

## Hemming of Thin Gauge Advanced High-Strength Steel – Executive Summary

The goal of Auto/Steel Partnership Hemming of Thin Gauge Advanced High-Strength Steel (AHSS) project was to demonstrate that thin gauge AHSS is a viable material for automotive closure outer panels. Three grades of thin gauge AHSS were formed into coupons (steel samples) representing dimensional characteristics of automotive closure assemblies. These coupons were hemmed into assemblies. Hemmed assemblies were evaluated for various failure modes and other deformities. White-light scanning was used before and after hemming to enable a dimensional analysis of the effects of hemming. Computer aided engineering (CAE) software was applied to enable the prediction of the hemmed assembly results. Finally, samples of hemmed assemblies were baked at temperatures consistent with automotive painting operations. These baked assemblies were then light-scanned and the results compared with pre-baked light scanning results.

### **PROJECT OBJECTIVES:**

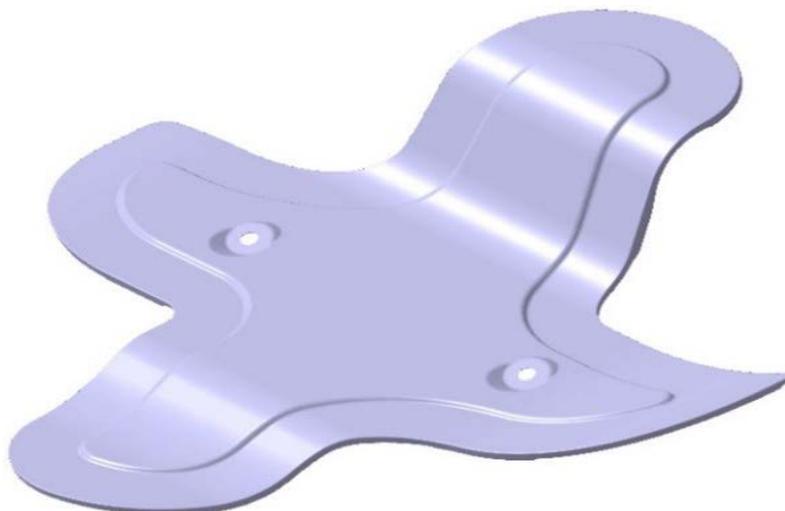
To meet the project goal, the project team set the following objectives:

- Demonstrate thin gauge AHSS can be successfully hemmed into shapes representative of those typically encountered in automotive closure assemblies.
- Demonstrate CAE tool could be developed which accurately predicted the results of hemming operations involving thin gauge AHSS.
- Demonstrate that post-hemming baking operations would be encountered in automotive painting operations do not adversely affect hemmed thin gauge AHSS assemblies.

### **METHODOLOGY**

#### Coupon design

The project team designed an 18" x 18" coupon shape that contained shapes and contours typically encountered in body closure assembly panels. The coupon shape was later refined to include typical character lines and locator holes.



### Material selection

Three grades of thin gauge AHSS were selected for the coupon outer panels:

- BH-250, 0.55 mm
- BH-440, 0.55 mm
- DP-490, 0.50 mm

0.70 mm mild steel was selected for the assembly inner coupons.

### Hemming process

A roller-hemming process was used for the fabrication of the hemmed coupon assemblies.

### Dimensional evaluation

All coupons were white light scanned prior to hemming and the assemblies were again white light scanned after hemming. The scans from before and after hemming were then compared. Dimensional changes, springback, or other issues that may have resulted from the hemming operation were analyzed. The assemblies were visually inspected for cracking, splitting, thinning, compression or other surface distortion.

### CAE tools

The ability to use existing or modified CAE tools to predict the results of hemming processes is critical in reducing uncertainty regarding the use of thin gauge AHSS for hemmed body closure outer panels.

### Baking

Samples of hemmed assemblies made from each grade of AHSS were subjected to a baking process. The sample assemblies were white-light scanned following baking and the scanning results were compared to un-baked scanning results.

## **RESULTS:**

### Dimensional analysis from hemming

- Hemming thin gauge AHSS outer panels did not introduce dimensional distortions beyond what would typically be encountered when hemming mild steel panels of thicknesses used in body closure assemblies.
- A number of coupon outer panels were hemmed with a zero hemming radius (i.e. hemmed onto themselves with no inner panel). No cracking or other notable deformation occurred.

### CAE predictions

Existing CAE tools successfully predicted the results obtained with the actual hemmed assemblies.

### Baking results

Only minor dimensional differences between the baked and unbaked hemmed assemblies were noted.

## CONCLUSIONS

1. Thin gauge AHSS can be successfully hemmed into body closure outer panel assemblies.
  - a. The various radii included in the coupon design represented typical closure panel design radii
  - b. Thinning, cracking and /or compression issues are comparable to that which is encountered using mild steel outer panels of a typical thickness
  - c. Any dimensional variations encountered can be compensated for by component die design
  - d. Panel surface deformations such as “oil canning” are not in excess of that which is encountered in mild steel outer closure panel hemming operations
2. CAE tools exist which can accurately predict the results of hemming operations involving thin gauge AHSS.
  - a. Dimensional variations can be predicted
  - b. Areas of thinning and / or compression can be predicted in body closure assembly designs
  - c. Areas of physical deformation can be predicted
  - d. The CAE tools can be used to provide a similar capability for other grades of AHSS
3. Heat treatments such as would be encountered in typical OEM painting operations do not result in appreciable dimensional change in hemmed thin gauge AHSS assemblies.
4. **Thin gauge AHSS can be hemmed into body closure outer panels. It is a viable option for achieving weight savings in vehicle body closure assemblies.**