



Use of Simulation in Railway Vehicle Acceptance Procedures

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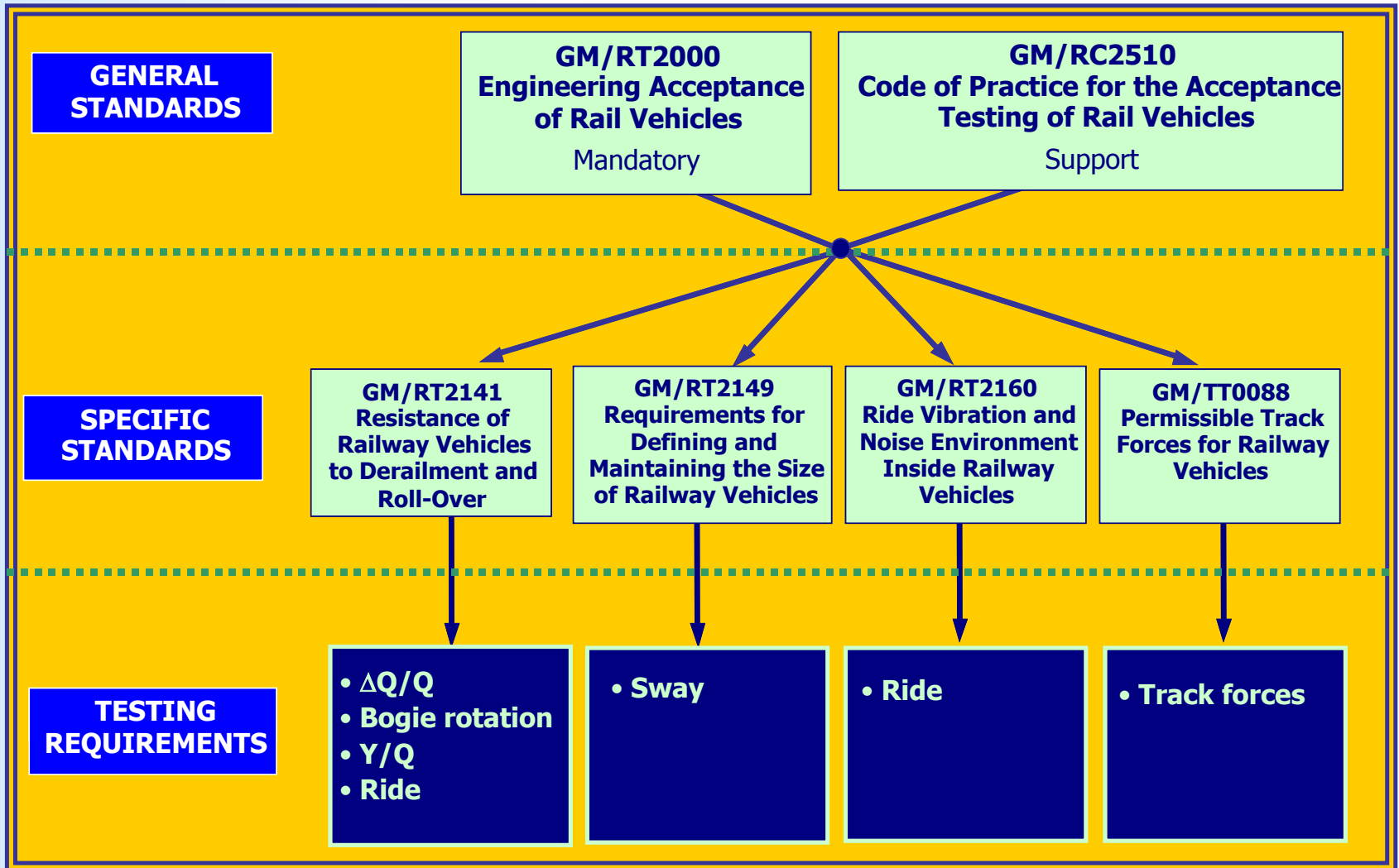
November 2004



Introduction

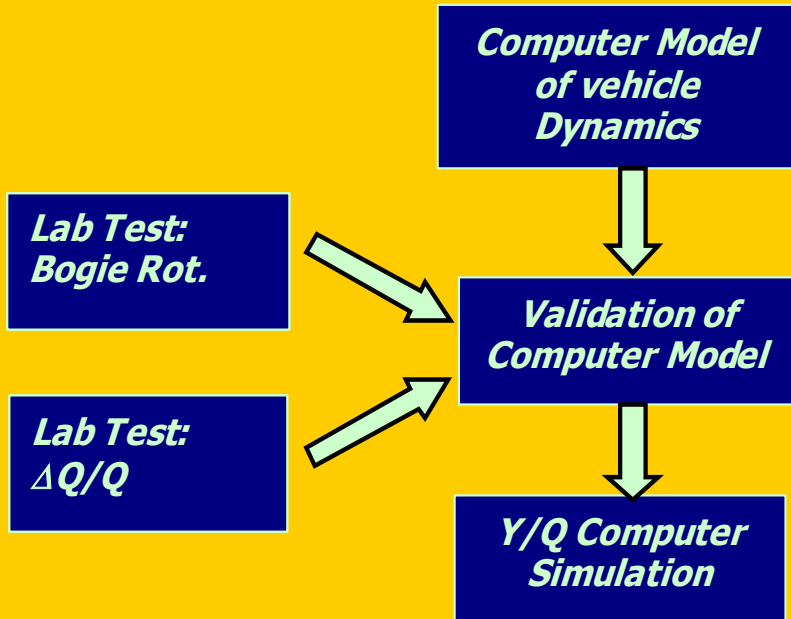
- **Tests required for vehicle acceptance are expensive, complex and time consuming**
- **How can simulation techniques improve this?**
 - When allowed by standards, substitution of test work
 - When not, as a tool for verification prior to actual tests
- **In both cases, significant savings of time and money**
- **In this presentation: A framework is produced within SIMPACK to simplify the simulation of UK acceptance tests.**

UK acceptance procedure (I): Standards



UK acceptance Tests (I): Derailment

Conventional Design



Innovative Design

Lab Test: Bogie Rotation

Lab Test: $\Delta Q/Q$

Y/Q On-track Measurement

All Cases

Ride On-track Measurement

UK acceptance Tests (II)

Gauging

*Lab Test:
Sway*



*Kinematic
gauging*



*Verification of
clearances on
route*

Comfort

*On Track
Acceleration
Measurement*



*Calculation of
Ride Indices &
Vibration Doses*

Track Forces

*Wheel-Track Force
Measurement*



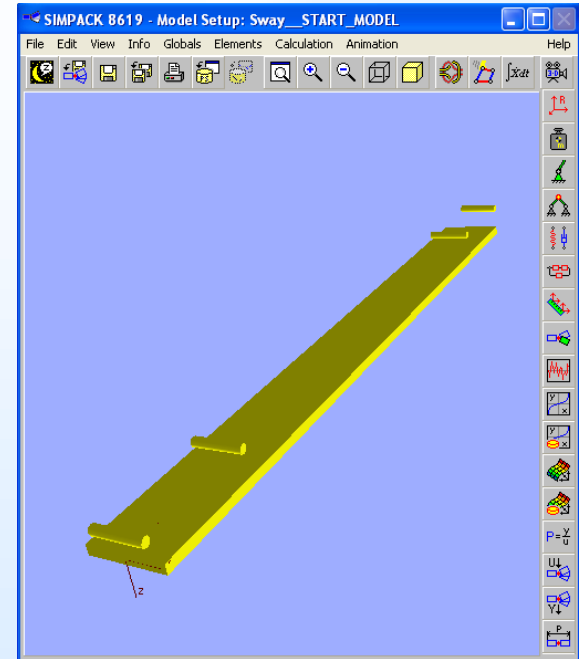
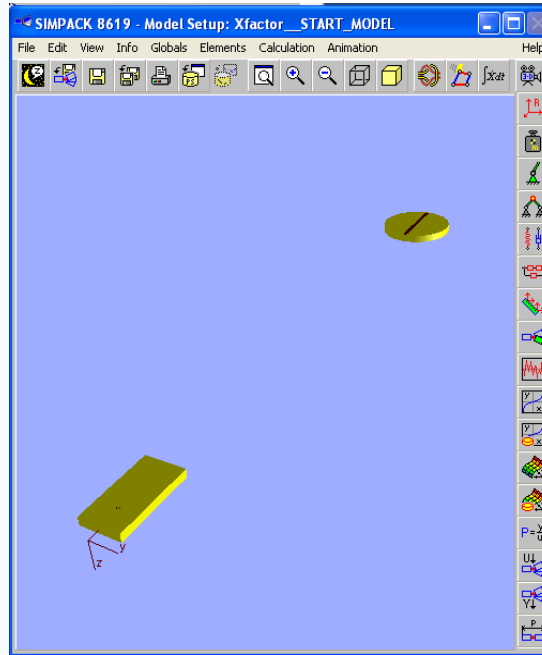
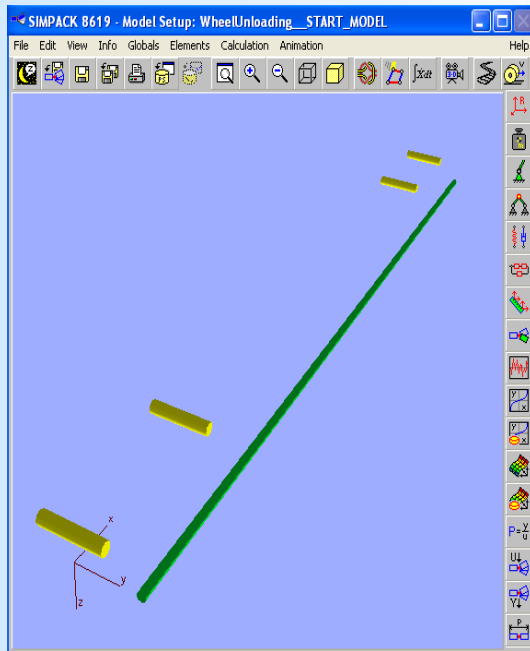
*Wheel-Track Force
Calculation*



*Verification of
Static &
Dynamic Limits*

Modelling Strategies (I): Standard Scenarios

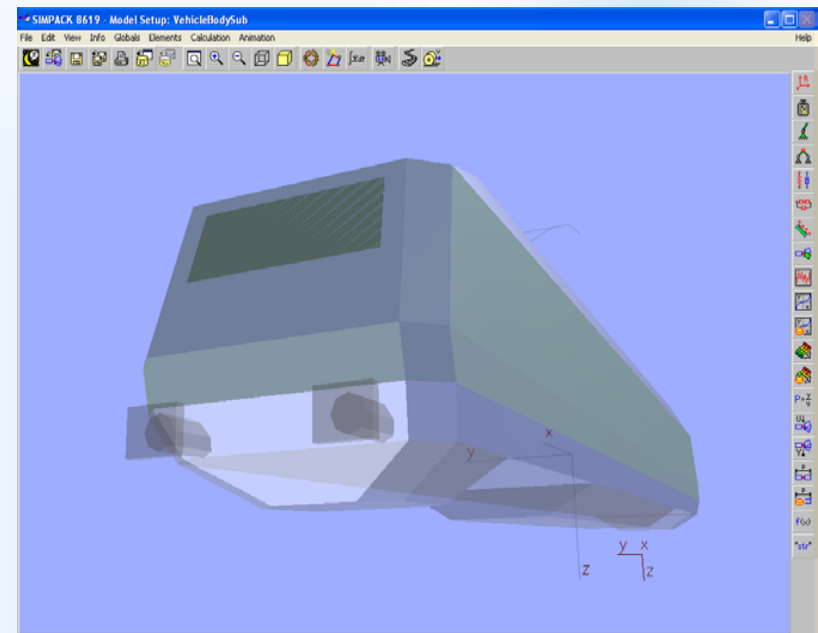
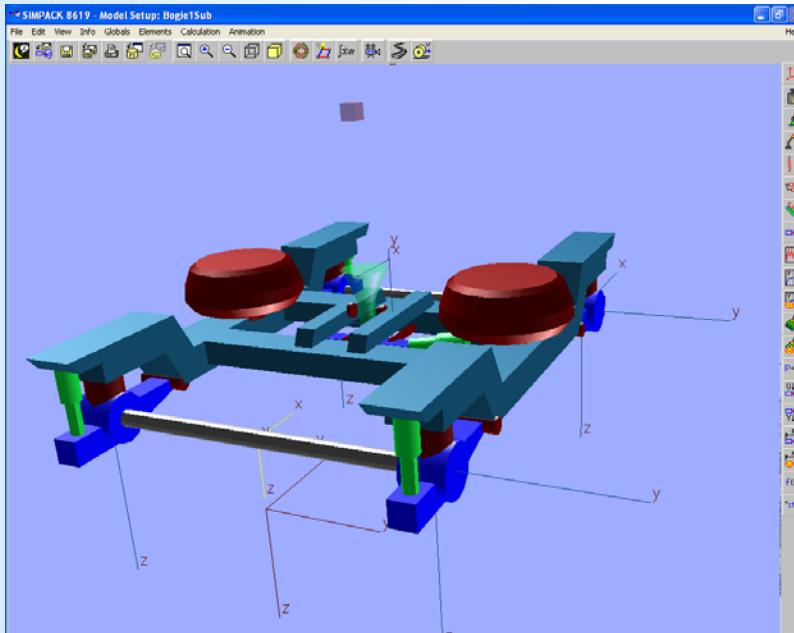
- **Generation of standard simulation scenarios and output results useful for any vehicle**



- **Mechanics of the lab equipment and measurement outputs are implemented**

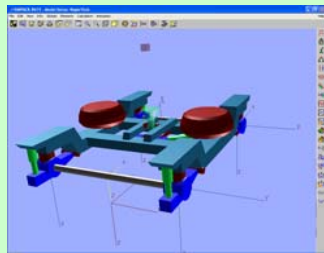
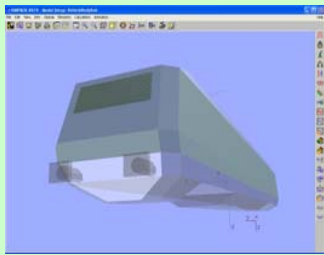
Modelling Strategies (II): Modular Vehicle

- **Vehicle model for both on-track time simulations and specific lab tests**
 - **Modular approach using substructures**
 - **Predefined interface points to fit the simulation scenarios**

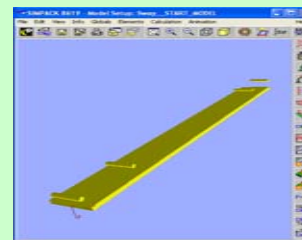
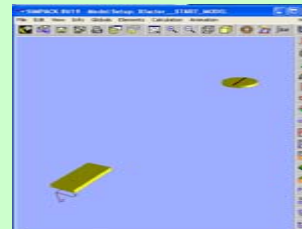
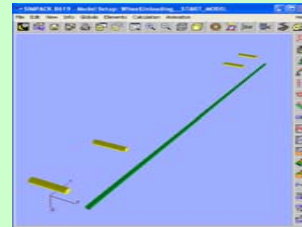


Modelling Strategies (III): Complete Process

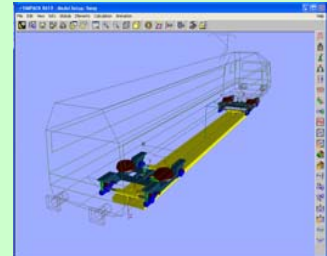
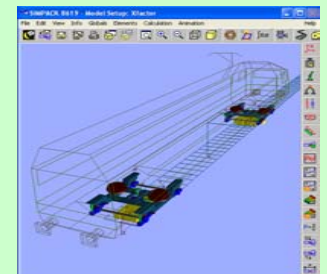
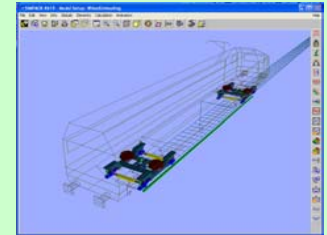
Common Database



Vehicle



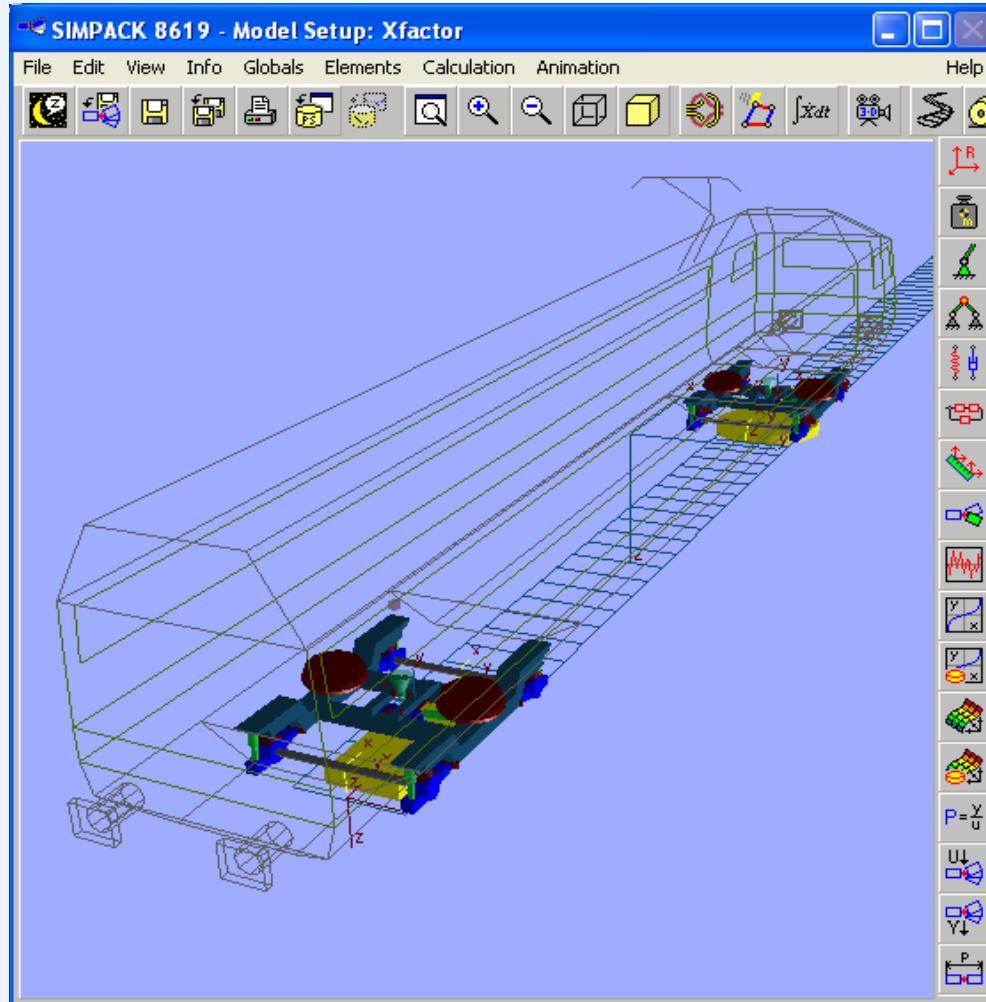
Test Scenarios



Test Simulation

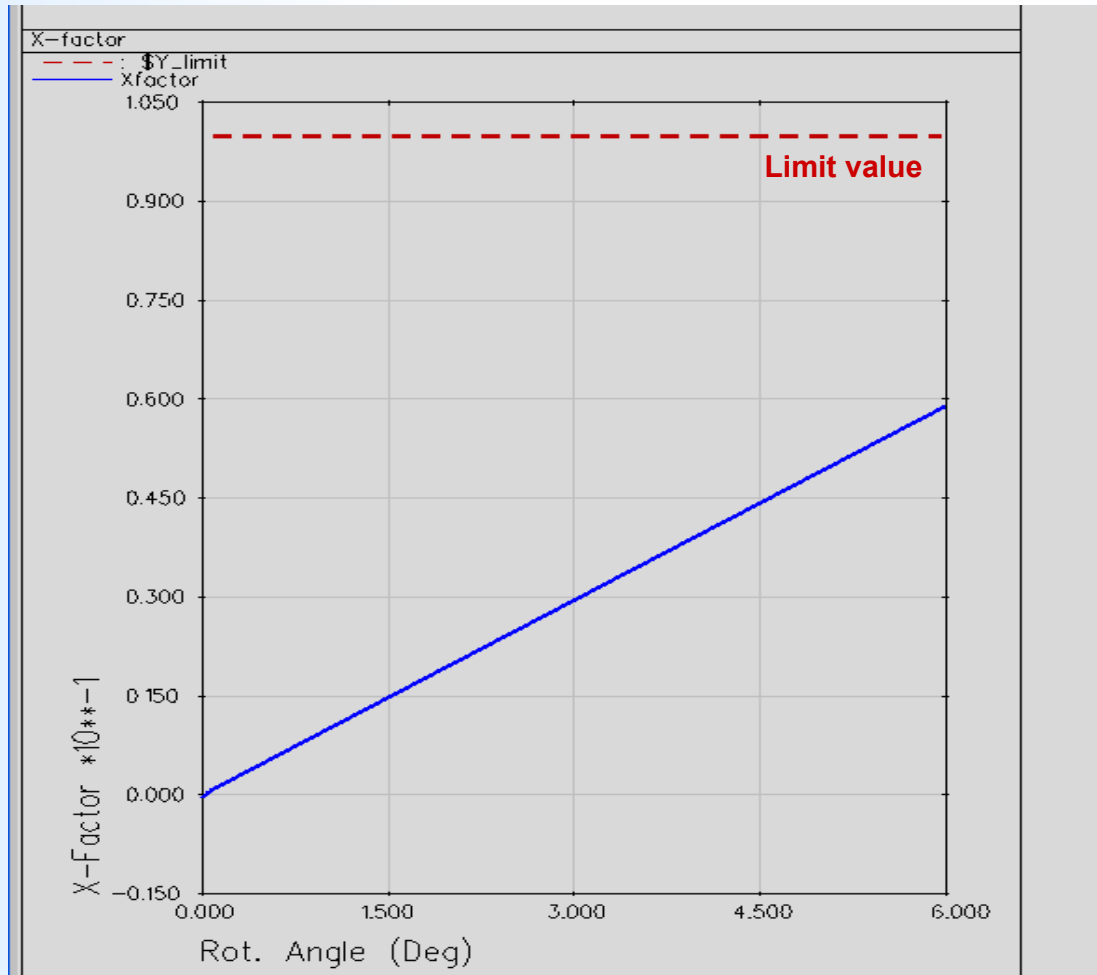
Case Study: Derailment (I)

1. Validation of Computer Model: Bogie Rotation Test



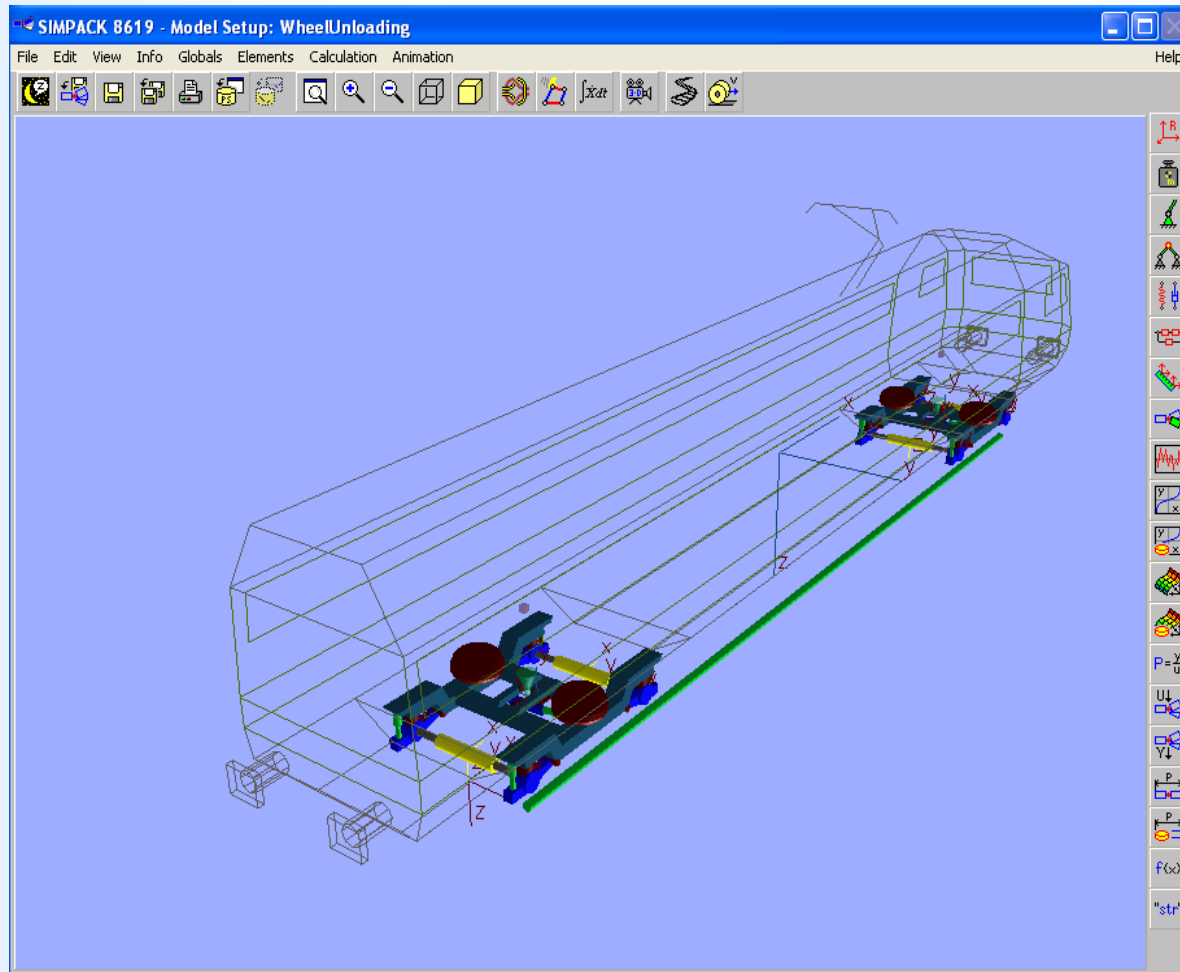
Case Study: Derailment (I)

1. Validation of Computer Model: Bogie Rotation Test



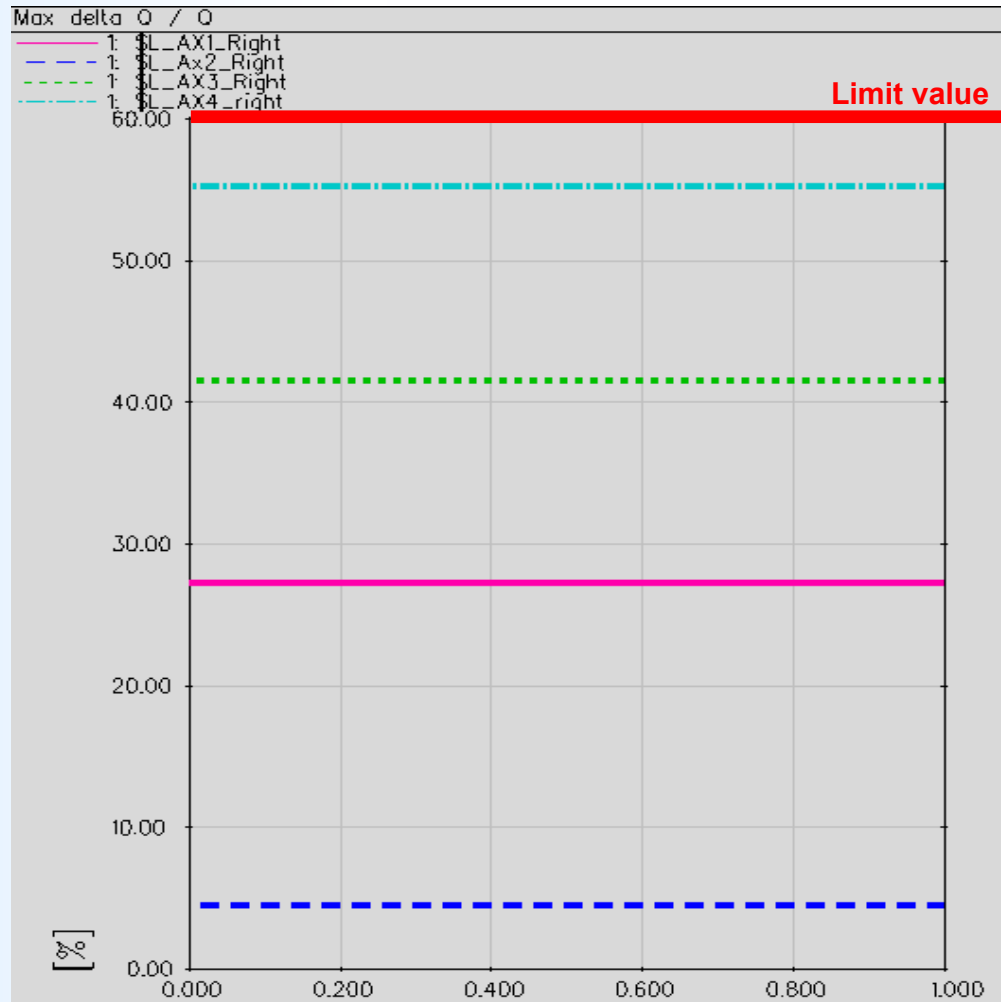
Case Study: Derailment (II)

2. Validation of Computer Model: $\Delta Q/Q$ Test



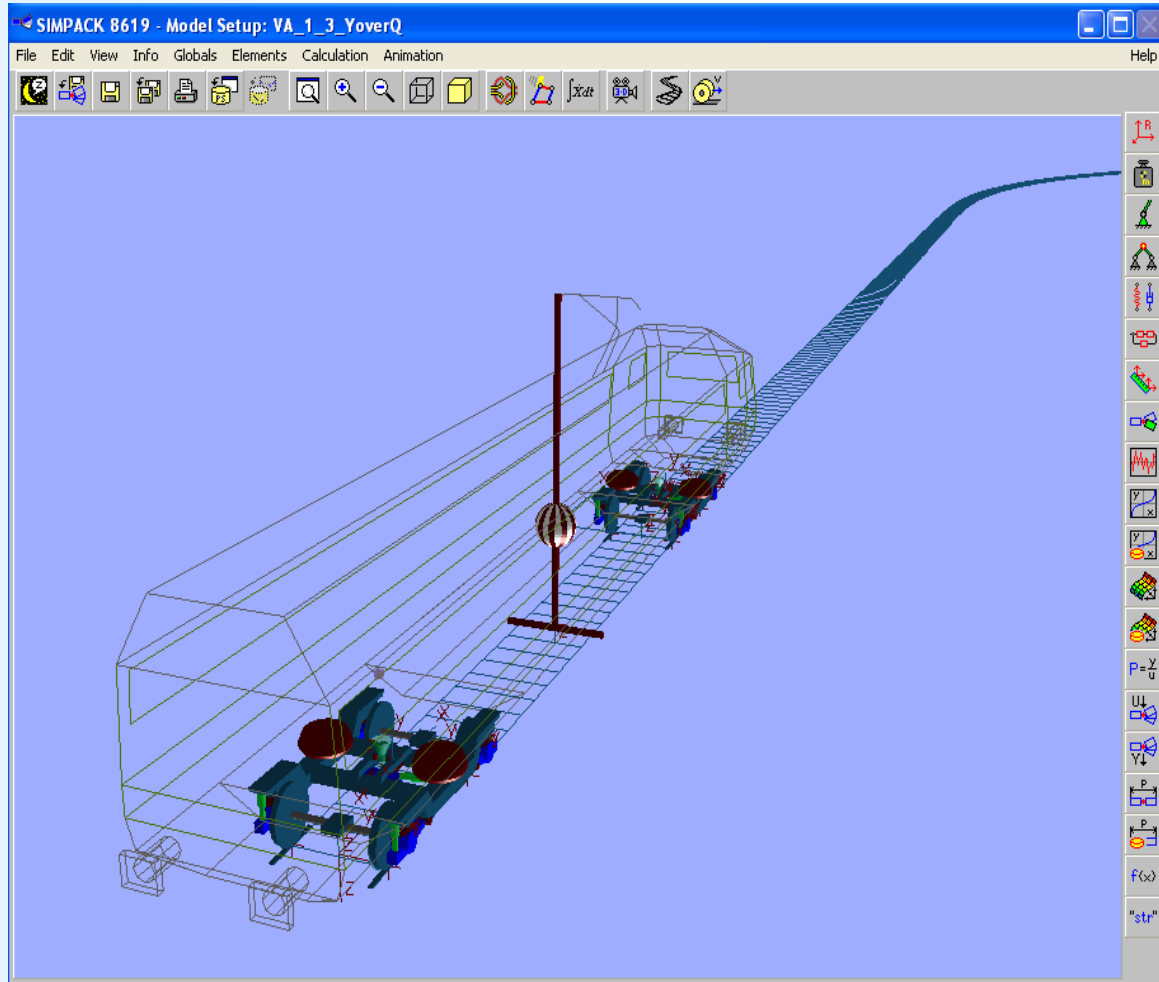
Case Study: Derailment (II)

2. Validation of Computer Model: $\Delta Q/Q$ Test



Case Study: Derailment (III)

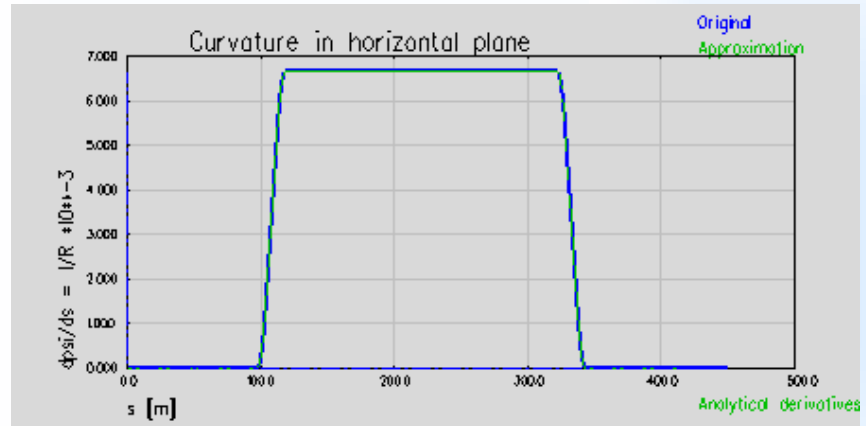
3. Y/Q Verification by Simulation:



Case Study: Derailment (III)

3. Y/Q Verification by Simulation: Parametric Scenarios according to standards

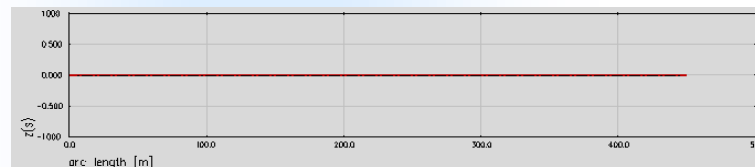
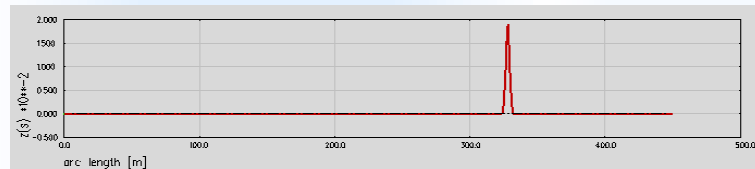
Curve definition:



Left

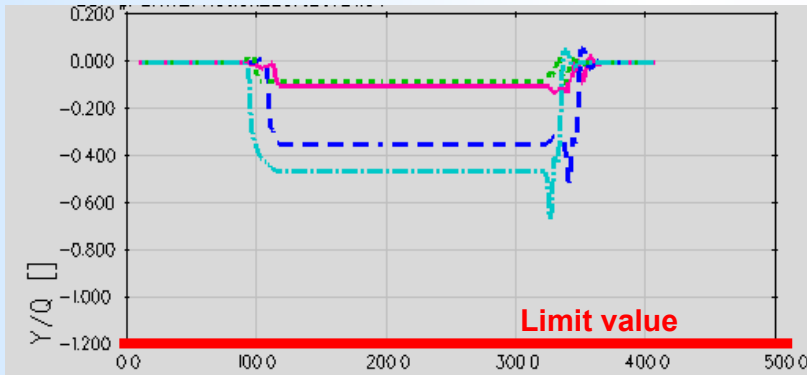
Irregularities:

Right

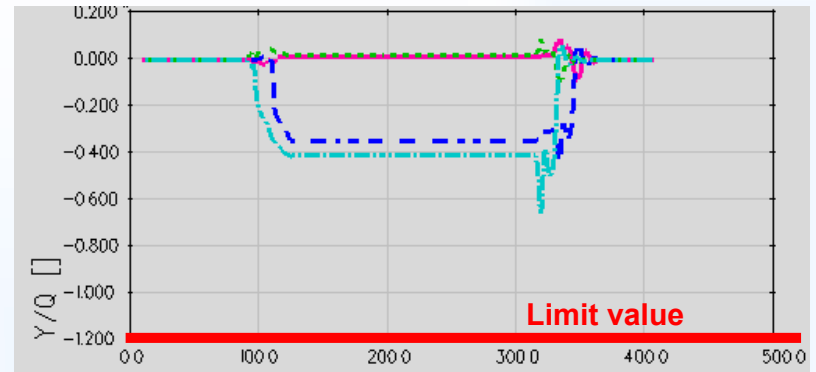


Case Study: Derailment (III)

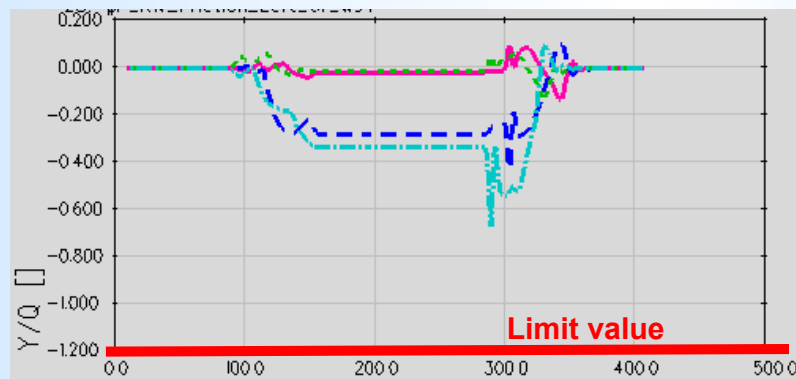
3. Y/Q Verification by Simulation: Results



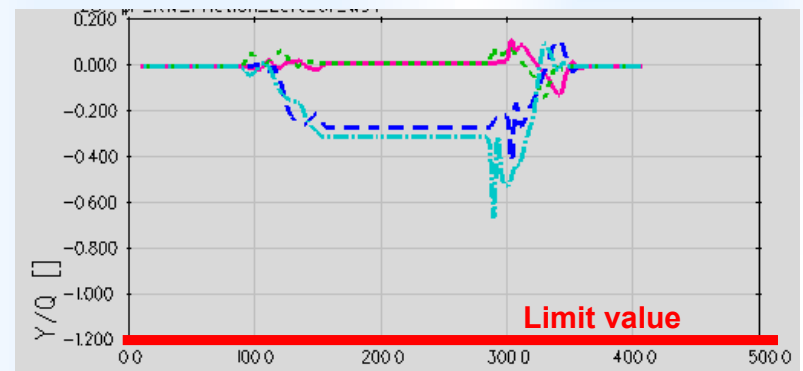
R=75



R=150



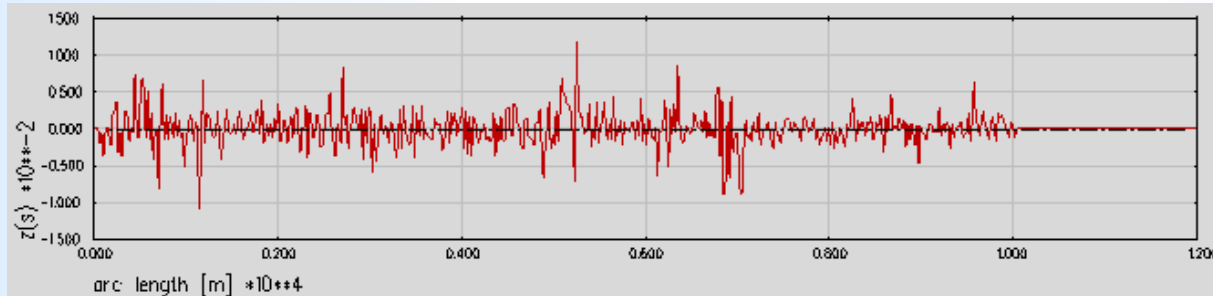
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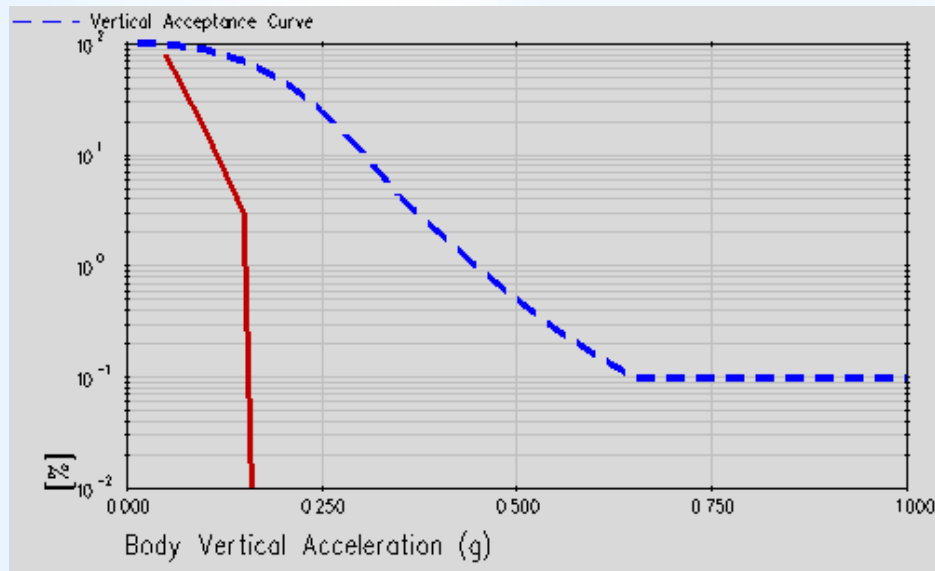
R=300

Case Study: Derailment (IV)

4. Ride Stability: Time Simulation with irregularities

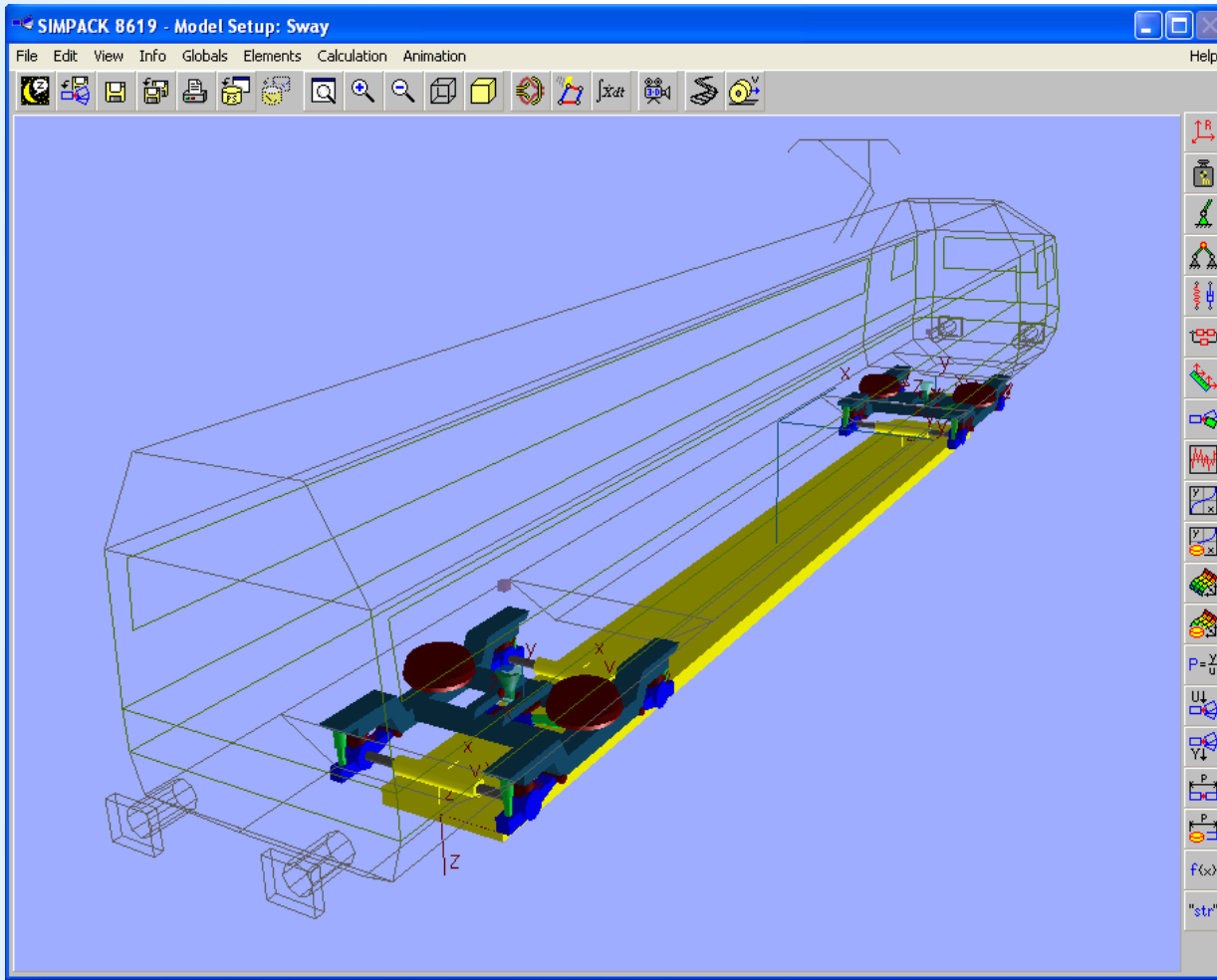


Cumulative acceleration peak counting:



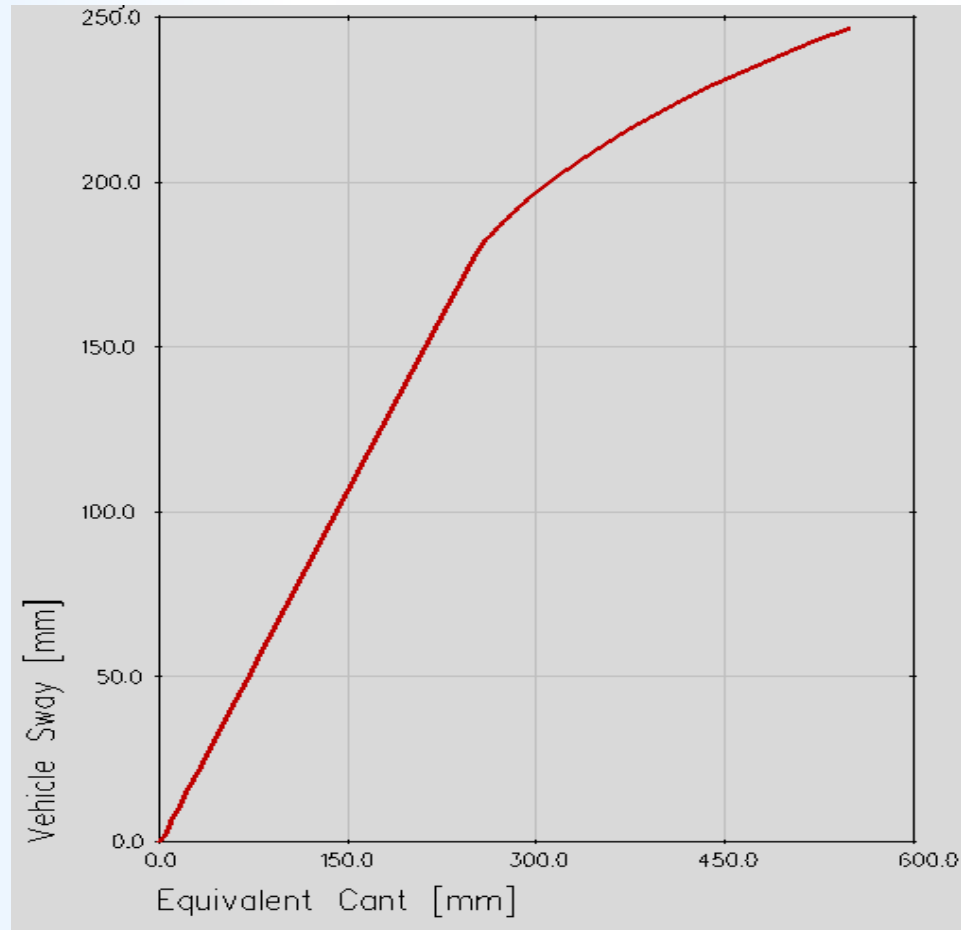
Case Study: Gauging

➤ Sway Test: Simulation of laboratory test



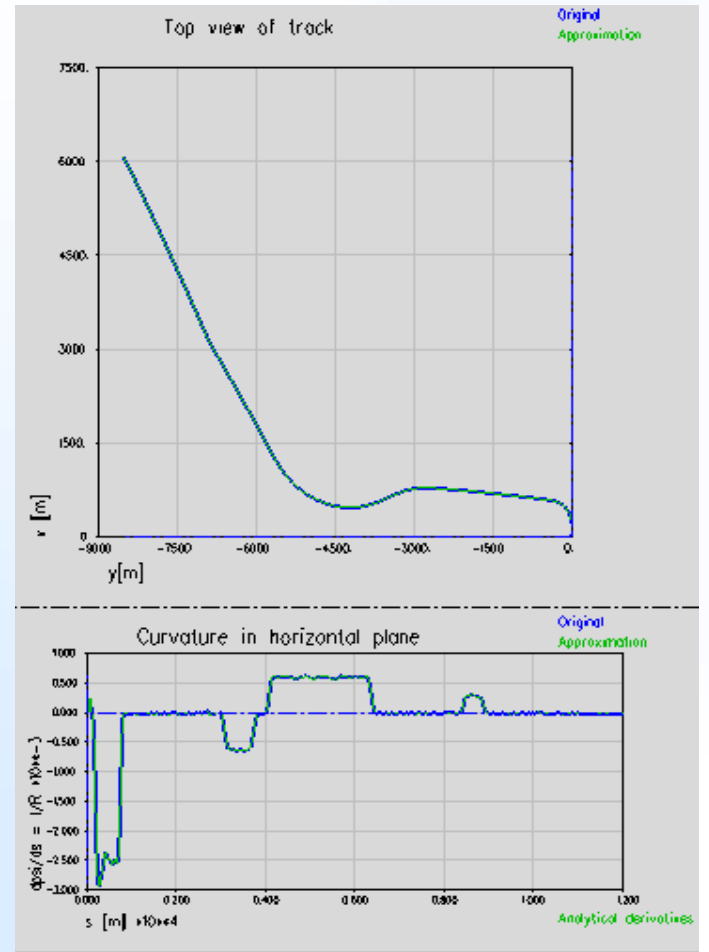
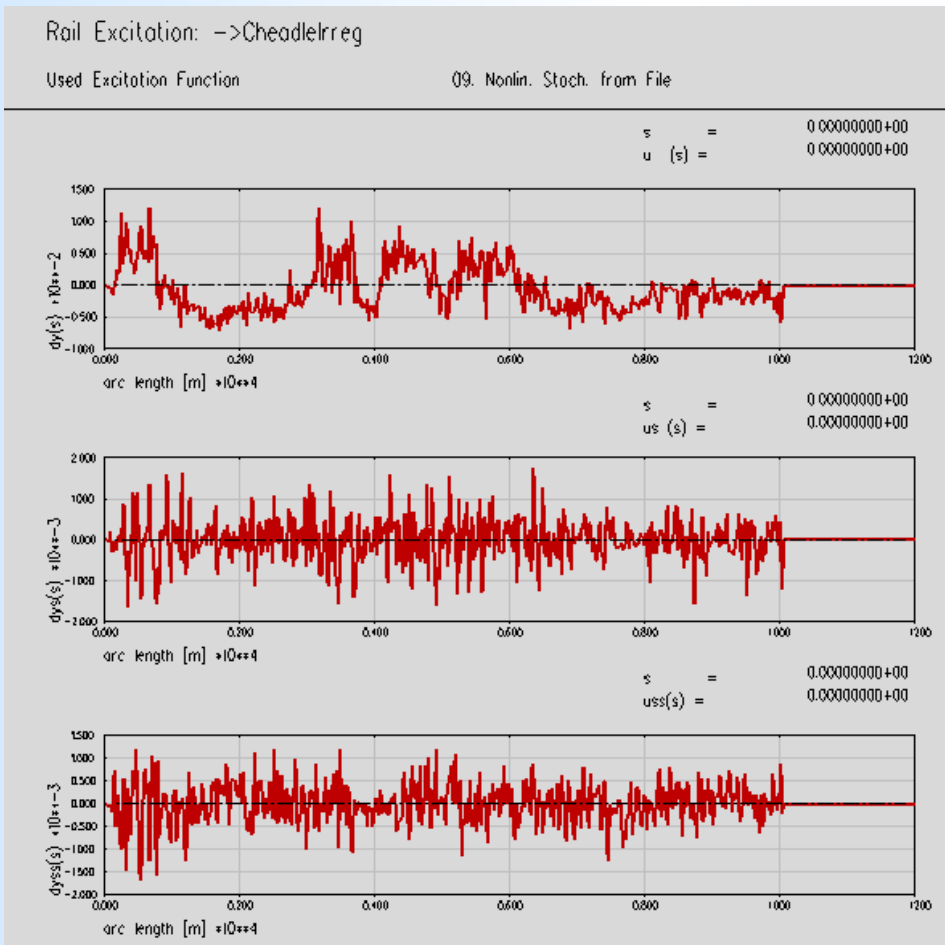
Case Study: Gauging

➤ Sway Test: Validation of sway model



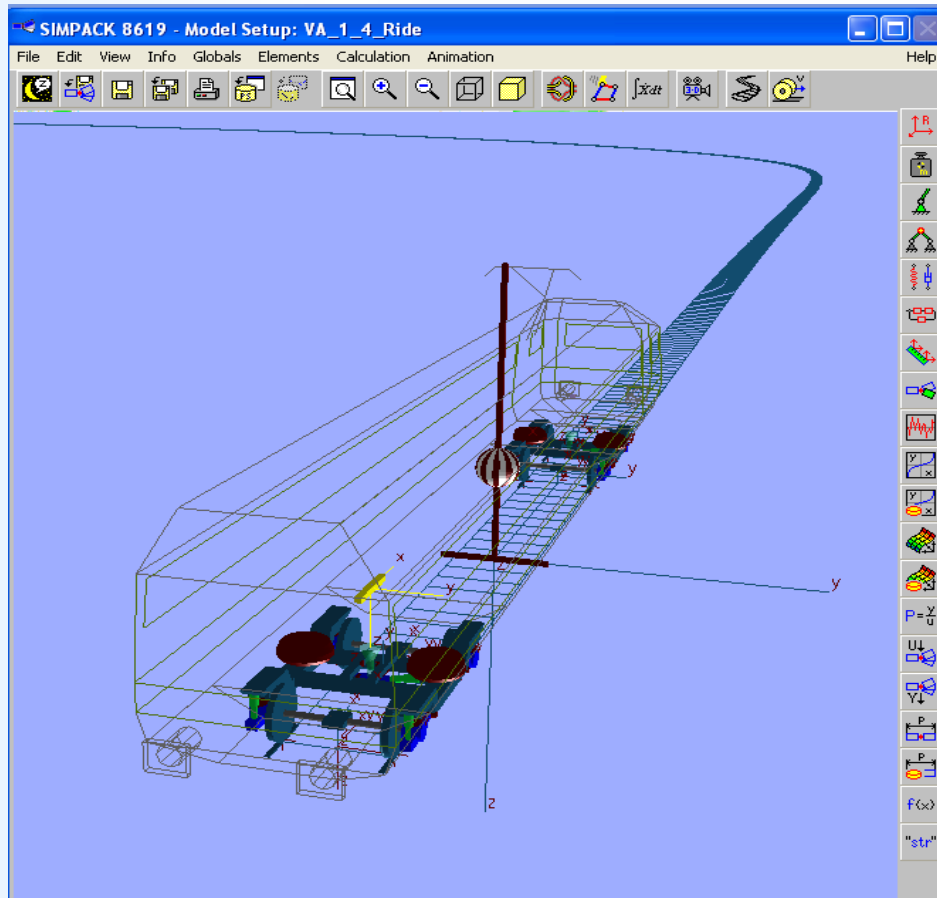
Case Study: Ride Comfort & Track Forces

➤ Ride and track forces from time simulation



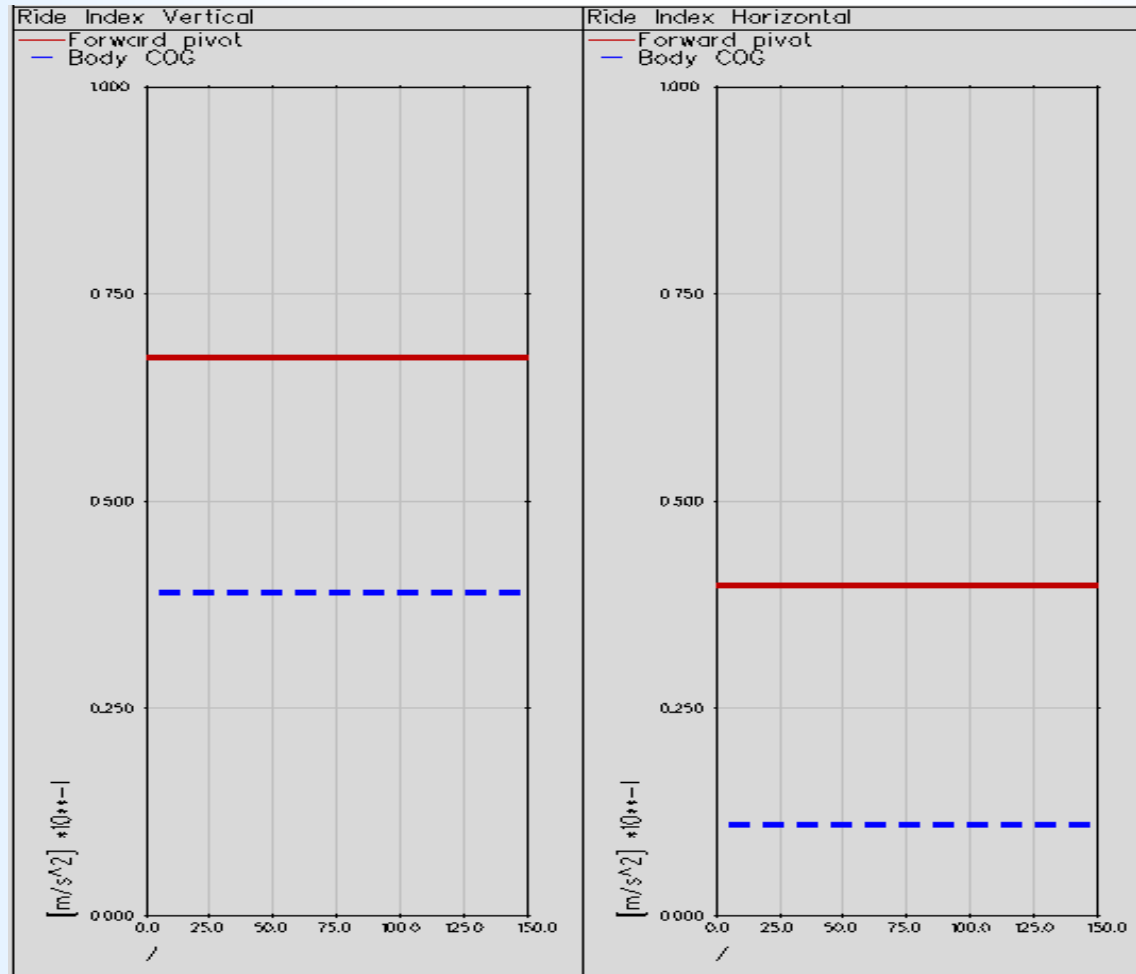
Case Study: Ride Comfort & Track Forces (II)

- **Time Simulation. Flexible vehicle body model necessary for comfort assessment.**



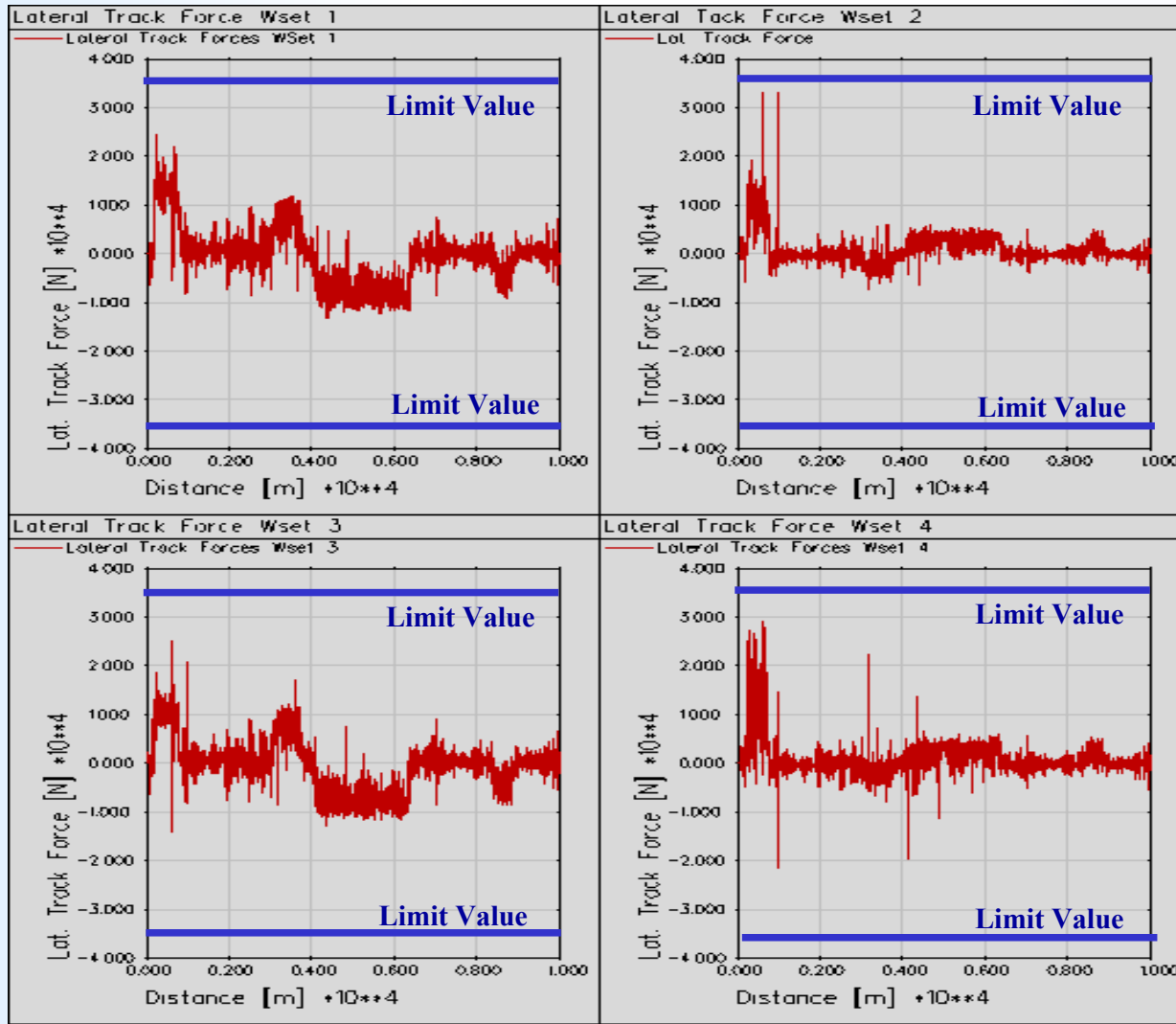
Case Study: Ride Comfort & Track Forces (II)

➤ Comfort indices



Case Study: Ride Comfort & Track Forces (II)

➤ Results: Lateral Track Force



Conclusions

- Creation of a **new framework** where the computer simulation of acceptance tests becomes a **routine task**
- **SIMPACK** offers the features to achieve this: **Flexibility, modularity, parametric modelling** based on a database
- These tools can be used to **save time and money** in the vehicle acceptance process
- **Future** acceptance requirements expected to move towards more **computer based simulation** than actual tests