

Study on Impact Parameter of the Hole Generatrix through a Center Hole Conical Part Cold Extrusion

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Keywords: Center hole conical part, Cold extrusion, Abaqus, Hole generatrix.

Abstract. Based on the characteristic distortion and the influence factors of cone parts by cold extrusion, cold extrusion process of a center hole conical part is simulated by Abaqus software, then the shape of the hole generatrix after cold extrusion is obtained by this method. According to simulation, the relation between the initial parameters of a center hole conical part with the hole generatrix after cold extrusion is built, and it provides a theoretical basis for the application of cold extrusion process of cone parts.

Introduction

Although the shape of cone parts is simple, it is difficult to process through the method of machining, and the parts that casted directly is very difficult to achieve the requirement of a few mechanical properties[1,2]. Cold extrusion process is able to improve the mechanical properties, however, during extruding, the differences in thickness and shrinkage of each portions of the blank that caused by its external taper and different deformation will make the horizontal and vertical proportion of the metal flow for each portions become different, and all of this will make the extruded hole generatrix be uncontrolled. Therefore, it is difficult to ensure the shape of hole generatrix by cold extrusion[2].

With the development of computer and simulation software technology, it is a very effective means to aid simulation software to analysis cold extrusion for perforated cone parts. As a simulation software, Abaqus has many advantages when simulating large deformation of the metal, such as simulating quickly and forming efficiently. It can reflect the characteristics of cold extrusion for the cone part more accurately, and it is relatively easy to operate. In this paper, cold extrusion of the cone part was simulated by Abaqus, the relation between the hole generatrix with the external taper and thickness to diameter ratio was built, and it provided a theoretical basis for the application of cold extrusion process of cone parts[1-4].

Establish Model and Programs

Establish Model

Figure 1 is a model diagram that a cone part formed by open - die cold extrusion, the cone part which hole have a certain taper is formed by the upper and lower die pressing a center hole conical part. The material of the blank is 20Cr, the blank is set as deformable, and the upper and lower die is set as analytical rigid. The coefficient of friction is set as 0.08 for the upper die and as 0.12 for the lower die between the blank. The size of the blank is shown in Figure 2. Considering the actual application, the finished product is assumed as Figure 3. Its thickness to diameter ratio is relatively small, and its outer diameter is 40mm for big end and 18mm for small end, its height is 50mm. The parameters are set based on the above. So the taper of the upper die is 12.41. The large diameter of the

blank is 40mm, and the height is 50mm, the other size of the blank is determined by the test program. The exceeded the height over 50mm after formed will be removed by shears.

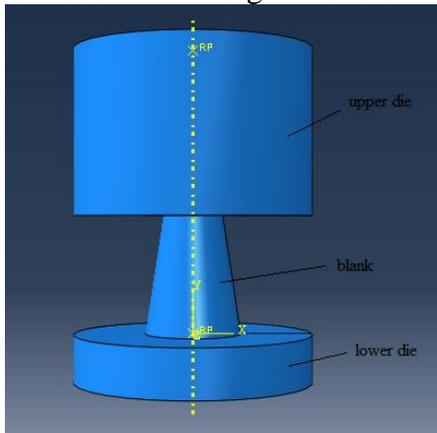


Fig. 1 Model of cold extrusion

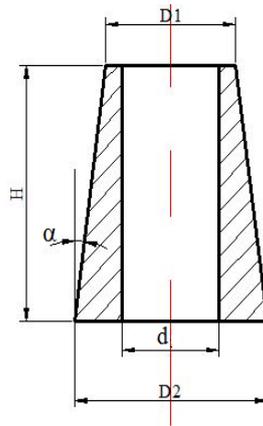


Fig. 2 Size of blank

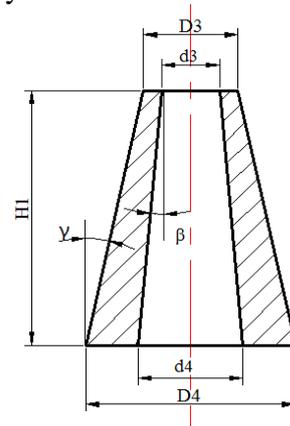


Fig. 3 Size of part

Tab. 1 Parameters of the blank

Number	D_1 (mm)	D_2 (mm)	D (mm)	H (mm)	A ($^\circ$)	K
1-1	25	40	20	50	8.53	0.25
1-2	26	40	20	50	7.97	0.25
1-3	27	40	20	50	7.41	0.25
1-4	28	40	20	50	6.82	0.25
2-1	25	40	21	50	8.53	0.2375
2-2	26	40	21	50	7.97	0.2375
2-3	27	40	21	50	7.41	0.2375
2-4	28	40	21	50	6.82	0.2375
3-1	25	40	22	50	8.53	0.225
3-2	26	40	22	50	7.97	0.225
3-3	27	40	22	50	7.41	0.225
3-4	28	40	22	50	6.84	0.225
4-1	25	40	23	50	8.53	0.2125
4-2	26	40	23	50	7.97	0.2125
4-3	27	40	23	50	7.41	0.2125
4-3	28	40	23	50	6.84	0.2125

Establish Programs

The blank that used for the cone part's cold extrusion is provided with an external tapered. According to the principle of cold extrusion for cone part, the main parameters affecting the degree of deformation of the blank is its outer tapered and thickness in the case of the mold is determined. Looking at Figure 2, we can find that if D_2 , d , H are determined, the size of D_1 will varies α change. Taking into account the actual application and processing, I set D_1 as independent variable substitute α . In addition, the outer diameter of the blank is changing, and so is the thickness to diameter ratio. However, the size of D_2 is constant, The outer diameter of the blank function can be expressed by the function (1).

$$D = D_2 - 2D_2\alpha. \quad (1)$$

Now it provides function (2) to represent the original thickness to diameter ratio of the blank, its original value will be changed by d [1,2].

$$K = (D_2 - d) / 2D_2 \quad (2)$$

In summary, the parameters of the blank is designed as Table 1 to study the affect of α and K to the hole generatrix. The simulation results can be detected by Abaqus measurements.

Results and Analysis of Simulation

Figure 4 is a typical result of these simulations, Look at Figure 4, it is found that the hole generatrix after extrusion is a straight line approximation with a certain taper, and its top and bottom is of a slight deviation but too small, and this can be ignored with affecting little the overall taper.

The taper of the hole generatrix, the outer taper ,the height and the increase of the height after extrusion were set as β_1 , γ_1 , H' and H_g . According to the data obtained by the simulation , β_1 and H_g were calculated and filled in Table 2. And then, Figure 5, Figure 6 and Figure 7 can be obtained by calculating β_1/γ_1 named the relative taper and H_g/H named increased rate of height and analyzing the relationship between them with the external dimensions of the blank before extrusion.

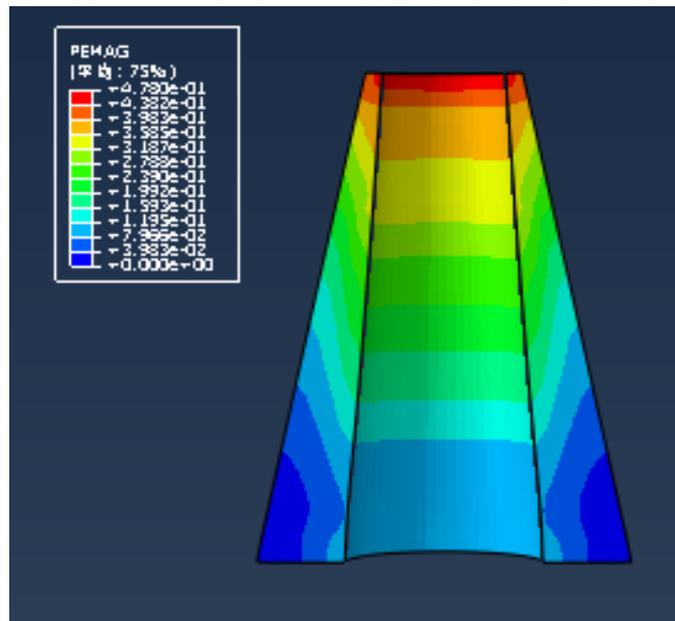


Fig. 4 Typical result simulation

Tab.2 The size of the part

Number	$\beta_1(^{\circ})$	β_1/γ_1	H' (mm)	H_g/H
1-1	4.32	0.35	53.07	0.0614
1-2	4.84	0.39	53.57	0.0714
1-3	5.57	0.45	54.05	0.081
1-4	6.10	0.49	54.57	0.0914
2-1	4.43	0.36	52.93	0.0586
2-2	4.88	0.39	53.40	0.068
2-3	5.52	0.44	53.82	0.0764
2-4	6.12	0.49	54.31	0.0862
3-1	4.33	0.35	52.83	0.0566
3-2	4.90	0.39	53.20	0.064
3-3	5.50	0.44	53.61	0.0722
3-4	6.13	0.49	54.02	0.0804
4-1	4.29	0.35	52.75	0.055
4-2	4.89	0.39	53.09	0.0618
4-3	5.63	0.45	53.42	0.0684
4-4	6.14	0.49	53.80	0.076

Relation between β_1/γ_1 with β_1

Figure 5 describes the relation between the relative taper with the outer taper of the blank. Looking at Figure 5, we can find that if the diameter of the inner hole is constant and the measurement and calculation error are allowed, the relative taper of the hole generatrix after extrusion will gradually decrease with the increase of the outer taper. And their relationship is substantially linear. If the outer taper of the blank is larger, and the thickness to diameter ratio of the blank is smaller, the thickness to diameter ratio of the blank has little impact to the hole generatrix of cold extrusion.

Relation between H_g/H with β_1

Figure 6 describes the relation between the increased rate with the outer taper of the blank. Looking at Figure 6, we can find that if the diameter of the inner hole is constant and the measurement and calculation error are allowed, the increased rate of the part after extrusion will gradually decrease with the increase of the outer taper. And their relationship is substantially linear. The thickness to diameter ratio of the blank have a certain influence to the curve, the increased rate of the blank after extrusion will gradually increase with the increase of the thickness to diameter ratio, and the slope of the curve will increase slightly with the increase of the thickness to diameter ratio.

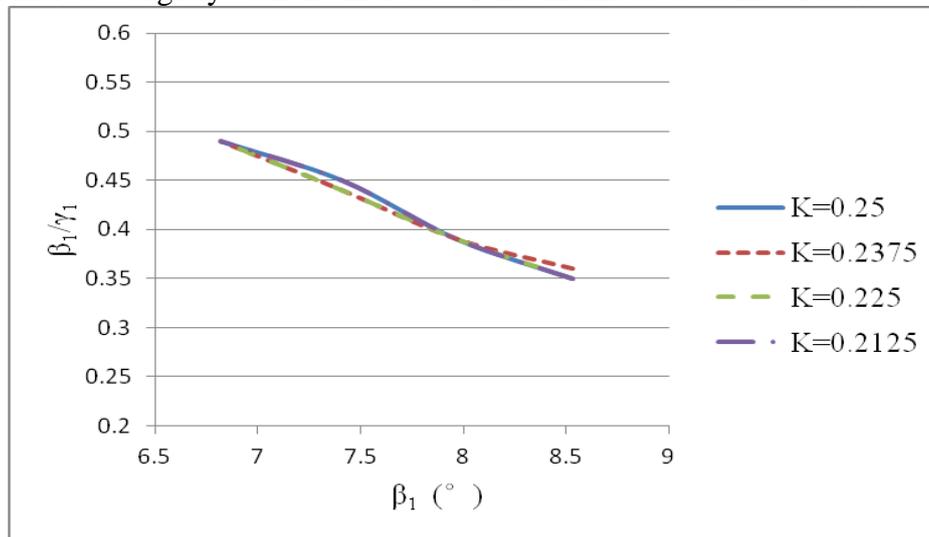


Fig. 5 Relation between β_1/γ_1 with β_1

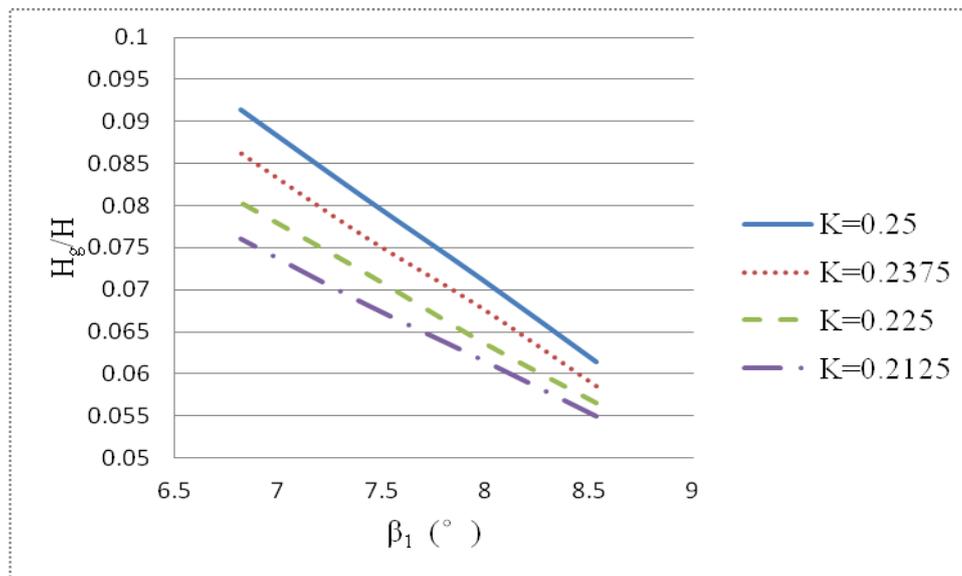


Fig. 6 Relation between H_g/H with β_1

Relation between H_g/H with K

Figure 7 describes the relation between the increased rate with the thickness to diameter ratio of the blank. Looking at Figure 7, we can find that if the outer taper of the blank is constant and the measurement and calculation error are allowed, the increased rate of the part will gradually increase with the increase of the thickness to diameter ratio. The relation curve between them is non-linear, and the slope increases slowly. The outer taper of the blank has a little influence to the curve, the larger the outer taper is, the smaller the increased rate of height is.

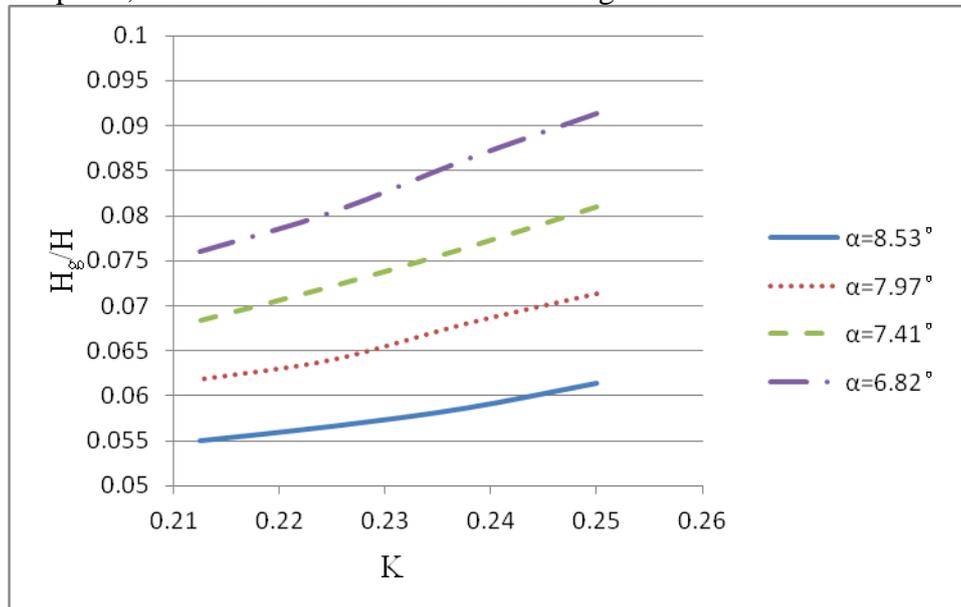


Fig. 7 Relation between H_g/H with K

Conclusion

Firstly, it is feasible to form cone parts which hole generatrix have a certain taper by open cold extrusion.

Secondly, the curve of the relation between the relative taper and the increased rate of height of the cone part with initial parameters of the blank was given. It is feasible to speculate or design the size of the blank and guide the production of open cold extrusion for cone parts through these curves.

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