Tooling Research and Application Department
Dr. Viktor P. Astakhov

Memo

To: [redacted]

Cc:

From: Professor Viktor P. Astakhov, Tool Research and Application Manager
Roland Jackson, Team Leader

Date: [redacted] 2009

Re: TTO TC Housing, Operation 10, tool 5 XXXXX end mill
M5 forming tap issue

1. XXXXX milling tool

As you well aware, there is a serious problem for the XXXXX end milling tool used on TC Housing line, operation 10, tool 5. Tool life is excessively low – milling tool life is 800 parts. PCD cartridges are found to be chipped on corners.

The results of observations the worn tools and machined surfaces have shown that chipping is the most common failure of the inserts brazed on cartridges. There are three areas of chipping: (a) on corners as seen in Figure 1, (b) on the flank surfaces as seen in Figure 2 and (c) on the non-working part of the cutting edge as shown in Figure 3. Moreover, the whole face of the PCD insert is covered by a thin layer of aluminum with the densest area in the center of inserts although there is should not be any contact of the chip in this area under normal cutting conditions.

Further microscopic investigations of the worn carriages revealed:

- The side edges of PCD inserts which are not involved in cutting have definite traces of aluminum as clearly seen in Figure 4.
- The chip deflators have heavy chip contact marks.

- The pained parts of the mill body adjacent to the chip deflectors have wear marks that removed the whole purple paint.

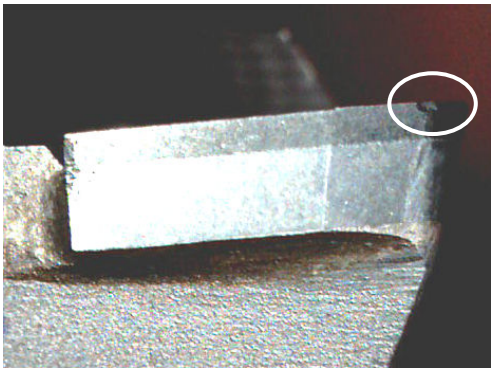


Figure 1. Chipping on the corner

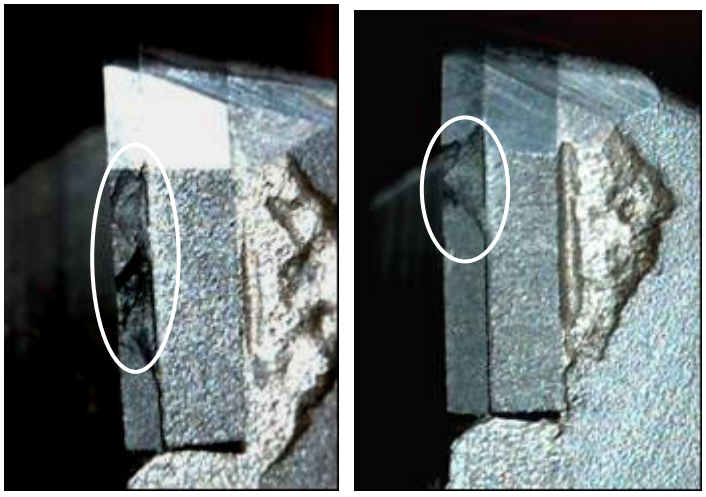


Figure 2. Chipping of the flank surfaces

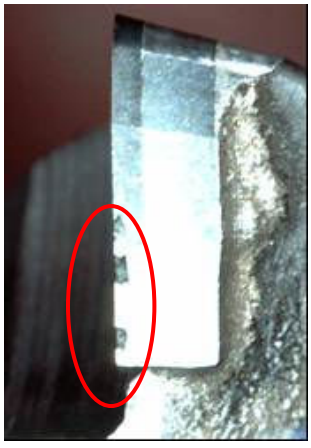


Figure 3. Chipping of the non-working cutting edge

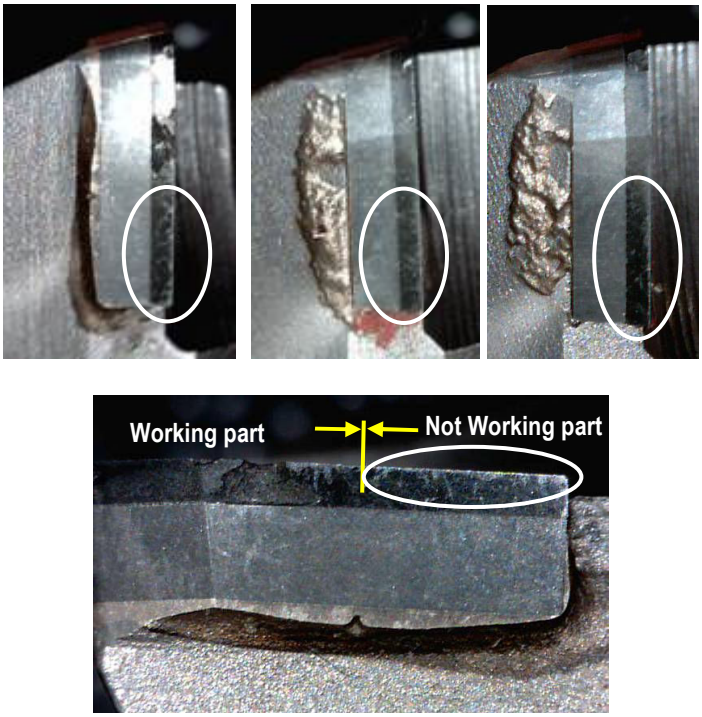


Figure 4. Aluminum deposit on not working parts of the cutting edge

The root cause of the problem is OBVIOUS: the design and geometry of XXXXX mill cutter is not suitable for the application because the formed chip has no room to escape. The double-positive geometry used for the cartridges directs the formed chip deep into the chip pocket (the explains aluminum deposit on the insert rake faces) where this chip hits the chip deflector (explains the chip marks on the deflector). As the chip pocked is of closed design, the chip tries to squeeze into the narrow gap adjacent to the not working part of the cartridges that explains aluminum deposit on this part (see Fig. 4) and wear marks on the tool body. The hot chip trapped in the chip pocket presents a number of problems as it imposes high pressure (and deflection of the rail) on the PCD inserts causing their significant heating, vibration and re-cutting of the once formed chip.

Microscopic observations of the machined surface clearly show (Figure 5) the traces of re-cutting and rail deflections on milling that confirms the root cause.

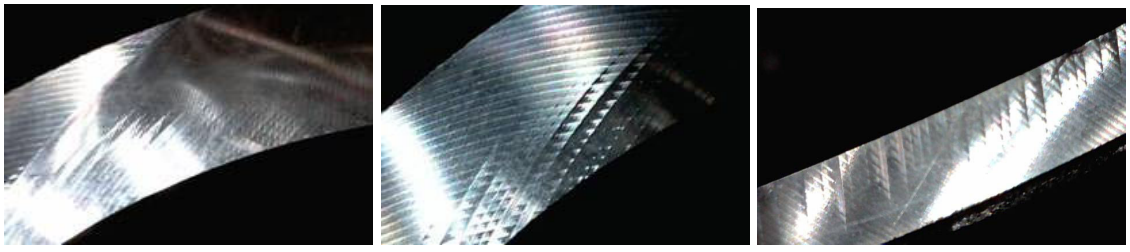
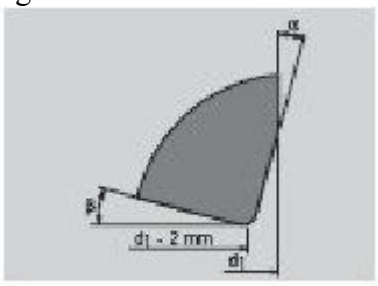


Figure 5. Traces of re-cutting and rail deflection

There two paths to follow to solve the problem:

1. Use a face mill without chip pockets (open cartridge design) as one used at YTO where consistent 15,000 pieces tool life is achieved.
2. Modify the design of XXXXX tool as follows:

- Use standard XXXXX cartridges with a neutral top rake this should allow chips to flow out the side of the cutter and not be re-cut.
- Tool geometry. The cutting inserts have a flat cutting edge that generates an excessive heat causing high temperature. Use the following XXXXX standard geometry for these cartridges



Type No. 9 PT blade

- Open chip pockets on the XXXXX mill to allow chip out freely, remove chip deflectors.
- Add an edge prep to the inserts which would strengthen the cutting edge.

PPCR is being written on Monday by [redacted] to cover these tests.

As additional observation, we would like to prevent your attention to really poor brazing of PCD inserts seen in Figures 1-4. Moreover, in our opinion, there is insufficient flank angle (relief) on the insert that may cause chipping of the flank surfaces. Unfortunately, neither brazing, not relief angles are specified on the cartridge drawing. In our opinion, these information MUST be added to the drawing should it designed to modify XXXXX tools.