Servo-driven presses for AHSS stamping

How the technology can simplify forming of complex parts

BY EREN BILLUR AND TAYLAN ALTAN

In the automotive industry, it is well-accepted practice to save weight and increase safety using advanced high-strength steel (AHSS), as well as hot-pressed and quenched boron steels. AHSSs include dual-phase grades (DP 600 to DP 1200) with tensile strength up to 1,200 MPa (175 ksi), as well as transformation-inducted plasticity (TRIP), martensitic (MS), and twinning-induced plasticity (TWIP) steels. Hot-pressed boron steels may reach 1,500- to 1,600-MPa (215 to 230 ksi) tensile strength after quenching.

The stamping industry is developing advanced die design and manufacturing techniques to help reduce the splitting and scrap associated with AHSS stamping. The use of servo-driven presses also can help to address the formability and springback issues.

The Challenges of Forming AHSS

AHSS can be challenging to form. Several characteristics make it difficult to work with:

•**Lower formability/ductility** than draw-quality low-carbon steels

•**Batch-to-batch variations in properties** such as yield, tensile strength, and elongation

•**Difficulty in predicting fracture** through process simulation because the fracture-prediction methods applicable to low-carbon steels do not work for AHSS

•**Higher forming loads** and energy requirements because the ultimate tensile strength of AHSS is high

•**High contact pressures** at the sheet and die interface, causing larger interface temperatures and galling and requiring new lubricants and tool steel inserts with coatings

•**More springback** caused by higher strength (see **Figure 1**)

Of these issues, low formability and springback generally are the most challenging for stampers.

Advantages of Servo-driven Presses

Servo-driven presses are used frequently in the stamping industry. Built with capacities up to 3,000 tons, they are suitable for use by OEMs and Tier 1 suppliers worldwide. Their main advantages include:

•**Precise ram position and velocity control in stroke**, which allows for easier setup, prevention of noise and shock on contact and during upstroke, improved formability by forming at optimum velocity, and reduced reverse tonnage in blanking (see **Figure 2**)[1].

•**Adjustable stroke length**, which allows drawing and blanking in the same press with increased strokes per minute (SPM). The press also can be run in pendulum motion.

•**Ram position/velocity synchronized with automatic (or robotic) part transfer**, resulting in increased SPM.

•**More parts per minute produced** compared to mechanical presses of comparable capacity because of rapid downstroke and upstroke while reducing ram speed during deformation. For example, a 2,500-ton servo press line can run up to 17 or 18 SPM as compared to the typical 10 to 12 SPM obtainable in a comparable mechanical press line.

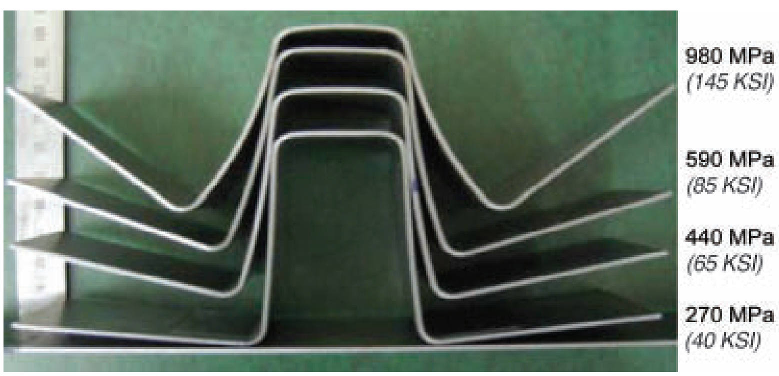

Figure 1

As yield or tensile strength increases in AHSS material, springback increases as well. Reducing or controlling springback is one of the major issues in forming AHSS.

•**Energy savings,** since the press has no continuously driven flywheel.

•**Possibility of dwell anywhere in the stroke**—mainly at bottom dead center (BDC)—and restriking capability, allowing springback reduction and control.

•**Availability of maximum motor torque during entire stroke,** depending on press linkage design.

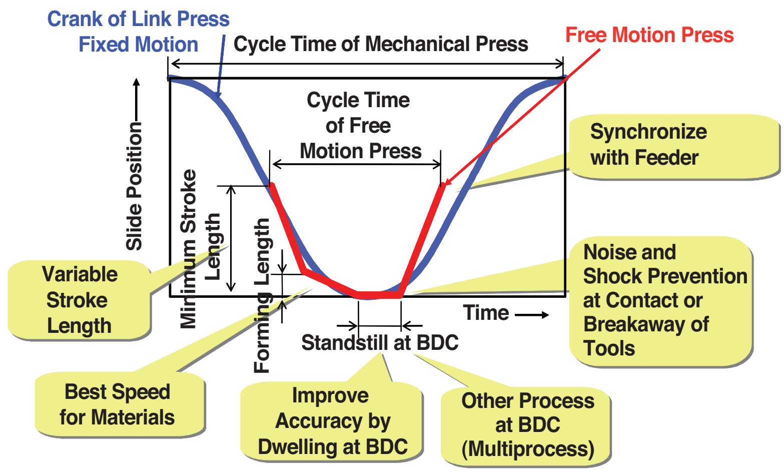

Figure 2

The slide motion of a servo-driven press can be programmed for high parts per minute, decreased drawing speed to reduce defects, and dwelling or restriking at bottom to reduce springback. Courtesy of K. Miyoshi.

> The stamping industry is developing advanced die design and manufacturing techniques to help reduce the splitting and scrap associated with AHSS stamping.

How Servo-driven Presses Can Help in Forming AHSS

AHSS blanks strain-harden during deformation. The materials' strength causes temperatures to increase in the formed part and the material/die interface.

The ram deceleration and cushion preacceleration in servo presses help minimize impact shock on the blank holder and maintain lubrication on the blank. Splits and scrap are reduced, as is reverse loading in blanking, resulting in improved tool life and allowing deeper drawing.

In addition, servo presses' slow forming speed reduces heat generation at the die/sheet interface, keeping the die cooler despite the increased stroke rate. This improves lubricant effectiveness and die life.

Finally, the multiple hits and dwell at BDC achievable with a servo press help to reduce material springback.

R&D in Servo-driven Press Use

While the observations shared here are valid, there is no scientific and quantitative data on these issues. Therefore, considerable trial and error still is necessary to identify optimum forming conditions. A few universities and research laboratories are conducting R&D on these issues, including IFU at the University of Stuttgart, Germany (Prof. M. Liewald); Fraunhofer Institute for Machine Tools and Forming Technology (IWU) in Chemnitz, Germany (Prof. R. Neugebauer); Institute for Production and Forming Technology at the University of Darmstadt, Germany (Prof. P. Groche); and the Center for Precision Forming (CPF) at The Ohio State University (Prof. Taylan Altan), in cooperation with industry.

More R&D on servo-driven presses will be beneficial so that scientific, objective, and quantitative information can be generated regarding the challenges of forming AHSS. The result could be the development of guidelines to optimize ram speed control, dwell time, and multiple hits at BDC for forming different AHSS grades. ST

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Note:

1. K. Miyoshi, "Current Trends in Free Motion Presses," in proceedings of the 3rd Japan Society for Technology of Plasticity (JSTP) Inlt. Seminar on Precision Forming, March 2004, Nagoya, Japan.