Research and Application of Combined Forming Method of Multi-scale Hot Stamping Parts

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Abstract. It is easier to realize the "one-mold multi-cavity" forming process for large-scale parts or parts with similar dimensions, and the blank size is similar to facilitate the transport of the manipulator. Since the mold positioning space is sufficient, stable positioning can be obtained with a simple method and device. When parts of different sizes are combined into the production of family kits, there are many difficulties in positioning the upper mold of the conveyor for the blanks of parts of different sizes. Through simulation research and experiments, a combined forming method that meets the requirements of multi-scale hot stamping parts is developed, the cost of the mold is reduced, and the process is simple and feasible.

Keywords: High-strength steel · Hot stamping · Multi-scale parts combination

1 Introduction

As the level of safety crash inspection increases year by year, and the technology of hot stamping and strengthening of high-performance sheet metal is becoming more and more mature, and the cost is reduced, more and more passenger car body structures choose to use hot stamping to manufacture body parts. [1, 2]. The application of thermoforming parts for a single car body has grown from 4–8 pieces per machine to the current 16–20 pieces, and more use to more than 30 pieces. Among the parts that use a lot of hot stamping, in addition to the more traditional A-pillars, B-pillars and mid-channels, there are many small-sized parts that also require hot stamping [3].

It is easier to realize the "one-mold multi-cavity" forming process for large-scale parts or parts of similar size, and the blank size is similar to facilitate the transport of the manipulator. Since the mold positioning space is sufficient, stable positioning can be obtained with a simple method and device. When parts of different sizes are combined into the production of family kits, there are many difficulties in positioning the upper mold of the conveyor for the blanks of parts of different sizes.

2 Combined Production Process of Parts of Different Sizes

With the help of the small blanks produced by cold stamping, the "integrated skin" connecting different blanks can be designed, and the small part blanks can be connected

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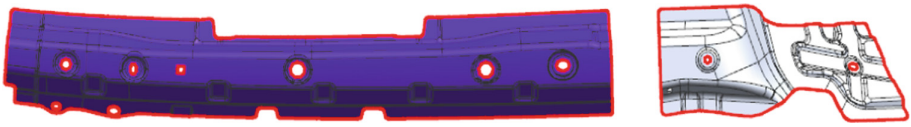

Fig. 1. Hot stamping parts with different plate thicknesses and different scales: (a) Large pieces with a thickness of 1.2 mm, (b) Small pieces with a thickness of 1.8 mm.

with the larger part blanks as a whole, so as to realize the "complete set" production of parts of different sizes. However, for small parts with complex shapes, it is difficult to achieve high-precision forming if there is not enough blank holder.

3 Large and Small Overlapping Blanks and Their Forming Methods

After production inspection, some of the small blanks used for conveying the upper die are designed to retain the "connected skin" to form a "bridge" connecting the large and small blanks, which can realize the conveying upper die conditions required by the hot stamping forming process. However, for parts with more complex shapes and large surface lifts, simple "integrated skins" cannot meet the forming requirements.

3.1 Hot Stamping with Different Plate Thicknesses and Different Scales

Two different parts are given in Fig. 1, one of which is shown in Fig. 1(a), with a longer dimension and a plate thickness of 1.2 mm. Figure 1(b) is a relatively short but with large fluctuations in the shape of the part, and the plate thickness is 1.8mm. Although the materials of these two parts are the same and the forming and cooling processes are similar, the clamping and conveying of the blank of the small parts, and the positioning on the die are more difficult.

3.2 Solutions for Simple Tailored Welding

If the two-piece blanks are temporarily welded [4], the larger ready-made blanks can be easily transported and positioned on the die, as shown in Fig. 2. Using the company's existing welding workstation to perform lamination welding of two sheets of different thicknesses (4 welding points are designed at the connection of the sheets). According to the plan of splicing blanks, the model of the part forming is designed, as shown in Fig. 3. The forming simulation analysis of the target shape is carried out, and the results show that the combined forming part can meet the forming accuracy specified by the two parts, as shown in Fig. 4. The actual parts of hot stamping are shown in Fig. 5. The welding parts of the sheets and the parts are in good shape, and there are no quality defects such as open welding and thinning.

The use of tailor-welded combination of multi-scale parts blanks can solve the difficulties of clamping, conveying and precise positioning of small blanks. For the formed components, a laser cutting machine needs to be used for cutting and separation. 3D cuts are made at the boundary of the large piece and the boundary of the small piece to obtain two separate parts.

Fig. 2. Tailored welding method for large and small blanks.

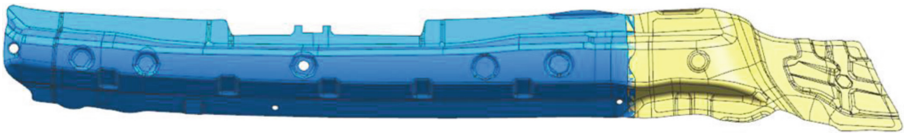

Fig. 3. Model design of tailor-welded composite formed parts.

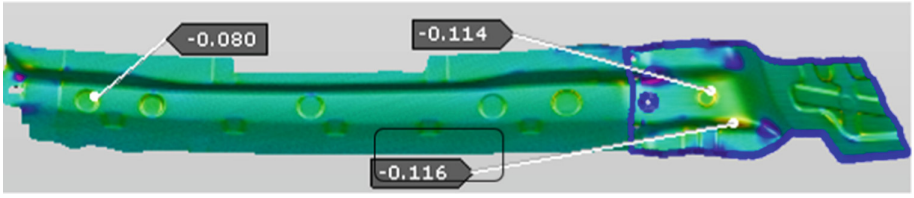

Fig. 4. The forming simulation shows that the combined forming part can meet the forming accuracy requirements of the two parts.

Fig. 5. The actual photo after hot stamping.

4 Summary

The research on the combined forming method of multi-scale hot stamping parts has been practically applied. In this project, according to the cost analysis, the cost of tailor welding and laser cutting is 2.89 yuan/piece, and the comprehensive forming of the two parts can reduce the cost by 3.81 yuan/piece. The transport of blanks is simplified and the reliability of the production process is improved due to the reduction of independent mold making of individual parts. While improving production efficiency, reducing manufacturing costs can reduce the cost of 700,000 yuan in the life cycle of the product project.

References

1. H. Karbasian and A. E. Tekkaya, A review on hot stamping, *Journal of Materials Processing Technology* **210**, 2103 (2010).
2. R. Neugebauer, F. Schieck, S. Polster, A. Mosel, A. Rautenstrauch, J. Schonherr and N. Pierschel, Press hardening-An innovative and challenging technology, *Archives of Civil and Mechanical Engineering* **12**, 113 (2012).
3. Y. S. Zhang, Z. J. Wang and L. Wang, Progress in hot stamping process and equipment for high strength steel sheet, *Journal of Plasticity Engineering* **25**, 11 (2018).
4. S. Xu, Z. J. Huang, Y. Q. Sun, K. H. Hu and T. Gong, Resistance spot welding test on ultra-high strength hot stamping steel, *Research on Iron & Steel* **40**, 36 (2012).