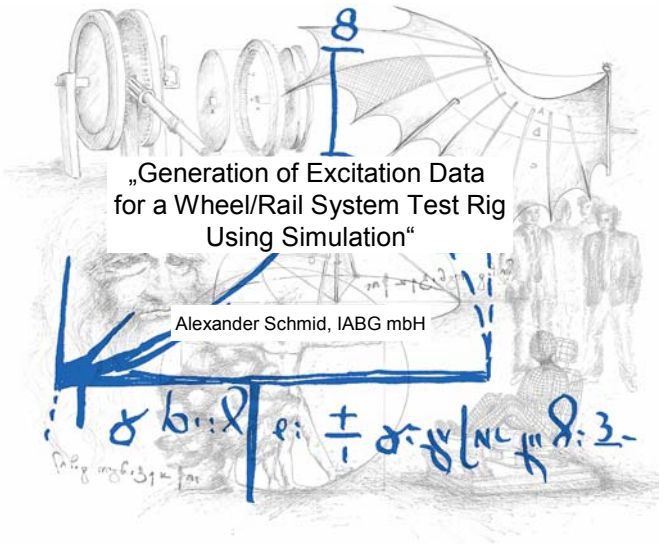


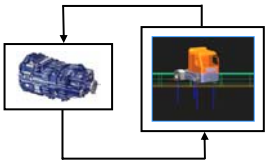
„Generation of Excitation Data for a Wheel/Rail System Test Rig Using Simulation“

Alexander Schmid, IABG mbH

IABG

Business Activities Test and Analysis Centre

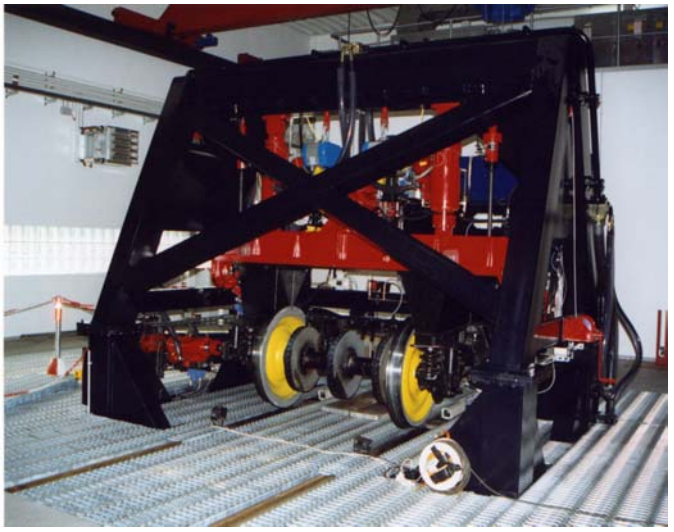
- Fatigue and Static/Dynamic Testing of Aerospace Structures
- Experimental Investigations in Vehicle Technology and Plant Engineering
- Test Facilities
- Maintenance and Damage Analysis
- CAE Services
- **Mechatronics Services**
- Maglev Transportation
- Environmental Services



IABG

Contents

Project Introduction — Wheel/Rail System Test Rig



Deutsche Bahn AG
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14774 Brandenburg

Application Areas

General:

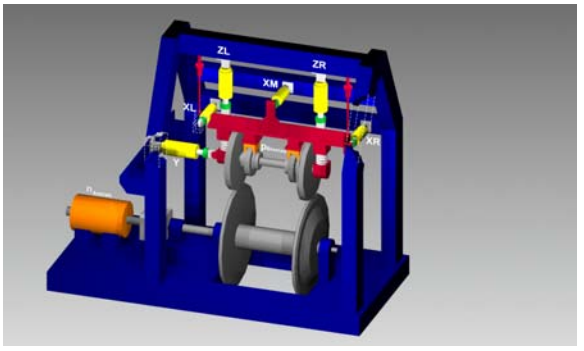
„Investigation of Interactions Concerning the Wheel Rail System“

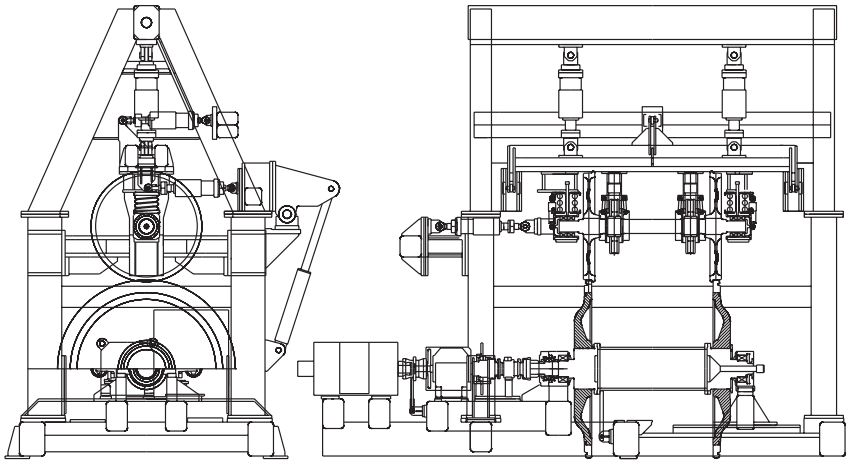
Examples:

- Investigation for the Causes and Mechanisms of Rolling Contact Fatigue
- Testing of Materials, Production Processes and Profile Combinations
- Analysis Concerning the Unround Phenomena of Wheels
- Testing of Components (e.g. Check Systems for Diagnosing Wheelsets)
- Investigation of the Noise Created and Propagated because of the Rolling Contact

Service Description

„The RASP allows full-size wheelsets to be subjected to stressing on a pair of rollers under reproducible dynamic contact conditions”





• Rail Roller Diameter	2,1 m
• Wheel Diameter	max. Ø 1,25 m
• Wheelset Load	max. 34 t
• Running Speed	max. 330 km/h

- Re-profiling Unit for Roller and Wheel
- Roller Consists of Rail Material (900A)
- Controlled Braking of the Wheelsets
- Lubrication Unit
- Strain Gauge Measuring Method for Axle and Disc (Wheel and Roller)

Overview

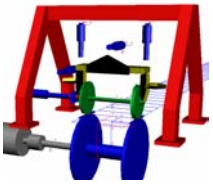
- Project Introduction
- Application Areas
- Service Description
- SIMPACK with the Wheel/Rail System Test Rig (RASP)
  - Development Process
  - Multi-Body System
  - Generation of Excitation Data
  - Applications
- Summary

Using SIMPACK — Development Process

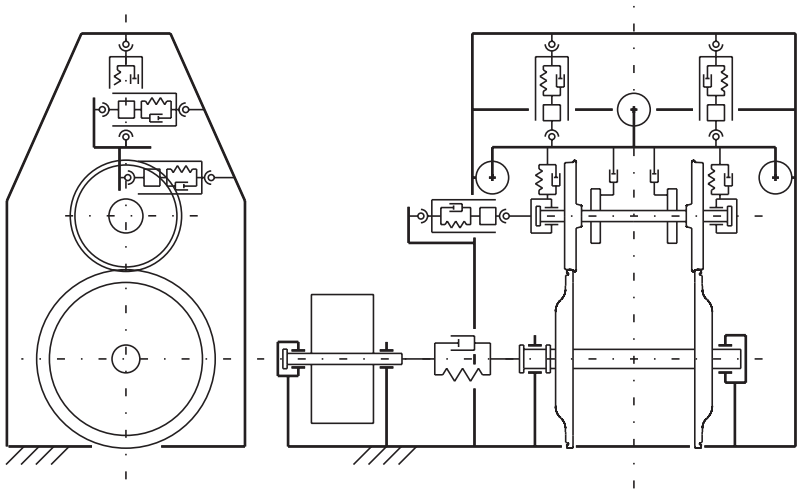
Verification

Adaptation

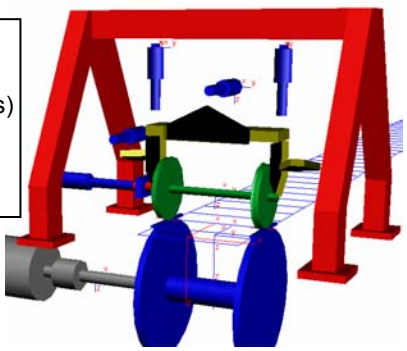
Objective: Identical Contact Conditions

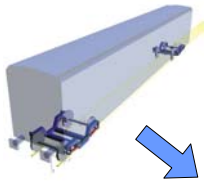


Identification, Verification



- 11 Rigid Bodies
- 7/9 Degrees of Freedom
- 6 Kinematic Loops (18 Constraints)
- Parametric Model
- Identified Parameters
- Non-linear Characteristic Lines





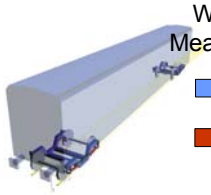
„INDIRECT“

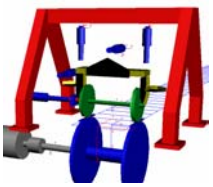
- Selected Positions
- Load Collectives

Target Values:
- Contact Patch Area
- Slip
- Forces / Torques
- Normal Stress
- …

„DIRECT“

- Selected Wheelset



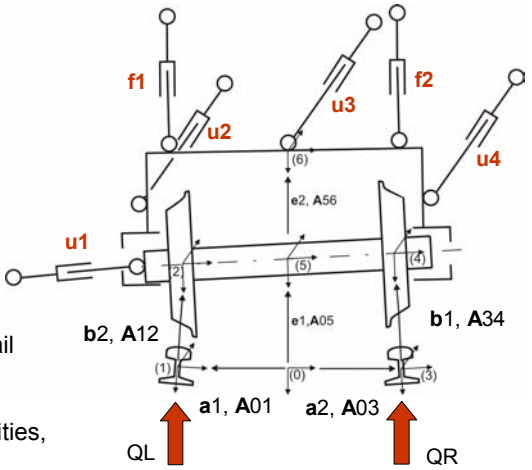


Output Values (Vehicle Model)
- Relative Measurement (Position, Orientation)
- Vertical Force in Track (Q)

Input Values (Test Rig Model)
- Cylinder Displacement
- Cylinder Force

Boundary Conditions
- Wheelset Positioning
- Difference Between Roller & Rail
- Elastic Wheelset Suspension
- Rigid Roller Axle (Curved Tracks, Track Irregularities, Superelevation)

Transformation

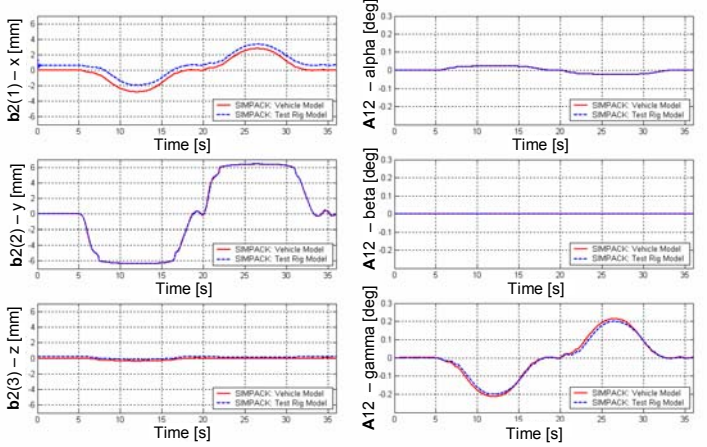


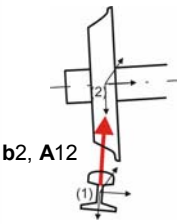
Comparison of In- and Output Values: Relative Measurement

Transformation

Position: **b**2

Orientation: **A**12





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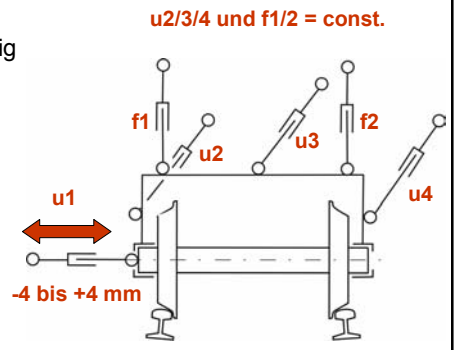
    - Wheelset Positioning
    - Difference between Roller Test Rig and Rail
- Summary

Intention: Centering – Exact Position of the Wheelset

- Wheelset Displacement
- Geometrical Displacement of the Test Rig
- Tolerances (Wheelset and Roller)



Procedure:

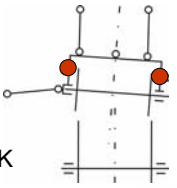
- Model Based Analysis/Identification of the Wheelset Displacement
- Test: Constrained Lateral Deflection of the Wheelset

Result:

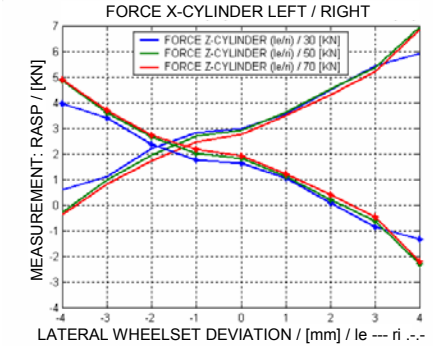
- Procedure to position the Wheelset
- Quantification of the Effect of Tolerances

Wheelset Displacement : Lateral Offset (1.5 mm)

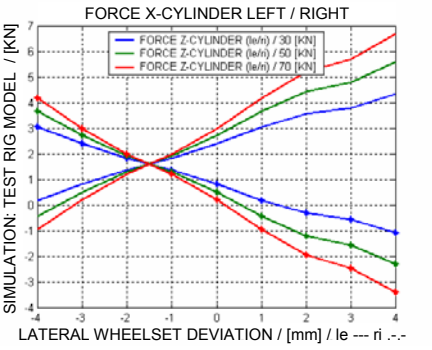
Constrained Forces of the Yaw Cylinders (X-Cylinders; u2 and u4)



Test: RASP

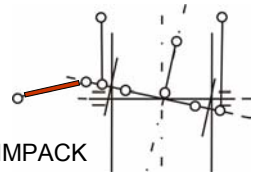


Simulation: SIMPACK

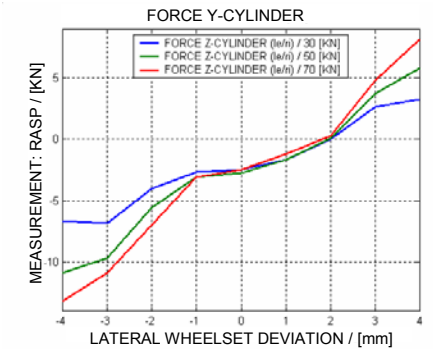


Wheelset Displacement: Tangential Deviation (0.06 deg)

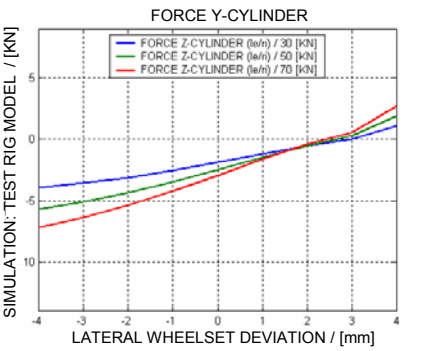
Constrained Force of the Lateral Cylinder (Y-Cylinder; u1)



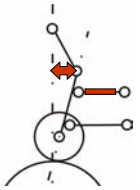
Test: RASP



Simulation: SIMPACK

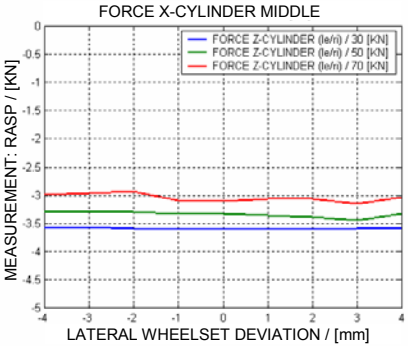


Geometrical Displacement of the Test Rig: Mismatch (6.5 mm)

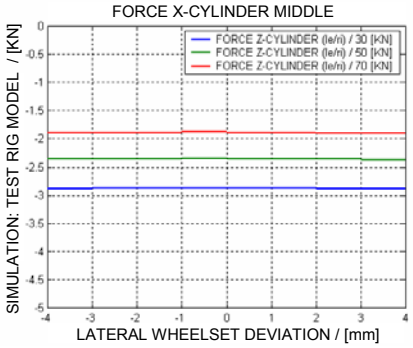


Constrained Force of the Pitch Cylinder (X-Cylinder; u3)

Test: RASP



Simulation: SIMPACK

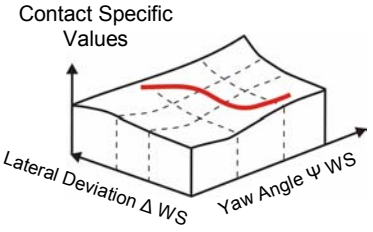


Intention: Adjustment – Difference Between Roller Test Rig and Rail

- Test Rig Dependency
- Vehicle Model / Dynamic Maneuver

Procedure:

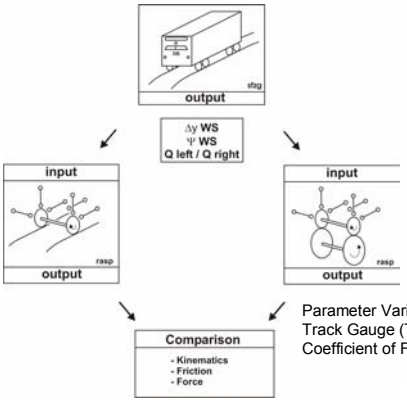
- Analysis of the Differences Using MBS-Simulation



Result:

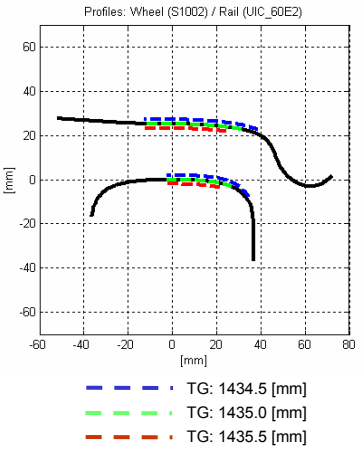
- Quantification of the systematic Differences
- (Effect of variations in Friction and Track Gauge)

Procedure:



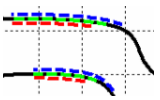
Parameter Variation:
Track Gauge (TG)
Coefficient of Friction

Used Contact Patch Area

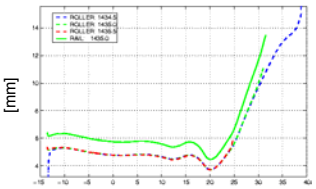


Using SIMPACK Difference between Roller Test Rig and Rail

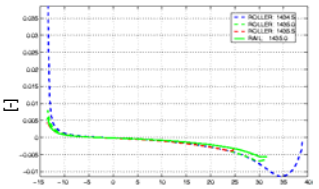
Track Gauge Variation: ± 0.5 mm

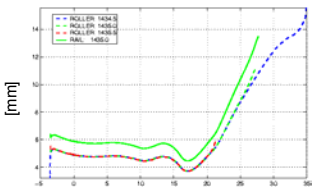


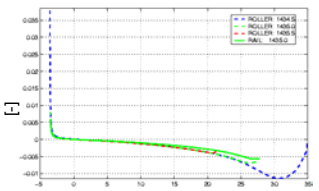
A: Semi-Axis



Longitudinal Creepage



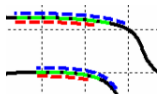




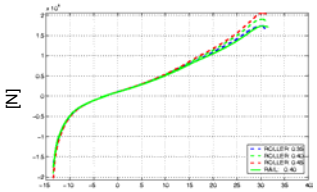
S-Curve	630 m
Superelevation	0.138 m
Wheelset Load	13.2 t
Velocity	100 km/h

Difference between Roller Test Rig and Rail

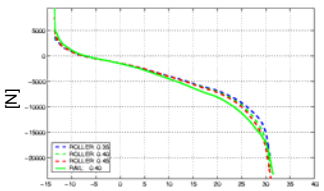
Coefficient of Friction Variation: ± 12.5 %

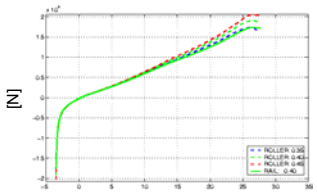


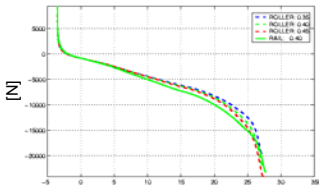
T_x Long. Creepage Force



T_y Lat. Creepage Force







S-Curve	630 m
Superelevation	0.138 m
Wheelset Load	13.2 t
Velocity	100 km/h

Using SIMPACK

"SIMPACK is an important tool within the development environment of the wheel/rail system test rig (RASP)"

Suggestions:

- Documentation of the Output Format – Direct Access (Time Integration-, Linear System- Analysis and Parametervariation)
- Further Development for Using the Batch – Mode on Operating System Platforms
- Info about the Complete Solver Input – Possibility to Check the Actual Used Parameters (Main Model, Database, …)
- Possibility to Define Time Excitations within a Sub-Structure Model
- Possibility to Select Characteristic Lines within a Parameter Input File