Great Designs in Steel

2011 Grand Cherokee

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Body Structure Outline

- **Body Functional Objectives: Essence of the Grand Cherokee**
  - Mandates:
    - Improve performance, increase size & lower weight
    - Body Stiffness/Torsion/Bending
    - Durability
    - NVH
    - Impact Performance:
      - 3rd Party Rating → including Top Safety Pick (4x SWR Roof Crush)
      - Trail Rated Performance
- **Body Design**
  - Body Topology Evaluation
  - Section / Connection / Continuity
  - Structural Front End Module (FEM)
  - Steel Gage and Grade Selection
  - Resultant Components Chart
- **Development**
  - Welding
  - Structural Adhesive
  - Multi - Disciplinary Optimization (MDO)
  - Structural Efficiency Calculation
  - Structural Adhesive Application
  - Body Static Stiffness
  - Body Modes
  - NVH
• Development - Continued
  – Tow Hooks
  – Water Fording

• Performance Confirmation
  – Road Test Simulator (RTS) Validation
  – Proving Grounds Duty Cycles
  – Impact Performance:
  – 3rd Party Rating including Top Safety Pick (4x SWR Roof Crush)
  – ‘Trail Rated’ and Rubicon Performance
Body Functional Objectives: Durability & Capability → Driver Confidence

• Global Body Functional Objectives: Essence of the Grand Cherokee
  Mandates:
  – Body Stiffness/Torsion/Bending
  – Durability
  – Impact Performance:
  – 3rd Party Rating including Top Safety Pick (4x SWR Roof Crush)
WK Load Cases & Functional Requirements

Roof Crush
- Platen angle
- 4 X GVW

Liftgate Loading
- Prop Rod Loads
- Hinge loading

Rear Impact FMVSS 301
- 70% offset direct push on Rail

Front Impact FMVSS 301
- 40% offset direct push on Rail
- Full Flat Frontal
- Euro NCAP

Sill loads – Wheel Input

Side Impact
- FMVSS 214
- IIHS Side impact
- Euro NCAP

1st & 2nd Row Seat FMVSS 207 / 210 Belt

Front & Rear Durability & Fatigue Loads (with and without max payload)
- Vertical 3G load at Susp mount
  (In phase & Out of phase)
- Cornering Load – 2G Lateral load

Torsional/Bending Stiffness
Body Design:
Experienced Engineers / State-of-the-Art Tools

- **Body Design**
  - Body Topology Evaluation
  - Section / Connection / Continuity
  - Structural Front End Module (FEM)
  - Steel Grade Selection
  - Resultant Components Chart
Topology: Mass and Geometry Optimized to Objectives

Typical Topology Process

- **Packaging Volume**
  - Holistic Forces:
    - Safety
    - Refinement
    - Durability

- **Topology Results**
  - Spatial load image

- **Beam Model**
  - Load paths

- **Body Design**
  - Detailed Components

- **Optimization**
  - Steel Gauge & Materials

Component: Toe Board Crossmember

Topology: Shock tower

Design Application: Upper Load Path
Section / Connection / Continuity: Energy Management Strategy and Execution
Structural Front End Module: Functional System and Plant Build Optimization

Hood Slam

Torsion

Tow Hook – Push / Pull

Front-to-Front Compatibility

Lo Speed Impact → No-Fire Threshold & 16 mph
Hi Speed Impact → 20-40 mph
High Strength Steel Usage: Weight Reduction and Impact Performance

2011 Grand Cherokee Material Usage

- 50% High Strength Steel

High Strength Steel: YS > 200 MPa
High Strength Steel Usage: Weight Reduction and Impact Performance

Previous Grand Cherokee

29% High Strength

2011 Grand Cherokee

50% High Strength

New Vehicles

70% High Strength

High Strength Steel: YS > 200 MPa
WK Body Components Chart: Body Shop Build Strategy
Body Development:
Body Complete -- Jeep

• **Development**
  - Welding
  - Structural Adhesive
  - Multi-Disciplinary Optimization (MDO)
  - Structural Efficiency Performance Factor (PF)
WK Underbody Spot Welding: Connecting the Structure for Jeep Capability

3308 Spot Welds in Underbody Shell
WK Upperbody Spot Welding: Connecting the Structure for Jeep Capability

2069 Spot Welds in Upperbody Shell
WK MIG welding:
Connecting the Structure for Jeep Capability

• 112 Mig Welds in Body Shell (Total mig weld length of 3494mm)
WK Welding Complete: Connecting the Structure for Jeep Capability

5489 Total Welds in Body-in-White Complete
WK Body Adhesive & Anti-Flutter: Finalization of Body Build Construction

- **Structural Adhesive (3mm bead)** 108.6m total length
- **Anti-Flutter (5mm bead or gum drop)** 8.3m total length
WK Multi - Disciplinary Optimization (MDO):
Wt. Optimization with no Functional Degradation

- Gages maintained for critical impact and durability parts
- Total Weight Savings = 23 kg
- No change in bending and torsion modes
- No degradation in mobility responses
- Maintained overall BIW NVH responses
Resultant Body: To Be Classified as a Jeep

• Development
  – Body Static Stiffness
  – Body Modes
  – NVH
WK BIW Static Stiffness:
Solid / Confident Driving Experience

Torsional Stiffness Setup

Bending Stiffness Setup

Torsional Stiffness = 23000 N-m/deg (CAE)
Bending Stiffness = 10200 N/mm (CAE)
11WK BIW Normal Modes:
Solid / Confident Driving Experience

First Torsion Mode 43 Hz
First Bending Mode 51 Hz
11WK Mobility Responses to Inputs @ Body
Attachments to Cradles: NVH Achieved

Target Met: < 0.2 mm/sec/N
11WK Acoustic Responses to Input @ Body Attachment to Cradles: Driver Delight

Target Met: < 55 dB
Tow Hooks: Rugged Performance and Capability

- Development
  - Tow Hook Development
“A Jeep Queue”

Front Tow Hooks (Two per Vehicle RT and LT) / Rear Tow Hook (one per Vehicle LT)

1. Design for Impact Requirements
   1. Requires pulse separation between low speed threshold vs. 16 FF.
   2. Common calibration with and without tow hooks.

2. Design for durability Requirements
   1. 1.0 /1.5 GVW pull.
   2. 2.0 GVW pull with no separation.
   3. 0.9 GVW 90 deg outboard pull no separation.
   4. 0.5 GVW push/pull (BUX).
Tow Hook Design:
Engineered Geometry for Multi-Purpose Objectives
Front Tow Hook Development:
System Level Confirmation Testing
Water Fording: ‘Trail Rated’ Requirement

- Development
  - Body Sealing - 20” Water Fording – Define P/1/P2 Sealing
Water Fording Requirements:
20 inches of Water Submersion Performance

69.4 meters of sealer on BIW
76.4 meters including closures and hem sealing
Water Fording:
Body Sealer – Robust Joints
Water Fording:
Body Sealer – Robust Joints

Robotically Applied Sealants - 76.4m total length
WK Water Fording:
Capable Results Achieved!
Performance Confirmation: Legendary Jeep Performance

- **Confirmation**
  - Road Test Simulator (RTS) Validation
  - Proving Grounds Duty Cycles
  - Impact Performance:
  - 3rd Party Rating → including Top Safety Pick (4x SWR Roof Crush)
  - ‘Trail Rated’ and Rubicon Performance
WK Road Test Simulator Testing:
Accelerated Discovery and Durability Results

2011 WK on Road Test Simulator Rig
- SUV Body/Chassis PG Durability Duty Cycle
- Represents 95\textsuperscript{th} Percentile Usage Customer
- 150K Customer Equivalent Miles
- Testing Performed to 2x Life
WK Proving Grounds Testing
## 2011 WK NEW US NCAP RATINGS

<table>
<thead>
<tr>
<th>New NCAP Mode</th>
<th>Mode Rating</th>
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<tbody>
<tr>
<td>Frontal</td>
<td>★★★★★</td>
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<tr>
<td>Driver</td>
<td>★★★★★☆</td>
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<tr>
<td>Passenger</td>
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<tr>
<td>Side</td>
<td>★★★★★★★</td>
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<tr>
<td>Front MDB</td>
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<tr>
<td>Rear MDB</td>
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<tr>
<td>Front Pole</td>
<td>★★★★★★★</td>
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<tr>
<td>Rollover</td>
<td>★★★☆</td>
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<tr>
<td>Overall Vehicle Rating</td>
<td>★★★★★</td>
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WK IIHS Offset:
All Injury Criteria in ‘Green Zone’
IIHS Side Impact: All Injury Criteria in ‘Green Zone’
WK IIHS Side Crush: After-test Geometry in ‘Green Zone’

CES1008 2011 Jeep Grand Cherokee

- Good
- Acceptable
- Marginal
- Poor
- Pre-crash
- Post-crash

Lateral Distance from Driver Seat Centerline (cm)

Height from Ground (cm)
<table>
<thead>
<tr>
<th>Model</th>
<th>Overall rating</th>
<th>Curb weight (lb)</th>
<th>Peak force (lb)</th>
<th>Strength-to-weight ratio</th>
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<tbody>
<tr>
<td>Jeep Liberty 2008-10 models</td>
<td>G</td>
<td>4,245</td>
<td>21,073</td>
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<td>Dodge Nitro 2007-10 models</td>
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<td>Toyota Venza 2009-10 models</td>
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<td>Jeep Grand Cherokee 2011 models</td>
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<td>Dodge Journey 2009-10 models</td>
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<td>19,649</td>
<td>4.55</td>
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**Roof Crush Rating**: Good
2011 Jeep Grand Cherokee: ‘Trail Rated’ Performance
Thank You for Your Attention!