Tire Analysis with Abaqus: Advanced Topics

2017
Course objectives
Topics covered in this course include:

- Steady-state rolling using Eulerian techniques in Abaqus/Standard
- Hydroplaning simulation using Coupled Eulerian-Lagrangian technique
- Efficient steady-state dynamics analysis
- Transient analysis using Abaqus/Explicit
- Substructuring and submodeling

Targeted audience
This course is recommended for tire analysts with experience using Abaqus

Prerequisites
Tire Analysis with Abaqus: Fundamentals
Day 1

- Lecture 1: Steady-State Rolling Analysis
- Workshop 1: Steady-State Rolling Analysis of a Tire
- Lecture 2: Transient Dynamic Analysis
- Workshop 2: Transient Rolling Analysis of a Tire
- Lecture 3: Linear Dynamics, Acoustics and Substructures
- Lecture 4: Submodeling
Additional Material

- Appendix 1  Co-simulation
SIMULIA is the Dassault Systèmes brand for Realistic Simulation solutions

Portfolio of established, best-in-class products
- Abaqus, Isight, Tosca, fe-safe, Simpack

Design Optimization, Tosca Structure *
Simulation-driven design refinement to improve performance

Durability Assessment, fe-safe *
Accurate life estimation to achieve certification

FEA Stress Analysis, Abaqus *
Detailed stress analysis using extracted load history from MBS

CAD Geometry, CATIA
Fully parameterized 3D geometry; FEA model generation via associative interface

Multibody Simulation, Simpack
System analysis to extract virtual load history of complete working cycle

Mesh Calibration, Isight *
Automated mesh calibration, sufficient mesh quality for accurate results

* Included in extended licensing pool
### SIMULIA’s Power of the Portfolio

<table>
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<th>Tool</th>
<th>Features</th>
<th>Applications</th>
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| Abaqus    | - Routine and Advanced Simulation  
- Linear and Nonlinear, Static and Dynamic  
- Thermal, Electrical, Acoustics  
- Extended Physics through Co-simulation  
- Model Preparation and Visualization | Realistic Human Simulation  
High Speed Crash & Impact  
Noise & Vibration |
| Isight    | - Process Integration  
- Design Optimization  
- Parametric Optimization  
- Six Sigma and Design of Experiments | Material Calibration  
Workflow Automation  
Design Exploration |
| Tosca     | - Non-Parametric Optimization  
- Structural and Fluid Flow Optimization  
- Topology, Sizing, Shape, Bead Optimization | Conceptual/Detailed Design  
Weight, Stiffness, Stress  
Pressure Loss Reduction |
| fe-safe   | - Durability Simulation  
- Low Cycle and High Cycle Fatigue  
- Weld, High Temperature, Non-metallics | Safety Factors  
Creep-Fatigue Interaction  
Weld Fatigue |
| Simpack   | - 3D Multibody Dynamics Simulation  
- Mechanical or Mechatronic Systems  
- Detailed Transient Simulation (Offline and Realtime) | Complete System Analyses  
(Quasi-)Static, Dynamics, NVH  
Flex Bodies, Advanced Contact |
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## Revision Status

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Lesson 1: Steady-State Rolling Analysis

**Lesson content:**

- Steady-State Transport (SST) Analysis
- Model Definition and Analysis
- Mullins Effect
- Viscoelasticity
- Limitations
- Steady-State Rolling Example
- Tread Wear
- Workshop Preliminaries
- Workshop 1: Steady-State Rolling Analysis of a Tire
Lesson 2: Transient Dynamic Analysis

Lesson content:

- Introduction
- Time Integration Algorithm
- Automatic Time Incrementation
- Damping
- Bulk Viscosity Damping
- Material Damping
- General Contact
- Interface between Abaqus/Explicit and Abaqus/Standard
  - Example: Impact of rolling tire with curb
- Introduction to CEL
- Modeling Tire Hydroplaning/Aquaplaning
- Workshop 2: Transient Rolling Analysis of a Tire

2.5 hours
Lesson content:

- Goals of Steady-State Dynamics
- Overview of Steady-State Dynamic Procedures
- The Subspace Projection Method
- Example: Steady-State Analysis of a Tire on a Bumpy Road
- Rotational Effects
- Example: Vibration characteristics of rolling tires
- Overview of Acoustics Features
- Acoustic Rotational Effects
- Example: Coupled Structural Acoustic Analysis of a Stationary Tire Filled with Air
- Example: Coupled Structural Acoustic Analysis of a Moving Tire
- Concept of Substructuring
- Advantages of Substructuring
- Substructure Generation and Usage
- Dynamic Substructuring
- Application of Substructuring to Tires

1.5 hours
Lesson 4: Submodeling

Lesson content:

- Concept of Submodeling
- Motivation for Submodeling
- Fundamental Assumptions
- Implementation
- Transfer of Data
- Prescribed Values
- Example: Submodel Analysis of a Tire Footprint
Appendix 1: Co-simulation

Appendix content:

- FTire Co-simulation