

Optical Measurement for Flank Wear in Peripheral Cutting Edges in Endmills

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1. Introduction

In order to evaluate tool wear of peripheral cutting edges in endmills precisely, whole length of cutting edges have to be monitored. As well known, since the peripheral cutting edges of endmills have spiral geometry, conventional tool measuring method for turning tools cannot be applied as it is [1], [2]. This study aims to evaluate the flank wear in peripheral cutting edges quantitatively, a new optical measuring method of flank wear is proposed.

2. Measuring Principle of Wear Measurement

Since the geometrical shape of peripheral cutting edge is spiral in three dimension, flank wear taking place in whole cutting edge cannot be measured simultaneously. Therefore, in this study, flank wear occurred in whole edge is measured by repeating measurement of minute cutting edge part. That is, clamping an endmill to a rotating axis, a CCD camera is located on a slider fed in axis parallel to the rotating axis. Since this CCD camera is located with an incline as same as the edge twist angle, in this case 30 degree, cutting edge can be monitored horizontally. After positioning rotary axis to the measured part, camera is positioned to the measuring part and a video data is acquired. Repeating this procedure, whole image data in peripheral cutting edge can be monitored. Arranging these video data straight as shown in figure 1, flank wear in whole cutting edge can be evaluated.

3. Design of Measuring Equipment

Figure 2 shows the schematic diagram of this measuring system. An endmill is clamped to a collet chuck located on a rotatory axis. While, a CCA camera and a halogen lamp are located on a linear stage. Rotatory and translatory axes are controlled by two servo motors which have

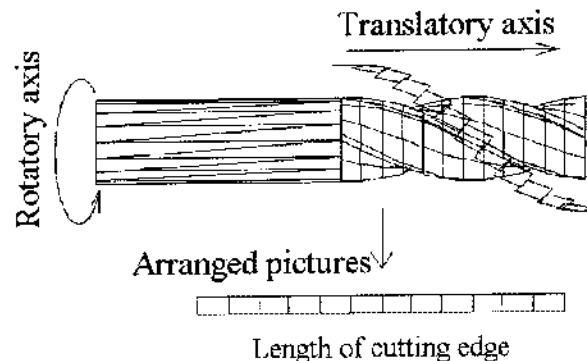


Fig.1 Repetitive measuring method

least input increments 1/3 degree and 0.1 mm respectively.

Horizontal and vertical length of one video data is 512 pixel, 2.304 mm. In this measuring method, horizontal 200 pixel data, 0.9 mm, are acquired in a video data, and then data acquisition number is needed 23 times for the measuring 20 mm length of cutting edge. It takes

about 2 minutes to measure 20 mm length edge.

4. Wear Measurement by Designed Equipment

4.1. A Measured Example of Flank Wear

Figure 3 shows a measured example of cutting edge after up-cutting. Figure 3(a) shows the cutting edge before cutting operation. In this figure, plots are concentrated linearly near the cutting edge. Figure 3(b) shows the same cutting edge after cutting operation, cutting length is 10,800 mm, removed metal volume per unit width is $4,320\text{mm}^3/\text{mm}$. In this figure, the number of plots are increasing in the area from 2.5 to 15.0 mm from the right end which means the top of cutting edge. This area corresponding to the part used in cutting, 3.0 ~ 13.0 mm from the top of cutting edge.

4.2. Flank Wear in Cutting Process

Figure 4 shows the variation of measured flank wear in cutting

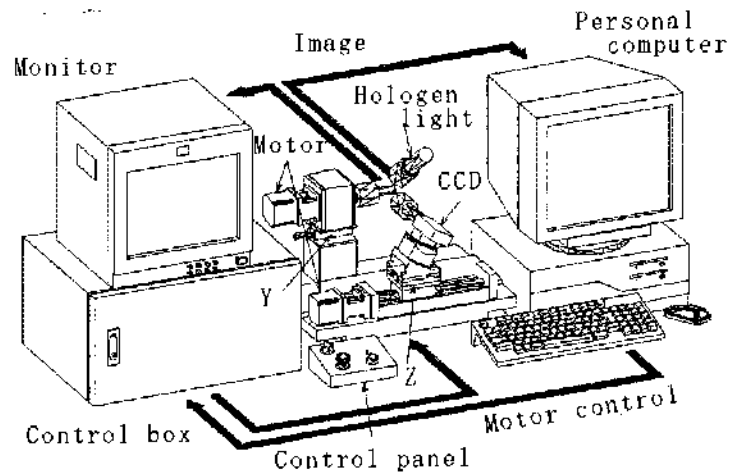
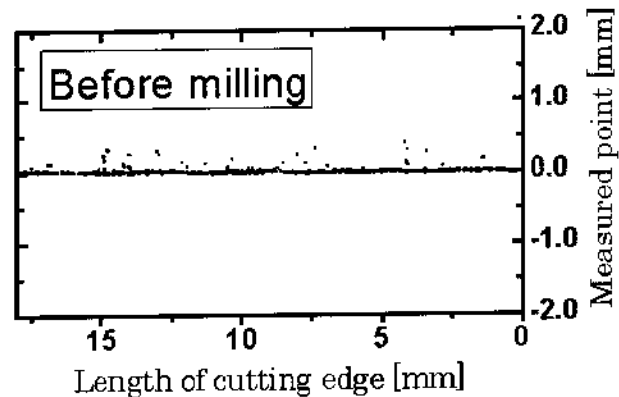
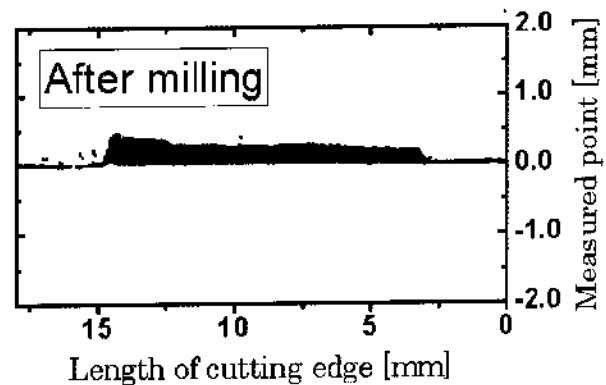


Fig.2 Schematic diagram of measuring equipment



Area of flank wear : $0.1 [\text{mm}^2]$

(a)



Area of flank wear : $1.65 [\text{mm}^2]$

Max. width of flank wear : $0.24 [\text{mm}]$

(b)

Fig.3 Measured example of flank wear

process. This figure shows that the flank wear increases with the increase of cutting length. Figure 5 shows the variation of the area of flank wear in cutting process. This figure shows that the areas of flank wear in both cutting methods are increasing with the increase of cutting length.

4.3. Measurement of Retreat of Cutting Edge

Figure 6 shows a schematic diagram of cutting edge. As well known, width of flank wear shown a in this diagram increases in cutting process, and cutting edges also retreats as shown b simultaneously.

In conventional optical measurement, it is very difficult to identify the retreat of cutting edge shown b in this diagram. In this study, a quantitative measuring method of this retreat is also proposed. Figure 7 shows a schematic diagram of the flank wear in cutting edge. In this figure, white part shows the flank wear as same as shown in figure 3. However, the bottom line does not coincide with the cutting edge before cutting operation. And then, superimposing the data before cutting and carrying out their subtracting operation, retreat of cutting edge can be identified quantitatively. A measured example is shown in figure 8. The area a in this figure shows the flank

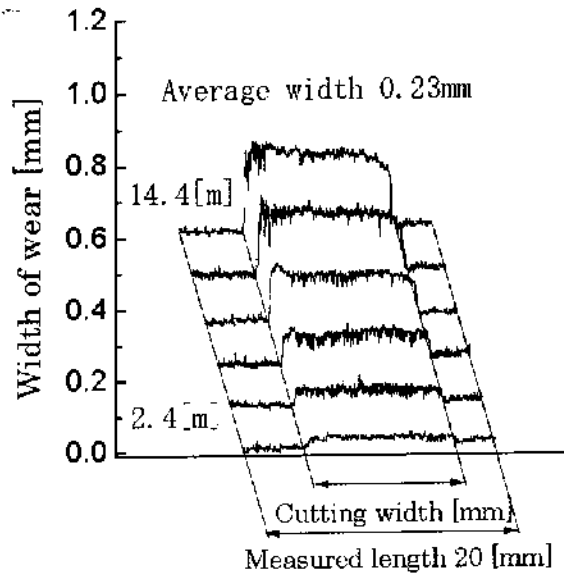


Fig.4 Measured flank wear in cutting process

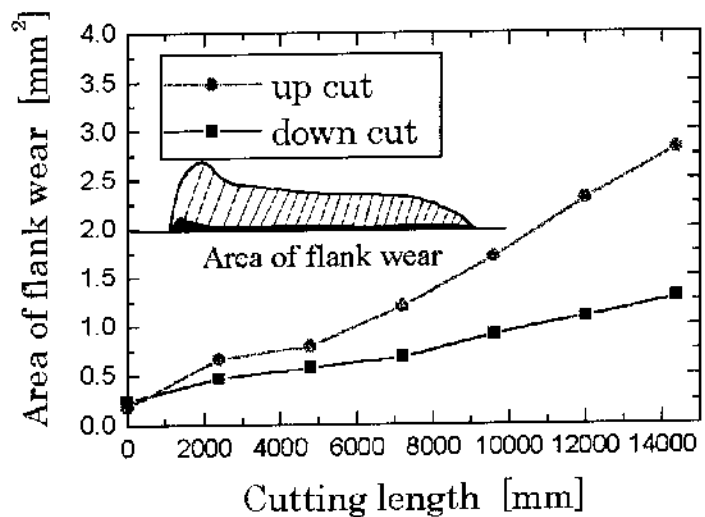


Fig.5 Area of flank wear in cutting process

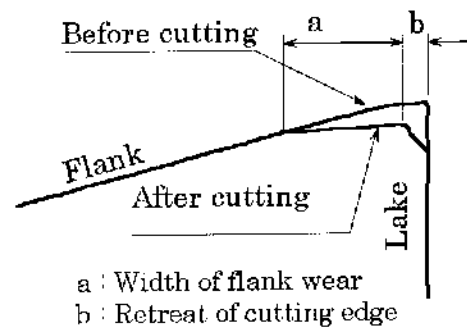


Fig.6 Flank wear and tool retreat

wear, and the area b shows the retreat of cutting edge. In this case, it is known that the amount of retreat is about 0.05 mm.

5. Conclusions

In this study, an optical measuring method of flank wear of peripheral cutting edge in endmill is proposed. As the result of this trial, flank wear and retreat of cutting edge can be measured quantitatively.

Acknowledgment

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References

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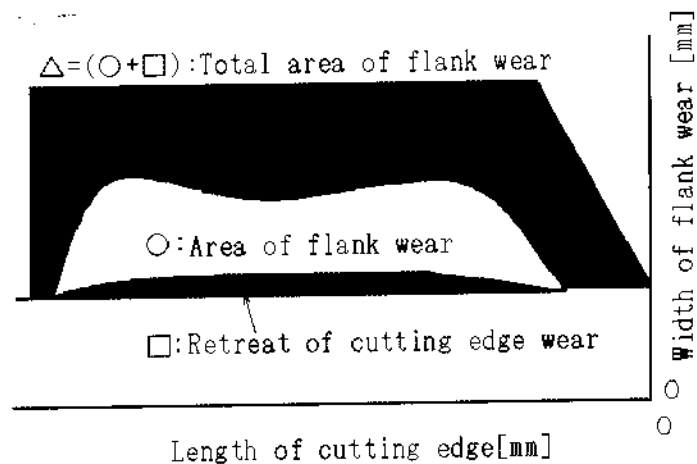


Fig.7 Measuring method of cutting edge retreat

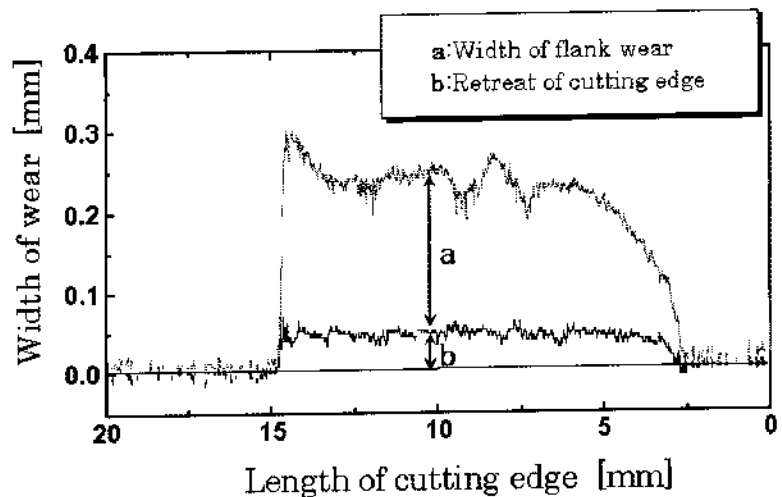


Fig. 8 Measured example of flank wear and edge retreat