Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Modeling of a virtual grinding wheel based on random distribution of multi-grains and simulation of machine-process interaction

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Cite this as: Xiang-lei Zhang, Bin Yao, Wei Feng, Zhi-huang Shen, Meng-meng Wang, 2015. Modeling of a virtual grinding wheel based on random distribution of multi-grains and simulation of machine-process interaction. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 16(11):874-884. [doi:10.1631/jzus.A1400316]

Virtual wheel model

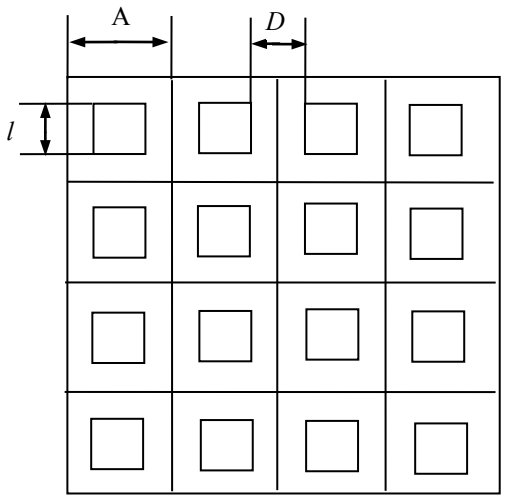


Fig. 1 Grinding grain of a random position distribution diagram

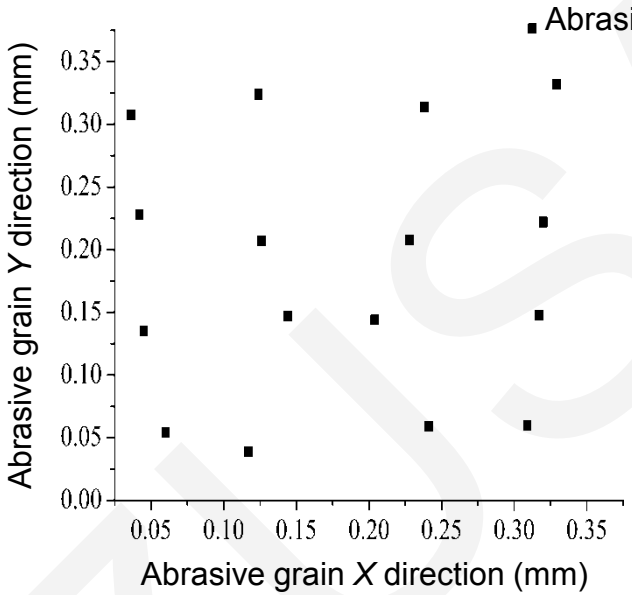


Fig. 2 Random distribution of the abrasive particle coordinates

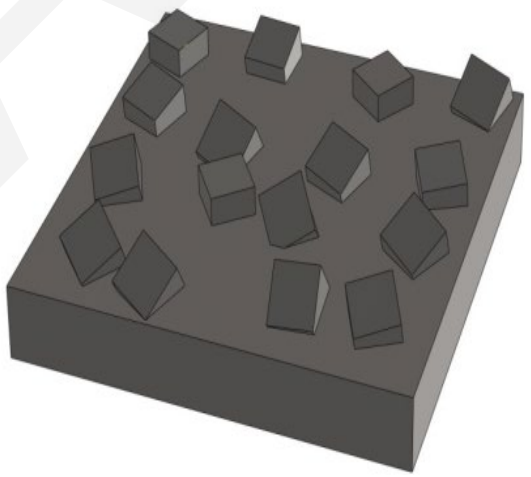


Fig. 3 3D view of virtual grinding wheel

Based on the assumption of interval distribution of abrasive grains and virtual grid method, the surface of virtual grinding wheel is randomly distributed with multi hexahedron abrasive grains which are equal in density. Besides, the posture of abrasive grains is randomly allocated to simulate the real topography of grinding wheel.

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Grinding model

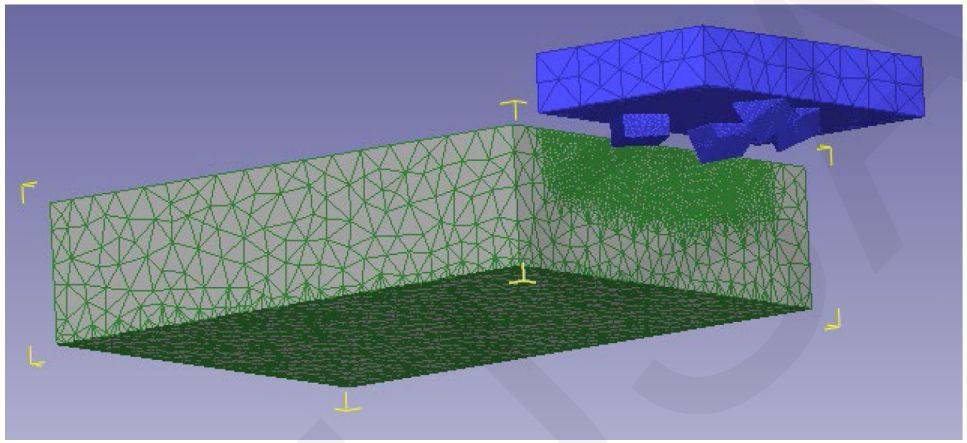


Fig. 4 Finite element model of the virtual grinding wheel and workpiece

The grinding model is built by importing the virtual grinding wheel model into Deform-3D software and the simulated grinding force value of multi grains is obtained as follow:

$$\begin{cases} F_t = \dfrac{1}{4} N F_{ft} \\ F_n = \dfrac{1}{4} N F_{fn} \end{cases}$$

Machine-process interaction

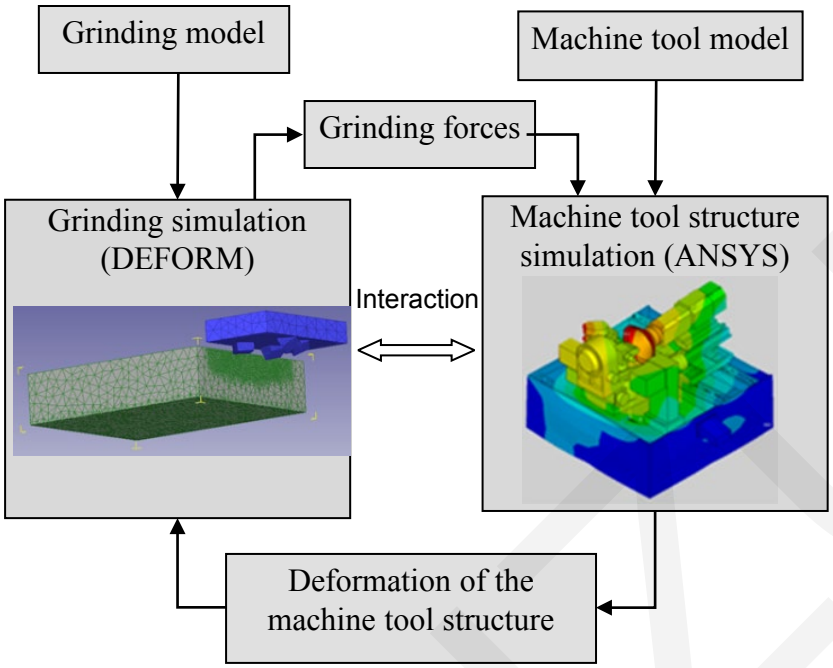


Fig.5 Coupling modeling and simulation of machine-process interaction

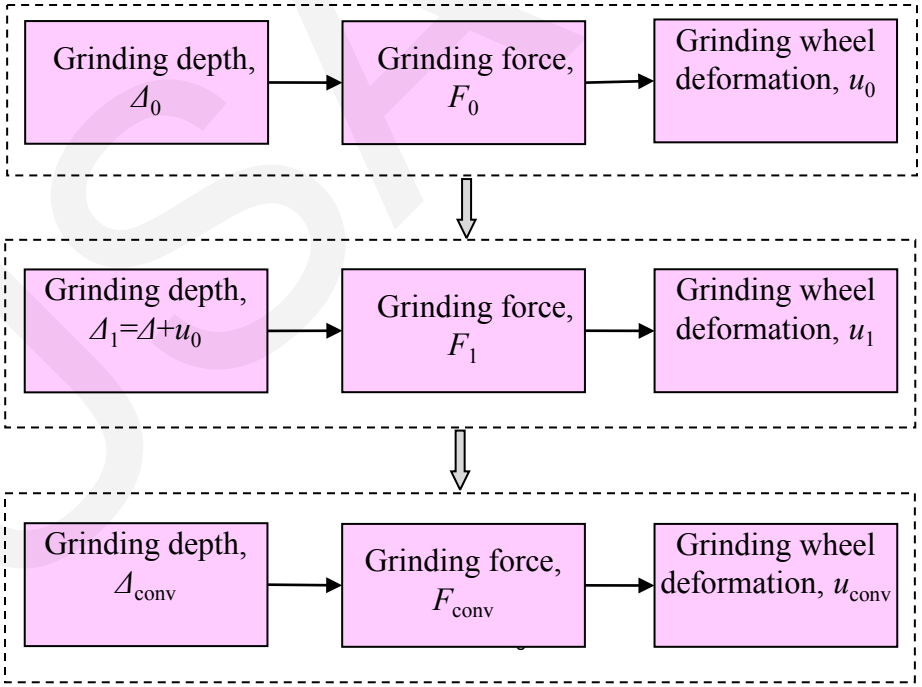


Fig. 6 Coupling iteration process of grinding force and grinding wheel deformation

Results of coupling simulation

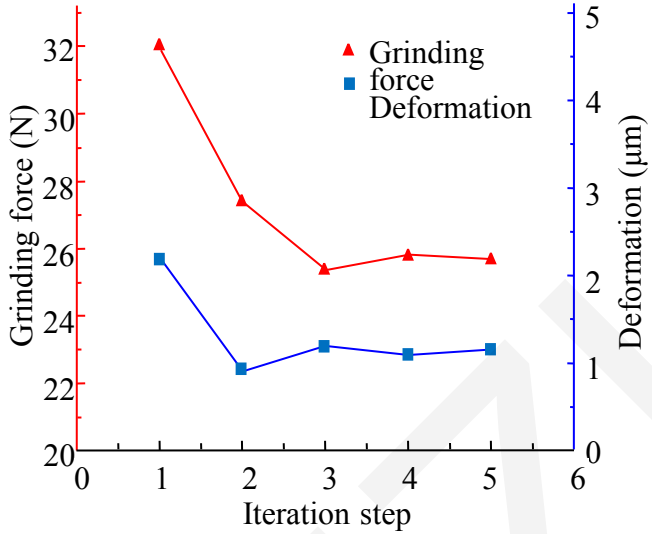


Fig. 7 Iteration of the coupling simulation

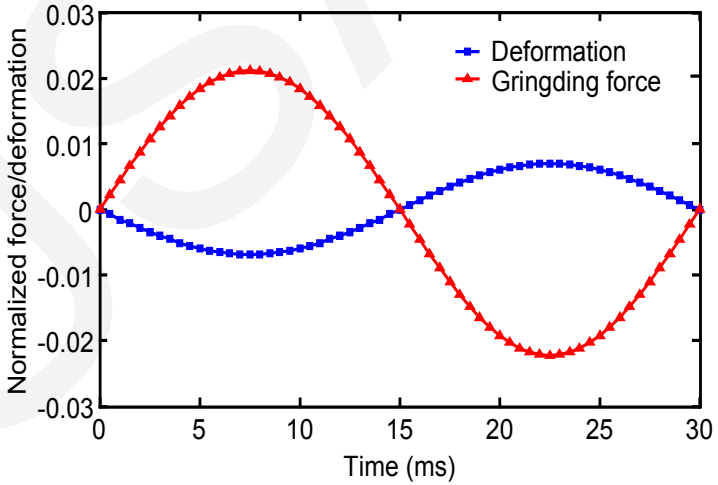


Fig. 8 Coupled iteration of the grinding force and deformation

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Conclusions

- The virtual grinding wheel with random distribution of multi-grains is built.
- The grinding model of multi-grains grinding carbide material has been constructed, and the model has been experimentally validated.
- The integrated model of the machine tool structure and grinding process is constructed.
- The coupling simulation method of the integrated model has been taken to study the interaction between the machine tool and the grinding force.
- The coupling simulation result shows that there is a remarkable interaction influence between the machine tool and the grinding force.

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