TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 58, Issue III, September, 2015

DETERMINATION OF CUTTING HEAD VIBRATIONS DURING ABRASIVE WATER JET CUTTING PROCESS

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Abstract: *Mechanical water jet process is influenced by the existence of vibrations and will be variations on cutting width and channel quality, which are due harmonized action forced vibrations during cutting. The mesurements presented in this paper refers to the vibrations arising during the abrasive water jet cutting process to machining the specimens made of carbon fiber composite material.*

Key words: *abrasive water, jet cutting, carbon fiber, vibrations*

1. INTRODUCTION

In the research of physical base of processes in abrasive water jet (AWJ) cutting, a broad spectrum of accompanying phenomena occur which behave outwards as a spectrum of vibration, [1].

Composite materials reinforced with carbon fiber processed by conventional methods are hard to be machined. The same like in the case of carbon steel [2], the hardness of these composites materials is high and the wear of cutting tools used in the machining process is very fast.

Using the water jet cutting process, the factors that affect the life of the tool (material of tool, tools design, production method, the method of heat treatment, thermal and mechanical stress of tool) [3] are avoid because in this case the cutting tool is a fluid with abrasive water jet.

2. PLANNING OF THE EXPERIMENT FOR MEASUREMENT OF VIBRATION

The mesurements presented in this paper refers to the vibrations arising during the abrasive water jet cutting process to machining the specimens made of carbon fiber composite material.

The measurement of vibrations that occur during cutting with a abrasive water jet a carbon-fiber composite material. The accelerometer, which measures the vibrations, has been placed on the work head, it has been fixed using a magnet.

Following the generation of independent values using central compositional programming was calculated the optimal number of experiments in order to better cover the space of variation of these variables. Thus, it results that are needed 30 attempts representing central compositional structure center.

The program has generated a table of 30 data groups with different values, chosen to be covered the ranges and to provide (following the 30 processing) conclusive results. For each of the cutting experiments were measured vibration generated at the cutting head of the abrasive water jet.

Table 1 are found the results of experiments conducted. As can be seen in the table, based on the independent variables and experiments were performed, the parameters set with Design Expert software.

Table 1

Vibration measurement results for waterjet cutting of carbon fiber composite materials.

Std	Run	Factor 1 A:Presiune d... Bar	Factor 2 B:Viteza de ... mm/min	Factor 3 C:grosimea ... mm	Factor 4 D:Distanta di... mm	Response 1 Vibratie cap d... mm/s
26	1	2750.00	2500.00	3.50	2.75	0.00628518
16	2	3125.00	3500.00	4.25	3.88	0.0135406
21	3	2750.00	2500.00	2.00	2.75	0.0230783
6	4	3125.00	1500.00	4.25	1.63	0.00729089
17	5	2000.00	2500.00	3.50	2.75	0.014694
4	6	3125.00	3500.00	2.75	1.63	0.0120275
1	7	2375.00	1500.00	2.75	1.63	0.0171897
3	8	2375.00	3500.00	2.75	1.63	0.0142709
2	9	3125.00	1500.00	2.75	1.63	0.0146076
28	10	2750.00	2500.00	3.50	2.75	0.0163169
11	11	2375.00	3500.00	2.75	3.88	0.0142654
5	12	2375.00	1500.00	4.25	1.63	0.00966791
12	13	3125.00	3500.00	2.75	3.88	0.0114578
27	14	2750.00	2500.00	3.50	2.75	0.00954252
15	15	2375.00	3500.00	4.25	3.88	0.00954252
9	16	2375.00	1500.00	2.75	3.88	0.0139146
13	17	2375.00	1500.00	4.25	3.88	0.0112316
10	18	3125.00	1500.00	2.75	3.88	0.0140434
24	19	2750.00	2500.00	3.50	5.00	0.0131461
19	20	2750.00	500.00	3.50	2.75	0.0119305
30	21	2750.00	2500.00	3.50	2.75	0.0146557
29	22	2750.00	2500.00	3.50	2.75	0.0173628
25	23	2750.00	2500.00	3.50	2.75	0.0132663
7	24	2375.00	3500.00	4.25	1.63	0.0135382
8	25	3125.00	3500.00	4.25	1.63	0.0110127
18	26	3500.00	2500.00	3.50	2.75	0.0126413
20	27	2750.00	4500.00	3.50	2.75	0.013215
23	28	2750.00	2500.00	3.50	0.50	0.0120145
14	29	3125.00	1500.00	4.25	3.88	0.0126438
22	30	2750.00	2500.00	5.00	2.75	0.0123114

3 ANALYSIS OF PROCESS PARAMETERS ON THE PROCESSING HEAD VIBRATION

Based on data obtained from experiments conducted, were plotted the influence of independent variables (pressure, feed rate and distance between the processing had and blank) on the dependent variable, vibration machining head.

The following is presented an analysis of the characteristics studied graphics processing material used in this experiment. To analyze the influence of process parameters on the vibration head was examined sequentially processing each parameter involvement.

Figure 1 present the dependence between the vibration of the machining head and pressure jet. The range of the pressure is between 1500 and 3500 [bar] processed material having a thickness of 2.75 [mm], the distance between the cutting head and blank 1.63 [mm] and a feed rate of 2527.03 [mm / min]. It is noted that with increasing the processing pressure of the jet, the machining head vibration decreases from 0.017-0.013 [mm/s].

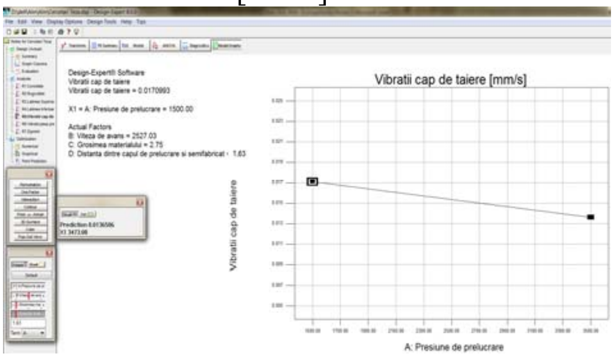

Fig. 1 Pressure influence on processing head vibration

Figure 2 is represented dependence between the processing head vibration and feed rate, observing that with increasing feed speed the processing head vibration value increases from 0011-0012 [mm / s]. The variation interval of the feed rate parameter is between 1500 and 3500 [mm / min], using a processing pressure of 1716.22 [bar] theb thickness of processed material 3.99 [mm] and the distance between the machining head and blank 2.39 [mm].

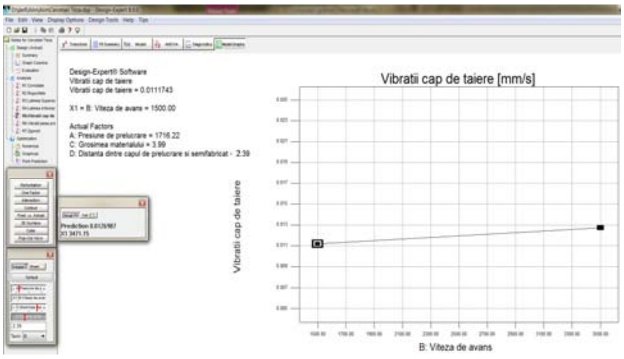

Fig. 2 The influence of the feed speed on processing head vibration

Figure 3 is represented the dependence between the processing head vibration and the distance between the processing head and blank. The variation interval for the distance between the processing head and the blank was 1.63 ÷ 3.88 [mm], using a processing pressure of 1689.18 [bar], the feed rate of of 3500 [mm / min] and the thickness of the processed material 3.5

[mm]. As shown in the graphical representation in the specific case, with increasing the distance between the processing head and blank, the machining head vibration falls from 0.017 to 0.012 [mm/s].

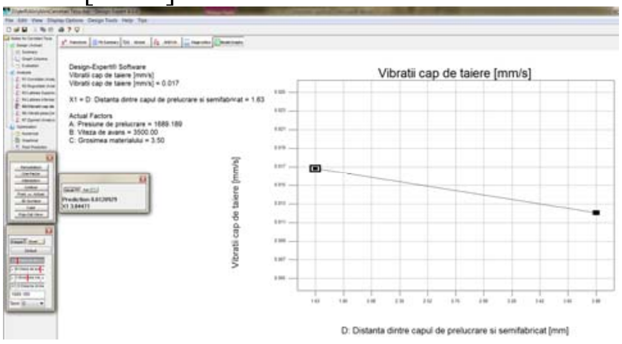

Fig. 3 The influence of the distance between the processing head and blank on the processing head vibration

Using Design Expert software, was made an analyze on the common influence that can have two process parameters on the quality characteristics sought. As such, it was obtained 3D graphical representation of the variation of the processing head vibration according to the process parameters (pressure, feed rate, and the distance between the cutting head and blank).

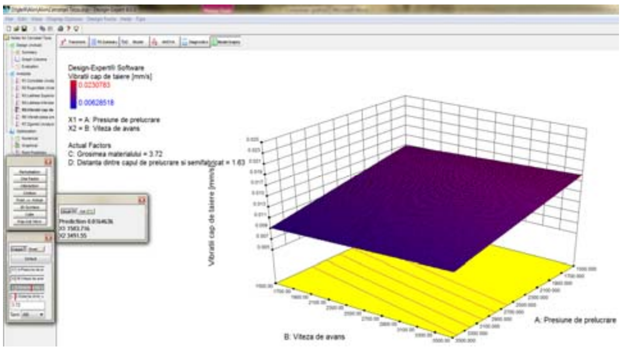

Fig. 4 The variation of the processing head vibration according to the feed rate and pressure

Analysing the graphic representation in figure 4 it can see that by increasing the processing pressure and decreasing the feed rate the machining head vibration falls. Based on this observation it can be said that to achieve machining with water jet cutting and abrasive agent with a machining head small vibration is recommended as high pressure processing and feed rate low. It was obtained a variation of the cutting head vibration between 0.009 and 0.016 machining [mm/s], after using a material with a thickness of 3.72 [mm] and the distance between the cutting head and blank 1.63 [mm], for a change a processing pressure flow between 1500 and 3500 [bar] and speed of advance between 1500 and 3500 [mm/min].

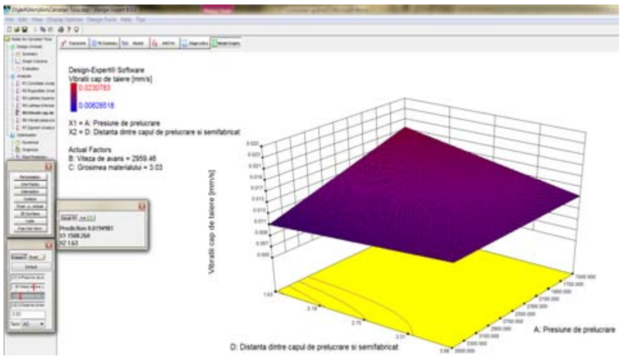

Fig. 5 The variation the processing head vibration according the processing pressure and distance between processing and blank

The graph in Figure 5 illustrates the cumulative influence of the working pressure and the distance between the processing head and blank, on the processing head vibration. Diagram 3D was determined under the following conditions: feed rate - 2959.46 [mm / min], the thickness of the machined material - 3.03 [mm], the distance between the machining head and blank 1.63 and 3.88 [mm] and the jet pressure between 2000 and 3500 [bar]. By varying the distance between the processing head and blank 1.63 and 3.88 [mm] and between 1500 and 3500 [bar] the jet pressure was obtained a variation of processing head vibration contents 0.011 and 0.0194 [mm/s].

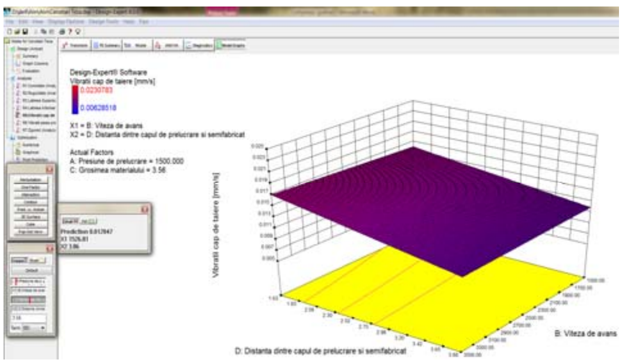

Fig. 6 The variation of the processing head vibration depending on the feed rate and distance between processing head and blank

As can be seen in 3D diagram in Figure 6, to minimize machining head vibration is recommended using the low feed rates, and a biggest distance between head and blank machining. This graphic was determined when used processing pressure 1500 [bar] processed material thickness of 3.56 [mm] and varying the distance between the cutting head and blank from 1.63 and 3.88 [mm] and the feed rate of 1500 3500 [mm/min]. According to this diagram by varying these process parameters to obtain a variation of the machining head vibration between 0.012 and 0.017 [mm/s].

6. CONCLUSIONS

In this research were carried out practical experiments measuring the vibrations occurring during waterjet cutting process a composite material. Vibration measurement was carried out at the cutting head level with the Microlog Analyzer AX aid.

The analysis conducted that both jet pressure, feed rate and distance between processing head and blank influences the processing head vibration, but in different ways: by increasing the processing pressure and the distance between the cutting head and blank, the machining head vibration decreases and by increasing the feed rate, it increases.

7. ACKNOLEDGEMENTS

This paper is supported by the Sectoral Operational Programme Human Resources Development POSDRU/159/1.5/S/137070.

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Determinarea vibraţiilor capului de tăiere la prelucrarea cu jet de apă şi agent abraziv

Procesul de prelucrare cu jet de apă este influențat de existența unor vibrații și variatii ale tăieturii și calitatea canalului tăiat, acestea sunt acțiuni armonizate din cauza vibrațiilor forțate în timpul tăierii. Măsurătorile prezentate în această lucrare se referă la vibratiile care apar în timpul procesului de tăiere cu jet de apă cu agent abraziv abraziv pentru prelucrarea materialelor compozite din fibra de carbon.

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