Regulation No. 55
Mechanical Couplings – Coupling Balls and Towing Brackets

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CARLOS TC (CAR LOading Standard, Trailer Coupling) Consortium Participants

Car OEMs:

Adam Opel AG
Audi AG
BMW Group
DaimlerChrysler AG
Ford-Werke AG
Porsche AG
Skoda AG
Volkswagen AG
Volvo Car

Technical Control Boards:

RWTÜV Fahrzeug GmbH, Essen
TÜV Automotive, München

Suppliers:

AL-KO GmbH
Bosal Research
Karmann GmbH
MVG mbH
Oris Fahrzeugteile Hans Riehle GmbH
PD&E Automotive Solutions
Magna Steyr Fahrzeugtechnik AG & Co KG
Westfalia Automotive GmbH & Co KG

Research Institutes:

Fraunhofer Institute for Structural Durability LBF (project manager)
KATECH
(Korea Automotive Technology Institute)

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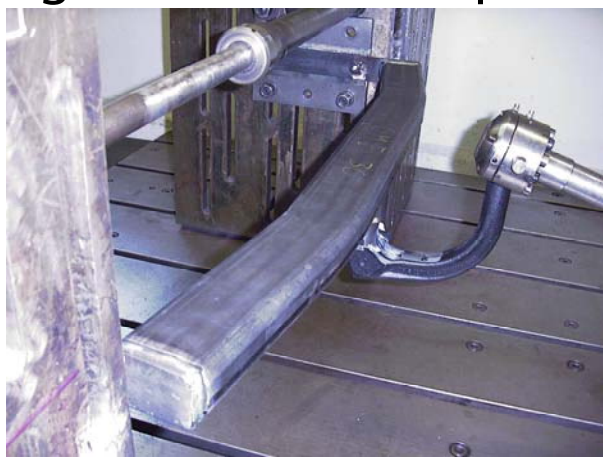
Introduction

- Trailer coupling devices (TCD) are safety-critical components
- Tests for the homologation of TCDs according to 94/20/EC are performed with
  - sinusoidal loading
    - → 1-dimensional loading (1-D)
    - → constant amplitudes (CA)
    - → no mean load (R=-1)



- Fatigue relevant local stresses and strains on TCDs are depending on
  - service loads
    - → 3-dimensional loading (3-D)
    - → variable amplitudes (VA)
    - → variable mean load (R≠–1)

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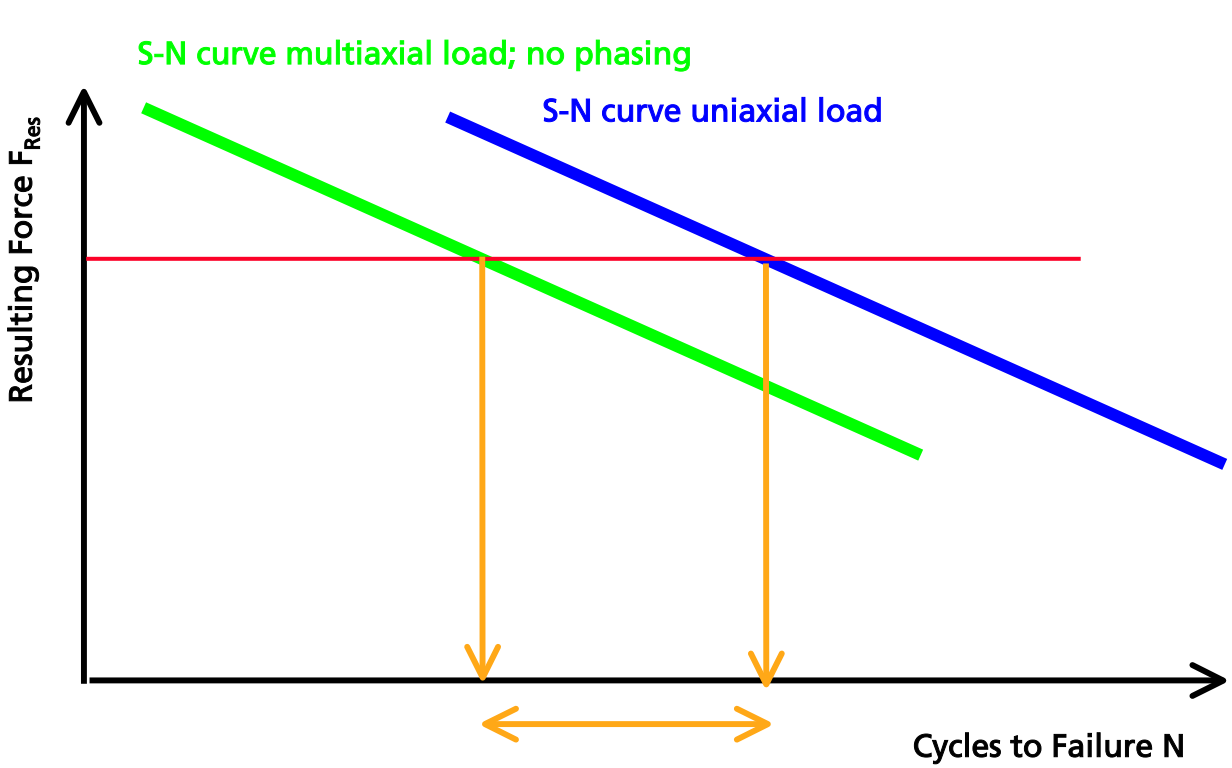
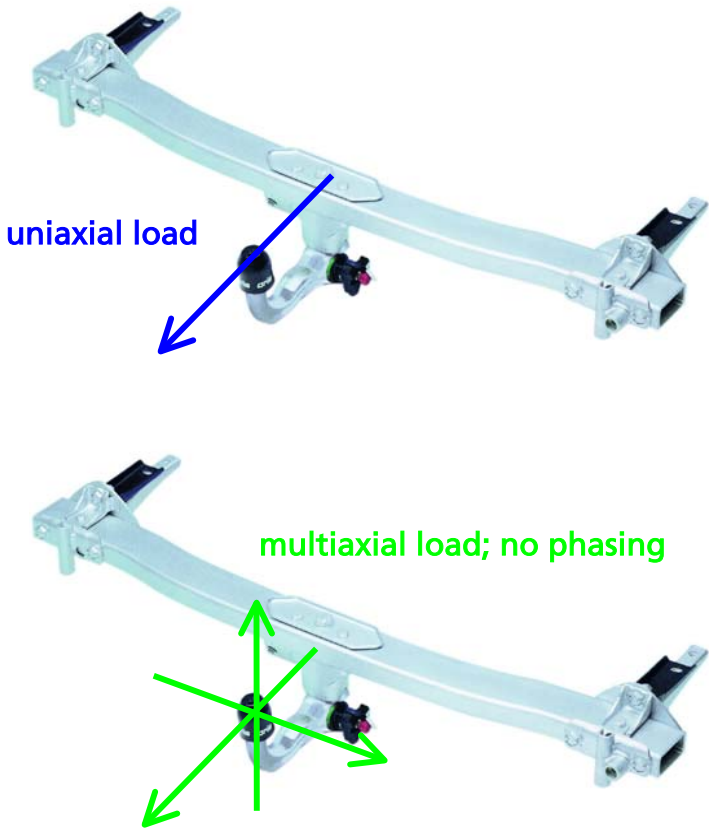
Uni- & Multiaxial Load – Cycles to Failure





Uni- & Multiaxial Load:

- different cycles to failure with the same force amplitudes.

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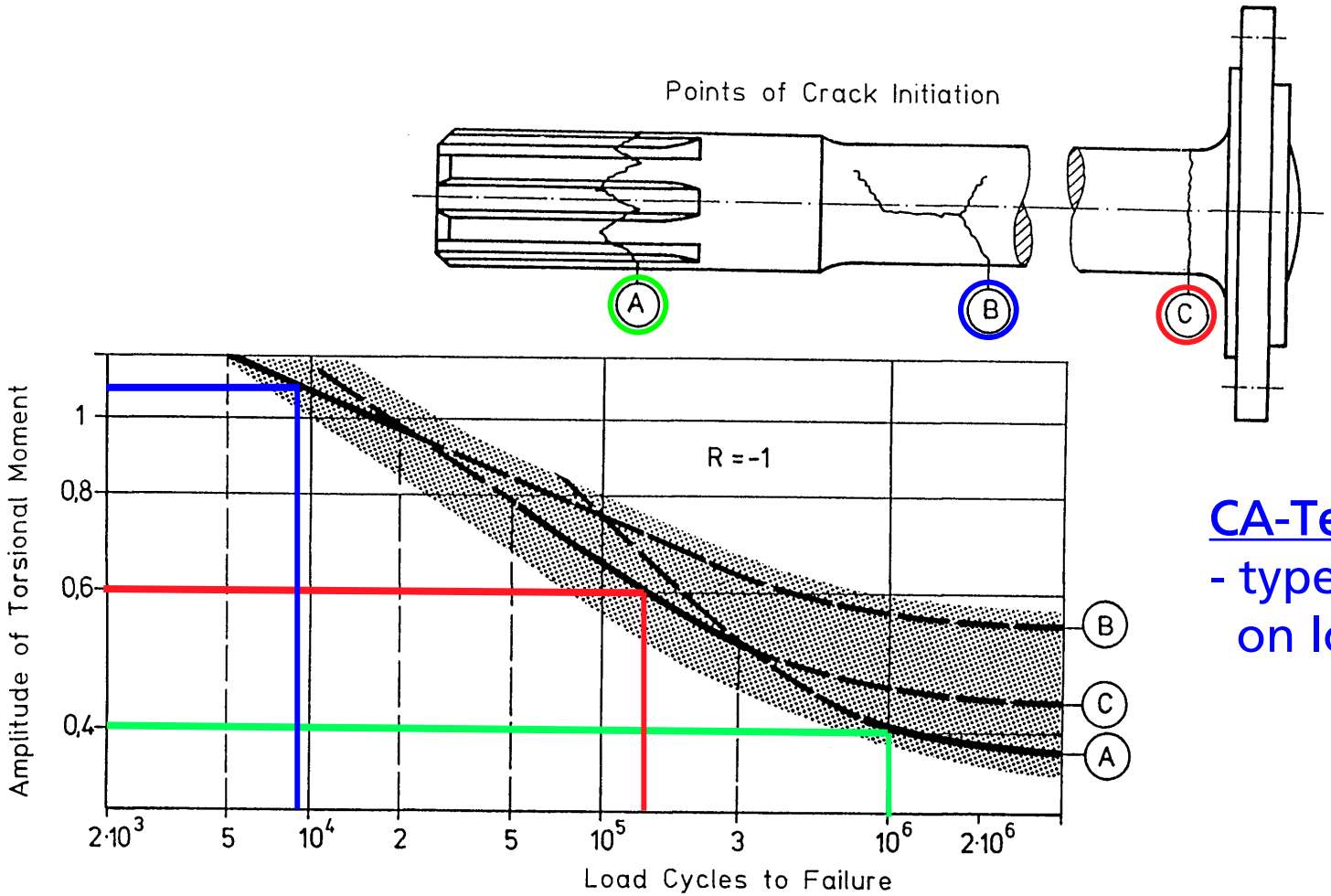
Constant Amplitude Testing – Type of Failure



CA-Testing:

- type of failure depends on load amplitude.

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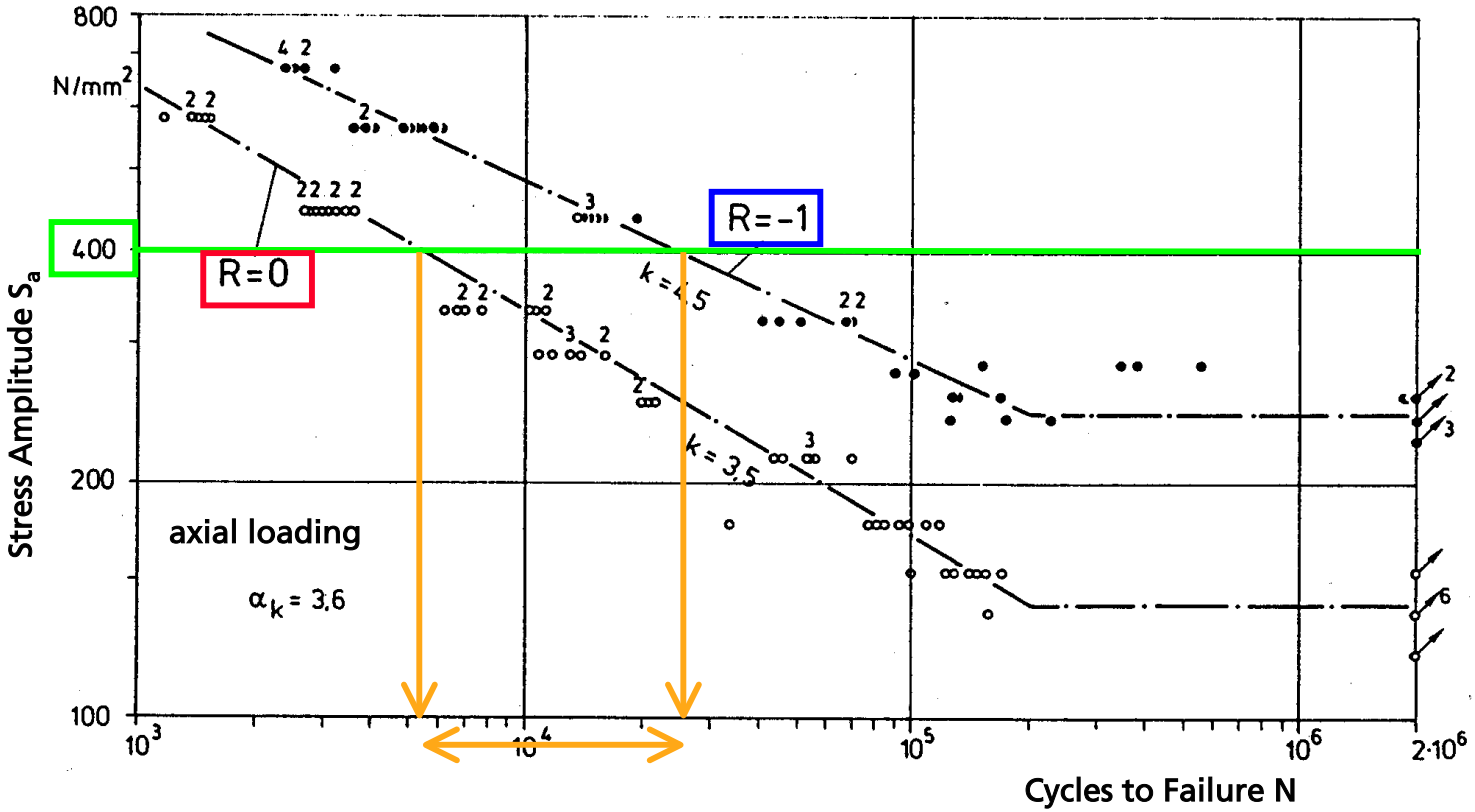
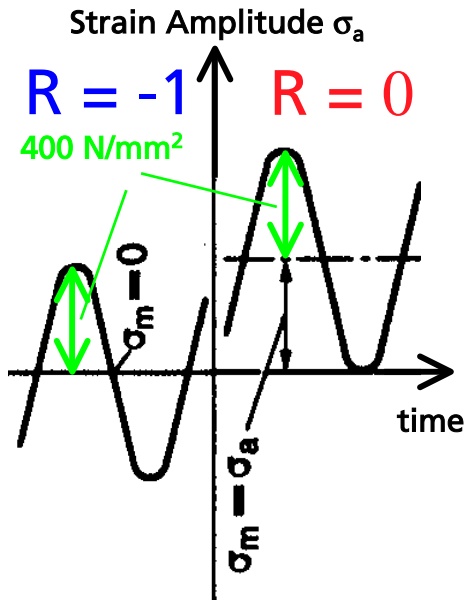
Mean Load - Cycles to Failure





$$R = \sigma_u / \sigma_o$$

Mean Load:

- different cycles to failure with same load amplitude

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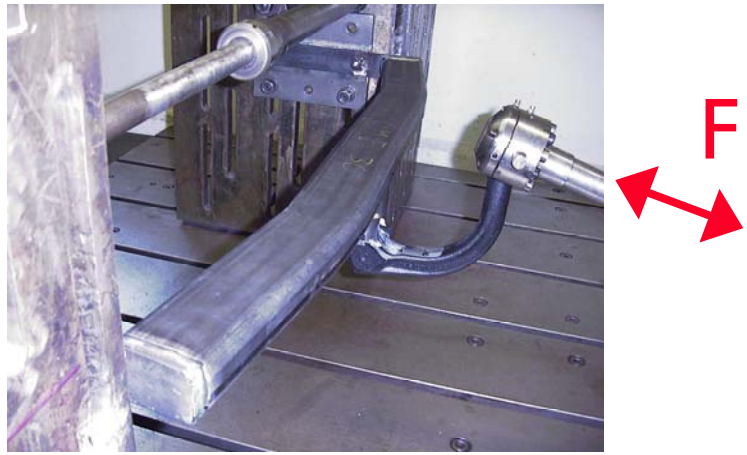
Currently used guideline 94/20/EC resp. ECE R 55.01

<u>The 94/20/EC resp. ECE R 55.01 guideline:</u>

- sinusoidal loading
  - → 1-dimensional loading (1-D)
  - → constant amplitudes (CA)
  - → no mean load (R=-1)



→ Durability assessment is critical with respect to:

- type of failure
- cycles to failure

<u>Possible Improvement:</u>

A testing procedure oriented on 3-D service loads will lead to customer oriented type of failures resp. cycles to failure .

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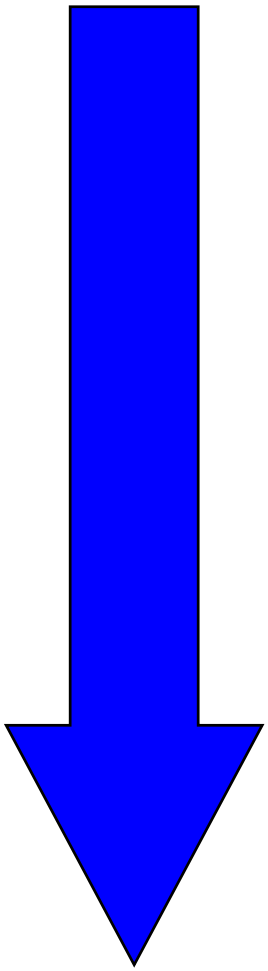
Derivation of a Testing Procedure based on Service Loads



Input:

42 verification tests / measurements from OEMs

Signal analysis:

verifications, normalizations, correlations, load spectra

Derivation of 3 Modules:

based on representative 22 load segments

Testing Procedure:

damage sums, duration (<150h), frequencies, max. amplitudes

CARLOS TC:

duration: ~92h, module mix: 10*(5*(10*M1+M2)+M3)

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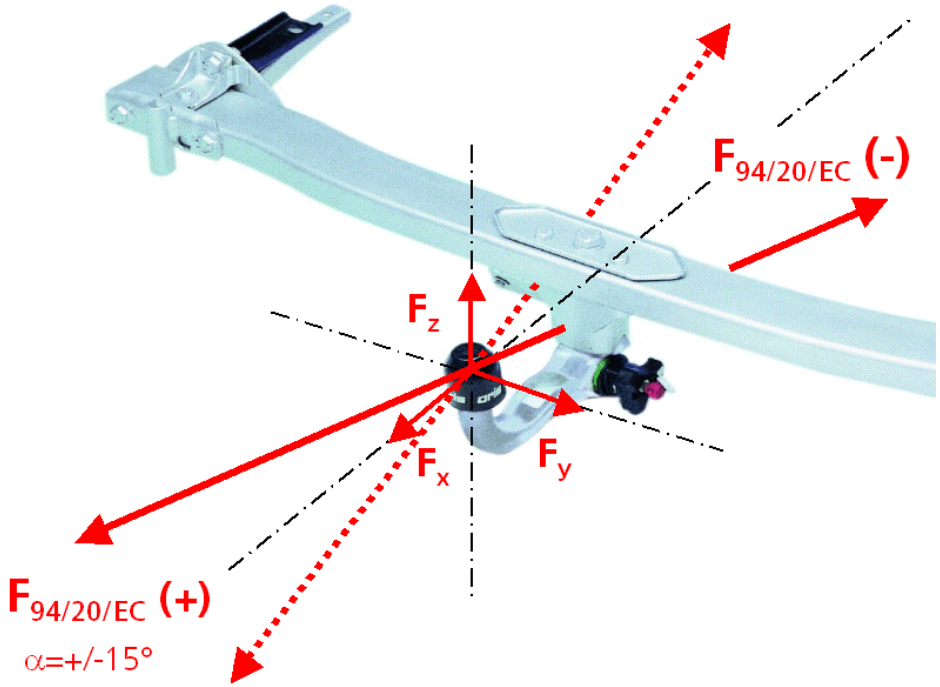
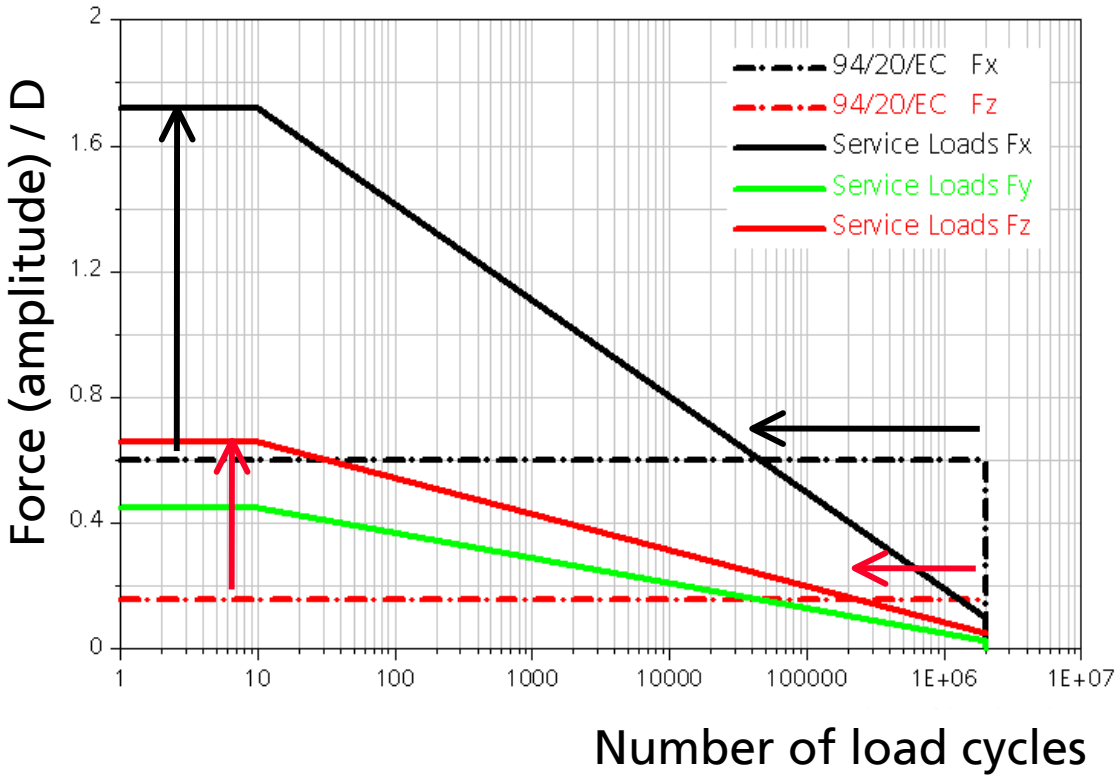
Current EC Homologation Test 94/20/EC (1-D, CA) and CARLOS Trailer Coupling (Realistic loading: 3-D, VA)





- increasing of max. force amplitude
- introducing Fy as further testing direction
- 3D-testing with variable amplitudes and mean load

→ More realistic testing procedure!

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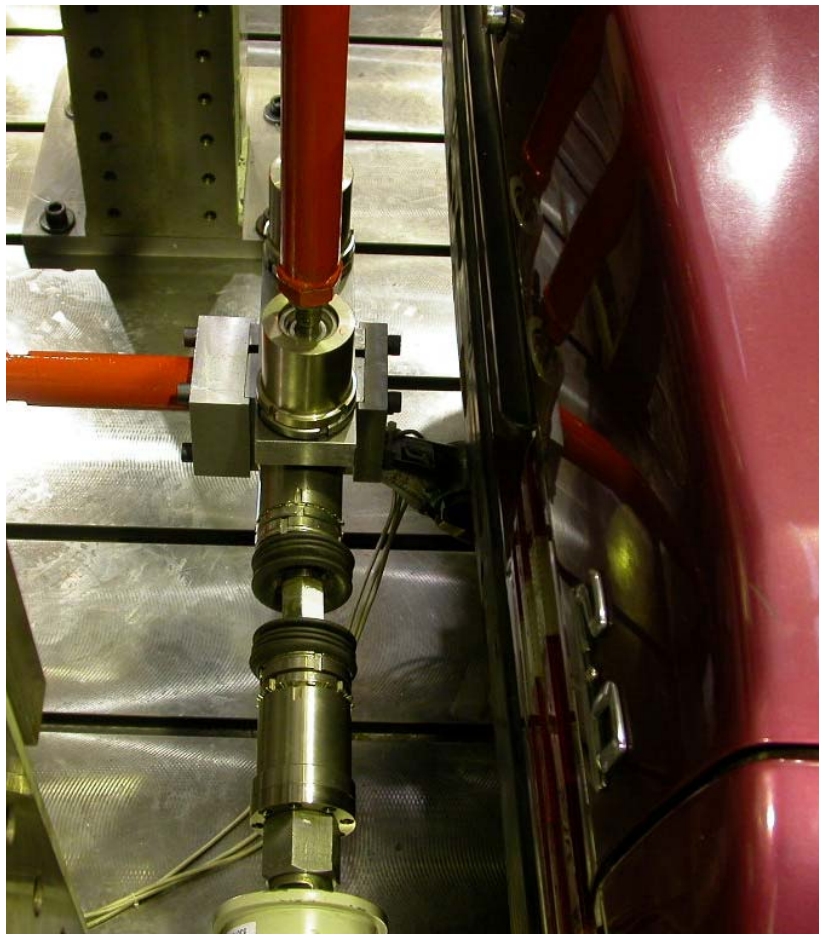
Multiaxial Test-Rig for Trailer Coupling Devices



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Testing Result: CARLOS TC

The additional testing-direction Fy, may lead to additional failures.

→ Additional failure criteria in the guideline will be needed.

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Summary

- Currently used testing procedure is representing a fictitious testing scenario.
- Proposed testing procedure CARLOS TC is representing customer oriented service loading.
- Proposed testing procedure leads to customer oriented failures.

The proposed testing procedure is oriented on
3-D service loads and represents the customer usage more closely.

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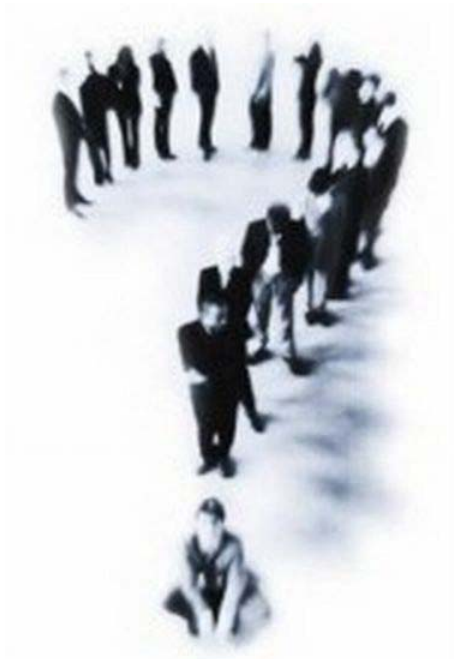
Thank you for your kind attention!



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59th GRRF, item 6 ECE R55-01 current test procedure for A50-X (p.1)

current procedure – 1960‘s technology:

- hydropulse test bench, uni-axial loading
- coupling device rigid (?!) mounted
- constant test force ±0,6*D under 15°
- 2 * 10^6 cycles for designs made of steel
- no lateral forces
- result: fatigue strength (Wöhler)
- ??? cycles for design made of light alloy

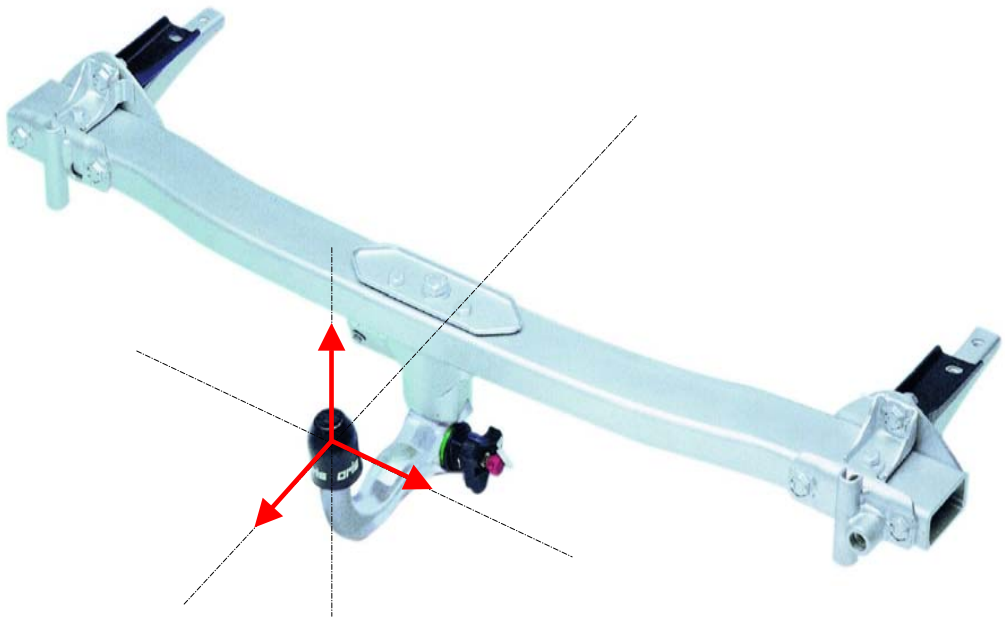
59th GRRF, item 6 ECE R55-01 optional test procedure for A50-X (p.2)

- car manufacturers must release permissible trailer mass, vertical static load and fitting points (see also EC directive “mass and dimensions“ 92/21/EEC including 95/48/EC)
- verification: harmonized **car lo**ading **s**tandard (CARLOS) for car bodies
- **intention**: use of CARLOS test also for A50-X devices **and** acceptation in ECE 55-01

59th GRRF, item 6 ECE R55-01 optional test procedure for A50-X (p.3)

new procedure – state-of-the-art:

- hydropulse test bench, multi-axial loading



59th GRRF, item 6 ECE R55-01 optional test procedure for A50-X (p.4)

- coupling device directly mounted at car body or directly at the test bench
- not constant test forces – load-time histories of the variable force components: Fx longitudinal, **Fy lateral** and Fz vertical
- test duration 92 hours
- designs made of steel and/or light alloy
- result: service strength (long life)

59th GRRF, item 6 ECE R55-01
optional test procedure for A50-X (p.5)

proposal for further approach:

Installation of an ad hoc group to study and discuss the presented details quite similar as previously done with main discussion for ECE 55-01

time schedule for an ad hoc group meeting:

April 2006 or later