High-Feed Cutter SEC-Sumi Dual Mill DMSW Series

1. Outline

A milling cutter is a cutting tool with a cutting edge on the periphery, end face, or side face. Various kinds of parts are machined by revolving the cutter. Milling cutters with indexable inserts are widely used today for various types of machining.

Recent performance improvement of machine tools is increasing the need for tools specialized in high-efficient machining in the automotive, aerospace, ship building, industrial machinery, die-mold, and other sectors to improve productivity. Environmentally friendly machining has also become a focus of attention as a part of CO_2 emissions reduction activities to achieve a decarbonized society.

Sumitomo Electric Industries, Ltd. has recently developed the SEC-Sumi Dual Mill DMSW series (DMSW), which enables more efficient machining and contributes to increasing productivity and saving energy.

Photo 1. SEC-Sumi Dual Mill DMSW Series

2. Features

2-1 Ultra-high feed and large depth of cut

DMSW is a type of high-feed cutter, a milling cutter that has a high feed per tooth for machining. DMSW has a complex arc-shaped cutting edge, as shown in Photo 2, and achieves a higher feed rate than conventional cutters do. The complex arc-shaped cutting edge also achieves a larger depth of cut that is essentially difficult to balance with a high feed rate (Fig. 1).

To achieve an ultra-high feed rate with DMSW, we use Eq. (1) among the cutting edge angle θ, feed per tooth f_z, and chip thickness h. For example, when the feed per tooth is 2 mm/t, shouldering and facing cutters cannot be used because chips with a thickness of 1 mm or more will break the cutting edge; however, DMSW can be used because the thickness is reduced to around 0.3-0.5 mm due to its cutting edge angle θ of 15° or less (Figs. 2 and 3). In combination with high-strength inserts developed by our advanced coating technology, more efficient machining than ever before is enabled.

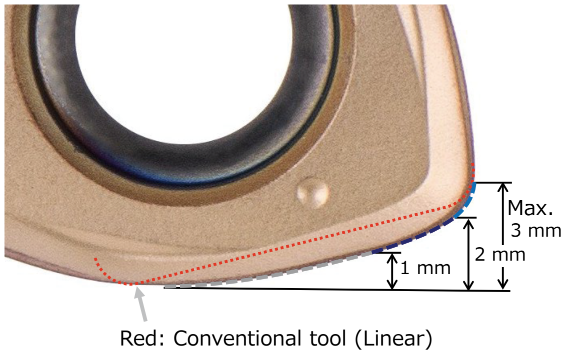


Photo 2. Cutting edge of DMSW

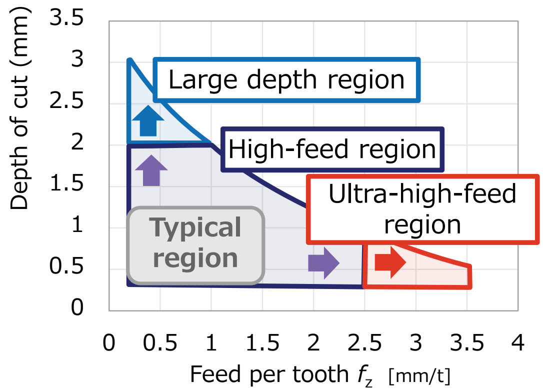


Fig. 1. Applicable region

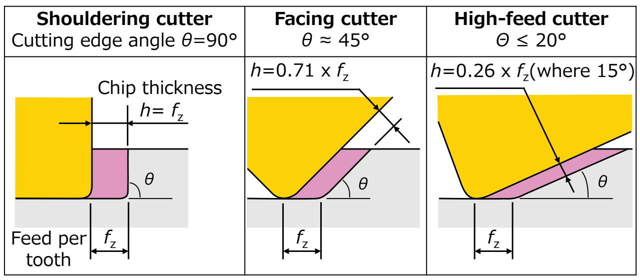


Fig. 2. Cutting angle and chip thickness

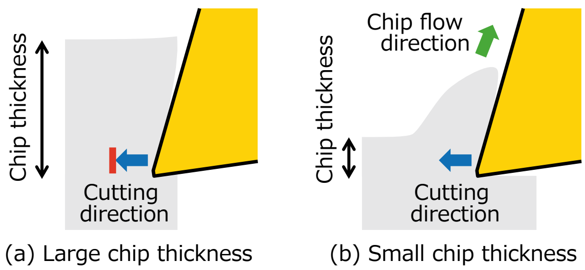


Fig. 3. Two-dimensional cutting model

$$h = \sin\theta \times f_z \quad \text{(1)}$$

2-2 Stable machining with a long overhang

When large parts, such as die/molds or construction machines, are machined, a long tool overhang is applied to avoid interference between the workpiece and the machine (Photo 3). DMSW enables stable machining under such unstable and chattering-prone conditions. As mentioned above, since the cutting edge angle of high-feed cutters is commonly 20° or less, the direction of the cutting force is controlled toward the spindle rotational axis direction, which has a high rigidity. Therefore, it is difficult for high-feed cutters to induce chatter in long tool overhang machining compared to shoulder milling and other cutters. DMSW has superior anti-chattering performance and shows high stability even under conditions where chatter occurs among the high-feed cutters of competitors (Fig. 4).

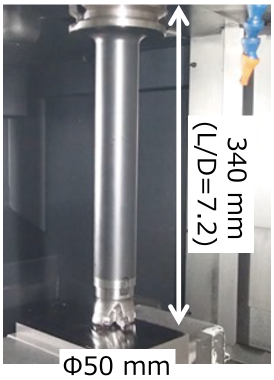


Photo 3. Machining with a long tool overhang

Machine: Vertical M/C, BT50 Material: Carbon steel
Arbor: Steel arbor, 300 mm (No anti-vibration mechanism)
Cutter: DMSW08050RS04 (Ø50 mm, 4 teeth, Length: 40mm)
Insert: WNMU0807ZNER-G (ACU2500)
Cutting conditions: v_c = 160 m/min, f_z = 0.65 mm/t,
a_p=0.8mm, a_e=45mm, Dry

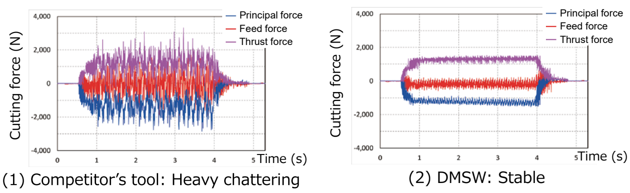
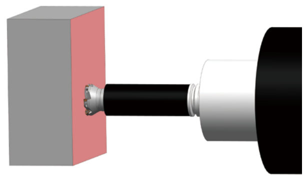


Fig. 4. Comparison of cutting forces

3. Application Examples

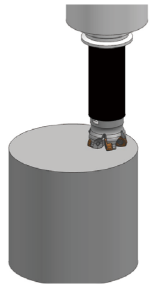
Machine: Horizontal boring machine, BT50
Material: Pre-hardened steel, 40HRC
Cutter: DMSW08100R06 (Ø100 mm, 6 teeth)
Insert: WNMU0807ZNER-G (ACP3000)
Cutting conditions: v_c = 180 m/min, f_z = 1.5 mm/t,
a_p = 1 mm, a_e = 65 mm, Dry



- No chatter even when the cutting speed was increased at an overhang amount of 380 mm (steel arbor). Efficiency increased 1.5 times.

Fig. 5. Test piece

Machine: Vertical M/C, BT40
Material: Tool steel, 48HRC
Cutter: DMSW08050RS05 (Ø50 mm, 5 teeth)
Insert: WNMU0807ZNER-G (ACU2500)
Cutting conditions: v_c = 120 m/min, f_z = 1.83 mm/t,
a_p = 0.5 mm, a_e = 36 mm, Wet



- Larger diameter for increased tool rigidity.
  Higher feed per tooth reduced machining time to 1/6.

Fig. 6. Forging die

4. Contribution to Achieving a Decarbonized Society

Activities to reduce CO_2 emissions are globally gaining momentum and there is a demand for reducing electric energy consumption in machining processes. Improving machining efficiency with DMSW can reduce electric power consumption per part.

Broadly, two factors contribute to the energy consumption of a machining tool in machining processes. One is the motors that are used to rotate and move tools and work material. Their total power consumption does not change between before and after the improvement in efficiency because the machining time shortens in inverse proportion to the improvement in efficiency, but the power consumption of the motor per unit time increases in proportion to the efficiency. (The bar areas show the power consumption in Fig. 7.)

The other factor is peripheral devices, such as a control PC, the panel the machining tool is equipped with, and the cooler that cools coolant for cutting. Since their power consumption does not change depending on the machining efficiency, improving the efficiency and shortening the machining time can reduce the total power consumption (the hatched area in Fig. 7). DMSW can drastically improve efficiency, as shown in 3. Application Examples, and reduce power consumption even more.

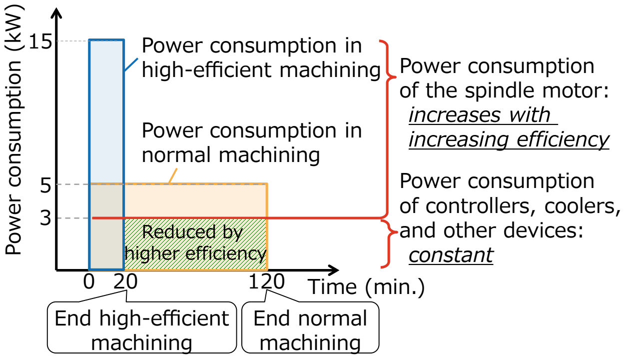


Fig. 7. An example of power consumption in machining processes

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