STUDY ON A MEASURING METHOD FOR GRAIN CUTTING EDGES IN GRINDING WHEEL SURFACE

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ABSTRACT

Present study aims to propose a measuring method for the grinding wheel profile and the distribution of cutting edges in the same time. As the results of experiments, cutting edges in the periphery of grinding wheels can be measured directly by the proposed contact method. And it is confirmed that the distribution, the density and the length of cutting edges can be easily measured by the present method simultaneously.

1. INTRODUCTION

A grinding wheel surface removes workpiece material. A wheel surface is closely related to a workpiece surface form and roughness. And then it is important to measure grinding cutting edges in a grinding wheel in order to carry out the precision grinding. Some measuring methods for grinding wheel surfaces have been developed [1-3]. However, any method to measure the profile of grinding wheel surface and grain cutting edges simultaneously cannot be found. In order to evaluate the grinding wheel surface quantitatively, the wheel surface, that is, the distribution of cutting edges and the surface profile of wheel surface have to be measured in the same time. From such a viewpoint, present study aims to develop a method to measure the surface profiles of grinding wheel surfaces and grain cutting edges simultaneously. And the experimental result with an newly designed instrument, it is confirmed that the proposed method can be used reliably.

2. A MEASURING INSTRUMENT AND METHOD

Figure 1(a) shows a measuring instrument for grain cutting edges developed in this study, which is loaded on a chuck of a surface-grinding machine. The detective part of measuring instrument is settled on an X-Y axis stage, which is able to move along the directions of a wheel axis and wheel radius. The detective part consists of spools, a direction roller, a guide, wire, an acoustic emission sensor (AE), a stepping motor and etc. An AE sensor, which cannot be seen in figure 1, is fitted to the guide. A wire is driven by a stepping motor. The wire goes through the guide, and is reeled by a spool. As shown in this figure, a wire is used as a stylus in this measuring system. The contact of a grinding wheel surface and a wire is detected by an AE sensor. By reeling the wire after every contact, the wire in the contact part can be kept fresh in every measurement. Hence, this instrument can be used to measure the grinding wheel surface in contact methods. In this study, X-axis and Y-axis are defined as the direction of grinding wheel axis, and as the vertical direction of a magnet-chuck respectively.
On the other hand, a photo interrupter is installed to the end of the spindle of a grinding machine as shown in Figure 1(b), and it generates pulse signals when a reference slit passes through the photo sensor. The origin of the rotational angle of grinding wheel can be calculated from these pulse signals.

Figure 1  Measuring instrument

Figure 2 shows a schematic diagram of the present measuring system. A computer connected to a stepping motor, can send a command to role a spool, by which a fresh part of wire
is supplied to the top of the guide. The computer also controls the X-Y stage. Namely, the detecting part of the instrument is controlled in X-axis and Y-axis. The AE signal generated from the AE sensor due to the contact of grinding wheel and wire is transferred to an amplifier, a high-pass filter, a rectifier and a discriminator. The discriminator evaluates the contact of the wire to wheel and transmits the pulse signal to a digital memory. In the same time, lift up motion of the detective part is stopped.

On the other hand, a digital memory records two pulse signals generated from the photo interrupter and the discriminator. A rotational angle of a grain cutting edge in a grinding wheel surface from a reference point is calculated. Measuring condition of this experiment is shown in table 1.

### Table 1 Measuring condition

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<table>
<thead>
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<tbody>
<tr>
<td>Grinding wheel</td>
<td>WA36G8V</td>
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<tr>
<td>Peripheral speed</td>
<td>1800m/min</td>
</tr>
<tr>
<td>AE sensor</td>
<td>500kHz</td>
</tr>
<tr>
<td>Wire</td>
<td>Tungsten, 0.1mm</td>
</tr>
<tr>
<td>X-stage least incremental input</td>
<td>1µm</td>
</tr>
<tr>
<td>Y-stage least incremental input</td>
<td>0.5µm</td>
</tr>
<tr>
<td>Dressing condition</td>
<td>10µm×10pass(lead=0.1mm/rev)</td>
</tr>
<tr>
<td></td>
<td>5µm×10pass(lead=0.05mm/rev)</td>
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3. DISTRIBUTION OF GRAIN CUTTING EDGES AND GRINDING WHEEL PROFILE

Figure 3 shows a measured example of distribution of grain cutting edges and geometrical shape of grinding wheel. Figure (a) shows a grinding wheel profile, and figure (b) shows grain cutting edge distribution of figure (a). From figure (b), the distribution of cutting edges can be evaluated. Some of the grain cutting edges are converging in the same rotational angle. These aligned cutting edges indicate one cutting edge is continuing. From these results, it can be known that the length of grain cutting edge is about 0.08mm in this case.

4. THE DISTRIBUTION OF GRAIN CUTTING EDGE AND ITS DENSITY

Figure 4 shows the distribution of cutting edges measured after dressing and after grinding. In this experiment S45C (HRC33) was used as a workpiece. The distribution of after dressing shown in figure 4 (a) is the coarsest in three results. Namely the number of grains in after dressing is the least. And it has a tendency that the number of grains increases and their distribution becomes dense in the grinding process. This tendency may be...
caused as follows. That is, in the grinding process, grain cutting edges are gradually worn and released, and then, the distribution of grains height also decreases. The numeric values of density are shown in figure 4. The density of cutting edge at the after dressing is 0.04mm⁻². And it increases to 0.098mm⁻² with the progress of grinding process and saturated. As shown in figure 4, it is clarified that the number and the density of cutting grains in wheel surface can be evaluate quantitatively by using the measuring method proposed in the present study.

![Graph showing grain cutting edge distribution](image)

Figure 4  Grain cutting edge distribution

5. CONCLUSIONS

In this study, a measuring method of grinding wheel surface profile and the distribution of cutting edge is proposed. The results obtained in this study are summarized as follows.

(1) The geometrical shape of grinding wheels and the distribution of cutting edges can be measured precisely in the same time.

(2) The distribution of cutting edge can be evaluated quantitatively.

(3) As the results shown above, the condition of grinding wheel surface can be evaluated precisely.

REFERENCES

