Simulation Based Optimization of a Hot Forging Process to Avoid a Lap, using Simufact.forming

A.J. Buijk
Simufact-Americas LLC
(arjaan.buijk@simufact-americas.com)

Harish Sehgal
Cornell Forge
(hsehgal@cornellforge)

Keywords: Hot Forging, Finite Volume, Simulation, Simufact.forming.

ABSTRACT

Using simulation a 2 stage hot-forging process was optimized to avoid a lap.

INTRODUCTION

In this paper we will demonstrate how simulation was used to understand and to avoid a lap that occurred in the rougher stage of a hot forging process. The simulated part with flash is shown in figure 1.

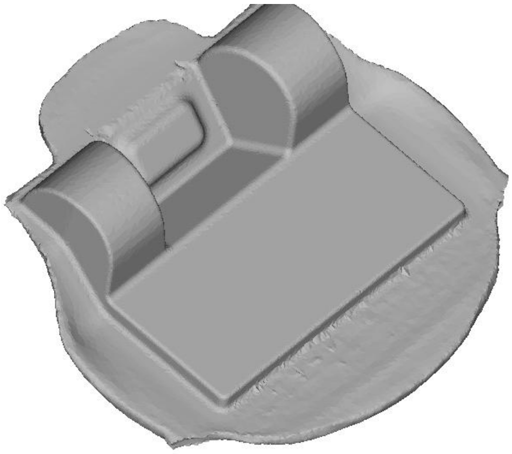


Figure 1: Hot Forged Part with Flash

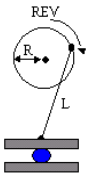
The part is made in a 2 stage process, rougher & finisher, on a 1,600t press. The lap that occurred during the physical try-out is shown in figure 2.

Figure 2: Lap that occurred during physical try-out

THE SIMULATION SETUP

The 1,600t forging press is defined as a crank press, with following characteristics:

- Crank Radius (R) = 14,645”
- Rod Length (L) = 35.4”
- Revolution (REV) = 70 RPM



The material of the part is AISI 4140, which is available in the Simufact.forming material database as 1_7225-42_CrMo_4#w__u. Some details of the material data is given in Figure 3.

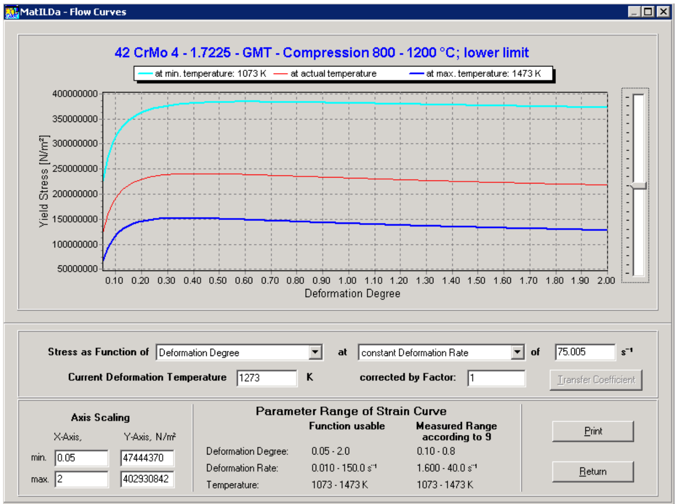
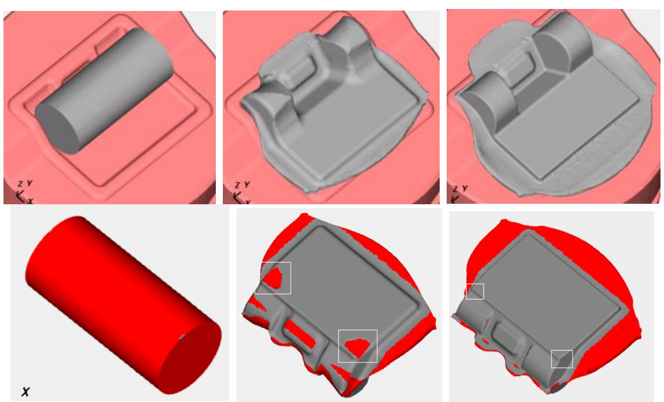


Figure 3: Material Data for AISI 4140

Lubrication was modeled using a Plastic Shear Friction of 0.27.

SIMULATION RESULTS - BASE LINE PROCESS

The simulated progression sequence for the baseline process is given in figure 4, and the cross-section visualizing the fold creation is given in figure 5.



(Initial) *(End of Rougher)* *(End of Finisher)*

Figure 5: Baseline Progression Sequence – Simulated

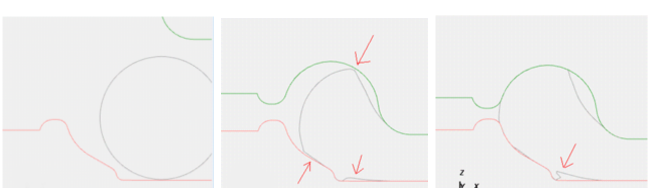


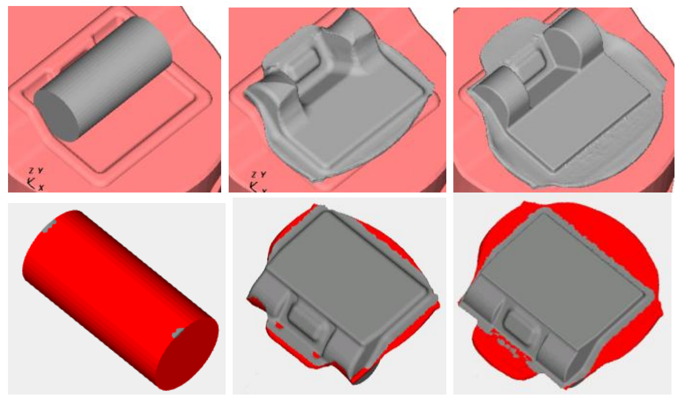
Figure 6: Progression of Fold in Rougher – Simulated

The simulated fold was in identical location as the actual fold that occurred during the physical try-out. This allowed a study why the fold occurred and to correct the process, as described in the next section.

THE OPTIMIZED PROCESS

By reviewing the simulated material motion & material flow during the baseline process, it became clear that the billet in the rougher had a tendency to roll back-wards. This tendency was also observed during the physical try-outs. A close look at the material flow in the cross-sections of Figure 6, show that the fold is really a flow-through defect. When the billet rolls back before the forging operation starts, the following happens. During the rougher stage, the material is not contacting the top-die as was designed, and as a result, the material accelerates forward un-checked, and pulls itself loose from the lower-die surface. This then results in a fold that fully develops during the finisher stage.

When the billet is positioned in the correct position, further forward as designed, no fold occurs. This is shown in Figure 7 and Figure 8.



(Initial) *(End of Rougher)* *(End of Finisher)*

Figure 7: Optimized Progression Sequence – Simulated

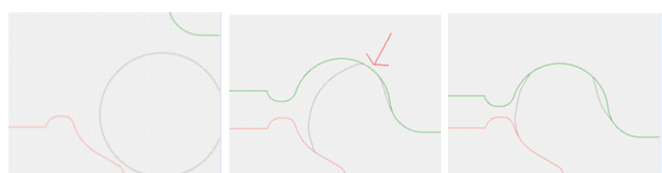


Figure 6: Avoidance of Fold in Rougher - Simulated

With this understanding, a fix was easily made. A locator was added to the lower die geometry of the rougher stage, avoiding that the billet inadvertently rolled back-wards. After this correction, the lap no longer occurred.

CONCLUSION

The Simufact.forming simulation program was used to get a full understanding of the reason a fold occurred during physical try-outs of a hot forging process.

A simple correction to one of the dies was made, resulting in a robust production process for forging the part.

CONTACT INFORMATION

For further details about this work, the authors can be contacted at the following e-mail address:

Arjaan Buijk: arjaan.buijk@simufact-americas.com
Harish Sehgal: hsehgal@cornellforge.com