KRONE Design Criteria for Semi-Trailer Development Process and KRONE Wheel Approval Procedure

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Fahrzeugwerk KRONE GmbH
Overview

- Fahrzeugwerk KRONE
- Numerical Analysis at Fahrzeugwerk KRONE
- Design Criteria for Semi-Trailer
- KRONE Wheel Approval Procedure
Bernard Krone (Dipl. Kfm.)
Managing director and co-owner
of Bernard Krone Holding GmbH & Co. KG

Comprehensive Trailer Service Provider

Whether it is parts, telematics, financing, service packages such as FairCare, or our used trailer service KRONE Used and our new service offer KRONE Fleet:

We are always a reliable partner for our customers in all sectors.
PLENTY OF SPACE FOR YOUR LOAD

THE VERSATILE KRONE TRAILER PROGRAM

- Curtain Sider
- Insulated & Dry Freight Semi-Trailers
- Box Liner
- Carrier System
- Trailers / Superstructures
- Future Projects
- Load securing
- DWC
- KRONE Telematics
- KRONE Trailer Axle
Sales performance (consolidated) | COMMERCIAL TRAILERS

Domestic market

- 2009/10: €311, 52% domestic, 48% export
- 2010/11: €804, 40% domestic, 60% export
- 2011/12: €878, 34% domestic, 66% export
- 2012/13: €925, 30% domestic, 70% export
- 2013/14: €1,078, 28% domestic, 72% export

Export

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Sales development by product

- **Trailers & Semi-Trailers**
- **Closed Semi-Trailers**
- **Swap Bodies**

<table>
<thead>
<tr>
<th>Year</th>
<th>Trailers &amp; Semi-Trailers</th>
<th>Closed Semi-Trailers</th>
<th>Swap Bodies</th>
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<td>2009/10</td>
<td>14,567</td>
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<tr>
<td>2010/11</td>
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<td>2011/12</td>
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<td>2013/14</td>
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NEW CONCEPTS FOR THE TRANSPORT BUSINESS
INNOVATIONS FOR THE FUTURE

ENVIRONMENT PROTECTION THAT PAYS
THE FUEL-SAVING ECOPACKAGE

NOTHING MORE TO EXPECT
THE LONG HGV

EXCESS WEIGHT – NEVER AGAIN
THE DWC WHEEL BASE CONTROL

RENERGY
THE GREEN TECHNOLOGY

AERO LINER + CONCEPT S
FUTURE ALREADY STARTS TODAY
World Cup Winners Travel by Krone

After winning the FIFA World Cup in July 2014, the German national football squad paraded the trophy on a converted KRONE Cool Liner past thousands of fans in Berlin.

The ‘World Cup Liner’ was prepared by a crack team of Krone engineers at Werlte in a record time of only four days.
Numerical Analysis at KRONE

Stress Analysis (FEM)

Analysis of components, groups and complete vehicles related to relevant load cases

- Calculation 1
- Optimisation Step 1
- Final Design optimised for force distribution and mass

Special investigations

- Rolling of a fork lift wheel on a trailer floor
- Stress analysis and deformation control
Structural Durability / Fatigue

- Application of all relevant load cases
- Stress analysis and damage accumulation
- Local evaluation
- Local design spectrum
Virtual Testing / Certification Procedures

e.g. UIC 596-5 Testing Procedure for Railway Transport

Since 2013
KRONE Virtual Testing was certified by Deutsche Bahn
Special Applications - Trailer Evaluation Tool

Evaluation in consideration of operational, technical and economic conditions and their system correlation

- Operational conditions: route, loading, breaks
- Technical solution: technical trailer configuration
- Cost structure: financing concept, service, staff
- TRAILER EVALUATION: fuel & energy consumption, costs p.a., transportation costs

Key factors:
- Speed
- Topography
- Loading conditions
- Purchase price
- Leasing
- Fuel
- Wear and tear
- Damage
- Working days
- Service life / mileage
- Loading conditions...
Design Criteria for Semi-Trailer

Determination of Operational Demands

Loading conditions
- number of loading and unloading actions
- kind of loading procedure
  - e.g. by fork lift (floor rolling)
- kind of loading
  - full load
  - partial loaded
  - point loaded
  - double deck
- load securing systems

Geometry model preparation for different loadings, e.g. support areas for coil loading application
Determination of Operational Demands

*Driving conditions*
- driving load cases with different loadings
  - straight driving (potholes)
  - torsion
  - cornering
  - shunting / parking
  - braking
- additional load cases
  - coupling and uncoupling

Adaptation of wheel resp. axle loads and design criteria to semi-trailer configurations e.g. 3-axle load combinations
Definition of Operational Conditions for Semi-Trailer Wheels

Load cases derived from measurements on public roads and testing areas

**Straight Driving (Potholes)**
- 2 load cases with different vertical and lateral load combination
- same frequencies as LBF

**Cornering**
- 2 load cases (for outer and inner wheel in a curve)
- loads for outer wheel similar to LBF
- less vertical and lateral loads for inner wheel
- same frequencies as LBF

**Shunting**
- 2 load cases (for outer and inner wheel during shunting)
- less vertical and lateral loads for the inner wheel during shunting
- frequencies adapted from axle design criteria

Influence of Shunting
Design Criteria for Semi-Trailer Wheels

Influence of Shunting

*LBF.WheelStrength Results – RFS Values – 11,75x22,5 Offset 0*

Standard LBF front axle design spectrum

KRONE semi-trailer design spectrum including shunting

Dependend on wheel design high influence in the disc area

Stress level – espacially for offset 0 – caused by combination of a high lateral load for outside position and also a high lateral load for the inside position during shunting
Surface (Coating) Quality and Corrosion Protection

According to EUWA Standard ES 3.03 / 3.14 and additions

- **Over-coating ability**

- **Corrosion Test**
  - Steel Wheels
    - Salt spray test NSS
    - Alternating test related to EUWA 3.03 for passenger car wheels
  - Aluminium Wheels
    - Salt spray test NSS
    - Salt spray test CASS

- **Jet Cleaning Test (no EUWA standard)**
Lifespan Tests

**EUWA Standard ES 3.11**

- Rolling Fatigue Test RFT
- Cornering Fatigue Test CFT

**EUWA Standard ES 3.23**

- Biaxial Fatigue Test (at the moment front axle programmes)

Because of effort and costs KRONE accepts in case of low unit quantity a numerical durability evaluation using the LBF.WheelStrength methodology.

For the future

- KRONE sees the need of a semi-trailer test cycle
- KRONE has interest to support the development process
Thank you for your attention

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