Use of Simulation in Railway Vehicle Acceptance Procedures

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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

GENERAL STANDARDS

GM/RT2000 Engineering Acceptance of Rail Vehicles
  Mandatory

GM/RC2510 Code of Practice for the Acceptance Testing of Rail Vehicles
  Support

SPECIFIC STANDARDS

GM/RT2141 Resistance of Railway Vehicles to Derailment and Roll-Over

GM/RT2149 Requirements for Defining and Maintaining the Size of Railway Vehicles

GM/RT2160 Ride Vibration and Noise Environment Inside Railway Vehicles

GM/TT0088 Permissible Track Forces for Railway Vehicles

TESTING REQUIREMENTS

• $\Delta Q/Q$
• Bogie rotation
• $Y/Q$
• Ride

• Sway

• Ride

• Track forces
UK acceptance Tests (I): Derailment

Conventional Design

- Lab Test: Bogie Rot.
- Lab Test: \( \Delta \frac{Q}{Q} \)
- Computer Model of vehicle Dynamics
- Validation of Computer Model
- Y/Q Computer Simulation

Innovative Design

- Lab Test: Bogie Rotation
- Lab Test: \( \Delta \frac{Q}{Q} \)
- 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
1. Validation of Computer Model: Bogie Rotation Test

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

Irregularities:
- Left
- Right
Case Study: Derailment (III)

3. Y/Q Verification by Simulation: Results

- R=75
- R=150
- R=225
- R=300
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)

- Comfort indices
Case Study: Ride Comfort & Track Forces (II)

- Results: Lateral Track Force

![Graphs showing lateral track force for different cases with limit values indicated.](image-url)
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