SURVIVABILITY ENHANCED RUN-FLAT VARIABLE FOOTPRINT TIRES

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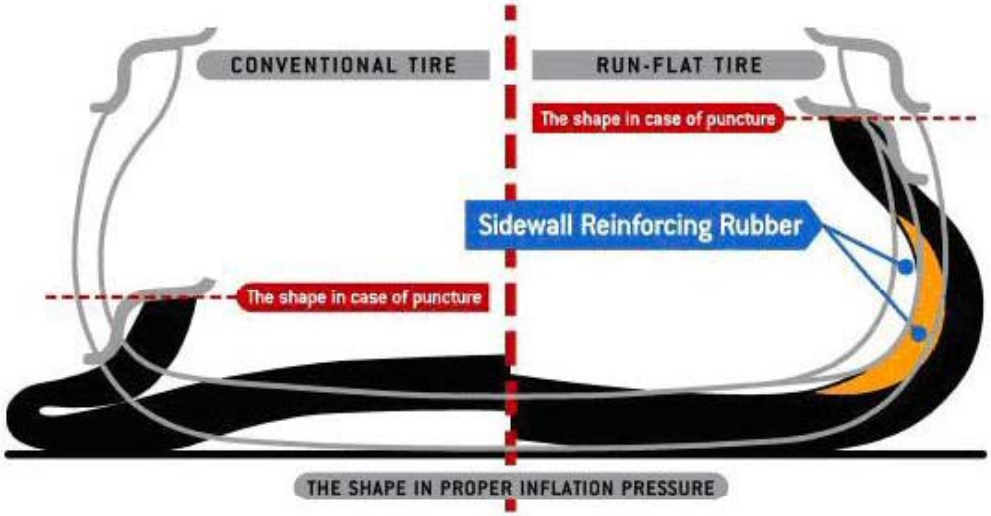
Current Run-Flat Technology

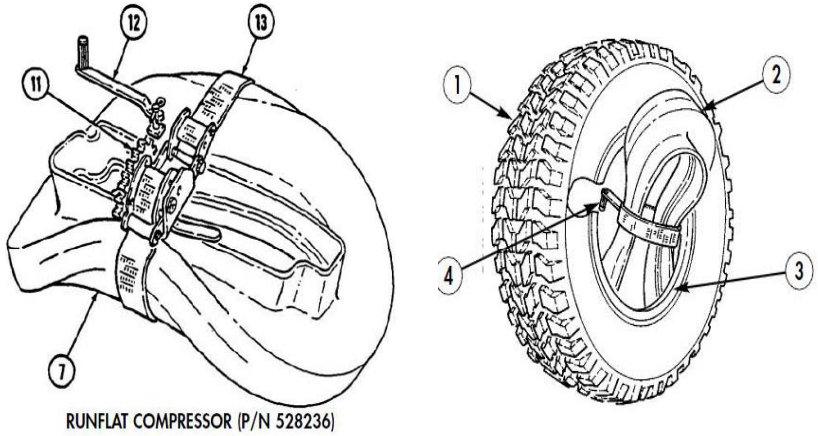
Military Run-flat Tire with Insert [1]



Comparison of Conventional Tire to a Stiff Sidewall Tire [2]

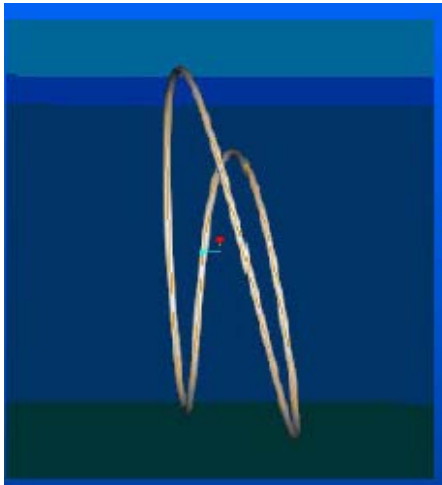
Current Run-Flat Technology Issues

- **WEIGHT**
- **LOGISTICS BURDEN**
- **SHOCK & VIBRATION**
- **SIZE LIMITATION**
- **PERFORMANCE**

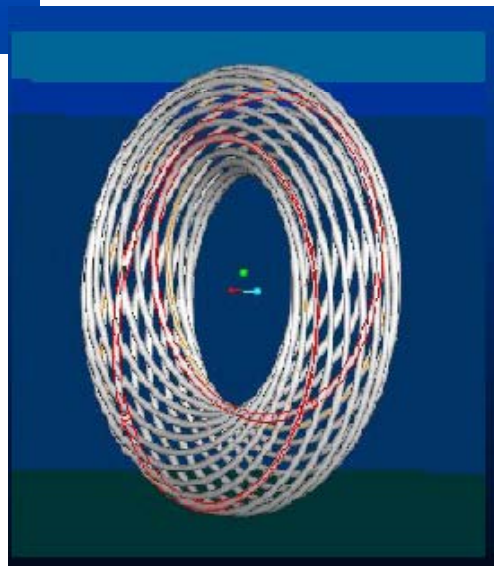


HMMWV Run-flat Insert Special Tool and Installation [2]

Spiral Spring Modeling

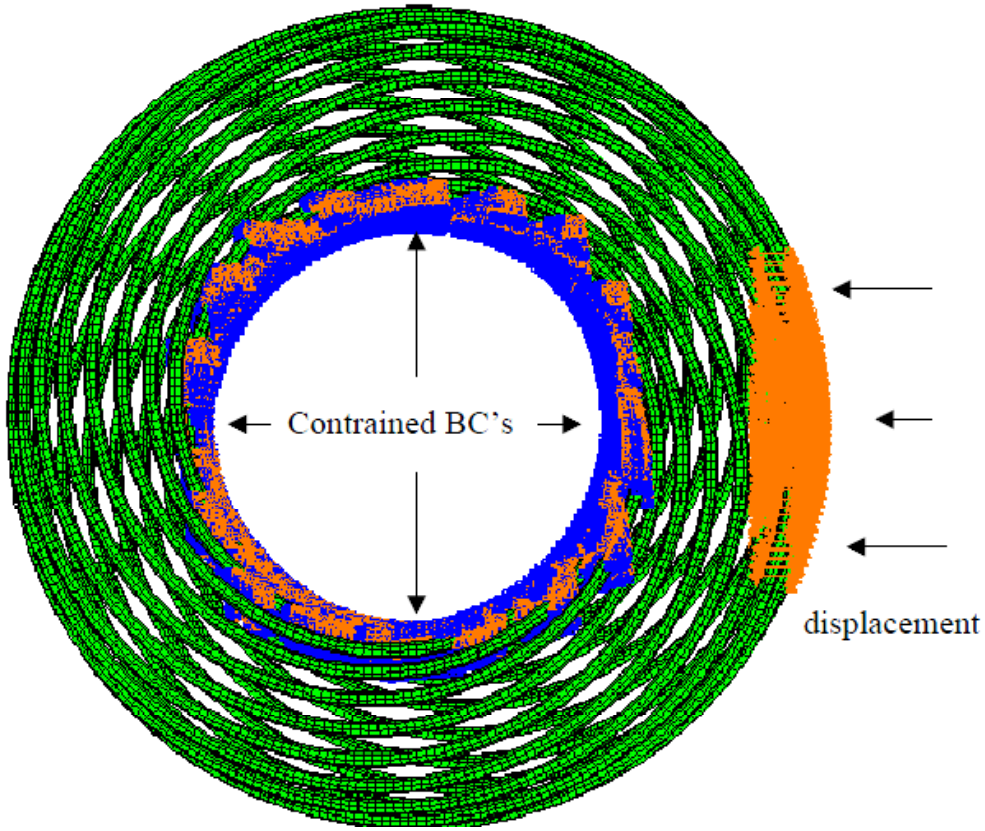


Side view of single wire of tire spring



Isometric view of the 10 circular closed springs

Spiral Spring FEA



Load and Boundary Conditions Applied on the Model for a First Order Foot Print Analysis

Load Deflection Testing

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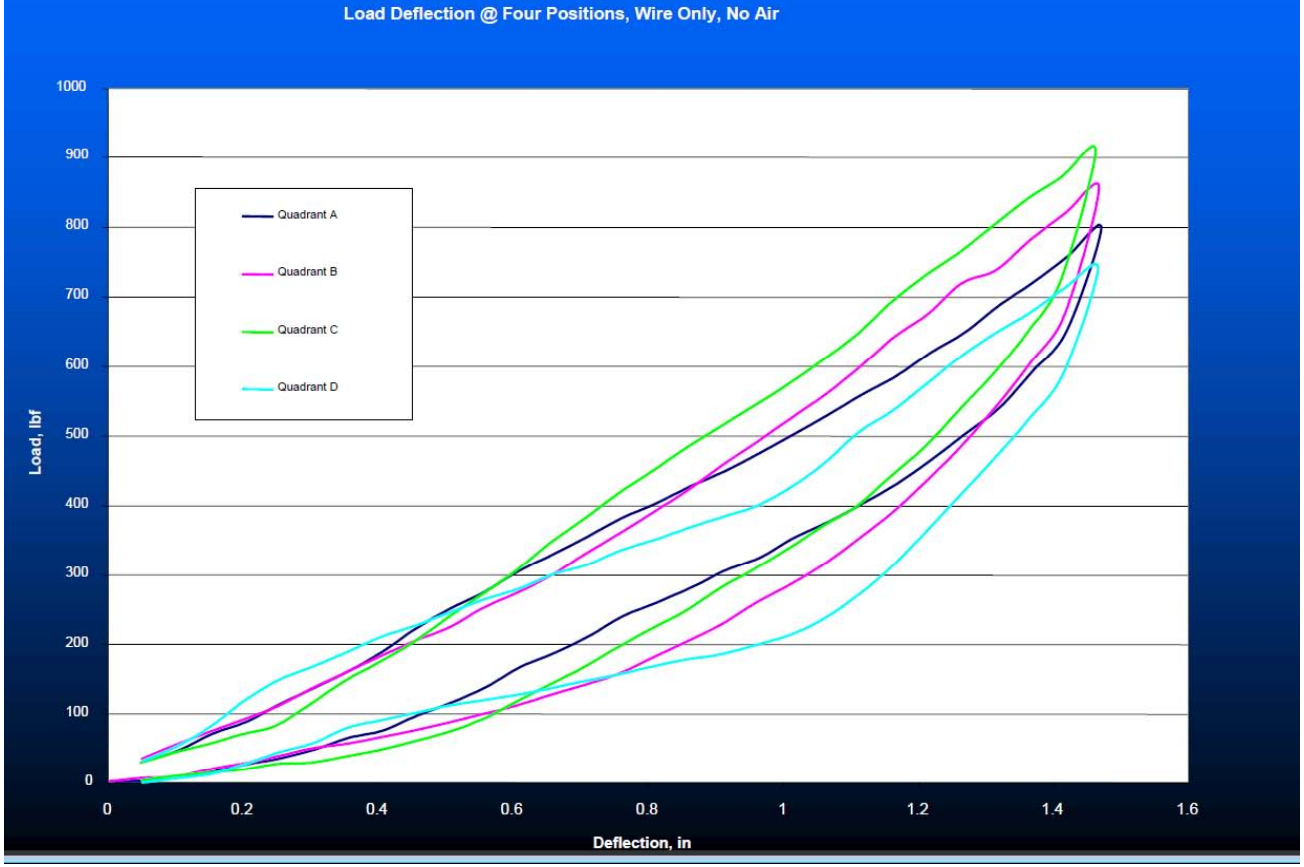
MODELING AND SIMULATION, TESTING AND VALIDATION

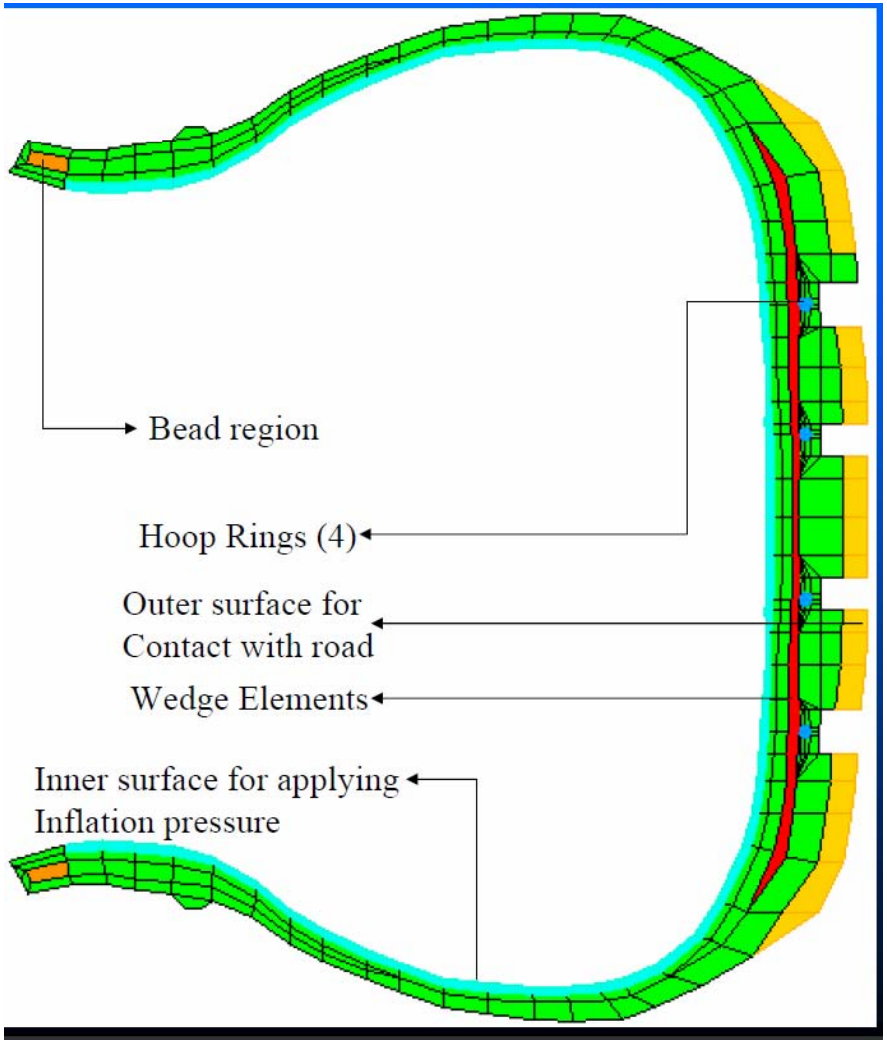
Concept #2: Load- Deflection Testing on Prototype Run Flat Tire with Spiral Spring with 0 Psi inflation pressure (185/80R13 Passenger Tire).



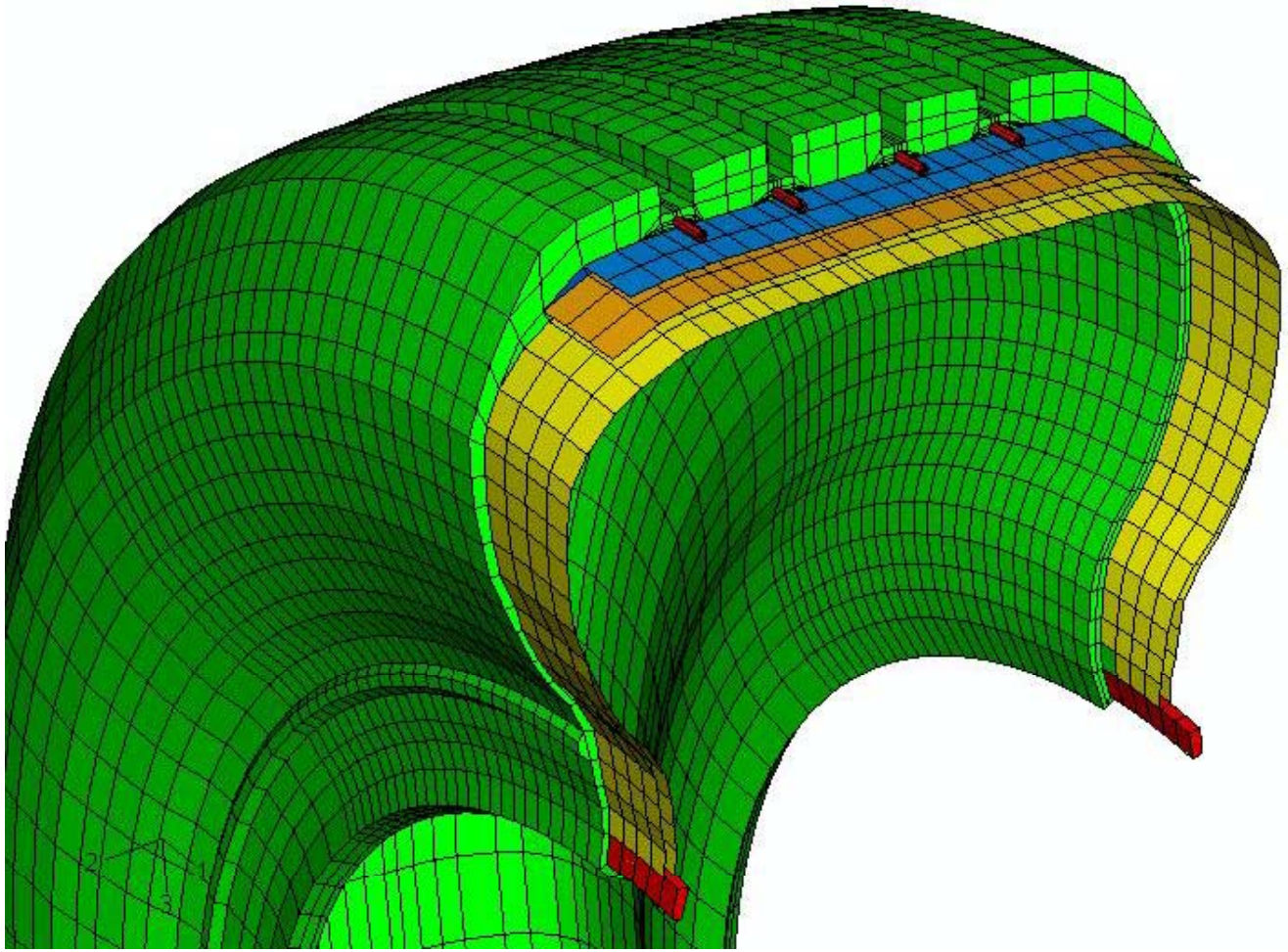
Carbon Fiber Reinforced Tire

- Composite Ring-Reinforced tire
- Comprising of carbon, which is encapsulated as composite hoops into the tire tread
- The undertread layer adheres the tire tread to the primed encapsulated composite hoops. Composite hoops will be spaced above belts in the undertread region.
- Carbon fiber is utilized with the binder so that the resulting composite has high modulus and high strength.

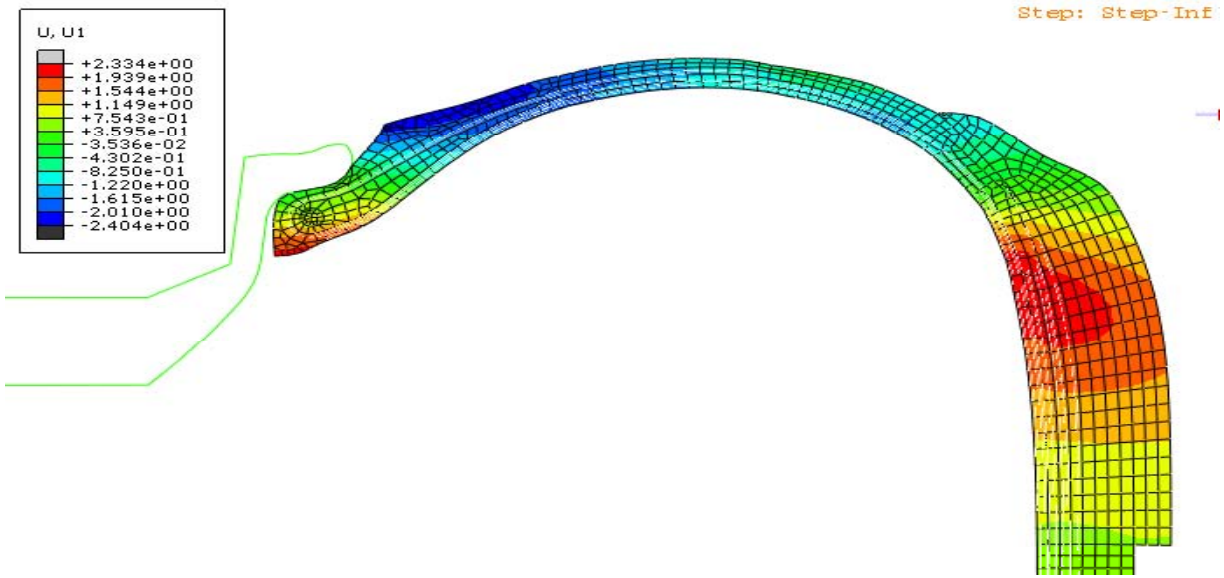
Carbon Fiber Hoop Tire Cross Section



Survivability Enhanced Run-Flat Variable Footprint Tire Sectional View

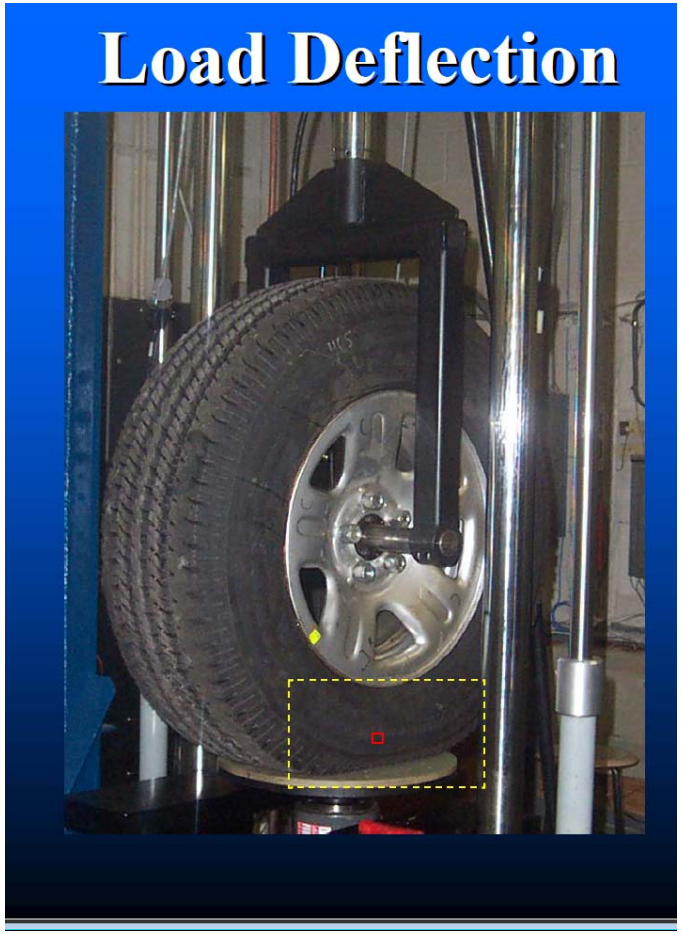


FEA of Inflated Tire



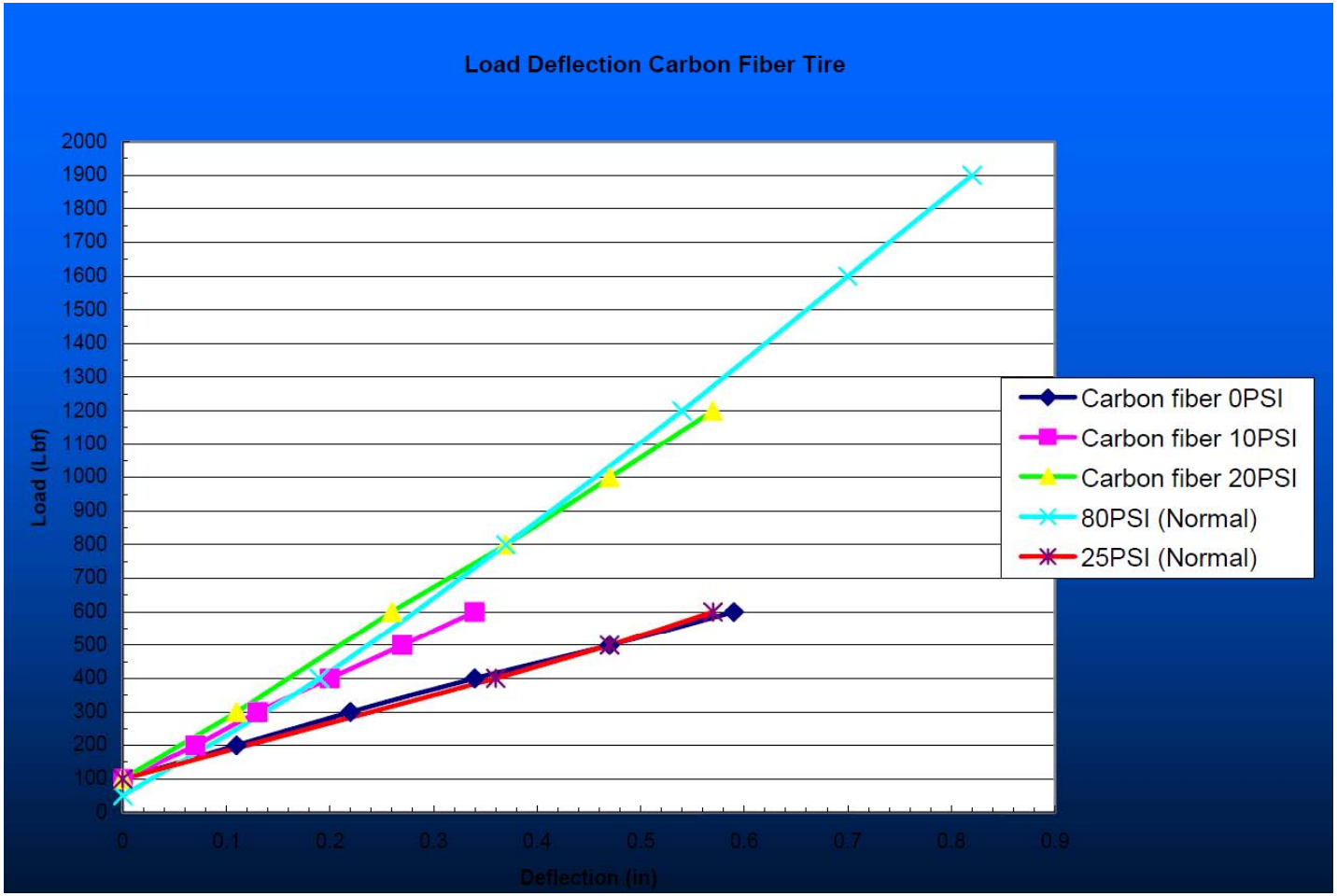
Carbon Fiber Hoop Tire

Carbon Fiber Manufacturing

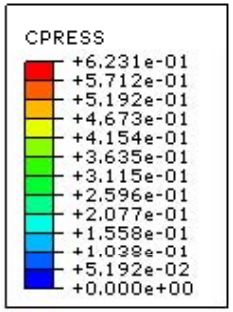


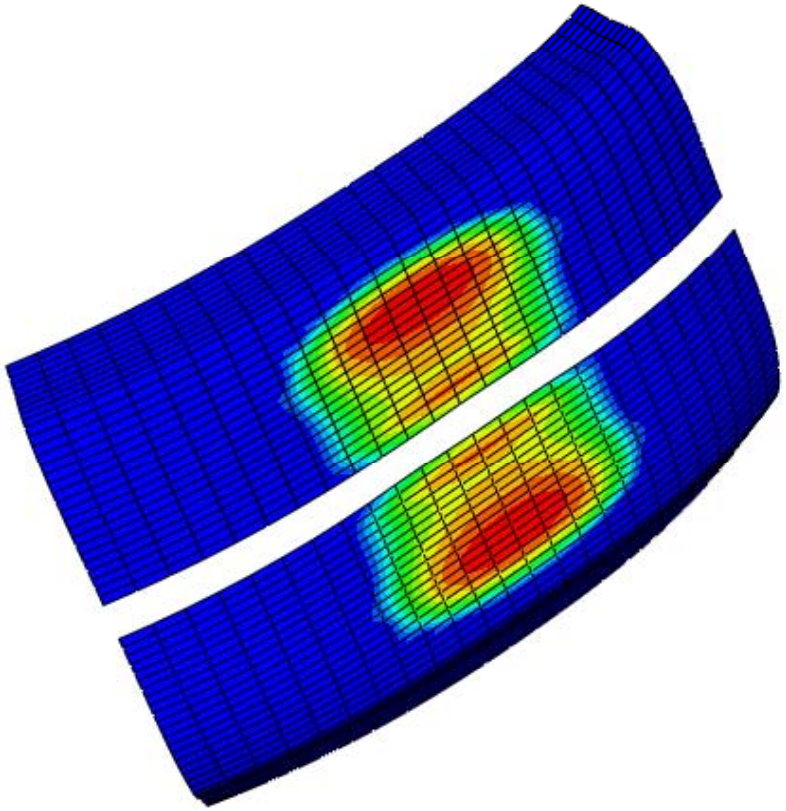
DURABILITY

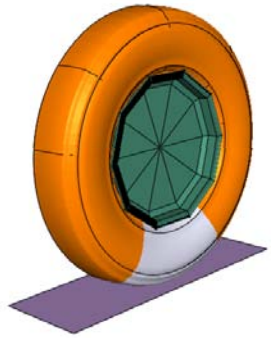
Test Results



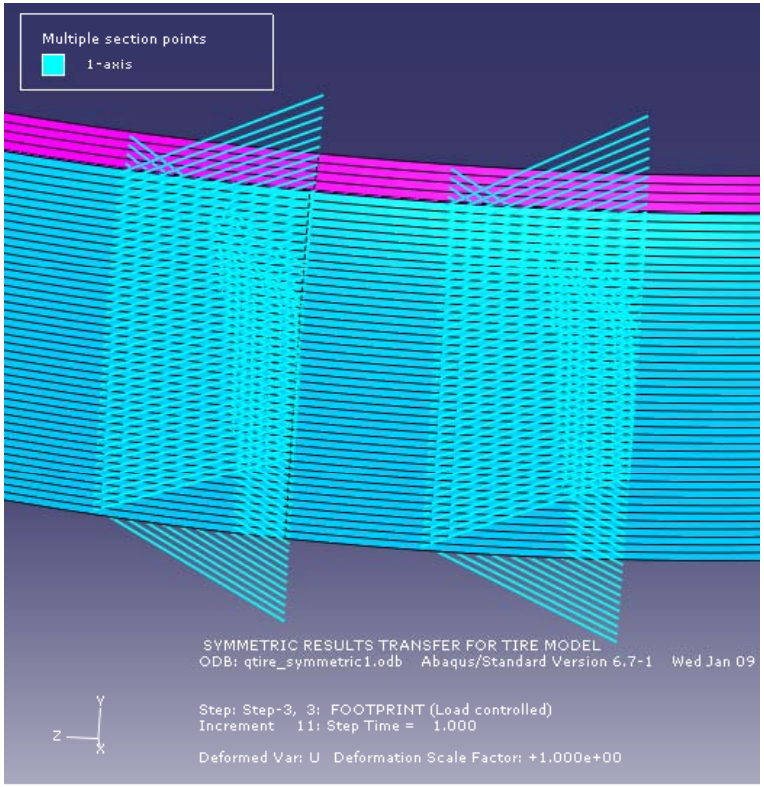
Ground Pressure FEA



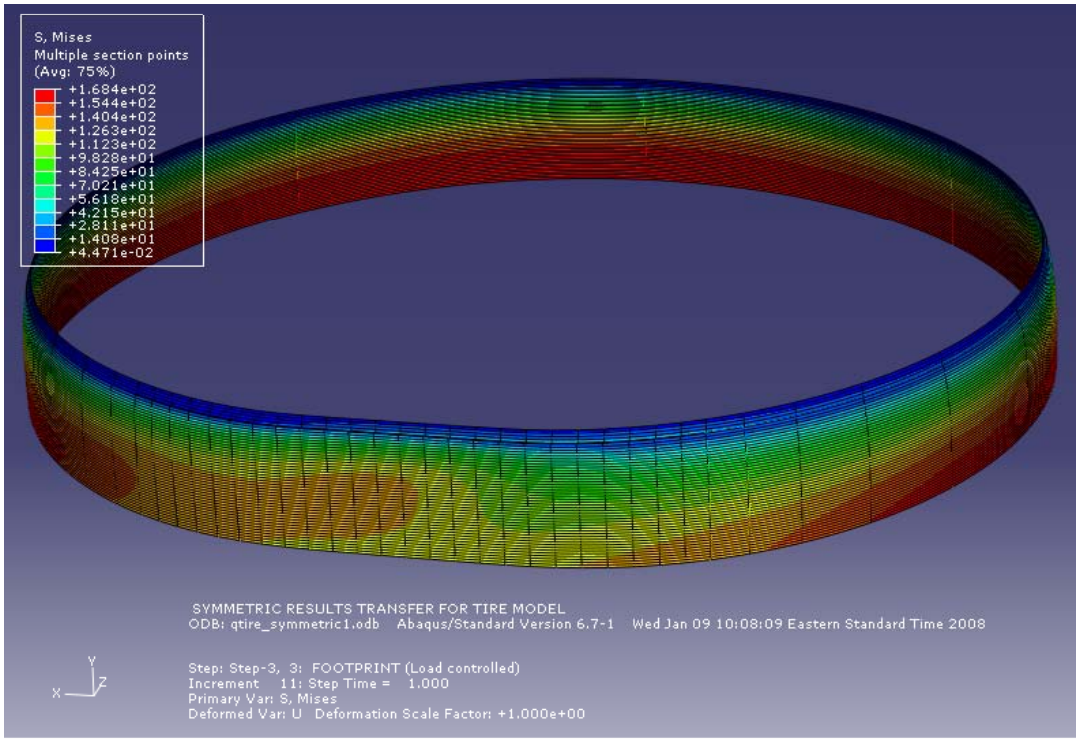




Stress in Carbon Fiber Hoop

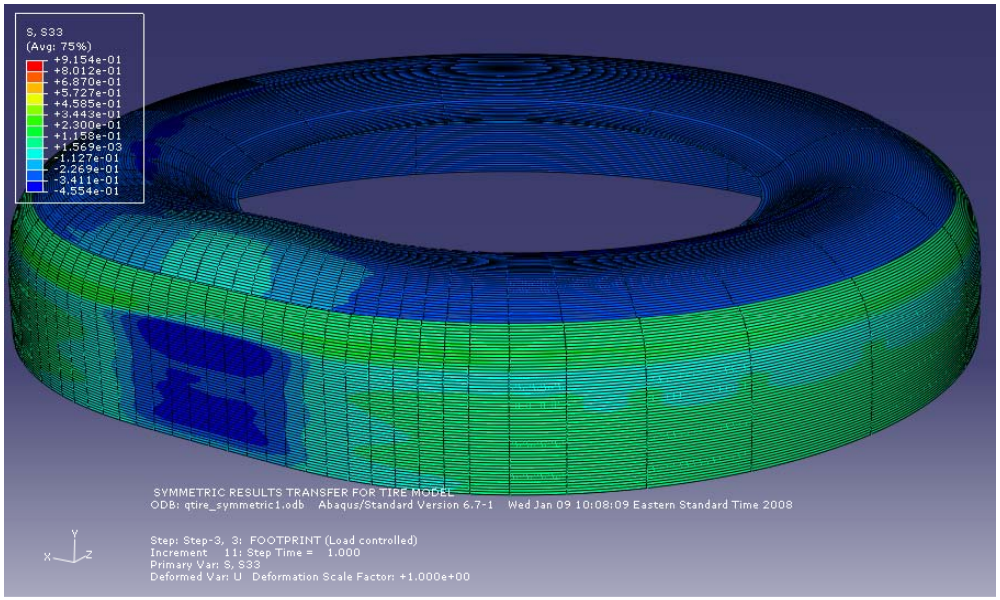


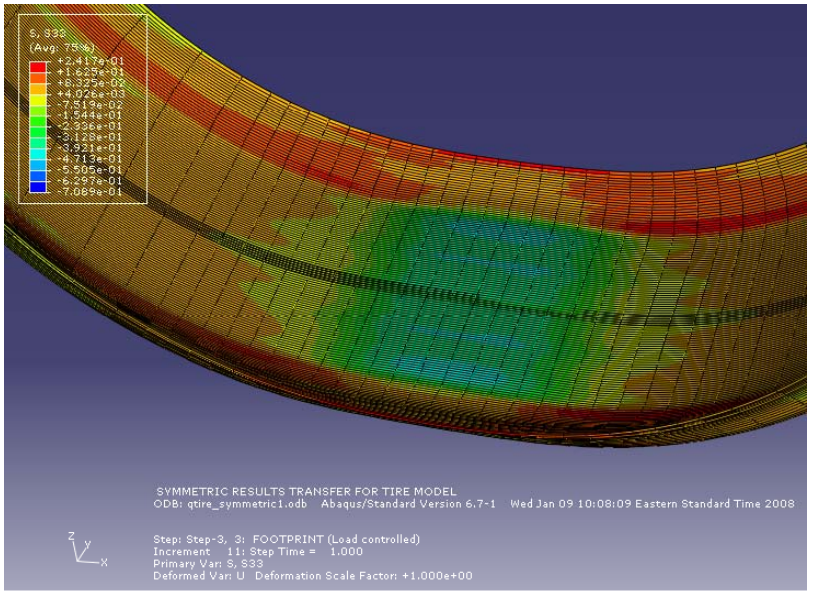
Steel Belt Orientations



Mises Stress generated in carbon fiber
Max – 168.4 MPa

Core – Tread Interface Stresses

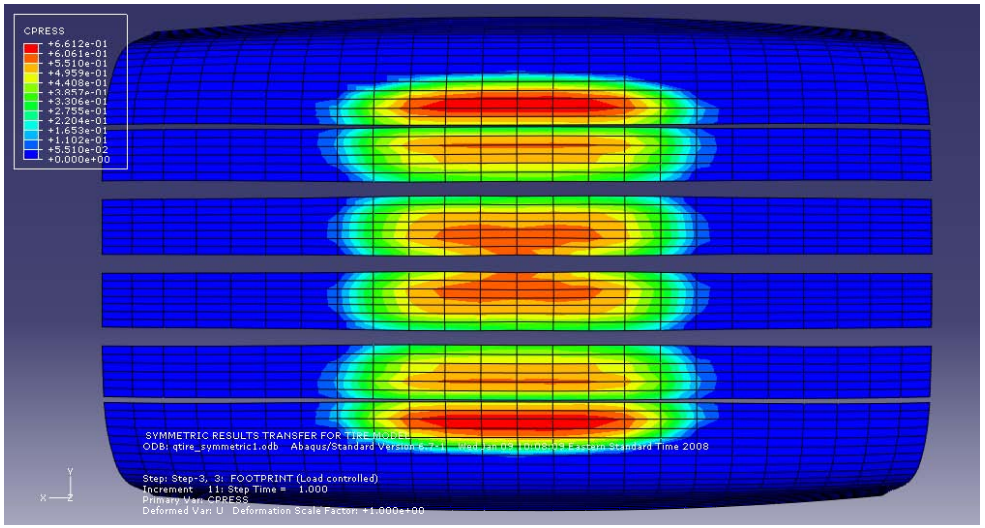


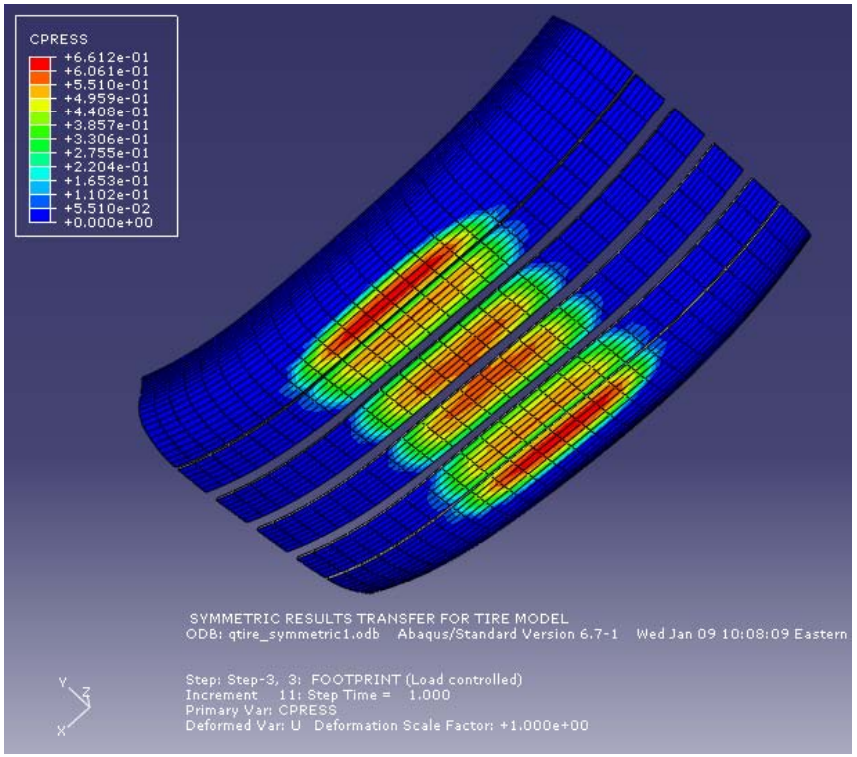


Maximum Normal Stress(S33) in the Core Side = 0.9154 MPa

Maximum Normal Stress (S33) in the Tread Side = 0.2417 MPa

Foot Print Area – Smooth Tire





Contact Area (CAREA) = 21.08934 sq inch for half-tire
Total Contact Area = 42.17868 sq inch
Total Foot Print Area (Contact Area + Void Area) = 7.395251 in x 6.571889 in
= 48.600780 sq inch

Maximum Contact Pressure = 0.6612 MPa = 95.89 psi
Average Contact Pressure = 2335/42.17868 = 55.35 psi

Benefits

- **SURVIVABILITY**
- **RUN-FLAT RANGE GREATER THAN MISSION RANGE**
- **POTENTIALLY NO DEGREDATION IN PERFORMANCE AT ZERO AIR PRESSURE**
- **UNSPRUNG MASS REDUCTION *(ELIMINATE RUN-FLAT)***
- **REDUCED LOGISTICS BURDEN**
- **SAFETY *(ZERO OR SIGNIFICANTLY REDUCED AIR PRESSURE)***
- **PERFORMANCE**
- **POTENTIAL TO BE USED ON VEHICLES THAT DON'T CURRENTLY HAVE RUN-FLATS**

Survivability Enhanced Run-Flat Variable Footprint Tires

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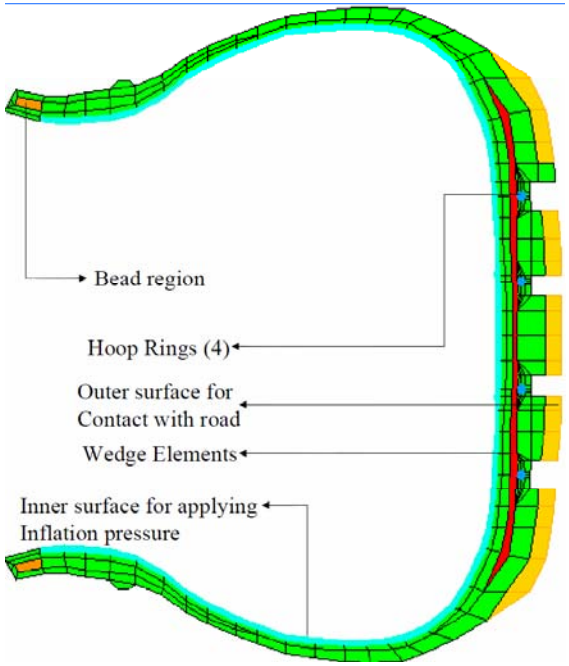

TARDEC

DEVELOPING TOMORROWS TECHNOLOGY TODAY

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15 July 2010.