Improved Materials and Powertrain Architectures for 21st Century Trucks

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IMPACT Project

Outline

- Introduction
- System Descriptions
  - Body
  - Chassis & Frame
  - Pickup Box
- Selected Lessons Learned
- Conclusion
INTRODUCTION

• IMPACT was a multi-phase joint project among:
  – Ford Motor Company
  – American Iron & Steel Institute
  – U.S. Army
  – University of Louisville
  – Mississippi State University
I.M.P.A.C.T.

Improved Materials and Powertrain Architectures For 21st Century Trucks

PHASE I
"Analysis"
Method for comparing weight reduction opportunities for different metals and analysis

Technology Implementation and Platform Demonstration Vehicle

PHASE II
Based on a full size truck.

Expand the portfolio of Weight Reduction Technologies and CASCADE to other truck platforms.

PHASE III
“Cascade to other trucks”
Targets & Approach

• By default, the targets were to meet baseline system performance.

• In some cases, the team was challenged to improve performance while reducing weight.

• System level degradation was allowed if vehicle level performance was unaffected.

• CAE-led parallel system level optimization followed by full vehicle verifications.
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IMPACT Phase II – Cab Structure

- Structural adhesives to recover stiffness
- DP600 rocker and 3 floor cross-members
- TWB for body side outer and C-pillar
- Magnesium radiator support
- 20% Weight Savings
Phase III CAB Underbody

- Phase II had limited architectural changes
- Phase III allowed complete architectural optimization
- DP600 cross members
- DP600 longitudinal members
- Improved stiffness & durability
- 10% weight savings
Phase III Front End

- Stamped DP600 shotgun with design changes for stamping feasibility (30% weight reduction)
- Stamped DP500 EG Fenders (20% weight reduction)
- Initiated hydroformed front end design for further design and package optimization
Chassis & Frame

- Phase II included some alternate materials (aluminum cross-members, knuckles, & LCAs)
- However, cost and durability considerations made steel the lead choice in Phase III.
- In Phase III:
  - HR DP600 frame side rails
  - HR DP600 cross-members
  - Higher durability targets
  - 10% overall weight savings
Transmission Cross Member

Baseline Design (27 kg)
HSS Transmission Cross Members
Hydroformed & Clam Shell Design

- 28% Weight Reduction
- No overlapping flanges reduces weight.
- 70% less MIG welding required.
- Eliminates one set of dies (1 part).
- Plate reinforcement to improve stiffness.

<table>
<thead>
<tr>
<th></th>
<th>Mass (kg)</th>
<th>Freq. (Hz)</th>
<th>Bracket Gages (mm)</th>
<th>Center Gage(s) (mm)</th>
<th>Static Stiffness (N/mm)</th>
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</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>27</td>
<td>217</td>
<td>5</td>
<td>3.5</td>
<td>x: 2767, y: 5405, z: 3665</td>
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<tr>
<td>Hydroformed</td>
<td>19.5</td>
<td>250</td>
<td>3.5</td>
<td>3.2</td>
<td>x: 2653, y: 4037, z: 2896</td>
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<tr>
<td>New Clam</td>
<td>19.7</td>
<td>250</td>
<td>3.6</td>
<td>3</td>
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<tr>
<td>New Clam with 3 mm Reinf.</td>
<td>20.9</td>
<td>250</td>
<td>3.6</td>
<td>3</td>
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</tbody>
</table>

| Percent Increase | 48%        | 38%        | 31%                  |

Stripes represent different gages at different levels of expansion.

3 mm Plate Reinforcement

t = 2.56 mm (20% expansion)
t = 3.2 mm (0% expansion)
Phase III Pickup Box

- DP600 rollformed floor
- DP700 rollformed cross-members (‘Z’ cross-section vs. hat section)
- DP500 EG box outers
- Lower investment & variable cost vs. stamped alternative
- 20% weight savings
Phase III Tailgate

- Addition of DP700 2nd strainer
- DP500 EG inner with design changes for stampability
- DP500 EG outer
- Improved performance
- 25% weight savings
Phase III Tailgate

Formability Index Contour of 0.7 mm DP500 Steel
For Tailgate Inner

Formability Index Contour of 0.7 mm DP500 Steel
For Tailgate Outer

wrinkles
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Considerable weight reduction can be achieved without cost increase.
Step Up & Save Strategy

45 lb. Mass Savings
$7.37 Cost Savings

Grade step-up and gage reduction strategy may be used with existing tooling.
NVH performance loss due to stiffness reduction may be recovered through vehicle level root cause identification and optimization.
The IMPACT Project delivered:

- Extensive CAE modeling to drive weight efficient designs.
- A technology road map to achieve 25% weight reduction.
- Fully functional vehicles that demonstrated compatible attribute performance.
- An application map for steel grade usages throughout body/chassis structures.