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08 Steel Numerical Simulation Study on Cold Forging of Buffer Seat

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Abstract: For the problem of uneven hardness in the specified area of the buffer seat, we analyze the reasons of this problem. With the goal of promoting the hardness uniformity in the specified area of the product, the forging temperature, the R angle of the mold were selected as the influencing factors, and simulation experiments were designed and the results were obtained through multiple simulations. The simulation results show that the processing conditions are that the forging temperature is 30 ℃, and the R angle of the mold is 0.2mm, which are the process solutions to make the hardness of the product uniform.

Keywords: Numerical simulation, Buffer seat, Cold forging, Effective strain, Hardness deviation.

1. Introduction

Fastener manufacturing is a very important aspect in the field of mechanical engineering. The use of finite element method [1] makes it possible to know the impact of the structure of the mold and the design of the product on the final product before the mold is made and before the product is actually produced. It saves time, reduces production costs and improving production efficiency. Liu Zheng [2] et al. analyzed the mold life problem of automotive nuts, designed a 5 factor 3 level orthogonal simulation experiment, optimized the nut forming process, and came up with the optimal solution for the nut forming process. chang T P [3] et al. used the method of finite element simulation to get the optimal mold geometry parameters through simulation, thus avoiding the folding defects of the product in the cold forging process and getting qualified hollow small flange fastener products, which matched well with the actual product test results. Zhou Zheng [4] et al. used deform software to simulate the results of effective stress, forming load and process temperature for the pre-forging and final forging processes of aluminum alloy wheel parts, and echoed the previous simulation results with the simulation results of microstructure, which pro-vided theoretical guidance for the actual production. In this paper, we simulate the forming process of buffer seat, take the values of effective strain at three relevant positions, and consider factors such as the forging temperature, the R angle of the mold, etc., to arrive at the process parameters with optimal hardness uniformity of the product, and provide guidance for actual production.

Table 1. 08 Steel Chemical Composition (%, mass fraction)

element	C	Si	Mn	S	P	Cr	Ni	Cu
content	0.07-0.14	0.17-0.37	0.7-1	≤0.035	≤0.035	≤0.25	≤0.25	≤0.25

2. Experimental

2.1. Finite Element Modeling

The object of the study in this paper is a small 20g 08 steel buffer seat of a company, the material is 08 steel and its chemical composition is shown in Table 1. The 2D model of punch, material and die is designed by CAD software, and the 2D geometric model with fixed relative positions is saved as a dxf file and imported into deform-2D. The assembly diagram of the model structure and the completed meshing are shown in Fig. 1 and Fig. 2 respectively. Fig. 1 shows the assembly diagram consisting of punch, workpiece and bottom die. The punch and die are set as rigid bodies and the workpiece is set as a plastic body, and the loss of volume of the workpiece is ignored during the simulation. In deform-2D, we choose a low carbon steel material, codenamed AISI-1008, and use deform-2D's own material library to provide the relevant data support. The product is an axisymmetric 3D rotating body, and in order to improve the efficiency of the simulation, the simulation model is 1/2 the size of the product in 2D. to ensure the accuracy of the simulation, the model is divided into 2-dimensional meshes of about 2000 and 2105 nodes. The initial press speed of the punch is 2mm/s, the temperature of the punch and die is 20°C at room temperature, and the friction coefficient is 0.12.

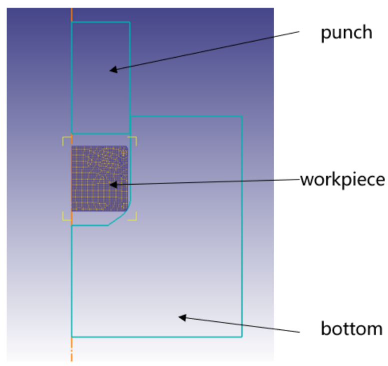

Figure 1. Model structure

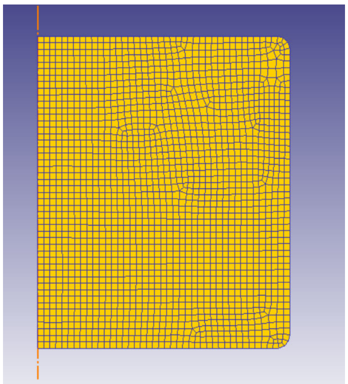

Figure 2. Mesh division

2.2. Simulation Process

According to the structure of the product and the actual process requirements, the forming of the product can be divided into five operations, respectively, upsetting, chamfering R angle, upper slotted, lower slotted, forming to size, The final product has a complex structure, with a round slot at the top end, a round slot at the bottom end, and a solid structure in the middle. It looks like a side-placed "H" shape.

2.3. Simulation Results and Discussion

2.3.1. Data Results Analysis Method

As shown in Figure 4, there is a direct relationship between the hardness value and the effective strain [5], so the hardness of the material can be characterized by taking its effective strain value at the relevant location on the product, and the difference in hardness of the material in this region can be characterized by the deviation of the three effective strain values.

In this paper, the study characterizes the difference of these three values by the Mean deviation of the three effective strain values, which in turn characterizes the hardness difference of the material.

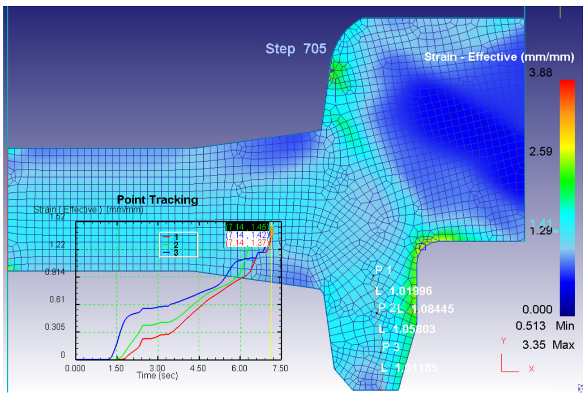

Figure 3. Effective strain point location

2.3.2. Effect of Different Forging Temperatures on the Effective Strain of the Product

The process of this product is cold heading. In the process of cold heading, a certain amount of heat will be generated between the mold and the material, so the temperature of the material is considered in this simulation, and the temperature range is 20-60 ℃.

The mean deviation of effective strain of different material temperatures is compared and analyzed, as shown in Figure 4.

It can be seen from the analysis in Figure 4 that under the condition that other conditions remain unchanged, with the increase of the material temperature, the difference of the effective strain of the product detection position is not large and tends to be stable, and the temperature generated between the mold and the material is not high and the impact is not large during the cold heading process.

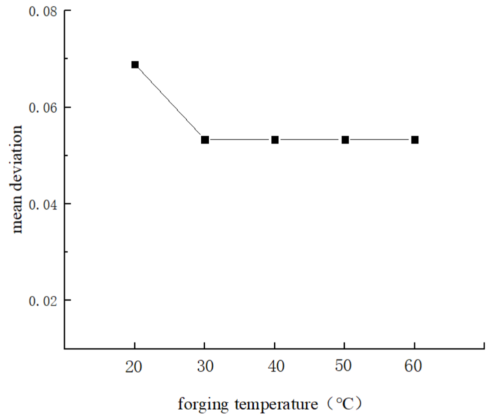

Figure 4. Mean deviation of effective strain at different forging temperatures

2.3.3. Effect of Different Mold R Angles on Effective Strain of Products

The mold R angle will directly affect the fluidity of metal materials, and then have a significant impact on the deformation process of materials. Therefore, this simulation considers the impact of mold R angle on the product, R angle range of 0.1-0.5mm.

The mean deviation of effective strain of different mold R angles is compared and analyzed, as shown in Figure 5.

It can be seen from the analysis in Figure 5 that, on the whole, under the condition that other conditions remain unchanged, with the increase of the R angle of the mold, the effective strain difference of the product detection position first decreases and then increases; When the mold R angle is 0.2mm, the effective strain difference of the product detection position is the smallest. When the mold R angle is greater than 0.2mm, the effective strain difference of the product detection position slightly increases, but when the mold R angle increases, the difference between the mold and the target size will also increase accordingly; When the R angle of the die is less than 0.2mm, the material deforms violently here, resulting in large stress and strain.

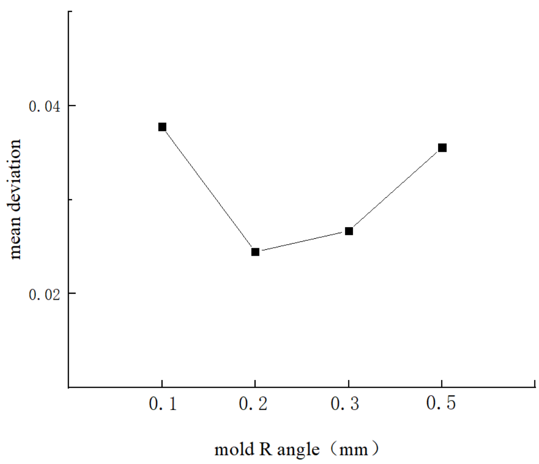

Figure 5. Mean deviation of effective strain at different mold R angles

3. Conclusion

Under the condition that other conditions remain unchanged, with the increase of the material temperature, the difference of the effective strain of the product detection position is not large and tends to be stable. Moreover, during the cold heading process, the temperature generated between the mold and the material is not high and the impact is not large.

On the whole, under the condition that other conditions remain unchanged, with the increase of the R angle of the mold, the effective strain difference of the product detection position first decreases and then increases. When the mold R angle is 0.2mm, the effective strain difference of the product detection position is the smallest. When the mold R angle is greater than 0.2mm, the effective strain difference of the product detection position slightly increases, but when the mold R angle increases, the difference between the mold and the target size will also increase accordingly; When the R angle of the die is less than 0.2mm, the material deforms violently here, resulting in large stress and strain.

The processing conditions suitable for the hardness uniformity of the product testing position are that the material forging temperature is 30 ℃ and the mold R angle is 0.2mm;

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