A New Hybrid Bead with Post-stretching Method to Effectively Control Spring-back for Advanced High-Strength Steel

Yu-Wei Wang, AK Steel Corporation

Auto/Steel Partnership

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Name	Company
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Y. Shen	Ford Motor Company
C. Roman	GM
W. Sun	Nucor Corporation
J. Catterall	A/SP

Problem: Spring-back in Manufacturing

- How to Control it? Stretch it!

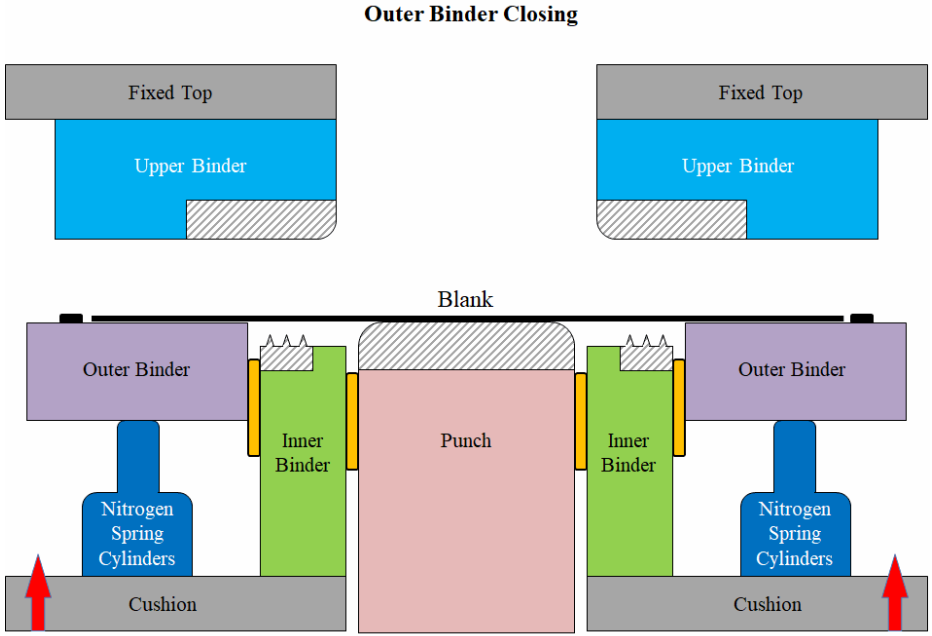
- How to Stretch it? Clamp it!
  - Hybrid beads

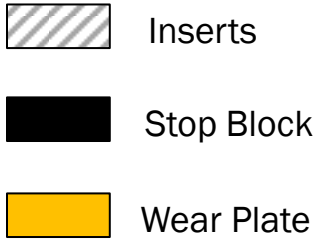
Solution: Post-stretching

- **Phase 1 Lab-scaled Hybrid Bead Development**
  - U-channel Lab-scaled Hybrid Bead Die Concepts
  - Hybrid Bead Design Based on Finite Element Simulations
  - Test Die, Results and Analysis
  - Advantages and Conclusions
- Phase 2 (Hat Section Rail Die): Production-Scale Application Study
- Phase 3 High Volume Production Robustness Study

U-channel Lab Scaled Die Design

- A U-channel die was designed and manufactured to implement the Clamp-Stretch concept.
- A clamp hybrid bead was developed and applied to clamp the blank.
- Multiple conceptual inserts were designed.





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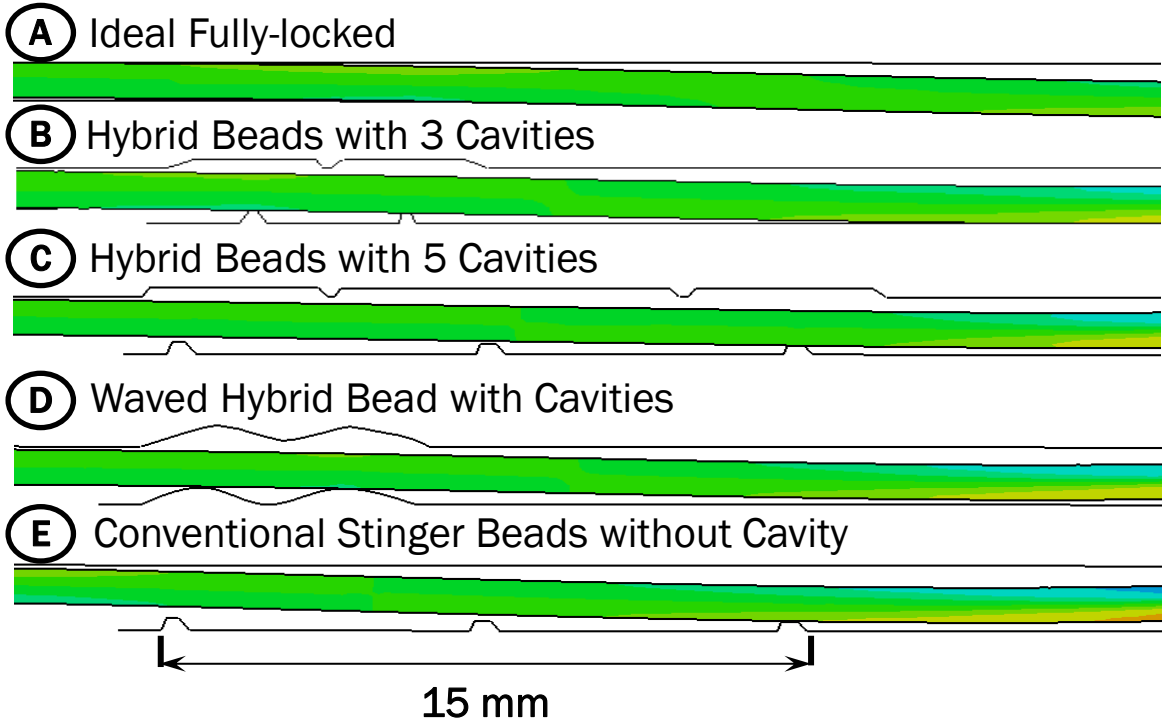
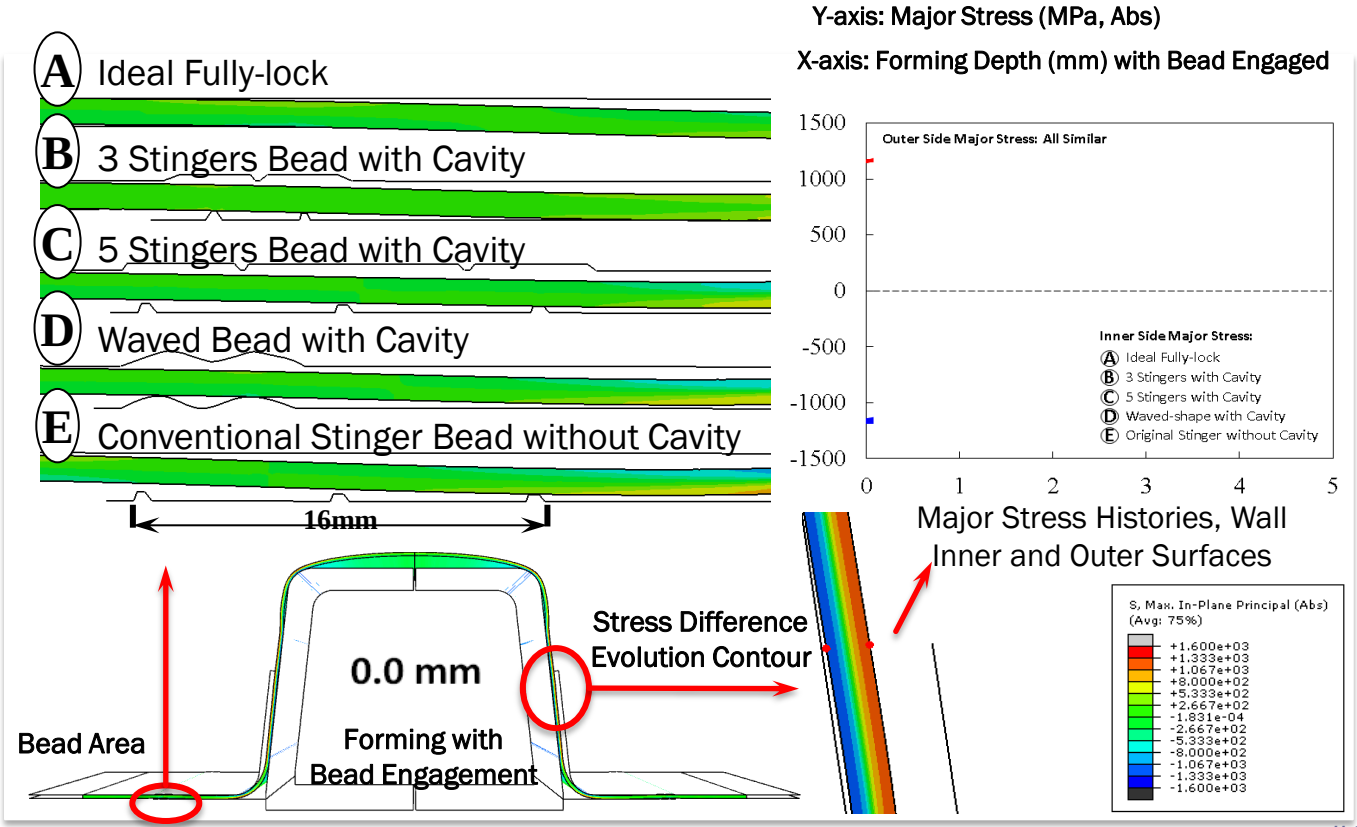
Hybrid Bead Design with FE Simulation

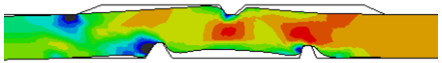


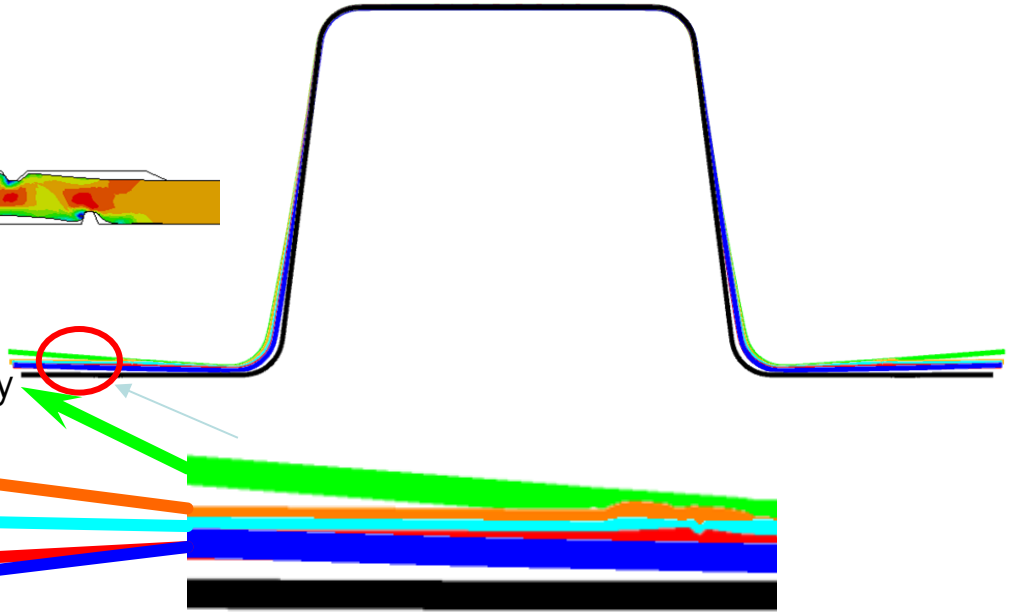
Hybrid Bead Design for Effective Stretch



Hybrid Bead Design with FE Simulation

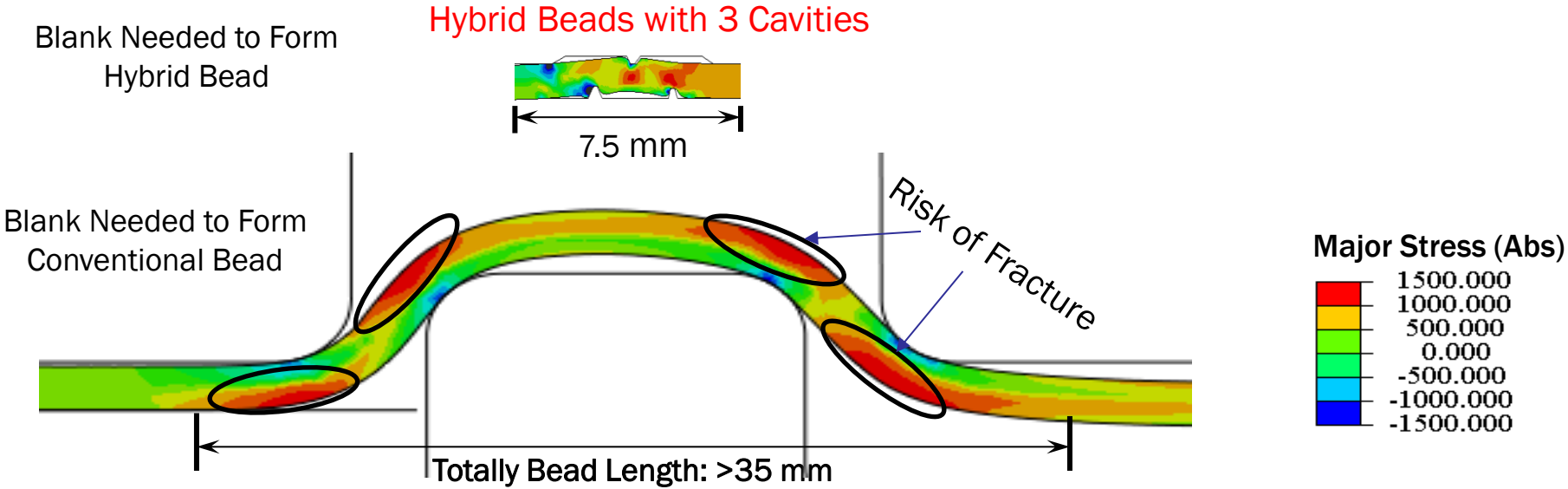
- Spring-back behavior was simulated and winner is … Design B: Hybrid Beads with 3 Cavities! with least Springback





Preferred Hybrid Bead Design

- Synergistic effect of both wave-shaped bead forming and teeth penetration.
- Material Saving: 78%, with reduced risk of fracture in bead forming vs. traditional draw bead.
- Lower risk of fracture at bead



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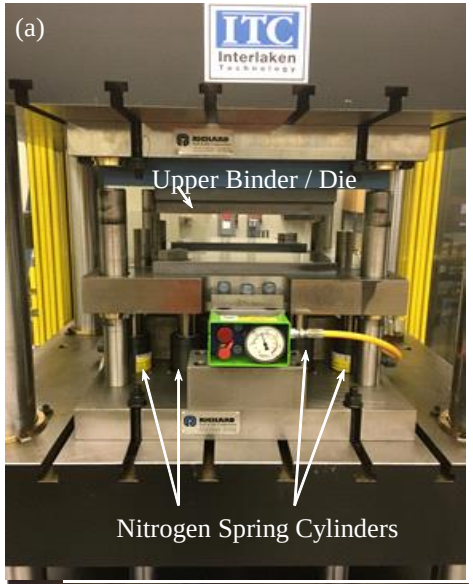
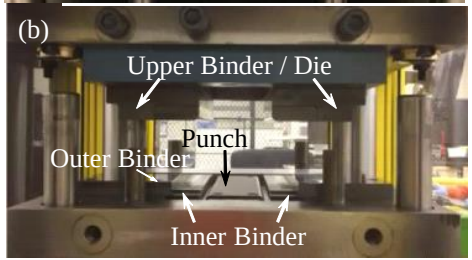
U-channel Die

- The die was installed in a Servo Press to stamp U-channel parts.
- The parts were successfully stamped as the FEA predicted.





Test Results: Great Springback Control

Part Geometry without Post-stretching (top)

vs.

Part Geometry with Post-stretching (bottom)

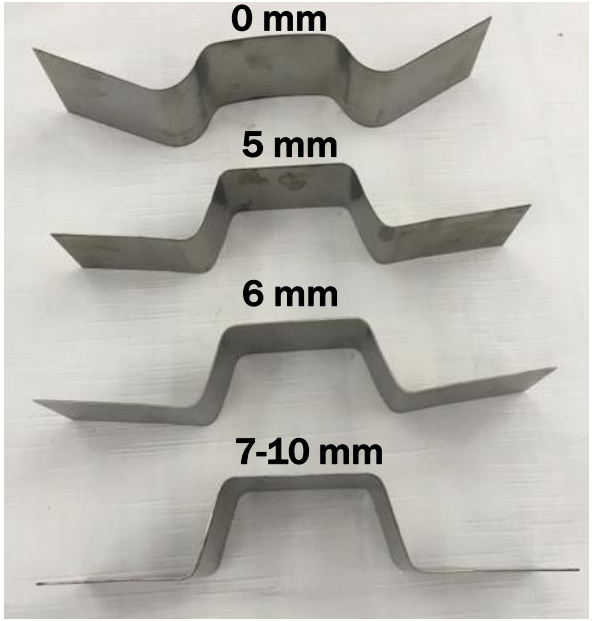
Top view

Front view

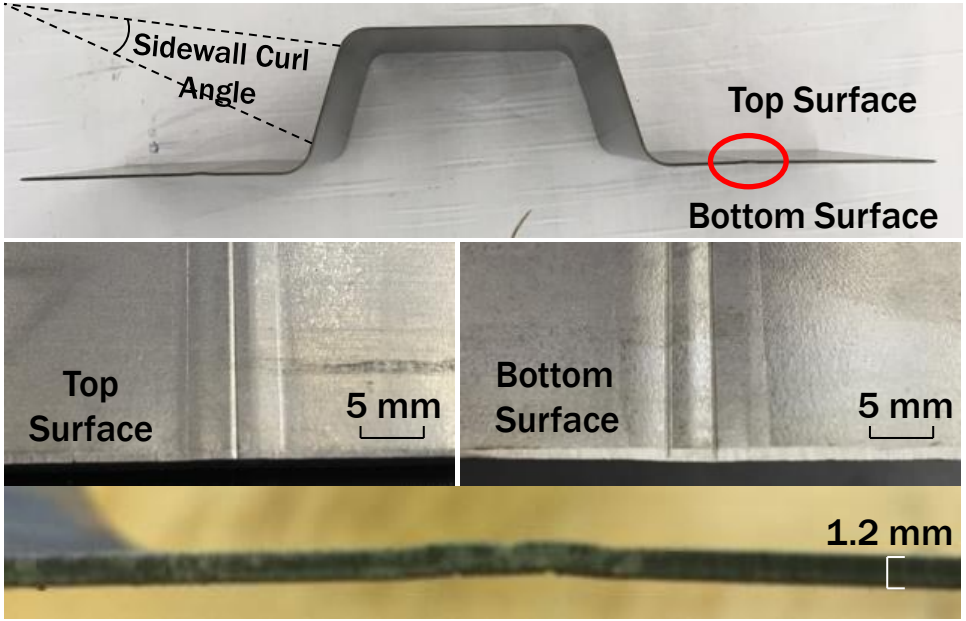
U-channel Die: Test Results

U-channel Die Test Results

- **Excellent spring-back control** was achieved with successful clamping
- DP980, CP1180, 3rd Gen. 1000 MPa, 1200MPa



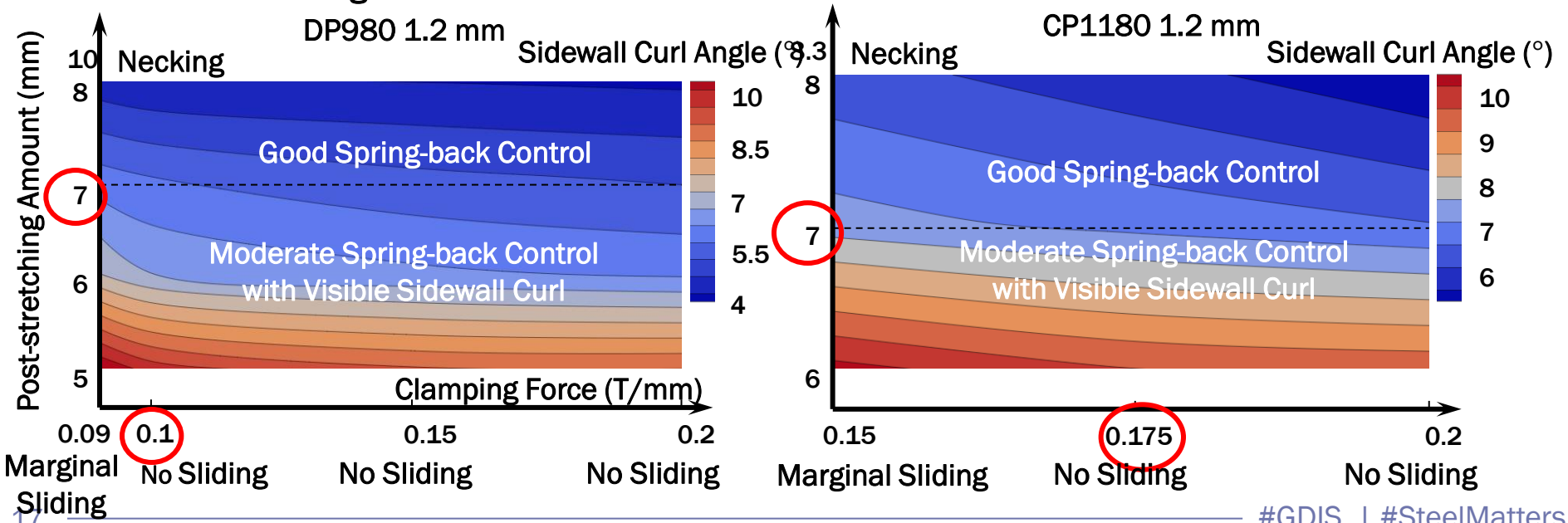
Effect of Post-stretching Amount



Hybrid Bead: **No Material Sliding**

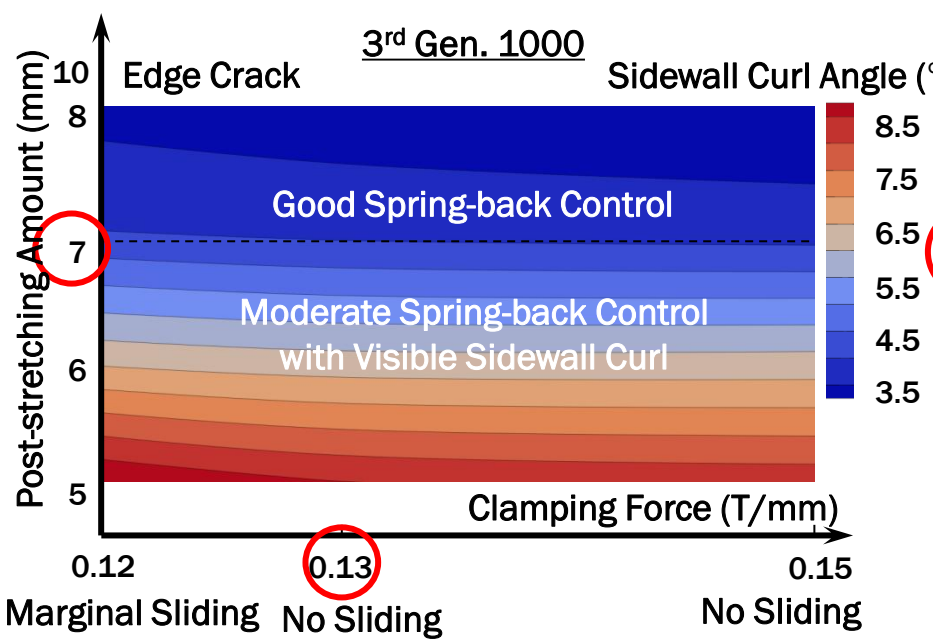
Post Stretch / Clamping Force vs. Springback

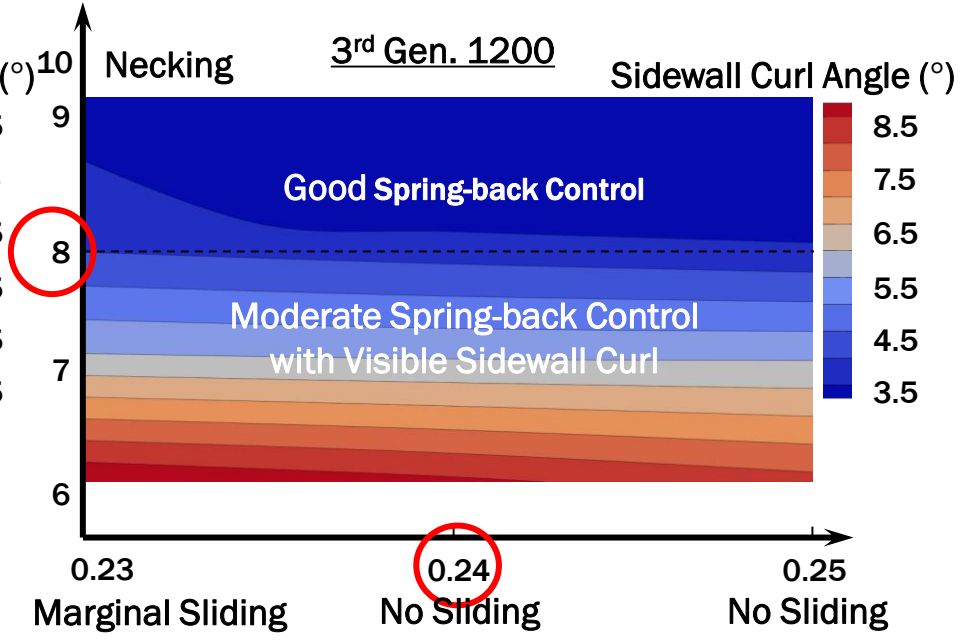
- Achieved excellent spring-back control
- Minimal tonnage requirement - significantly reduced the clamping force to 0.1T/mm for DP980 (50%), 0.175T/mm for CP1180 (12.5%)
- Post-stretching amount to 7 mm.



Post Stretch / Clamping Force vs. Springback

- Significantly reduced the clamping force to 0.13T/mm (3rd Gen. 1000 MPa), 0.24T/mm (3rd Gen. 1200 MPa)
- Stretching amount 7 mm (3rd Gen. 1000 MPa), 8 mm (3rd Gen. 1200MPa).





Hybrid Bead: Capable and Strong

Strong, Robust Hybrid Bead performance, Excellent performance of resistance to failure

.

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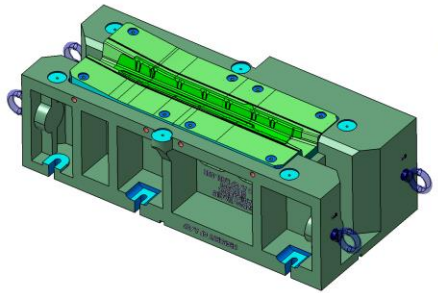
Advantages and Conclusions

- Comprehensive Spring-back Control
  - Excellent Synergistic Clamping Effect in Lab Trials.
- Material savings: 78% flange reduction
  - For Shotgun Panel, 15% less of part blank.
- Lower risk of fracture at bead
  - No bending over tight bead radius and related potential fracture.



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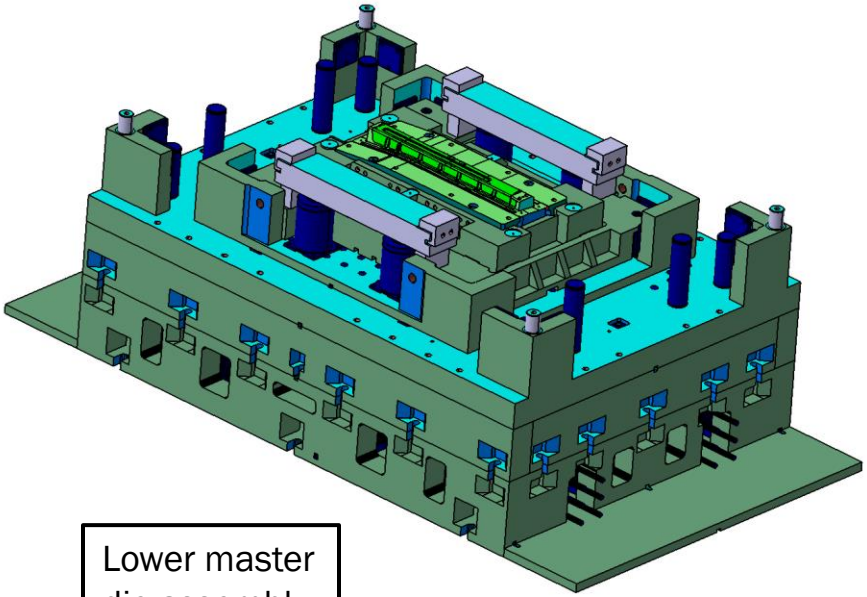
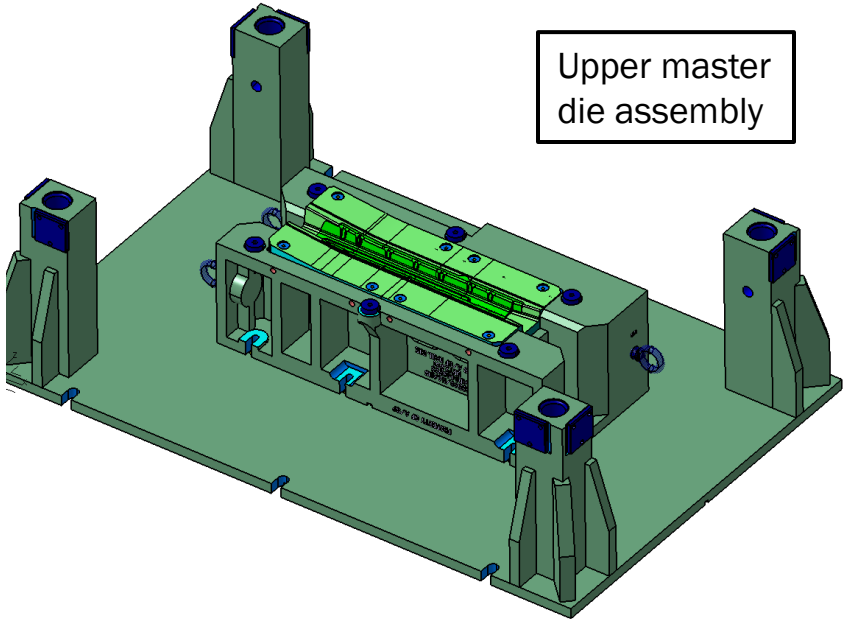
Phase II: Production Scale Application

- Hybrid Beads are being implemented on a production scale die at AutoDie LLC



Lower master die assembly



Upper master die assembly

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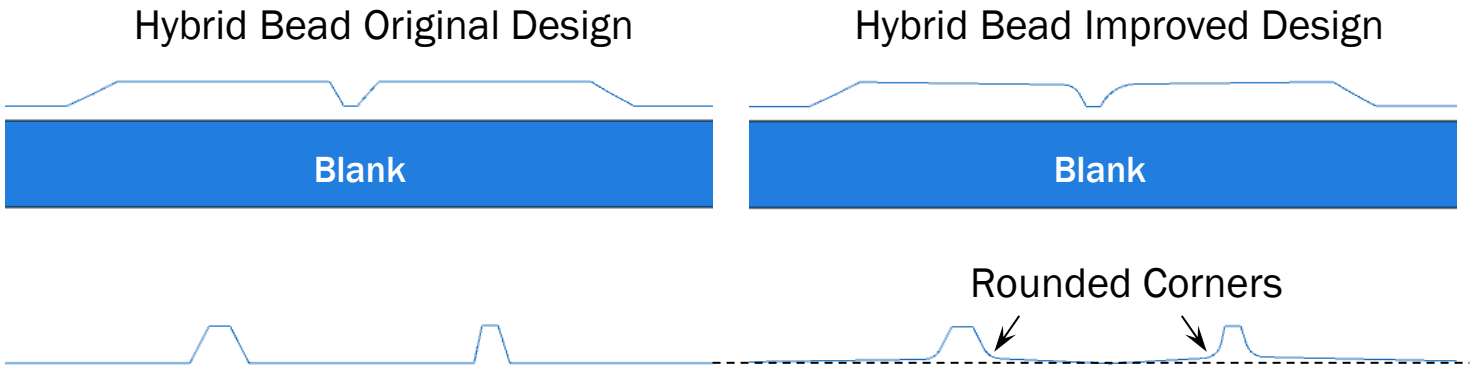
- **Phase 3 High volume production robustness study**

Phase 3 High Volume Production Robustness

- **Bead Profile Optimization**
  - Rounded corners and small ramps were added to reduce the stress concentration
  - New Profile Design: FEA is underway to assess bead designs
- **Surface Treatment**
  - Laser Cladding of hard carbide powder to improve teeth durability Synergy Additive Manufacturing LLC (SAM)

Improvement of Bead Robustness

- Rounded corners and small ramps were added to reduce the stress concentration of the bead.
- Outstanding performance of clamping.



For More Information

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