2019 Chevrolet Silverado
Structure Review
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General Motors Company
VEHICLE INTRODUCTION

// Vehicle Overview
// Mass Reduction Strategy
// Material Utilization
// Frame Design Features
// Cab Design Features
// Bed Design Features
2019 CHEVROLET SILVERADO

ALL-NEW DESIGN
2019 CHEVROLET SILVERADO

BOLD SHAPE HIGHER AND TALLER
WHEELS MOVED FORWARD
SHORTER FRONT END
2019 CHEVROLET SILVERADO

4" LONGER WHEELBASE
1.5" LONGER OVERALL
2019 CHEVROLET SILVERADO

MORE PASSENGER VOLUME
MORE CARGO VOLUME
2019 CHEVROLET SILVERADO

LARGER CABS
MORE COMFORTABLE SEATING POSITIONS
2019 CHEVROLET SILVERADO

7% INCREASE IN AERODYNAMIC EFFICIENCY
ALL-NEW DURAMAX
3.0L INLINE-SIX DIESEL
WITH 10-SPEED TRANSMISSION
SILVERADO’S UPGRADED 5.3L AND 6.2L V8

PROGRAM OBJECTIVES

MAINTAIN PROVEN SMALL BLOCK ARCHITECTURE

IMPROVE OPERATING EFFICIENCY AND FUEL ECONOMY

EXPAND AND IMPROVE AFM

MAINTAIN LEGENDARY SMALL BLOCK PERFORMANCE AND DURABILITY
INDUSTRY-FIRST
DYNAMIC FUEL MANAGEMENT

AFM IS PROVEN METHOD TO REDUCE PUMPING WORK & IMPROVE FUEL ECONOMY

DFM ADDS CYLINDER DEACTIVATION CAPABILITY ON EVERY CYLINDER

ONLY USE THE CYLINDERS YOU NEED – OPTIMIZES EFFICIENCY

N & V REFINEMENT
2019 CHEVROLET SILVERADO MASS STRATEGY

/ Increased use of UHSS / AHSS / HSLA materials in the cab, higher HSLA grades in the bed and frame
  — Multi-disciplinary optimization of the steel structure for the greatest possible mass reduction
  — Best balance of mass reduction and piece cost
  — Maintains the existing manufacturing base

/ Aluminum closures
  — Easily integrated into the existing manufacturing base
  — Acceptable cost increase for mass reduction

/ Disciplined part design: scalloped flanges, lightening holes, no extra metal, etc.

/ Integral front structure v. previous structural fender or hydroformed options

/ Frame mount designs revised for improved NVH and durability

/ Aggressive redesign of the upper body structure for mass reduction
Multi-disciplinary optimization CAE procedures were utilized in the development of the cab and frame.

Three distinct cycles were completed with differing objectives:
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- Topological to determine the best load paths
2019 CHEVROLET SILVERADO MASS STRATEGY

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  - Shape optimization to establish the most efficient section sizes within the possible design envelopes.
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Three distinct cycles were completed with differing objectives:

- Topological to determine the best load paths
- Shape optimization to establish the most efficient section sizes within the possible design envelopes
- Part specific for gauge and material optimization of the cab and frame

Smaller optimizations conducted on many specific components: grille, door, prop shaft, door mirror patch, rear bumper bracket, etc.
Vehicle level mass reduction of 204.5 kg (crew cab)

Painted cab structure mass reduced by 27.2 kg
- Cab structure mass reduced by 35.6 kg
- Aluminum plenum reduced mass by 6.6 kg
- Liquid applied sound deadener reduced by 1.3 kg
- Increased sealing for corrosion protection and noise control added 8.9 kg

Aluminum closures reduced mass by 42.0 kg
- Doors: 31.9 kg
- Hood: 0.6 kg
- Tailgate: 9.5 kg

Box mass increased less than 1 kg despite size increase.
Frame mass reduced 40 kg
MATERIAL STRATEGY – CAB WITH CLOSURES AND BOX

- Mild Steel
- HSLA and Bake Hardenable
- AHSS
- UHSS
- Aluminum
- PHS

The pie chart shows the distribution of materials:
- Mild Steel: 39.4%
- HSLA and Bake Hardenable: 21.6%
- AHSS: 14.5%
- UHSS: 11.9%
- Aluminum: 7.2%
- PHS: 5.5%
CAB AND BOX MATERIAL DISTRIBUTION
21.6% MILD STEEL
CAB AND BOX MATERIAL DISTRIBUTION
39.4% HSS

High Strength Steels (HSS): BH
High Strength Steels (HSS): HSLA
CAB AND BOX MATERIAL DISTRIBUTION
11.9% AHSS

Advanced High Strength Steels (AHSS): DP
CAB AND BOX MATERIAL DISTRIBUTION

7.2% UHSS

- Ultra High Strength Steels (UHSS): MP
- Ultra High Strength Steels (UHSS): MS
CAB AND BOX MATERIAL DISTRIBUTION
5.5% PHS

Press Hardened Steels (PHS)
CAB AND BOX MATERIAL DISTRIBUTION
14.5% AL

- Aluminum sheets: 5xxx series
- Aluminum sheets: 6xxx series
CAE OPTIMIZATION

/ Mixed materials:
   - Higher strength steel grades
   - Aluminum for the rear lower control arm cross member

/ Advanced manufacturing technologies:
   - Allow the use of the advanced steel grades
   - Increase part optimization opportunities
     / Tailor rolled blanks for the rear frame side members
     / Roll formed front and rear rail tips and mid-rails

/ Design improvements:
   - Spare tire support structure
   - 2 piece clamshell front rail for better material optimization
   - Mid bay cross member
   - Improved integration of crash reinforcements
FRAME MATERIAL UTILIZATION

- **Mild Steel**
- **Aluminum**
- **HSLA**
### FRAME MANUFACTURING PROCESSES

<table>
<thead>
<tr>
<th>Process</th>
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<tbody>
<tr>
<td>Clamshell Bracketry &amp; Weldments</td>
</tr>
<tr>
<td>Roll Form</td>
</tr>
<tr>
<td>Hydroform</td>
</tr>
<tr>
<td>Tailor Rolled Part</td>
</tr>
<tr>
<td>Aluminum Extrusion</td>
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<tr>
<td>Formed Tubing</td>
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</tbody>
</table>
2019 CHEVROLET SILVERADO – INTEGRAL FRONT END

2018 Silverado
Bolted Front Structure

2019 Silverado
Integral, Welded Structure
2019 CHEVROLET SILVERADO – INTEGRAL FRONT END

Mass savings >15% v. previous generation
- Use of stamped/welded structure v. competitors’ tubular hydro-form
- Utilization of thin gauges
  - Robust sealing strategy for corrosion protection
  - Extensive use of structural adhesive to maximize performance
- Geometry optimized for ideal load paths

Enabled many styling opportunities

Strong dimensional capability
## 2019 CHEVROLET SILVERADO – INTEGRAL FRONT END

<table>
<thead>
<tr>
<th>Metric</th>
<th>Welded Aluminum Front Structure (Alternate solution)</th>
<th>Integral, Welded Steel Front Structure</th>
<th>Bolted Structural Fenders (Current production)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass, kg</td>
<td>+</td>
<td>+</td>
<td>Baseline</td>
</tr>
<tr>
<td>Piece Cost, $</td>
<td>+</td>
<td>++</td>
<td>Baseline</td>
</tr>
<tr>
<td>Labor / Vehicle, $</td>
<td>+</td>
<td>+</td>
<td>Baseline</td>
</tr>
<tr>
<td>Cost of Mass Reduction, $</td>
<td>+</td>
<td>+</td>
<td>Baseline</td>
</tr>
<tr>
<td>Vendor Tooling, $ Millions</td>
<td>+</td>
<td>+</td>
<td>Baseline</td>
</tr>
<tr>
<td>Manufacturing*, $ Millions</td>
<td>--</td>
<td>–</td>
<td>Baseline</td>
</tr>
</tbody>
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* Includes Die & Press, Assembly Plant, Containers
2019 CHEVROLET SILVERADO – INTEGRAL FRONT END

Improved dynamic stiffness
/ Out performed competitive benchmark data
/ Allows increased tuning in mount stiffness for better ride and handling
/ Helps to maintain quiet interior cabin

<table>
<thead>
<tr>
<th></th>
<th>Competitor A (Hz)</th>
<th>Competitor B (Hz)</th>
<th>2019 Silverado (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FESM Lateral</td>
<td>20.8</td>
<td>19.4</td>
<td>21.8</td>
</tr>
<tr>
<td>Global Vertical Bending</td>
<td>15.8</td>
<td>18.4</td>
<td>20.9</td>
</tr>
<tr>
<td>Global Torsion</td>
<td>28.5</td>
<td>27.1</td>
<td>29.8</td>
</tr>
</tbody>
</table>
THE LONGEST LASTING FULL SIZE TRUCK ON THE ROAD

/ Corrosion prevention
  – Extensive use of weld through sealer as well as paint shop applied sealer
  – Double sealed flanges to prevent water and contaminants from entering either side of the flange
  – Areas of high exposure have triple sealing to prevent edge corrosion
  – In total, cab sealer and adhesive was increased by 8.9 kg compared prior year
  – Significant addition of structural adhesive for sealing and durability improvement: ~34 m

/ Improved cab sealing enhances corrosion resistance and reduces airborne noise
2019 CHEVROLET SILVERADO – SEALING STRATEGY

/ Motor-compartment is double sealed
   – Adhesive in weld flanges for corrosion protection and increased stiffness
   – Increased paint shop sealer for added corrosion protection

/ Fully boxed out panel overlaps

Surface boxed out with weld through sealer

Paint shop sealer to protect from water intrusion into flange
2019 CHEVROLET SILVERADO – SMALL OFFSET CRASH STRATEGY

1. Early engagement of the barrier by frame components to absorb energy and begin to deflect the vehicle away from the barrier
2. Control wheel kinematics with chassis tuning and body and frame blockers
3. Absorb energy through the frame to body mount
4. Provide strong back up structure in the cab to reduce intrusion
Frame reinforced and braced to increase energy absorption early in the event and create lateral velocity

Frame and body mount structure designed to allow tire rotation and absorb energy
Cab structure reinforced to control deformation in the toe pan and rocker area.
2019 CHEVROLET SILVERADO – SMALL OFFSET CRASH COUNTER MEASURES
2019 CHEVROLET SILVERADO – UPPR BODY STRUCTURE MASS REDUCTION

GAUGE REDUCTIONS: 4.4 kg

/ All cab outer panels

/ Enabled by:
  – Panel shape optimization
  – Bake hardenable roof
  – HSLA cab back
  – Increased experience with thin materials

NOTE
2019 Bodyside panel:
56 mm longer
75mm taller
2019 CHEVROLET SILVERADO – UPPER BODY STRUCTURE MASS REDUCTION

DESIGN OPTIMIZATION: 16.6 kg

/ Expanded use of AHSS
  – MP 1180 rocker outer
  – MS 1500 rocker reinforcements

/ More efficient rocker and A-pillar designs

/ Tailor rolled center pillar reinforcement

/ Mass efficient cabin boom mitigation
2019 CHEVROLET SILVERADO – UPPER BODY STRUCTURE MASS REDUCTION

GAUGE REDUCTIONS: 4.4 kg

DESIGN OPTIMIZATION: 16.6 kg

TOTAL MASS SAVINGS: 21 Kgs
CABIN BOOM

/ Developed new analytical tools to assess both powertrain and road induced boom
/ Modeling identified the need for:
  – Optimized roof, cab back and floor shapes
  – Interlocked floor to cab panel beading
  – Multi-functional cab back reinforcements strategically located and designed for boom reduction
/ No tuned absorbers or header masses required
/ Liquid applied sound deadener reduced
2019 CHEVROLET SILVERADO – INTEGRATED SEAT BACK STRUCTURE

2018 Chevy Silverado

/ Child seat anchor and head rest loads carried by seat structure
/ Separate acoustic panel for NVH performance

2019 Chevy Silverado

/ Child seat anchor and head rest loads carried by body structure
/ NVH performance managed by seat foam

SYSTEM MASS SAVINGS : 16 Kgs
THE MOST FUNCTIONAL BED OF ANY FULL-SIZE TRUCK
2019 CHEVROLET SILVERADO – INCREASED BED FUNCTIONALITY

/ 23% more storage space: 63 cu ft., Best-In-Class short bed
/ Bed is 2" taller, 1" longer and 6.75" wider
/ 21 fixed tie downs: 8 more than in 2018, pullout force doubled
PLATFORM OPTIMIZATION

Mass increase less than 1 kg with larger bed
/ Platform gauge reduced from .95 to .85 mm
/ Material strength increased: HSLA 500
/ Corrugation geometry improved
/ Sill section shape optimized
2019 CHEVROLET SILVERADO BED PERFORMANCE

PUNCTURE AND IMPACT PERFORMANCE EQUIVALENT TO THE 2018 SILVERADO!
Silverado Pick Up Bed – Additional Features

More of what truck customers want

Larger Cornerstep

120-Volt Outlet

LED Task Lighting
INDUSTRY-FIRST
POWER TAILGATE