DEVELOPMENT OF FORMING PROCESS OF THE MUFFLER TUBE FOR HEAVY EQUIMENTS

K.T. Han[1] and Y. Jin[2]
[1] School of Mechanical Engineering, Pukyong National University, Busan, Korea
[2] Graduate School, Pukyong National University, Busan, Korea

1. Introduction

A muffler is an important part used to reduce noise and to purify exhaust gas in cars and heavy equipments. Recently there has been a growing interest in the design and manufacturing of the muffler tube due to the strict environment regulation. In this study, we analyzed the burr and deformation of product as shear clearance, punch radius and plate holder force. The part of tube, punch, and die shape are modeled using the commercial S/W, CATIA. In analysis, using one-fourth component of the punch and die, metal forming process is simulated and Cockcroft-Latham ductile fracture theory is used. Also we studied the tube deformation, stress on punch using finite element code, DEFORM^{TM}-3D, and analyzed the results through the simulation.

The simulation results are reflected to the forming process design for the muffler tube.

2. Development of forming process of the muffler tube

In the perforating process, the die is inserted at the inside of the tube and the punch to be put to fixed arrangement operates to the vertical. Shearing process is processed in the part that the tube contacts with the punch. At this time we simulated by a proper shear clearance. Additional, in order to optimize the simulation, a plate holder and a punch radius will be applied in the perforating process.

Through the simulation results, the optimal metal forming process for the muffler tube will be developed.

3. Finite element analysis

Ductile fracture condition is adopted to investigate the shear plane formation process of the piercing part using finite element method. Cockroft proposed a growth model of pore and ductile fracture condition by the plastic deformation energy concept.

Solving the perforating process problem by three dimensional modeling instead of two dimensional analysis is used due to tube characteristics. In the analysis of three dimensional piercing process, the stress concentration occurred at edge level needing the mesh size to make smaller. Notably, it is modeled so that the observation of the part to be sheared is simple.

In the simulation, the stroke per step is defined as one-third of the minimum element size, the friction coefficient is chosen based on the recommendable value in DEFORM^{TM}-3D, and the punch speed is according to the real speed in the factory.

The mesh conditions for modeling are shown in Table 1.

Number of Nodes	14839
Number of Elements	66434
Surface Polygons	13986
Min Element Size	0.09 mm
Max Element Size	0.3 mm

Table 1. Mesh conditions for modeling.

The simulation conditions are shown in Table 2.

	Clearance (mm)	Stroke (mm)	Plate holder force (N)	Punch radius (mm)
Case 1	0.08	3.6	Fixed	0
Case 2	0.08	3.6	1500	0
Case 3	0.04	3.6	1500	0.05

Table 2. Simulation conditions.

4. Simulation results and discussions

In order to testify the effect of plate holder and punch radius in the process of muffler tube, three cases of the one-fourth component muffler tubes are simulated in this paper.

Case 1 is the normal case with the fixed plate holder. In case 2 the plate holder force is exerted and in case 3 a punch radius is used to optimized the design. The punch load of Case 3 is smoother than Case 2, it means when the tube is being processed the vibration is slight. Case 3 is the best among these three cases because the burr is minimized and optimal shear section is obtained.

5. Conclusions

In this study, the conditions to decide the perforating process of the muffler tube for automobiles are studied using finite element analysis. The conclusions of this study obtained can be summarized as follows:

1. When the shear clearance is 0.04mm, the value of plate holder force is 250KN, the punch radius is 0.05mm, the burr is minimized and optimal shear section is obtained.
2. The plate holder can reduce the value of die load and extend the life of it.
3. The punch radius can make the punch load smoother and reduce the value of damage, it results the process stable.
4. The analysis results by FEM are reflected in the perforating process design for the muffler tube and better products in dimension and quality are obtained.

6. References

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