

On the Validation of Cross-Wind Calculation Models for Railway vehicles

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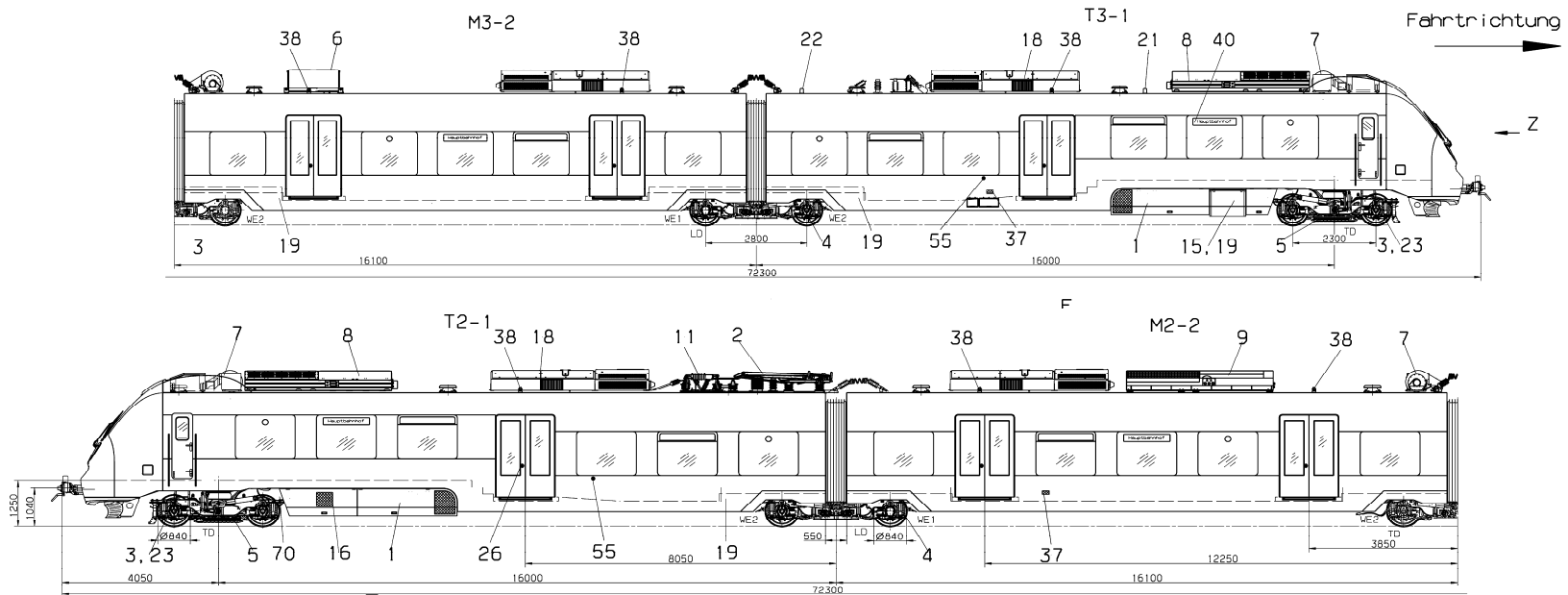
SIMPACK User Meeting, May 2011, Salzburg

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Introduction

- cross wind calculations according to RIL 807
- for full vehicle since 4-car EMU with Jakobs bogies
- set up of 4-car SIMPACK- model
- verification of model by comparing calculation results with
 - **measured sway coefficient** from
 - scale
 - **verification problems with sway test**
 - **measured wheel unloading** from
 - test runs
 - scale
 - **verification successful**
- verified model serves as basis for cross wind calculations

Cross wind calculations according to RIL 807

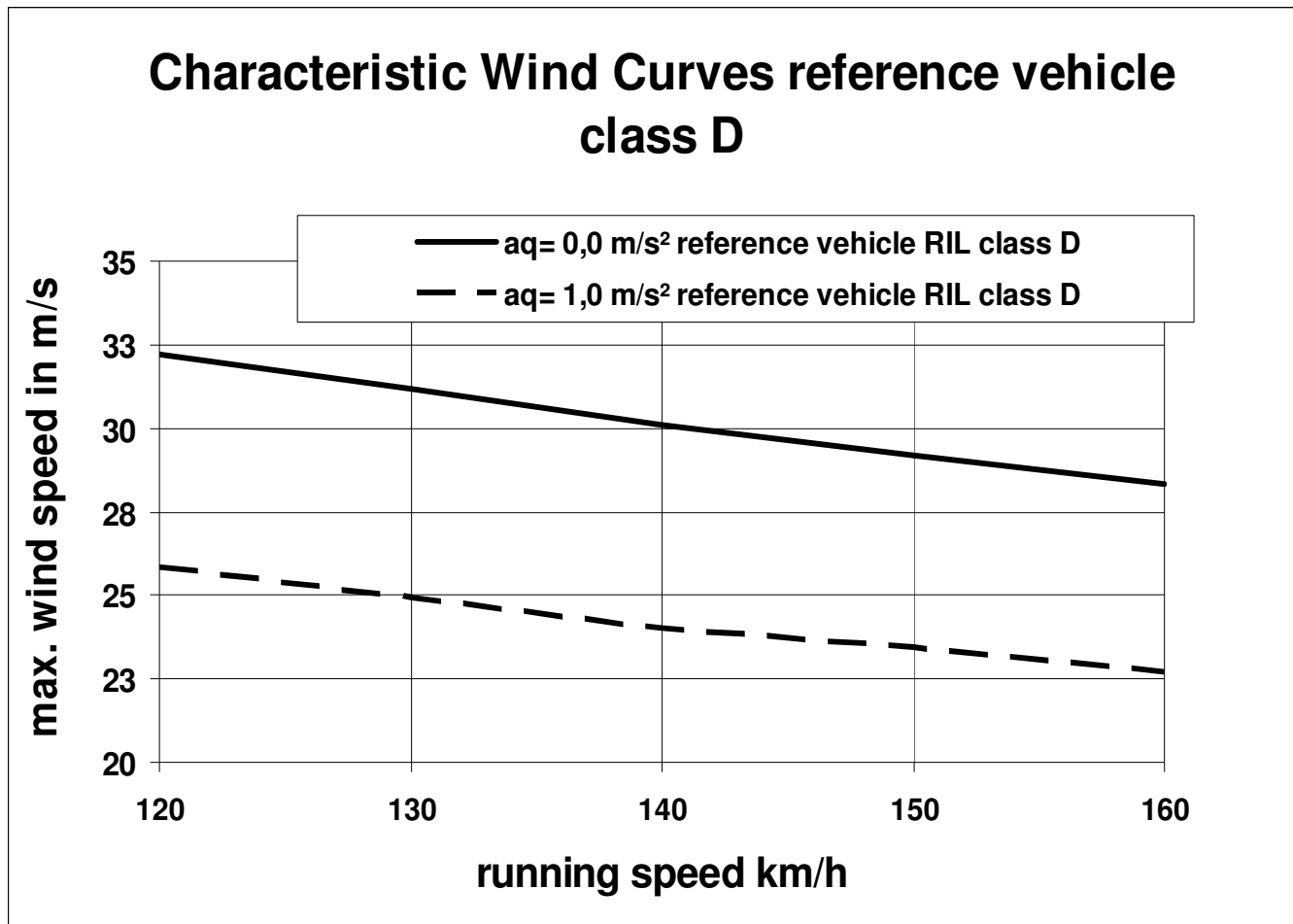


vehicle for $v_{\max} = 160$ km/h, conventional, non tilting

→ RIL 807, Class D

EMU with Jakobs bogies → full vehicle for calculation

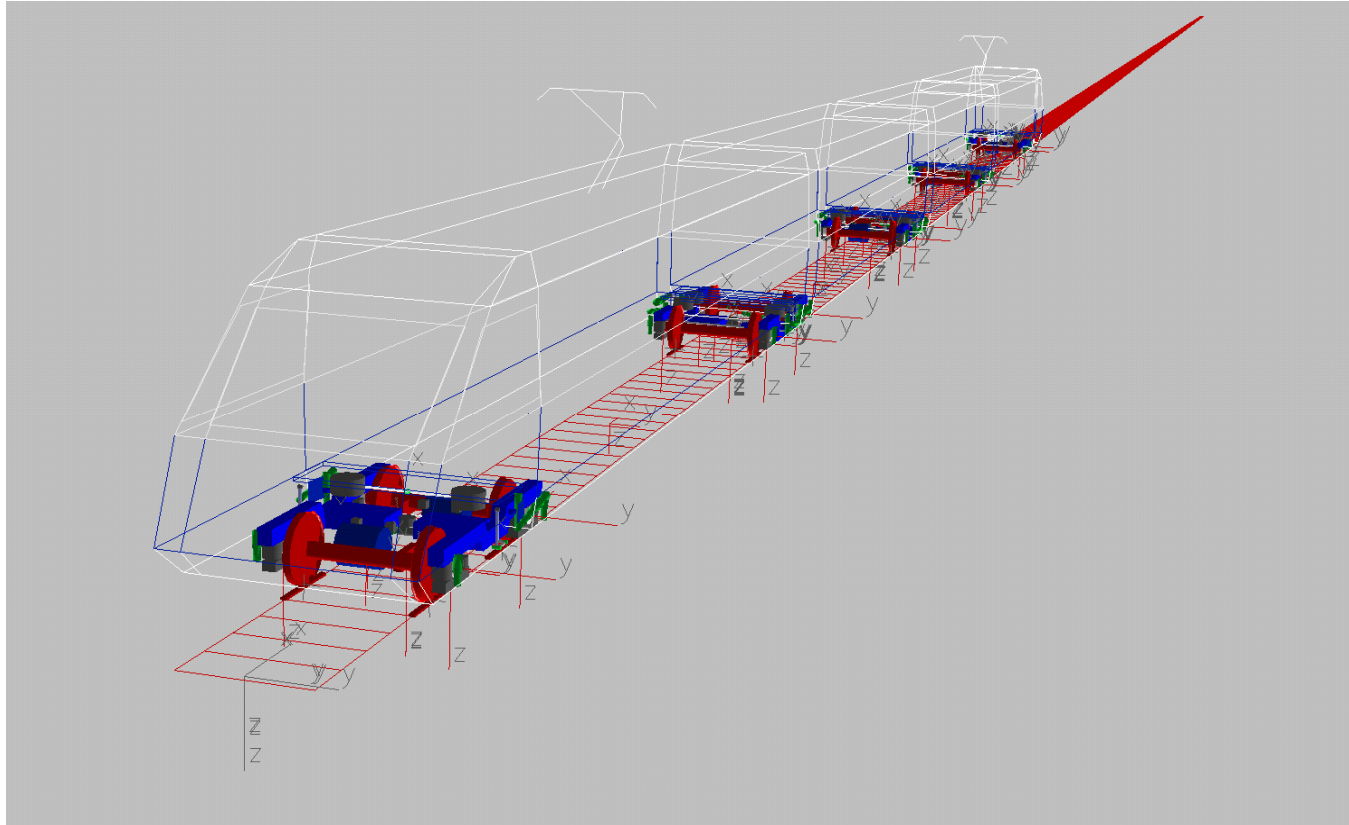
CWC reference for class D vehicle acc. to RIL 807



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CWC for reference vehicle RIL 807, Class D

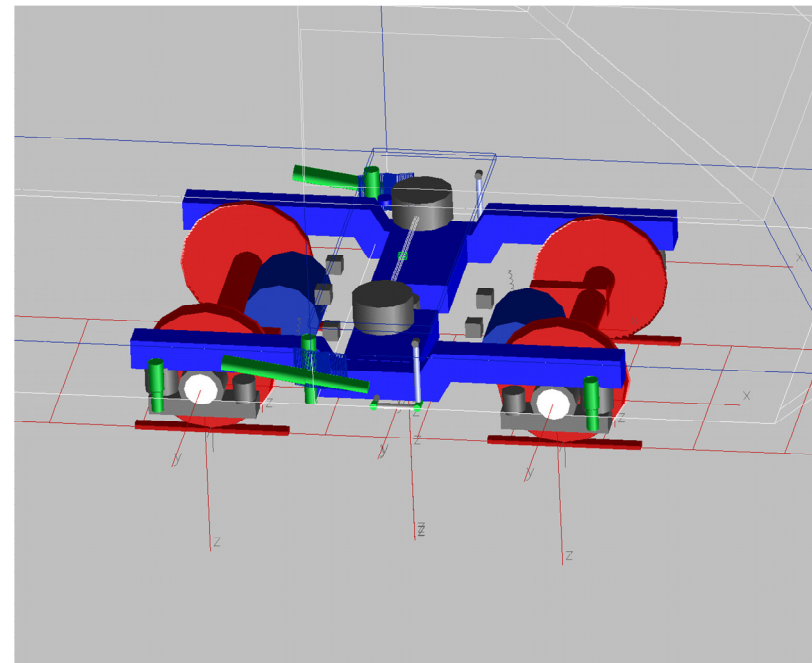
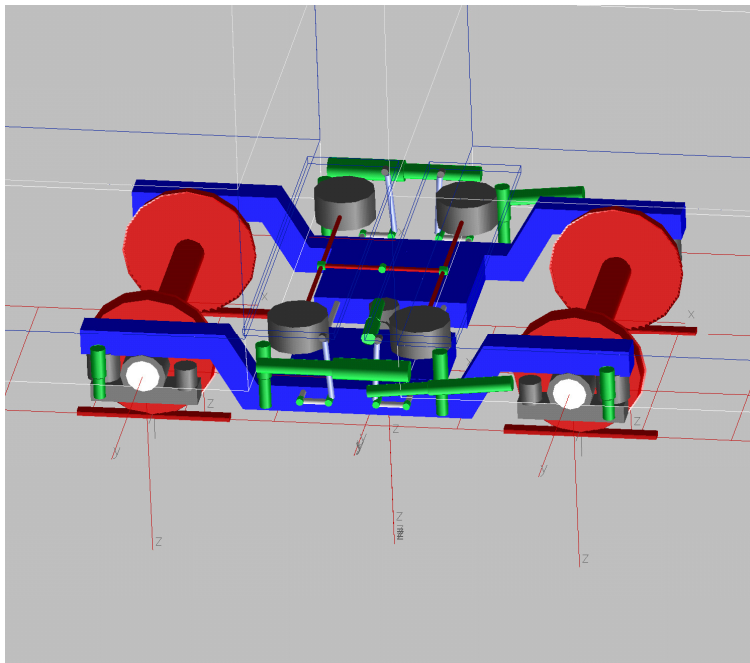
SIMPACK calculation model: Full vehicle



MBS- Vehicle model including

- four car bodies with articulation
- two conventional end bogies
- three Jakobs bogies

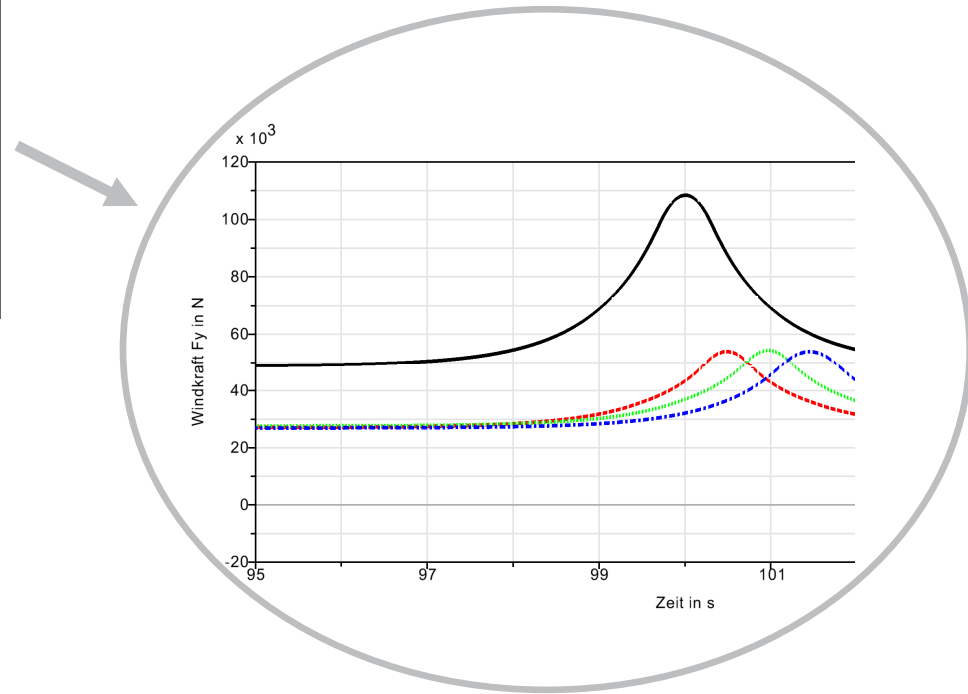
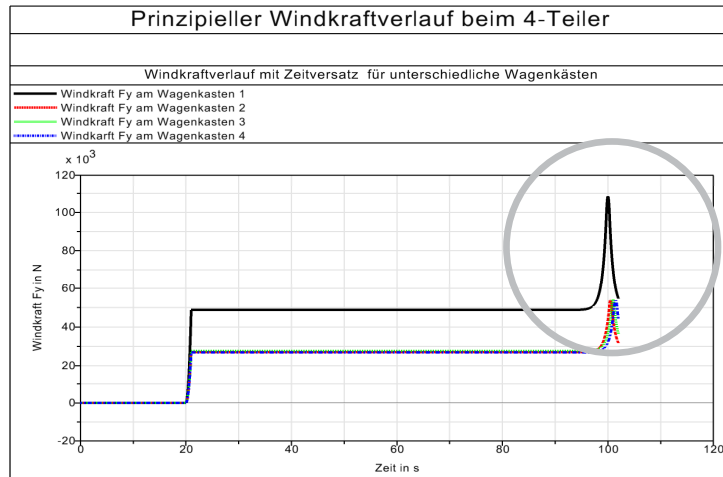
SIMPACK calculation model: Bogies



MBS- Bogie models

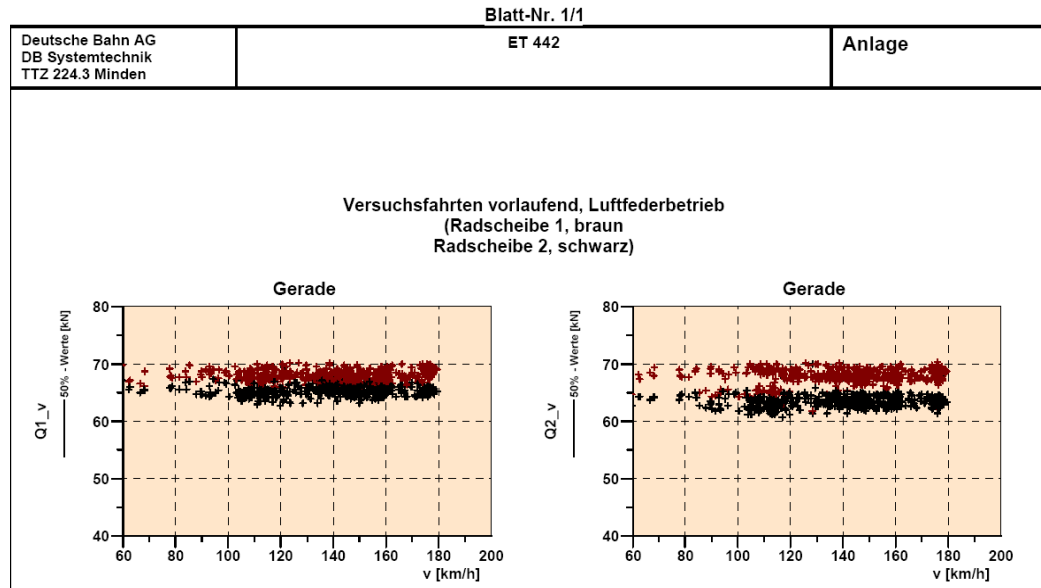
- two point air spring leveling + anti roll bar
- nonlinear lateral bump stop characteristic
- vertical secondary spring limitation by emergency springs and lift stop

Cross wind forces according to RIL 807



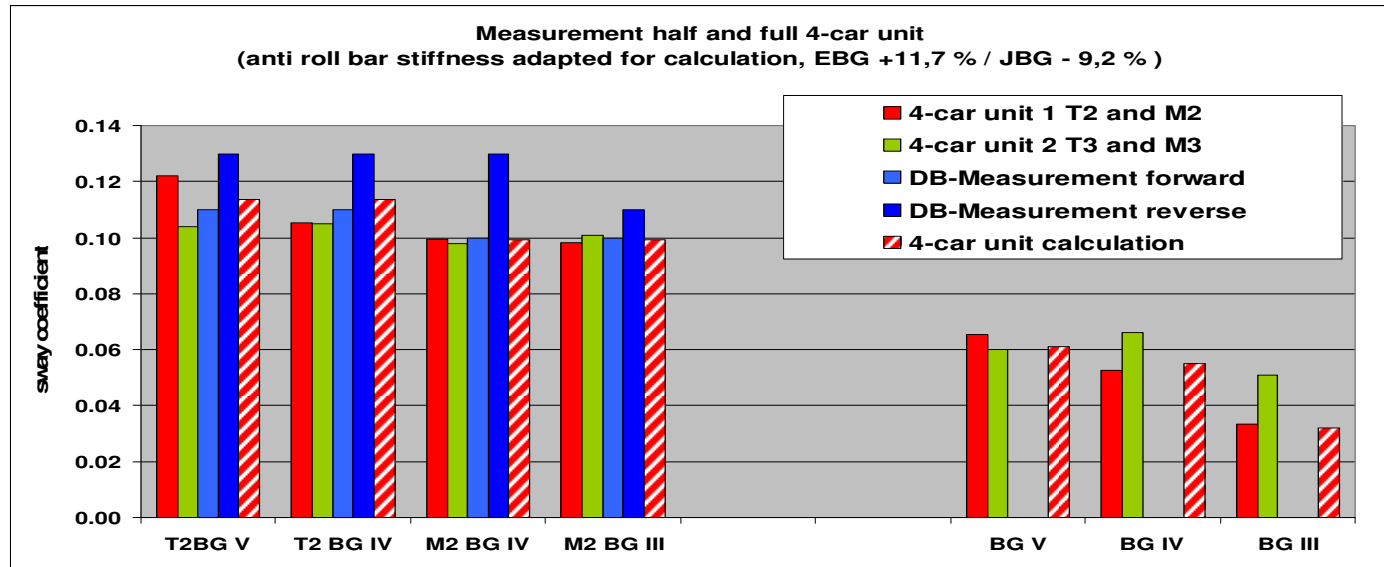
“Chinese Hat” wind scenario acc. to RIL 807
applied with time shift on different car bodies

Model adaption to test vehicle: static wheel loads



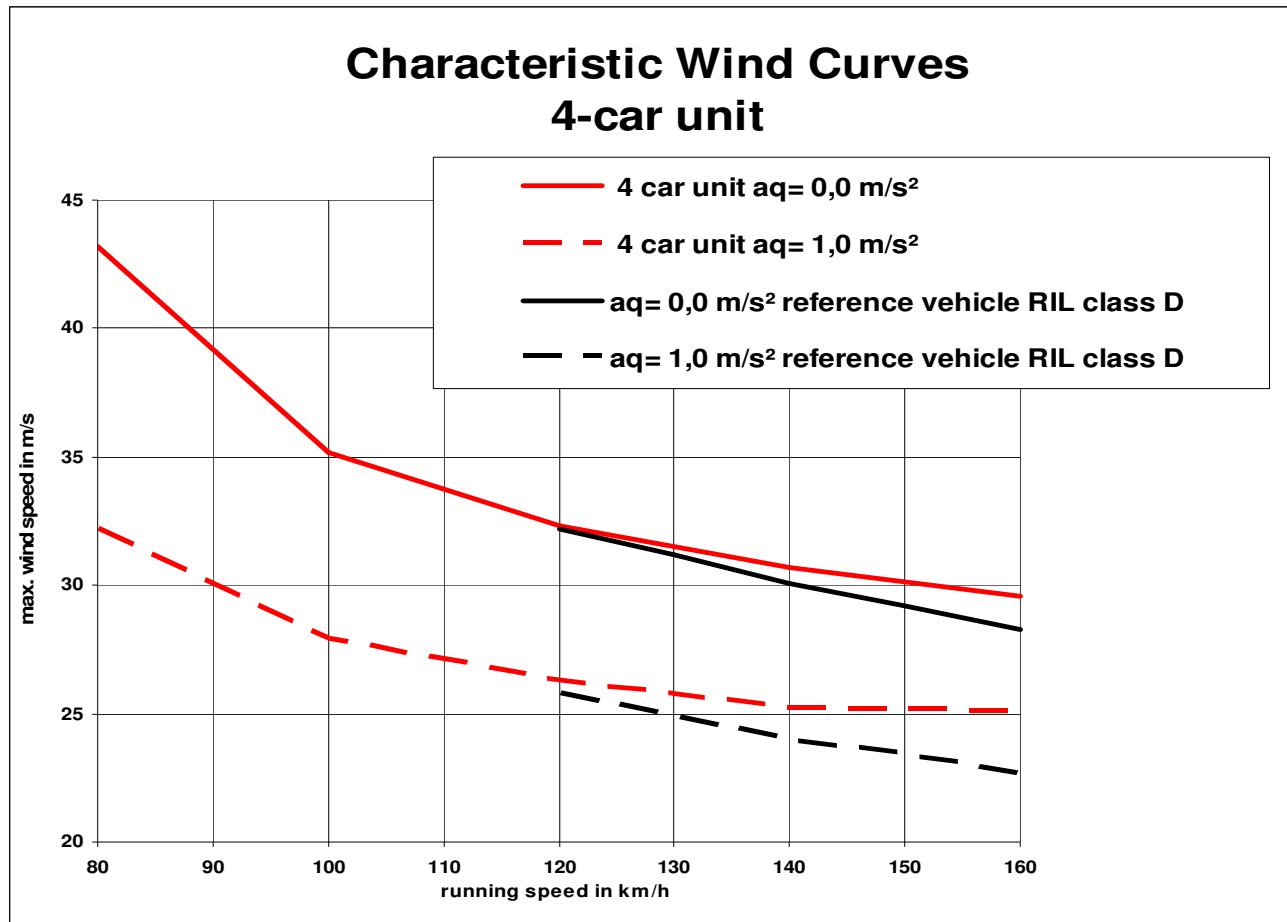
model adapted to measured “static” wheel loads from test runs on straight track by manipulating mass and center of gravity data

Model adaption to test vehicle: sway coefficient



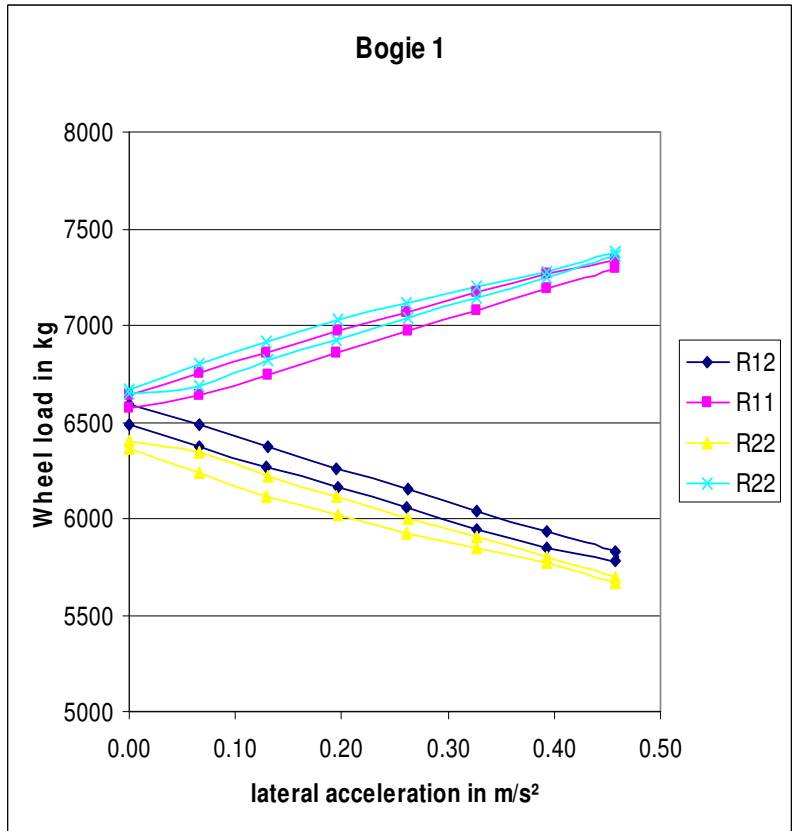
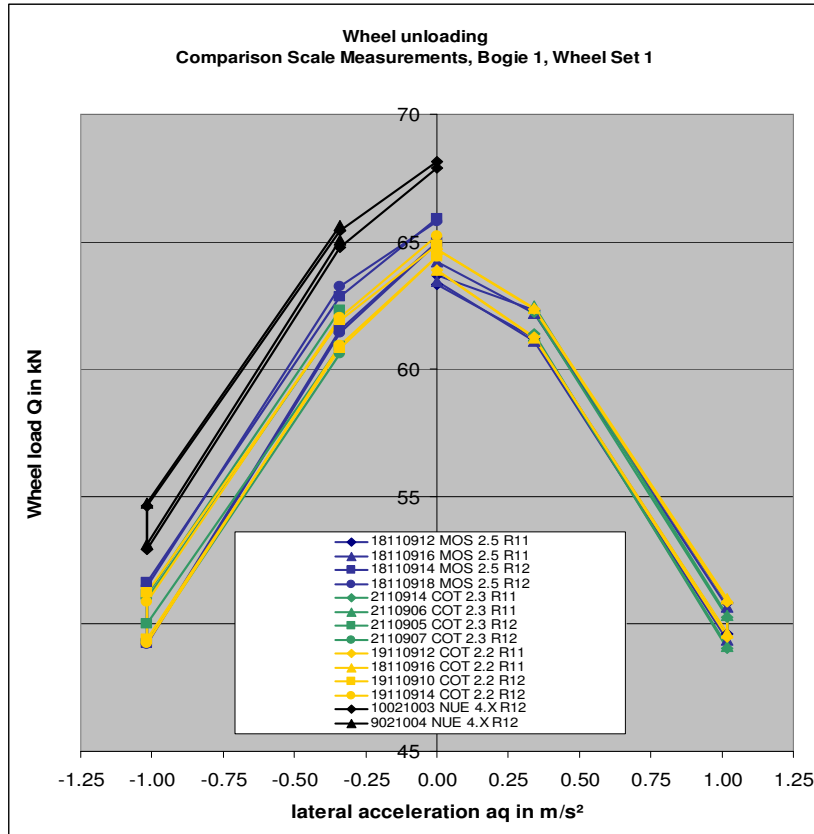
MBS- Model adapted to sway test results by manipulation of anti roll bar stiffness

Calculation of CWC according to RIL 807



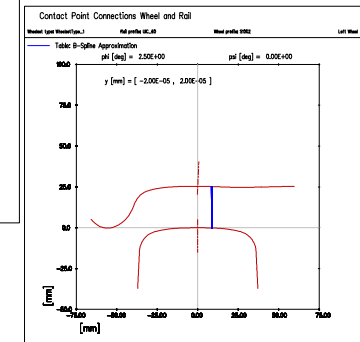
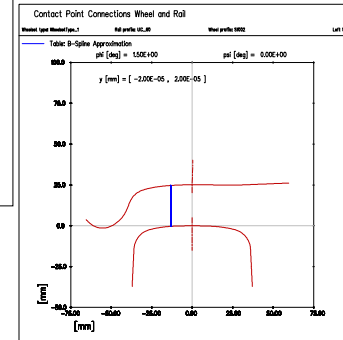
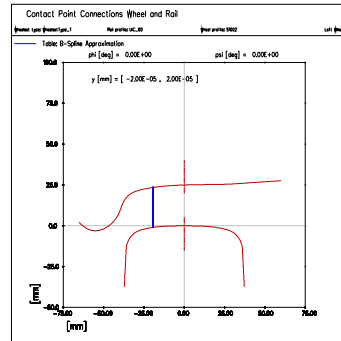
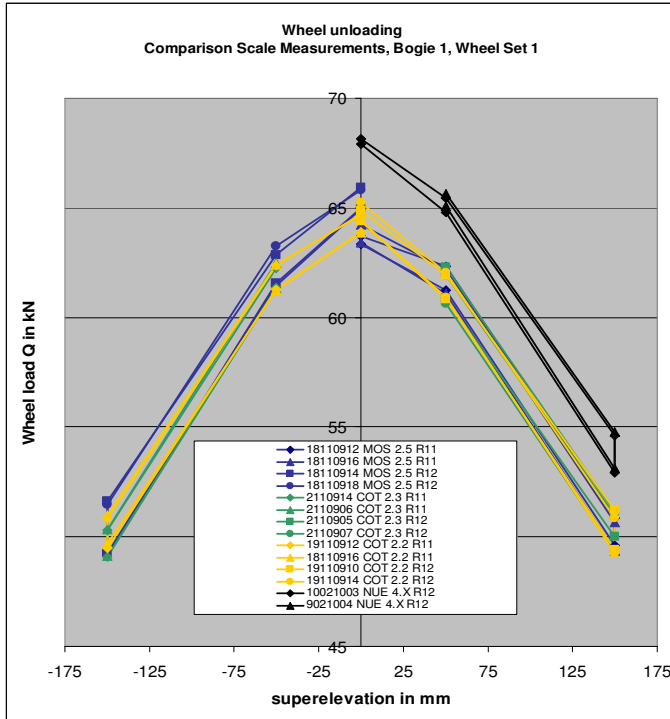
CWC show values worse than expected → homologation critical

Model verification: wheel unloading on the scale



- sway test with measurement of wheel unloading,
- calculated wheel unloading wrong with anti roll bar stiffness adapted to reproduce sway coefficient
- calculated wheel unloading o.k. with nominal anti roll bar stiffness

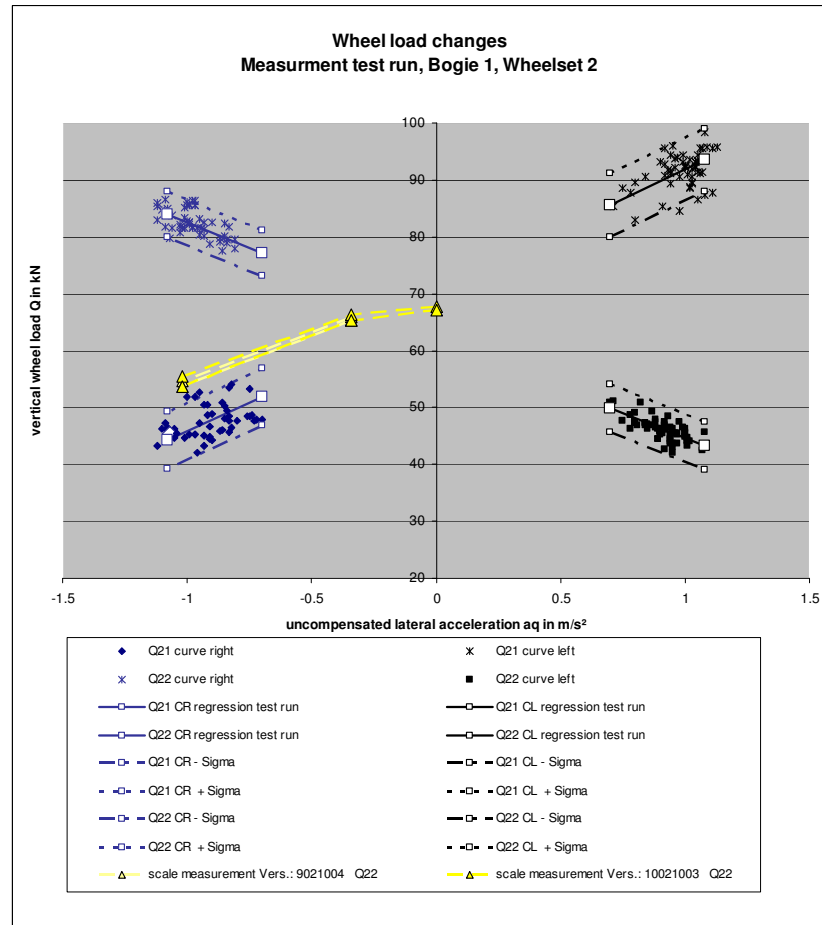
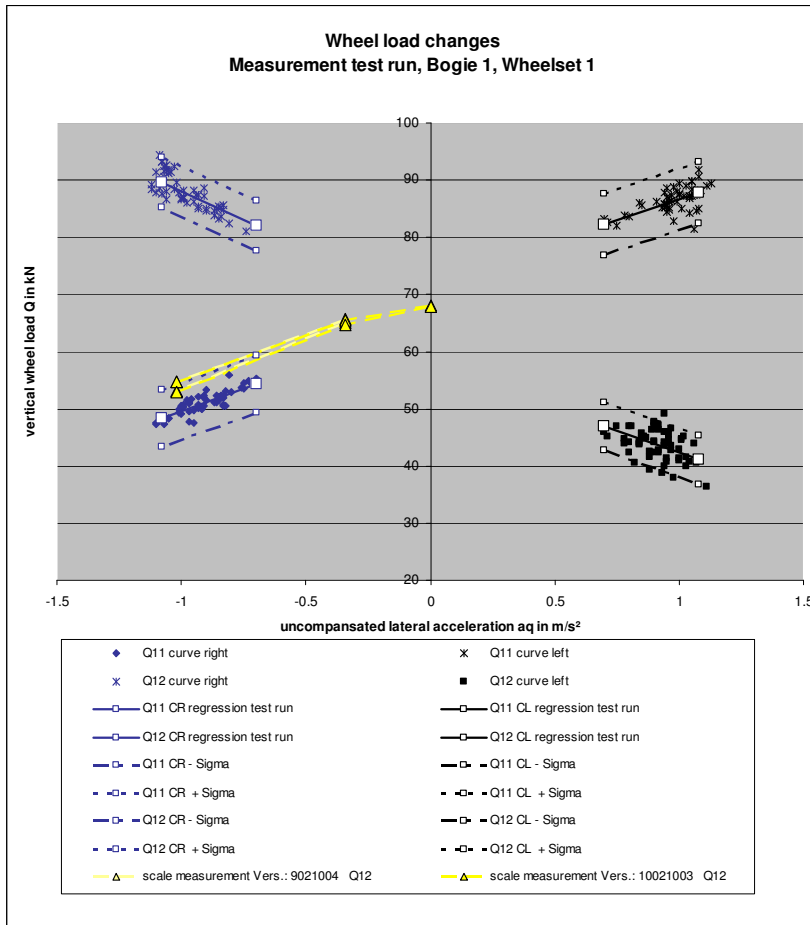
Explanation of „nonlinear“ wheel unloading on the scale



Application of cant leads to contact point „jump“ between 40 and 65 mm due to scale measurement procedure.

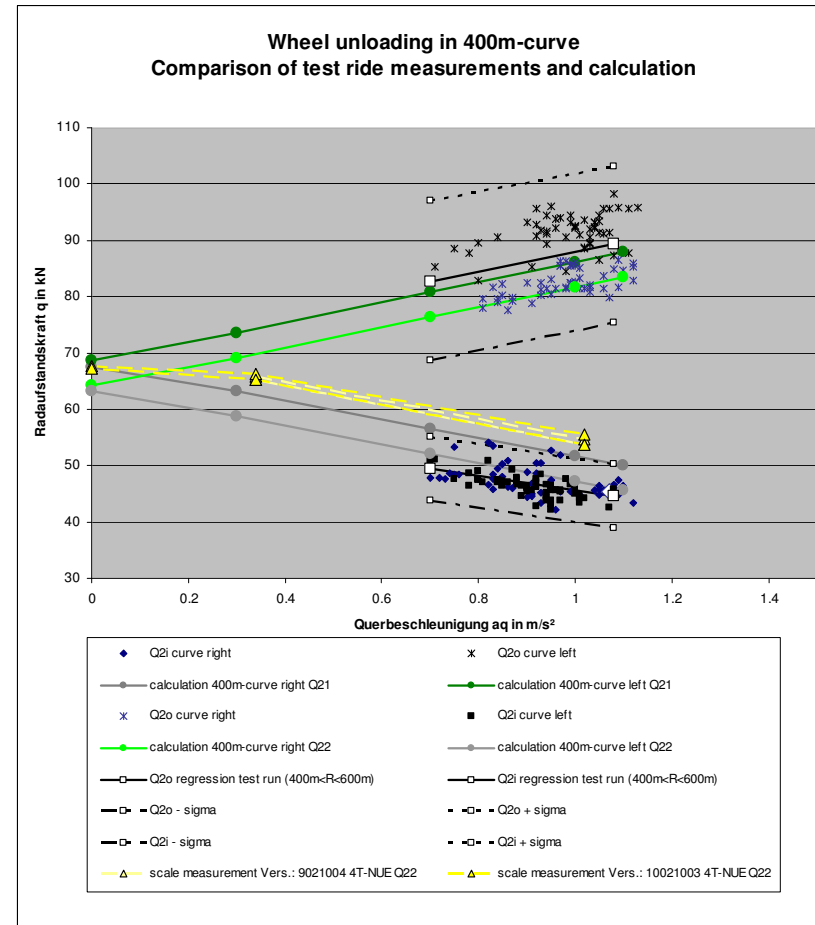
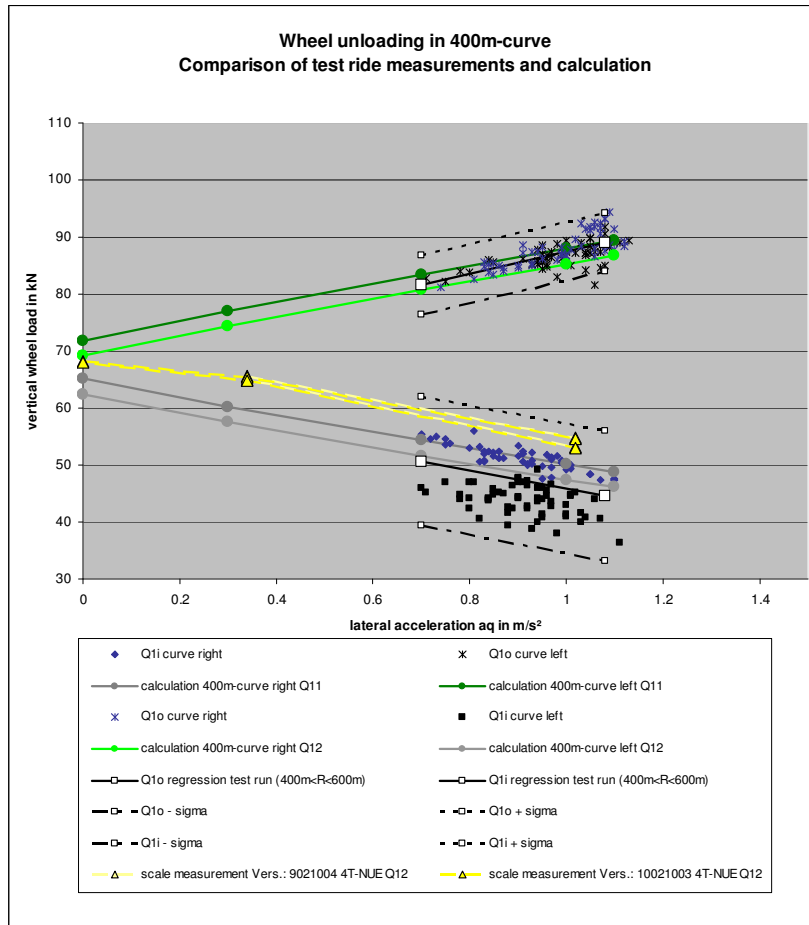
This suggests a nonlinear wheel unloading which does not occur during real test runs

Model verification: measured wheel unloading



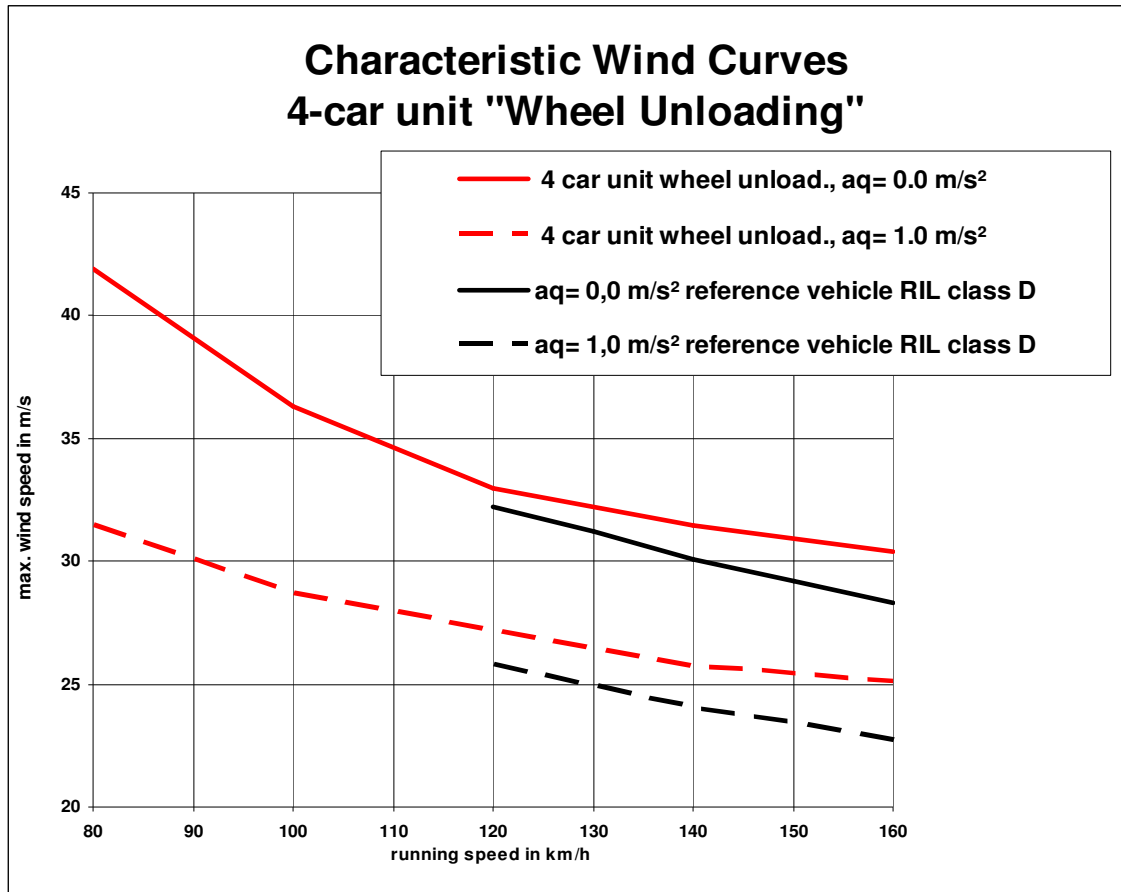
Wheel unloading from test runs coincides with scale results

Comparison of measured and calculated wheel unloading



Good agreement of wheel unloading results from calculations and test

Recalculation of CWC with verified model



CWC for verified model show higher cross wind stability
→ homologation no longer critical