Reducing springback in U and hat bending of AHSS

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Advanced high-strength steels (AHSS) are used widely in the automotive industry to reduce body weight and increase crash resistance. Precision and reduction of springback are challenging when forming these alloys, so the industry is continuously developing new techniques to compensate for springback and to prevent recuts of the dies during tryouts.

Opel of Germany recently developed a new die/punch geometry that significantly reduces springback in U and hat bending of AHSS. In this application, a round punch corner design is modified to have a double-S profile with three radii (see **Figure 1**).

The three radii are defined as r_1, r_2, and r_3. Conventional springback is caused by the two convex radii r_1 and r_3. The addition of the r_2 radius in the middle allows springback compensation, because the third radius leads to

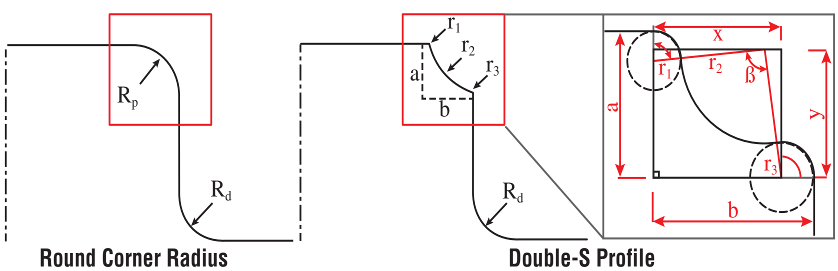

Figure 1

The double-S profile, developed by Opel, is used to reduce springback in U and hat bending shapes.

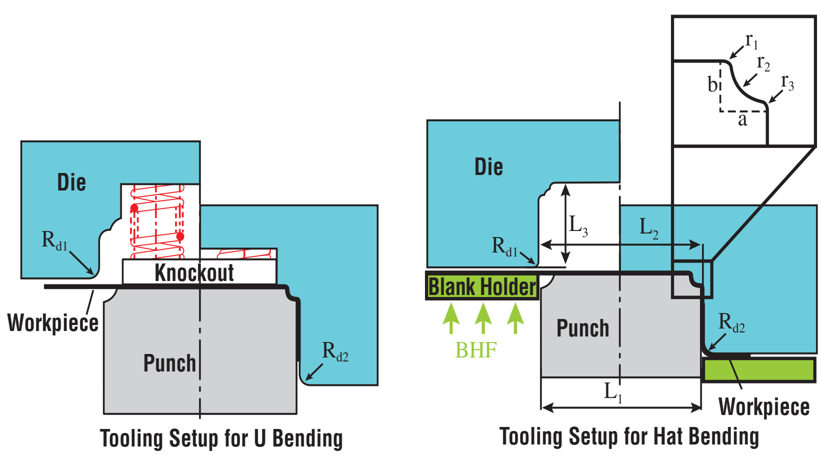

Figure 2

This schematic shows the tool designed used in FE analysis of double-S profile bending of 1.5-mm-thick DP800 material: L_1 = 66.6 mm, L_2 = 70 mm, L_3 = 50 mm, R_d = 7.6 mm.

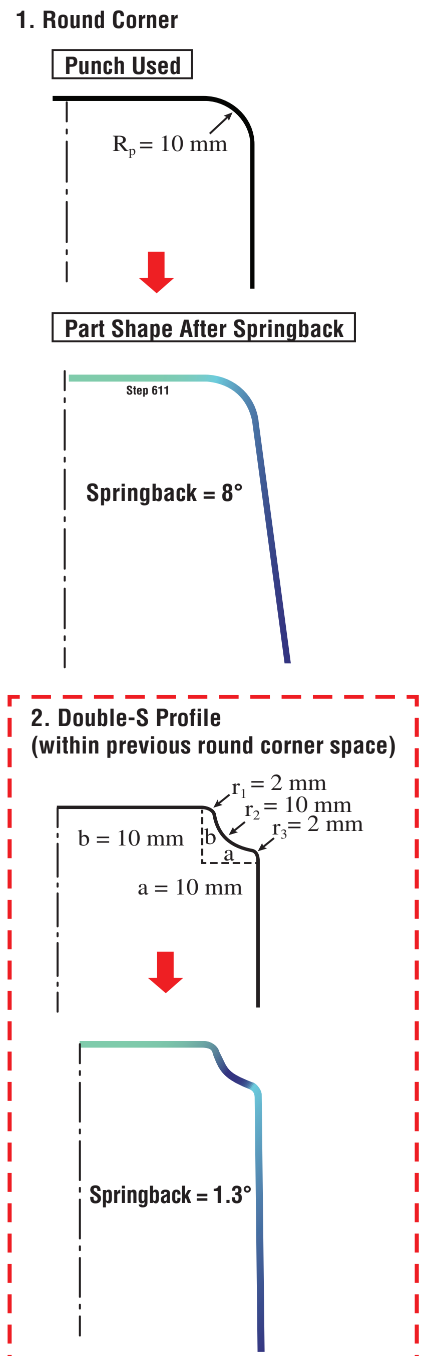

Figure 3

Shown here are the results of FE simulations for predicting springback in U bending with and without the double-S profile.

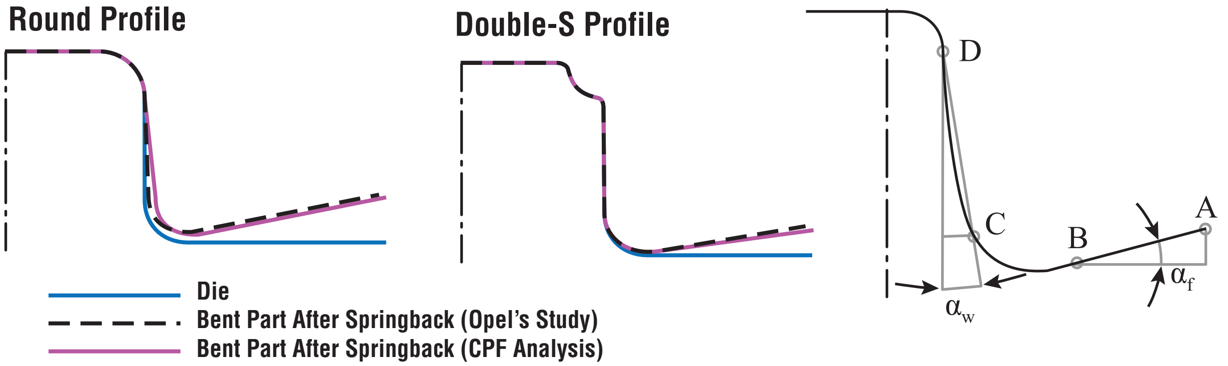

Figure 4

The double-S profile affects springback reduction in hat-bending.

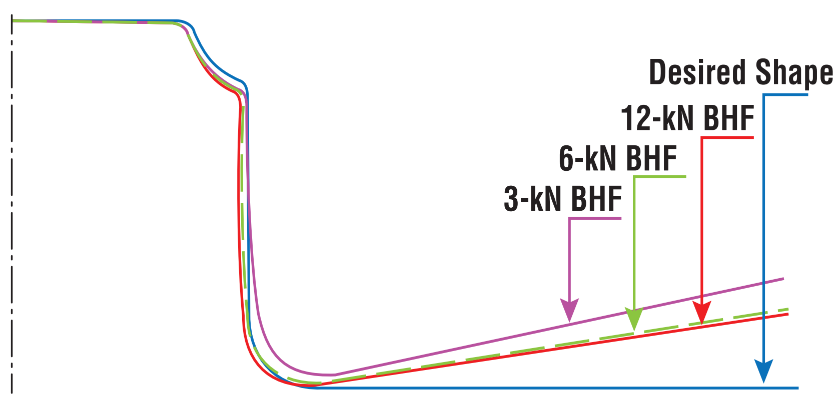

Figure 5

This graph shows the effect of constant BHF on springback reduction in hat-bending.

springback in the opposite direction.

The Center for Precision Forming (CPF) has investigated the double-S profile further in an effort to eliminate springback in AHSS sheets during the U-bending and hat-bending processes. In this case, part corners were bent with a punch with three corner radii. Researchers applied this method to a U-shaped profile and a hat-shaped profile, both made of 1.5-millimeter-thick DP800 material as in previous studies. They conducted finite element simulations of the bending processes using DEFORM 2D software (see **Figure 2**).

U-bending Results

U-bending simulations were performed for a round corner shape and a double-S profile to compare results for springback reduction. The double-S profile was effective in reducing springback in U bending (see **Figure 3**). A larger r_2 value and smaller r_1 and r_3 values resulted in lower springback. In this case, the optimal combination of three radii was determined to be 2, 10, and 2 mm for r_1, r_2, and r_3, respectively.

Hat-bending Results

CPF researchers conducted hat-bending simulations using dimensions similar to those used by Opel. The results prove the effectiveness of the double-S profile in reducing springback in hat-shape bending on flange angle (α_f), wall angle (α_w), and side wall curl (see **Figure 4**).

FE simulations also were conducted with different constant blank holder force (BHF) values. For the given material, sheet thickness, and geometry, as expected, higher constant BHF leads to a reduction in springback (see **Figure 5**).

Some analyses also were performed using a variable BHF. Researchers found that, for the given material, sheet thickness, and geometry, the use of variable BHF does not lead to lower springback than that obtained using constant BHF. ST

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