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The quality of the machined surface in the drilling process laminated chipboard.

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Summary: *The quality of the machined surface in the drilling process laminated chipboard.* In this study trials were made eighteen durability tools for different values of the parameters analyzed cut. Based on the results obtained from the study, the influence of selected parameters on the cutting surface quality. Proposed mathematical models using ANOVA, allowing to estimate the surface quality in the test cutting process.

Keywords: drilling, tool wear, surface quality, laminated chipboard

INTRODUCTION

Wood based composites are manufactured from waste wood particles such as saw dust, mill shavings, wood chip and smaller diameter trees. Nowadays wood based composite are replacing the solid wood because, they are cheaper, denser, uniform, defect free and flexible to make products of different shapes. Medium Density Fiberboard (MDF) is a homogeneous material made from wood fibers of softwood mixed with resin and pressed to sheet form. As MDF has high strength, dimensional stability and good machinability, it finds many applications in construction and furniture works. Generally the MDF panels are coated with veneer and other plastic laminates. Drilling is the commonly used machining process in furniture assembly. The quality of drilled surface and damages are associated with machining conditions, cutting parameters, tool geometry, tool and work material, etc [1, 4, 5]. Normally drilling damages like delamination and edge chipping occur in drilling. As these damages reduce the functional performance of the product and appearance, many research works were carried out to study the influence of cutting parameters (such as cutting speed, feed rate), tool geometry and tool material, etc., in drilling of MDF panels. Aguilera et al. [1] found that high density and low chip thickness produce optimal levels of surface roughness in machining of MDF. Davim et al. [2, 3, 4] performed drilling tests to evaluate the delamination on two kinds of MDF panels and observed that spindle speed and feed rate were the dominant factors. They concluded that higher cutting spindle speed reduces the delamination tendency. Gaitonde et al. [5, 6] studied the influence of machining conditions on F_d and concluded that feed rate followed by spindle speed were the most significant factors in minimizing the F_d both at entry and exit of the holes in drilling of MDF panels. They concluded that low feed and high spindle speed produces less thrust force and delamination. Palanikumar et al. [7] investigated the delamination in drilling of MDF and observed that the delamination can be reduced at low feed rates. Prakash and Palanikumar [8] studied the effect of drilling parameters and observed that the increase in drill diameter increases the delamination.Valarmathi and Palanikumar [9] performed drilling experiments on laminated MDF panels to minimize the delamination and found that thrust force developed in drilling can be reduced with high spindle speed and low feed rate. Valarmathi et al. [10, 11] conducted drilling experiments on plain and laminated MDF panels using high speed steel and carbide drills of 10 mm diameter with three different point angles and developed a mathematical model to evaluate the effect of drilling parameters on thrust force. They found that low feed rate and high spindle speed are the preferable cutting conditions to reduce the thrust force in drilling of MDF panels. The present investigation deals with the measurement and analysis of delamination in drilling wood composite panels.

MATERIAL AND METHODS

The experiments are performed on pre-laminated PB of 12 mm thickness with Faba HW drills of diameter 10mm on Buselatto JET 130 CNC vertical machining center with a maximum spindle speed of 18,000 rpm. Experimental set up and drills used for the experiments are shown in Figure 1. Table 1 depicts the properties of PB composites tested.

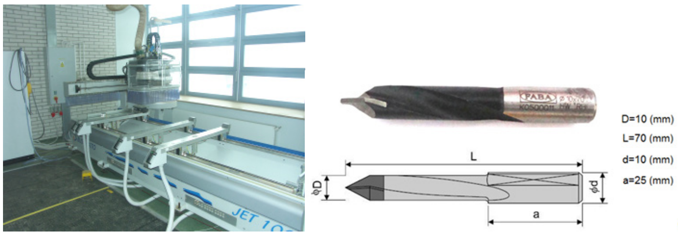

Fig. 1. Experimental setup and drill bits used for the experiments

Table 1. Mechanical and physical properties of laminated chipboard used in research

	Tensile strength (N/mm²)	**Flexural strength** (N/mm²)	**Modulus of elasticity** (N/mm²)	**Moisture Content** (%)	**Density** (kg/m³)
Particle board	0.43	16.39	2453	8	670

Processing parameters with which tests were performed are shown in Table 2 As shown in Table 2 were performed, including durability testing tools. Tests performed to the maximum value accepted indicator of tool wear. Durability experiments of the to the test execution tools consisted of repetitive operations, in which each performed 252 holes. While studies have been conducted eighteen tests of the tool life. The cutting parameters are presented in Table 2.

Table 2. Machining parameters used and their levels

Tool number	Feed (mm/rev)	Cuting speed (m/min)	Speed (min^{-1})
1.	0,2	376,8	12000
2.		376,8	12000
3.		314	10000
4.		251,2	8000
5.		188,4	6000
6.		125,6	4000
7.	0,25	376,8	12000
8.		376,8	12000
9.		314	10000
10.		251,2	8000
11.		188,4	6000
12.		125,6	4000
13.	0,3	376,8	12000
14.		376,8	12000
15.		314	10000
16.		251,2	8000
17.		188,4	6000
18.		125,6	4000

To further characterize the workpiece conducted laboratory measuring its local density (Fig. 2).

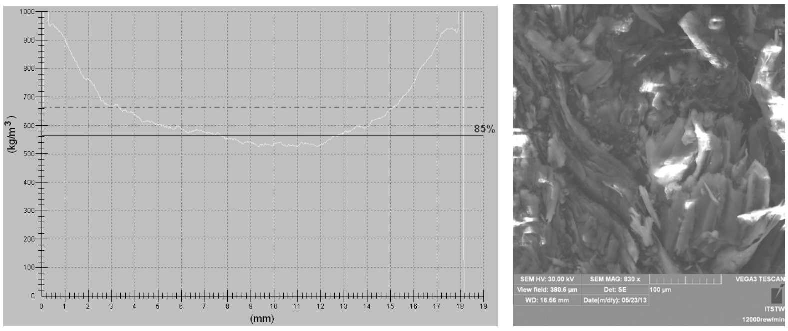

Fig. 2. Medium density profile for laminated chipboard and photo scanning

MEASUREMENT OF DELAMINATION

In our studies as a tool wear indicator assumed VB_{max} = 0.2(mm). Measurement of tool wear was performed on the microscope Mitutoyo TM. with drop-on eyepiece digital camera with a resolution of 600 dpi, which allows image archiving tool performed on a personal computer.

In order to determine the quality of the surface around the hole in the study it was decided to adopt the two most commonly used indicators: the maximum radius R_{max} of the laminate was pulled and torn surface area of the laminate A. The two ratios were determined at the entrance of the tool into the material workpiece. In this way determined by two indicators of symbols: A_{wej}, R_{wej}. To determine the accepted indicators recorded images were processed in the LabView environment (Fig. 3).

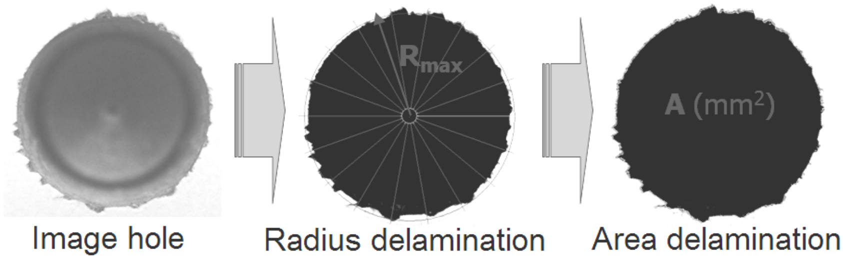

Fig. 3. Digital image processing in the LabView environment

THE TEST RESULTS

The table below presents the results of the study, in which, with the help of ANOVA analyzed delamination area of the laminate at the entrance of the drill into the material (Awej) and the maximum radius delamination laminate at the entrance of the drill into the material (R_{wej}), using three different feed rates (f), five-speed (v_c) and four compartments of tool wear (V_{Bmax}). The analysis (Fig. 4) rejected (at significance level p = 0.000) hypothesis about the lack of impact factor V_{Bmax} on the area of delamination laminate (A_{wej}). So we can say that the value of tool wear significantly affect the process of delamination laminate, using as an indicator of measurement (to assess the magnitude delamination) - delamination area of the laminate (A_{wej}). Similar conclusions can be drawn in relation to the effect of cutting speed (v_c). It is noted here as well (at the significance level p = 0.000) significance of the effect of cutting speed on the torn area of the laminate. While the impact of the feed (f) is statistically insignificant (at the significance level p = 0.139). In summary, both the change in the value of cutting speed and wear significantly affects the area of the delamination laminate (A_{wej}), while a change in the feed rate has no significant effect. There was also an interaction (statistically significant) between the studied factors.

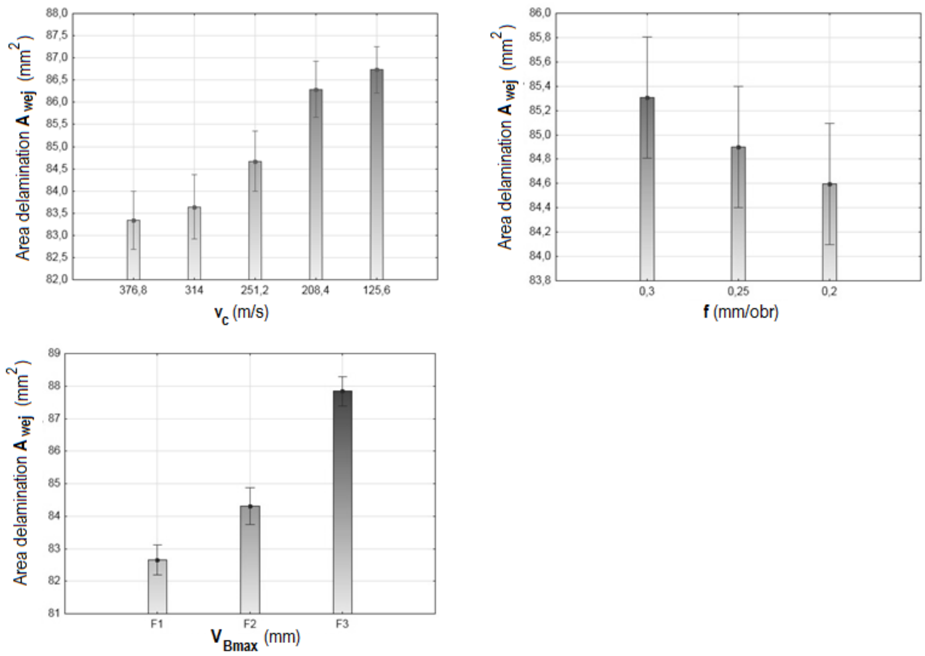

Fig. 4. The influence of cutting parameters on the value of the damage to the laminate surface at the entrance of the drill into the material (Awej)

The analysis (Fig. 5) rejected (at significance level p = 0.000) hypothesis about the lack of influence of VBmax and f for the maximum radius of delamination (Rwej). So we can say that the value of tool wear and feed significantly affect the process of delamination, using as an indicator of measurement (to assess the magnitude delamination) - maximum radius delamination (R_{wej}). There was no effect of cutting speed on the maximum radius delamination. In summary, both the change in the value wear and feed significantly affects the maximum radius delamination (R_{wej}). There was also an interaction (statistically significant) between the studied factors.

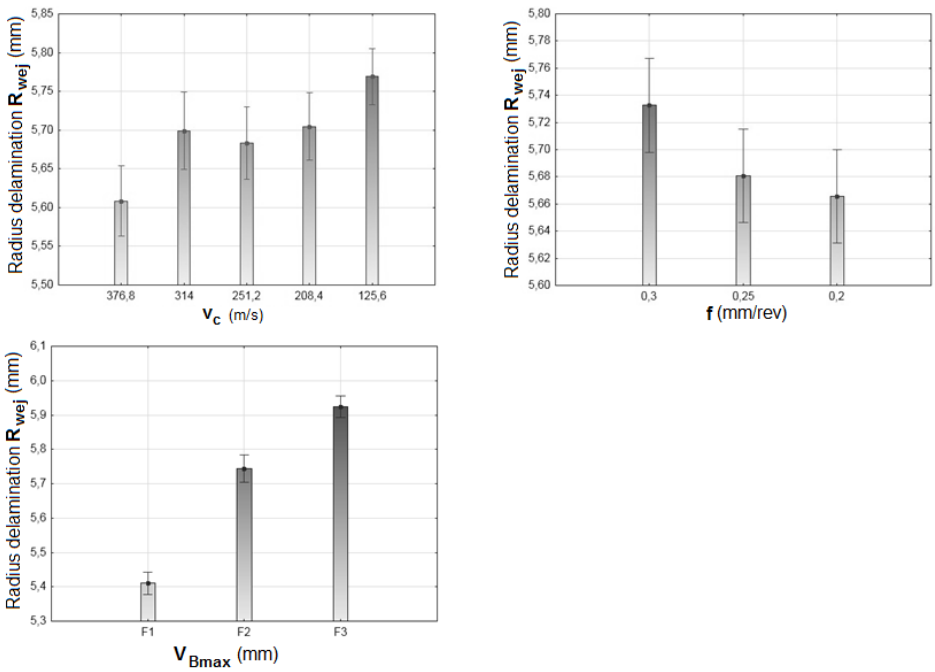

Fig. 5. The influence of cutting parameters on the value of the maximum radius of damage to the laminate at the entrance of the drill into the material (Rwej)

Assessed the studies performed made an estimate of the maximum radius delamination (R_{wej}) and the delamination area of the delamination (A_{wej}) using linear regression. This resulted in dependence described equations 1 and 2.

$$A_{wej} = 80.75 + 50.27 * VB - 0.008 * v_c \quad (1)$$

$$R_{wej} = 5.22 + 3.83 * VB + 0.35 * f \quad (2)$$

CONCLUSION

On the basis of the analysis and received on the basis of its dependencies 1 and 2 can be seen that the maximum radius delamination (R_{wej}) strongly depends on both the tool wear what feed rates. The surface area of delamination (A_{wej}) depends on both how the tool wear cutting speeds.

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Streszczenie: *Jakość powierzchni obrobionej w procesie wiercenia płyty wiórowej laminowanej*. W przeprowadzonych badaniach wykonano osiemnaście prób trwałościowych narzędzia dla różnych wartości analizowanych parametrów skrawania. Na podstawie wyników uzyskanych z przeprowadzonych badań określono wpływ wybranych parametrów skrawania na jakość powierzchni obrobionej. Zaproponowano modele matematyczne, wykorzystując analizę wariancji *ANOVA*, pozwalające oszacować jakość powierzchni obrobionej w badanym procesie skrawania.

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