

PRODUCT AND PROCESS EFFECTS ON STAMPING PERFORMANCE OF ADVANCED HIGH STRENGTH STEELS

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Stamping Project

- Project background
- Description of experimental tools and procedures
- Results
 - Effects of product features and process parameters
- Summary



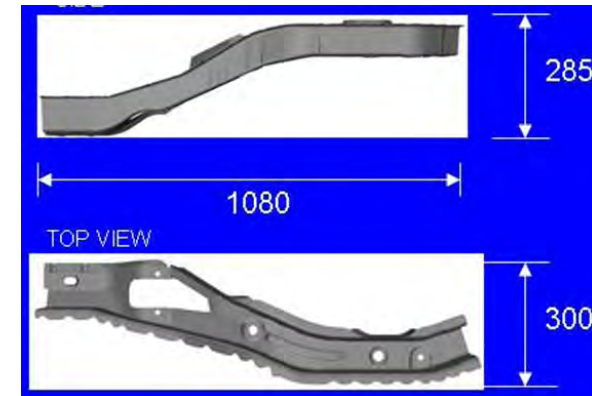
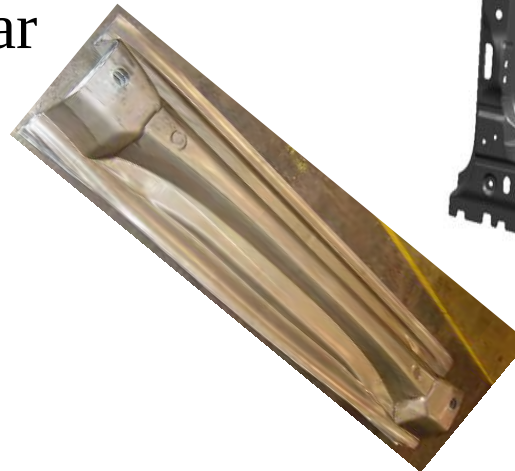
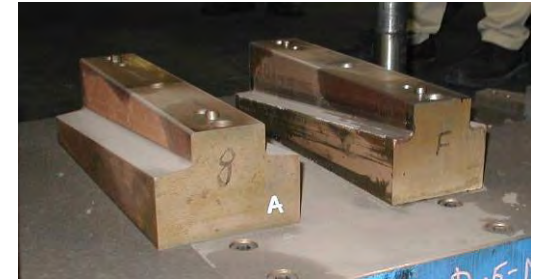
- Definitive process and product guidelines for critical stamped parts made from advanced high strength steel do not exist

- Evaluate production-intent processes and part features for best part quality in AHSS
 - Minimum springback/curl
 - Minimum wrinkling
 - Dimensional accuracy

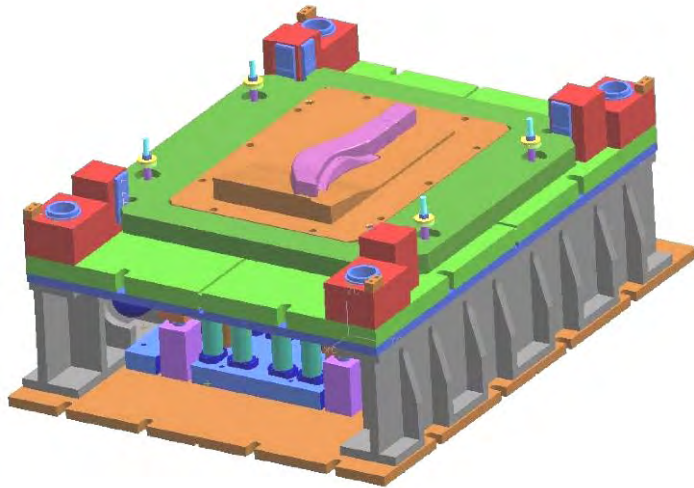
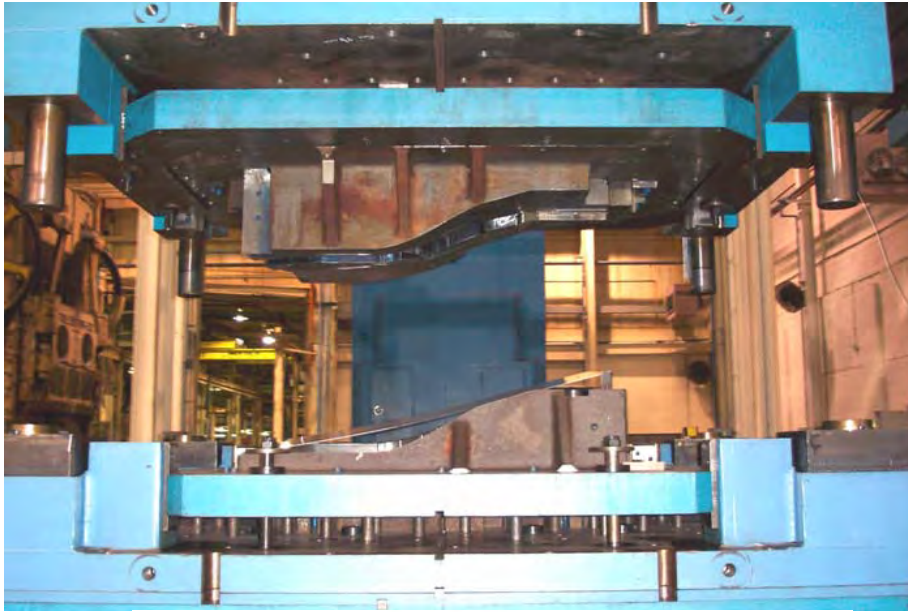
- OEM team members select HSS parts with forming challenges
- A/SP project team evaluates the part, and proposes alternative processes and part features
- Tooling is built and validated
 - Existing lab-scale experimental tooling is also used
- Experimental plan is developed and executed
 - Materials
 - Process parameters
 - Part features
- Project team evaluates results

LIST OF PARTS AND TOOLING

- DaimlerChrysler Fender Load Beam (93 LH)
- “15 Flange” Die – (Flange Springback)
- Double Action Pan Die
- Two-hit Channel Die
- DaimlerChrysler Rear Longitudinal Rail
- Ford Crossmember (Five Hundred)
- GM B-Pillar



MULTIFUNCTION MASTER SHOE



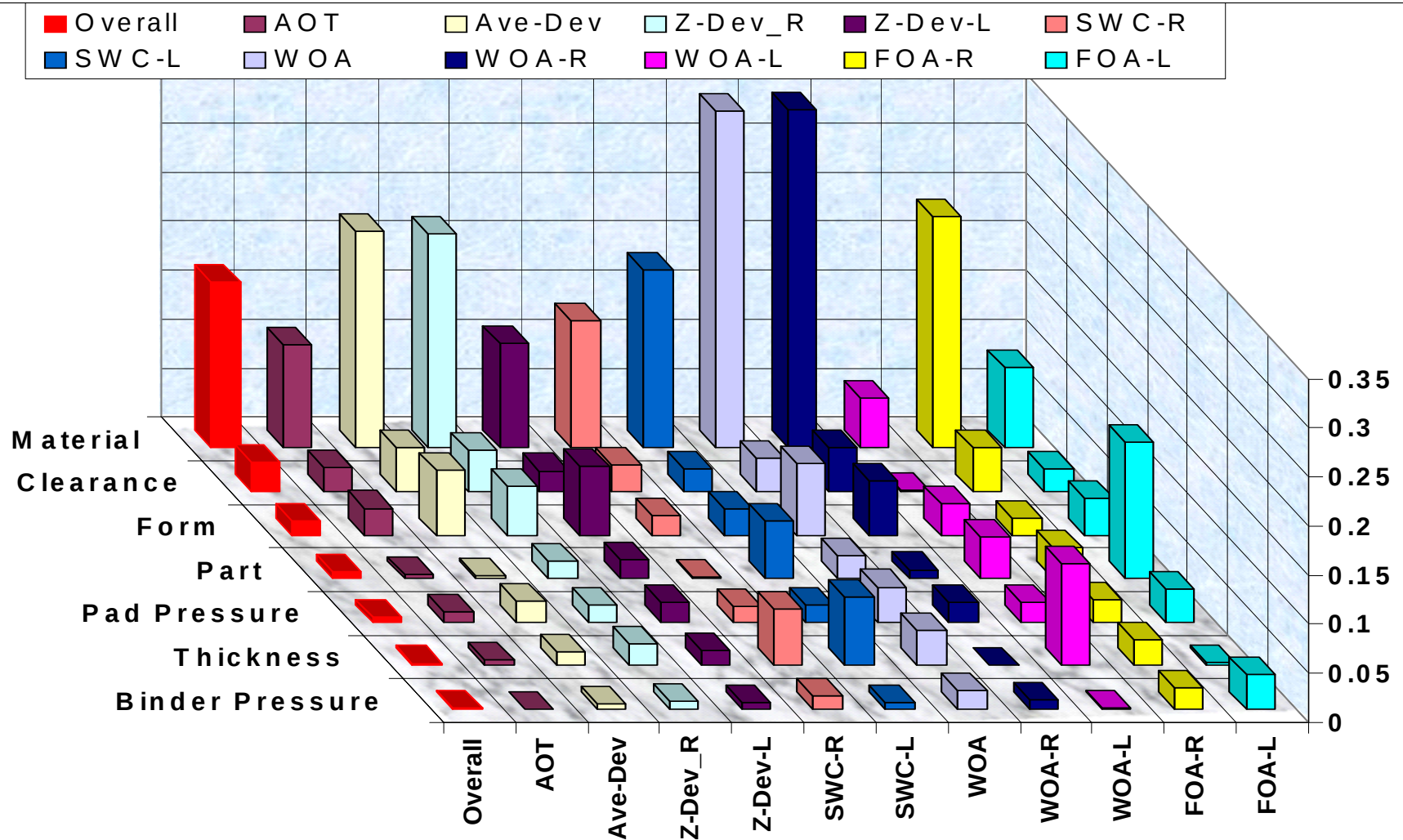
- Features
 - Hydraulic lower cushion
 - Delayed return
 - “Soft touch”
 - Force spike at end of stroke
 - 150 ton capacity
 - Nitrogen upper cushion with two controllable zones
 - Insertable cassettes to hold working steels for easy changeover

- Parameters Studied
 - Process (POP, POB and form die/developed blank)
 - Binder Force
 - Pad Force
 - Thickness (2.2 vs. 1.6)
 - Material (DP600, DP780, DP980)**
 - Parts trimmed, scanned and measured

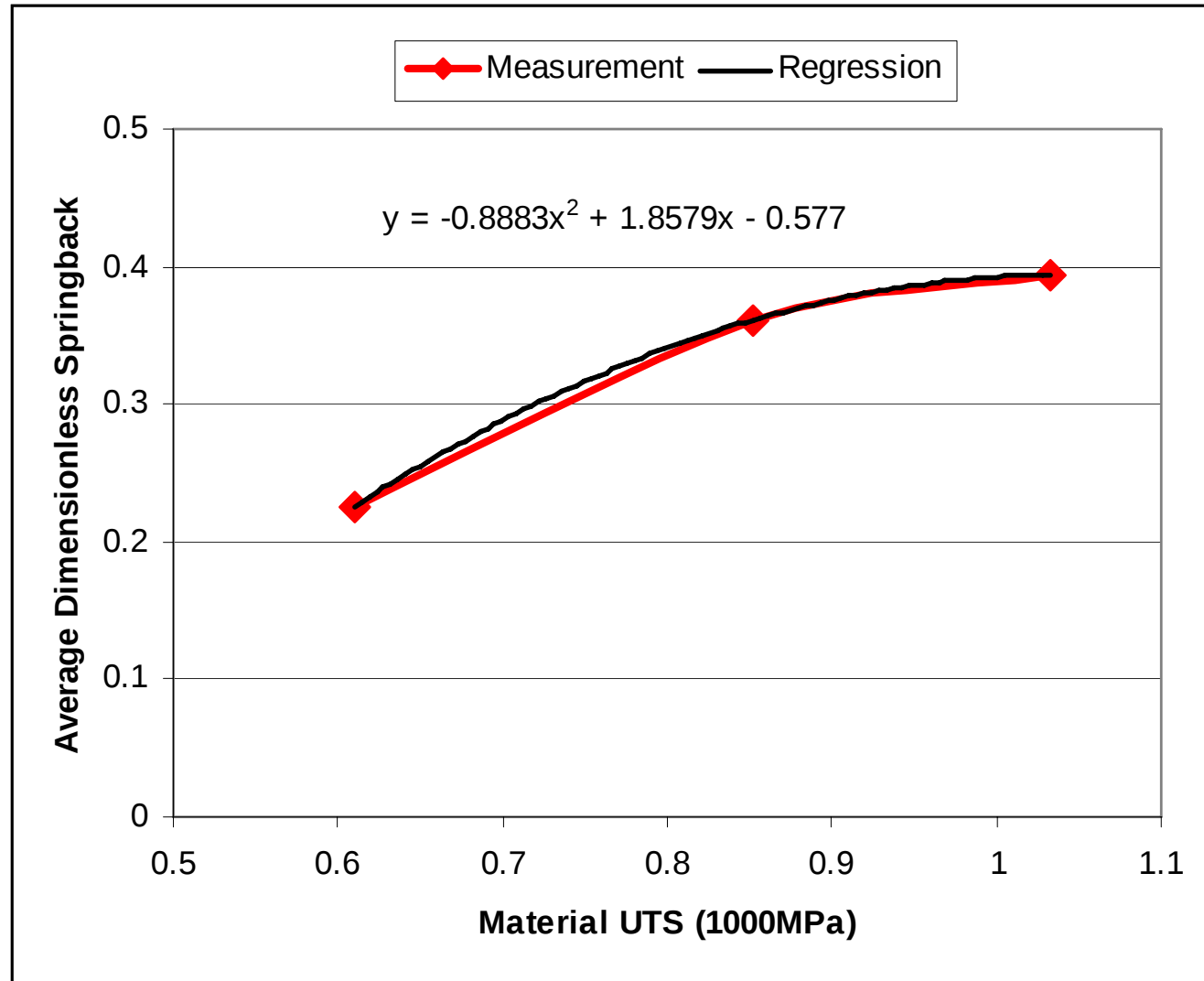


DAIMLERCHRYSLER REAR RAIL – EFFECT OF MATERIAL PROPERTIES

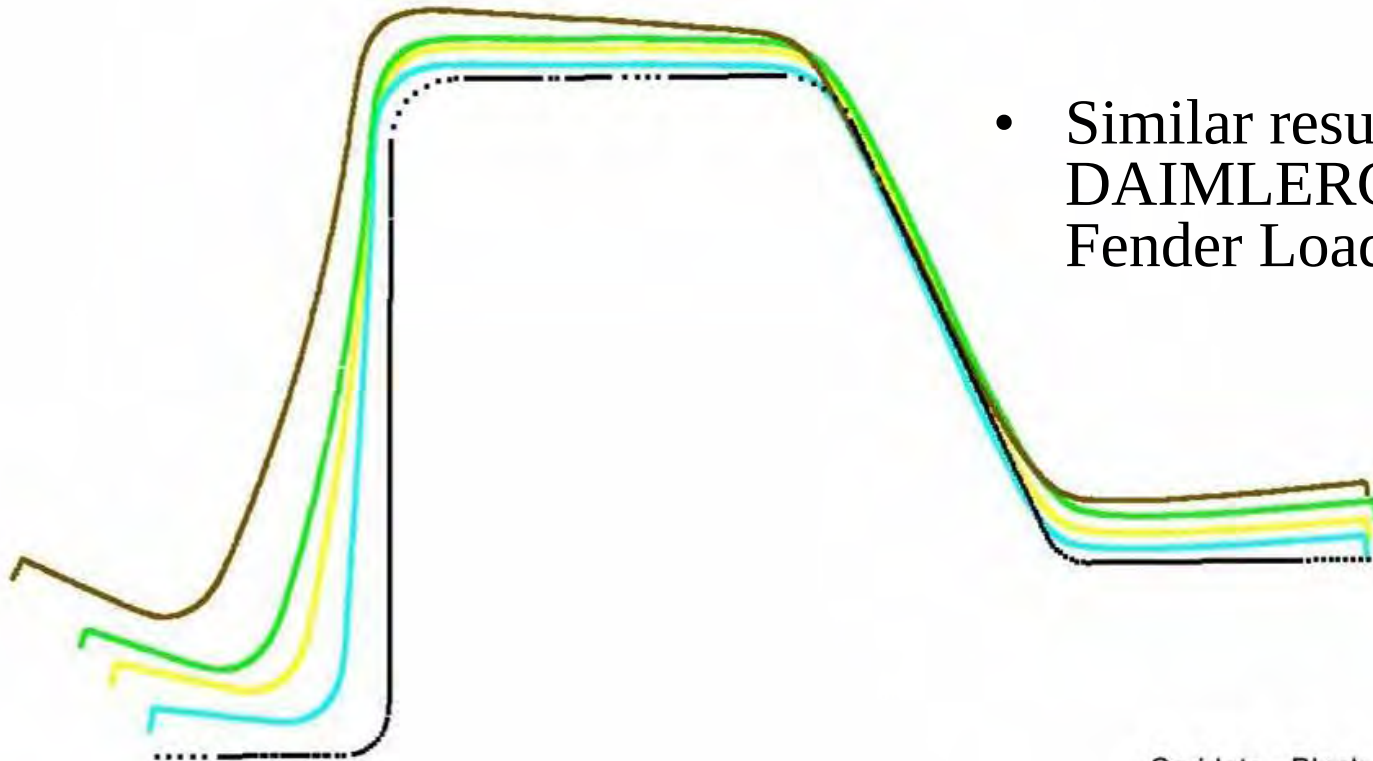
- Effect of material outweighed all other effects



- Increased springback correlates with tensile strength



DAIMLERCHRYSLER LOAD BEAM – EFFECT OF MATERIAL PROPERTIES



- Similar results found for DAIMLERCHRYSLER Fender Load Beam

Caddata - Black
DP980 1.4 - Brown
DP780 1.4 - Green
DP600 1.4 - Yellow
50KSI 1.5 - Cyan

- Beads in wall result in ~10% less springback



- 6” strips formed in straight sections and compared to parts stamped from full blanks
- Visually, strips appear to have much higher curl and springback
- Plan view shape appears to be an effective feature for reducing springback and curl

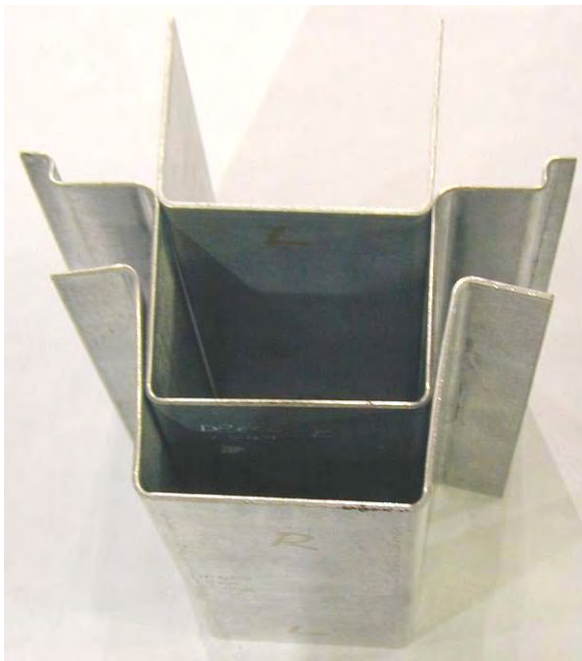




- Sidewall post-stretch effective springback minimizer, even at DP980 strength levels



- Two-break flange can also help minimize springback and sidewall curl

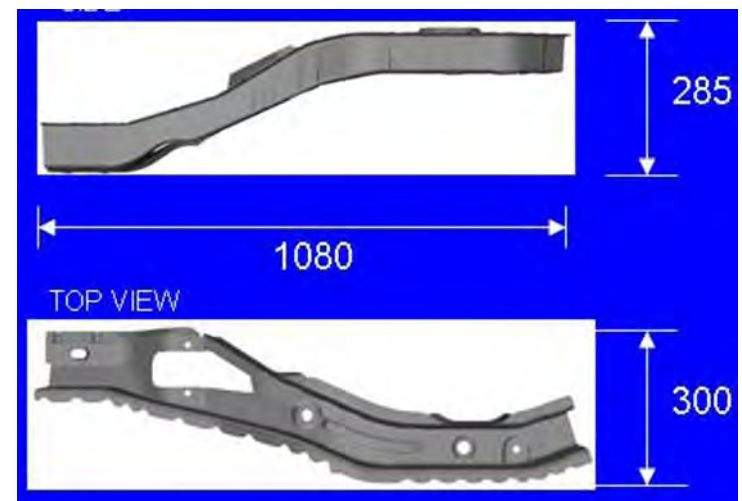


DP600

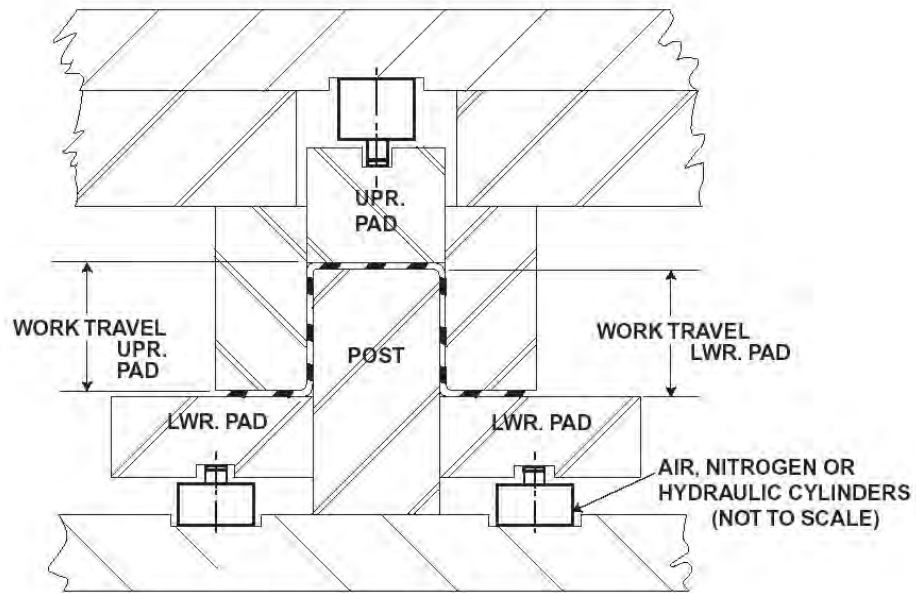


DP780

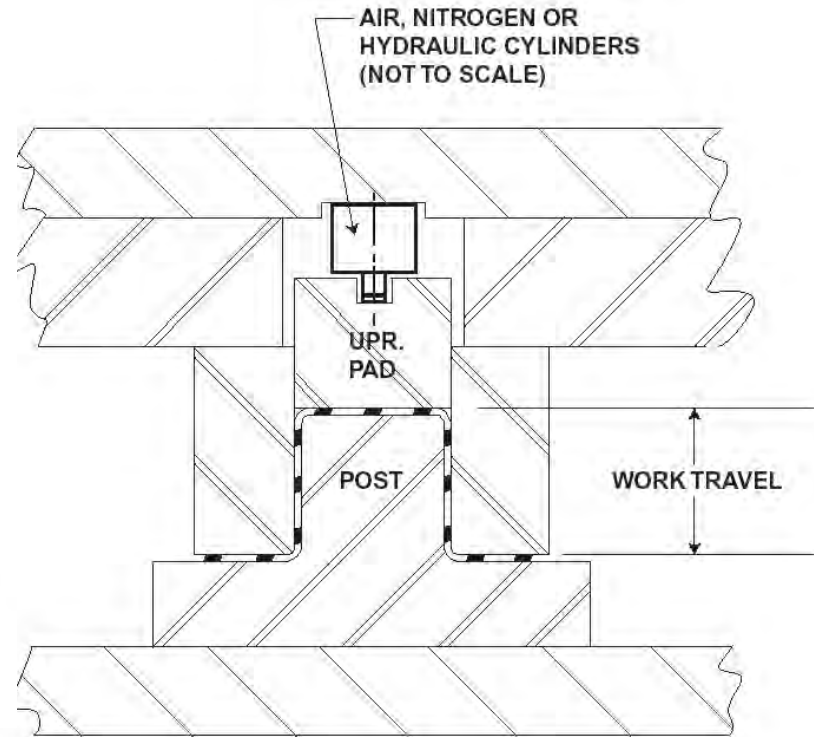
- Parametric study on material and process variables
 - 2.2mm DP600 and 1.6mm DP600
 - 1.6mm DP600, DP780, DP980
 - Processes
 - Draw action (upper and lower pad)
 - Part on post
 - Part on binder
 - Requires delayed return binder
 - Form die with upper pad (developed blank)
 - Binder and pad force
- Part on Binder produces less springback than Part on Post. However, Part on Post produces less twist in case of 2.2mm DP600.
- In general, form die with upper pad produces less springback than draw action. However, form die with upper pad produces more twist than draw action in case of DP600.



DAIMLERCHRYSLER REAR RAIL – PROCESS EFFECTS



Draw Action (Upper
and Lower Pad)



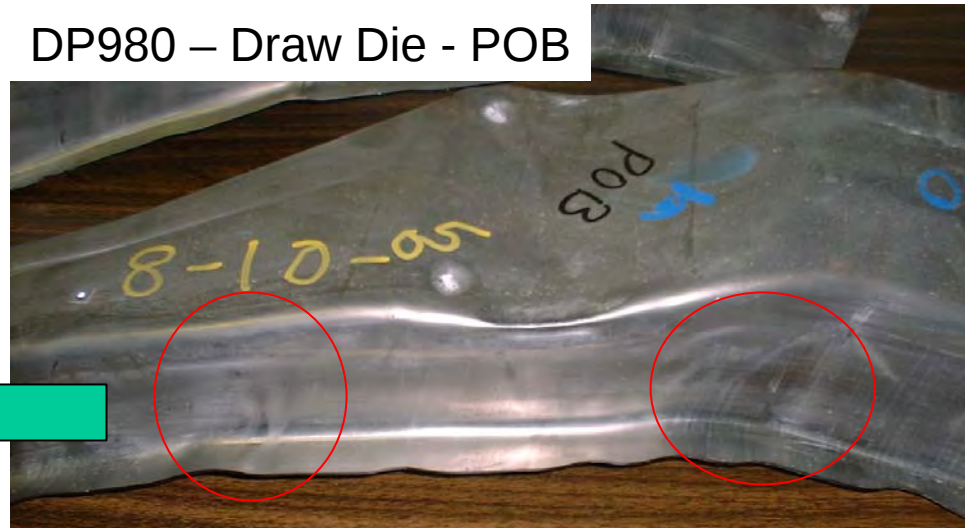
Form Die (with Upper Pad)

DAIMLERCHRYSLER REAR RAIL – PROCESS EFFECTS

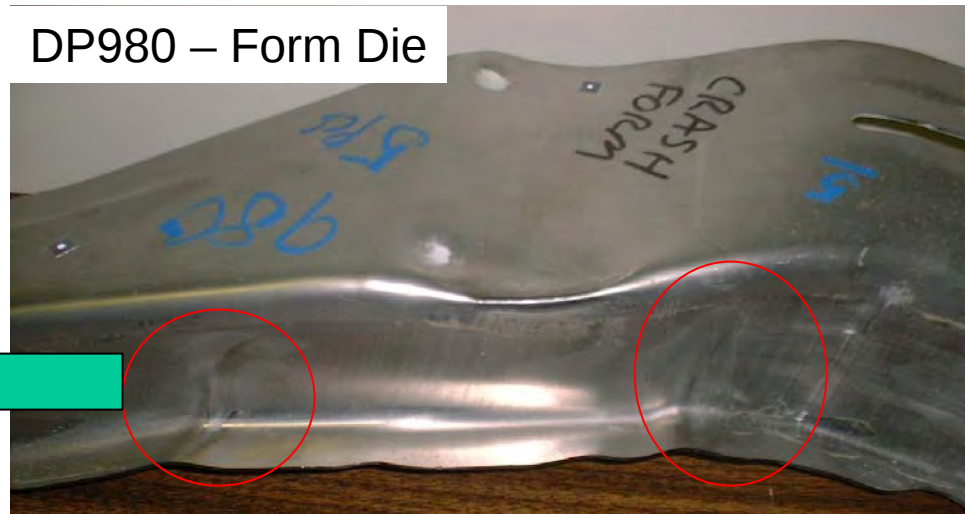
- However, more wrinkling was observed in form die process than draw form (part for part)
- Wrinkling can influence part acceptability



DP980 – Draw Die - POB

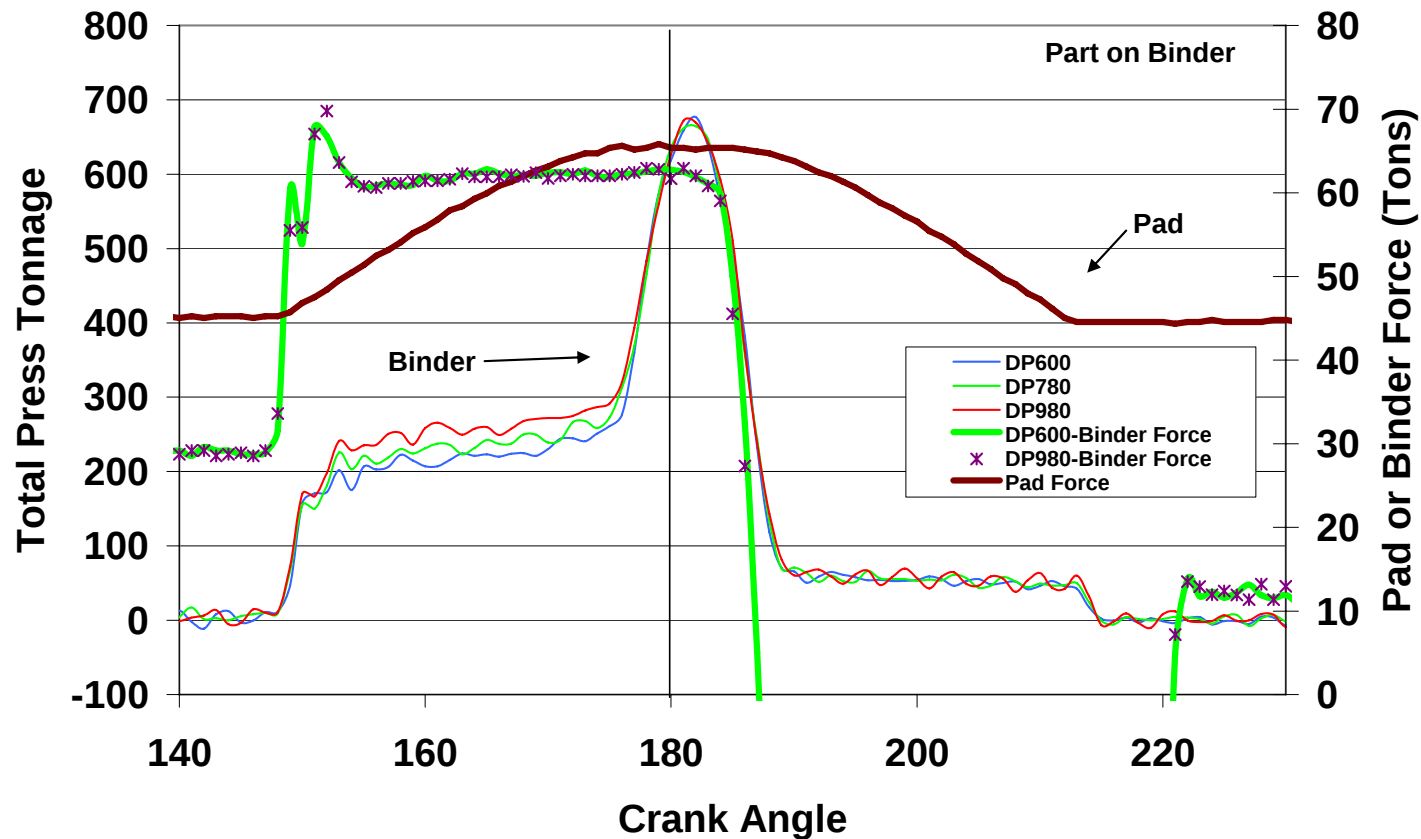


DP980 – Form Die

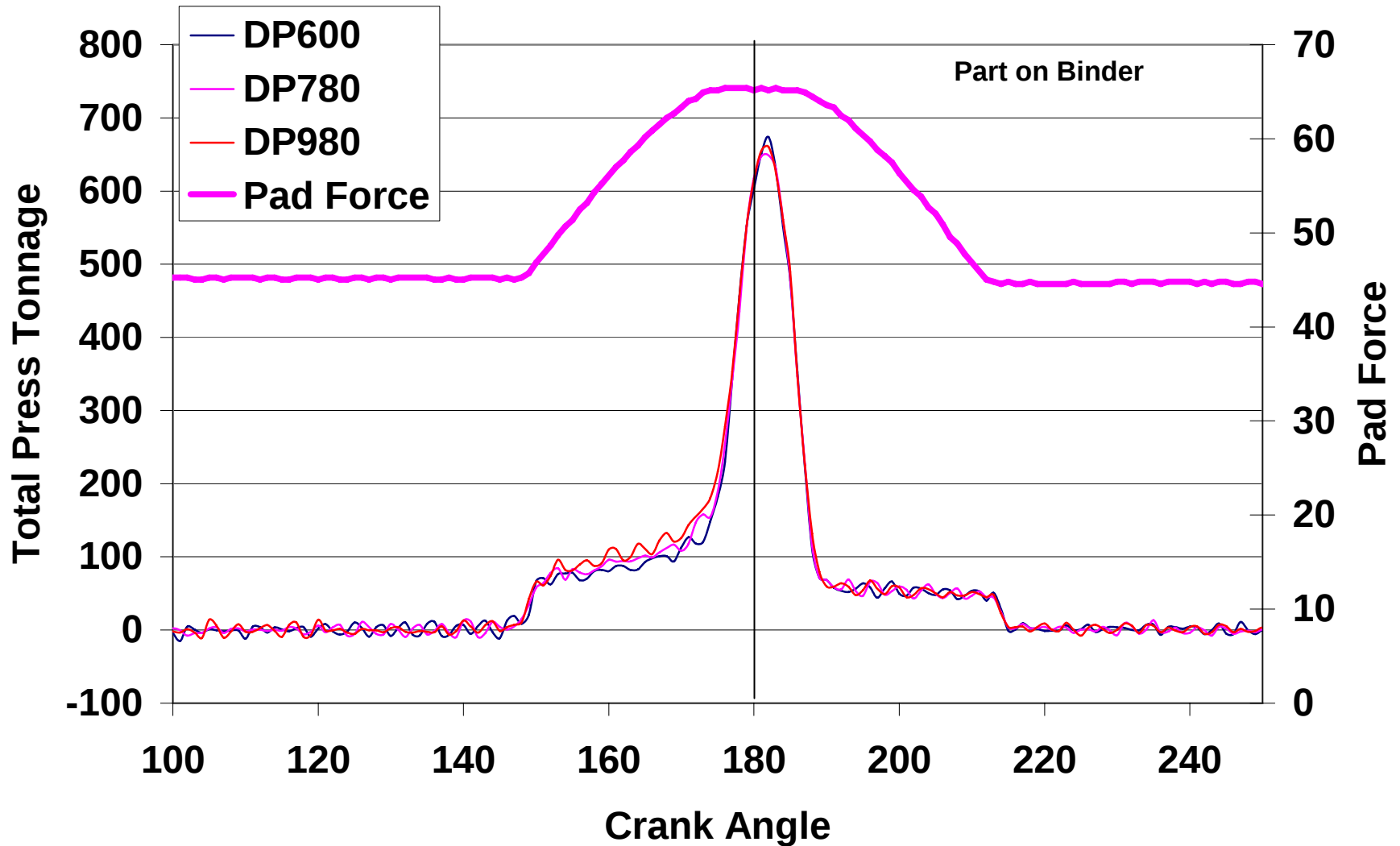


- Minor increases in forming tonnage were observed with increasing material strength
- Increased binder force can drive increased press tonnage requirements

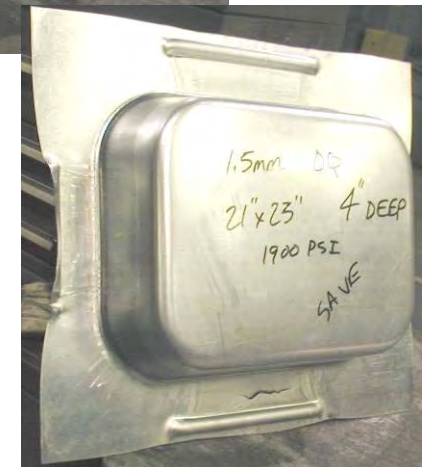
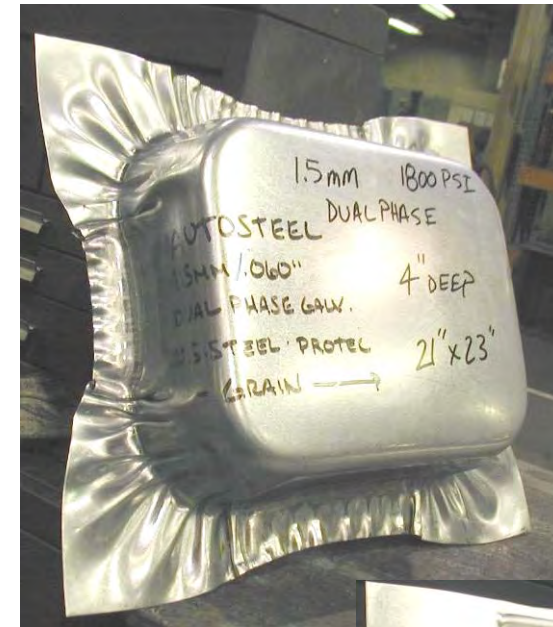
Press Tonnage - 66 Ton Pad - 63 Ton Binder



Press Tonnage - 66 Ton Pad - Form Process



- However, significantly higher binder forces needed to control wrinkling with AHSS
- This effect CAN push press capacity!



Ford cowl crossmember

Parameters Studied



- Form die (with upper pad) vs. Draw form (upper and lower pad) (compare against toggle draw production parts).
 - Part quality
 - Potential materials savings
 - HSLA 350, DP 600, DP 780, and DP 980 (production part DP 600).
 - Press tonnage effects
- (data currently being summarized and examined)

- GM – B Pillar

MATERIALS

GM3399M-ST-S CR 780T/420Y Dual Phase

GM3399M-ST-S CR 980T/550Y Dual Phase

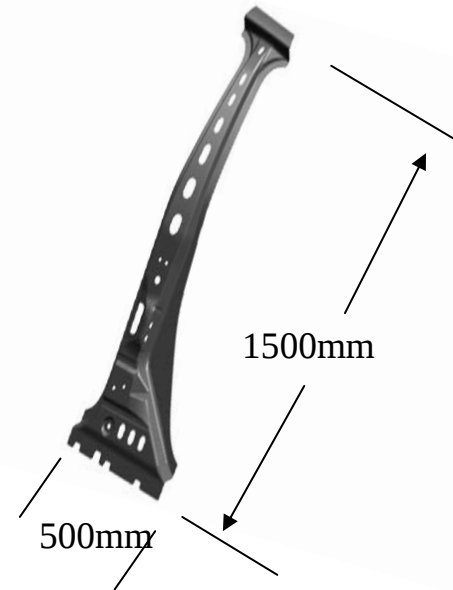
Gauge range 1.2mm – 1.5mm

Approximate Parameters:

Binder Travel - 95mm

Binder Tonnage – 80 Tons

Forming Tonnage – 300 Tons



- Based on current work, material strength has largest effect on dimensional deviation (springback, curl and twist)
- Part features can help reduce springback and curl
 - Sidewall beads
 - Plan view shape
- Process features can help improve dimensional control
 - Post-form stretch
 - Form-die (upper pad process)
 - May not be feasible due to wrinkling
 - May not control twisting
- Draw-form process can help minimize wrinkling,
 - Drives increased press tonnage requirements
 - Drives increased springback and curl (with current process capability) – post form stretch highly desirable
 - Drives increased material use
- Current evaluated processes are not adequate for robust performance with AHSS materials. More development work needed