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PRELIMINARY IDENTIFICATION OF THE FEED SPEED INFLUENCE ON CHOSEN EFFECTS OF LAMINATED PARTICLEBOARD DRILLING

The aim of the investigations was to determine the influence of the feed speed during drilling on the multi-spindle drilling machine on the affluence height of the machined laminated particleboards. It was noticed that the affluence height got lower with the feed speed increase up to about 0.4 m/min, above this value the affluence height was stable till the speed reached about 2 m/min and above this feed speed value the affluence height became higher. The results of the investigation show that the optimal feed speed, i.e. the speed allowing to achieve the best quality of drilling of particleboards covered with chosen edge bands, is the feed speed in the range of 0.4–2 m/min.

Keywords: drilling, feed speed, laminated particleboard

Introduction

The contemporary development of techniques and technologies provides a wide range of possibilities in terms of wood and wood-based material machining. There are high-tech machines which give opportunity of high machining efficiency. One of the limitations of the machining efficiency increase is the necessity to obtain the proper quality. This proper quality can be achieved by using proper technological parameters.

In most wood machining techniques the feed speed is the easiest technological parameter to be changed when a machining efficiency increase is needed. In the case of chosen machining techniques, i.e. sawing or turning, the influence of the feed speed on the machining quality is already known. But in the case of

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drilling the importance of the feed speed is more often ignored and the feed speed value is increased to a maximum. The reason for this situation is the lack of information about the influence of the feed speed during drilling on drilling quality. Single, general publications concerning this matter describe the influence of the feed speed on the quality of particleboard drilling, but without any reference to the most commonly used tools and machining techniques [Taylor, Lemaster 2006]. This causes difficulties in applying investigation results to industrial machining parameter adjustment.

The aim of the investigations was to determine the influence of the feed speed during drilling on the multi-spindle drilling machine on the quality of machined laminated particleboards measured as the machined material affluence height.

Materials and methods

Machine

The machining was conducted on a typical industrial multi-spindle drilling machine. The rotation speed of the spindles was about 2880 min^{-1} . The movement of the working unit was caused by a pneumatic actuator. The following 10 feed speeds were chosen for investigations: 0.18, 0.27, 0.4, 0.6, 0.75, 0.92, 1.35, 1.99, 2.47, and 3.09 m/min. Two different depth of drilling were used as well: 5 and 30 mm. The feed direction (hole axis) was parallel to the wide surface of the panel. Before machining a technical inspection of the machine was carried out.

Tools

Two types of 8 mm diameter drills were used in the investigations:

- screw drill, with the centric spike, with pre-cutting edges placed on the main cutting edge, one-material, with additional calibrating edge, with a screw grip and the centric cone (D1);
- screw drill, with the centric spike, with pre-cutting edges placed on the additional cutting edge, one-material, with additional calibrating edge, with a cylindrical grip (D2).

The criterion for the selection of tools was the repeatability of the essential parameters of the drill's working section.

Material

Typical commercially-available particleboards with three different narrow surface materials (edge bands) were used in the investigations:

- smooth, paper-based, 0.8 mm thick,

- porous-like, paper-based, 0.3 mm thick,
- HPL, 0.7 mm thick.

The drilling of the narrow surface of the panel which was previously covered with the above-mentioned edge band is not a common way in which particle-boards are machined in industry. The reason for using such machining method was on the one hand easier machining on the multi-spindle drilling machine, and on the other hand improvement to the affluence height measuring. The height of material affluence, in this research called the quality of drilling, was measured in the passing light using the workshop microscope (fig. 1).

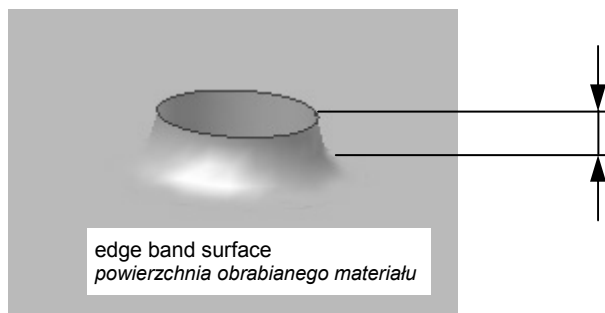


Fig. 1. The idea of affluence height measurement
Rys. 1. Koncepcja pomiaru wysokości napływu

Results and discussion

The results of the 5 mm-depth drilling with D1 drill are shown in fig. 2. At a slow feed speed (lower than 0.5 m/min) the height of the machined material affluence for all machined surfaces is quite similar. And what can be interesting the affluence height is lower as the feed speed increases up to about 1 m/min. Above this feed speed value the height of the affluence increases (quality of drilling becomes lower). The smallest influence of the feed speed on the affluence height at 5 mm depth is observed for smooth edge band. The biggest changes almost 0.6 mm of the affluence height are noticed for HPL edge band.

The influence of the feed speed changes during 30 mm-depth drilling with D1 drill on the affluence height is shown in fig. 3. It can be seen that the situation is similar to the results of drilling with the same drill to 5 mm depth. As the feed speed increases up to about 1 m/min a lower affluence height can be observed. Over this value the affluence height becomes higher. The smallest changes of the affluence height are noticed for smooth edge band and the biggest for HPL edge band. It should be pointed out that the quality (the value of the affluence height) after machining with the highest feed speed is better for the

smooth edge band than the quality of drilling of this material with the slowest feed speed. It means that there is no necessity of keeping the feed speed slow; it can be even better to increase the feed speed up to about 2.5 m/min. Also for HPL edge band type the increase in the feed speed up to about 2 m/min can improve the drilling quality.

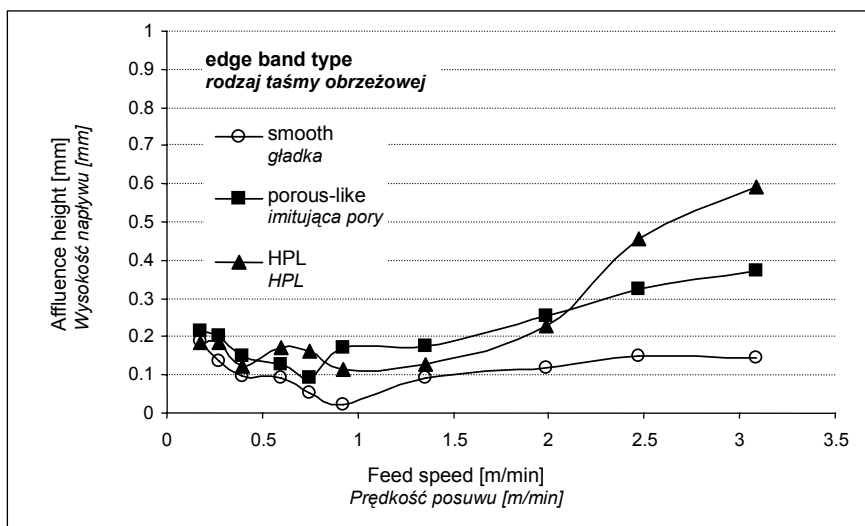


Fig. 2. The dependence of the affluence height on the feed speed observed for D1 drill and the drilling depth of 5 mm

Rys. 2. Zależność wysokości napływu od prędkości posuwu dla wiertła D1 oraz głębokości wiercenia 5 mm

The machined material affluence heights for the different feed speeds when drilling with D2 drill to 5 mm depth are displayed in fig. 4. It is clearly visible that after a small improvement of the drilling quality (low affluence height) with the feed speed increase up to about 0.4 m/min the increase in the affluence height can be observed for all investigated particleboard edge covers; in this case the smallest affluence height changes are observed for HPL and the highest for porous-like and smooth edge covers. It can be pointed out that the highest values of the affluence height are similar for D1 and D2 types of drill (less than 0.6 mm). It should be also mentioned that the quality of drilling of the HPL edge band yields the best results in the range of the feed speed between 0.5 and 2 m/min.

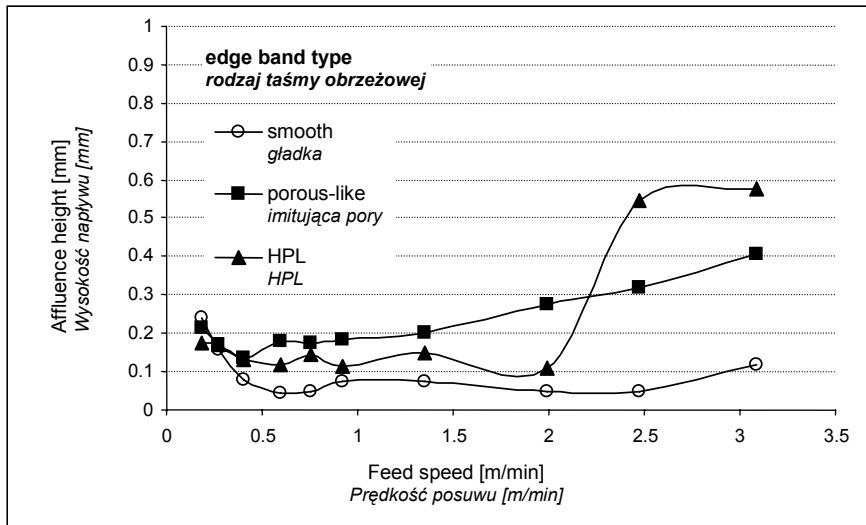


Fig. 3. The dependence of the affluence height on the feed speed observed for D1 drill and the drilling depth of 30 mm

Rys. 3. Zależność wysokości napływu od prędkości posuwu dla wiertła D1 oraz głębokości wiercenia 30 mm

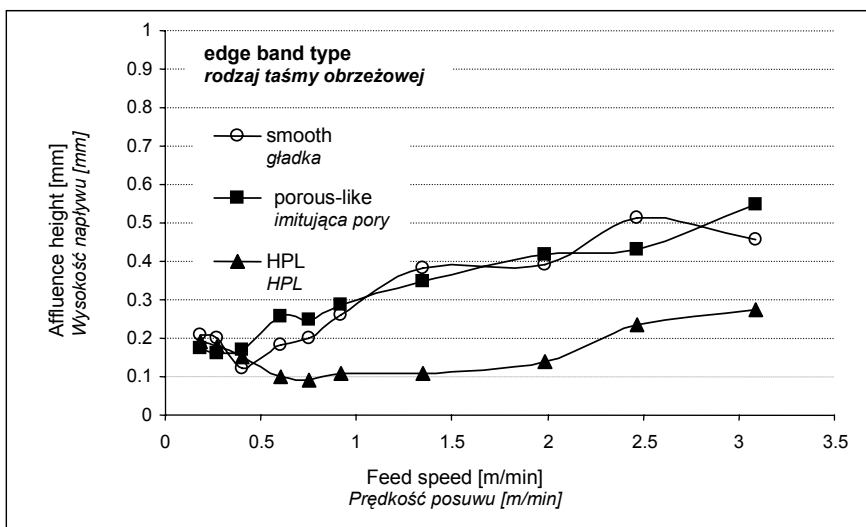


Fig. 4. The dependence of the affluence height on the feed speed observed for D2 drill and the drilling depth of 5 mm

Rys. 4. Zależność wysokości napływu od prędkości posuwu dla wiertła D2 oraz głębokości wiercenia 5 mm

The results of drilling with D2 drills to 30 mm depth are shown in fig. 5. According to this figure the affluence height initially decreases till the moment when the feed speed reaches 0.4 m/min and above this value the affluence height becomes higher for all investigated edge band types. The highest affluence height after drilling was measured for porous-like edge band and the lowest for HPL edge band. It can also be pointed out that the optimal affluence height can be achieved at the feed speed between 0.4 and 2 m/min; above this feed speed value the affluence height increase is observed.

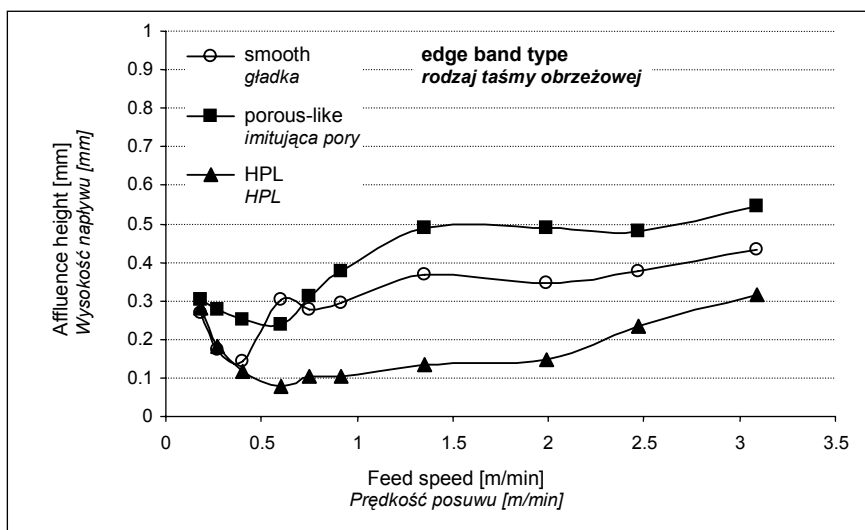


Fig. 5. The dependence of the affluence height on the feed speed observed for D2 drill and the drilling depth of 30 mm

Rys. 5. Zależność wysokości napływu od prędkości posuwu dla wiertła D2 oraz głębokości wiercenia 30 mm

Looking at the above described results it can be noticed that the differences between the drill types used in the research have no clear and significant influence on the affluence height of all machined edge bands. During drilling of smooth edge band a higher affluence height for D2 drill type was observed. When porous-like edge band was machined no significant influence of the drill type on the affluence height was found. The higher affluence height for D1 drill was observed when drilling HPL. Therefore the above-mentioned results do not allow affirmation as to what is the influence of the drill type on the affluence height. According to Taylor and Lemaster [2006] there is a strong correlation between the drill type and the quality of a hole entry and exit edge quality. This remark can be explained by the fact that totally different types of drills were

used in Taylor and Lemaster [2006] investigations: saw tooth Forstner bit, standard Forstner drill bit, standard twist drill, brad point drill. The results achieved by the above-mentioned scientists confirm also a decrease in the quality of drilling when the feed speed exceeds 2.5–3 m/min. A local decrease in the quality of drilling, when the rotation speed is constant and the feed speed is below 0.4 m/min, can be caused by too small force parallel to feed direction which is the result of the feed speed. If this force is too small the machined material is torn-off and the created chip is incorrect. With an increase of the feed speed up to 0.4 m/min the force parallel to feed speed increases as well and machined material is pressed during cutting and the created chip is more correct. To confirm this notion additional investigations are needed, including theoretical modelling.

Conclusions

The research conducted shows that from the affluence height perspective there is an optimal feed speed during drilling for all investigated edge band types and for both drill types used. This optimal feed speed range is between 0.4 and 2 m/min. It is worth stressing that reducing the feed speed below 0.4 m/min during drilling leads to an affluence height increase. At the same time an increase in the feed speed over 2 m/min causes a drilling quality decrease (higher affluence height). Therefore it can be recommended to increase the feed speed in the above-mentioned range to achieve high drilling efficiency with the optimal machining quality.

References

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WSTĘPNA IDENTYFIKACJA WPLYWU PRĘDKOŚCI POSUWU NA WYBRANE EFEKTY WIERCENIA PŁYT WIÓROWYCH LAMINOWANYCH

Streszczenie

Celem badań było określenie wpływu prędkości posuwu, podczas wiercenia na wiertarce wielowrzecionowej, na wysokość napływów obrabianego materiału powstających po obróbce. Zbadano płyty wykończone trzema różnymi typami taśm obrzeżowych. Stwierdzono, iż wysokość napływu obrabianego materiału jest mniejsza przy wzroście prędkości posuwu do wartości 0,4 m/min, powyżej tej wartości do 2 m/min stabilizuje się, natomiast po jej przekroczeniu powstają napływy o większej wysokości. Wyniki badań wykazały, iż optymalną prędkością posuwu przy wierceniu jest przedział wartości od 0,4 do 2 m/min.

Słowa kluczowe: wiercenie, prędkość posuwu, płyta wiórowa laminowana