New Harleys Cruise with Deep-Drawn Fenders

Tools, Inc. deep-draws the stainless-steel outer fender of this new Harley-Davidson Rocker. The outer fender is bonded to a high-strength inner fender for increased strength.

Die-design and simulation software; a switch in tool steel and coating; new hydraulic-press technology; and tight-tolerance laser trimming combine to provide Harley-Davidson with a breakthrough fender design for its new Rocker motorcycles.

BY BRAD F. KUVIN, EDITOR

The motorcycle-enthusiast/magazine reporter writes: "Hovering a mere finger's width above the tread (of the rear wheel) is a fender that has no visible means of support. In fact, it's attached directly to the swingarm and 'rocks' with the tire, hence the name Rocker, short for Rocker Tail. In order to withstand the 100+ g's of force that Harley claims can be exerted over bumps, the stainless-steel outer fender is bonded to a steel inner fender for increased strength."

Sounds simple enough to the average bike enthusiast, but we in the metalforming community know that forming a fender from stainless steel is anything but simple. Yet that's exactly what Harley-Davidson requested of its supplier, Tools, Inc., Sussex, WI, when it released production requirements for its new 2008 Softail Rocker motorcycles.

Tools, Inc., a long-time supplier of metal stampings, assemblies and tooling to Harley-Davidson, operates a pressroom stocked with three deep-draw hydraulic presses (450, 850 and 1000 tons) as well as mechanical presses from 95 to 600 tons. The firm also provides value-added activities including five-axis laser trimming, robotic gas-metal-arc welding and resistance welding.

A Big Role for Die-Engineering Software

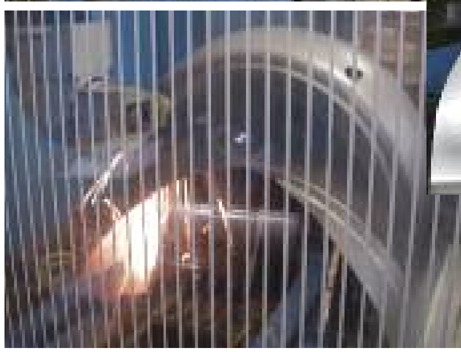
For its latest Harley project, Tools, Inc. invested 10 months developing a process to deep draw the new Rocker motorcycle's fender, of 20-gauge Type 304L stainless steel. It started by using its Dynaform die-system simulation software (from Engineering Technology Associates, Troy, MI) to gain a basic model of what the tooling would look like, and calculate blank and die sizes.

Tools, Inc. employs three of the Dynaform modules to streamline the die development and virtual tryout process: Blank Size Engineering module, for blank-size estimation as well as forming-failure analysis from blank thinning (the module also creates a forming-limit diagram); Die Face Engineering module, which provides CAD surface and CAE meshing tools to generate binder surfaces, addendum profiles and draw-bead layouts; and Formability Simulation module, a complete incremental die-simulation program that performs design-feasibility analysis and verification, plotting stress, strain and thickness results, and generating a complete forming-limit diagram.

A Switch of Tool Steel and Coating

"The key to the project was selecting the right tool steel, coating and blank dimensions to get a successful draw," says Brian Snyder, Tools, Inc. president. "Typically, to draw stainless steels we would use an aluminum-bronze material, to prevent galling and any imperfections on the Class A drawn part. But given the rigors of this application, a stronger material was required."

After researching various tool-steel



Type 304L stainless-steel blanks, 20 gauge, are deep drawn in an 850-ton AP&T hydraulic press, then laser-trimmed in a five-axis Prima cutting machine before undergoing a final restrike in a 1000-ton hydraulic press.

options for the fender project, the firm settled on DC 53, an alloy manufactured in Japan by Daido Steel and marketed in the United States by International Mold Steel, Florence, KY.

"We also investigated several different tool coatings for the DC 53 tools, eventually specifying a proprietary coating after first testing the tools with coatings deposited by ion-nitride and titanium-nitride processing," says Snyder. The firm also tested a variety of drawing lubricants, settling on a dry lube supplied by PPG. "Wet lubes failed to withstand the drawing severity and heat created during the draw," adds Snyder. "We've deep-drawn stainless steel before—more symmetrically shaped parts such as wheel inserts for tractor-trailers. But the asymmetrical fenders are more challenging, creating forces that proved difficult to balance with conventional materials and lubes."

The combination of DC 53 tool steel, the proprietary tool coating, and the dry lube proved very successful for drawing the stainless steel. The firm expects an increase in tool life by a factor of three to four compared to aluminum-bronze tooling, Snyder says.

Extreme Cushion Tonnage Required

With tool steel and coating specified, the firm went to work developing the blank and draw-bead layout, to provide the required holding force to complete the 9-in. draw, yet minimize the size of the addendum.

"We focused a lot of time and energy profiling the cushion tonnage and other press parameters," adds Snyder, describing the process developed to draw the fenders on a 2002-vintage 850-ton AP&T hydraulic press. The press boasts a 450-ton cushion and 63 by 99-in. bolster.

"We have to use a relatively high cushion force of 300 tons," Snyder says, "probably 2.5 times what we'd use for a mild-steel blank of this size. We also use a larger-than-typical blank in order to keep the shock lines off of the Class A surface. To minimize oil canning and manage the residual stresses building up in the sidewalls during drawing, we located the draw beads outside of the Class A surface, which necessitated a wider blank than we might typically use. This contains the stresses in the offal."

Residual-Stress Buildup a Challenge for Laser Trimming

After a single draw in the press, parts move to one of four five-axis laser-cutting machines at Tools, Inc. All of its laser-cutting machines were provided by Prima North America, Chicopee, MA.

"Laser trimming of deep-drawn parts has really taken off for us," shares Tools, Inc. sales manager Mark Voegeli, "not only for stainless-steel parts but for some of the newer advanced high-strength steels gaining in popularity. Some of these alloys are too hard to trim using traditional dies. We've added two laser-cutting machines in the last couple of years to better handle this type of work. Trimming the Rocker motorcycle fender would have taken multiple die hits, rather than one setup in the laser cell."

Each of the firm's laser-cutting machines are dual-cabin setups that allow cutting in one cabin and load/unload in the second cabin. Or, the partition separating the two cabins can be removed to allow processing of large stampings.

Laser-trimming the deep-drawn fenders proved challenging as the exceptionally high residual stresses in the sidewalls initially caused the stampings to shift in their fixtures during cutting. "The way the scrap would peel off of the part during trimming caused us to re-engineer the laser-cutting fixture," shares Snyder. "We had to develop a combination of electronic, mechanical and pneumatic clamps and use proximity sensors to gauge the part during fixturing, and to more securely hold the part during cutting. The sensors check the location of critical-tolerance part features to within ±0.010 in. The fender has subtle form features that must be accurately located relative to the trim line."

On to Restrike

After laser trimming, the Rocker-motorcycle fenders move to a 1000-ton hydraulic press for punching (to make holes for the license plate and tail-light brackets) and then are hand-transferred to a second die for a restrike operation, to straighten the sidewalls.

"The success of this project, and other more challenging deep-draw work," shares Snyder, "comes from our recent investments in new hydraulic-press technology, laser-cutting capacity, tool-steel development, and our ability to try out and develop dies virtually using the Dynaform software. We're poised to perform the most complex draws that designers can draw up, particularly with the newer high-strength steels as well as stainless steels." **MF**