TUNGALOY CERAMIC CUTTING TOOLS AT INTERRUPTED MACHINING

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Abstract: The paper deals with testing of ceramic cutting tools with an interrupted machining. Tests will be provided on fixture – interrupted cut simulator. This simulator has four mouldings on circumference and cutting edge gets shocks during one revolution. Criterion of tool wear is destruction of cutting tool or 6000 shocks. As testing cutting tool material will be ceramic cutting tools of Tungaloy Company. Machined materials were steels 15 128 (13MoCrV6) and 12 050 (C45). Cutting speeds and cutting feeds were variable parameters and cutting depth was a constant parameter.

Key words: machining, interrupted cut, tool-life tests, ceramic cutting tool, longitudinal turning, testing

1. INTRODUCTION - THE METHODOLOGY OF CUTTING TOOLS TESTING

Turning tests are focused on machining by smooth cut at constant or variable depth of cut (Dobransky & Hatala, 2007), (Cep et al., 2008), (Jurko et al., 2009). In this work we will use one of the developed tests. It is longitudinal turning, so-called "slat test" (Cep, 2010). Experiments were conducted on a special construction which was constructed at Department of Machining and Assembly, VŠB – Technical University of Ostrava (see Fig. 1.).

A preparation in the shape of a cylinder consists of four exchangeable slats which are clamped in the grooves by the chucking wedge. The basic construction consists of special cylinders which are milled four mortises (measurement: 70 x 48 mm in 600 mm length). Slats can be put under by washers so that are clamped by wedge-shaped jaws. The basic construction consists of special preparation which was constructed at Department of Machining and Assembly, VŠB – Technical University of Ostrava (see Fig. 1.).

Fig. 1. Scheme of preparation (Reiner, 2009)

We choose these parameters with regard to manufacturer's recommendation of cutting ceramics and experience of the resolvers. The following cutting conditions were chosen for testing these types of cutting materials:

- Cutting speeds \( v_c = (408; 580) \) m/min,
- Feeds \( f = (0,15; 0,20; 0,25; 0,30) \) mm,
- Cutting depth \( a_p = 1 \) mm.

2. CUTTING PARAMETERS, CUTTING GEOMETRY AND MACHINE TOOL

Cutting geometry for tool testing from cutting ceramics was chosen with regard to ISO 3685 standard - Tool Life Testing of Single Point Turning Tools (ISO 3685, 1990). All types of indexable cutting inserts, that we will be tested, have a normalize shape SNGN 120716 and will be attached to the tool holder CSRNR 25x25 M12-K. Tests were conducted on the turning lathe ZMM SLIVEN. This lathe has a rigid structure that allows rigid clamping and absorbs shocks very well and reaches mostly 2000 RPM. This turning-lathe is conveniented for this type of experiments.

3. MONITORING NUMBER OF SHOCKS

The main criterion of tool wear was a tool-fracture at measurement. This moment was noticed by changing the cutting sound, sparking or worsen in surface roughness. Limit value of 6000 shocks was determined on the basis of previous experience in terms of time and material demandingness. If
indexable cutting inserts withstand this value, the experiment will be finished. Cutting insert will be described as satisfactory. Measurement is repeated three times.

Formula for calculation the number of shocks:

\[
R = \frac{4}{l} \cdot \frac{c}{f}
\]  

(1)

\( R \) – number of shocks [-], 
\( l \) – machining length [mm], 
\( f \) – feed per revolution [mm].

4. EVALUATION OF MEASUREMENT

We processed all measured values for all types of ceramic cutting inserts from Tungaloy Company that were tested. The results for all feeds are displayed in following diagram.

From the dependency graph of number of shocks on the cutting speed at 0,15 mm feed can be concluded that the number of shocks is maximal for all cutting inserts at \( v_c = 408 \) m/min and \( v_c = 580 \) m/min. It concludes that these ceramic cutting inserts are suitable for interrupted cut at 0,15 mm feed.

From the dependency graph of number of shocks on the cutting speed at 0,2 mm feed can be concluded that the number of shocks is maximal for all cutting inserts at \( v_c = 408 \) and \( v_c = 580 \) m/min too. It concludes that these ceramic cutting inserts are suitable for interrupted cut at 0,2 mm feed. Both ceramic inserts achieved maximum number of shocks at lower feeds.

From the dependency graph of number of shocks on the cutting speed at 0,25 mm feed can be concluded that the number of shocks is the same for all cutting inserts and materials at lower cutting speed \( v_c = 408 \) m/min. Cutting inserts did not withstand the maximum number of shocks at both cutting speeds. Inserts withstand the maximum number of shocks only on 13MoCrV6 material at higher cutting speed. FX105 ceramic cutting inserts achieved the lowest number of shocks on C45 material - at higher cutting speed.

From the dependency graph of number of shocks on the cutting speed at 0,3 mm feed can be concluded that the number of shocks is the same for all ceramic cutting inserts and materials at \( v_c = 408 \) m/min as in previous case. Cutting inserts withstood maximal number of shocks at higher cutting speed only on 13MoCrV6 materials. FX105 ceramic cutting inserts achieved the lowest number of shocks on C45 material. The ability to withstand shocks decreases with increasing feed.

Through the centuries, producers of ceramic cutting tools have taken big steps forward. Properties have improved - their resistance to mechanical stress and tool wear, high temperature resistance, high accuracy. Some producers advise ceramic cutting inserts for interrupted machining at the present time.

5. CONCLUSIONS

FX105 ceramic cutting inserts (13MoCrV6 material) reached the limit number of shocks at both cutting speeds and feeds of all. It means, that they have a high resistance and ability to perform interrupted cut in this material.

FX105 ceramic cutting inserts (C45 material) reached the limit value at lower cutting speed for all feeds. The cutting inserts withstand fewer number of shocks when cutting speed is \( v_c = 580 \) m/min and with increasing feed of cutting insert. The number of shocks decreases with increasing value of the feed. FX105 ceramic cutting inserts were able to withstand the limit value of 6000 shocks at 0,15 mm and 0,2 mm.

FX105 ceramic cutting inserts (13MoCrV6 material) reached the limit number of shocks at both cutting speeds and feeds of all. That means they have a high resistance and ability to perform interrupted cut in this material. This material have higher of toughness and heat conductivity than FX105.

FX105 ceramic cutting inserts (C45 material) reached the limit value at lower cutting speed for all feeds. The cutting inserts withstand fewer number of shocks when cutting speed is \( v_c = 580 \) m/min and with increasing feed of cutting insert - like in previous case for the C45 material. The number of shocks decreases with increasing value of the feed. FX105 ceramic cutting inserts were able to withstand the limit value of 6000 shocks at 0,15 mm and 0,2 mm.

These tests showed that FX105 and CX710 ceramic cutting inserts can be used for interrupted cut. Both cutting inserts withstood maximum number of shocks at 13MoCrV6 material (at lower or higher cutting speed). It means, that FX105 and CX710 inserts have a high resistance and ability to perform an interrupted cut at 13MoCrV6 material.

The next steps in the future will determine the effect of thermal and mechanical shock and tool-life at unbalanced preparation. The gap between slits will not be constant.

7. REFERENCES

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