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

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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 sucessful
- verified model serves as basis for cross wind calculations
Cross wind calculations according to RIL 807

vehicle for $v_{\text{max}} = 160$ 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

Characteristic Wind Curves reference vehicle class D

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

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<tr>
<th>Deutsche Bahn AG</th>
<th>ET 442</th>
<th>Anlage</th>
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<td>DB Systemtechnik</td>
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<td>TTZ 224.3 Minden</td>
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**Versuchsfahrten vorlaufend, Luftfederbetrieb**
(Radscheibe 1, braun
Radscheibe 2, schwarz)

\[
\begin{align*}
\text{Gerade} & : Q_2 \text{ vs. } v \\
\text{Gerade} & : Q_1 \text{ vs. } v
\end{align*}
\]

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

Characteristic Wind Curves
4-car unit

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

Characteristic Wind Curves
4-car unit "Wheel Unloading"

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