Influence of Particle Size of Magnetorheological finishing on Shear Stress

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Abstract

Magnetorheological finishing is a new polishing technology, has a greater development.It processing speed, high efficiency; high precision machining, processing surface roughness up to nano-level; there is no tool wear problems; polishing debris and polishing heat in time to be taken away to avoid affecting the processing accuracy.At present the main problem is to improve the processing accuracy and processing efficiency, the main factors are the size of abrasive grain, polishing speed and so on.In this paper, the effect of abrasive grain size on the shear stress is studied.

Keywords

Magnetorheological finishing; improve; brasive grain siz.

1. Introduction

Polishing powder directly on the surface of the material, its particle size and hardness of the mechanical cutting effect has an important impact. Polishing the harder, the higher the efficiency of polishing, the effect of particle size on the polishing efficiency is more complex. The results show that the higher the particle size is, the higher the polishing efficiency is. In a certain range, the polishing efficiency is proportional to the size of the particle size. However, when the particle size is large enough to a certain extent, the polishing efficiency is reduced, and the particle size should be selected according to the actual situation The At present, the common polishing powder is Al2O3, CeO2, diamond powder, the hardness from large to small were diamond powder, CeO2, Al2O3, diamond powder used to polish the highest efficiency, but taking into account the expensive diamond powder, so the choice of CeO2 as a polishing powder。[1]

2. Magnetorheological finishing mechanism

The rheological properties of MR fluid are analyzed by Bingham model [2].The equation for the Bingham model is

$$\begin{cases} \tau = \tau_y(B) + \eta\dot{\gamma} & \tau \geq \tau_y(B) \\ \dot{\gamma} = 0 & \tau < \tau_y(B) \end{cases}$$

where B is magnetic induction density of magnetic field and $\tau_y(B)$ is yield stress induced by magnetic field, η is viscosity of MR fluids and $\dot{\gamma}$ is shear rate.

3. Siumlation of MR Fluid

3.1 Preprocessing

The use of CeO2 as abrasive, the silicon surface material removal. Among them, the diameter of the ball is 0.16mm, the distance from the silicon plane is 0.45mm, and the radius of the raised surface is 0.1mm, 0.5mm high. The ball is in contact with the protrusion. As the Fig. 3.1.1 shows.

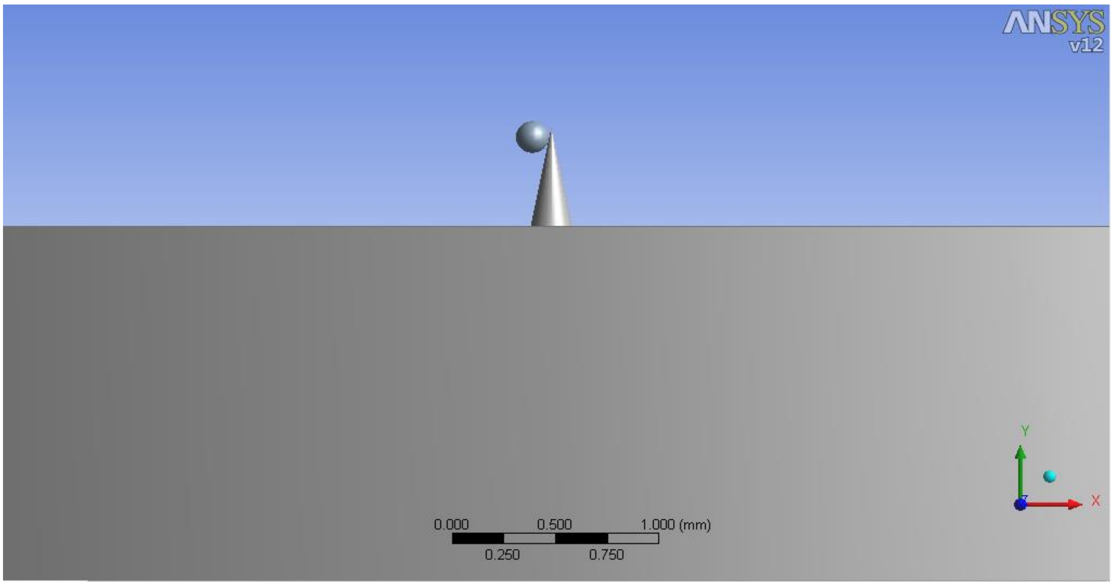


Fig. 3.1.1

And then meshing, get the following Fig. 3.1.2.

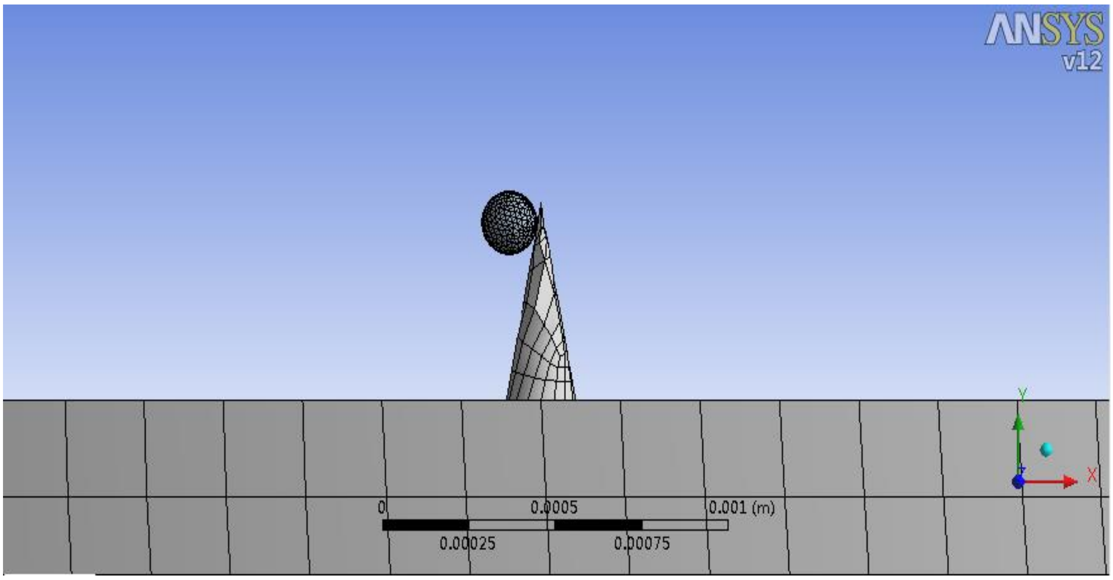


Fig. 3.1.2

3.2 Constraint

Due to the influence of the immersion depth on the material removal stress, three identical velocities were set for the study. In the process of material removal, the cerium oxide particles are subjected to three forces, namely: (1), the pressure, from the surrounding carbonyl iron powder particles in the magnetic field in the magnetic field of the force and fluid dynamic pressure. (2), shear stress, from the magnetorheological fluid power. (3), resistance, from the abrasive and the workpiece surface contact, friction. Therefore, given the silicon surface fixed constraints, as shown, given cerium oxide abrasive a certain level of speed and vertical velocity and $\tan\alpha \approx 0.1667$.As shown in Fig. 3.2.1, Fig. 3.2.2, Fig. 3.2.3.

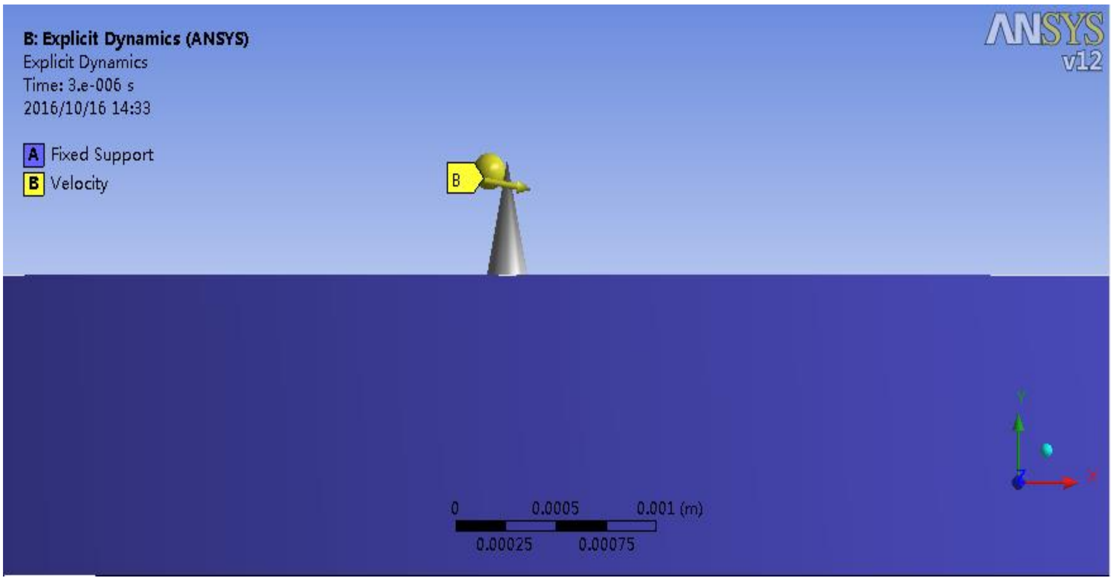


Fig. 3.2.1

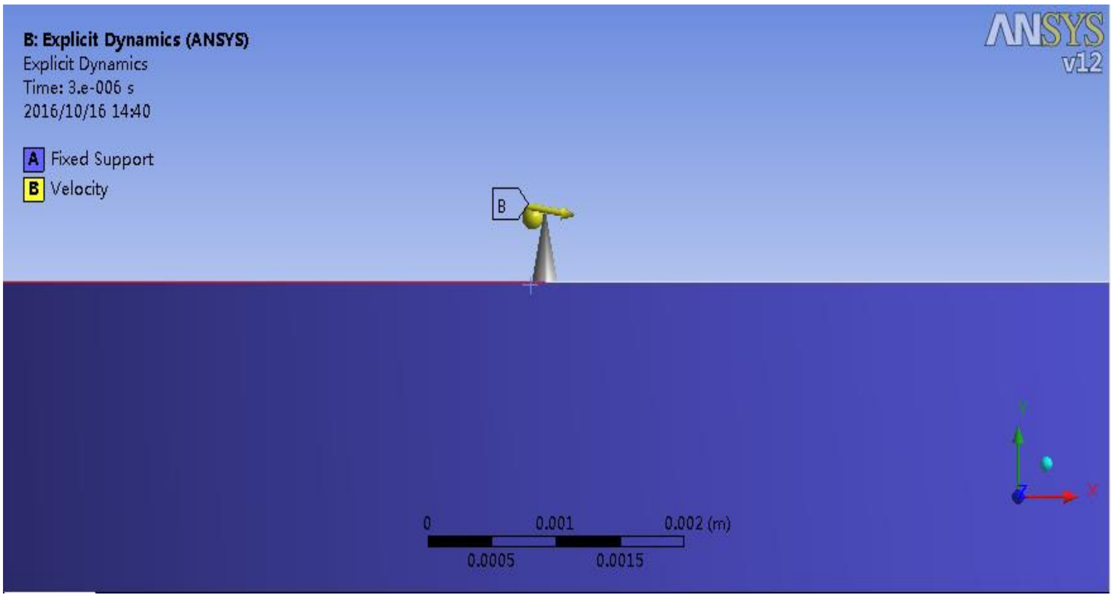


Fig. 3.2.2

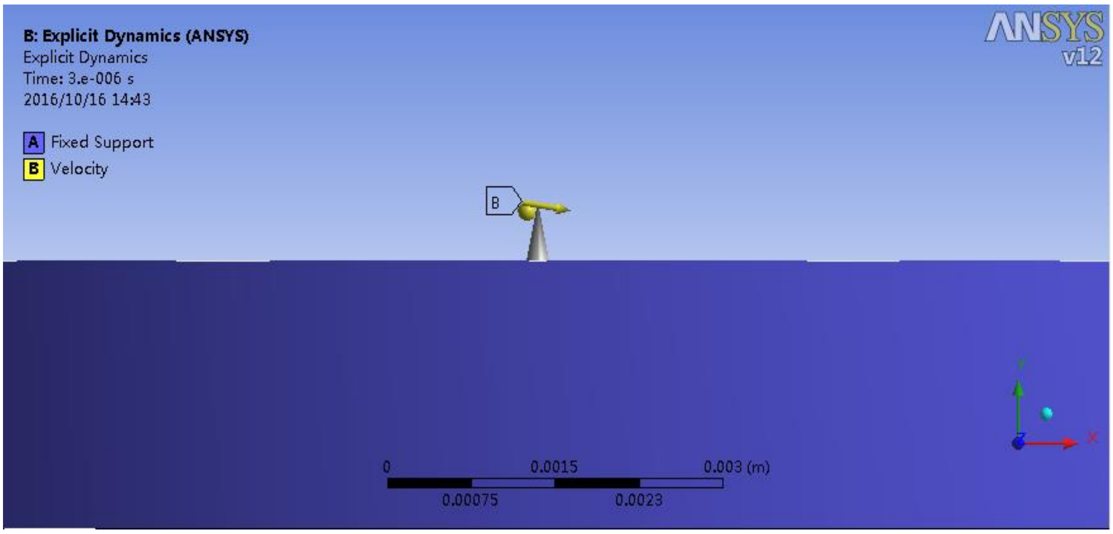
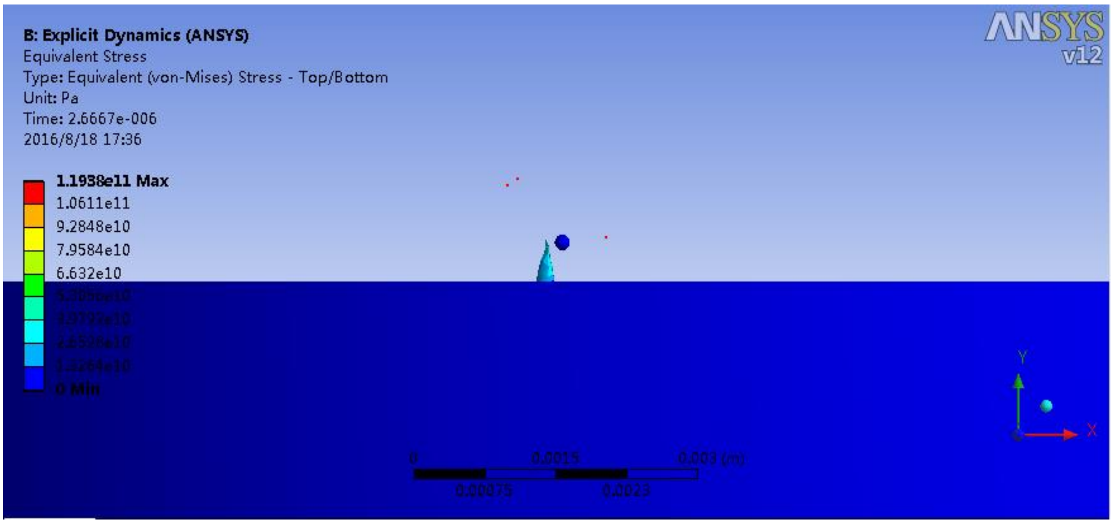


Fig. 3.2.3

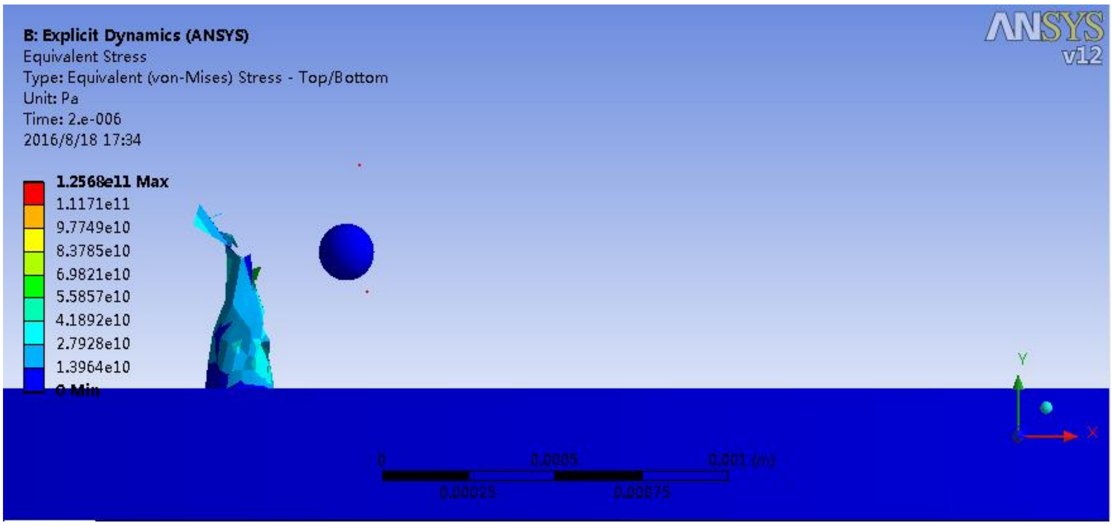
3.3 Post-processing

The following results are obtained which show in Fig. 3.3.1, Fig. 3.3.2, Fig.3.3.3 by solving the problem.



B: Explicit Dynamics (ANSYS)
Equivalent Stress
Type: Equivalent (von-Mises) Stress - Top/Bottom
Unit: Pa
Time: 2.6667e-006
2016/8/18 17:36

Fig. 3.3.1



B: Explicit Dynamics (ANSYS)
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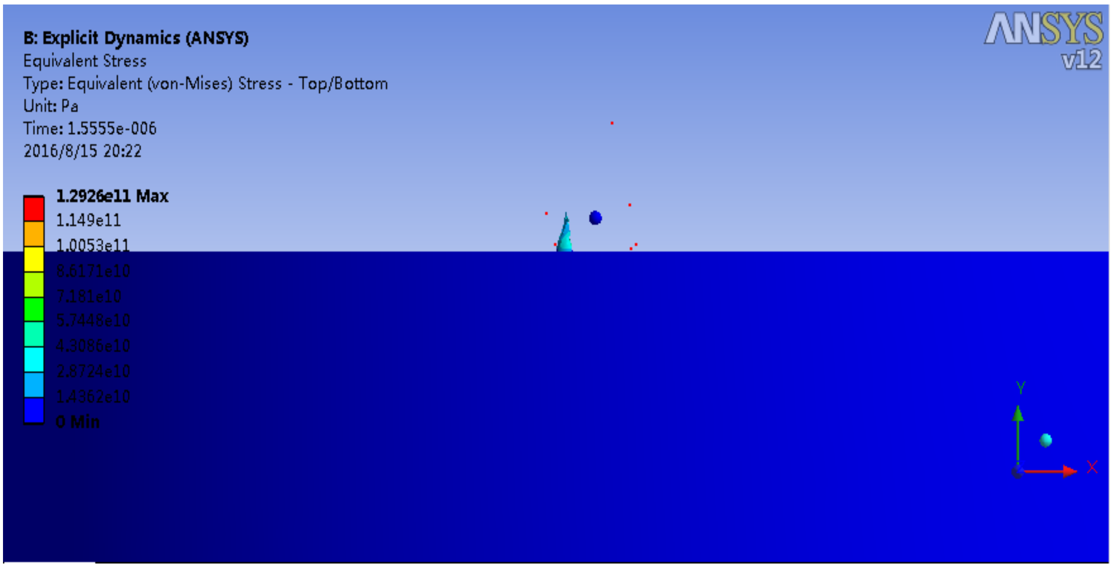
Fig. 3.3.2



B: Explicit Dynamics (ANSYS)
Equivalent Stress
Type: Equivalent (von-Mises) Stress - Top/Bottom
Unit: Pa
Time: 1.5555e-006
2016/8/15 20:22

Fig. 3.3.3

List the above data in a table to get Table 1.

Table 1 Three Data comparing

Velocity(m/s)		Stress(MPa)	Time(s)
X	Y		
100	-16.667	119380	2.6667×10^{-6}
200	-33.333	125680	2.0×10^{-6}
300	-50	129260	1.5555×10^{-6}

4. Conclusion

It can be seen that the stress removal of the material gradually increases with the increase of the velocity in the process of CeO2 removal of the silicon surface, and the surface roughness is reduced, and it can be seen that the removal efficiency is proportional to the speed relationship.

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