J. Krieger: Safety and Security of Bridges on Federal Highways in Germany
Structure

1  Introduction

2  Bridge Management System

3  Load Bearing Capacity

4  Adaption to Climate Change

5  Security of Bridges and Tunnels

6  Conclusions
Traffic on Federal Motorways

1950

1975
Traffic on Federal Motorways
Federal Roads in Germany

<table>
<thead>
<tr>
<th>Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAB</td>
<td>12,000 km</td>
</tr>
<tr>
<td>BStr</td>
<td>41,000 km</td>
</tr>
<tr>
<td>BfStr</td>
<td>38,000 Bridges</td>
</tr>
<tr>
<td>BfStr</td>
<td>220 Tunnels</td>
</tr>
</tbody>
</table>
Age Distribution of Bridges on Federal Roads
(Bridge Deck Area)
Prognosis of Freight Traffic

Leistung in Mrd. Tonnenkilometer

(Quelle: progtrans 2007)
Gesamtgewichtsverteilung

WIM Measurements

Häufigkeit
Frequency

0,08

Gross weight (t)

J. Krieger – IBF

Tuesday 15th September 2009
Traffic with special Permission
Possible systematic problems

**Concrete bridges**
- Reinforced Concrete
- Shear strength insufficient shear reinforcement
- Corrosion insufficient concrete cover
- Cracks due to insufficient steel reinforcement
- Other problems/defects

**Prestressed Concrete**
- Coupling joints temperature, min. reinforcement
- Stress corrosion cracking of prestressing steel
- Insufficient grouting

**Steel bridges**
- Steel
- Cracks in orthotropic bridge decks
- Defects at cables
- Wind induced fatigue
- Other problems/defects

**All materials**
- Traffic loads BK 60, BK 60/30
- Temperatures
- Defects of bridge bearings
- Pavement, Sealing
- Other defects
Challenges for Bridge Owners/Operators

• The age distribution of German bridges shows a large proportion of bridges built until 1980.
• Bridges constructed before 1980 can have insufficient load bearing capacity compared to actual and future traffic on Federal Highways.
• Bridges can have systematic problems according to the used design standards.
• Bridges have deteriorated during the last years.
• Prognoses show a strong increase of freight transport.
• The percentage of vehicles with gross weights > 40t has increased.
• HGV Traffic with special permission has strongly increased.
Structure

1. Introduction

1. Bridge Management System

1. Load Bearing Capacity

2. Adaption to Climate Change

3. Security of Bridges and Tunnels

4. Conclusions
Bridge Management System

- Inspection
  - Condition assessment
  - Maintenance alternatives
  - Costs, prognosis

- Damage investigations
  - On object level

- Effects on user and environment

- Evaluation on network level

- Evaluation on object level

- Maintenance program

- Evaluation of strategies
Evaluation on Network Level (Quality Scenario)
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Bridge Classes of Bridges on Federal Roads (Bridge Deck Area)
Traffic Load Models

DIN 1072, Nov. 1967

DIN 1072, Dec. 1985

DIN EN 1991
Prioritization

- RZ Traffic
- RZ Condition
- RZ Coupling Joints
- RZ Temperature gradient
- RZ Prestr. Steel Corrosion
- RZ Shear Force
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Scenarios for Climate Change in Germany
Temperature changes winter (left) and summer (right)

Mean values for the years 2071-2100 compared to the period 1961-1990, Scenario A1B
Scenarios for Climate Change in Germany
Precipitation changes winter (left) and summer (right)

Mean values for the years 2071-2100 compared to the period 1961-1990, Scenario A1B
Climate Change and Road Infrastructure

- Increasing temperatures
- Changes in precipitation
- Sea level rise
- Flooding of rivers
- Heat waves
- Extreme rain incidents
- Extreme storm incidents
- ....

Consequences for design and maintenance of road infrastructure
Need for Research

Deutsche Anpassungsstrategie (DAS) an den Klimawandel

Bericht zum Nationalen Symposium zur Identifizierung des Forschungsbedarfs

27./28. August 2008 in Leipzig
am Helmholtz-Zentrum für Umweltforschung – UFZ

German Adaption Strategy to Climate Change

Research Categories

www.ufz.de/das
Object Level

Changed actions due to Climate Change

Vulnerability analyses
  - Bridge types
  - Tunnels
  - Other constructions

Measures for improved resilience

Critical Structures
  - Bridge types
  - Tunnels
  - Other constructions
Climate Change and Road Infrastructure

Network level

Prioritization
- Strengthening
- Repair
- Replacement

Object level
- Vulnerability
- Measures
- Effectiveness

Program for Climate Change Adaptation
Structure

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Motivation

Bridges and tunnels are key elements of the road network. Reduced availability leads to:
• intense traffic interferences on the surrounding road network
• negative impacts on the user,
• high economic follow-up costs,
• negative environmental impacts and
• domino effects (interdependence with other traffic modes)

Thus: Protection of structures and users against threats caused by:
• Natural disasters
• Terrorism / Sabotage
• Other man-made hazards (e.g. accidents)
Objectives

- Identification of natural and man-made hazards,
- Formation of decisive threat scenarios,
- Determination of the effects on the structures and the users,
- Investigation of the effects of possible protection measures (risk- and scenario-analyses, cost-effectiveness analyses),
- Selection of the most effective and efficient protection measures.

Focus on:

- Security of users
- High availability of bridges and tunnels
Research Activities

WP1: Analysis of threats

WP2: Analysis of measures

WP3: Criteria for critical bridges and tunnels

WP4: Effectiveness of measures

WP5: Recommendations for the implementation of measures for bridges and tunnels

WP6: Demonstration

National Research Project
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Conclusions

PMS
- Condition
- Climate Change
- .......

BMS
- Condition
- Load Bearing Capacity
- Security
- Climate Change

Other
- Traffic Management
- Traffic safety
- .......

Asset Management

Multi-objective and harmonized Maintenance Programs