Algorithms for Simulating Dressing Process of Rotary Diamond Dresser

Kitami Institute of Technology °M.A.K. Chowdhury, Akihiko Kubo, Jun'ichi Tamaki, Sharif Ullah

Abstract

Topography of grinding wheel (G.W.) surface is determined by dressing and a systematic approach is needed to understand the generation process of the G.W. surface topography under various dressing conditions. In this study, the algorithms for simulating dressing process of rotary diamond dresser are considered in the case of traverse dressing. The main component of the algorithms is to determine the total ratio of dressed area and the ratio of overlapping-dressed area of G.W. surface. Some results are shown to demonstrate the usefulness of the algorithms for optimizing the dressing conditions, i.e., the dresser depth of cut, the dresser feed ratio and the velocity ratio of grinding wheel to rotary diamond dresser.

1. Introduction

Many types of dresser are used to keep the material removal effectiveness of a G.W. and a rotary diamond dresser, which has a better wear resistance than single point diamond dresser, is one of the useful options. In the previous paper[1], a kinematic model was developed in which the dressing mark, i.e., contact length, on the working surface of G.W. left by a diamond grit embedded on the surface of rotary diamond dresser was introduced. In practice, multiple passes of dresser are required and every after each pass the dresser depth of cut increases to complete the dressing. This type of operation creates highly complex dressing patterns and overlapping-dressed area on the G.W. surface. A systematic approach is required to understand this phenomenon. In this paper, an algorithm is developed for simulating dressing process as well as for calculating ratio of dressed area and ratio of overlapping-dressed area for multiple passes of rotary diamond dressing.

2. Simulation of Dressing Process

The flow chart of the simulation is shown in **Figure 1**. The inputs of the model are dresser parameters, G.W. parameters and dressing parameters (see **Table 1**). Dressing parameters are dresser feed speed f_d, dresser depth of cut t, velocity ratio VR, and number of times of dressing D_N. By using these inputs, three parameters, contact length l_a, pitch of contact P, and length of undressed area g are calculated for drawing dressing marks.

Figure 2 illustrates the drawing process of the dressing marks on G.W. surface. x-axis is in the widthwise direction of the G.W. and y-axis is in the circumferential direction of the G.W. During the representation, some dressed area and undressed areas are cut-off in part at $y=\pi D_g$, which depends on the dressing conditions. The excess part is moved to the point at $y=0$ of the next rotation. The feed of dresser is given in the widthwise direction, either in left-to-right direction and or in the opposite direction (right-to-left direction), as shown in Fig. 2.

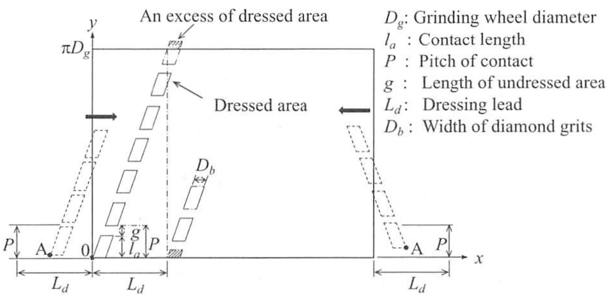


Fig.2 Drawing of dressing marks on the G.W. surface

At the change of two consecutive passes, starting point of the dressing marks A is given at random. At the end, ratio of dressed area and ratio of overlapping-dressed area are calculated from the representation of dressing marks.

3 Results of Simulation

3.1 Effect of dresser feed rate in single pass dressing

Dressing lead is a very important parameter in the generation

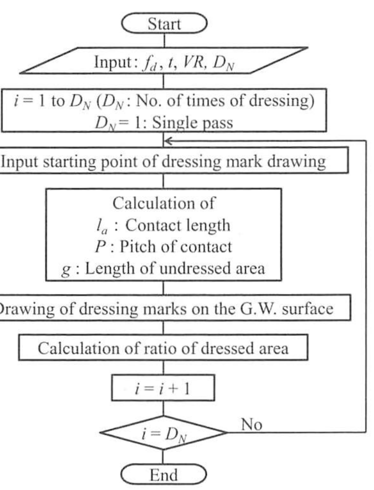
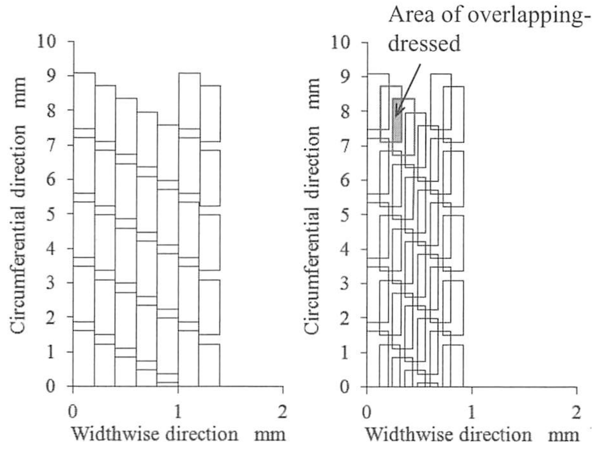


Fig.1 Flow chart of simulation

Table 1 Dressing conditions

Grinding wheel diameter Grinding wheel velocity	D_g = 140mm V_g = 37m/s
Rotary dresser Dresser diameter Number of diamond grits Length of diamond grits Width of diamond grits Dresser depth of cut Velocity ratio Dresser feed speed Dressing lead Dresser feed ratio	Prismatic diamond rotary dresser D_d = 50mm n = 120 m = 0.2mm D_b = 0.2mm t = 2, 4, 6, 8, 10μm V_d/V_g(=VR) = 0.1～1.0 f_d = 10～5050mm/min L_d =0. 002～1mm/rev L_d/D_b = 0.01～5
Dressing method Dressing pass	Up cut, down cut Single pass, multi-pass



(a) L_d=0.2mm/rev (L_d/D_b=1) (b) L_d=0.12mm/rev (L_d/D_b=0.6)
Fig.3 Change of G.W. surface in single pass dressing

of G.W. surface topography. In **Figure 3**, dressed area is observed in the case of t =2μm (single pass), V_d/V_g=0.7, and up-cut for two scenarios: a) dressing lead L_d=0.2mm/rev (L_d/D_b =1) and b) dressing lead L_d=0.12mm/rev (L_d/D_b=0.6). It is found that undressed area in scenario (b) is smaller than in scenario (a), however, overlapping-dressed area exists in scenario (b).

Figure 4 shows the plots of ratio of dressed area and ratio of overlapping-dressed against dresser feed ratio in single pass dressing. It is seen that the dressing of whole G.W. surface is realized at L_d/D_b =0.5, although 72% of G.W. surface is overlapping-dressed for 1 time. It is also seen that 100% dressing can be realized at L_d/D_b=0.2, however, 94%, 69%, and 44% of G.W. surface is overlapping-dressed for more than 1, 2, and 3 times, respectively. From these results, it can be stated that the optimum dressing can be obtained at L_d/D_b=0.5 in terms of 100 % dressing with minimum overlapping-dressing.

3.2 Effect of number of times of dressing in multi-pass dressing

The overlapping-dressed area is generated due to multi-pass dressing. Therefore, the number of times of dressing is critical in the dressing performance.

Figure 5 shows the G.W. surface after 5 passes of rotary diamond dresser for f_d =1010mm/min, t =2μm (multi-pass), V_d/V_g=0.7, and up-cut.

Figure 6 shows plots of ratio of dressed area and ratio of overlapping-dressed area against number of times of dressing. The plotted data are the average after 100 times simulation. In Fig.6, 100% dressed area is realized when the number of times of dressing is 2. In this case, 87% of G.W. surface is overlapping-dressed for more than 1 time. Variation is also observed in the ratio of dressed area and the ratio of overlapping-dressed area due to the randomized nature of the starting point of dressing marks.

4. Conclusions

A systematic approach is developed to understand the generation process of the grinding wheel surface topography for multiple passes of rotary diamond dresser. The key point of the algorithm is to determine the ratio of dressed area and the ratio of overlapping-dressed area of the grinding wheel surface. This algorithm will be used for the development of simulation system for multi-pass rotary diamond dressing.

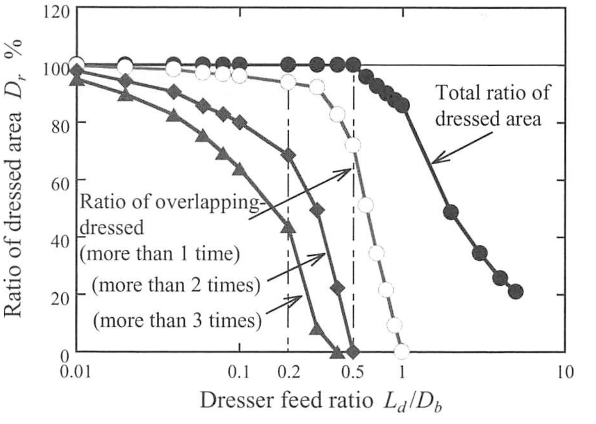


Fig.4 Ratio of dressed area vs. dresser feed ratio

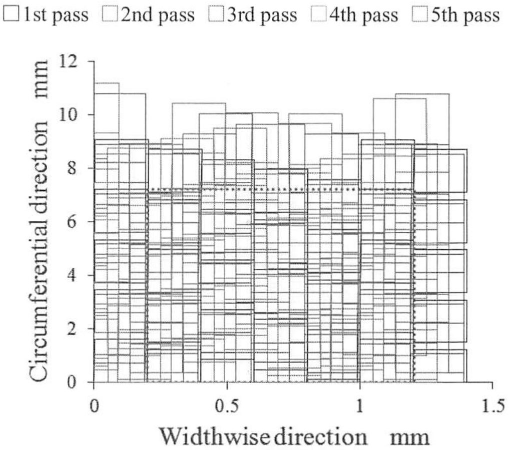


Fig.5 Change of G.W. surface in multi-pass dressing

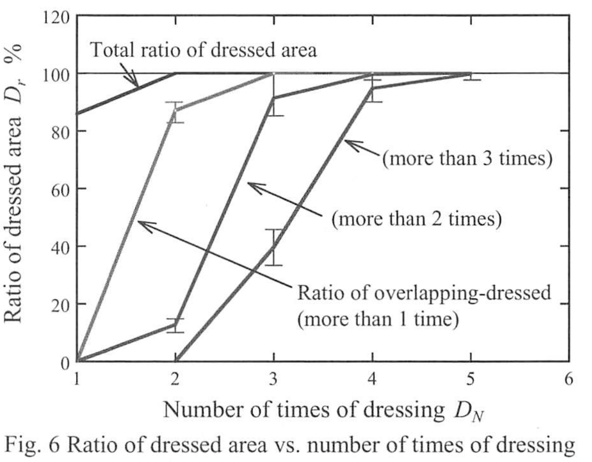


Fig. 6 Ratio of dressed area vs. number of times of dressing

5. References

1) M.A.K. Chowdhury, J. Tamaki, A. Kubo, and S. Ullah: An Analytical model of rotary diamond dressing, *Proceedings of the Japan Society for Precision Engineering Annual meeting, Hokkaido Branch*, pp.105-106 (2011).