THE TOOL INFLUENCE ON THE QUALITY OF THE BIRCH WOOD STRAIGHT MILLED SURFACES

Fotin, A.; Cismaru, I; Cismaru, M. Cosereanu, C; Brenci, L.M. & Curtu, I.

Abstract: The paper presents the results on the quantitative assessment of the quality of the straight edge surfaces when longitudinally and transversally milling the birch wood surfaces using two types of milling cutters of 80 mm diameter: one with removable metal inserts and one with brazable inserts. Variable parameters as processing direction, rotative speed, feed speed, cutting height and the milling width were considered. The results prove that a better quality of the surface is obtained when milling it with cutters with removable metal inserts. The final conclusion may contribute to the rehabilitation of the Betula pendula (birch wood) status, by changing the attitude of the specialists regarding the possibilities of using it on a large scale in industry.

Key words: birch, surface quality, roughness, milling cutters.

1. INTRODUCTION

The actual tendency is to develop the international (and also national) basis of raw materials using the less representative species of wood for products or components, or in the structure of wooden composites. Thereby, more and more specialists in Romania are investigating the possibilities of processing and using the less representative species of wood, The birch wood is one of the species of wood that can by used on a large scale for furniture manufacturing, but for this purpose the producers must reach the necessary information regarding the optimum milling parameters of birch wood in order to obtain an appropriate quality of the surfaces recommended for furniture products.

The milling operation is considered to be, by the specialists, the most important one in the wood machining due to the fact that it has the role of defining the shape and dimensions of the wooden part or component. That is the reason why many national and international researchers focused on the study of wood machining \cite{1}, \cite{2}, \cite{3}, tools and equipment necessary for milling operation and of the optimum working process parameters in particular \cite{4}, \cite{5}, \cite{6}. The final analyzed indicator of a good workability in case of milling operation is always the adequate quality of the surface \cite{7}, \cite{8}, \cite{9}, aiming permanently to the establishing of the optimum working parameters. The analysis of the surface obtained after milling operation is done by scanning the topography of the wood surface using various methods with contact or without contact on the surface and interpreting the results of the roughness parameters considered to be more representative for the wood surfaces, as: $Ra$, $Rz$, $Rk$, $Rpk$, $Rvk$.

Some researchers \cite{10}, \cite{11}, consider that $Rk$ and $Rpk$ are indicators appropriate to provide accurate information about the influence of the machining on the quality of the surface.

The main objective of the present paper is to conclude if the way of mounting the inserts into the milling tool has influence on the quality of the surface, in the conditions of variable parameters of the milling process of birch wood and to establish the optimum milling parameters when machining this species of wood.
2. SAMPLES AND METHOD

The samples made of birch wood (*Betula pendula*), had a moisture content of 8%, the length of 700 mm and a variable width for longitudinal milling and the width of 700 mm and a variable length for transversal milling. The sample edges were machined longitudinally and transversally by milling on MNF 10 - vertical milling machine with detachable mechanical feed device (Fig.2), using two types of milling cutters with sintered carbide inserts as follows: removable metal inserts and brazable inserts (Fig.1). The variable milling parameters in case of straight milling of the edges are shown in Table 1. The principle of the tests were established according to PROGR software, based on the method of factorial experiment for three variables: feed speed (u), cutting height (h) and milling width (b).

The roughness of the processed surfaces was measured by a MicroProf FRT (Fries Research Technology) type, a German optical equipment for measuring the roughness without contact (Fig.3). The roughness was measured parallel to the milling direction, the samples being placed in a device when measured, so to keep the measuring position (Fig.3).

Two measurements were performed on each sample, on different areas and the final value of the roughness was calculated as the average of the two determinations. The scanning parameters of the MicroProf FRT roughness measuring equipment, of a high performance, are shown in Table 2. The roughness was measured parallel to the milling direction, the samples being placed in a device when measured, so to keep the measuring position (Fig.3). The data acquisition was performed by ACQUIRE software, provided with the possibility of saving the results in. frt and .txt files, but also with the possibility of viewing the surface topography. The analysis of the roughness profile was done by MARK III software, which allowed to save files as .log files type. The roughness profile was obtained after filtering the data with Gaussian filter. The .txt files resulted with ACQUIRE software were processed by a software of conversion into a DELPHI programe.

![Fig. 1. Milling cutters with brazable metal inserts (a) and removable metal inserts (b)](image)

![Fig. 2. Vertical milling machine type MNF10 with mechanical feed device.](image)

![Fig. 3. MicroProf FRT optical equipment](image)

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotation speed, (n) rpm</td>
<td>6620; 9732</td>
</tr>
<tr>
<td>Feed speed, (u) m/min</td>
<td>4.5; 9; 13.5; 18; 22.5</td>
</tr>
<tr>
<td>Cutting depth, (h) mm</td>
<td>1; 2; 3; 4; 5</td>
</tr>
<tr>
<td>Cutting width, (b) mm</td>
<td>20; 25; 30; 35; 40</td>
</tr>
</tbody>
</table>

Table 1. Milling parameters
Table 2. The scanning parameters of the MicroProf FRT roughness measuring equipment

TheDELPHY programme has used mathematical regression method with a nonlinear model degree II - for three variables, namely $u$, $h$ and $b$ [7], according to equation:

\[ Y=a + bx_1 + cx_2 + dx_3 + ex_1x_2 + fx_1x_3 + gx_2x_3 + hx_1^2 + ix_2^2 + jx_3^2 \]  \hspace{1cm} (1)

Table 3. Analyzed roughness parameters

Among the parameters characterized by ISO 4287: 2001, $Ra$ was used and by ISO 13565-2: 1999, $Rk$ and $Rpk$ were selected to be analyzed. (Table 3)

3. RESULTS AND DISCUSSIONS

The paper presents the comparison between the roughness parameters $Ra$, $Rk$ and $Rpk$, measured experimentally after machining with two types of milling cutters with sintered carbide inserts, namely removable metal inserts and brazable inserts of a milling cutter of 80 mm diameter, at a rotation speed of 6620 rot/min. The first conclusion of the experimental results was that the milling width has no significant influence on the quality of the surface. The paper investigates only the samples having a width of 30 mm. The title of each diagram indicates the diameter of the milling cutter, measuring direction, type of the inserts, rotation speed (in rpm), milling width (in mm) (Fig.4 ... Fig.12).

Fig. 4. Roughness parameters ($Ra,Rk,Rpk$), when using removable metal inserts

Fig. 5. Roughness parameters ($Ra,Rk,Rpk$), for brazable inserts, longitudinal milling
The roughness parameters resulted after the experimental determination concluded to different values and tendencies depending on the way of mounting the inserts, rotation speed, feed speed, cutting depth and direction of processing, as follows:

- For the longitudinal milling, no matter of rotation speed, the lowest values of the roughness parameters were obtained for a speed feed $u=18$ m/min and cutting depth of 1 mm for both types of milling cutters (Fig. 12, Fig. 13);
- The results were more satisfactory for low rotation speeds when using brazable inserts, whilst the best quality of the surface was obtained at high rotation speeds when using removable metal inserts;
- The best quality of the surfaces processed transversally by milling was obtained at a feed speed of 9 m/min and a cutting height of 1 mm for both rotation speeds studied, in the case of using removable metal inserts (Fig. 14, Fig. 15).
4. CONCLUSIONS

Conclusions regarding the influence of the way of mounting the inserts into the tool (removable metal inserts and brazable inserts) and of the working parameters on the quality of the processed surfaces by milling, using milling cutters of 80 mm diameter are as follows:

- In case of longitudinal milling, the roughness value increases when the cutting height (h) increases;
- In case of transversal milling, the roughness value decreases when the cutting height (h) increases;
- The values of the roughness parameters Ra, Rk, Rpk are approx. two times higher on the transversal direction against the longitudinal one.
- In case of using the same milling tool it is recommended to mount removable metal inserts on it, both on the longitudinal and transversal milling.
- The best longitudinal processed surfaces are obtained for high feed speeds (u), whilst for the transversal milling are recommended low feed speeds and minimum cutting heights (h).

The present research offers clear information on the optimum milling conditions of birch wood in industry and thus the wooden products manufacturers are entitled to use the birch wood in order to enlarge the raw material basis in Romania.

5. REFERENCES

2. Iskra, P.; Tanaka, C. The influence of wood fiber direction, feed rate and cutting width on sound intensity during routing,


6. ADDITIONAL DATA ABOUT AUTHORS

1) Lecturer Dr. Fotin, A.; Proff. Dr. Cismaru, I.; Ass. Proff. Dr. Cosereanu, C.; Ass. Proff. Dr. Brenci, L. M. & Proff. Dr. Curtu, I.

2) The tool influence on the quality of the birch wood straight milled surfaces

3) Fotin, A./ Lecturer Dr. Eng./ Transilvania University of Brașov/ Faculty of Wood Industry/ B-dul. Eroilor 29, 500036 Brașov / +40268415 315, adrianafotin@unitbv.ro

Cismaru, I./ Proff. Dr. Eng./ Transilvania University of Brașov/ Faculty of Wood Industry/ B-dul. Eroilor 29, 500036 Brașov/ Tel/Fax :0040 268 415315, icismaru@unitbv.ro

Cosereanu, C./ Ass. Proff. Dr. Eng./ Transilvania University of Brașov/ Faculty of Wood Industry/ B-dul. Eroilor 29, 500036 Brașov /Tel/Fax: +40268415 315, cboieriu@unitbv.ro

Brenci, L.M./ Ass. Proff. Dr. Eng./ Transilvania University of Brașov/ Faculty of Wood Industry/ B-dul. Eroilor 29, 500036 Brașov /Tel/Fax: +40268415 315, brenlu@unitbv.ro

Curtu, I./ Proff. Dr. Eng./ Transilvania University of Brașov – Faculty of Mechanics/ B-dul. Eroilor 29, 500036 Brașov/ Te/Fax 0040 268 415315/ curtui@unitbv.ro

4) Corresponding Author: Fotin, A./ Lecturer Dr. Eng./ Transilvania University of Brașov/ Faculty of Wood Industry/ B-dul. Eroilor 29, 500036 Brașov / +40268415 315, adrianafotin@unitbv.ro