Using SIMPACK Wheel/Rail for Model Verification and Optimization at STADLER RAIL

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Vehicle Dynamics - Stadler Bussnang AG, Switzerland
The Stadler Rail Group

Switzerland

- Stadler Bussnang AG
  - Bussnang
  - 800 employees

- Stadler Altenrhein AG
  - Altenrhein
  - 250 employees

- Stadler Winterthur AG
  - Winterthur
  - 180 employees

Germany

- Stadler Pankow GmbH
  - Berlin
  - 400 employees

- Stadler Weiden GmbH
  - Weiden
  - 80 employees

International

- Stadler Hungary Kft.
  - Budapest

800 employees
250 employees
180 employees
400 employees
80 employees
Stadler Rail Group: History

1962
First Workshop in Bussnang built in 1962
18 employees

2006
New production facilities, built in 2004
> 1700 employees ...
Railway vehicles
Modular Vehicle concept

RS1
GTW
FLIRT

Streetcars
Modular Vehicle concept

Tango
Variobahn

product portfolio

tailor made
tailor made

Passenger coaches
Rack-railcars
Narrow-gauge railway
Trogenerbahn
Forchbahn
Stadler Vehicle Dynamics Team

C. Kossmann responsible for GTW Family
(currently >390 units in >27 variations)

K. Tillmetz responsible for FLIRT Family
(currently >249 units in >16 variations)
SBB Stadtbahn Zug, Regio-S-Bahn Basel, Seehas and TILO, Switzerland / Germany / France / Italy
51 low floor multiple unit FLIRT, electric (15 / 25 kVAC, 16.7 Hz), standard gauge
19 low floor multiple unit FLIRT, electric (15 kVAC, 16.7 Hz / 3kVDC), standard gauge
FLIRT: Model Verification and Extension

Simulation of running behaviour in very small-radius curves

- **Result values in measurements** (type tests according to EN 14363)
  - radius class: $250m \leq R \leq 400m$
  - track length $>10km$ (sum of sections)
  - expected 99.85%-values (from statistics)

- **Result values in simulation**
  - realistic worst case conditions (present on type tests)
    - measured wheel profiles
    - smallest radius: $R = 250m$
    - high friction: $\mu = 0.5$
    - scaling of measured track irregularities
    - ...
  - max-values of short track ($<1km$)
FLIRT: Model Verification and Extension

Good correlation of measured and simulated results with the found conditions for all vehicle conditions (empty / loaded; in- / deflated air springs)

simulated values (4 vehicle conditions)

measured values (4 vehicle conditions)
FLIRT: Model Verification and Extension

- Sensitivity analysis – Prediction of wheel/rail forces for extended vehicle conditions (empty −15% / loaded +15%; in- / deflated air springs)

4 verified vehicle conditions

4 extended vehicle conditions
FLIRT: Switch Series at Zurich Main Station

- Modelling of test conditions
  (Switch series incl. 6x double-slip switch,DKW-160-1:8' and very short intermediate sections, v = 40km/h)
FLIRT: Switch Series at Zurich Main Station

- **Modelling of test conditions**
  (Switch series incl. 6x double-slip switch 'DKW-160-1:8' and very short intermediate sections, v = 40km/h)

- **Verification of wheel/rail forces and lateral acceleration**
  (very high stress at vehicle state 'loaded and deflated airsprings')

- **s-depending limits for track shifting forces in switches**
  (ΣY-criterion in switches and double-slip switches)
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- \(s\)-depending limits for track shifting forces in switches
  (\(\Sigma Y\)-criterion in switches and double-slip switches)
- Curve radius depending play of lateral bumpstop not yet possible
  (FE-018: no 2-point contact for bumpstop surfaces, FE-045: only parameters, no characteristics)

motion links
(on bogie frame)

rubber and metallic bumpstops
(on bolster/carbody)
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• Longitudinal prestress of intercar coupling not yet implemented
  (1st vehicle: constant speed, 2nd vehicle: constant traction power)
FLIRT: Switch Series at Zurich Main Station

• Animation of single unit
  (v = 40km/h, carbody fixed view)
Thurbo AG (SBB Group), Switzerland
51 articulated railcars GTW 2/6, electric (15 kV, 16.7 Hz), standard gauge and
24 articulated railcars GTW 2/8, electric (15 kV, 16.7 Hz), standard gauge
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51 articulated railcars GTW 2/6, electric (15 kV, 16.7 Hz), standard gauge and
24 articulated railcars GTW 2/8, electric (15 kV, 16.7 Hz), standard gauge
GTW: Model Verification and Optimization

- Investigation of the dynamic behaviour in narrow curves
- Scaling of track irregularities to obtain measured accelerations
- Comparison of statistic values from measurement with single values from simulation
- Model shows the measured behaviour for the criteria running safety and ride characteristic
- Lateral accelerations at motor car depending on running direction
GTW: Model Verification and Optimization

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GTW: Model Verification and Optimization

- Comparison of rms-values and frequency spectra

rms-values

THURBO GTW 2/6

Spektrum der Beschleunigungen im Wagenkasten

Wagenkasten 1

Wagenkasten 2

Wagenkasten 3

rms-Werte Wagenkastenquergeschleunigungen bei üf=165 mm

maximale rms-Werte [m/s^2]

Tara Messung vorwärts 400-250m

Brutto Messung vorwärts 400-250m

Stadler Bussnang AG
Fahrzeug-Dynamik - C.Kossmann
2006-01-05 - 08:04:53

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GTW: Model Verification and Optimization

- Comparison of rms-values and frequency spectra
- Good correlation at motor bogie
- Need of parameter adjustment for the trailer bogie at tare load

![Graphs showing rms-values and frequency spectra for Wagenkasten 1, 2, and 3 in lateral and vertical orientations.](image-url)
GTW: Safety against Derailment

- Calculation of shim height according to EN 14363
- Twisted track (as found at DB Systemtechnik in Minden (D)) defined as cartographic track
GTW: Safety against Derailment

- Using moved marker in the primary spring for simulation of shims
- Testing of GTW 2/8 on twisted track (as found at SBB in Olten (CH))
Tango: Damper Optimization

- Development of a new articulated vehicle for BOGESTRA (Bochum – Gelsenkirchen)
- Definition of suspension parameters
- Optimization of damper characteristics
- After optimization of vertical damper still bad vertical comfort at the trailing articulation (pitching)
Tango: Damper Optimization

- Evaluation of influence of damping in the articulation
- Implementation of a longitudinal damper in the articulation for damping the pitching of the carbody structures
- Optimization of the damping characteristic (damping rate and maximum force)
- Definition of the maximum resilience of the carbody structure to ensure effectiveness of damper
SIMPACK: Further Activities

• Complete comparison of SIMPACK simulation results with measurements of FLIRT and GTW
  (Adjusting of parameters to obtain good agreement)

• Setup of SIMPACK models for further projects (e.g. FLIRT with 2 to 5 cars)

• Using SIMPACK for supporting fatigue analyses by implementation of flexible carbody or/and bogie frame structures
  (first tests of importing ABAQUS® FE-models successfully done)

• Definition of new SIMPACK plot templates ...
Requests for plot automatization

- **plot conversion** int-run to parvar
  (currently only possible in file editor – but 'forbidden')

- **global replacement of parvar-runs**
  (currently only possible in file editor – but 'forbidden')

- **export psets as modules**
  (combination of different plot-projects)

- **filterpipes / macrofilter**
  (ride comfort UIC513, running behaviour UIC518, ...)

- **shortcuts** for global livetext
  (filename, date, page, sum.pages...)

- **subvars and strings** in livetext
  (titles, documentation of run conditions, filter, limits, ...)