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Influence of Selected Parameters of the OSB Boards Cutting Process by the Mean of Abrasive Water Jet on Its Lag

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Abstract: *Influence of Selected Parameters of the OSB Boards Cutting Process by the Mean of Abrasive Water Jet on Its Lag.* The article is dealing with the issue of OSB boards cutting by water jet at the pressure of 400 MPa with abrasive agent (GMA Australian garnet, 80 MESH grain) related to the water jet lag magnitude. The experiment has been carried out at the feed speed values of 0.2, 0.4 and 0.6 $m.min^{-1}$ and material thicknesses of 16, 32 and 48 mm. The results indicate the power potential of the abrasive water jet. Its lag was increasing with the increase of both feed speed and material thickness.

Keywords: water jet, abrasive agent, lag, material thickness.

INTRODUCTION

Material cutting by the mean of water jet as known today, is an integral part of the production (Kminiak and Gaff, 2014). When cutting the wood mass, it still has significant limits and insufficiencies. Therefore, it should be researched, thus making the manufacturing process more perfect (Gaff, 2009). For the process pactice, the cutting procedures based on energy jets are important from the point of view of lower power consumption, which also ensure the cut higher quality and increase the cutting performance (Gaff and Gáborík, 2009). The abrasive water jet (AWJ) cutting process has several advantages when compared with other processes, mainly cheaper and simpler equipment, wider application for different materials and relatively simple operation (Vlastník 1983, Hloch a Fabián 2006).

Currently, mainly two basic methods of cutting by water jet are used in practice: cutting with continuous clear water jet and cutting with continuous abrasive water jet (Krajný 1998). The application range of the latter is much greater than that of the former. For abrasive water jet, the machining takes place with liquid jet containing an abrasive agent. This is, as stated by Maňková (2002), a high-speed erosion process. Natural garnet, aluminum oxide, mineral sand, quartz sand or steel grit are used as abrasive agents. The abrasive water jet allows the cutting of virtually each type of material.

Removal mechanism of the processed material during the cutting by abrasive water jet is similar to that of the material removal at grinding (Krajný, 1998). From this point of view, the abrasive water jet belongs to the multiangular tools with undefined cutting edge. The abrasive agent grains represent the cutting wedges.

Like all high-energy jet methods, also AWJ leaves visible scratching on the machined surface (Maňková 2002). Such scratching affects adversely the machined surfaces quality as well as the shape accuracy of the products. The scratching starts only at certain depth under the surface and deepens gradually. So, the machined surface is divided to smooth and rough (scratched) zones (Gaff, et. al., 2010).

In his theory of cutting by abrasive water jet, Hashish (1991) gives the following explanation of this phenomenon: when the jet penetrates the material, it is loosing gradually its kinetic energy and deviates (Fig. 1). This generates two typical zones, which change the surface texture.

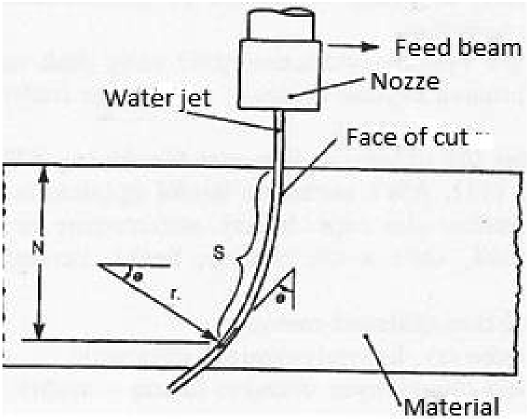

Figure 1. Water jet course and its deviation
(Maňková, 2002)

The relatively smooth zone in the upper part of the cut results from the cutting wear zone and the other, zone scratched in the lower part results as the aftermath of the deformation wear during the AWJ cutting.

MATERIALS

A methodology of experimental measurements was selected according to Kvietková (2012).

Tested Samples

- thickness of the test sample: 16 mm / 32 mm / 548mm – OSB,
- the required width of the test sample: š = 180 mm (± 2.5 mm),
- required length of the test sample: l = 500 mm (± 5 mm),
- moisture content of the test samples: w = 8% (± 2%).

Table 1. Combined translational velocity and mass flow abrasives

cut	forward speed V_f=[m.min^{-1}]	abrasive mass flow m_a=[g.min^{-1}]
A	0,6	250
B	0,6	350
C	0,6	450
D	0,4	250
E	0,4	350
F	0,4	450
G	0,2	250
H	0,2	350
I	0,2	450

Parameters of Cutting Process

Breaking down of tested samples was realised under operational conditions of the company of Dema s.r.o in Zvolen, Slovakia.

- Cutting liquid pressure: 400 MPa,

- Abrasive: Australian Garnet GMA (grain composition 80 MESH),
- Abrasive jet diameter: 1 mm,
- Water jet diameter: 0,013 inch = 0,33 mm,
- Nozzle distance above a work piece: 4 mm.

The combination of the sliding velocity and the mass flow of abrasives are given in Table 1.

Methodology of Water Jet Lagging Evaluation

Definition of Terms: L - water jet lagging (Figure 2) is the lagging of the jet path while breaking down the material, a difference of X coordinate of water jet path at the input and at the output of the water jet to and from material (Hashish 1991).

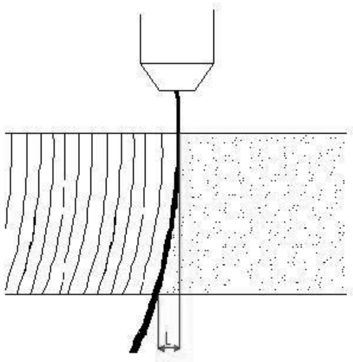

Figure 2. Abrasive Water Jet Lagging

Working Procedure:

1. Creation of a digital photo of the surface together with a reference gauge:

- placement of measurement points on the sample

2. Cutting path parameters measurement - lagging
3. Transfer of proportional dimensions to real dimensions:

$$(X/Y/L)= \frac{(X_P/Y_P/L_p).a}{a_p} \quad [mm] \qquad (1)$$

X/Y/L - Real lagging of water jet [mm],
Xp/Yp/Lp - Proportional dimension of water jet lagging [--],
a - Real dimension of reference gauge unit [mm],
ap - proportional dimension of reference gauge unit [--].

4. Statistic evaluation of data

The experiment was aimed to monitor the influence of the feed speed and material thickness changes, affecting the abrasive water jet lag.

RESULTS

Based on the evaluation, it is possible to conclude that both monitored parameters are statistically significant.

During the cutting process, on one side, there is the abrasive water jet bearing the energy needed to cut the material, and on the other side, a material with a resistance against the cutting, which is consuming the AWJ enegry. Right the AWJ lag is the indicator of interaction of these two parameters.

Feed Speed Influence

While increasing the feed speed from 0.2 to 0.4 m.min^{-1}, the AWJ lag decreased by 0.3 mm; at the feed speed increase from 0.4 to 0.6 m.min^{-1}, the AWJ lag value decreased again.

Table 1. Feed speed influence on AWJ lag value

Feed Speed (m.min^{-1})	0.2	0.4	0.6
The average value of lagging (mm)	2.64	2.34	1.82
Standard error (mm)	0.12	0.12	0.12
- 95,00 % (mm)	2.51	2.21	1.69
+95,00% (mm)	2.98	2.67	2.16

When cutting the OSB boards by abrasive water jet and increasing the feed speed, AWJ lag value is decreasing. Great amount of abrasive particles striking the cut unit course is causing this phenomenon.

Material Thickness Influence

The AWJ lag average value was changing with gradual change of the thickness. When the thickness increased from its minimum to its maximum, the lag value was increasing.

Table 2. Material thickness influence on AWJ lag value

Material Thickness (mm)	16	32	48
The average value of lagging (mm)	0.84	2.71	4.23
Standard error (mm)	0.09	0.09	0.09
- 95,00 % (mm)	0.43	2.51	3.94
+95,00% (mm)	1.25	2.98	4.32

The resistance value depends on the material type, sample thickness, cut direction and it also influences on the lag value.

The AWJ lag increase also indicates the impairment of such cut quality indices as the cut gap width, cut sides deviation and surface roughness.

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Streszczenie: *Wpływ wybranych parametrów procesu na opóźnienie cięcia płyt OSB strumieniem wody.* Praca dotyczy cięcia płyt OSB wodą o ciśnieniu 400 MPa z dodatkiem środka ściernego i oceny opóźnienia w tym procesie. Badania przeprowadzano przy prędkości posuwu 0.2, 0.4 i 0.6 m.min-1 na materiale o grubości 16, 32 i 48 mm. Wyniki wykazują potencjał obróbczy strumienia wody, opóźnienie strumienia wzrasta z prędkością posuwu oraz grubością materiału.

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