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Research Article

STUDYING THE EFFECT OF SHARPEN MATRIX RADIUS ON DEEP DRAWING OPERATION

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ABSTRACT
In the study, the effects of sharpen matrix radius has been examined on deep drawing process. For this reason, a cylindrical cup as a shell model has been simulated for deep drawing operation. The work has been performed in ABAQUS software. The model has been resolved by explicit method. It is obvious that the drawing force decreases when matrix radius increases. Furthermore, it is clear with alterations of punch forces. The results were found with comparison of obtained consequences from investigation of radius.

Keywords: *Deep Drawing, Matrix Radius, Radius Effect*

INTRODUCTION

Deep drawing is a process in sheet metal forming for transforming sheet metal blanks to hallow parts without excessive seam. Work piece material, tooling parameters; plastic deformation mechanism and material flow control are the different factors for the deep drawing process (Moon, 2001).
The equipment and tooling parameters which affect success or unsuccessfulness of deep drawing operation consist of: punch and die radius, clearance of punch and die; press speed, lubrication, Blank Holder Force (BHF) and Blank Holder Gap (BHG) (Coa, 1997). The are many factors such as die shape, size and shape of blank, boundary condition, and friction and lubrication between die and blank that influence the drawing and prevent to reach the desirable height (Gavas, 2006). One of the main important points is blank size that depends on limiting drawing ratio (LDR) which is obtained from primary diameter of blank in the ratio of the punch (Marumo, 1999). Some pieces can obtain only by using an operation while due to the frequency of LDR but deeper cups with complex shape cannot be obtained by a drawing operation. They require multiple drawing operations to form the final shape. In other words, LDR prevents to reach the desired drawing height. Such multiple drawing process increase the production costs and takes more times for reaching the desired shape of Cup (Gavas, 2006). In forming of a cup, a part of blank which is under the punch does not change greatly and its surrounding area forms the walls of cup. The section is under the pressure until it is in the walls of the cup due to stretch to the center of blank and radius traction and environmental traction because of diameter deduction of each environmental element. Therefore, each element due to these tensions during the formation is pressed in the environmental direction and is stretched in the radical direction (Rasti and Rafiie, 2004).

Simulation of Deep Drawing Process

In the article, ABAQUS finite element analysis software has been used for modeling and analysis. The model is defined as axisymmetric form. For enhancing the speed and decreasing the analysis time, the right section of figure 1 was used. Figure 1 shows a two -dimensional section of deep drawing process. Simulation of the process consists of eight processes. In first step, geometry of the model was created. Material properties were allocated to the next step. The table of material properties is shown as follow.

Table 1

Yield Stress (Pa)	Plastic Strain
400e6	0.0
420e6	2e-2
500e6	20e-2
600e6	50e-2

In third step, assembly of pieces was performed. Figure 2 shows an assembled piece. In step four and five, the processes of resolving the problem and contact between surface such as the upper surface of the sheet with the punch, the upper surface of sheet with holder, the lower surface of sheet with die should be defined, respectively. In sixth step, the loading and the boundary conditions was defined. One of the contact methods is applying the force in the holder that in the case, the holder may move the rigid body due to lake of contact between the holder and the sheet. Therefore, it is better that holder moves by applying the boundary condition of movement in order to establish a soft contact between the sheet and die. Based on the process, the contact method between sheet and die is defined. The amount of placement should be so that in one side the contact between elements should be established and the other hand, the sheet should not be yielded.
In an example, friction coefficient between the sheet and punch is zero and between sheet and the other elements was supposed 0.07 that the number considering the existence table was extracted. Therefore, two type of contact behaviors should be defined for friction and non- friction contact.

Table 2

Material	**Coefficient k**
Sheet steel	0.07
Aluminum	0.02
Other material sheet	0.04

In the next step, meshing of the model was done. For determining the element type, the cases such as geometry of model, final piece formation, applying loading is considered. Finally, the results of problem solving have been examining (Rahmanian).

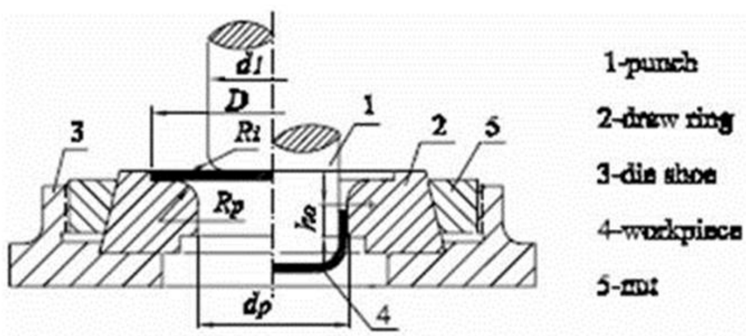

Figure 1: Deep drawing

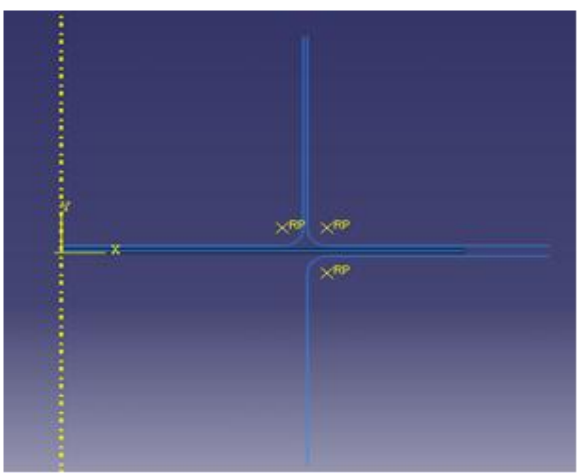

Figure 2: Assembly of piece step before loading

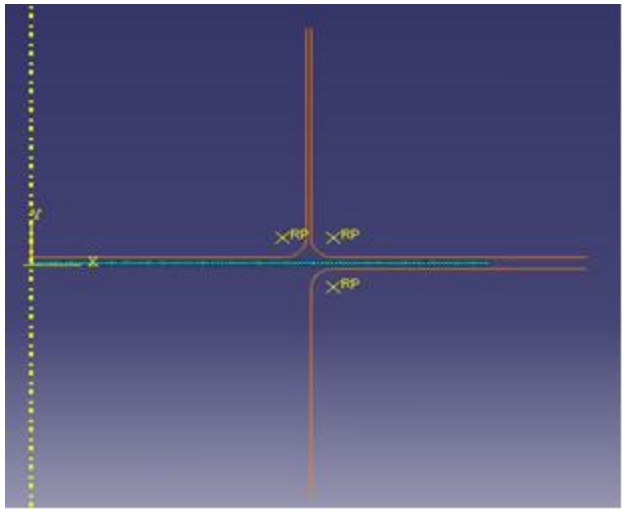

Figure 3: Meshing of piece

The process of issue implementation has been considered with different radiuses and its obtained diagrams have been represented as follow.

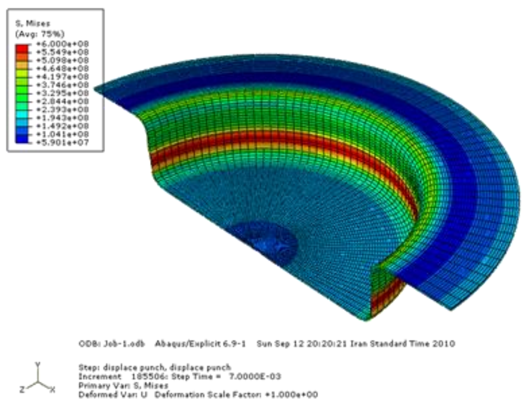

Figure 4: A piece after loading (die radius: 0.005)

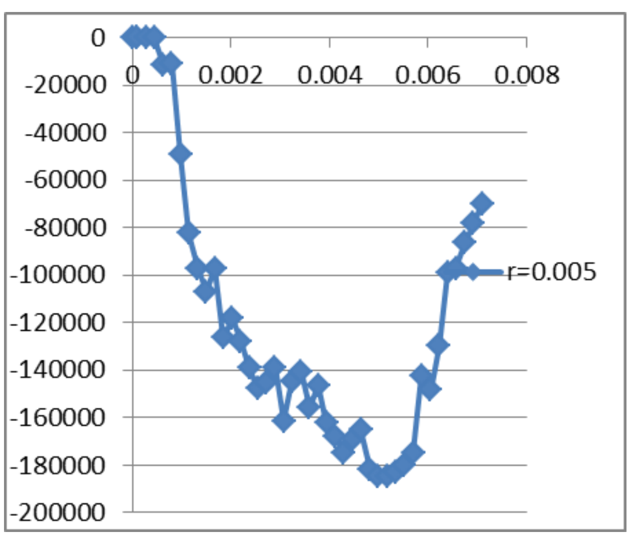

Figure 5: A diagram of punch force (die radius: 0.006)

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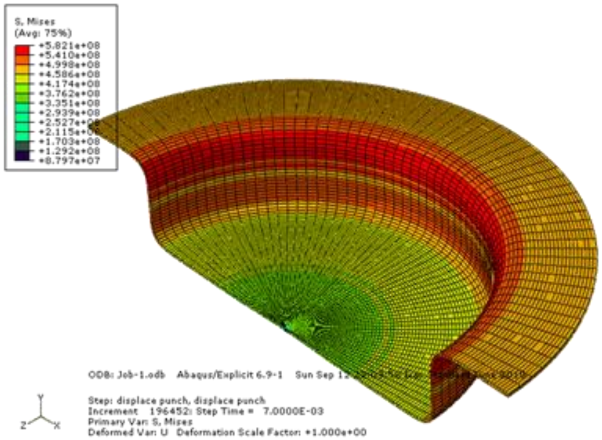

Figure 6: A piece after loading (die radius: 0.006)

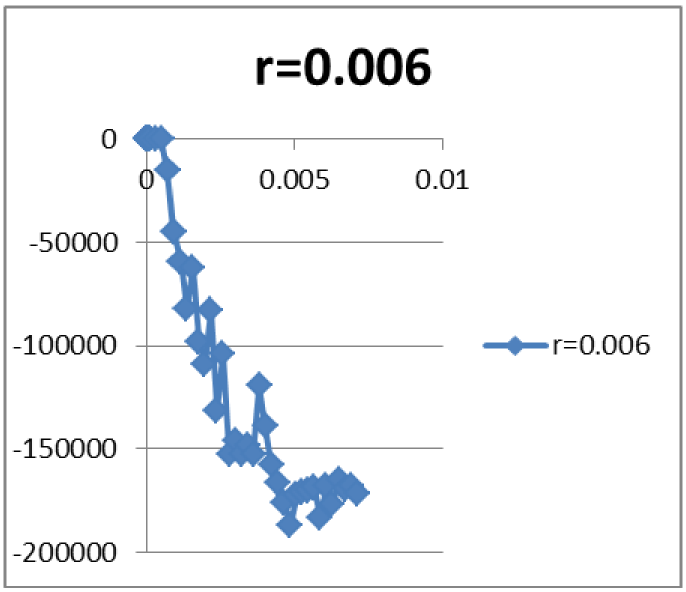

Figure 7: A diagram of punch force (die radius: 0.006)

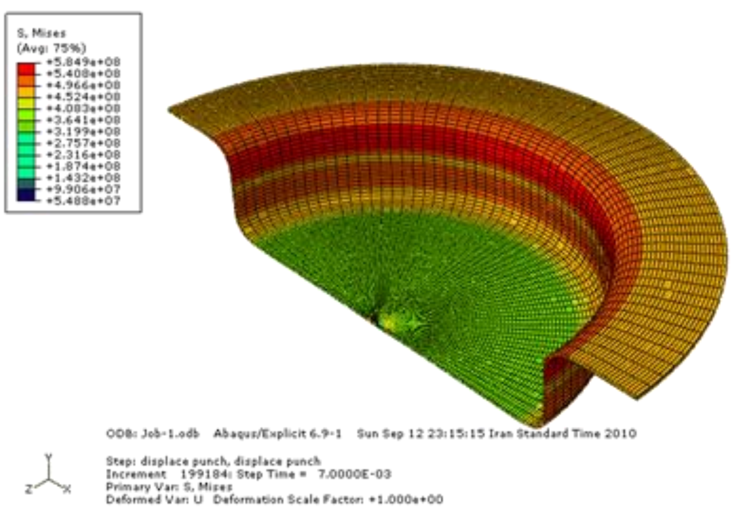

Figure 8: A piece after loading (die radius: 0.007)

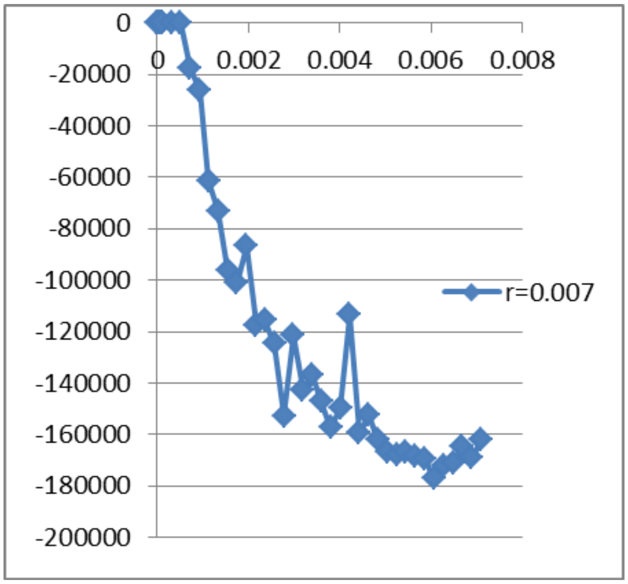

Figure 9: A diagram of punch force (die radius: 0.007)

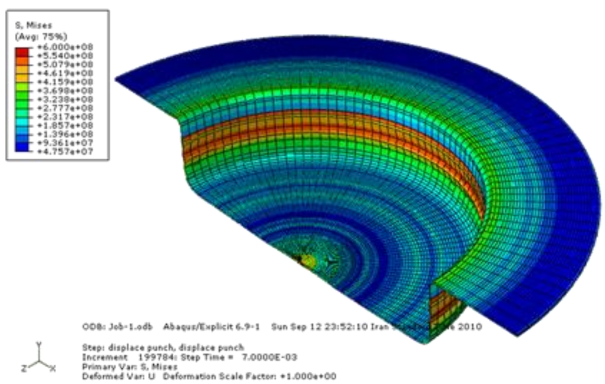

Figure 10: A piece after loading (die radius: 0.003)

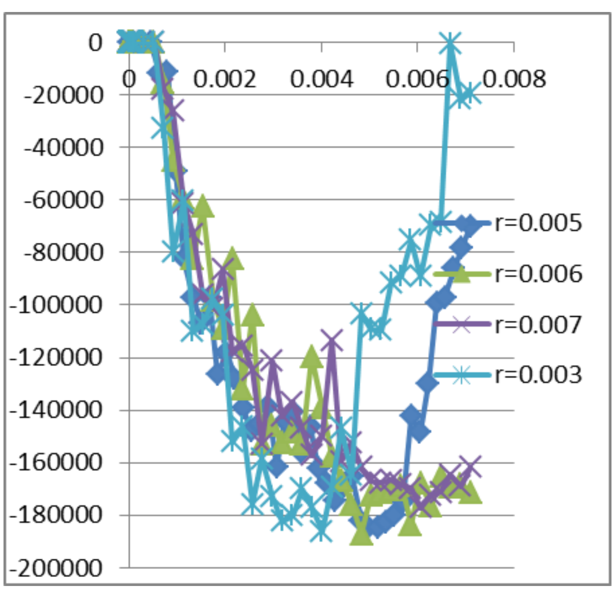

Figure 11: A diagram of punch force for all radiuses

Conclusion

This paper examines the matrix radiuses in deep drawing process. For this examination, a deep drawing model has been simulated in ABAQUS software. The simulation was performed as axisymmetric form. After examination, the obtained results of the analyses show that by enhancing the matrix radius, tensile force is decreased and also, by decreasing the radius, the force enhances.

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