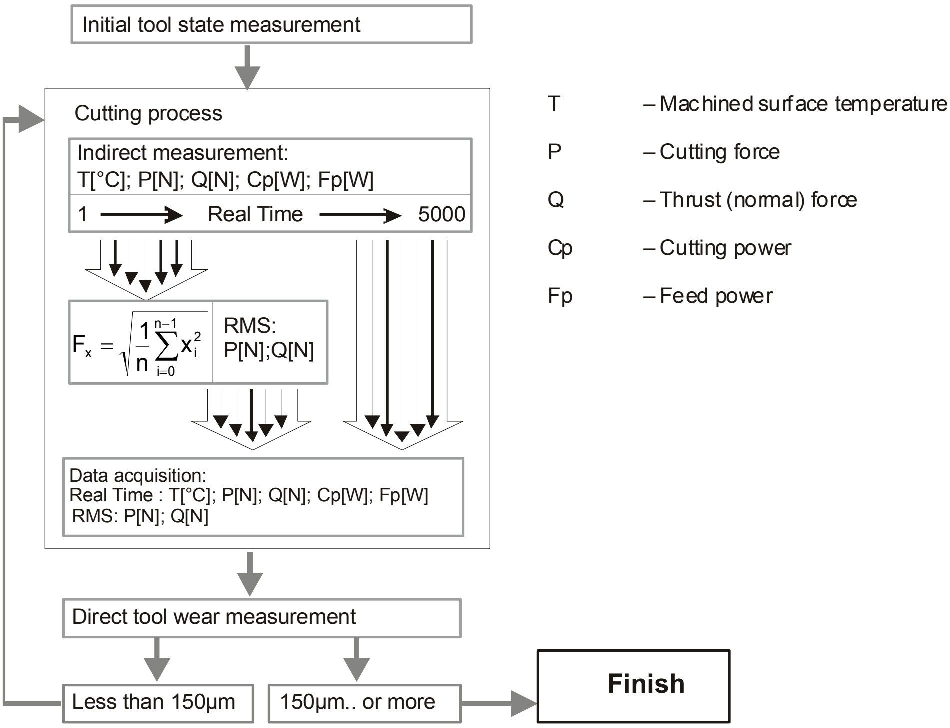
Machining tests consisted of simple edge milling of the manufactured boards, except tool wear following milling parameters were tested:

- Machined surface temperature
- Impact and RMS cutting force
- Impact and RMS thrust (normal)
- Cutting power (not presented)
- Feed power (not presented)

Table 1. Milling parameters

Tool diameter	160mm
Head cutters	1
Milling depth	2mm
Average chip thickness	0,112mm
Rotational speed	3000 rpm
Cutting speed	25,13m/s
Feed speed	3m/min

Basic measurement procedure was presented on figure 2.



$$F_x = \sqrt{\frac{1}{n}\sum_{i=0}^{n-1} x_i^2}$$

Fig.2 Machining test procedure, with simple edge milling.

RESULTS

Machining tests of the wood-polyethylene and control reference boards are presented on the following figures:

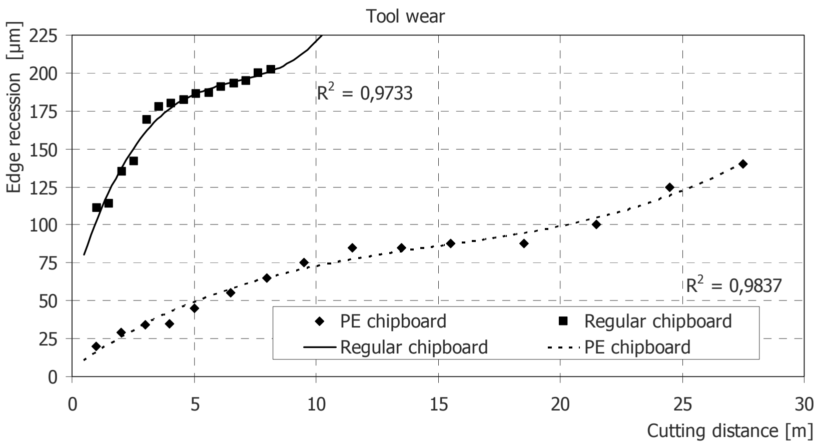


Fig.3 Tool wear in dependence on cutting distance.

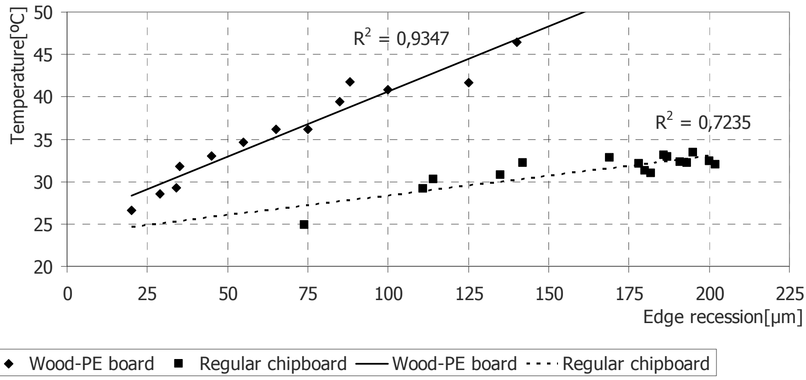


Fig.4 Machined surface temperature in dependence on tool wear.

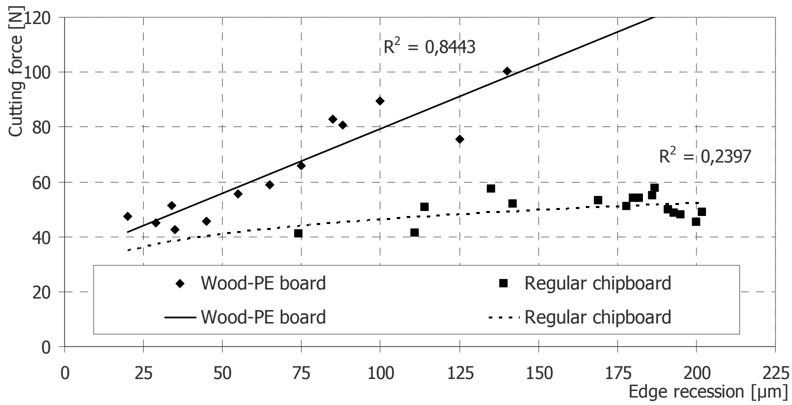


Fig.5 Cutting forces in dependence on tool wear.

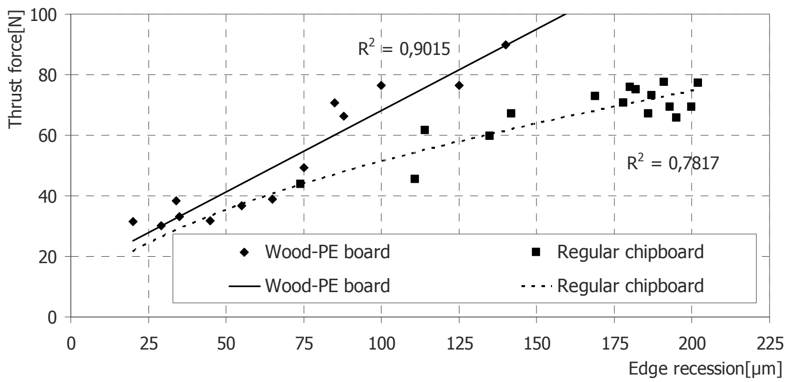


Fig.6 Thrust (normal) forces in dependence on tool wear.

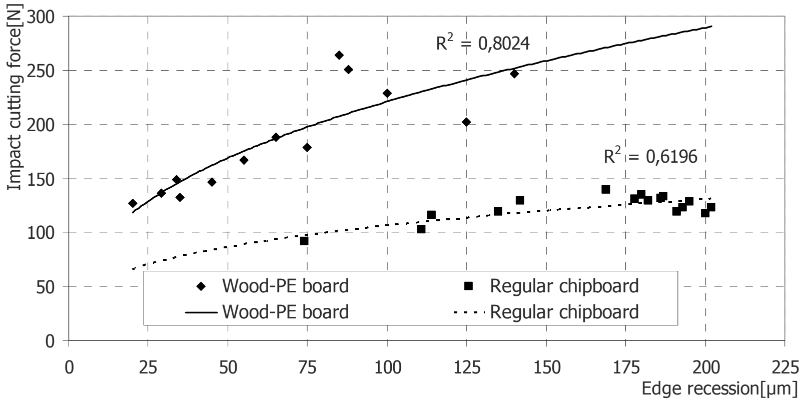


Fig.7 Impact cutting forces in dependence on tool wear.

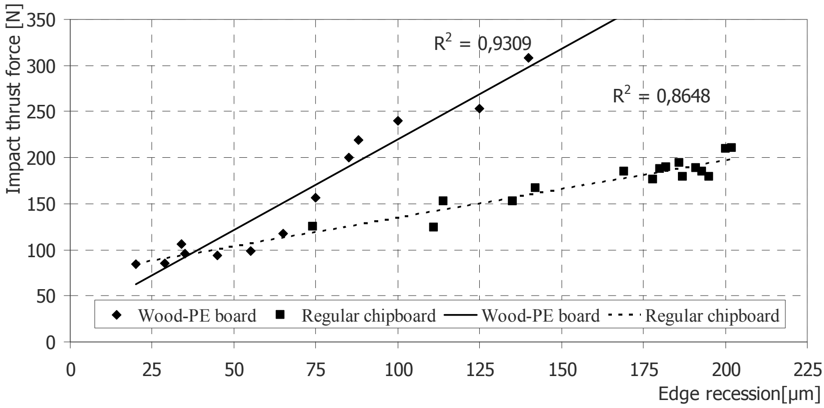


Fig.8 Impact thrust (normal) forces in dependence on tool wear.

DISCUSSION

Determination of the tool wear was the main point of interest during the test. As seen on figure 3 tool wear with wood-PE chipboard is around 10 times lower than in the regular chipboard. It is due to non-crystalline structure of the chipboard bond, despite the similar density distributions tool wear on the thermoplas-bonded board was more uniform in character, not showing typical high density wear zones as with regular chipboard. All other parameters, including machined surface temperature, impact and average cutting and thrust forces were considerably higher in tested composite board. In fact, parameters were uniformly twice as high. Increased temperature however, did not cause any melting of the polyethylene bond, at least traces were not visible on the cutting edge. Increased forces in case of the woodworking machinery should not cause any problems, because of excess construction of the working spindles, supports and engines. Machined surface in the composite chipboard was very clear, non-porous of an excellent quality, worn tools did not cause chip ripping as in regular chipboard.

CONCLUSION

Basing on the performed tests, one may conclude as follows:

- Application of the PE bonded chipboard does significantly increase tool lifetime in the regular usage range (0-150µm of edge recession), performed test showed 10 times increase.
- Temperature, cutting forces and thrust forces when milling of polyethylene bonded chipboard showed significant increase (around 100%) when comparing with regular chipboard.
- Cutting and feed power do not show any significant differences when milling of polyethylene bonded and regular chipboard.
- Polyethylene bonded chipboard seems to be comparable with regular chipboard, have much lower affect on the tool wear process and do not show any properties causing technological process in case of machining.

REFERENCES

1. BORYSIUK P., MAMIŃSKI M., NICEWICZ D., BORUSZEWSKI P., ZADO A., 2008: Waste thermoplastics as binder for green and recycled wood bonding in particleboard manufacturing. Proceedings: International Panel Products Symposium 2008, 24–26 September Espoo, Finland: 249-254.
2. BORYSIUK P., PAWLICKI J., NICEWICZ D., 2006: New types of raw materials in technologies of wood-based materials. Proceedings of COST Action E44-49 Wood Resources and Panel Properties, Valencia, p. 277-281
3. KOWALUK G., PAŁUBICKI B., MARCHAL R., FRĄCKOWIAK I., ZBIEĆ M., BEER P.. 2007: „Friction and cutting forces when machining particleboards produced from different lignocelluloses' raw materials". Annals of Warsaw University of Life Sciences – SGGW, Forestry and Wood Technology No 61 2007 s. 362 - 365.
4. ZBIEĆ M., ROUSEK M., KOPECKÝ Z.. 2006: „ Diagnostic importance of various cutting parameters in milling of MDF. Part I", Annals of Warsaw Agricul. Univ. Forestry and Wood Technology No 59 2006 s. 410-414
5. ZBIEĆ M., ROUSEK M., KOPECKÝ Z.. 2006: „ Diagnostic importance of various cutting parameters in milling of MDF. Part II", Annals of Warsaw Agricul. Univ. Forestry and Wood Technology No 59 2006 s. 415-419.
6. ZBIEĆ M., MAZUREK A., KOPECKÝ Z.. „ Influence of chip thickness on various cutting parameters in milling of chipboard". 5th International Science Conference „Chip and chipless woodworking processes" 12 - 14 października 2006, Stary Smokovec s. 299 - 304.
7. ZDENĚK KOPECKÝ, MIROSLAV ROUSEK, EMIL SVOBODA, MARCIN ZBIEĆ 2006: **„** Problems of measuring the blunting of coated milling knives**",** Annals of Warsaw Agricul. Univ. Forestry and Wood Technology No 58 2006 s. 417-423.
8. ZBIEĆ MARCIN, MAZUREK ANDRZEJ, ROUSEK MIROSLAV 2008: „Tool wear diagnostics in milling of selected wood species. Birch wood". (*Diagnozowanie stopnia stępienia narzędzia przy frezowaniu wybranych gatunków drewna. Brzoza*). Annals of Warsaw University of Life Sciences – SGGW, Forestry and Wood Technology No 66 2008 s. 265-269.