Aluminum Automotive Rivet Forming: Case Study Using Simulation Software

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Simulation is a very necessary tool used for cold forming tool design to reduce development cost and product development lead time.

Omni-Lite Industries recently designed a new part that exhibits an interesting material flow. The part is cold formed out of 1100 aluminum material. The manufacturing process for this new part utilizes a three-die progression, and it is produced on a Nakashimada TH3-6A cold forming machine.

The initial tool design was completed and reviewed using the Simufact.forming simulation program from Simufact-Amercias LLC, Plymouth, MI, USA. Upon initial review, everything appeared to be acceptable with the exception of the volume of material in the flange of the part. The second station trap extrusion die radius was then reduced in order to accommodate the reduced material volume requirement.

The updated die geometry was not re-evaluated with Simufact.forming simulation software, because it was expected that this small change in extrusion die radius would not have a major impact.

The tooling was produced to this revision, which produced a “rejected” sequence. There was a material flow issue that resulted in a void on the top of the flange which was not acceptable to the customer.

At this time, the simulation was re-run with the reduced second station radius, and the simulation duplicated the actual results from the cold forming process, as shown in the images of the simulated rejected sequence in Figure 1.

A revision was then made to the diameter of the raw material in order to change the reduction of cross section area in the second station trap form die where the round material is trap extruded into the hex geometry. Simulation validated this design revision and new tooling was produced.

The parts that were produced with this process did not exhibit the void in material.

See the progression sequence photo and simulation images of the accepted sequence in Figure 2.

The parts that were produced with the reduced material diameter were then approved by the customer for full production.

Fig. 1 — Progression sequence and simulation photos of the rejected sequence.
Simulation Setup
This basic part was simulated in two dimensions only, because the part where the issue occurred is symmetrical. This is a very easy process to setup within Simufact software for the forming simulation.

Three-dimensional CAD models are created with SolidWorks and imported into Simufact as STEP files.

The workpiece material data is available within the database provided by the Simufact forming program.

The cold header characteristics (crank radius, connecting rod length and machine RPM) are also required. Friction approximation and temperature (ambient temperature is used for cold forming) data is also entered.

This particular case study only investigated material flow in the forming process. The Simufact forming program is also capable of three-dimensional simulation including tool stress, if required.

Simulation Review Using Animations
Several animations are available at the Simufact-Americas website (listed below), allowing the reader to get a better understanding of why the material flow generates this void at the top of the flange in the rejected sequence, and why it works correctly in the accepted sequence.

Conclusion
To summarize, it was found that there is a very accurate correlation between the software prediction of material flow and the real-world results from the heading tooling. This is another reason that simulation is a very necessary tool to use for cold forming tool design in order to reduce development cost and product development lead time.

Simufact forming provides Omni-Lite Industries with the capability to proceed from “paper-to-part” faster and with reduced cost.

To receive additional information and technical specifications on the simulation software available from Simufact-Americas LLC, visit the websites listed below.

www.omni-lite.com
www.simufact-americas.com

Company Profiles:
Founded in September 1992, Omni-Lite has grown into one of the world’s leading developers of precision components utilizing advanced composite materials and computer-controlled cold forging techniques. Omni-Lite’s early success came from the sports and recreation industry where its ultra light-weight ceramic composite track spikes quickly became the industry standard used by most of the world’s elite athletes. The company has since broadened its offerings to include automotive, commercial, aerospace and military products. www.omni-lite.com
Simufact-Americas LLC offers simulation software for applications including bulk forming, open-die forging and radial forging, ring rolling, sheet forming, welding and material properties. www.simufact-americas.com