Rail Vehicle Response to Carbody Excitations Imitating Crosswind

Dirk Thomas¹, Mats Berg¹,
Sebastian Stichel¹ & Ben Diedrichs²

¹ Centre for ECO² Vehicle Design, Royal Institute of Technology (KTH), Stockholm, Sweden
² Bombardier Transportation, Västerås, Sweden

Nordic Seminar on Railway Technology, 3-4 October 2012
Overview

• Introduction

• Measurement setup

• Simulation setup

• Measurement and simulation results

• Conclusions
Introduction

- Crosswind on rail vehicles may result in
  - large lateral displacements and roll motion of the carbody relative to the centre of track
  - large deflections in the vehicle secondary suspension
  - vehicle overturning about one of the rails in extreme cases

- Field tests to determine vehicle response to crosswind are not applicable due to
  - safety and economical reasons
  - defined conditions hard to realise

- Determination of vehicle response to crosswind thus requires simulations, but these need to be validated
In present work:

⇒ Full-scale measurements:
  Introduction of lateral, crosswind-like loads to the carbody of a still-standing vehicle and measuring the vehicle response

⇒ Calculate the corresponding vehicle response by means of multibody simulations
Introduction

Vehicle used in present work: One car of electric multiple unit
- Carbody length: 25.5 m
- Bogie centre distance: 19.0 m
- Axle distance within bogie: 2.7 m
- Axle load: 15.4 ton (4 axles)
Measurement setup: force application

Max. force 30 kN
Max. stroke 80 mm

1.45 m

19 m

Rear view

Top view

Bogie frame

Max. force 30 kN
Max. stroke 80 mm
Measurement setup: force application
Measurement setup: force application

Two quasi-static load cases

• synchronous

• asynchronous
Measurement setup: force application

Two dynamic load cases

• synchronous

• asynchronous
Measurement setup: vehicle response

Side view

Rear view
Simulation setup

- Detailed multibody dynamics model of the vehicle comprising 46 rigid bodies and 124 degrees of freedom

- Simulations performed using the software SIMPACK

- Measured actuator forces as input for the simulations

- Same output quantities as for the measurements
Measurement results & simulation input: actuator forces for quasi-static load cases
Measurement results & simulation input: actuator forces for dynamic load cases

**Synchronous**

**Asynchronous**
Measurement & simulation results: quasi-static synchronous load case
Measurement & simulation results: dynamic synchronous load case

measurement

simulation

Dynamic synchronous load case measurement and simulation results.
Measurement & simulation results: quasi-static asynchronous load case
Measurement & simulation results: dynamic asynchronous load case
Conclusions

• Responses of a still-standing rail vehicle due to carbody excitations imitating steady and unsteady crosswind have been investigated by means of full-scale measurements and multibody simulations.

• A gust-like event in the force application produces an overshoot in load transfer of vertical wheel-rail forces, which also represents the maximum force response of the vehicle.

• As compared to synchronous loads, the asynchronous loads result in carbody yaw, less roll response and less load transfer of vertical wheel-rail forces.

• Measurements and simulations show in general good agreement; simulated oscillations indicate too low damping.
Short movie
Thank you for your attention!

dthomas@kth.se