Optimizing Cold Forging in China
- Example of a successful introduction of Finite Element Analysis -

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As the development of the past two decades, China became the biggest vehicle manufacturer and the biggest domestic market in the world. Along with the developing of car industry Chinese local suppliers began to play more important roles. Gradually they improved the facilities and learned to use the latest technology in the area. Some of them show the ability to attend the competition in the global market.

This paper shows the successful application of simulation technology in cold forging industry to improve the forming technology of valve spring retainers.

The traditional development process is compared with the new way of development using simulation technology. The typical problems faced during traditional process design can be found in simulation and therefore can be avoided in future.

Keywords: Steel, Cold Forging, Simulation, FEA, Valve spring retainers

Introduction

China is the biggest producer of automotive vehicles and the biggest market for automotive vehicles in the world.

For the past few years fasteners with a certain level of difficulty are produced more and more inside the country.

The majority of those parts were produced by companies founded jointly by foreign investors providing the technology together with Chinese partners.

Over the years more and more new or privatized Chinese companies are coming up and develop state of the art production technology by using latest engineering techniques.

This article shows how XZB use latest FEA /1/ technology to improve the processes of forming valve spring retainers.

Design of a progression to produce a retainer

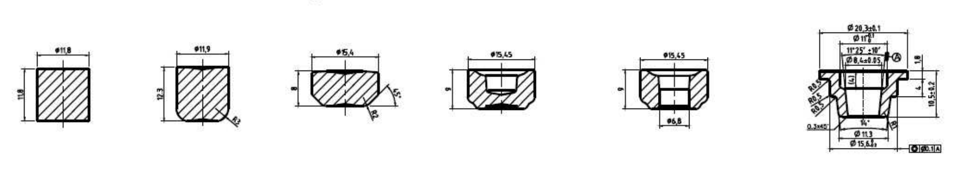

Fig. 1. Multiple Stage Process to produce a retainer

In Cold Forging retainers are normally produced on fast running multi station cold forming machines. Figure 1 shows a typical design approach. It starts from the cut-off. The part will be upset to make the cut-off more symmetric and then a second upsetting will enlarge the diameter and will make the part more symmetric as well. Operation three is preforming the main geometry and prepares for the piercing. The piercing will happen in operation four. In operation five the final forming will take place.

In the traditional way after having designed the progression the tooling will be produced and then there will be a try out on the machine.

Only in the very lucky case the process will run perfectly. That means the geometry will be ok, surface quality will be good and last but not least the tooling will show a good tool life.

Depending on the empirical skills of the engineers and the tool maker normally several loops in design and tool changes are needed to reach a good production result.

Sometimes a satisfying solution can not be reached based on the available experience and the part cannot be produced.

Typical production problems to be solved during the tryout phase

There can be various difficulties appearing during try out. The following picture shows some of them as typical examples.


Figure 2: Typical production problems

Figure 2 shows a very rough surface on the smaller outer diameter and a cracking at the radius at the bottom of the retainer.


Figure 3: Typical production problem

Figure 3 shows cracks at the radius at the inner diameter at the bottom.


Figure 4: Typical production problem

Figure 4 shows filling problems in operation three which lead to too big tolerances in the flange of the retainer.


Figure 5: Typical production problem

Figure 5 shows the forming of a flash.

Further problems like tool breakage, folding etc may be mentioned as well.

The use of modern FEA technology during design stage

Modern FEA technology can help the engineer to identify problems during design stage and enables him to make corrections directly. The process can be optimized before making any tooling even. Furthermore the tool design can be analyzed and optimized as well so that good tool life can be expected from the beginning.

The possibility to look into the pieces to check for local values of velocity, deformation and stresses etc helps the engineer to better understand the cold forging technology in general and the production of the actual product especially. He can improve his understanding and therefore will be able to create better designs.

The first example shows the generation of a folding at the part (figure 6).

Figure 6 : Folding at the part

This folding is generated during the forging sequence. Figure 7 shows the actual generation of the fold.

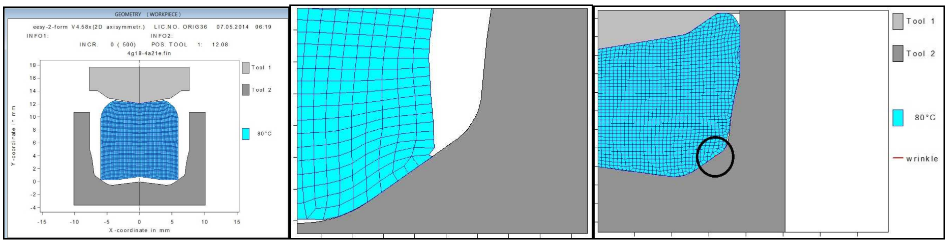

Figure 7: Building a fold in operation two

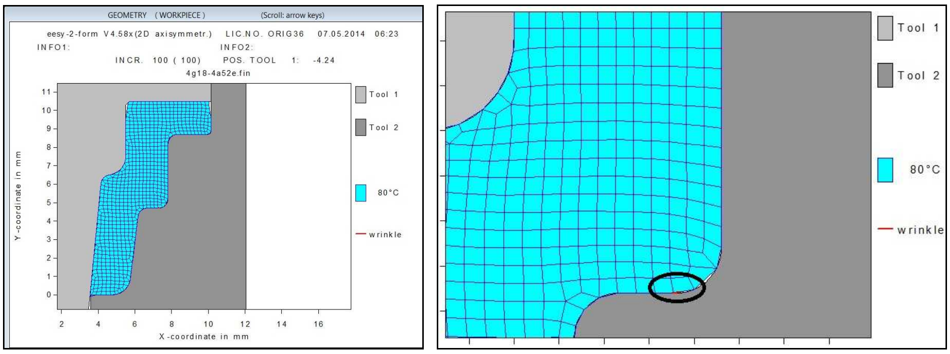

Figure 8: Failure at the finished part

Another problem that can be indicated by simulation is the rough surface and the crack shown in figure two.

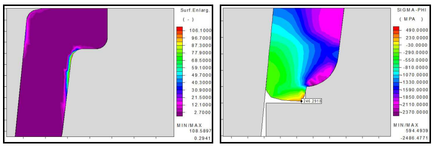
Figure 9: surface enlargement /tangential stress

Figure 9 shows the surface enlargement at the piece that can explain the rough surface structure and the high tangential stress at the bottom of the piece that explains the cracking (as shown in figure two).

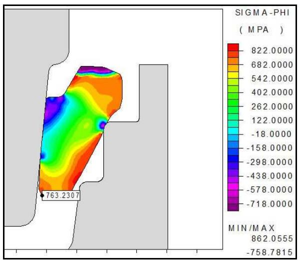

Figure 10: tangential stresses

Figure 10 shows tangential stresses that explain the cracking as shown in figure three.

The failures shown in figure four and five can be shown by similar analysis.

Successful application of FEA in process design

Using all the information provided by FEA and making appropriate changes to the progression design the engineers could design a good solution to produce the part

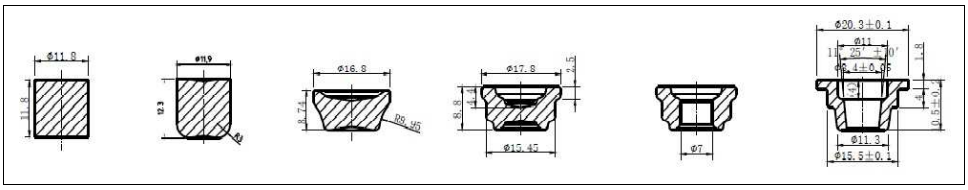

Figure 11: Optimized progression.

Figure 12: Optimized progression (real parts)

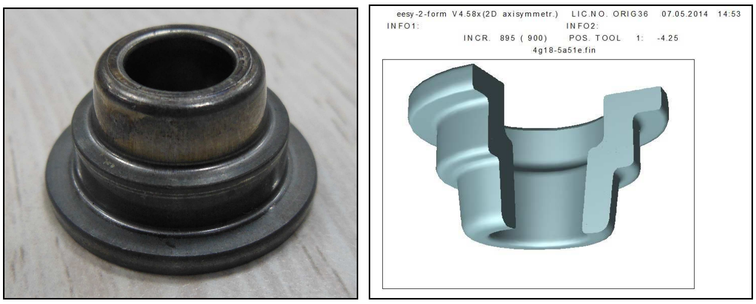

Figure 13: Optimized product

The part is produced on a National Mashinery cold forming machine at a speed of 120 pieces per minute.

The tool life in average is about 100.000 pieces.

Summary

This example shows how a huge potential of process improvement and cost reduction can be reached by consequent use of newly available technology. Such use of latest technology and development tools like FEA allowed the cold forging industry in China to develop significantly in the last years and to develop new technology in the future.

Literature

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