

ANALYSIS OF CUTTING FORCES IN TURNING OF WORKPIECE WITH A SLOT

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1. Introduction

Cutting forces in turning process are analyzed in this paper. Workpiece has a circular cross section with a slot, Figure 1. The measurements are performed using dynamometer made from turning tool with tensometric tapes placed on it [1]. The main cutting force F_c , radial force F_p and feed force F_f are obtained by recalculating of the measured strains on turning tool.

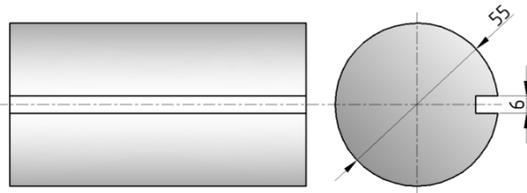


Fig. 1: Workpiece with a slot

The aim of this paper is to determine the effect of slot on the cutting forces in turning process in order to determine optimal processing parameters.

Turning of workpiece with a slot rarely occurs in practice, but that case is analogous to the milling in case when the milling tool enters the workpiece.

2. Cutting forces in the dependence of cutting speed

Constant parameters for this measurement are: cutting depth: $a = 3$ mm and feed rate: $f = 0,18$ mm/rev. The measurement was performed three times with following cutting speeds: $v_1 = 69$ m/min, $v_2 = 97$ m/min, $v_3 = 138$ m/min. Data acquisition was performed with a frequency of 2,4 kHz.

The diagrams on Figure 2 show the measured forces for the above mentioned parameters.

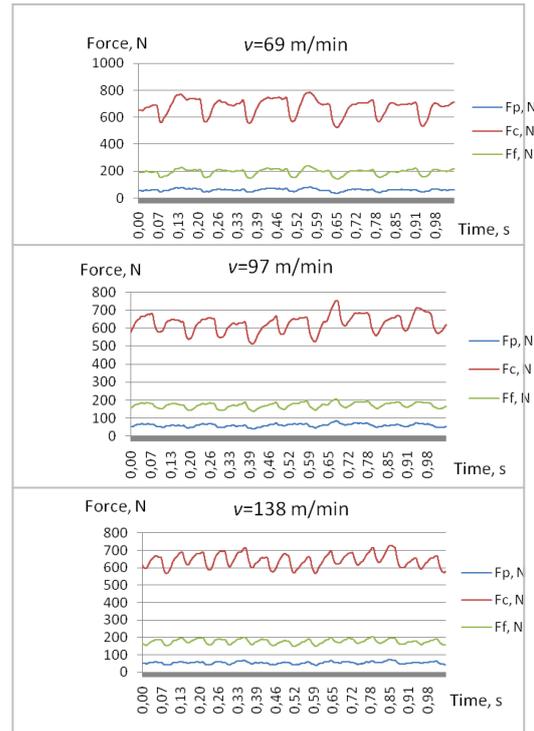


Fig. 2: Cutting forces in the dependence of cutting speed

By analyzing above diagrams it can be concluded that by increasing of cutting speed there is no significantly affect on the increasing of the cutting forces. It is obvious from the diagrams that there is an impact that occurs during the passage of turning tool blade through a rectangular slot and repeated entry into the material. The amplitude of impact is significantly higher in case of turning with lower cutting speeds. At higher cutting speeds, cutting tool has less time to return to the unloaded state when passing over the slot than in case of turning with lower cutting speeds. Therefore, with increasing of cutting speed, uniform forces with smaller impact amplitudes are obtained.

3. Cutting forces in dependence of cutting depth

The diagrams on Figure 3 show the measured forces for the turning of workpiece with a

rectangular slot and for various cutting depth. In this case, cutting speed ($v = 97$ m/min) and feed rate ($f = 0,18$ mm/rev) were constant, and measurements were performed for three value of cutting depth: $a = 1$ mm, $a = 2$ mm, $a = 3$ mm.

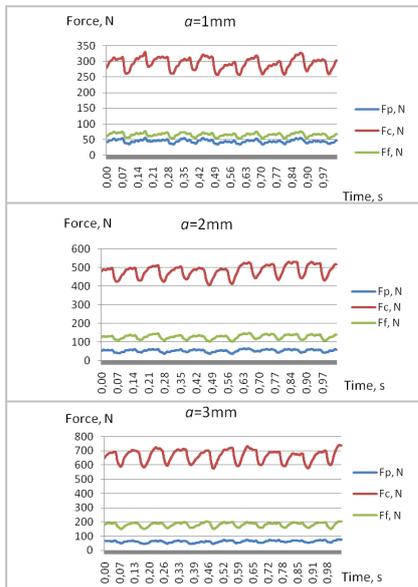


Fig. 3: Cutting forces in dependence of cutting depth

As expected and obvious from Figure 3, by increasing of cutting depth, cutting forces are also increasing as well as the amplitude of impact. As mentioned earlier, impact occurs during the passage of turning tool blade through a rectangular slot and repeated entry into the material. These impacts cause shortening of lifetime of turning tool blade. When operating with small cutting depth ($a = 1$ mm), vibrations of turning tool occurs when it passes through the slot, resulting with poorer quality of surface.

4. Cutting forces in dependence of feed rate

The diagrams on Figure 4 show the measured forces for the turning of workpiece with a rectangular slot with cutting speed of 97 m/min and cutting depth of 2 mm. In this case, measurements were performed for three value of

feed rate: $f_1 = 0,18$ mm/rev, $f_2 = 0,24$ mm/rev and $f_3 = 0,3$ mm/rev.

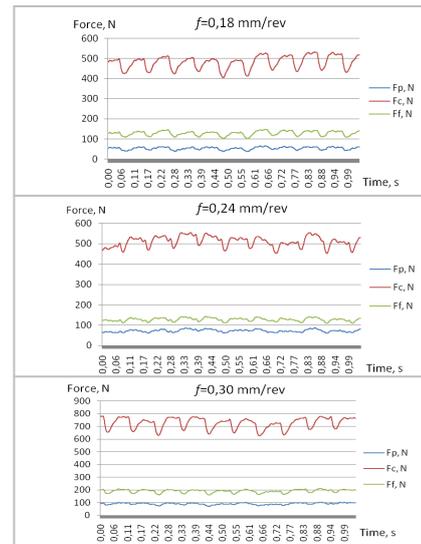


Fig. 4: Cutting forces in dependence of feed rate

It is obvious from the Figure 4 that by increasing of feed rate, cutting forces are also increasing, especially the main cutting force F_c . Increasing of feed rate does not significantly affect to the amplitude of impact which occurs during the passage of turning tool blade through a rectangular slot and repeated entry into the material.

References

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