GREAT DESIGNS IN STEEL

EFFICIENT STEEL BUMPER BEAM DESIGN

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EFFICIENT STEEL BUMPER BEAM DESIGN

AGENDA

1. Identify Requirements
2. Material Selection – Start with Steel
3. Case Study – Roll Form Steel vs. Aluminum

EFFICIENT STEEL BUMPER BEAM DESIGN

1. Identify Requirements
   A. Low Speed Impacts
   B. High Speed Crashworthiness
   C. Pedestrian Protection

EFFICIENT STEEL BUMPER BEAM DESIGN

1. Identify Requirements

A. Low Speed Impacts
   1. Regulatory – must meet – 2 regulations globally
      a. FMVSR 581 – US/Canada
      b. ECE R42 – China/Korea/Gulf States/Canada
   2. Consumer Metrics – competitive decision
      a. RCAR Bumper Test – Override/underride – 10 kph
      b. RCAR Structure Test (Danner) – 40% offset – 15 kph

Main Focus – Design Geometry to meet requirements efficiently

EFFICIENT STEEL BUMPER BEAM DESIGN

1. Identify Requirements

B. High Speed Impacts – Dependent on country of sale

1. Regulatory

   Note: US – 70% offset rear barrier – 80 kph

2. Consumer Metrics

   a. IIHS - US

      1. 40% Offset Barrier – 65 kph
      2. 25% Small Overlap Frontal – 65 kph

   b. EuroNCAP

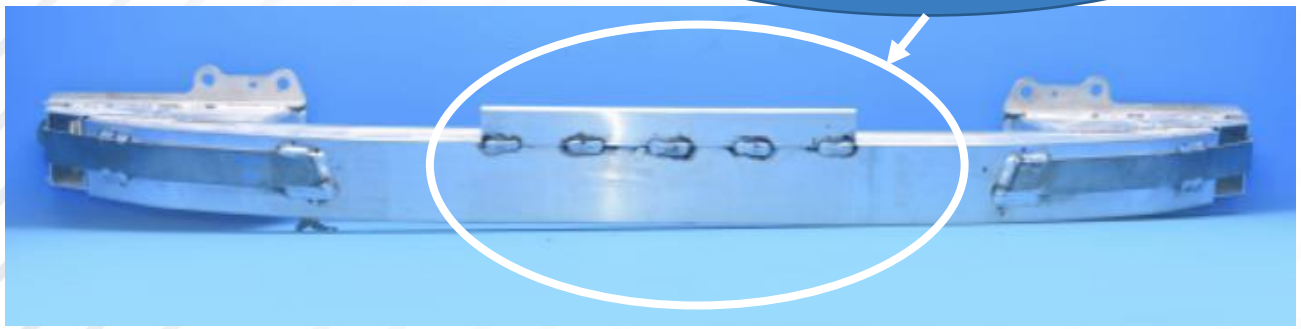
      - Mobile Progressive Deformable Barrier
      - 50% overlap – 50 kph

Higher loads in high speed crash and additional mass of BEV creating need for stronger Bumper Beams.

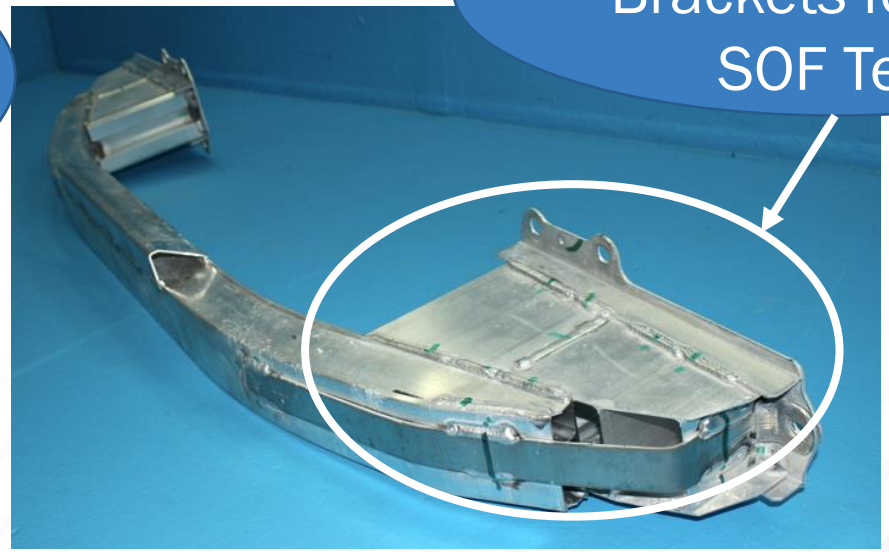
EFFICIENT STEEL BUMPER BEAM DESIGN

Requirements Drive Bumper Beam Design

Center Reinforcement for RCAR Override Test



Crush cans and Brackets for IIHS SOF Test



Examples of design geometry to meet Low and High Speed Requirements.

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1. Identify Requirements

A. Low Speed Impacts

B. High Speed Crashworthiness

C. Pedestrian Protection

Result: Initial design for vehicle packaging and CAE analysis.

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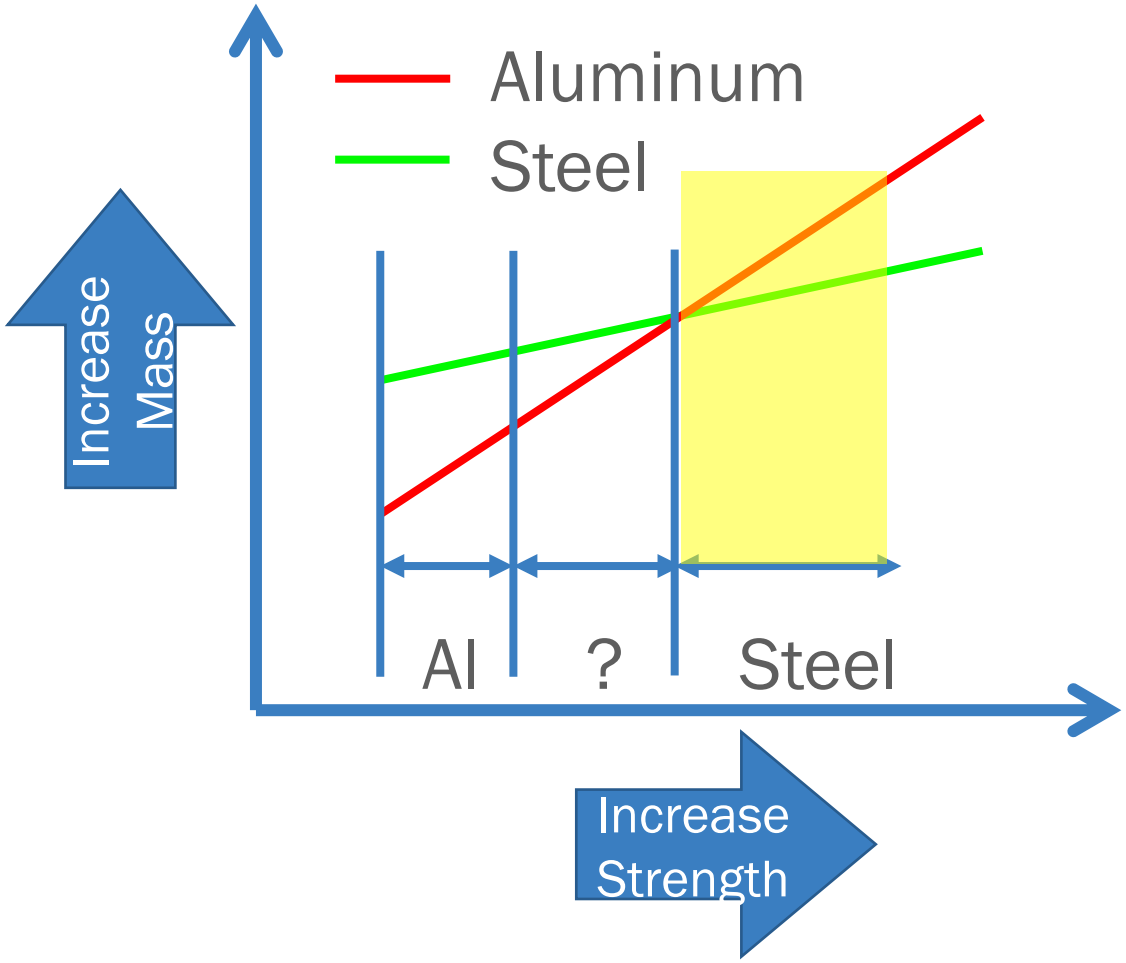
2. Material Selection – Reasons to Start with Steel
   - Availability of Ultra High-Strength Steel – globally
   - High Strength to weight capability
   - UHS Steel ability to withstand high loads in high speed crash

EFFICIENT STEEL BUMPER BEAM DESIGN



EFFICIENT STEEL BUMPER BEAM DESIGN

2. Material Selection – Start with Steel
   - Availability of Ultra High-Strength Steel – globally
   - High Strength to weight capability
   - UHS Steel ability to withstand high loads in high speed crash
   - Lowest Cost versus aluminum or plastic
   - Preferred material selection in industry globally
     - Study of mid-size car bumper beams – front and rear

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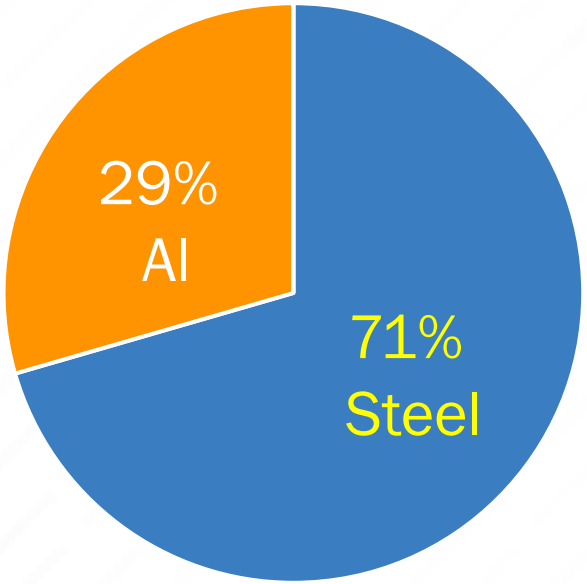
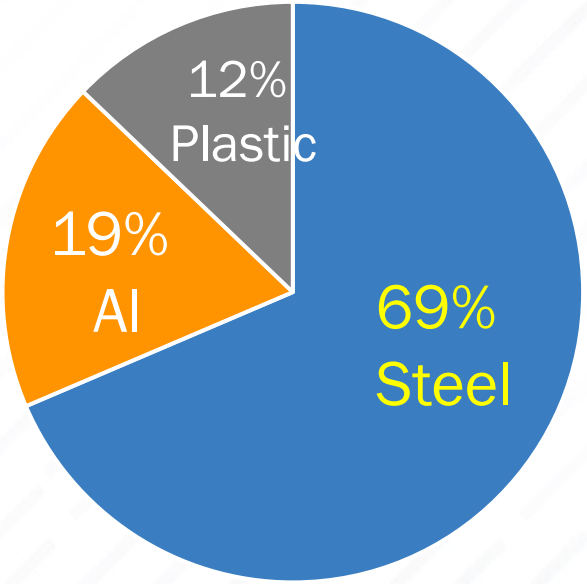
Bumper Beam Material

Front



Rear



Steel is the material of choice for bumpers – approx. 70% market

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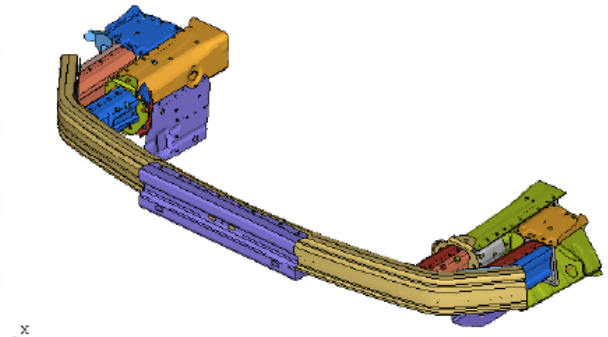
3. Case Study – Roll Form Steel vs. Aluminum

Comparison of Engineered Cost and Mass of:

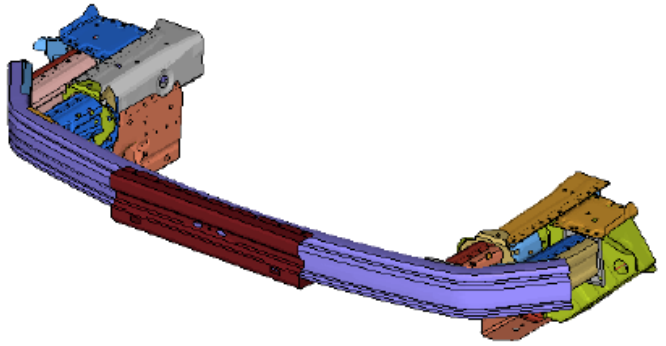
1. Extruded Aluminum – Production Part
2. Hot Form Steel Design – optimized by computer FEA
3. Roll Form Steel Design – optimized by computer FEA

Extruded Al

Hot Form Steel



Roll Form Steel



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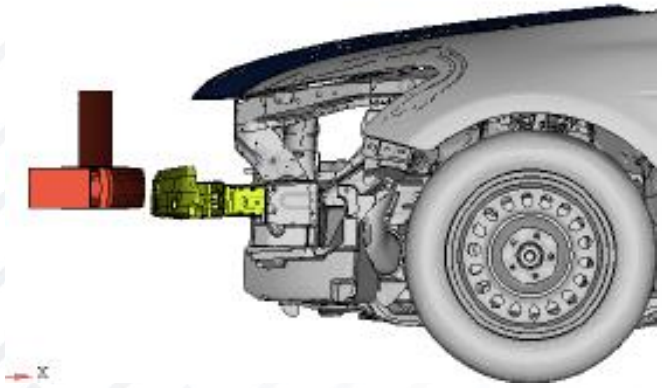
3. Case Study – Roll Form Steel vs. Aluminum

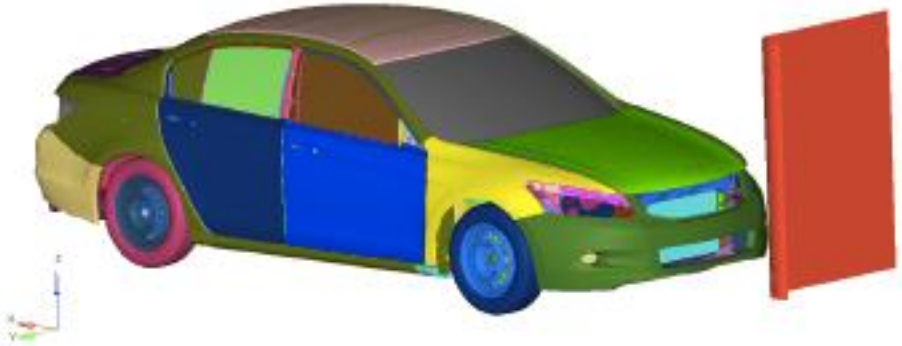
Requirements

1. Low Speed - RCAR Bumper Test – 100% overlap @ 10 kph
2. High Speed - IIHS Small Overlap Frontal – 25% overlap @ 64 kph

RCAR Bumper Test



IIHS Small Overlap Frontal



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3. Case Study – Roll Form Steel vs. Aluminum

Beam Mass Comparison

	Beam Mass (kg)	Difference (kg)
#1 Aluminum	4.0	
#2 Steel Hot Form	4.3	+0.3
#3 Steel Roll Form	4.2	+0.2

Goal: Reduce the mass of Steel Beams

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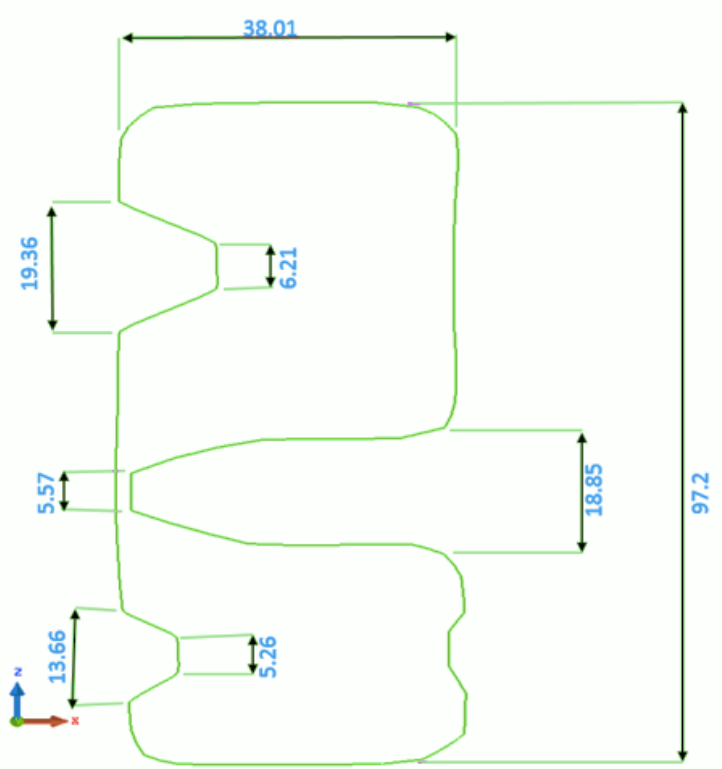
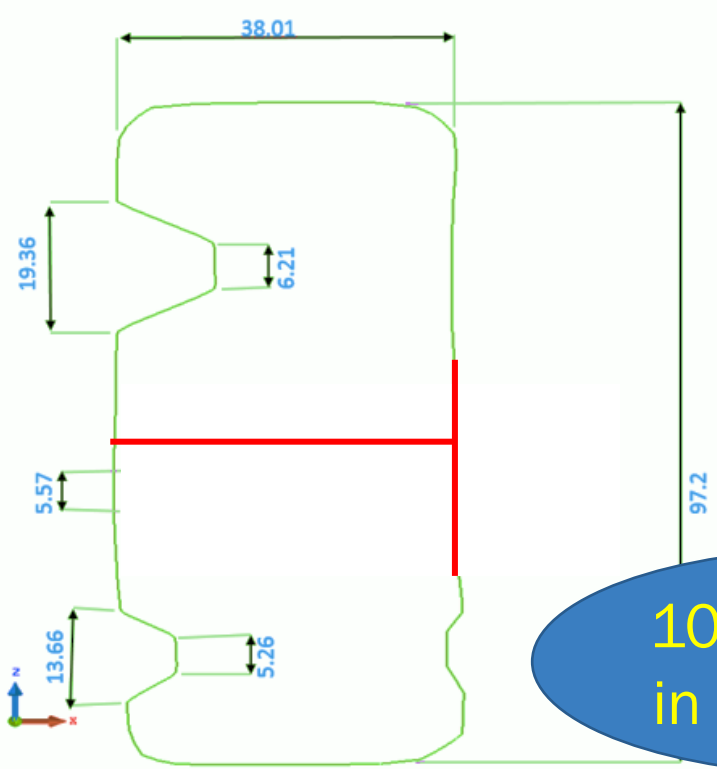
Case Study



Proposal



10% reduction in Beam mass

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3. Case Study – Roll Form Steel vs. Aluminum

Proposed Section Mass Comparison – 10% reduction

	Beam Mass (kg)	Reduce Beam by 10% (kg)	Diff (kg)
#1 Aluminum	4.0	Base	
#2 Steel Hot Form	4.3	3.9	-0.4
#3 Steel Roll Form	4.2	3.8	-0.4

Steel has technology to save mass over Al on Beams

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Conclusions

- Increasing High Speed Crash requirements creates a need for higher strength Bumper Beams.

- Higher mass Battery Electric Vehicles are creating additional performance requirements for bumper beams in high speed crash.

- Ultra-high strength steel enables stronger Bumper Beams at lower mass and lower cost.

FOR MORE INFORMATION

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