Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology No 90, 2015: 146-149
(Ann. WULS - SGGW, For. and Wood Technol., 90, 2015)

Effect of feed rate on cutting forces during drilling raw particleboard, laminated particleboard, MFP and OSB

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Abstract: *Effect of feed rate on cutting forces during drilling raw particleboard, laminated particleboard, MFP and OSB*. The paper describes the relationship between feed speed and drilling torque or feed force. The aim of the study was to compare the machinability of mentioned above materials by means of tool forces and power consumption method.

Keywords: particleboard, MFP, OSB, axial force, drilling, machinability

INTRODUCTION

Raw particleboard, particleboard, MFP (Multi Functional Particleboard – P5 type) and OSB are popular wood-based material, which are often used in practice. Drilling in wood-based materials is one of the most common processes in the wood industry or furniture manufacturing (***Podziewski, Górski 2010, 2011***).

A present-day wood industry is apparently based on a serial or even mass production. From the other hand we can observe the customization of products up to quite different, specific orders. The effective and fast technological preparing of the specific production becomes the more and more important service, which requires adequate methods. Sometimes there is no such trite thing like standard (typical) product and we have to deal with great variety of construction and structure problems. Moreover we have one fundamental, economic problem - the reduction in production costs is always demanded.

Works concerning technological preparing the production and every machining process are bringing such issues up among others as (***Morek 2012***):

- engineering knowledge bases for expert systems assisting the CAM in frames selection of machining parameters,
- algorithms of the selection of the toolkit for more than one technological operation,
- optimization of parameters of processing, including paths of the tool,
- physicochemical phenomena occurring as part of the process of processing.

A part of optimizing a production process is the use of knowledge about machinability of different construction materials. The work is focused on a machinability of some wood-based material observed during drilling process. One of basic criterion of the machinability was taken into consideration: cutting forces. Therefore the feed force and the cutting torque were measured.

MATERIALS AND METHODS

The test object was set of four standard wood-based materials: raw particleboard, laminated particleboard, MFP and OSB. All samples were 18 mm thick. Drilling was carried out using a standard CNC machine BUSELLATO Jet 130. The new Leitz single bladed drill with a cutting edge made of polycrystalline diamond (ID No: 091193) 10 mm diameter was used. During drilling (by means of the mentioned above tool) the drilling torque and feed force were monitored using the measurement platform with a piezoelectric sensor Kistler

9345. Drilling was conducted in series of 20 holes for each feed speed, what resulted in 140 measurements per material.

The scheme of the measuring path used during experiments is presented in Fig. 1. Measuring signals were being recorded on a computer PC class with the data acquisition card (National Instruments PCI-6111) in the LabVIEW environment. The card allowed the recording of the signal sample with the frequency of 50 kHz.

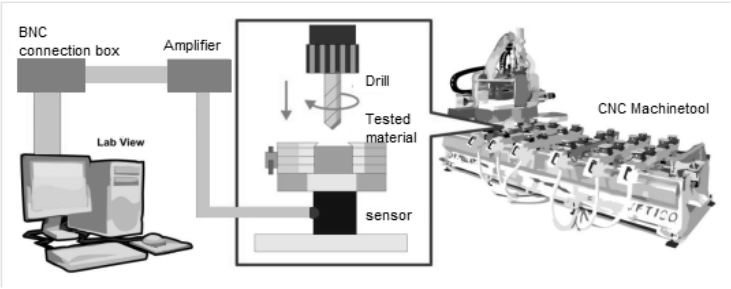

Fig. 1 Outline of the measuring path

The following results of measurements of axial forces (table 1) and drilling torque (table 2) were obtained.

Tab. 1 Mean value of axial force [N] for indicated values of the feed per revolution

Materials:	**Feed per revolution [mm/rev]:**						
	0,1	**0,15**	**0,2**	**0,25**	**0,3**	**0,5**	**0,7**
Mat.1 - Raw particleboard	64,83	75,1	81,05	91,39	95,5	119,89	147,56
Mat. 2 - Laminated Particleboard	75,29	83,09	94,3	101,32	111,75	132,96	146,35
Mat. 3 - MFP	67,87	83,43	92,16	102,47	115,23	161,07	186,07
Mat. 4 - OSB	62,6	63,12	83,13	88,88	99,07	125,68	160,51

Tab. 2 Mean value of the drilling torque [Nm] for indicated values of the feed per revolution

Materials:	**Feed per revolution [mm/rev]:**						
	0,1	**0,15**	**0,2**	**0,25**	**0,3**	**0,5**	**0,7**
Mat.1 - Raw particleboard	0,23	0,25	0,28	0,31	0,34	0,38	0,46
Mat. 2 - Laminated particleboard	0,23	0,27	0,28	0,31	0,31	0,41	0,47
Mat. 3 - MFP	0,23	0,26	0,28	0,31	0,33	0,42	0,48
Mat. 4 - OSB	0,22	0,22	0,26	0,29	0,3	0,4	0,46

Comparing the machinability during drilling in various materials (from a point of view of the cutting forces criterion) it is clear, that the greater machinability manifests itself with lower values of force accompanying the processing (of course under analogous conditions of the cutting). This rule doesn't enable putting studied materials in explicit order on account of the machinability during drilling. The question arises, which forces appearing in the cutting zone are more important - whether the axial force or the torque of the cutting. It is hard to get out of this dilemma. The considerable value of axial force is causing buckling or even breaking of drill bits (especially of small diameters) and is hampering the completion of the

feed (what is especially important when the feed is realized manually). However the considerable value of the torque is supporting so-called twisting off of drill bits of small diameters and is causing the bigger power consumption of the machines main drive.

The effect of feed rate on the cutting force and torque is presented in Fig 2 and Fig 3 (mat.1 – raw particleboard; mat.2 – laminated particleboard; mat.3 – MFP; mat.4 – OSB).

It is worth noting a following relationship: some of the materials (this is particularly evident for the first three of them) change the order when it comes to values obtained for subsequent feed rate. The order (ranking) are different for axial force and torque. Moreover the impact of the feed rate can be observed. From practical point of view the most important cutting parameters are values recommended by producers of tools. In this case the recommended feed per revolution was 0,15 mm.

Among the tested materials clearly stood out particleboard type P5 (MFP) that, especially for higher feed speed, obtained the highest values of the measured forces.

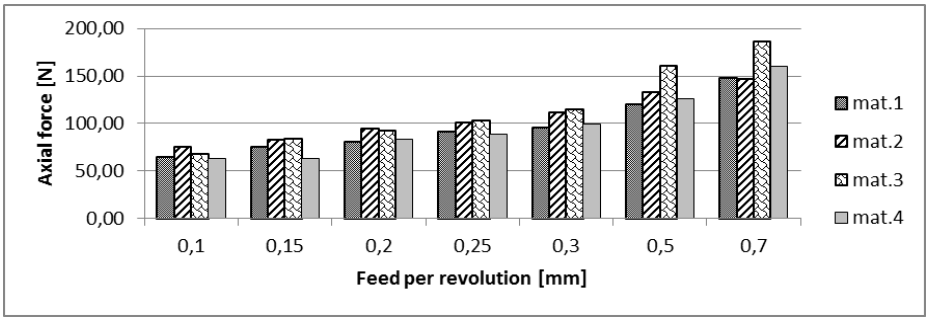

Fig. 2 Value of forces axial [N] for indicated values of the feed per the revolution

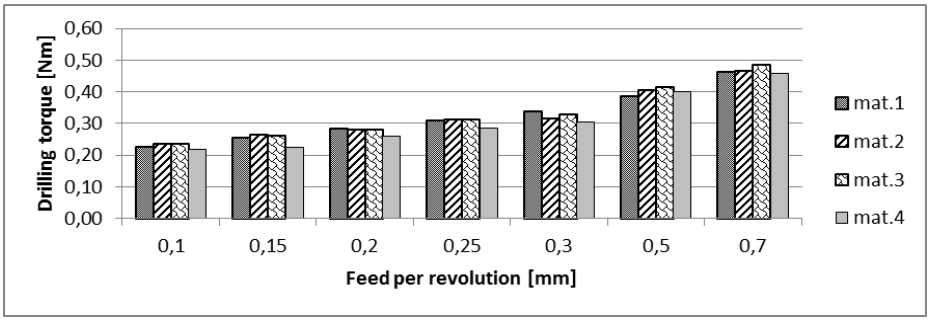

Fig. 3 Value of the torque [Nm] for indicated values of the feed per the revolution

CONCLUSIONS

The obtained results allow to formulate the following conclusion: the feed per revolution had a significant linear effect on both the feed force and torque.

The complete characterization of the material requires an analysis of both criteria - the axial force and the drilling torque.

In case of MFP at big values of the feed force for feed per revolution of (0,5 mm and 0,7 mm) are significantly higher than in cases of drilling in remaining materials which were tested.

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Streszczenie: *Wpływ prędkości posuwu na siły skrawania podczas wiercenia w płycie wiórowej surowej i laminowanej oraz w płycie MFP i OSB*. W artykule opisano wpływ prędkości posuwu na siły skrawania powstające podczas wiercenia otworów w typowych materiałach drewnopochodnych. W czasie wiercenia rejestrowano sygnał siły osiowej i momentu obrotowego skrawania. Celem badań było porównanie skrawalności wybranych materiałów wg kryterium sił skrawania i energochłonności obróbki.

Acknowledgement: *This paper was prepared in connection with the project „Machinability of wood based materials", which was financed by the Polish Ministry of Science and Higher Education (No. N N309 007537 grant).*

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