DEKRA Niederlassung Bielefeld

Fachbereich: Fahrzeugtechnik / Verkehrsunfallanalyse
Ladungssicherung

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Electronic Stability Control requirements for weight-reduced designs of vehicle bodies when adopting cargo-securing functions




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Electronic Stability Control requirements for weight-reduced designs of vehicle bodies when adopting cargo-securing functions

by Wolfgang Bühren and Alexander Berg

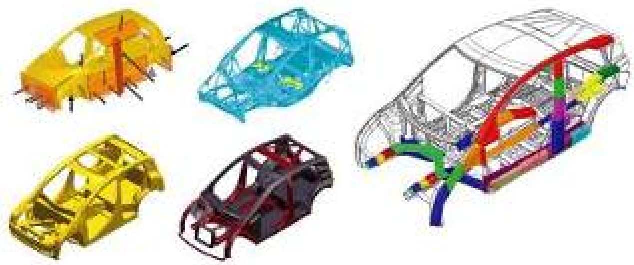
Structure:

- Lightweight design – a supreme discipline of vehicle development
- Weight-reduced semitrailers
- Findings from dynamic driving tests
- Solution statements

Lightweight design – a supreme discipline of vehicle development

- Lightweight design safes fuel and therefore it has a positive impact to the environment pollution and to the operational expenses of a vehicle
- Innovations in lightweight design are provided preferential by an integral implementation of construction techniques, material properties and manufacturing processes
- Capabilities are made accessible by lightweight material, with consideration of specific technical characteristics and development potentials

I-Trail Lightweight semitrailer
Origin: Hamacher et al., 2013



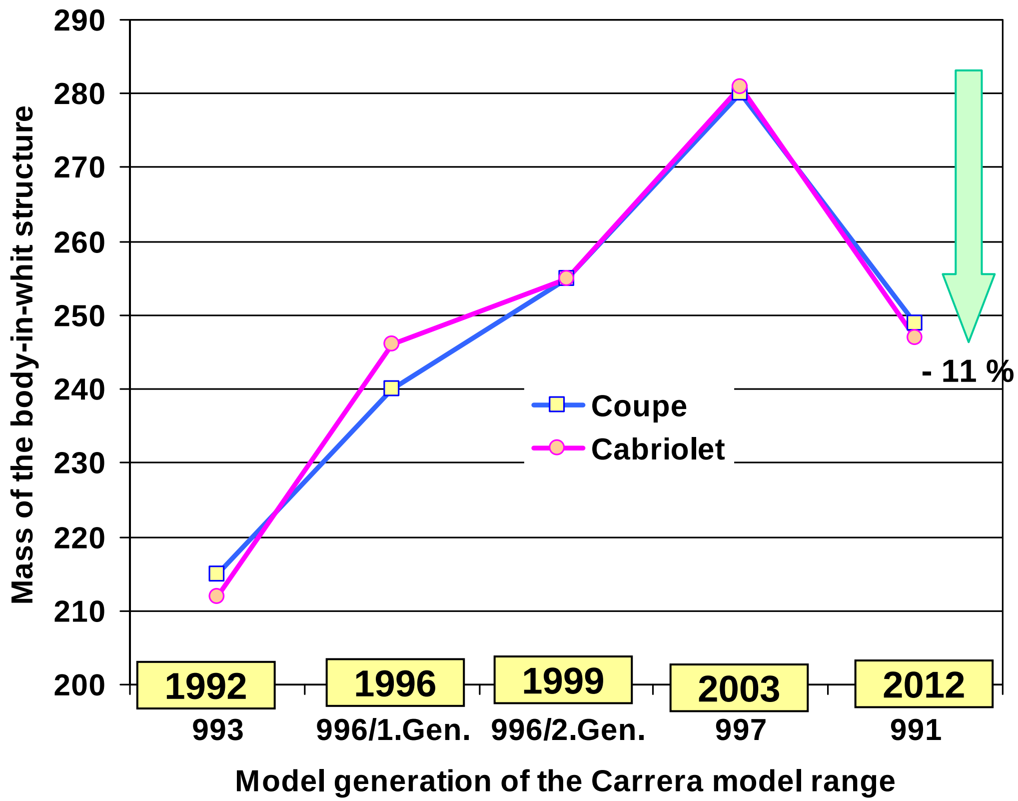
Future Steel Vehicle (car)
Origin: Broek et al., 2012

Lightweight design – a supreme discipline of vehicle development

High performance sports cars drive the development

Example: **Porsche Carrera**

- With model 991 change from steel-based lightweight design to aluminium-steel composite design
- Complete vehicle Porsche Carrera model range 991 is with comparable configuration and furniture for the first time lighter as the predecessor 1,455 kg – 1,415 kg = **- 40 kg**



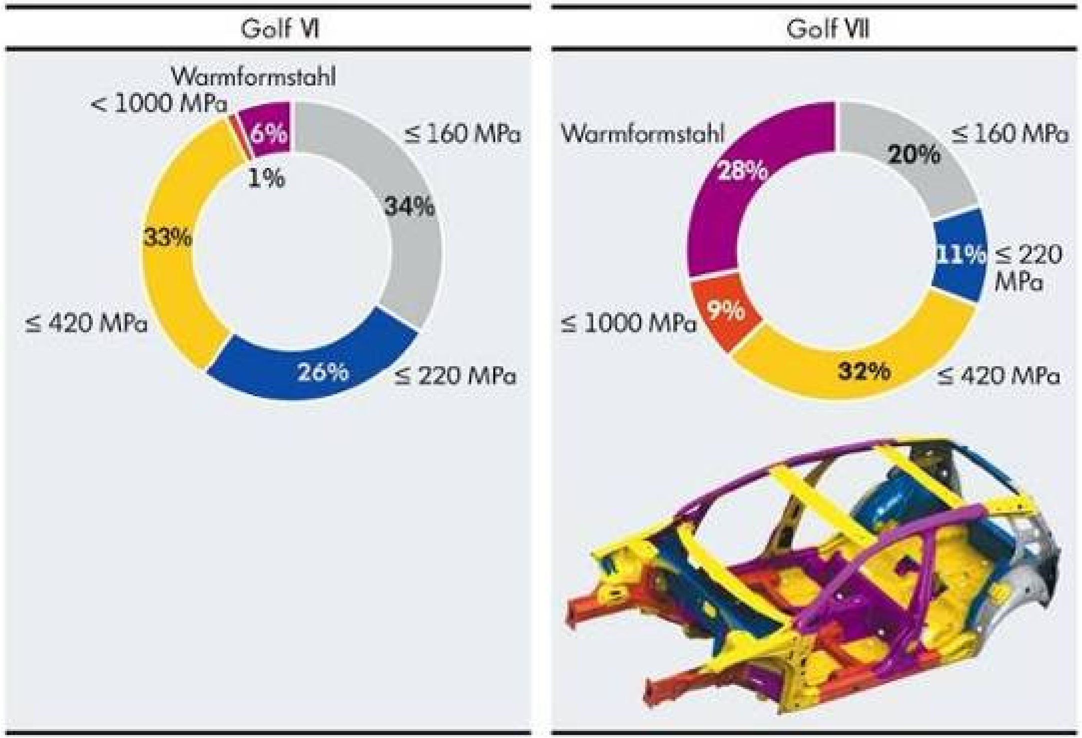
according to Heinisch, 2012

Lightweight design – a supreme discipline of vehicle development

In car production the all-time trend towards more heavy vehicles (due to furniture, safety requirements, …) is now broken.

Example: **VW Golf VII**

- Steel-based lightweight design using different high-strength steel grades
- Weight reduction in the body structure by 23 kg
- Lightweight design without extra costs by reducing material costs and production time



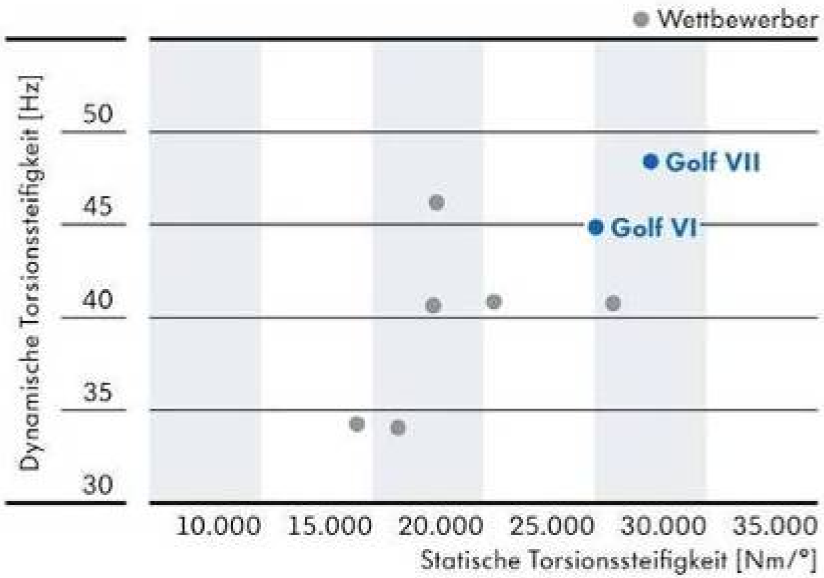
Origin: Kleimann und Schorn, 2012

Lightweight design – a supreme discipline of vehicle development

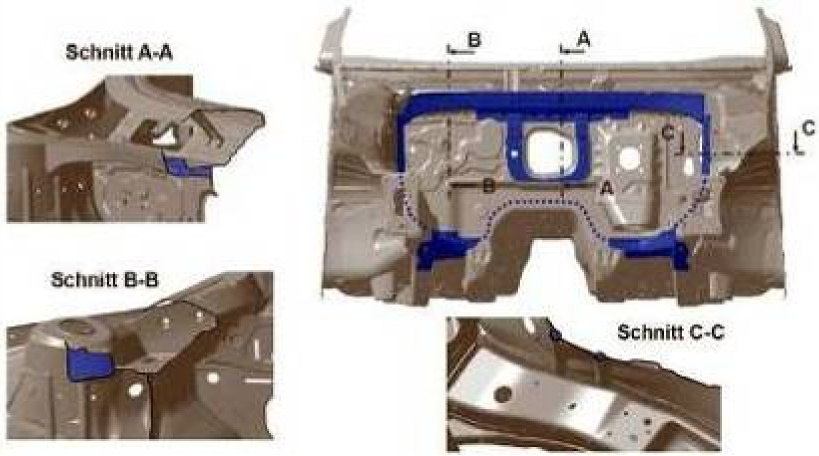
Torsion stiffness – Important item of performance for comfort and driving dynamic

Example: **VW Golf VII**

- Negative influence on the stiffness due to the reduction of steel-sheet thickness can be counterbalanced by intensive cross-section design and additional measures



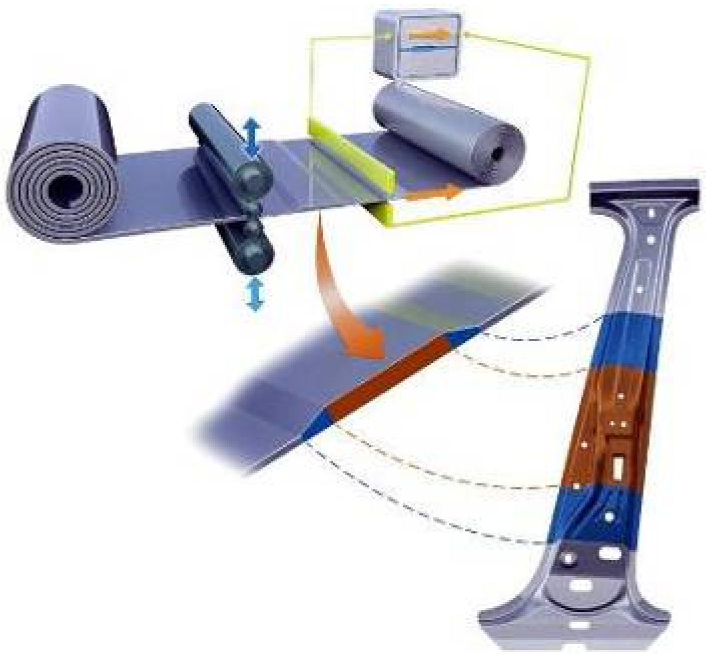
Example: Closed torsion ring in the front wall of the VW Golf VII



Origin: Kleimann und Schorn, 2012

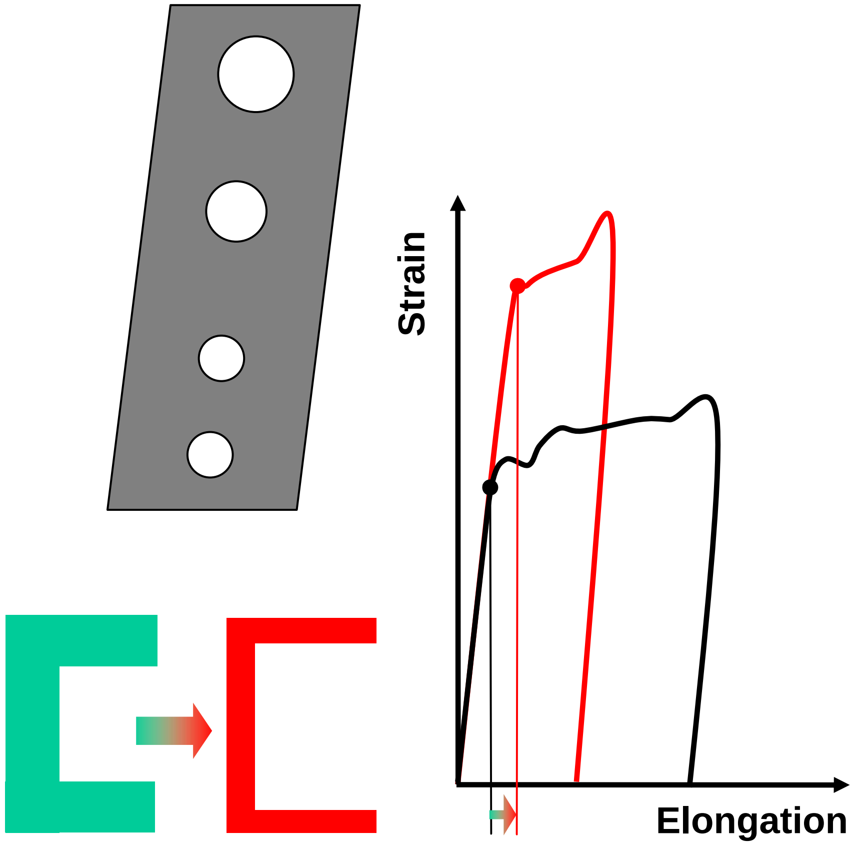
Lightweight design – a supreme discipline of vehicle development

Sophisticated lightweight design



B-pillar of VW Golf VII
Origin: Kleimann und Schorn, 2012

Simple weight reduction



Reduction of the kerb weight of semi trailers

6.8 t

5.6 t

Reduced kerb weight

4.7 t

In the past — Today

Light

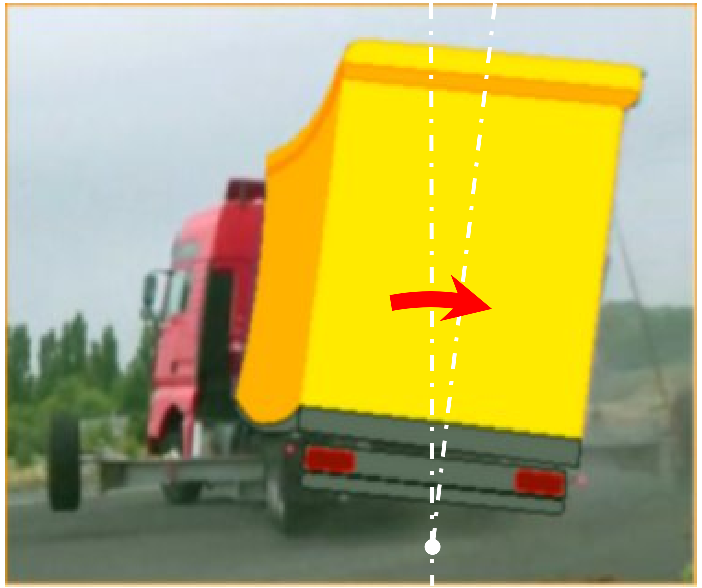
- 100 kg more pay load means approx. 1,000 EUR more receipts per year
- Additional reduction of tolls, if applicable

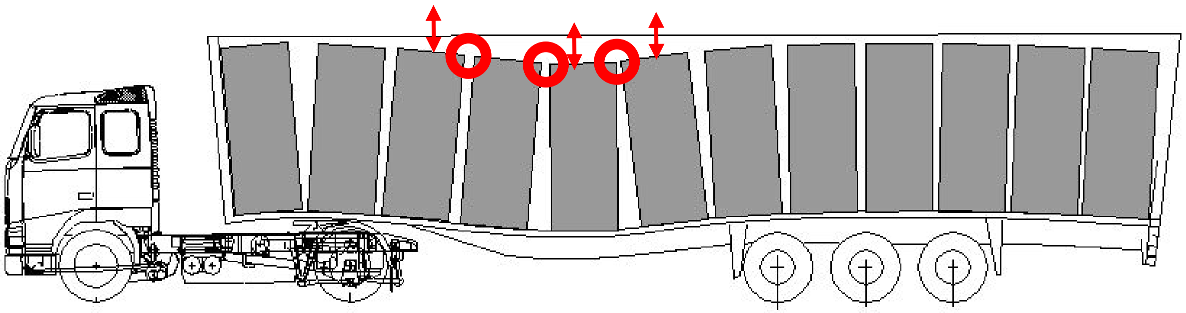
Super light

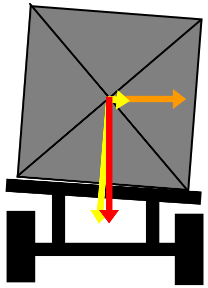
Torsion stiffness?

Reduction of the kerb weight of semi trailers

- Risk of transport damage at the cargo
- Impairment of cargo securing (calculations based on rigid representation models)
- Negative influence to the driving dynamics
- Increased tilting danger

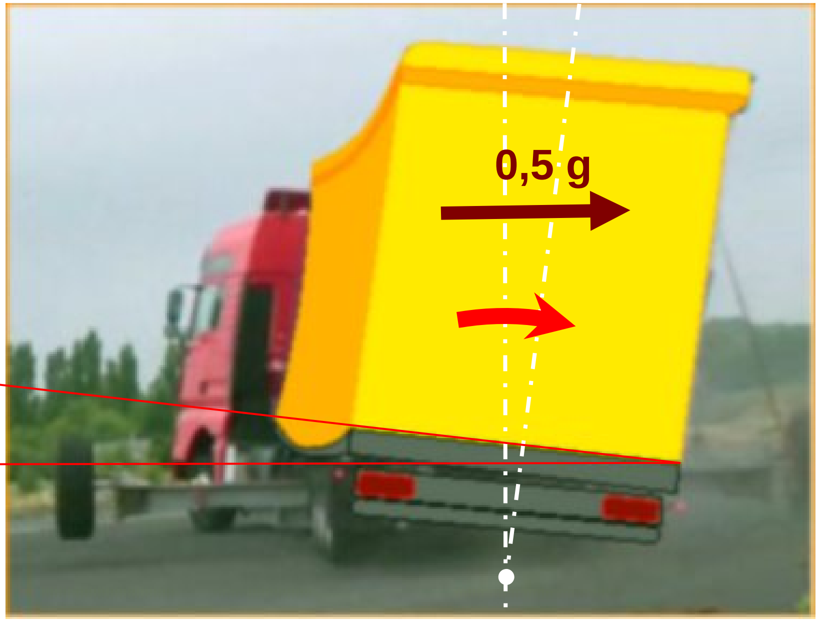






flexible/ torsion-weak weight reduced semi trailers

- Roll angle in the past: 6-7° (measured at the front wall)
- Roll angle today: 12-14°
- Extensive lateral bulges at roof-beam bodies with side curtains
- Increased tilting danger (only to control when using a very robust kibble tap)
- Problems with the connection of the kibble tap and the force application at the perforated longitudinals



Findings from dynamic driving tests

- Lifting of the rear wheel inside of the turn already happens with lateral acceleration > 0.25 g (Trailer fully laden with crates in the so called "double floor" without betwixt floor pan)
- Lateral test acceleration according to EN 12642 not accessible
- Lateral accelerations from 0.20 to 0.25 g can be reached in normal everyday vehicle operation

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Findings from dynamic driving tests

- **1999**
  Swap body stowed with small load carriers driven at the tilting limit with 0.5 g lateral acceleration: Magnitude 290 mm of the lateral bulge in the side plane

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Findings from dynamic driving tests

- steady-state test with R = 23 m and v = 26 km/h; tilting angle = 9°

Findings from dynamic driving tests

- steady-state test with R = 23 m and v = 27 km/h; tilting angle = 10°

Findings from dynamic driving tests

- Distortion of the body leads to lifting of the rear wheels inside the turn at lateral acceleration ~ 0.4 g

Findings from dynamic driving tests

- Distortion of the body leads to lifting of the rear wheels inside the turn at lateral acceleration ~ 0.35 g

Findings from dynamic driving tests

- Deformation of the roof beam at 0.5 g lateral acceleration

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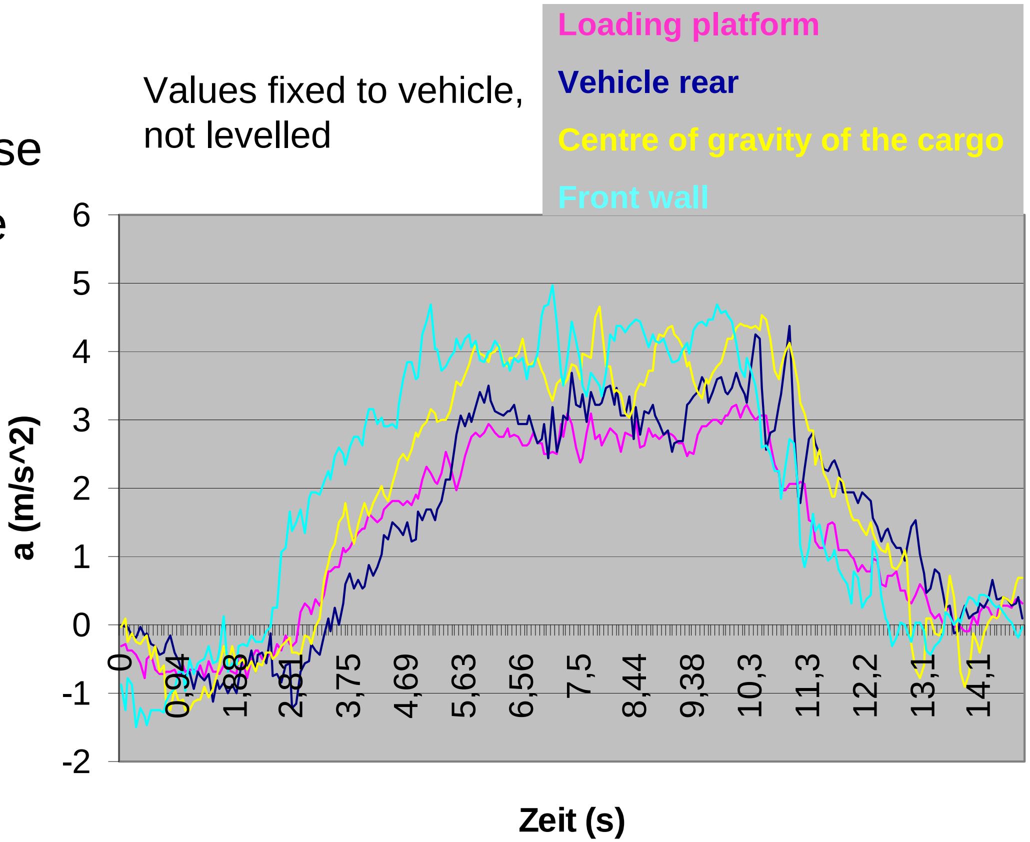
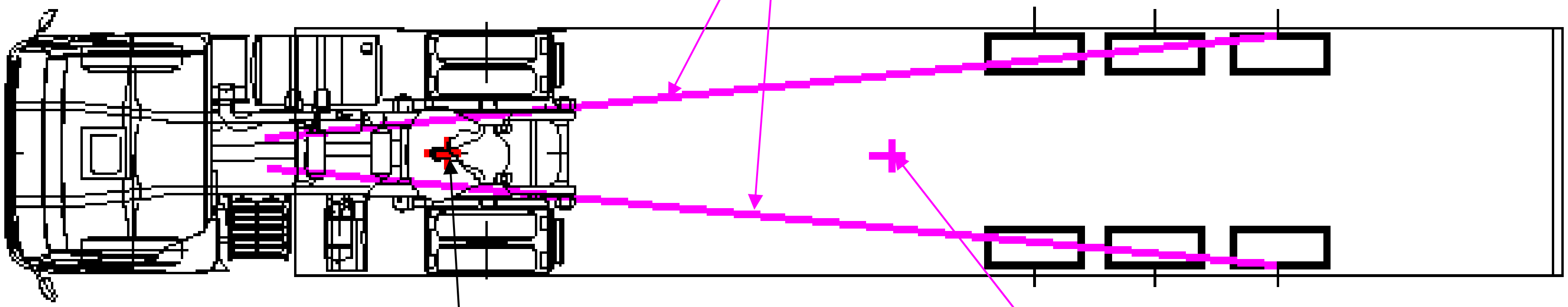
Findings from dynamic driving tests

- Time offset of the lateral acceleration measured:
  - Front wall leads in phase
  - Rear wall lags in phase
- Spread of maximal values of lateral decelerations:
  - Maximum values at the front wall and in the centre of gravity of the cargo
  - Smaller values at the vehicle rear and at the loading platform



Findings from dynamic driving tests



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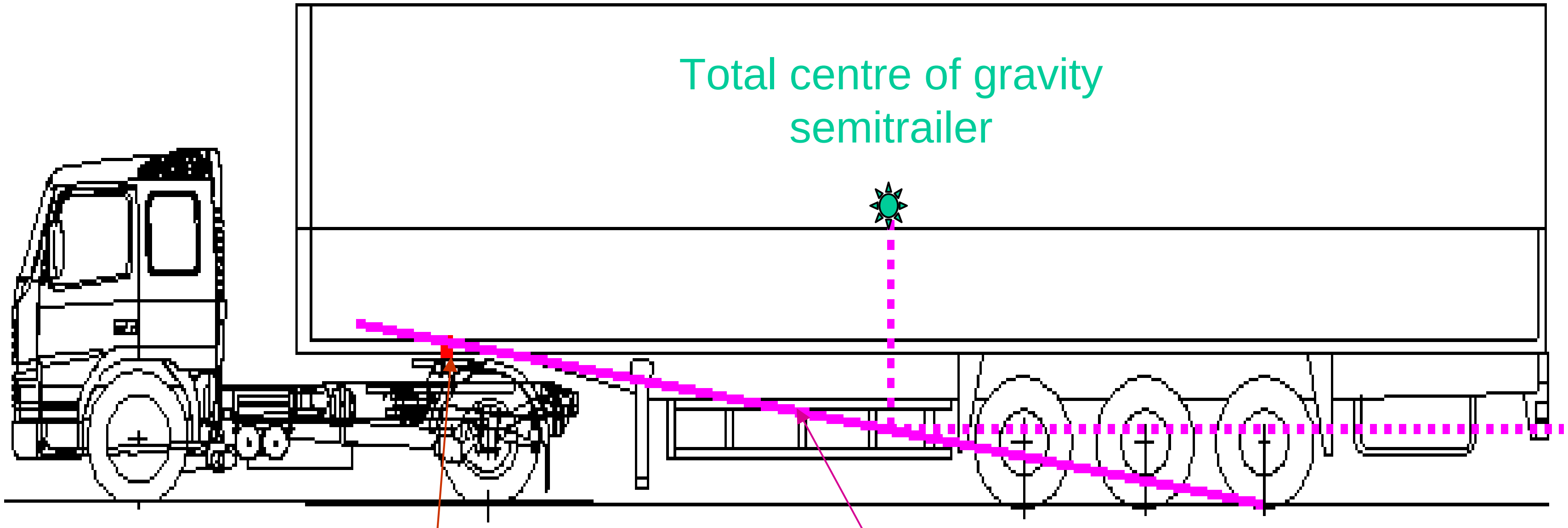
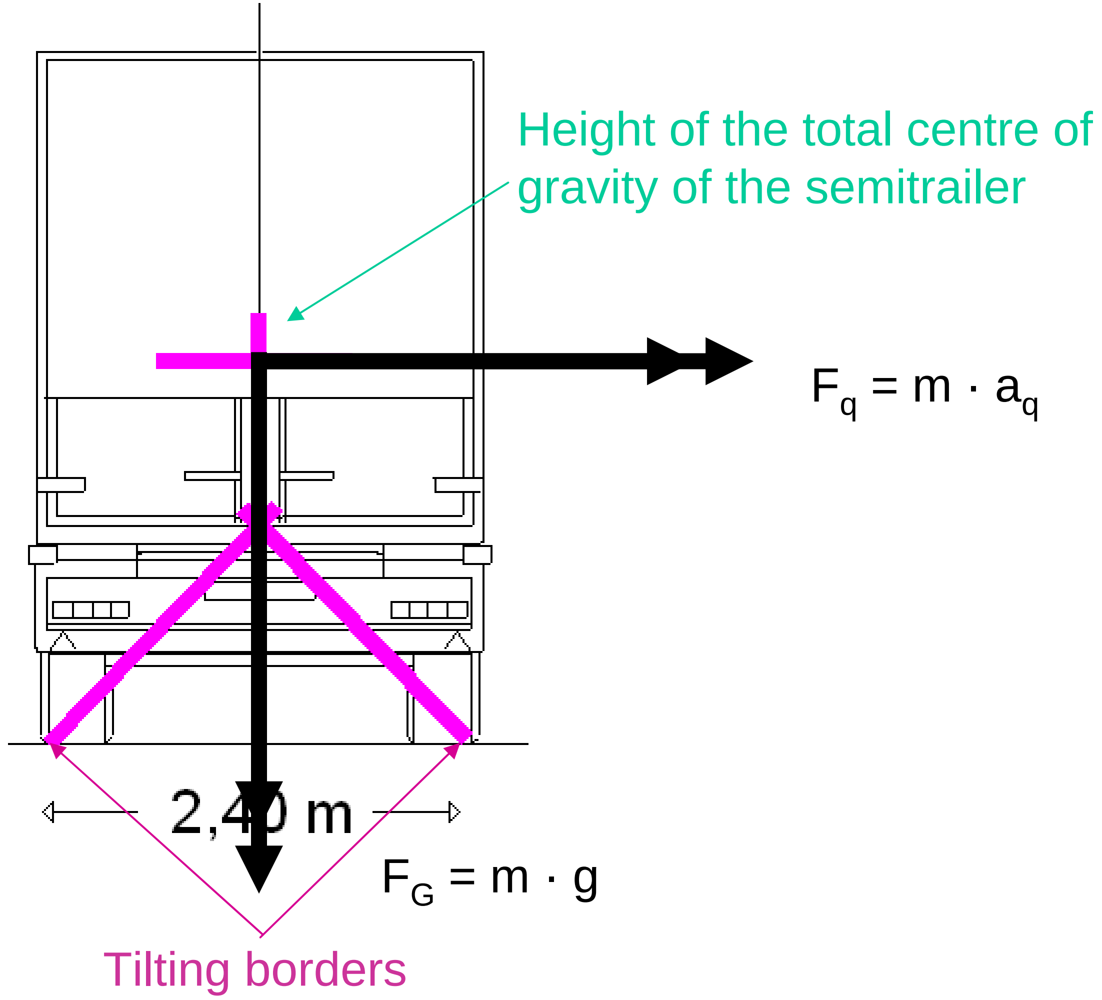
Findings from dynamic driving tests

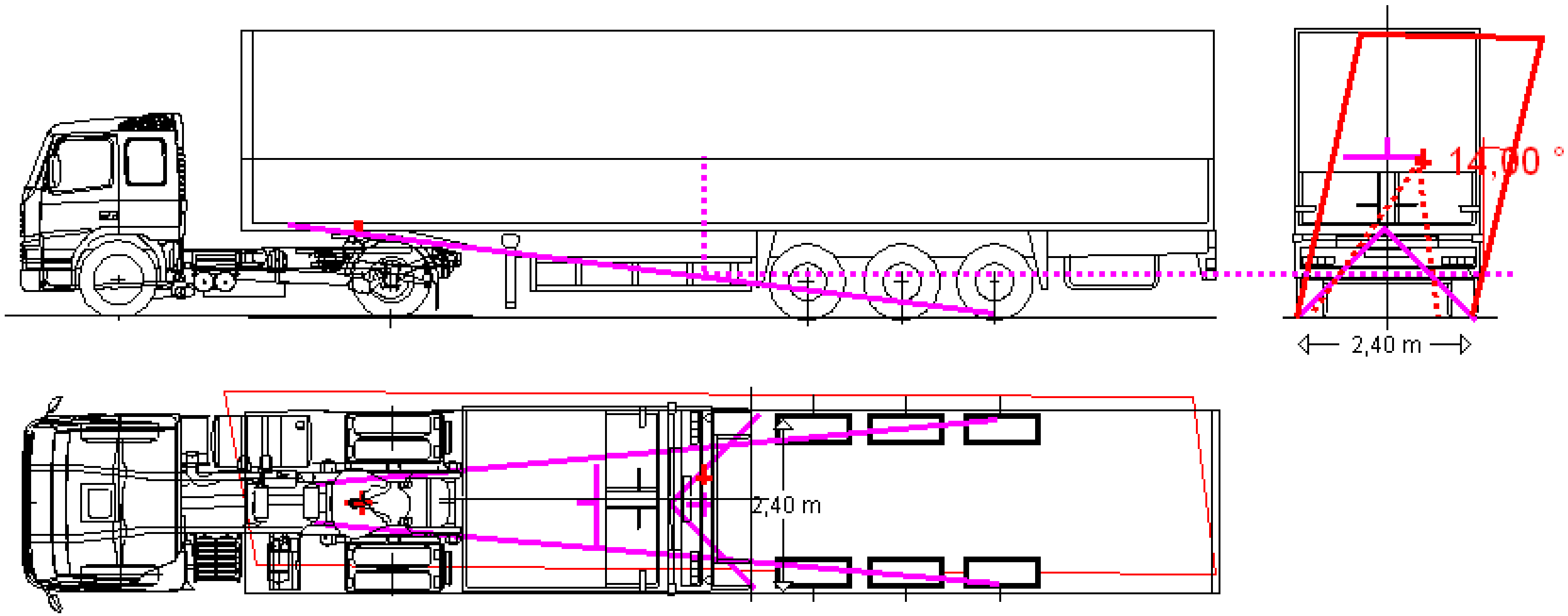


Findings from dynamic driving tests



Findings from dynamic driving tests

- Displacement of the total centre of gravity to the tilting line
- In the past lateral acceleration > 0,5 g at tilting border reachable with steady-state tests
- Today with torsion-weak bodies at 0.3 g wheels lift-off of inside the turn



Solution statements

- Determination and publication of the static and the dynamic torsion stiffness of semitrailers (for orientation and as benchmark)
- Stabilisation of chassis and body by sophisticated lightweight design (materials, cross sections, profiles, additional reinforcement)
- Dynamic limitation of the roll angle by the chassis
- Access of load sensitive adaptive ESC in tilting dangerous situations already at 0.25 g (position of the sensor for measuring of the lateral acceleration not optimal hitherto)
- Determination of the tilting angle of the body during dynamic driving tests according to EN 12642 (at the front wall for example) and introduction of an appropriate limit (for example 8°)
- For the long term: Harmonisation of dynamic driving tests for cargo securing (EN 12642) und for testing the dynamic driving behaviour (lane changing tests, braking in a curve, …) using typical „real“ cargo

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