TOOLDAMAGE CAUSED BY PROCESS DESIGN

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ABSTRACT: The article shows an example of the industrial application of simulation in forging. The original application from industry will be presented and the problems and the systematic way to solve them by means of simulation will be explained.

Keywords: Cold forging, Simulation, Toollife, Damage

1 INTRODUCTION

Simulation by Finite Element Analysis (FEA) is used by forging industry for more then 20 years now. With increasing success it is used for design studies to optimize progressions and tool design.

FEA became a reliable tool to the forging engineer who knows his process and the related technology. It helps him to do a better design in shorter time. Or to try "unrealistic" designs that he would not have tried on the machine directly.

To get good results the engineer must be able to set the relevant input data correctly. Material data, friction, machine characteristic and others have to be set realistically.
One of the most important things is that the engineer must be able to read and understand the simulation results.

This article explains the application of FEA in the production of a valve spring retainer to avoid premature tool failure.

2 HOW TO WORK WITH FEM

2.1 PRODUCTION OF A VALVE SPRING RETAINER

The production of valve spring retainers can be done on fast running cold forging machines.

The process starts from a zylindrical cut off. This zylinder will be formed in two stations into a pre-form whish will be pierced in the next step.
In the last operation this pierced pre form will be formed into the retainer.

In this example the progression was designed along empirical rules. The customer had long time expierince in making retainers. But surprisingly there was premature punch failure in the last operation.

Figure one shows the progression of the retainer.

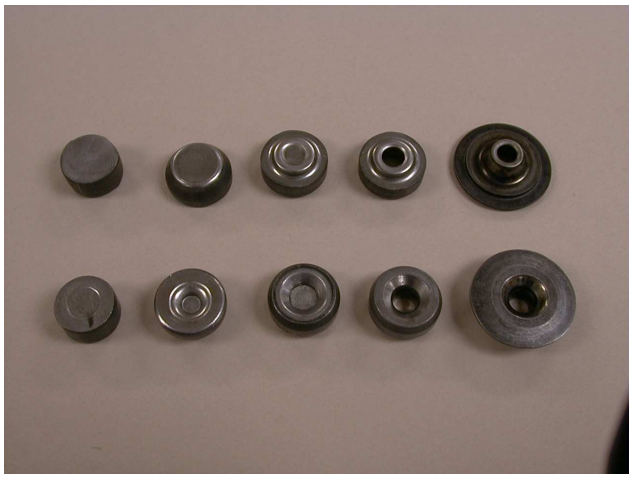

Figure 1: Progression to form the retainer

Abbildung 2: Versagen des Stempels

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2.2 TOOL FAILURE

The punch life in the cold forging of the valve spring retainer was not sufficient. Punches (made from M2) were failing by catastrophic fracture after 2000 to 4000 pieces production only.

With empirical knowledge this could not be explained. The geometry was formed correctly so that there was no visual indication for the damage.

Figure 2 shows the punch.

Figure 2: Punch failure

The customer tried a lot of technological variation to find a solution: Slowing down the machine, changing to fully annealed wire, coated tooling, etc. All attempts changed tool life only marginal.

2.3 MODELLING

The customer decided to simulate the process to be able to make some analysis of the stresses in the punch during forming.

The plastic simulation with rigid tools shows as well that the part could be produced correctly.

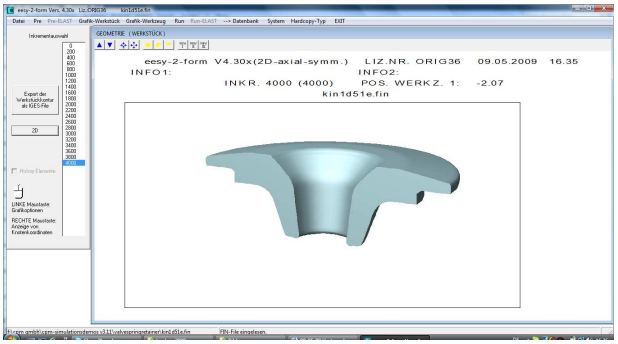

Figure 3: Final geometry of the retainer

To analyse the stresses in the punch during the forming the punch was modelled as an elastic tool. Then an elastic FEA of the punch was performed using the surface stresses obtained in the plastic simulation.

The analysis showed that in areas where the compressive elastic stresses normal to the tool surface were absent positive axial stresses (SigYY) were generated. These positive stresses were exactly in the position where the damage occurred.

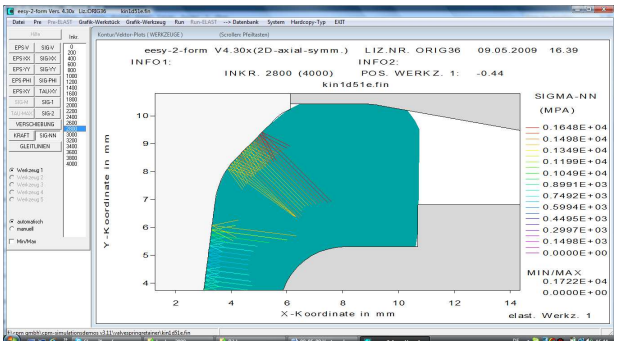

Figure 4: Non homogeneus distribution of stress normal to the surface

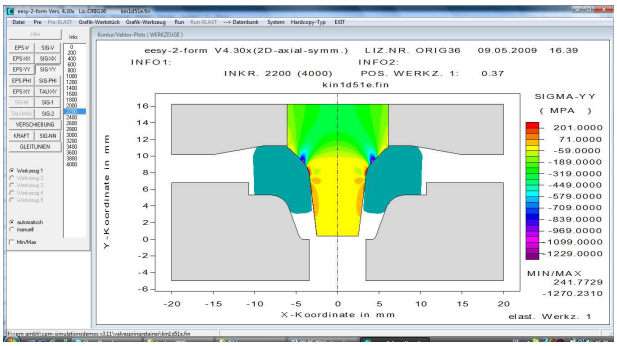

Figure 4: Positiv axial stresses in the punch

These stresses appear cyclic during the production so that fatigue can be assumed as reason fort he breakage.

Anyway these positive stresses were identified as reason for the breakage.

The aim was then to avoid these stresses by changing the progression design.

Eine Änderung der Vorform führte zu homogenem Werkzeugkontakt während des Prozesses, so dass keine lokalen Zugspannungen mehr auftraten. Die Standzeit des Stempels konnte dadurch auf über 100.000 Teile erhöht werden.