A SURFACE EFFECT OF CERAMIC CUTTING USING ABRASIVE WATERJET

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ABSTRACTThis paper presents factors that effect to surface property of ceramic cutting by using an abrasive water jet. The water pressures and the ceramic thicknesses have been assigned to investigate a kerf wave, a surface roughness and a cracking of ceramic. In the experiment, the water pressures 260 MPa, 290 MPa, 320 MPa, and 350MPa were applied to cut ceramic plate with thickness 7 mm, 10 mm and 13 mm. The surface qualities were analyzed by using a scanning Electron Microscope (SEM).The results showed that there were the relationship between the water pressure and a kerf wave height.

1. INTRODUCTION

Alumina ceramic is a popular material in many industrials such as a space industry, an electrical industry and medical industry. Its main properties are heat resistant, a chemical erosion resistant and an electrical insulator. There are two forming processes for this material: a compression molding and a slip casting. Moreover, there are three cutting processes for alumina ceramic: diamond cutting, laser cutting and water jet cutting. Those three processes are compared based on cutting velocity, dimension accuracy and price.

For water jet cutting, an erosion rate had been considered to compare with model strength, material gain size and cracking (Jiyue Zeng and ThomassJ.kim, 1995). In order to determine size and radius of ceramic cracking, the water pressure and diameter of nozzle (Gi sand choi & Giheung, 1996) and the propagation have been utilized to forecast (M.wakuda, et al., 2001 and Manabu et al.,2003).A ceramic surface roughness has been also improved 30% by using a vibration nozzle technique (L.chen,et al.,1998). In order to apply water jet to cut ceramic, the related parameters, increase pressure while reduce abrasive velocity were established to increase productively by 4% (A.A.Abdel-Rahaman & A.A.Ei - Domiaty,1998). Moreover, a tool path planning for ceramic cutting that was cut material along same direction with the constant velocity 3.33 mm/s presented a good surface roughness (J.wany&D.M.Cuo,2002). In order to improve process parameters for ceramic cutting using abrasive water jet technique, there are several researches that were established (P.Gudimetla, et al.,2002, YukihikoYamauchi & ShuzoKanZaki,2002, J. Wang, 2006, Ushasta, et al.,2014, Derzija Beaic–Hajdarevic, et al., 2014, M.Hshish, et al., 1996 and L.M. Hiavac, et al.,2009). Those researchers experimented by using alumina ceramic that was created by compression molding.

This paper presents factors that effect to surface property of ceramic cutting by using an abrasive water jet in which the ceramic is formed by slip casting. The water pressures and the ceramic thicknesses have been assigned to investigate a kerf wave, a surface roughness and a cracking of ceramic.

2. EXPERIMENTAL PROCEDURE

There are two factors that are investigated on this experimenter: water pressure and thickness of ceramic produced by slip casting. The water pressures 260 MPa, 290 MPa, 320 MPa, and 350MPa were applied to cut ceramic plate with thickness 7 mm, 10 mm and 13 mm.

The Abrasive water jet Machining (AWJM) used in the experiment, MAXIEM Water Jet Model 1530 type, as shown in Figure 1. In this experiment, 95% alumina ceramic casting type of 150 mm×150 mm were used as specimens in the form of plates, in which the relevant properties of ceramic are listed in Table 1. The size of

specimens equal 15 mm×35 mm., as shown in Figure 2. Trial cuts were conducted at recommended rates (P.Gudimetla,et al.,2002)and the range of values for the parameters were established. The water pressure was varied between 290 and 380 MPa, in steps of 30 MPa, thickness varied between 7 and 13 mm. All other parameters were kept constant using the standard system configuration: orifice diameter = 0.25 mm., mixing tube diameter 0.7mm,Q3 of surface quality, 80 mesh garnet sand for the abrasive, 2mm of stand-off distance between the nozzle and workpiece 0.368 kg/min of abrasive flow rate and traverse speed at 0.265 mm/s. The cutting conditions were controlled as following: 80 mesh garnet sand for the abrasive, 2 mm of stand-off distance between the nozzle and workpiece, 0.25 mm of orifice diameter, 0.7 mm of nozzle diameter, Q3 of surface quality, 0.368 kg/min of abrasive flow rate and traverse speed at 0.265 mm/s. The surface qualities were analyzed by using a scanning Electron Microscope (SEM), as shown in figure 3.

Table 1 Material properties of the alumina ceramic

Material property	Value
High purity grades	99.5% Al_2O_3
Sintering temperature (℃)	1700
Density(g/cm^3)	3.75
High bending strength(MPa)	285

Figure 1: Abrasive water jet Machining (AWJM)

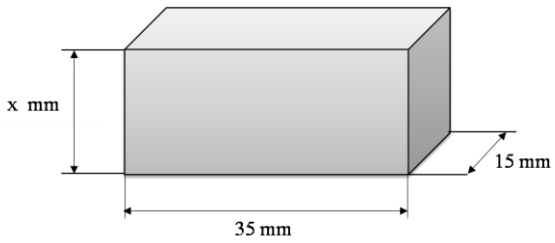

Figure 2: The size of specimens, when x is ceramic thickness

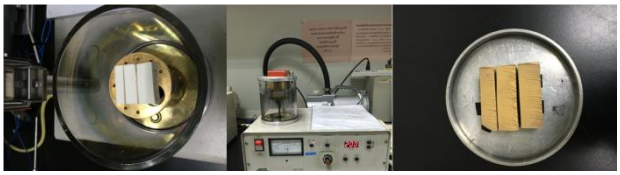

Figure 3: A scanning Electron Microscope (SEM)

3. RESULT

The shape of kerf wasestablished in the same pattern for any cutting conditions, as shown in figure 4. The experiment results shown that the high water pressure for cutting affected to reduce kerfs and the distances between the peaks of kerfs were related with the thickness of ceramic, as shown in figure 5. Additionally, the water pressure at 320 MPa that was assigned to cut ceramic thickness 7 mm. presented the appropriate surface roughness.

4. CONCLUSION

There are the relation between the water pressure and a kerf wave height for cutting ceramic formed slip casting by using abrasive water jet Machining. The thicker ceramic presented more distance between the peaks of kerfs. However, the high of kerfs has to be determineed by using Rhinoceros program as the further work.

Figure 4: Shape of kerf

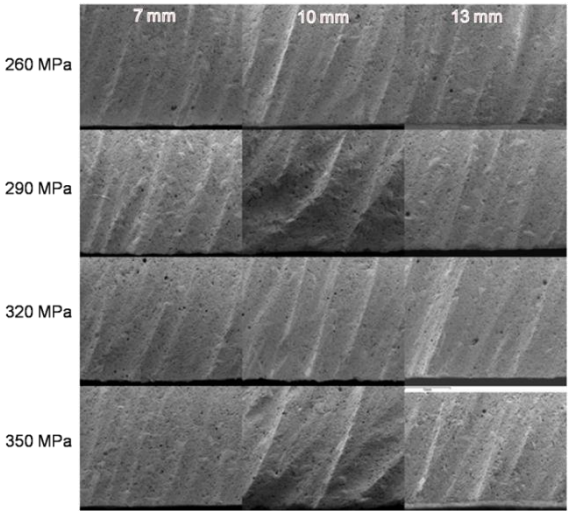

Figure 5: The results of kerfs from cutting conditions

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