



Forward. For all.

Dynamic Contact Simulation for Fatigue Analysis
New Mobility Truck related Use Cases

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Magna ECS Simulation Conference 2025, May 14 – 15, Waidhofen/Ybbs, Austria

Overview



1 Simulation driven Fatigue Assessment

2 Dynamic Contact Simulation

3 Exemplary Results

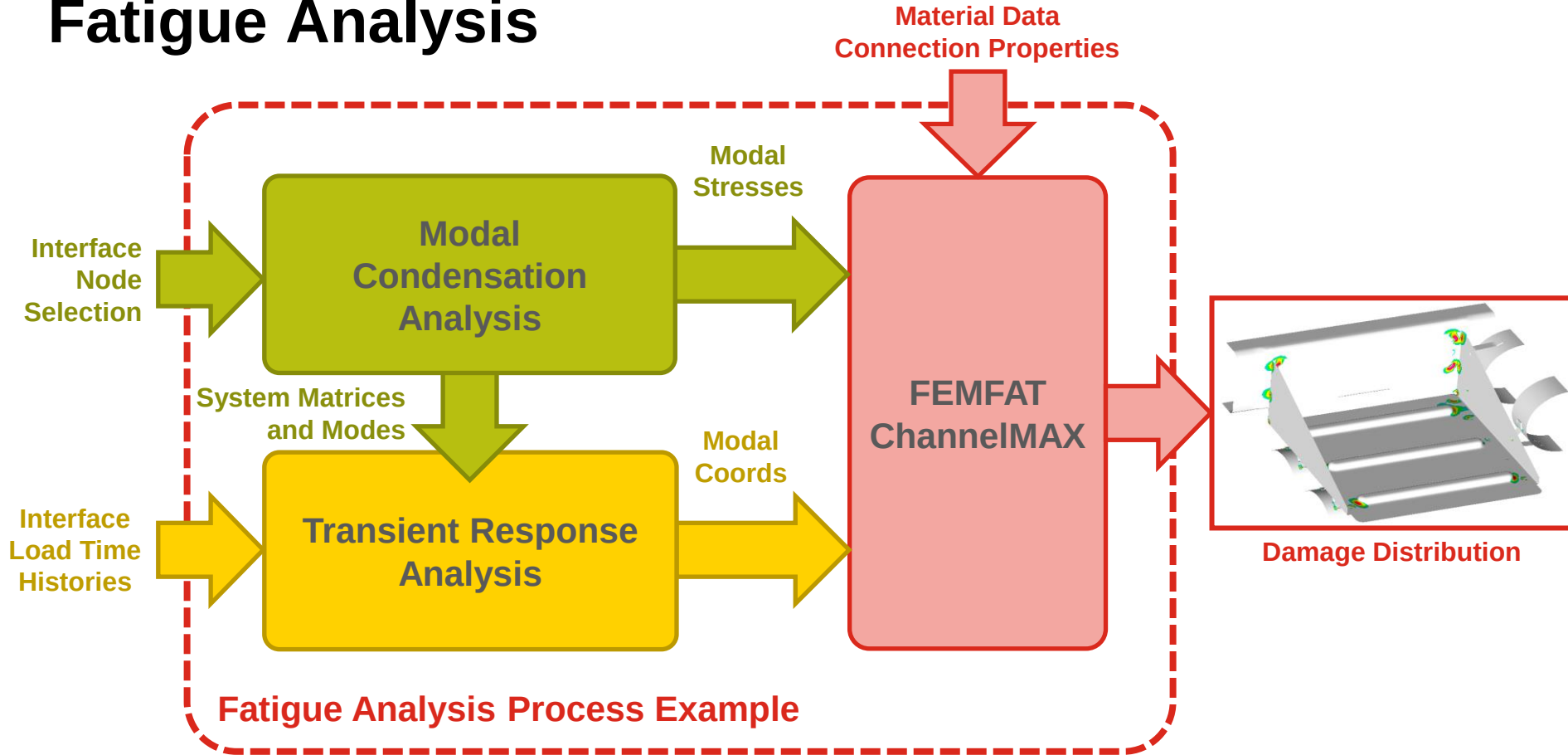
Conclusion

Simulation driven Fatigue Assessment

Simulation driven Fatigue Assessment



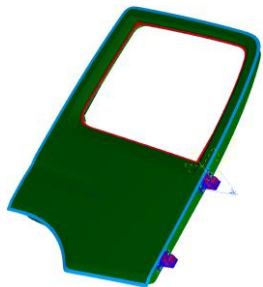
Fatigue Analysis



New Mobility Truck

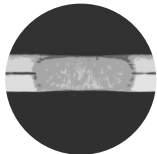
Dynamic Contact Analysis

Door Slam Durability
Cabin Fatigue Assessment

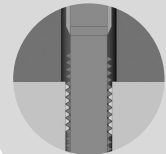


MAMBA enables
realistic modeling of

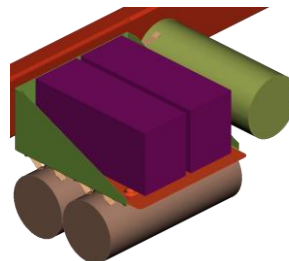
Spot Welded
Connections



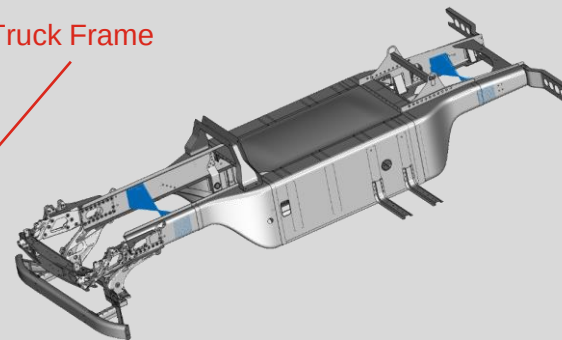
Bolted
Connections



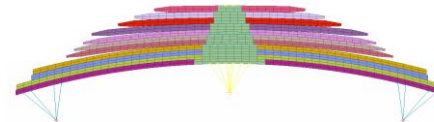
Side Rail Attachments



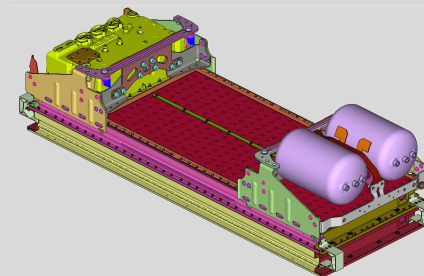
Truck Frame



Trunnion Spring



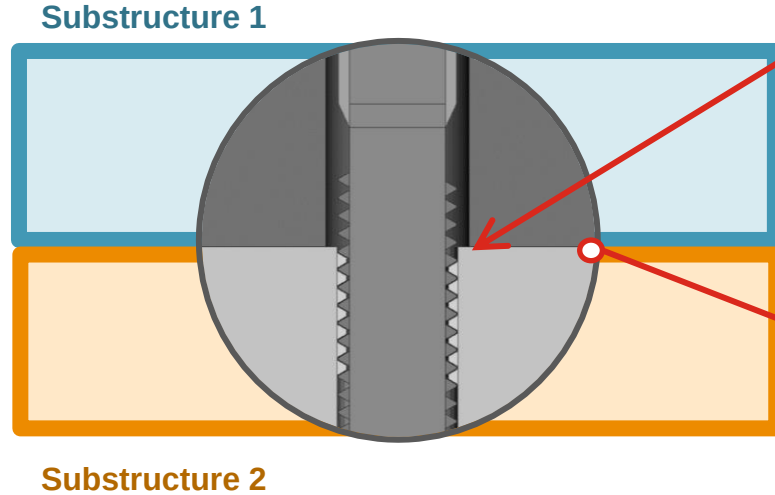
Battery Pack



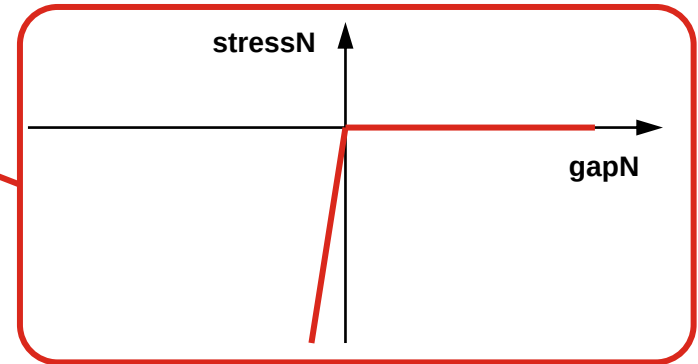
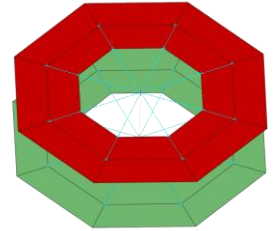
Dynamic Contact Simulation

Focus on Bolted Connections

Representation within linear FE Models



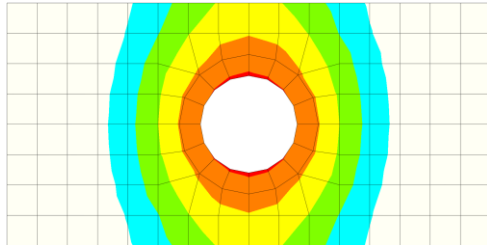
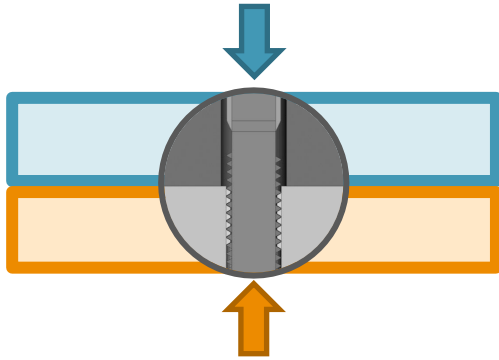
Commonly used connectors are
RBE2 – CBEAM – RBE2 or
RBE2 – CBAR – RBE2



- The contact pressure is not considered during a linear analysis
- Stresses due to bolt pretension are not considered either

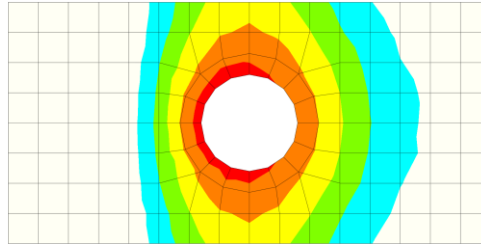
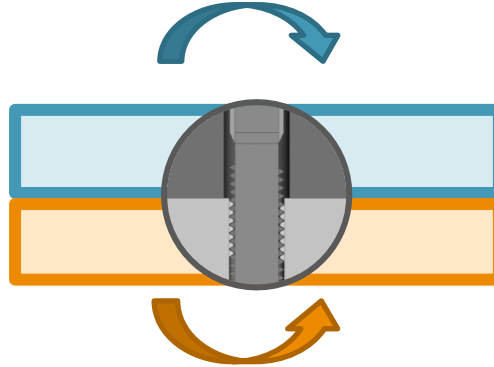
Contact Pressure within Bolted Connection

Pretension



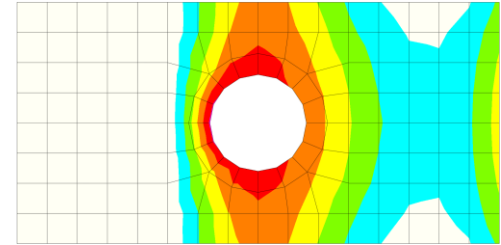
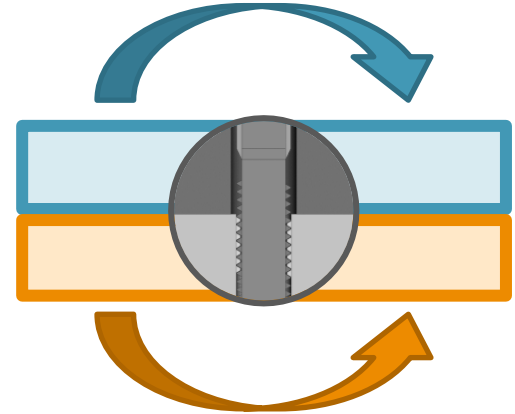
Contact Pressure

Typical Loading



Contact Pressure

Intense Loading



Contact Pressure

Dynamic Contact Simulation

Based on Streamlined Reduced Order Models

MAMBA Software

FEMFAT Software

FE Model

Model Reduction

Dynamic Contact
Simulation

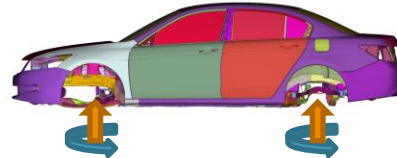
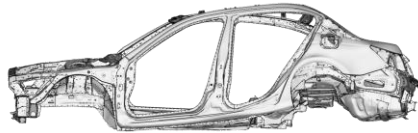
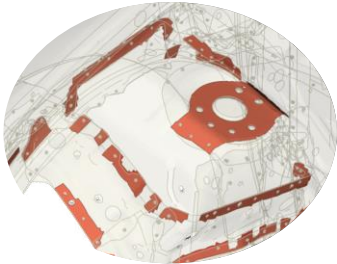
Fatigue Assessment

MAMBA
Contact Area

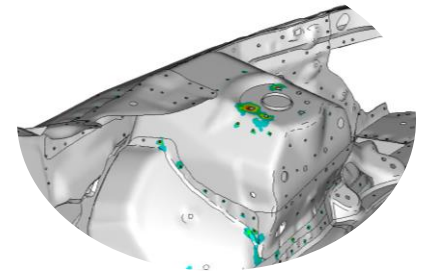
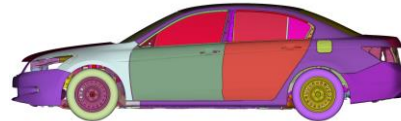
Displacement Shapes and
MAMBA Contact Modes

Loads at Interface Points and
MAMBA Solver

Improved
Damage Results



...or within MBD Solver



Exemplary Results

Truck Battery Pack Vibration Fatigue

- Key Facts

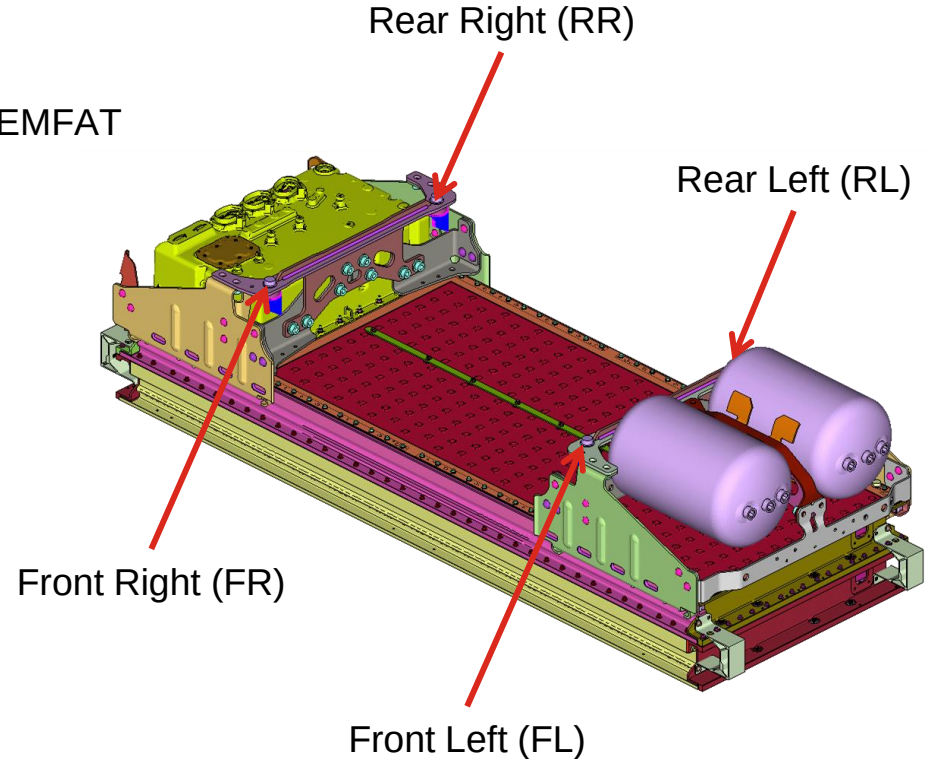
- Based on FE Solver, MAMBA Standalone and FEMFAT
- Mass trimmed battery pack model
- Imposed road load time history at 4 locations
- Represents a single maneuver

- Dynamic Contact Simulation Steps

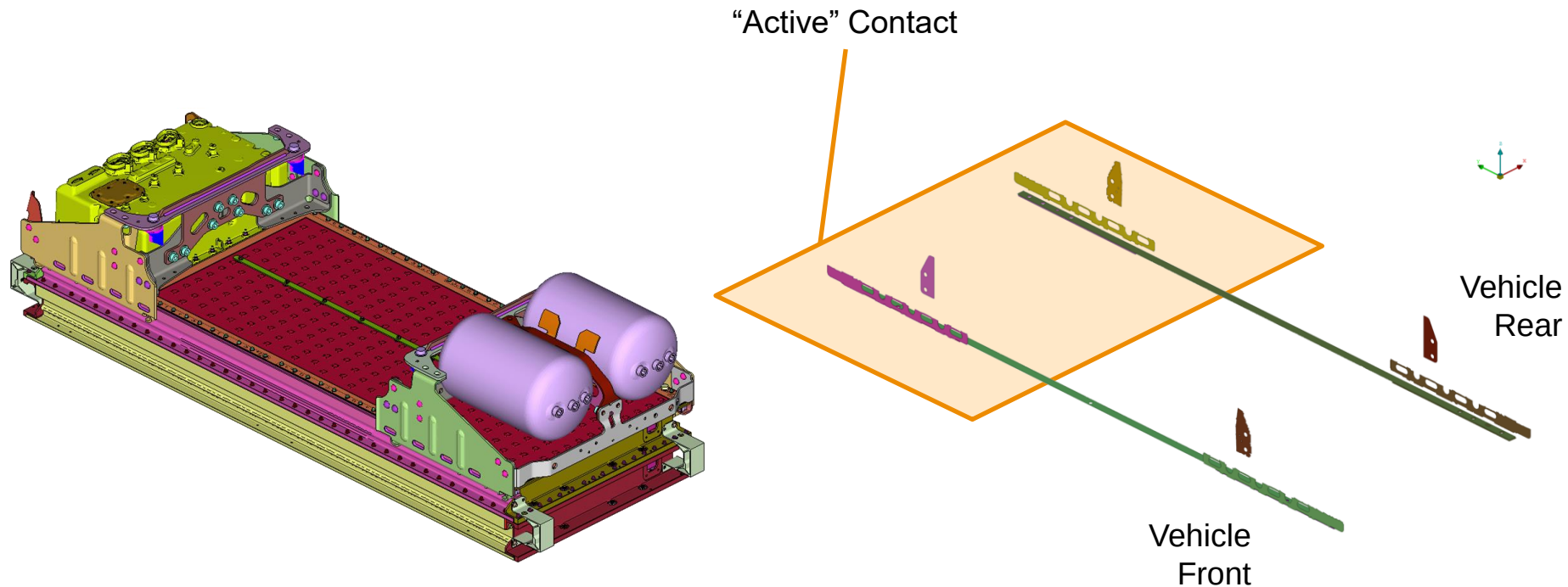
- Static equilibrium (avoid spurious oscillations)
- Dynamic contact analysis for 76 seconds

- Analysis Output

- Maximum contact pressure over time
- Modal coordinates for fatigue assessment
- Damage distribution

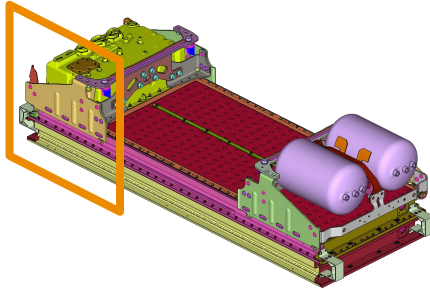


Considered Contact Areas



Maximum Contact Pressure over Time

Collected for each contact node



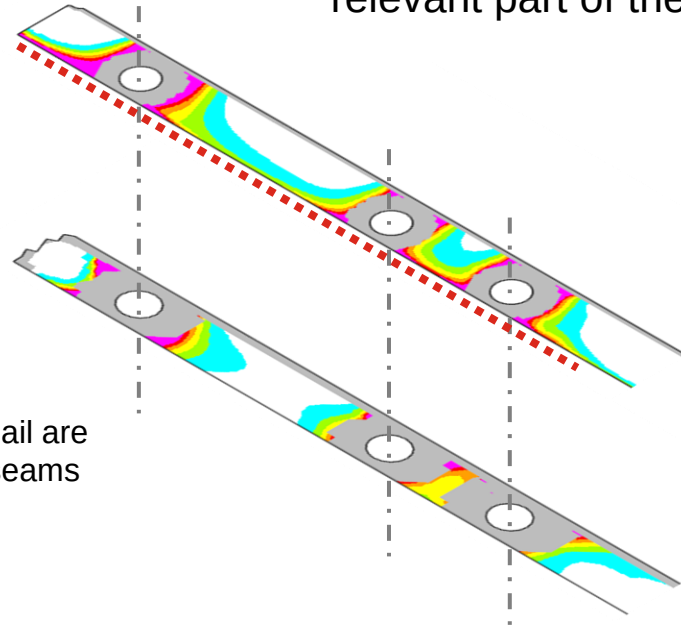
Contact FR2:
“Sliding Rail”
to “Battery Pack”

Contact FR1:
“Carrier”
to “Sliding Rail”

Note:
Carrier and Sliding Rail are
connected via weld seams
as well

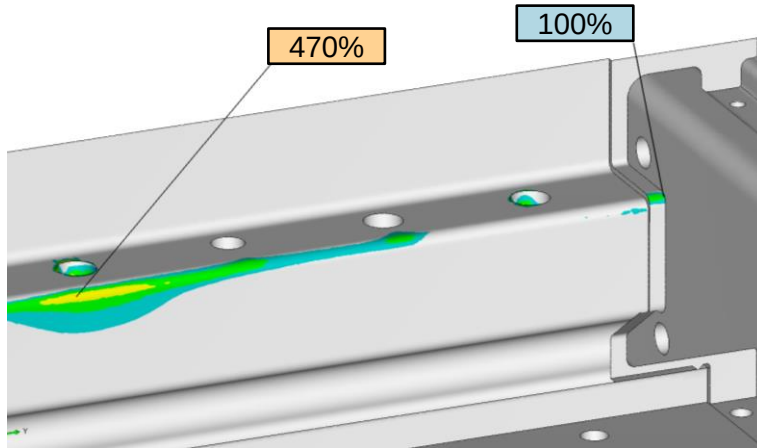
No value at permanently coupled nodes or
nodes without contact partner

→ Battery Pack outer edge is a
relevant part of the load path

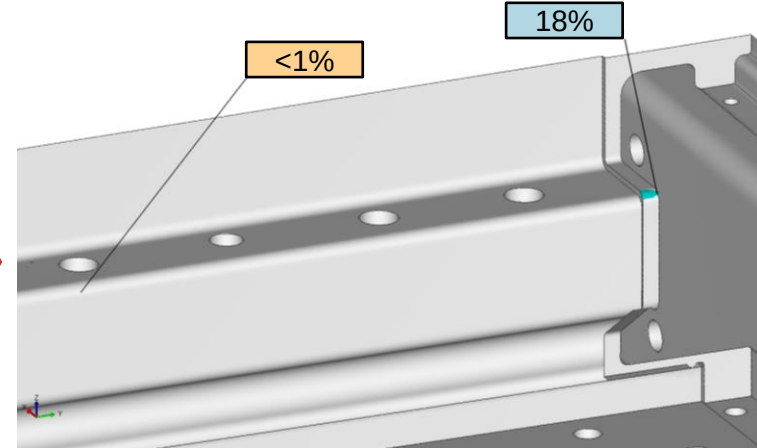


Damage Results at Location „Rear Right“

Linear Dynamic Analysis



Dynamic Contact Analysis



- Contact stresses ensure realistic load path nearby bolted connections
- Artificial damage arising from linearized bolt modeling vanishes

Truck Frame Cross Member Fatigue

- Key Facts

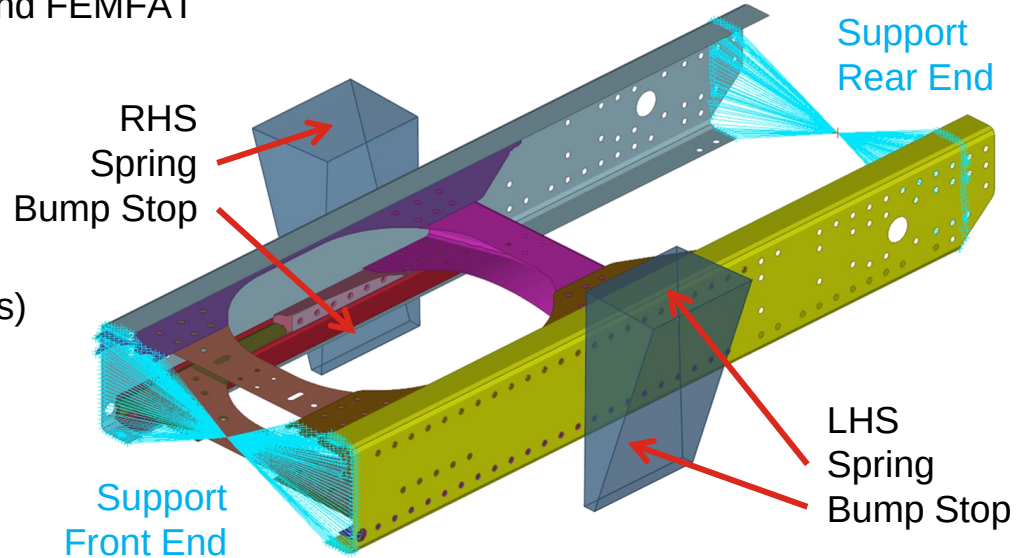
- Based on FE Solver, MAMBA Standalone and FEMFAT
- Frame segment, supported at both ends
- Imposed load time history at 4 locations
- Represents a single maneuver

- Dynamic Contact Simulation Steps

- Static equilibrium (avoid spurious oscillations)
- Dynamic contact analysis

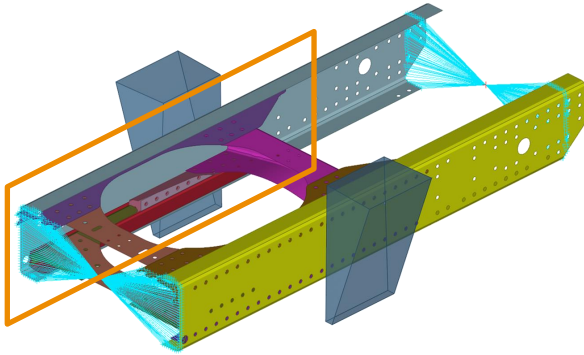
- Analysis Output

- Bolt tension forces
- Maximum contact pressure
- Modal coordinates for fatigue assessment
- Damage distribution

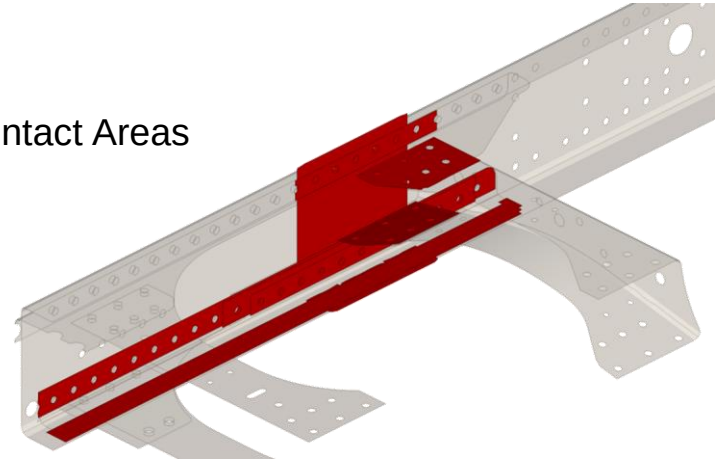


Considered Contact Areas

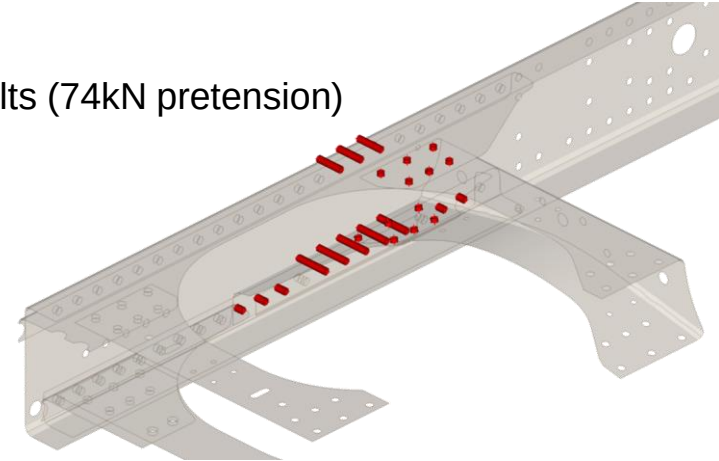
- Contact and bolts added on RHS
 - Almost symmetrical structure
 - Symmetrical loading



Contact Areas

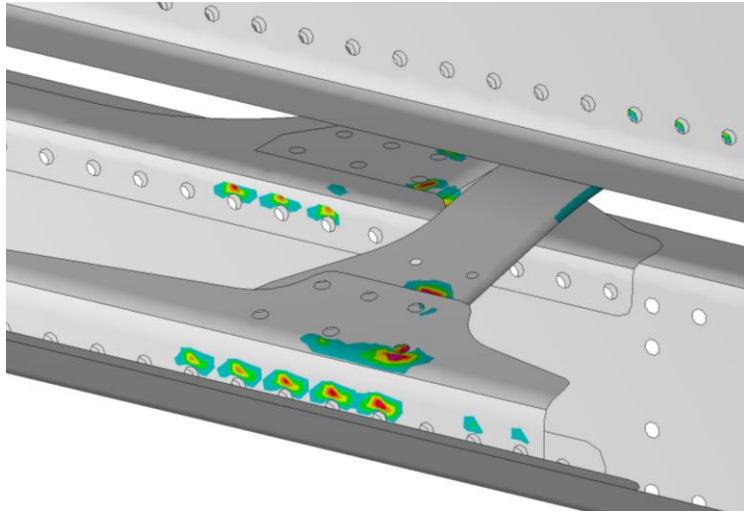


Bolts (74kN pretension)

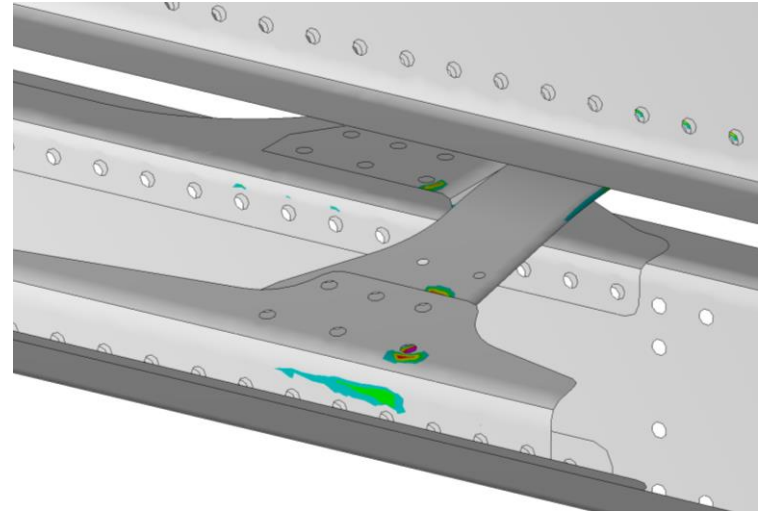


Damage Results at Gusset

Linear Dynamic Analysis



Dynamic Contact Analysis



- Contact stresses ensure realistic load path nearby bolted connections
- Artificial damage arising from linearized bolt modeling vanishes

Conclusion



- Dynamic analysis with contact consideration...
 - requires specialized simulation technology
 - ensures physical correct interaction of bolted components
 - enables fatigue assessment of areas close to bolted connections
- MAMBA is a tailored software which...
 - automates identification of relevant contact areas
 - provides modern model order reduction approaches
 - adds consideration of self-contact to dynamic simulations
 - considers stresses due to bolt pretension
 - integrates smoothly into fatigue analysis toolchains based on FE solvers and FEMFAT ChannelMAX

A long-exposure photograph of a multi-lane highway at night. The road surface is dark asphalt, and a concrete guardrail runs along the left side. In the distance, numerous light trails from cars are visible, creating vibrant streaks of red, yellow, and white against the dark sky. The text "Forward. For all." is overlaid in white on the left side of the image.

Forward.
For all.