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# Examination of Chip Breaker and Its Effect in Turning Operations

Sudhansu Sekhar Sahu,Kedarnath Hota , Madan Mohan Sahu, Subham Das
*Department of Mechanical engineering, Gandhi Institute for Technology (GIFT), Bhubaneswar*

***Abstract:*** *Chip breaker has significant role in machining process. Chip breaker and chip control in general, have long been known in continual form operations such as turning. In general machining process, chips are used to cut chips forms. Control of continuous chips in machining operation is a very significant issue to carry out productivity and operator safety. Also in particular, efficient chip control is essential for a CNC machine or automatic production system because any failure in chip control can cause the lowering in productivity. Therefore, a grooved chip breaker has been widely used for obtaining reliable discontinuous chips. In general, in order to develop a new cutting insert with a chip breaker, extensive time, research, and expense are required because several processes such as forming, sintering, grinding, and coating of products as well as different evaluation tests are necessary. A well-known method to control the chip size is utilization of chip breaker. Though, chips of highly of soft materials such as low carbon steel or thin chips created in finishing forms may not be cut simply with conventional chip breakers. Recently improvements in cutting tool technology have resulted in large number of variable chip breaker configurations. However, in most applications chip-groove design which is primary effective role, is being used try and see methodology. Special tool tips were developed and applied for chip control.*
***Keywords:*** *Chip Breaker, Chip Control.*

## I. INTRODUCTION

Turning is the one of the most effective machining operation which is commonly used conventional process. One of the issue in high-performance in turning process is unbroken chips. Unbroken and long chip is formed when the cut chip rings around itself against the workpiece or the tool. In order to avoid generating unbroken chip, chip breakers are widely utilized with grooved form for efficient chip disposal [2].

Cutting process with a single point, which has constricted and long chips that lead to problem for instance, mixing chip, hardship in chip handling, poor surface quality and safety risks for operator. Therefore it is necessary cut to chip in large [10].

In machining process chips that change in shape and length, short cut chips are desired. The study of chip-breaking is very significant role for optimizing the machining processes. Since chip which has big length cause decrease in productivity and unbroken chips are the major barrier for turning operation. [5] In addition, unbroken chips cause poor surface quality, damaged cutting tools, workpieces, cutting vibrations, tool life and machine performance [6].

Inability to control chip is related to surface roughness of workpieces, wear of tool. To explain this relationship , researchers have suggested theories, experienced approaches [19].

Today, there are lots of cutting tools available with different chip breaker shape. However, tool breaker design depends on experience of designer and ‘try and see’ methods are still common due to the lack of understanding of the main chip formation mechanism and of the difficulties predicting chip breakage [6].The most applied chip control method to obtain the proper chip shape is utilization of chip breakers. There are two kinds of chip breakers; obstacle type and grooved type [2]. Chip breakers has effective factor; feed rate, cutting speed, depth of cut, chip breaker angle, material and chip breaker forms (such as grooved form), these factor are significant role in machining process.

## II. MATERIALS AND METHODS

The method using in chip control is breaking chip. The chip breaker affect chip flow angle, chip curl radius and the type of chip breaker should be selected based on cutting situation. Chip breaker test needs to significant time and effort. Also, developing new cutting inserts need to forming, sintering, grinding, and coating processes, extends developing time and involves expensive research. [8] Chips created during machining form curling, and crash against workpieces or tools, result in chip breaking. Sizes of broken chips are different depending on deformation method and collision place. The generated chip makes continuous curling and it is known that chip breakability expands when reducing the up curling radius and down curling radius of a chip gap that is formed at this time. [8]

A chip breaker is the instrument which has a groove or a barrier placed on the slope face of the tool. Chip breaker can be used for increasing chip breaking that has resulted in efficient chip control and advanced productivity. It can also decrease cutting resistance, and improve the tool life and surface condition of a workpiece. A chip breaker is operated for improving chip breakability through the decrease of chip radius [9,13,14].

$$\frac{1}{P} = \frac{2}{K}\sin(\alpha+\beta)$$

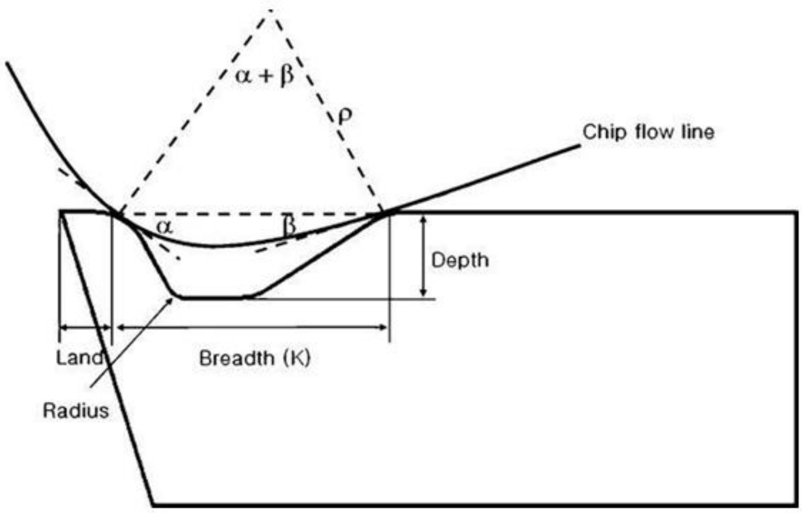


**Figure 1.** Radius of chip that flows touching chip breaker [8]

If angle and breadth increased, grooved will be decreased. In reality, groove is narrow. Generally angle is being used 15-30°. The chip breaker pattern effects breakability of chip. The most important factors for chip breaker shapes and the chip breakability is depth, land, breadth, radius. Figure 2 shows various chip pattern occurs during chip formation process in metal cutting operations.

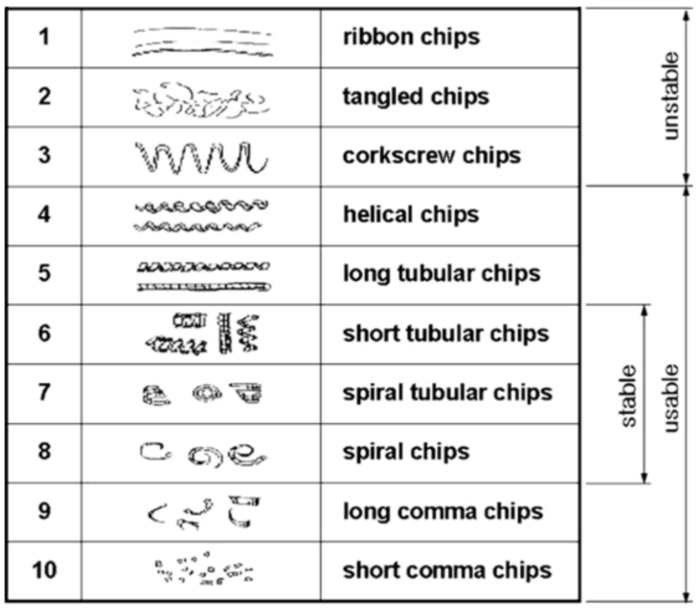


**Figure 2.** Classification of chip pattern [8]

## III. RESULTS AND DISCUSSION

Materials are the most important element for the design of new cutting inserts having chip breakers, and breaker type depends the difference of mechanical properties in workpiece materials. Steel is widely used in numerous industries for products including those in the cutting process. Feed rate, depth of cut and cutting speed in cutting situation are the most significant factors for chip formation. According to the change of these factors, there is example applied after setting the feed rate of cutting insert to 0.15 mm/rev, 0.3mm/rev, 0.4mm/rev, and changing the depth of cut with three steps to 0.5– 5.0 mm. A generated chip pattern is observed at each cutting condition. Cutting speed has been fixed at 100 m/min in order to observe the chip form changes according to feed rate and depth of cut [17,23,24,25].

**Table 1.** Specifications of chip breaker [8]

| Type | Depth | Land | Breadth | Radius | Use |
|---|---|---|---|---|---|
| -33 | 0.39 | 0.00 | 1.52 | 0.70 | Finishing |
| -KA | 0.21 | 0.04 | 1.41 | 2.00 | |
| -FG | 0.18 | 0.00 | 1.40 | 3.00 | |
| -A | 0.43 | 0.13 | 2.07 | 0.70 | LR |
| -AC | 0.72 | 0.00 | 2.00 | 2.00 | |
| -C | 0.24 | 0.22 | 1.90 | 1.08 | MR |
| -MP | 0.35 | 0.28 | 1.80 | 1.05 | |
| -55 | 0.45 | 0.18 | 1.61 | 1.07 | HR |
| -KE | 0.27 | 0.20 | 1.85 | 1.50 | |
| -KM | 0.31 | 0.11 | 2.67 | 2.60 | |
| -KV | 0.27 | 0.35 | 2.12 | 0.80 | |
| -MH | 0.19 | 0.30 | 2.15 | 0.00 | Roughing |
| -RT | 0.17 | 0.32 | 2.50 | 0.00 | |

LR, light roughing; MR, medium roughing; HR, heavy roughing

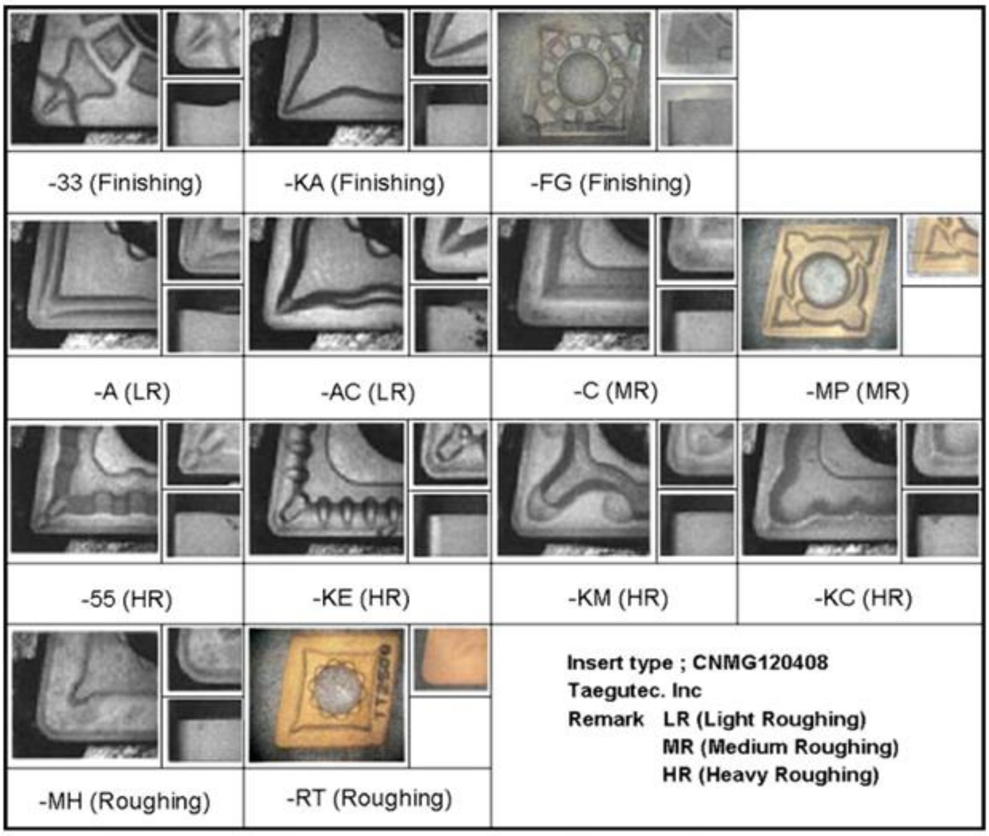


**Figure 3.** Shapes of commercial chip breaker [8]

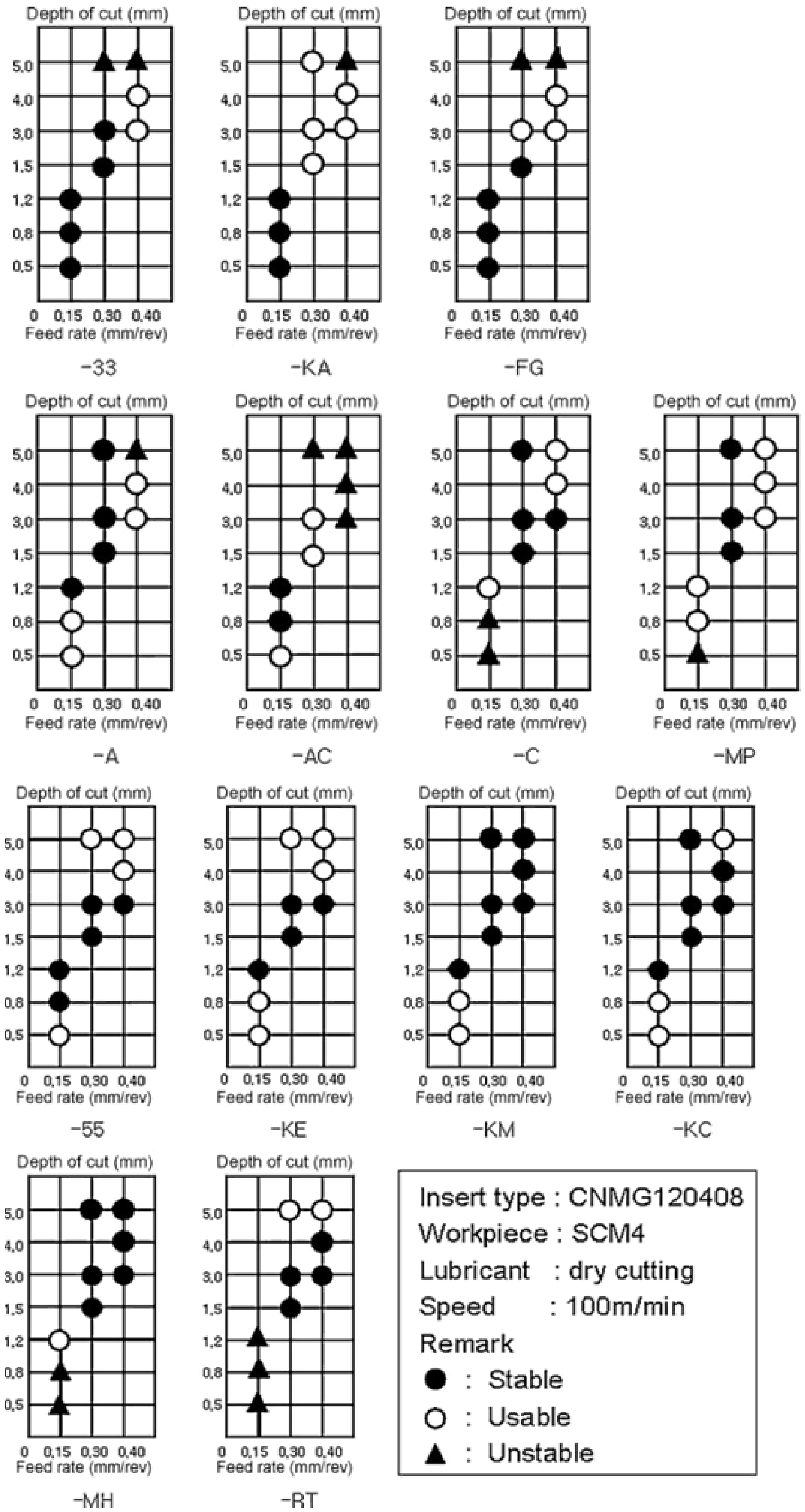


**Figure 4.** Result of chip breaking test in turning operation [8]

There are 3 examples applied by making FE analysis shown Figure 5. Results are in Figure 6-7-8-9 [10,16].

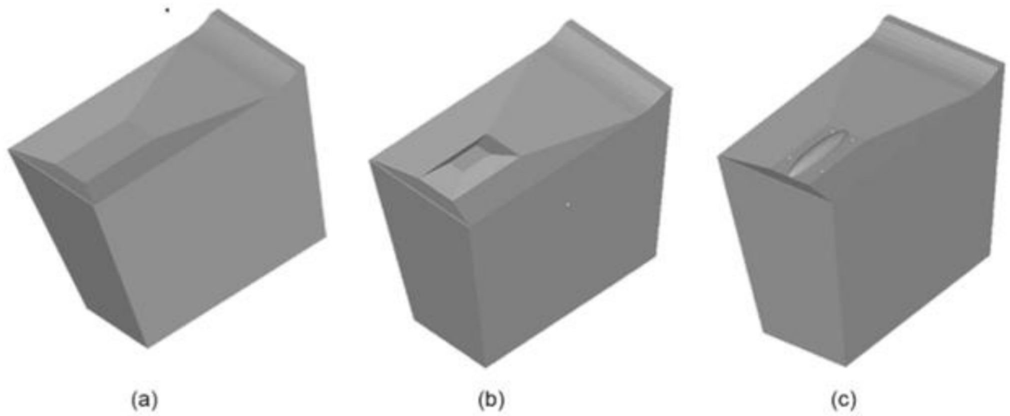


**Figure 5.** Simulation diagram of the different chip breakers: (a) without chip breaker (b) squared chip breaker, and (c) elliptical chip breaker.

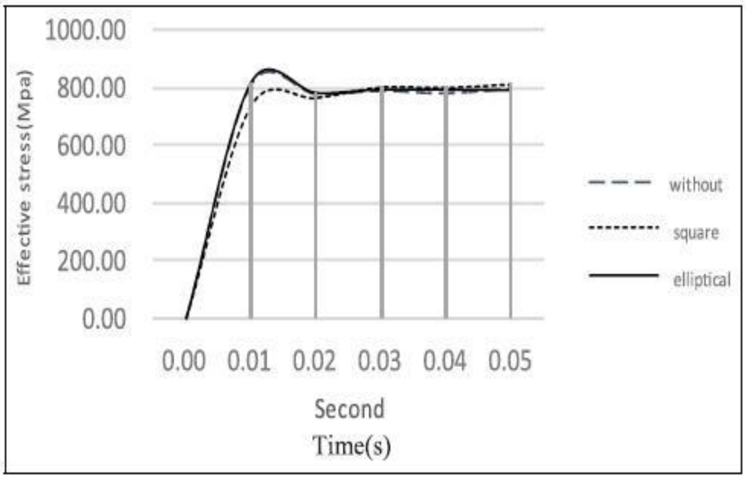


**Figure 6.** Effective stress of different chip breakers.


**Figure 7.** Effective stress of squared chip breaker.

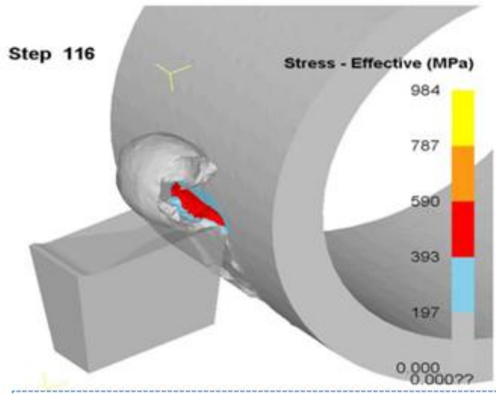


**Figure 8.** Effective stress of the tool without chip breaker.


**Figure 9.** Effective stress of elliptical chip breaker.

Results shows that tool with chip breaker has less stress than without chip breaker. This affect also temperature between tool and chip directly and tool life will be affected. Another factor; friction has significant role in chip breaking. To prevent friction contact time should be minimize between tool and chip [11].

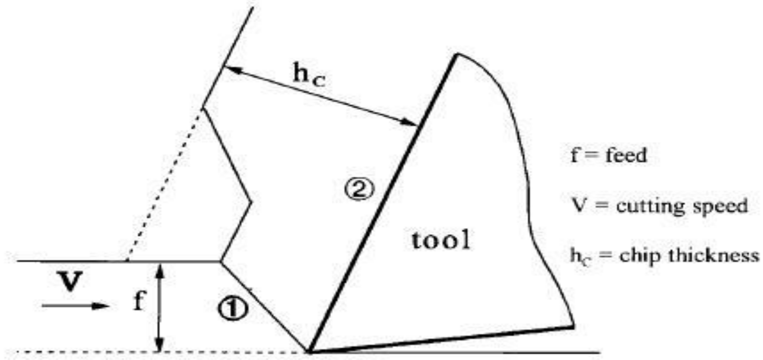


**Figure 10.** The temperature zones in cutting caused by bending and friction.

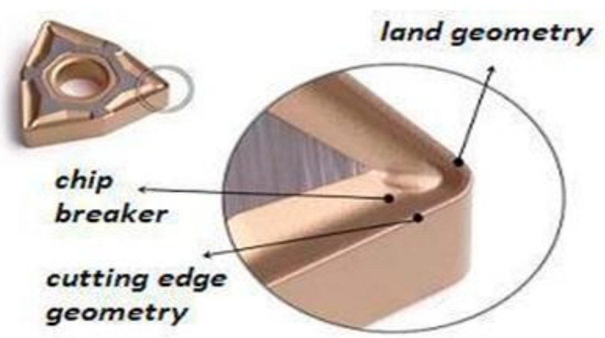


**Figure 11.** Geometry of cutting inserts

Main duty of the chip breaker is to improve chip forming and leaving from cutting area, reduce contact area between chip leaving and face of cutting tool, faster heat transfers from cutting area and reduce cutting resistance. The chip breaker with open shape or straight bottom less deforms chip and forms lower cutting forces. Geometry is specified for maximum a contact between chip and tool, and it causes a dispersion of cutting forces on bigger zone and a danger of cutting edge breaking is lower. These chips are longer and their leaving from cutting area is problem. However, closed/blocked geometry of chip breaker more deforms the chip, and then it cuts into small parts [22].

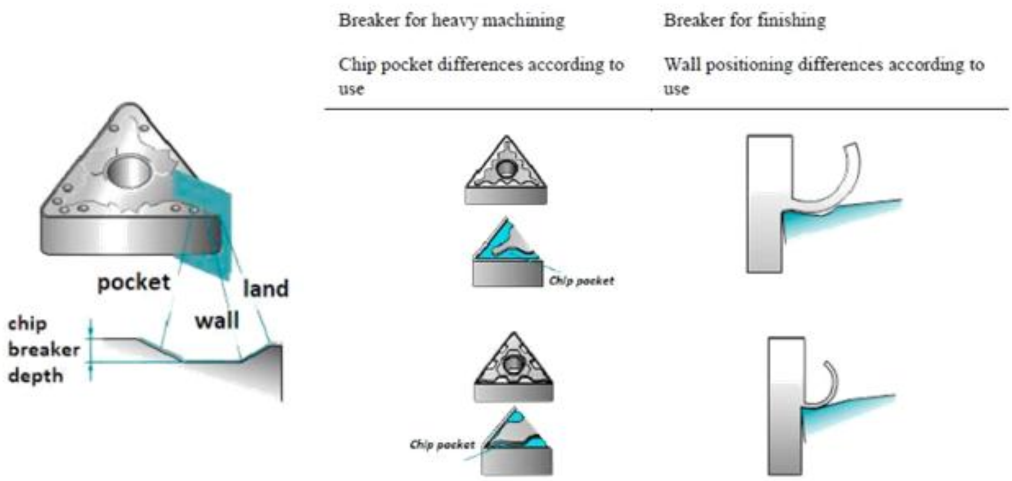


**Figure 12.** Graphical view of chip breakers for heavy machining and finishing operations

Chip breakers must be designed to have a large breaker width chip pocket to control chip and break.Productivity, quality, cost, and environment are four major concerns in manufacturing. Chip control has significant role in optimizing the manufacturing process. To reach the chip control goals in industry, chip-breaking predictive tool is important. Most common available cutting-tool inserts are designed on the basic of the traditional "try and see" methods which are non-systematic, unscientific and time consuming. Also, these methods often do not provide the best results. Therefore, it is necessary to work out a more significant design strategy to simplify improved usage and performance of cutting tool inserts in machining.

## IV. CONCLUSION

Chip control method with guide grooves and guide channel was developed and verified to realize continuous chip elimination as well as chip-pulling cutting. Using dynamic chip breaker, long chips can be broken. The horizontal distance between the cutting edge and chip breaker increases when chip length increases. If the vertical distance between the cutting edge and chip breaker decreases, the length of chip becomes shorter because of the force and impact acting on the chip surface with designed chip breaker. Small, broken chips are not disturbing the machine and the environment. They have positive effect on the cutting process and are far easier to handle, store, transport, and recycle.

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