BY LYNN STANLEY, SENIOR EDITOR

Answering the BIG QUESTIONS

Servo press technology helps automakers tame unruly super steels

Taylan Altan, Ph.D., and Product Manager Shrini Patil inspect a dual-phase 980 drawn part, produced on the R&D production cell at Aida-America.

To steel or not to steel? That is the question on the minds of automakers facing Corporate Average Fuel Economy (CAFE) standards. They mandate vehicles achieve 54.5 miles per gallon and reduce carbon intensity by 40 percent for model years 2012 to 2025. To reach that goal OEMs are turning to advanced materials for help in building lighter-weight, crash-resistant cars that appeal to the tastes and wallets of customers yet make for a healthy bottom line.

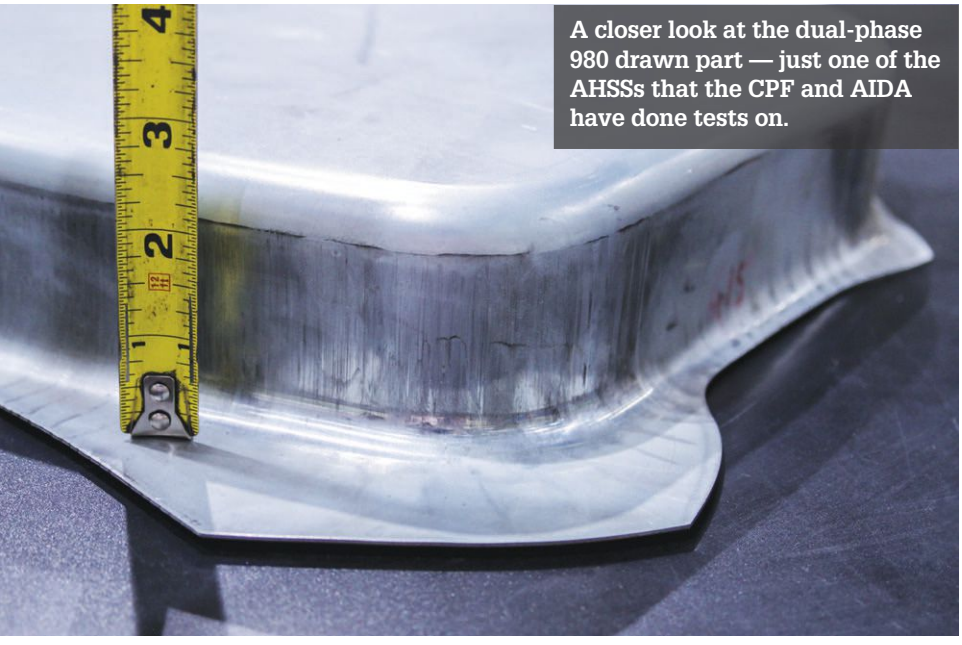
Composites reinforced with carbon fiber have made some inroads with automakers because of their high strength-to-weight ratio and stiffness-to-weight ratio. Ford's F-150 truck shed close to 15 percent of its vehicle weight, about 700 lbs., with high-strength, military-grade aluminum.

But steel continues to dominate. Developments over the last decade have produced a bevy of advanced high-strength steels that include dual-phase grades with tensile strength up to 1,200 MPa, transformation-inducted plasticity, martensitic and twinning-induced plasticity steels. Coveted for car body structures in particular, demand for AHSS is steadily growing but the multiphase metal also carries some big fabrication challenges.

A high-speed servo tandem line installed at a North American automotive OEM uses a regenerative servo-driven hydraulic die cushion similar to the one at Aida-America.

The power of partners

For starters AHSS material properties are inconsistent. They can fracture during forming and the alloy produces spring-back that results in parts that are dimensionally inaccurate. A lack of long-term, in-the-field data about the metal's material structure and properties makes it difficult for design engineers to accurately simulate and model processes for parts and tooling configurations. AHSS also requires a different forming approach.



A closer look at the dual-phase 980 drawn part — just one of the AHSSs that the CPF and AIDA have done tests on.

One press manufacturer and a university-based research group are working together to help automakers and their suppliers to solve these problems and equip them with tools able to manage higher tensile strength steels not yet on the market.

Aida-America, Dayton, Ohio, invested $500,000 in a 300-ton DSF direct drive servoformer press equipped with a servo hydraulic cushion for use by the Center for Precision Forming at The Ohio State University in Columbus. Funded by the National Science Foundation and member companies that include Aida, Honda Motor Corp., Shiloh Industries Inc., Fiat Chrysler Automobiles, Nucor Corp. and Batesville Tool & Die, CPF is using the test cell to evaluate and gather data on the formability of AHSS and high-strength aluminum under a variety of conditions in order to reduce the potential for defects, improve quality and lower costs.

Aida first introduced servoforming to the marketplace in 1996. The unique capabilities of the DSF direct drive servoformer make it suitable for AHSS. Aida's recent development of its new servo hydraulic cushion further improves accuracy by reducing impact at the point of contact at punch and die. And nearly 70 percent of cushion energy is regenerated.

Take your pick

"In one of our tests we programmed variable speed, variable blank holder force and cushion preacceleration to demonstrate a reduction in material fractures and wrinkling," says Taylan Altan, Ph.D., director of CPF. Programmability is at the core of the technology that allows the servoformer to adapt to the idiosyncrasies of AHSS.

Shrinivas Patil, product manager for Aida-America, explains why: "Advanced high-strength steels need more tonnage, lower speeds and higher energy to properly form parts," he says. "If you run a mechanical press at lower speeds, it can't generate enough energy to form the part and will subsequently stall. Reverse tonnage on a mechanical press is also quite high, resulting in poor part quality and a shortened life cycle for both tooling and press."

The servo press allows operators to program speed and position in a nearly unlimited number of combinations or profiles, he continues. "This means a fabricator can run the servo press at a speed as low as 1 spm during actual forming then return to full speed for the nonworking portion of the ram cycle to maintain overall productivity levels."

When Altan visits with carmakers that use servoforming, such as BMW, "the first thing they talk about is higher productiv-

ity," he says. "Compared to a mechanical press, the speed of a servoforming press is 60 to 90 percent faster. Combine the servo press with a servo hydraulic cushion and forming of AHSS and aluminum is even easier and [produces] better quality."

Altan has run tests on the 300-ton servoformer cell using dies built by Shiloh and Honda to form parts from different AHSS grades and shares the results with its member companies. "This is only the tip of the iceberg," he says. "The ability to test a large number of different types of AHSS allows us to determine material properties, information that helps to produce good parts."

Once material properties and parameters are identified, the data is used to create a computer simulation that puts the design engineer in the ballpark and ready to test. On entering the test cell, an Aida load analyzer provides real-time data. This helps establish parameters such as punch and die clearance, forming speeds and die cushion forces, which contribute to accurate modeling and simulation.

Fabricators also find that the lack of standard production processes for AHSS grades result in high material variations from batch to batch. "Production of mild steel is a well-established process," says Patil. "With AHSS we're finding that each steel [melt shop] is implementing its own unique process for producing the alloys, which adds another dimension to the variations fabricators are seeing."

For mechanical presses material variations are troublesome at best. Dies must be tweaked repeatedly, which results in lost production time. The DSF servoformer can be programmed to account for material variations without sacrificing productivity.

Programmability also accommodates escalating tensile strengths and the growing trend to match the material's MPa to specific applications. "The tensile strength properties of AHSS have nearly doubled in the last five years and the numbers are continuing to rise," Patil says. "Mechanical presses are ill-suited to these types of applications because the machines tend to be one-size-fits-all. The servoformer's motion profile can be optimized for each part geometry and application."

CPF is using the servoformer test cell to gauge the potential advantages of forming higher tensile strength steels particularly in coining and restriking processes. "We're finding that manufacturers can save material," says Altan. "Blanks produced with the servo press and servo hydraulic cushion are more precise, minimizing the need to trim excess materials. Everyone wants to increase productivity but if the parts are too costly it won't help much. Reducing material usage is an important aspect of a stamping operation because material is energy and it is cost."

The road ahead

For CPF the test cell provides substance to support its research. "It's one thing to simulate a process for parts production," says Altan. "It's another thing to be able to show a manufacturer a formed part."

Higher and higher tensile strength steels will continue to hit the marketplace. Altan believes the future of press technology is servoforming coupled with the servo hydraulic cushion. "The industry must learn how to use these tools."

To that end Aida is working with a Tier 1 supplier and an OEM to improve blanking, piercing and deep drawing of AHSS. Aida also recently partnered with the Edison Welding Institute, also located on OSU's campus, to study cold forming of high-strength aluminum.

"As a press manufacturer we have a vested interest in continuing to understand, develop and evolve our servoforming technology for stamping and metalworking," says Patil. "The advantages of AHSS will continue to expand. We, along with CPF, want to help the automotive industry and other markets access these materials." **FFJ**

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