Rail Vehicle Response to Carbody Excitations Imitating Crosswind

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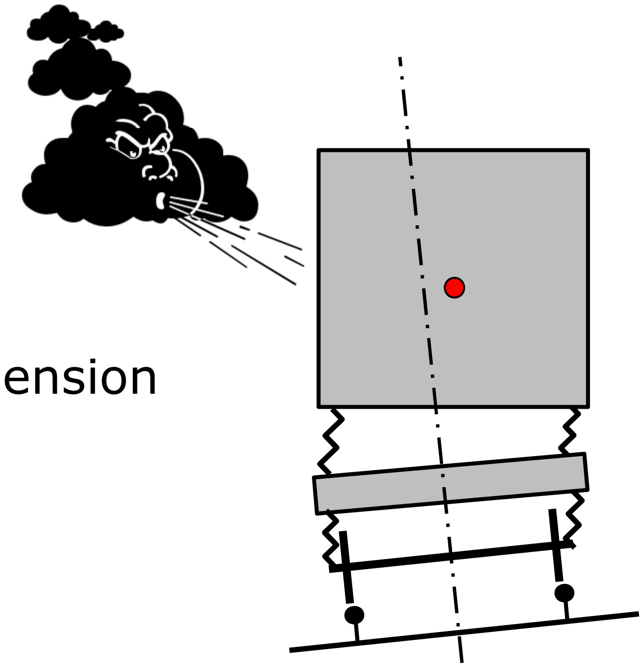
Overview

- 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

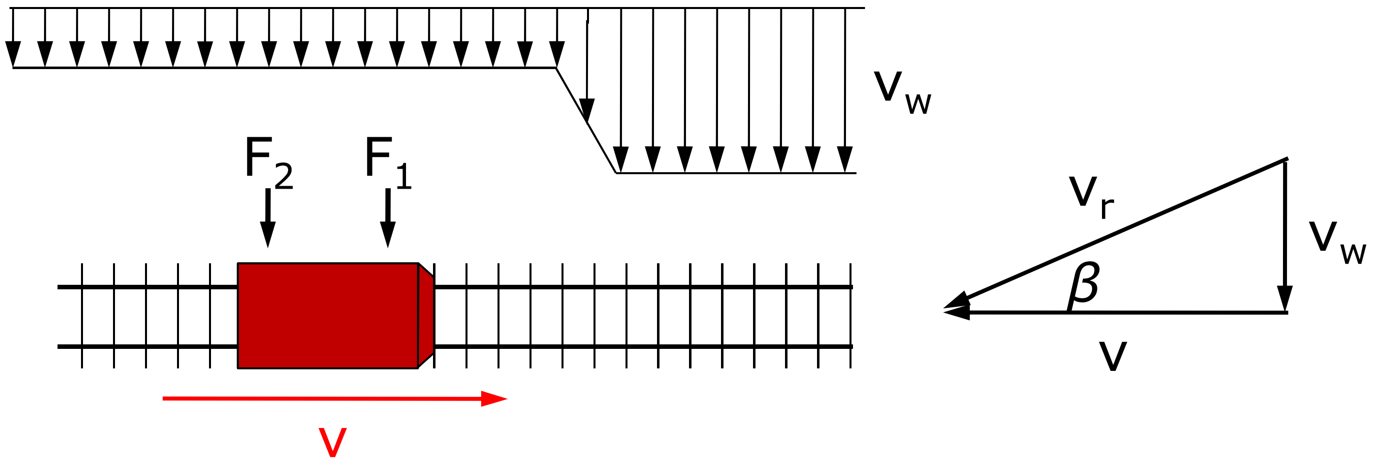


- Field tests to determine vehicle response to crosswind are not applicable due to
  - ⇨ safety and economical reasons
  - ⇨ defined conditions hard to realise

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

Introduction

Top view



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

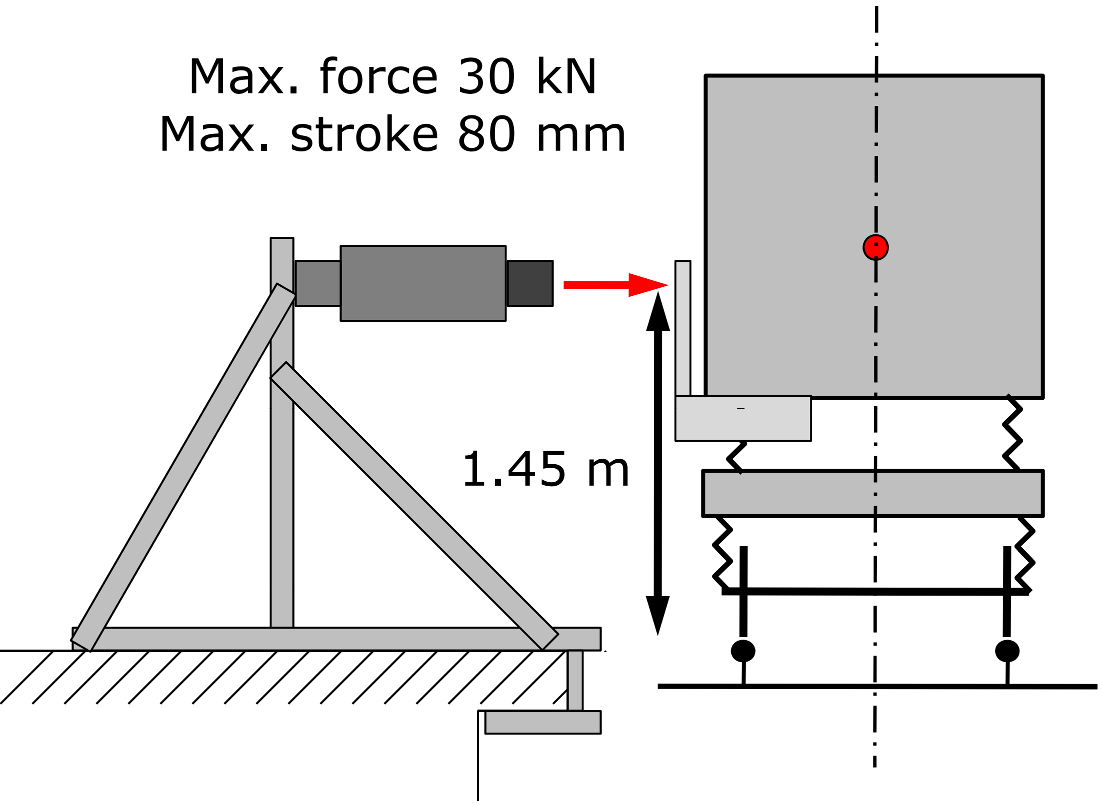
⇨ Calculate the corresponding vehicle response by means of multibody simulations

Introduction

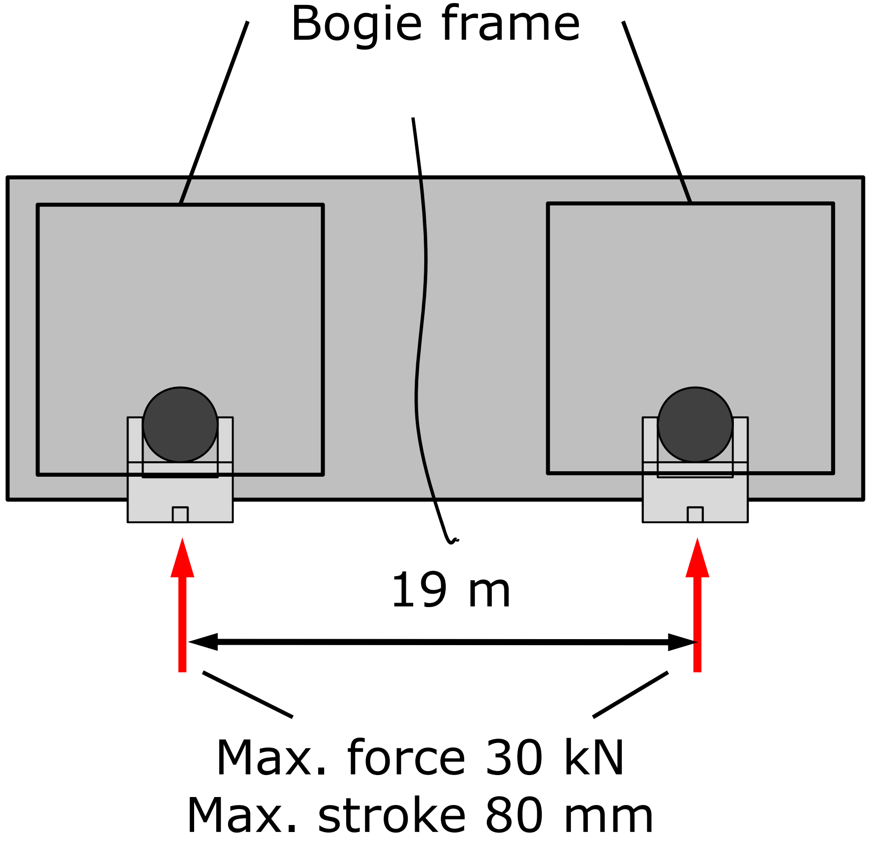
Vehicle used in present work: One car of electric multiple unit

- 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



Rear view



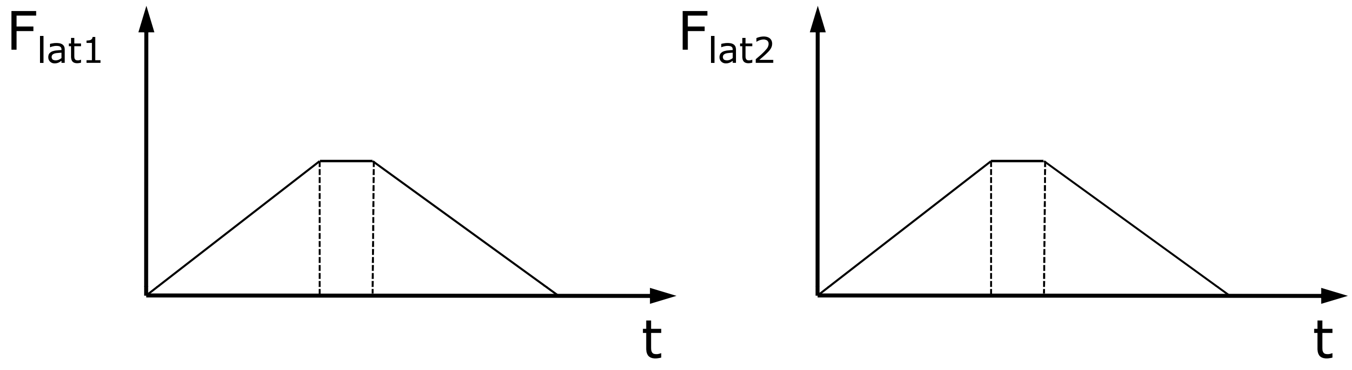
Top view

Measurement setup: force application

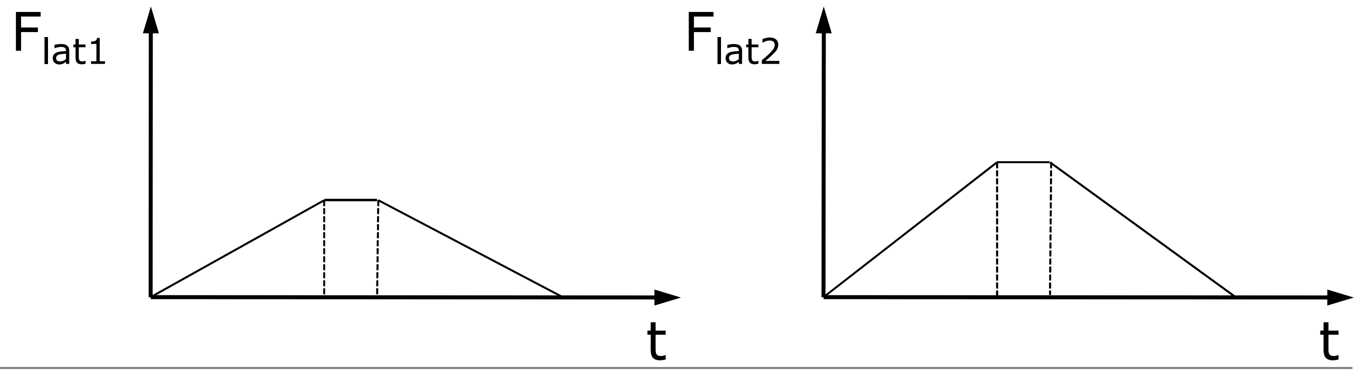
Measurement setup: force application

Two quasi-static load cases

- synchronous



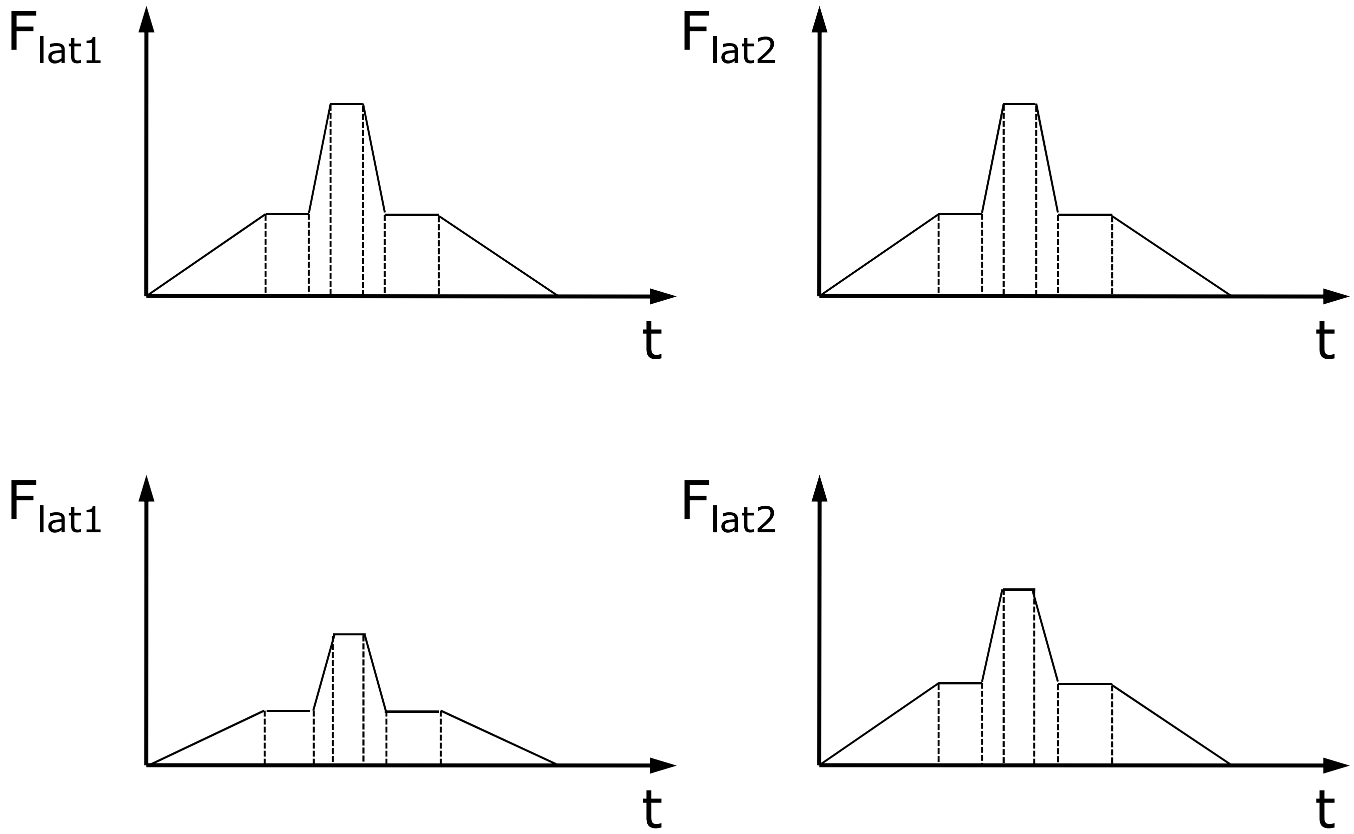
- asynchronous



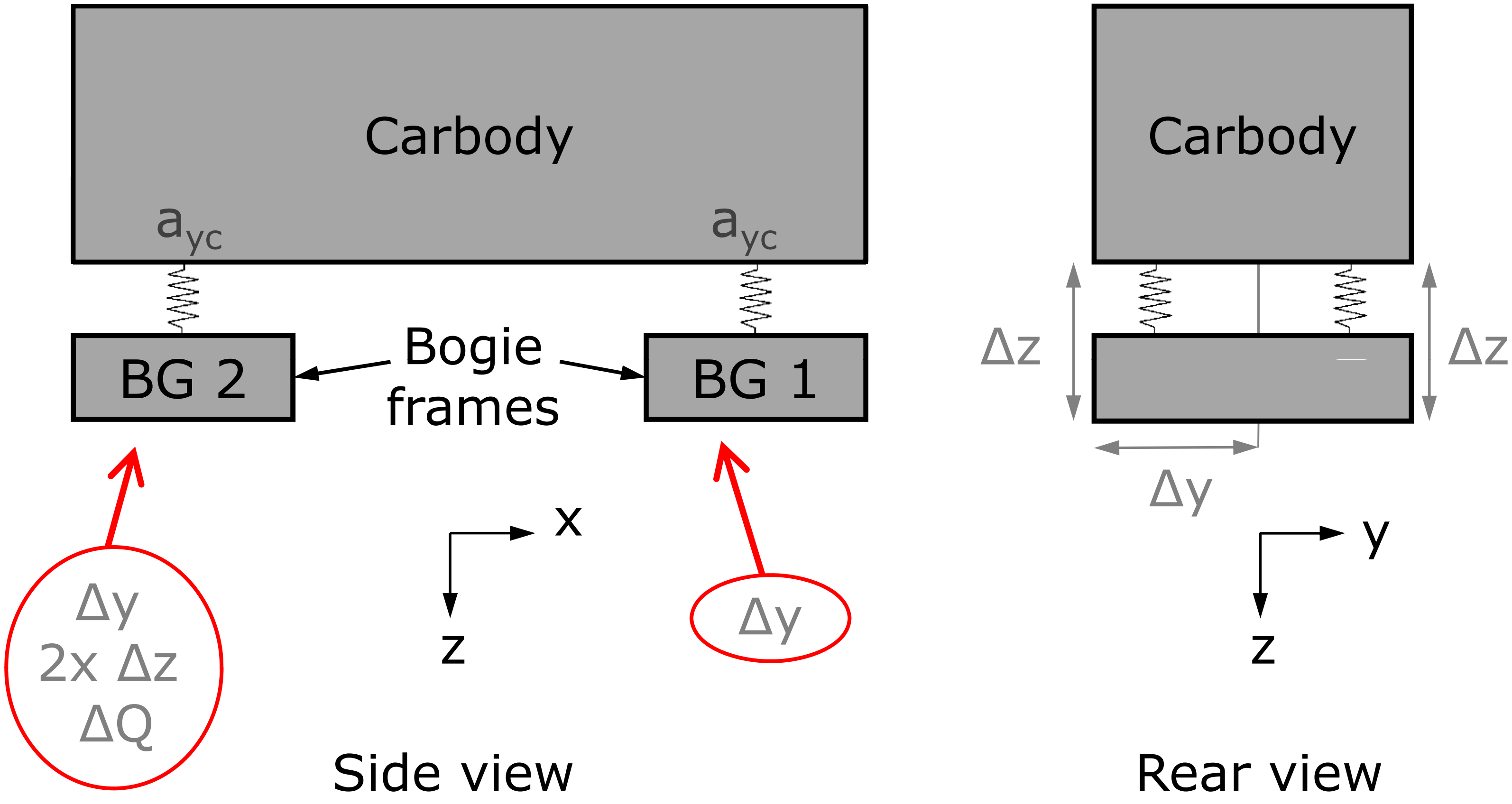
Measurement setup: force application

Two dynamic load cases

- synchronous
- asynchronous

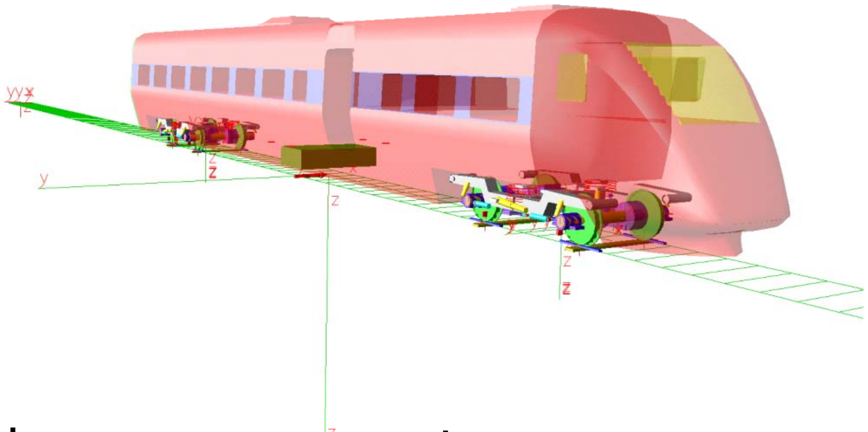


Measurement setup: vehicle response



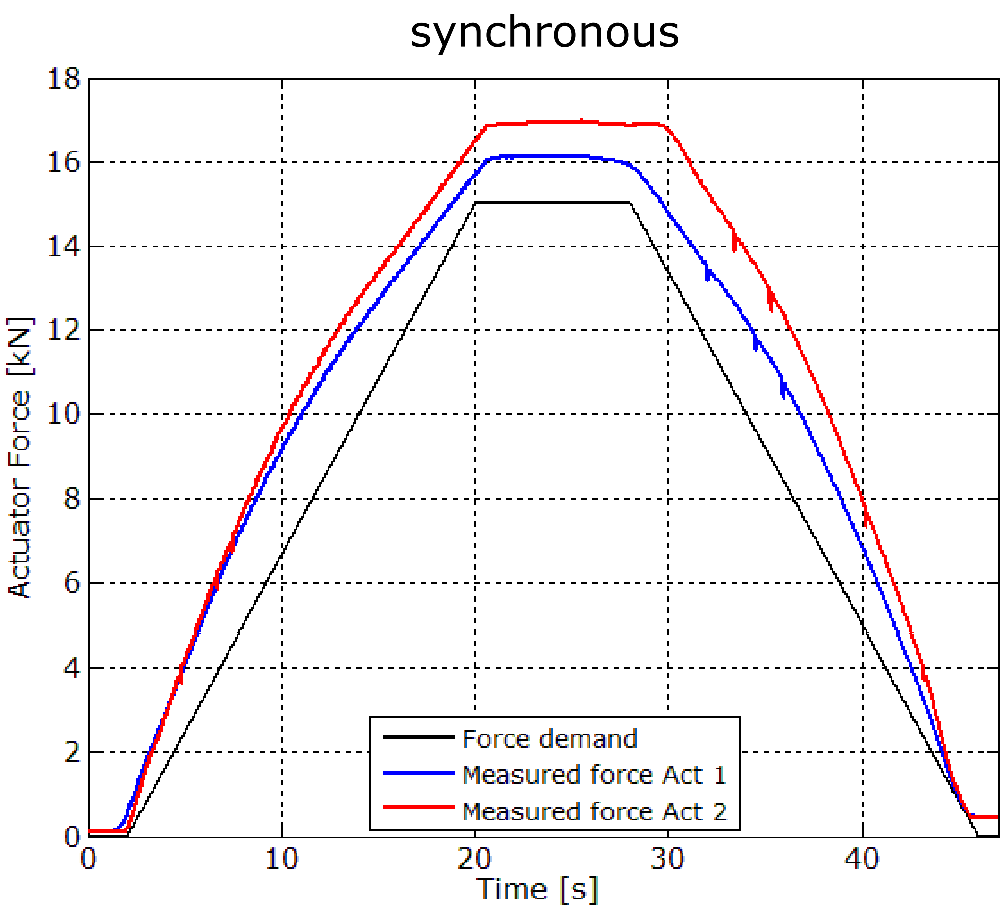
Simulation setup

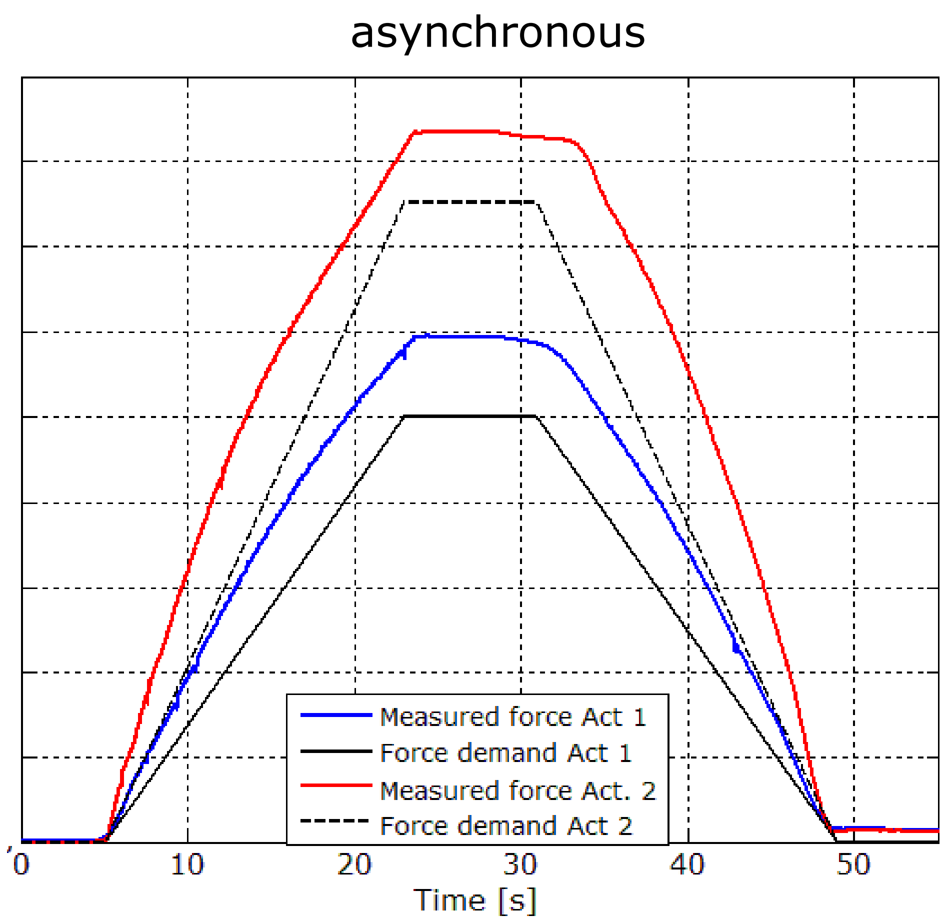
- Detailed multibody dynamics model of the vehicle comprising 46 rigid bodies and 124 degrees of freedom
- Simulations performed using the software SIMPACK
- Measured actuator forces as input for the simulations



- Same output quantities as for the measurements

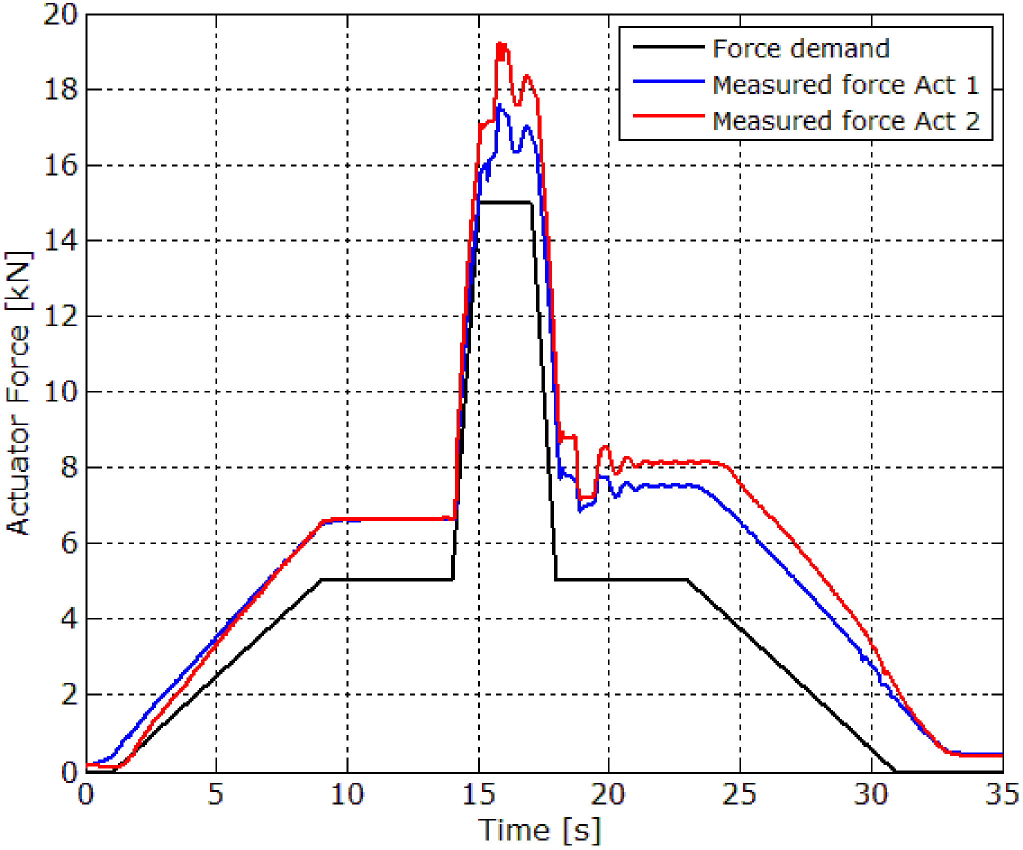
Measurement results & simulation input: actuator forces for quasi-static load cases



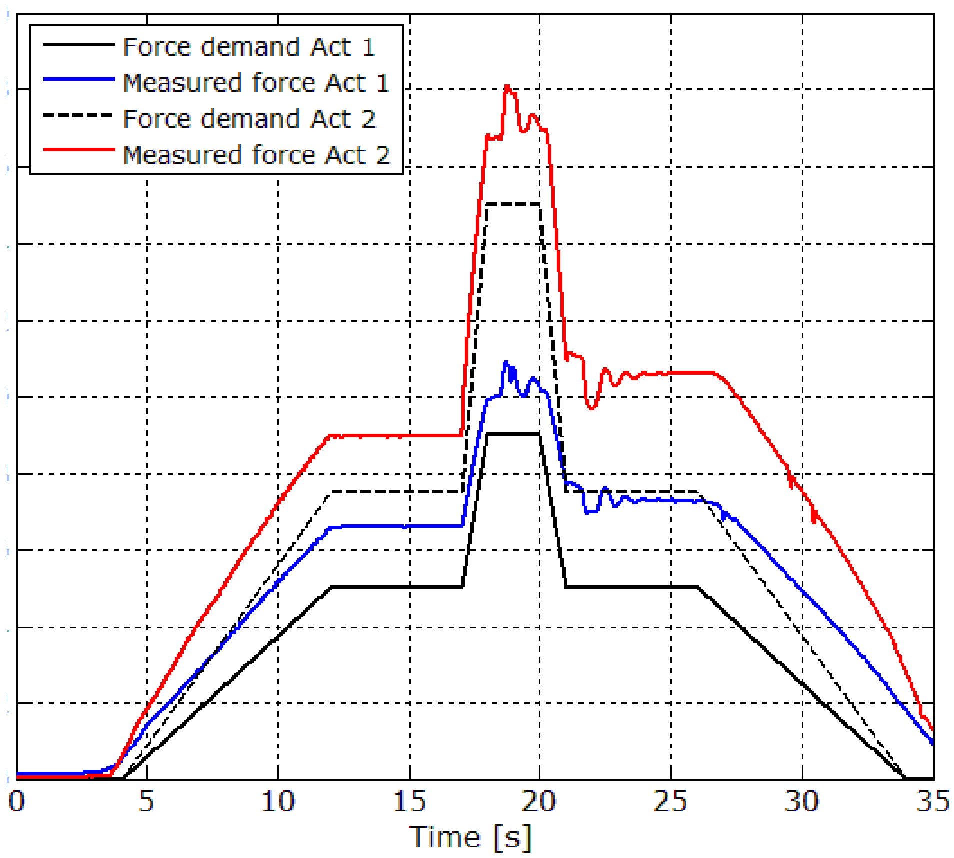


Measurement results & simulation input: actuator forces for dynamic load cases

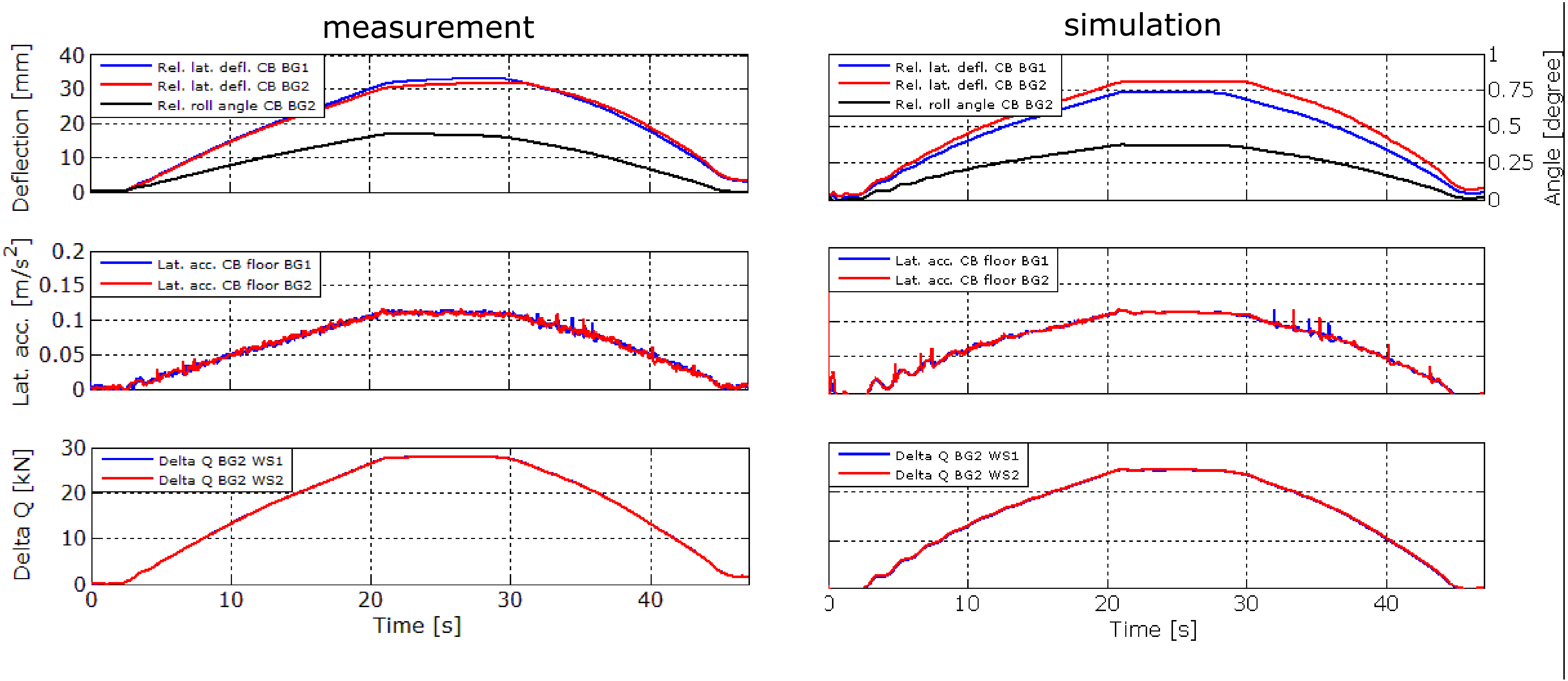
synchronous



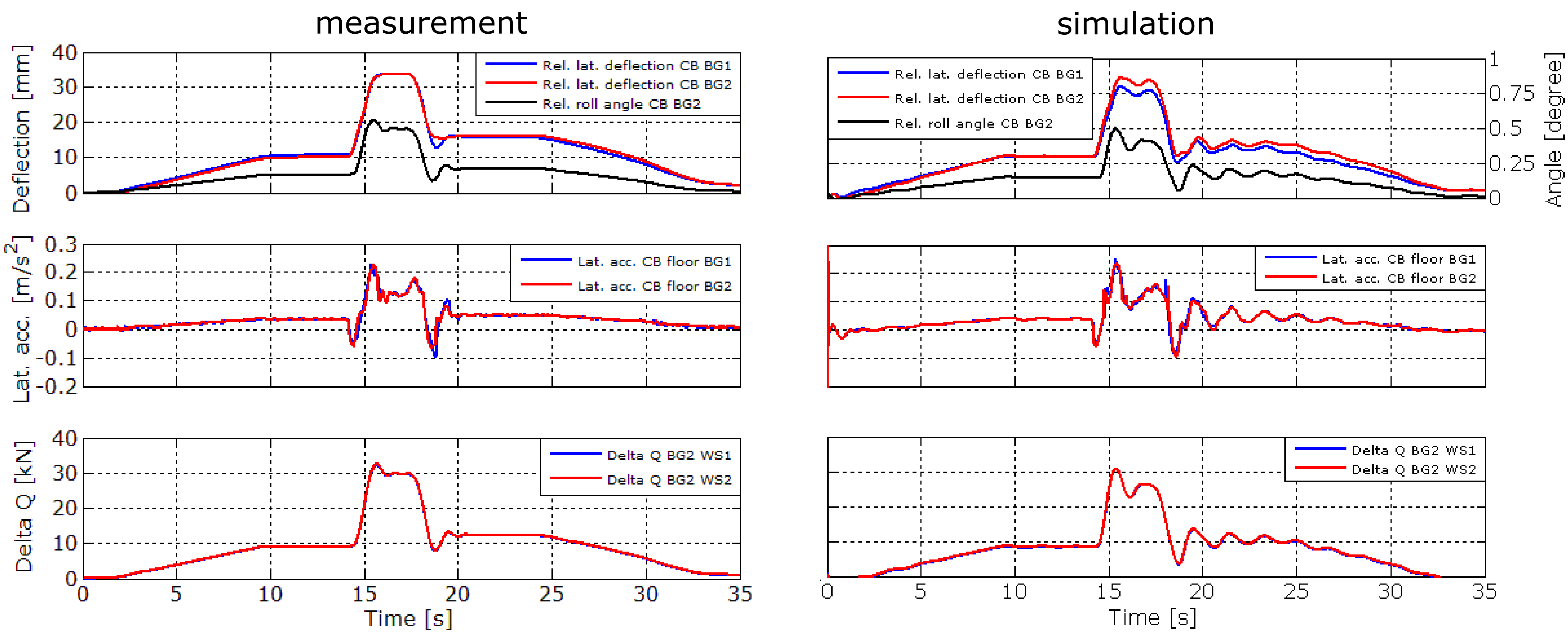
asynchronous



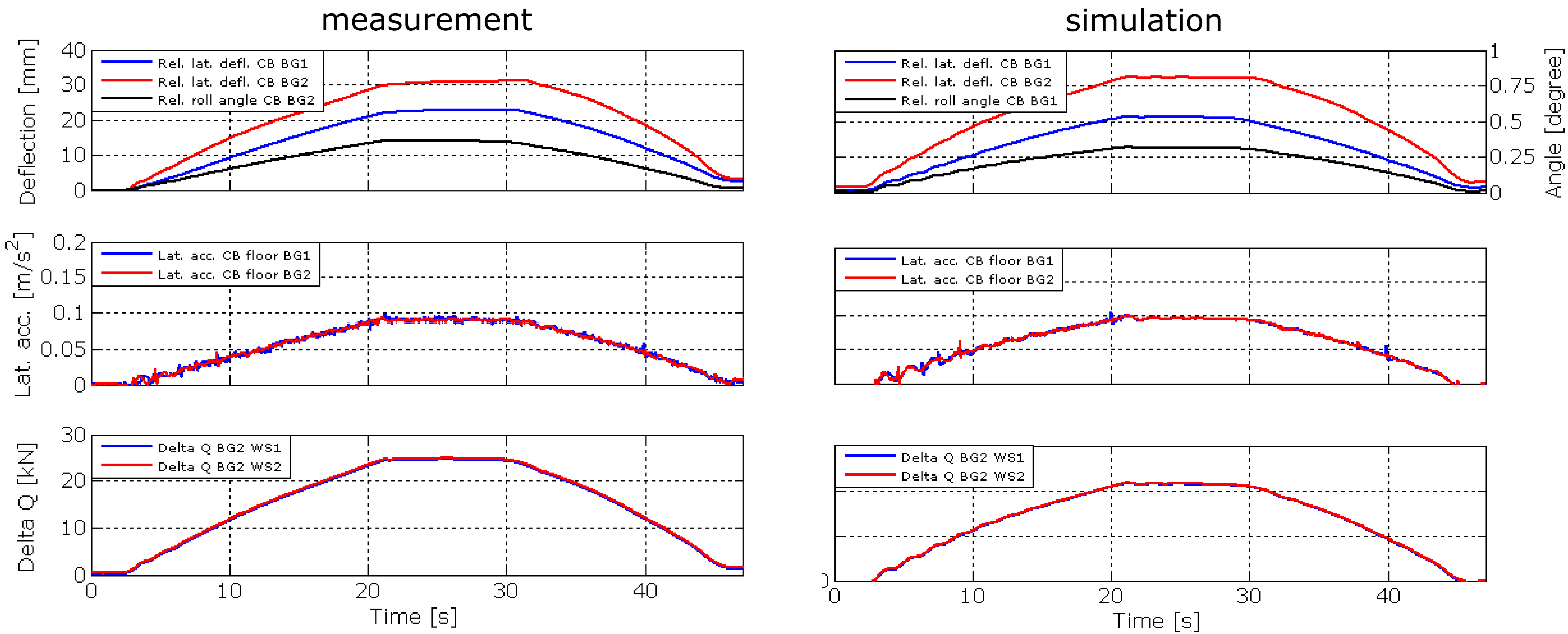
Measurement & simulation results: quasi-static synchronous load case



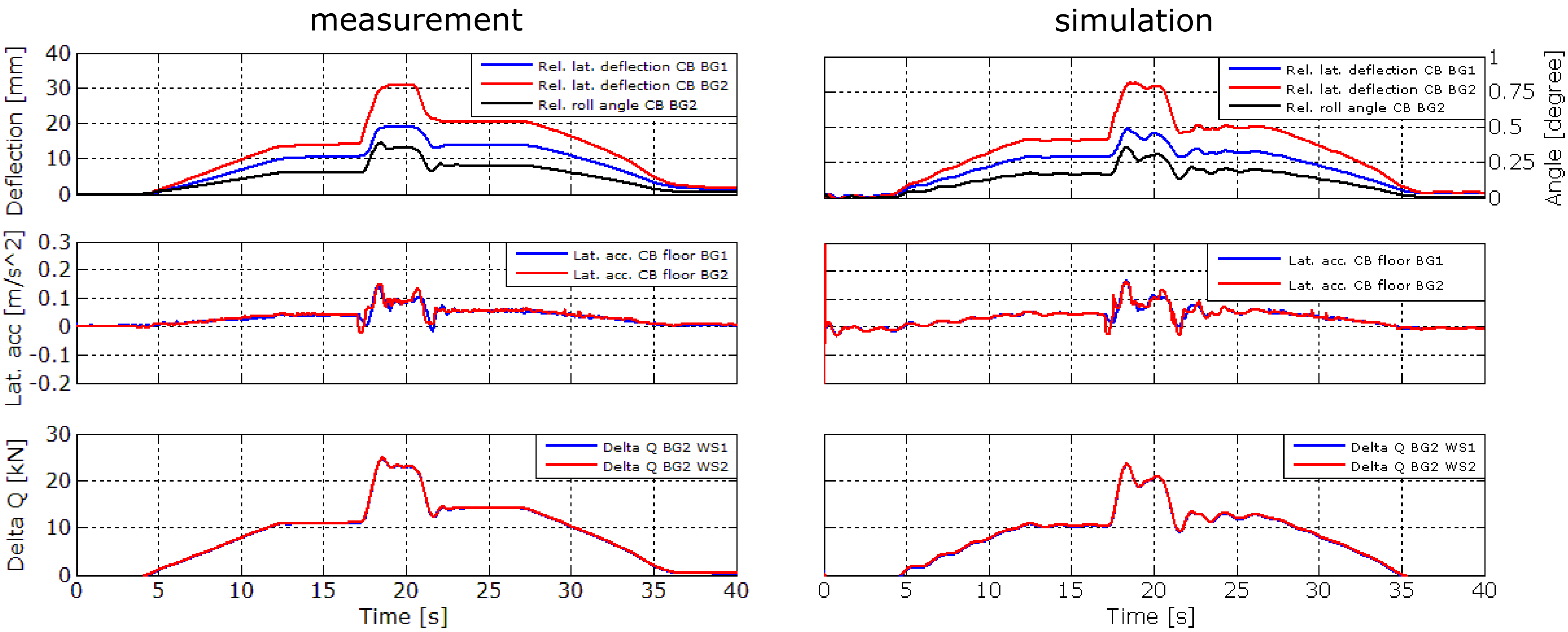
Measurement & simulation results: dynamic synchronous load case



Measurement & simulation results: quasi-static asynchronous load case



Measurement & simulation results: dynamic asynchronous load case



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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!

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