Development of SEC-DNX Series for Cast Iron and Cast Steel Milling Cutters with Indexable Inserts

Ai TANAKA*, Atsuhiko MAETA, Shigenori EMOTO and Shinya UESAKA

Machines used at construction and industrial sites are required to cut large and complex shaped parts and shave off large cast surface areas. However, this can lead to major problems such as time consumption and short tool life. To overcome these problems, Sumitomo Electric Hardmetal Corp. has developed a new milling cutter “DNX series” for cast iron and cast steel milling. This series enables a large depth of cut at a high feed rate, thereby enhancing milling efficiency. Moreover, its V-shaped cutting edge and unique insert breaker reduce cutting resistance and vibrations. Furthermore, the combination use of the cutter bodies and indexable inserts of this series can provide a wide application range.

Keywords: cast iron, casting steel, milling

1. Introduction

With recent economic growth in emerging countries and market expansion in the energy sector, demand for construction machinery and industrial machinery is increasing steadily. Since the equipment used in this field comprises large, intricately shaped cast iron and cast steel parts, requiring removal of large portions, they take time to be fabricated. Fabrication of these parts poses additional productivity problems, such as metal removal rate variance depending on black surface properties, and relatively short cutting tool life. Improving the efficiency of machining - particularly milling - and reducing tool cost will play important roles in productivity improvement. To meet user needs for productivity improvement under such circumstances, Sumitomo Electric Hardmetal Corp. has developed the new “DNX series” of face milling cutters fitted with indexable inserts. The new cutters ensure high-efficiency cutting, with a cutting depth 1.5 times that of conventional cutters, and are highly cost-effective. This paper describes their advantages and cutting performance.

Photo 1. SEC-DNX Series Milling Cutters

2. Advantages of DNX-Series Milling Cutters

2-1 Achieves both high cost-effectiveness and high-efficiency cutting

Indexable inserts for milling cutters are roughly grouped into negative inserts and positive inserts. Positive inserts ensure high cutting quality, while negative inserts, although they experience greater cutting resistance, are highly cost-effective because both cutting edge surfaces are available for cutting.

To enhance machining efficiency by increasing depth of cut, it is a common practice to increase the effective cutting edge length available for each feed. On the other hand, to achieve maximum depth of cut by increasing the number of cutting edges, the insert size must be increased, which increases cutting tool cost. In the target field of new milling cutter use, since casting surface of the raw material affects depth of cut, a key factor in new cutter design is to ensure sufficient cutting depth.

After considering the above factors, we designed a 12.7 mm diameter polygonal negative indexable insert with eight usable cutting edges. This insert, which is smaller diameter than any polygonal negative inserts supplied by competitors, achieves greater cutting depth than any other commonly used milling cutters, while maintaining high cost-efficiency. In addition, the approach angle was set at 25 degrees and other cutting edge specifications were op-

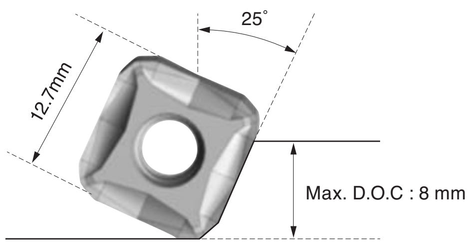

Fig. 1. DNX Series Indexable Insert Size and Cutting Edge Specifications

timized, to ensure high-efficiency, cost-effective cutting with ample cutting depth (**Fig. 1**).

In addition to reducing the cost of indexable inserts, we also focused on reducing the cost of cutter bodies. Our conventional cutter bodies were equipped with a wedge-type insert clamping mechanism consisting of many parts, which increased body cost. We modified the insert clamping mechanism to a screw clamping system to reduce the number of parts and cut body cost.

2-2 Ensure stable cutting operations

With the traditional technique, it was difficult to have both edge surfaces of negative indexable inserts available for finishing workpiece surfaces to desired quality, because the edges lost their sharpness in a short time. Since negative insert cutting edge specifications were subject to various restrictions, it was difficult to obtain the same level of edge sharpness as with positive inserts.

To overcome these shortcomings and provide negative indexable inserts with excellent sharpness and stable cutting performance, we devised a V-shape cutting edge and original chip-breaker (**Fig. 2**)

The newly devised cutting edge and chip breaker configurations ensure stable cutting operation with lower cutting resistance (**Fig. 3**) and lower vibration than any cutters made by competitors.

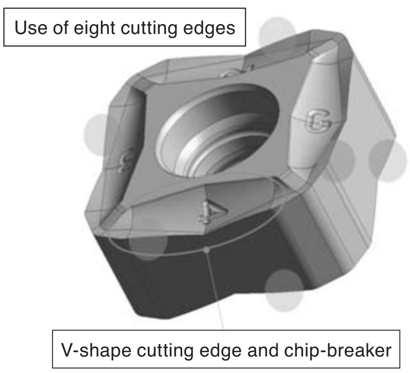

Fig. 2. Chip Breaker and Cutting Edge Configurations of Indexable Insert for DNX-Series Cutter

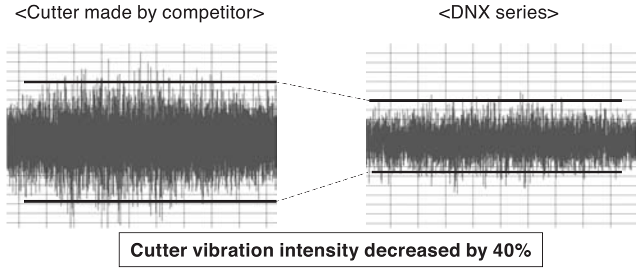

Fig. 4. Cutter Vibration Intensity Comparison

2-3 Wide range of application

DNH- and DNHS-type cutters fitted with the newly developed, highly cost-effective indexable inserts were also designed as part of the DNH series line-up, in order to meet a broader variety of user needs for higher feed rate, higher-efficiency cutting. The DNH-type cutters have an approach angle of 66 degrees. Since cutter cutting resistance generally decreases as its cutting edge angle decreases, the DNH-type cutter reduces cutting load so as to increase the feed per tooth. In fact, the DNH-type cutter can cut castings at a feed per tooth of 1.0 mm/t, which is higher than an DNX-series cutter (up to 0.3 mm/t).

On the other hand, the reduced cutting edge angle of the DNH-type cutter limits its maximum depth of cut to 3 mm. To ease this restriction, the DNHS-type cutter is fitted with pairs of staggered indexable inserts. This cutter thus enjoys a maximum depth of cut of 5 mm without compromising the high-feed cutting performance of the DNH-type cutter (**Fig. 5**). The above two types of cutters meet user needs for high efficiency cutting with large cutting depth or high feed rate (**Fig. 6**).

In addition to conventional G-type and H-type chip breakers, we have newly developed an SH-type breaker for cast steel chips having a shape similar to steel chips. Provided with straight cutting edges, the SH-type breaker reduces chip curl diameter, thereby easing chip discharge (**Fig. 7**).

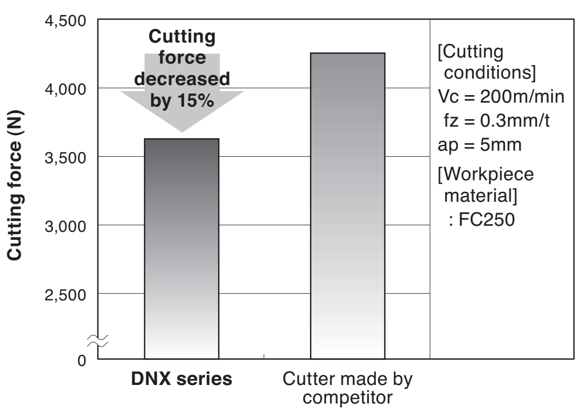

Fig. 3. Cutting Force Comparison

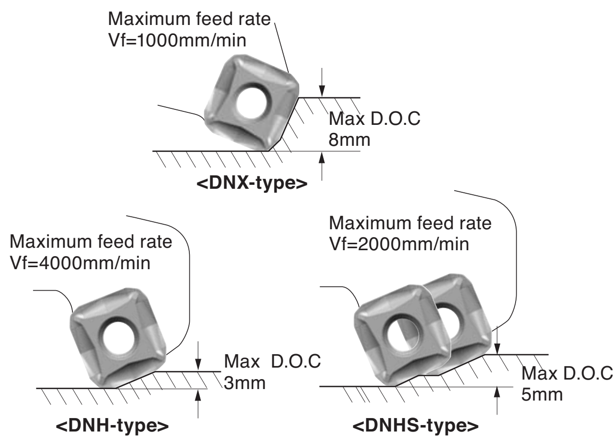

Fig. 5. Advantages of DNX-Series Bodies

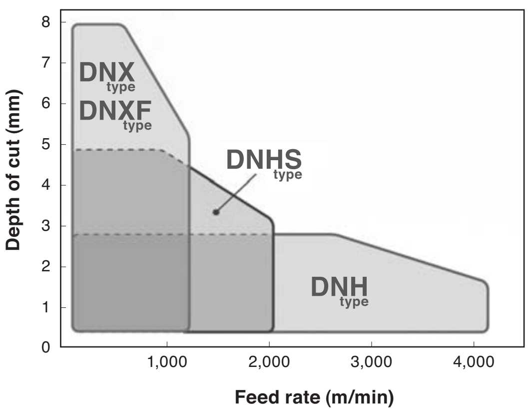

Fig. 6. Application Range of DNX-Series Cutters

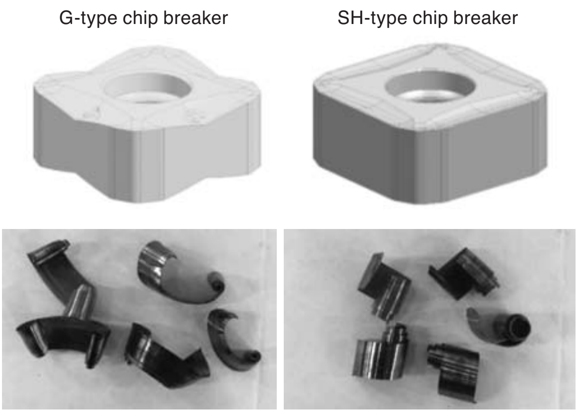

Fig. 7. Cutting Edge Configuration and Chip Comparison

3. Cutting Performance

DNX-series cutter users can meet various cutting needs by combining the cutter body and chip breaker best suited to the work material. Typical examples of the practical use of this series of cutters are described below.

[Example (a)] Use of a chip breaker with higher edge strength and lower cutting force than conventional cutter extended tool life 1.2 times and cutting efficiency 1.3 times.

[Example (b)] Since conventional cutters could not achieve sufficient cutting length, the user was forced to cut each workpiece with 3 strokes at a shallow cutting depth. Replacement with a new series cutter increased depth of cut to 7 mm and reduced the required stroke number from 3 to 1. Productivity was thus enhanced through 40% reduction in total cutting time, as compared to the previous cutter.

[Example (c)] In this example, material removal rate varied because of large workpiece size. The introduction of a DNX-series cutter with increased maximum depth of cut ensured stable cutting despite removal rate variance. In addition, use of an SH-type chip breaker streamlined the cutting of cast steel workpieces, extending tool life to 1.3 times that of previous cutters.

4. Conclusion

SEC-DNX series cutters meet the market need for cost-effective, high-efficiency cutting, and are expected to help users save cutting tool costs while improving productivity.

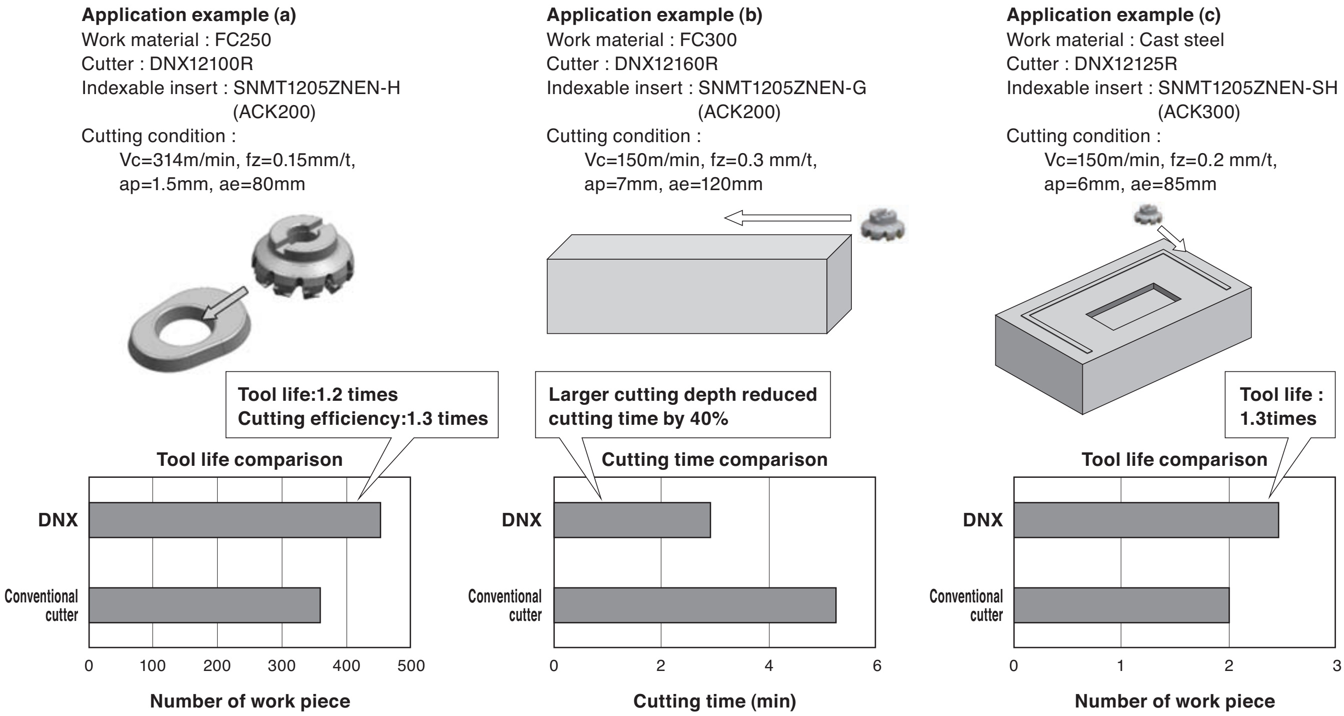

Fig. 8. Application Examples of DNX-Series Cutters

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