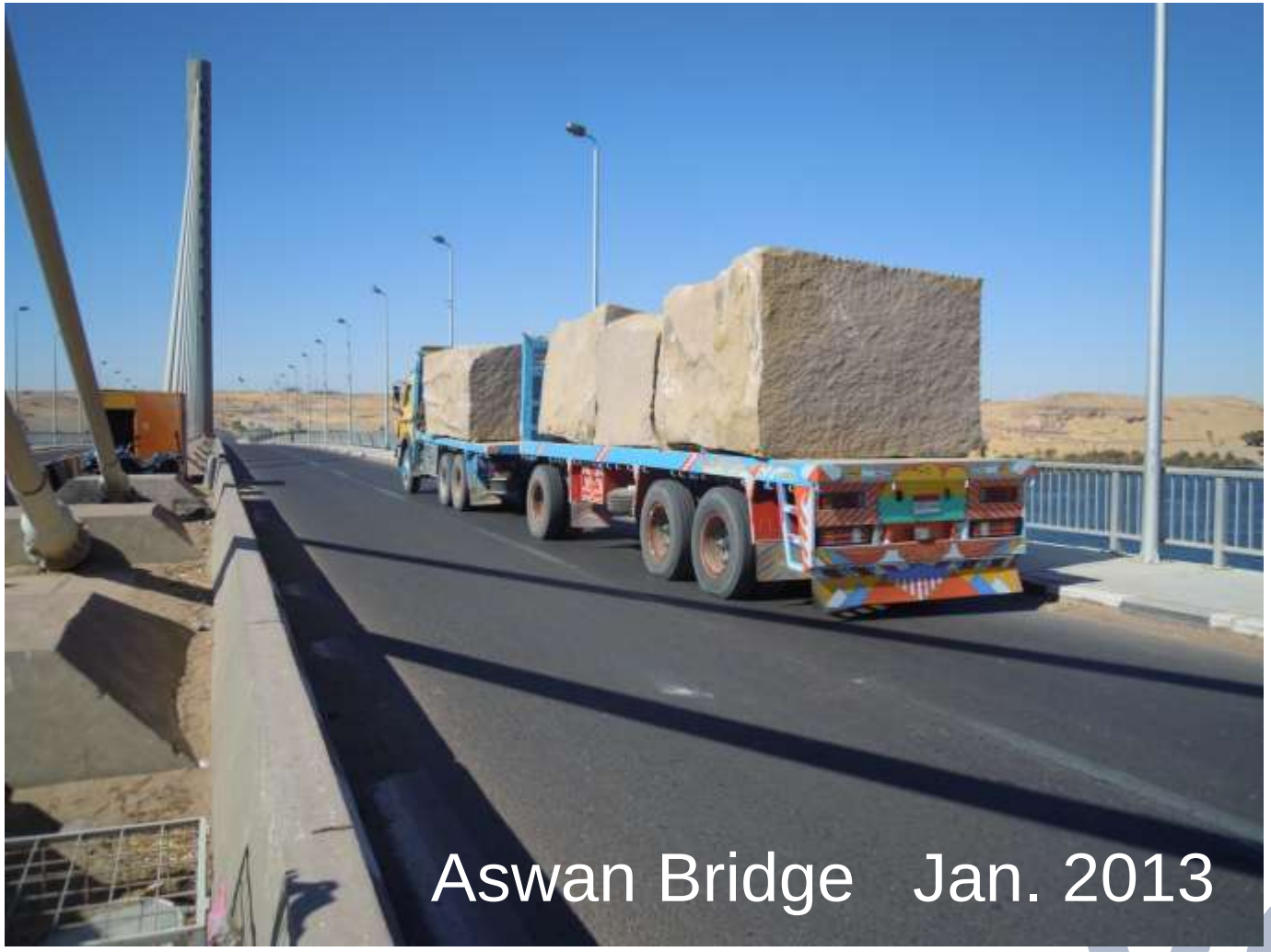
IWSHM Stanford 2013

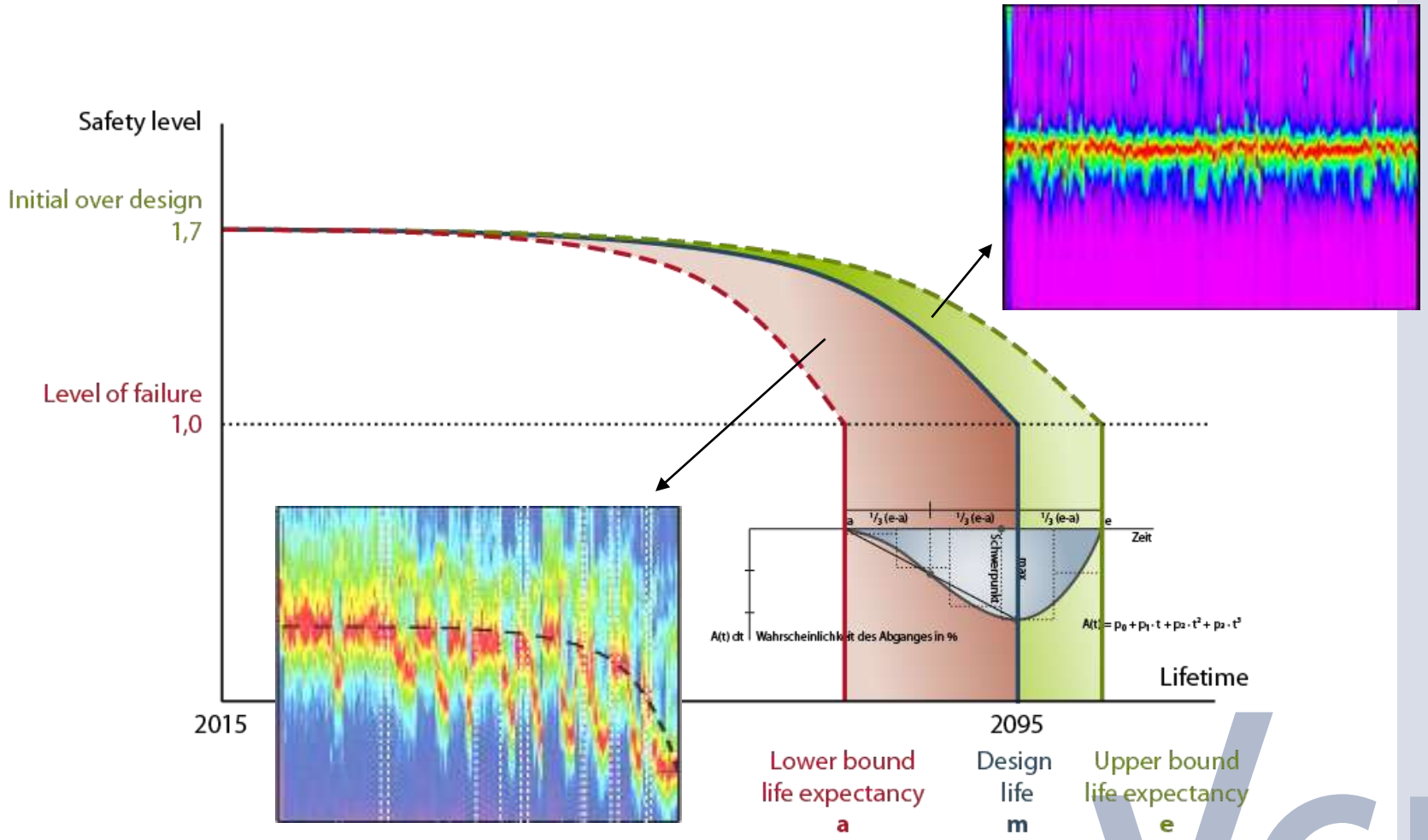
Activities on Standardization of SHM Methodologies in Europe

Helmut Wenzel

Standardization ?



IRIS Aging Formulation (CEN)



SHM Standardization Activities in Europe

/TC

Date: 2012-06

prCWA 63:2012

/TC

Secretariat: ON

Ageing behaviour of Structural Components with regard to Integrated Lifetime Assessment and subsequent Asset Management of Constructed Facilities —

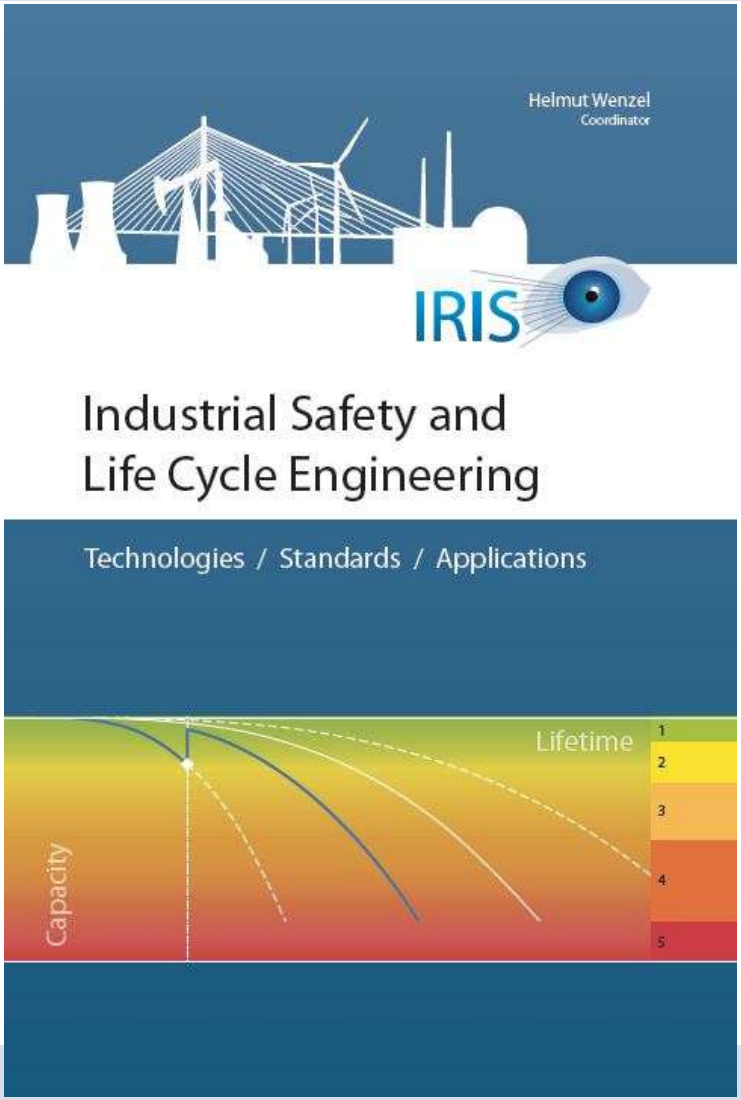
Alterungsverhalten von Bauteilen in Bezug auf ganzheitliche Lebenszyklusbewertungen und weiterführendes Erhaltungsmanagement von Infrastrukturbauten —

ICS:

Descriptors: Draft version May 16th, 2012

SHM Standardization Activities in Europe

Free Copies available !



Standardization Objectives

- Why
- What
- Who
- Where
- When
- How

Standardization

- Why is it so difficult in “Civil”

  - No standard industrial applications
  - Almost every structure is a prototype
  - Wide uncertainties in materials
  - Big tolerances in properties
  - Major regional differences

Standardization Road Map

- Who

  - All of us (all stakeholders) to reach wide consensus
  - Global participation required

Standardization Road Map

- Where
- Everywhere

Standardization Road Map

- When

  - Now!
  - First Stage 2 Years
  - Learn from Aerospace experience

Standardization Road Map

- Why (Motivation)

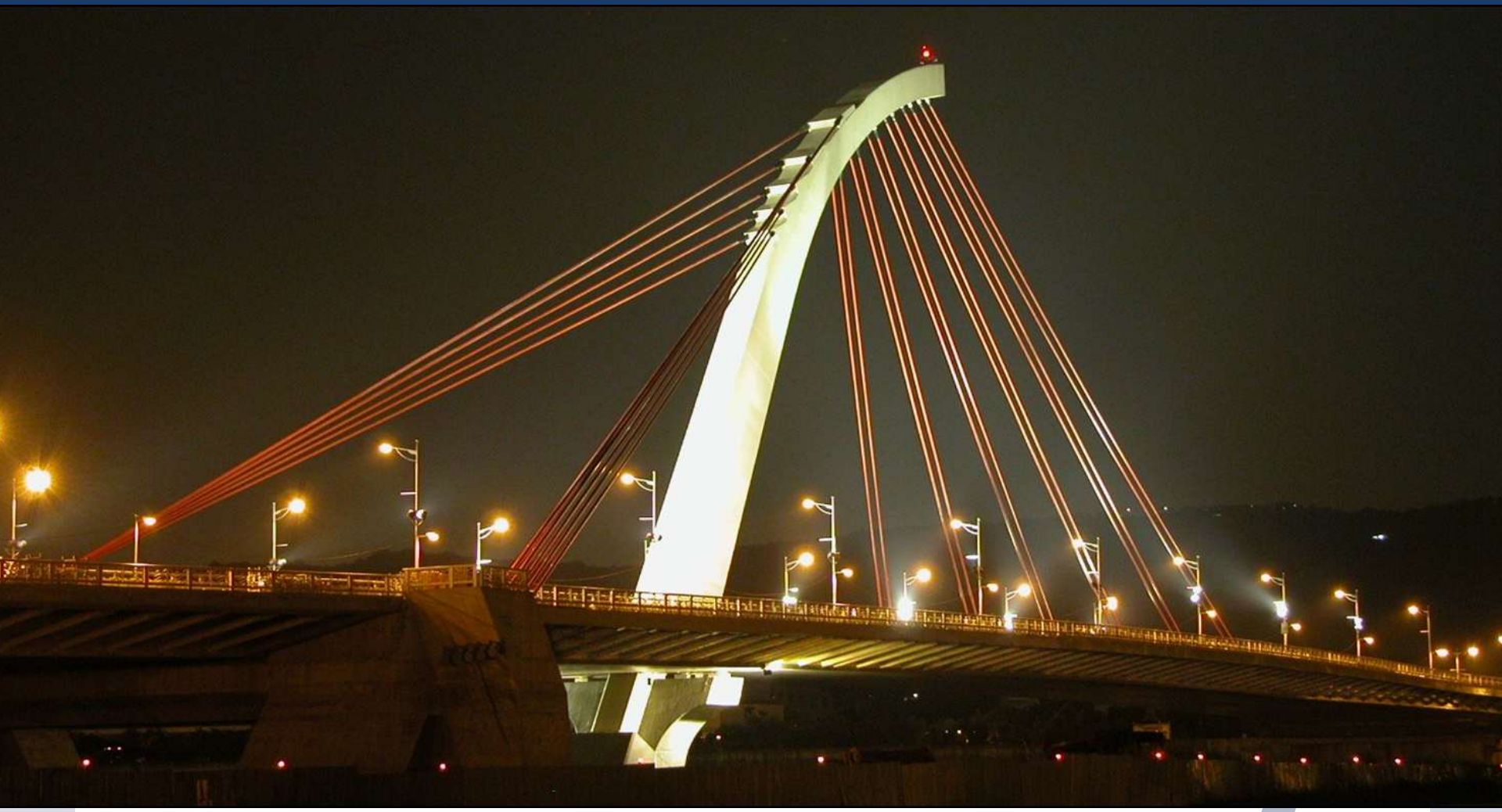
  - To comply with Owners Procurement Procedures
  - To comply with the demand of the community
  - To create a basic framework for SHM applications

Europe

Turkey

Costa Rica

Taiwan



Bangkok

China

High Speed Railways

High Speed Applications (330 km/h)

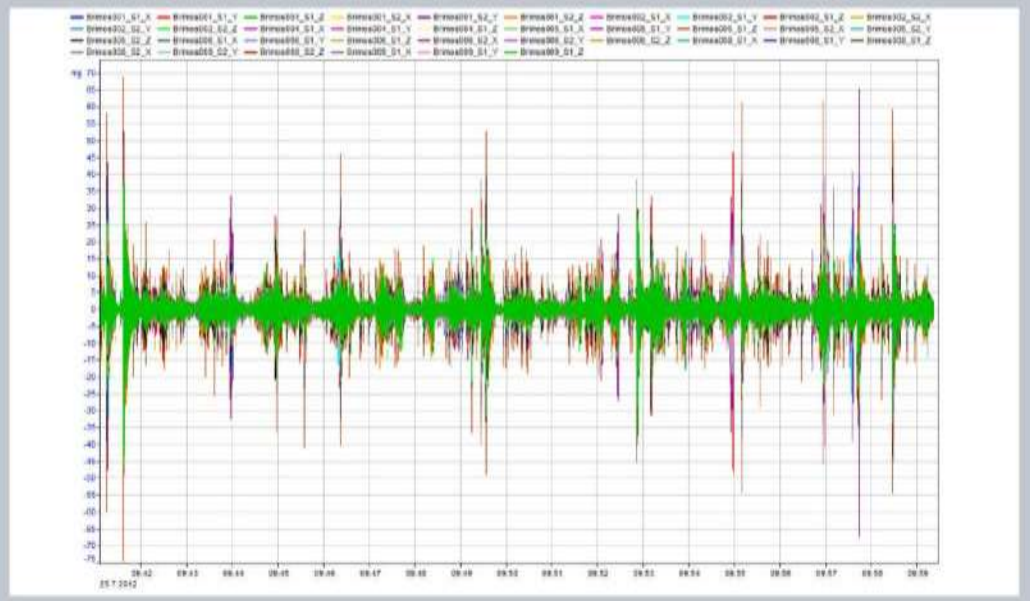
Offshore Structures

Standardization Road Map

- What

  - Distinguish between the State of Science and Technology and the daily practice
  - Issues where consensus has been reached within the community
  - Everything that requires to be reproduced and compared

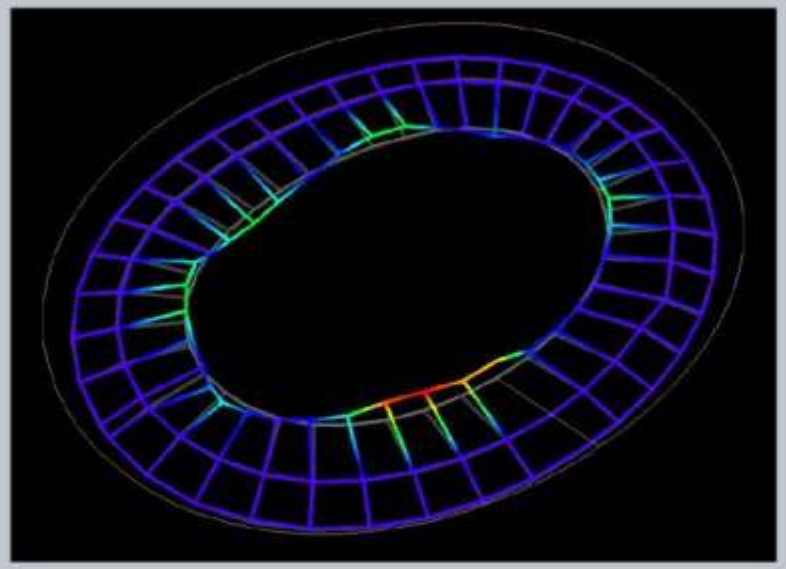
System Reponse (Monitoring)



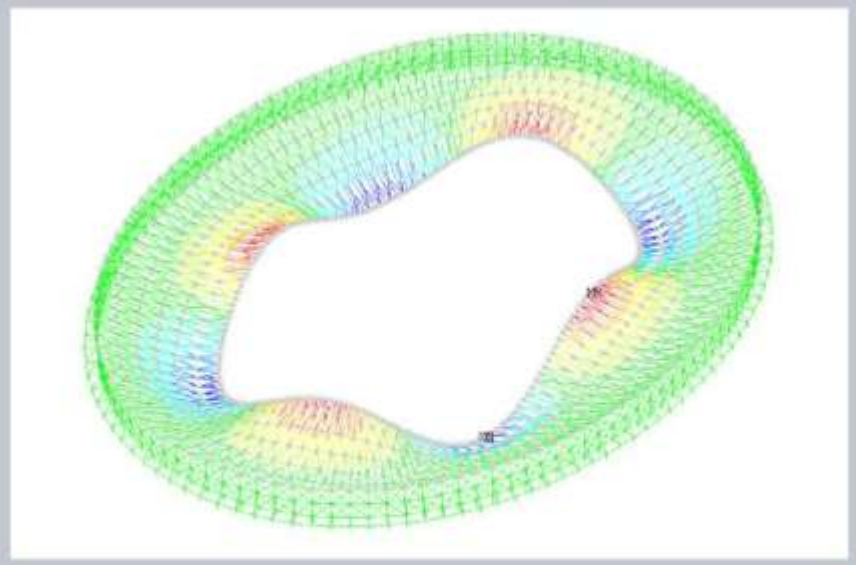
→ Data

IRIS

Modelling and Identification (Model based Observer)



$f_2^M = 0{,}70$ Hz

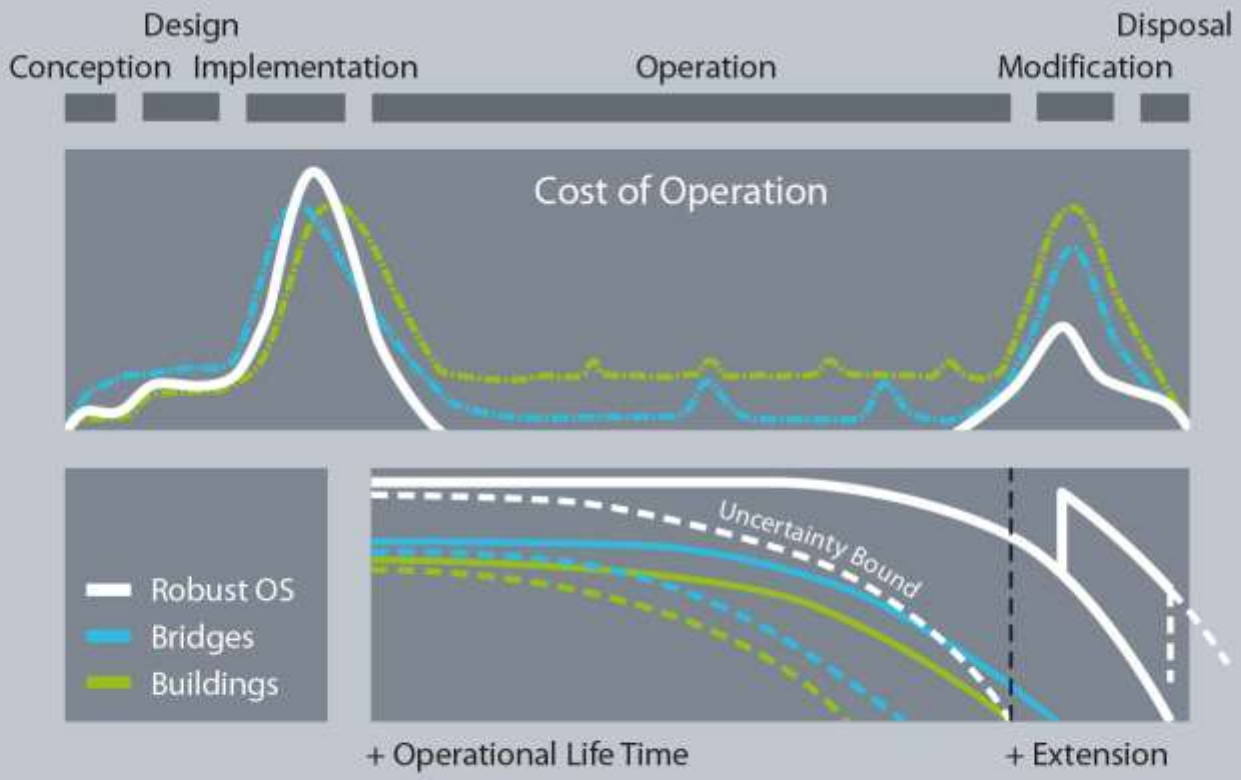


$f_{2S} = 0{,}65$ Hz

← Update

IRIS

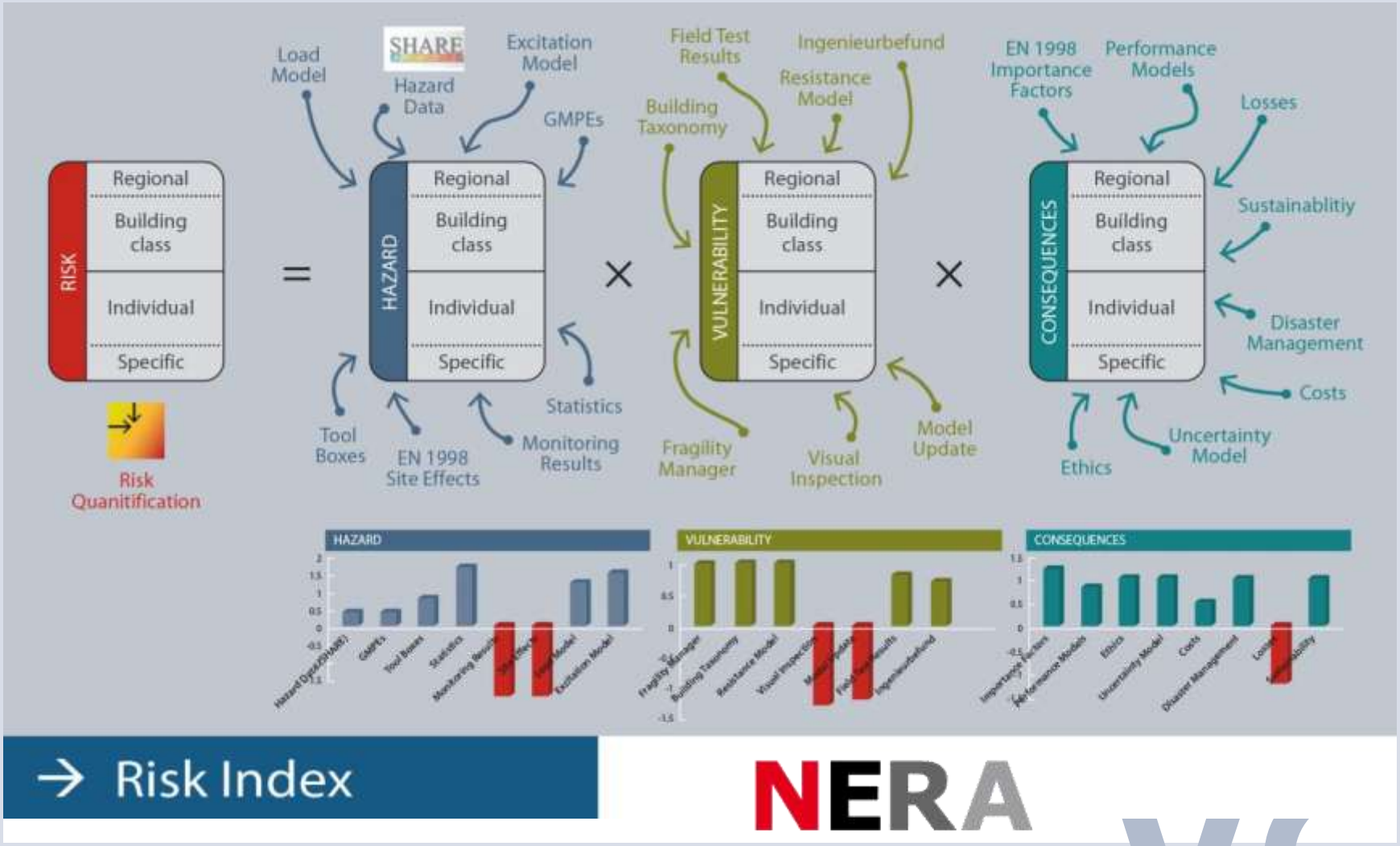
Life Cycle Engineering (Life Time and Costs)



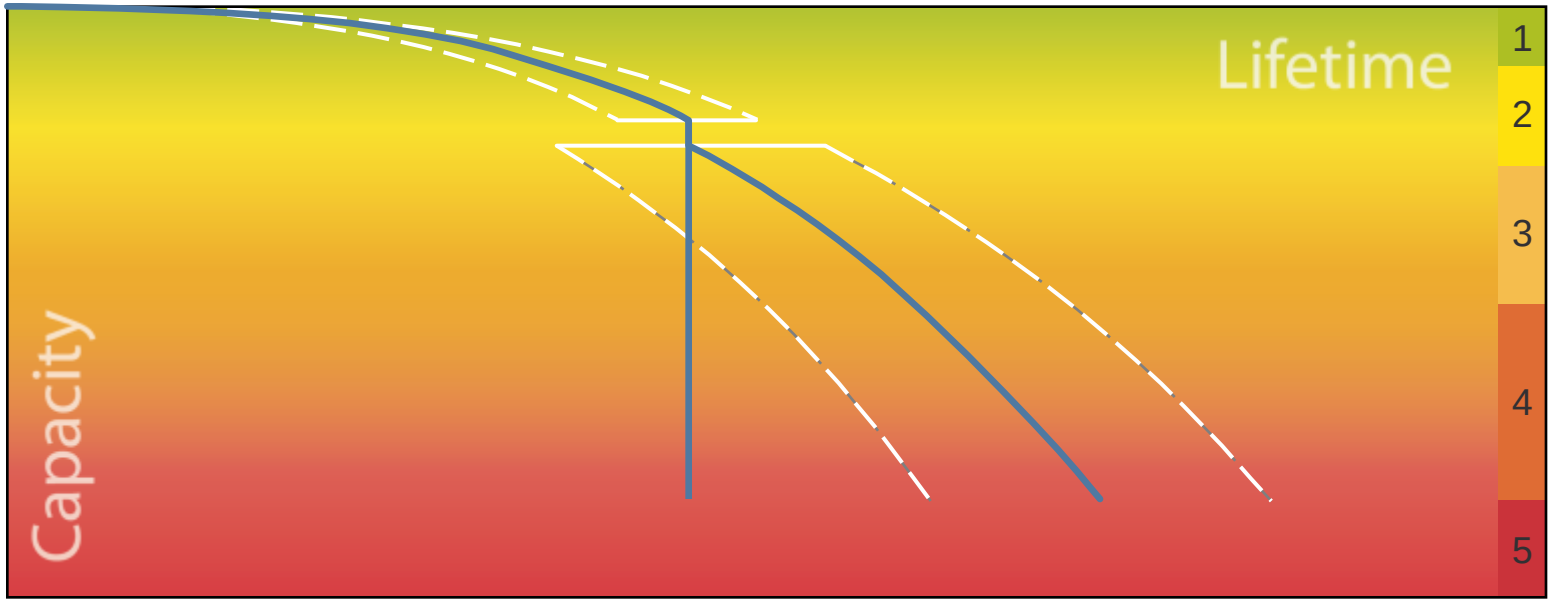
→ Total Costs and Life Time

IRIS

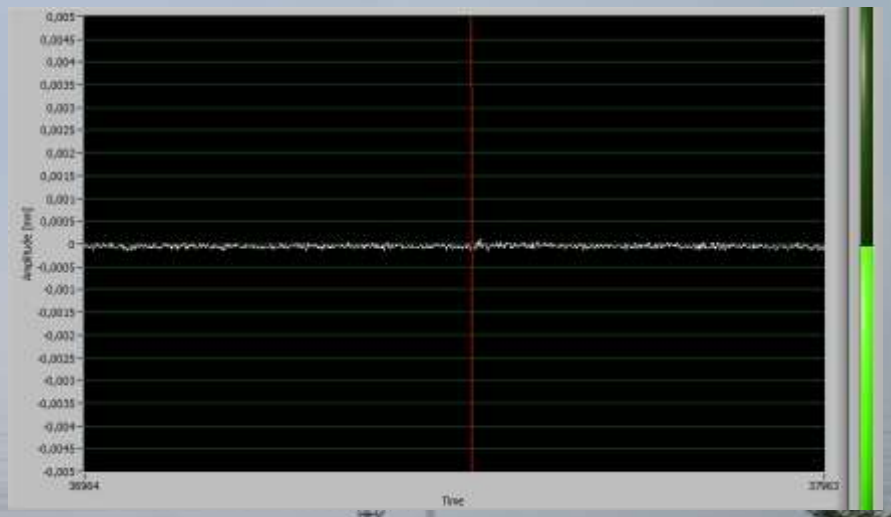
Risk Model and Quantification (Effect of Uncertainties)

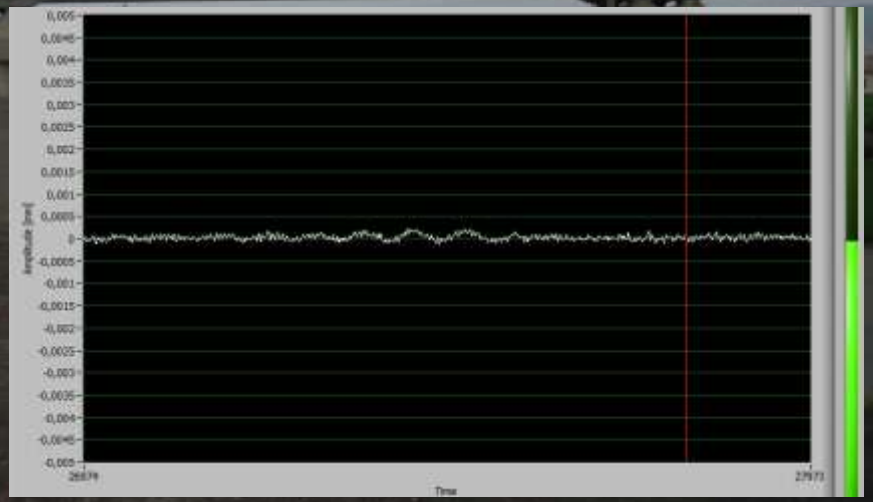


Real Time Decision Support Performance



SHM in Action (IRIS Chapter 24)





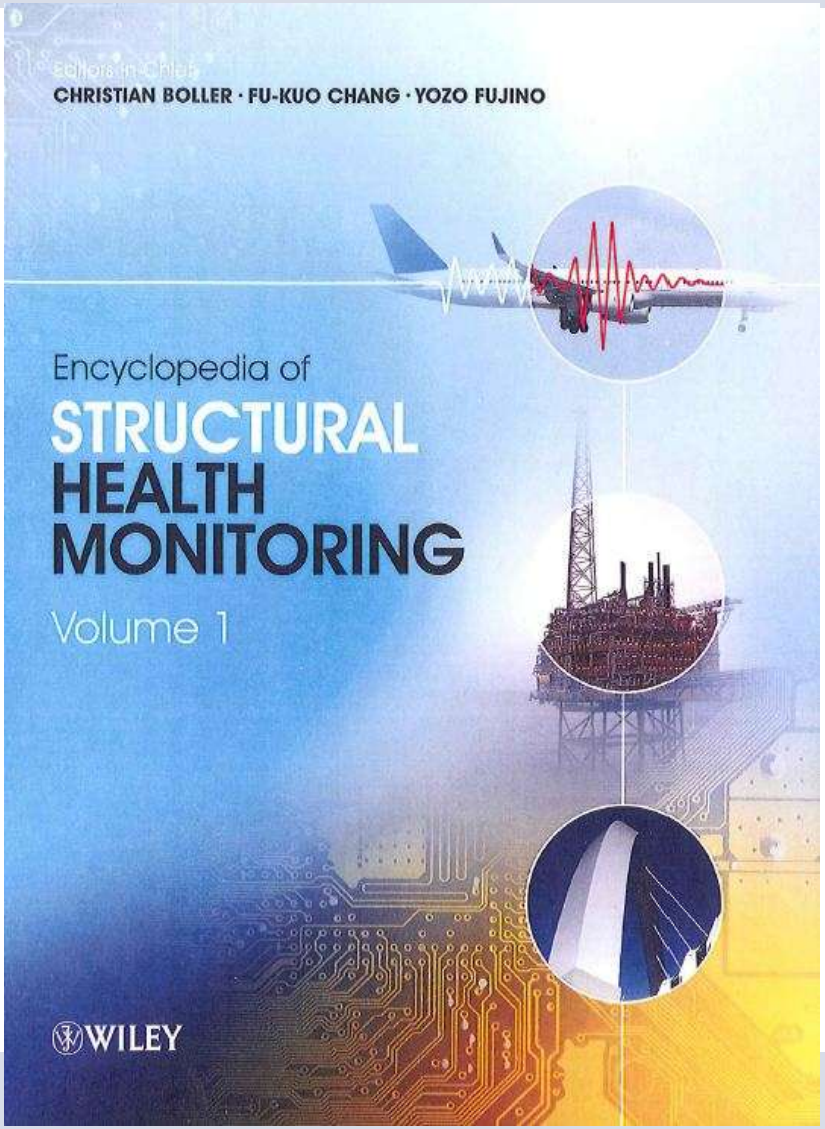
Earthquake M=6.4 27.3.2013

Standardization Road Map

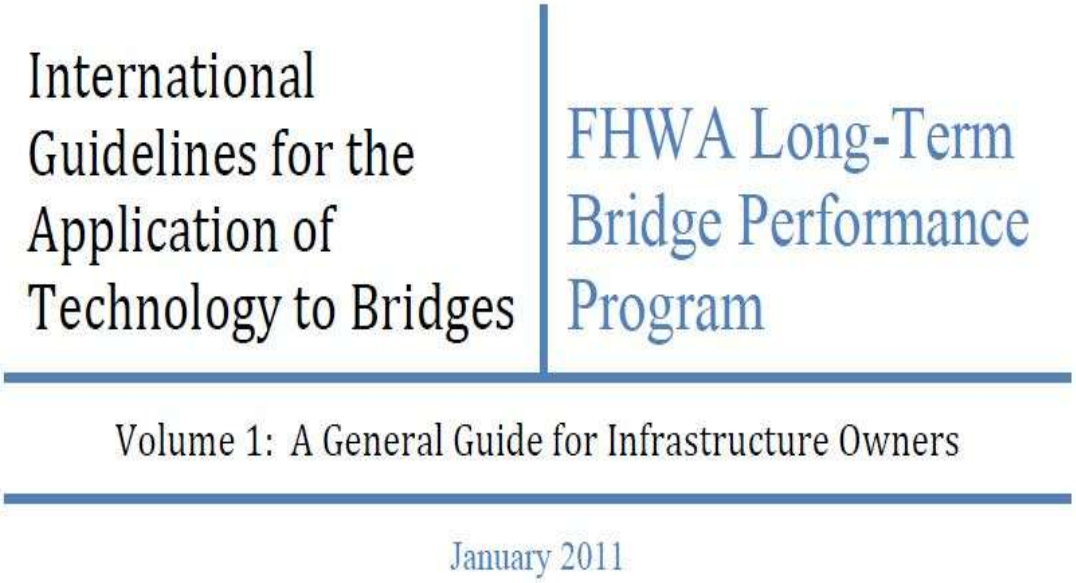
- How
  - Standardize Physics
  - Nationalise Politics

- There are many best practice documents already available (compare to ARP – Aerospace Recommended Practice)
- We have to reduce the scope to issues of common interest and wide consensus
- Connect to existing standards (ISO 31000)

Best Practice Document ?



Existing Standards



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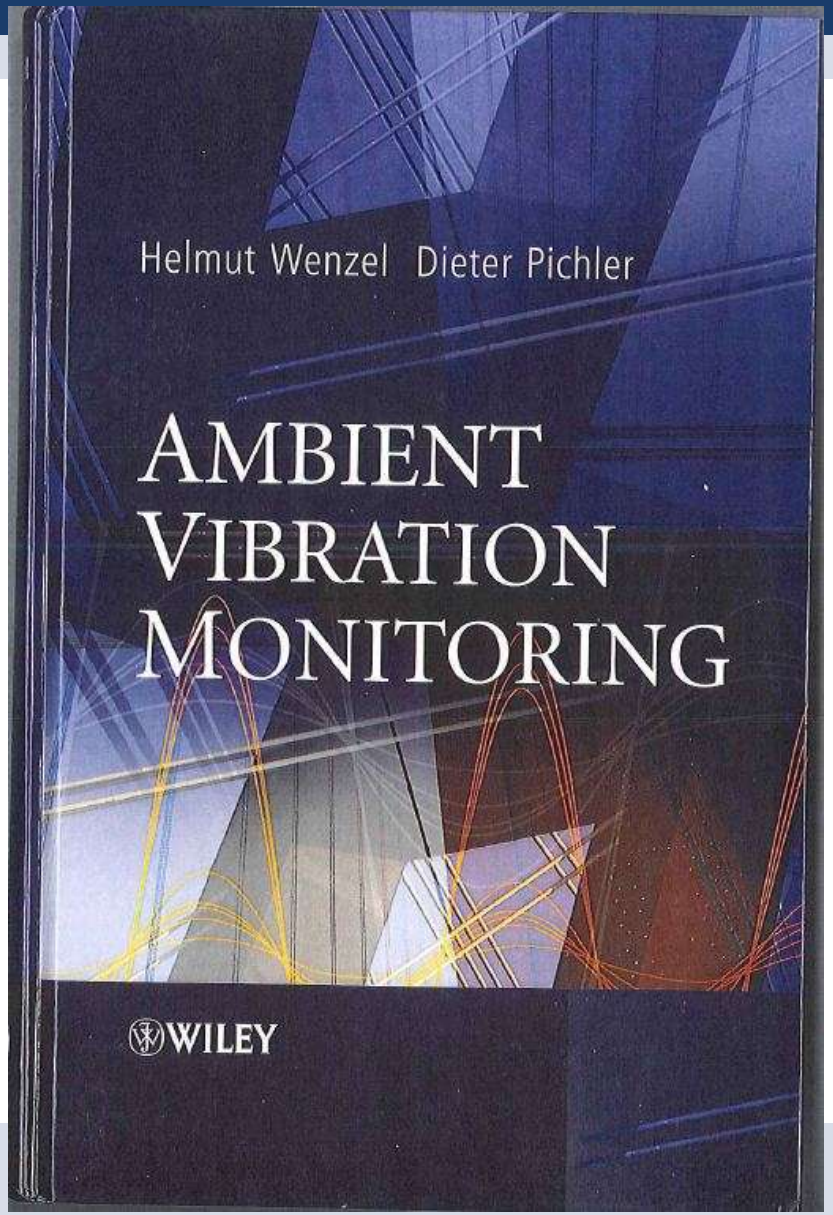
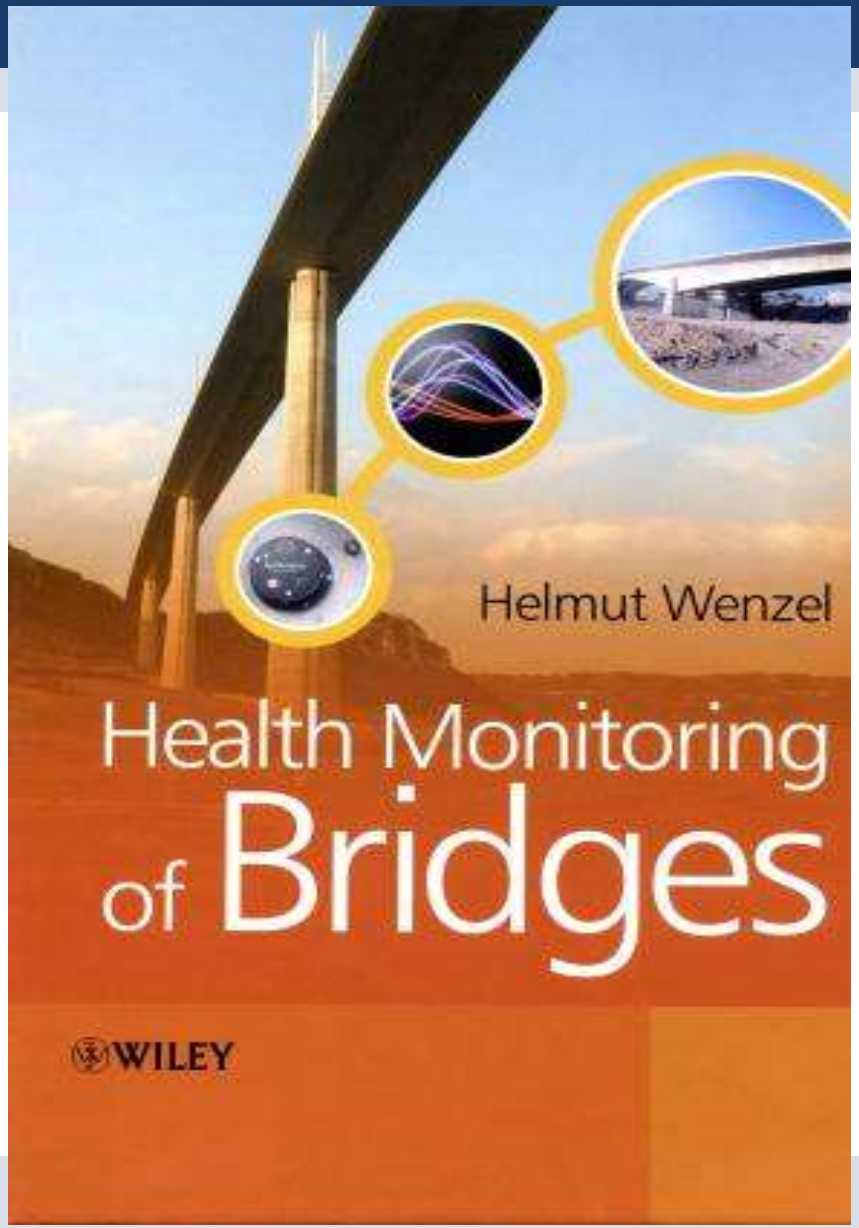


Monitoring and Assessment

Currently translated into Chinese



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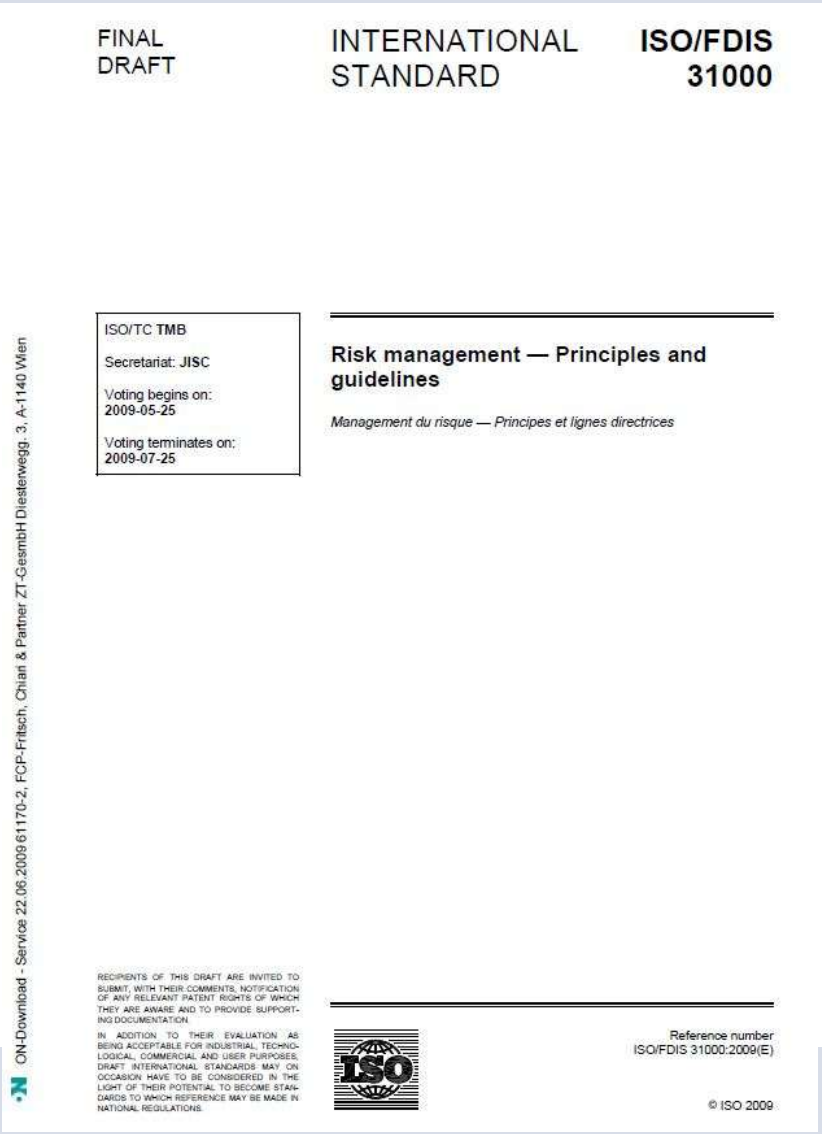


FINAL DRAFT

INTERNATIONAL STANDARD

ISO/FDIS 31000

ISO/TC **TMB**

Secretariat: **JISC**

Voting begins on:
2009-05-25

Voting terminates on:
2009-07-25

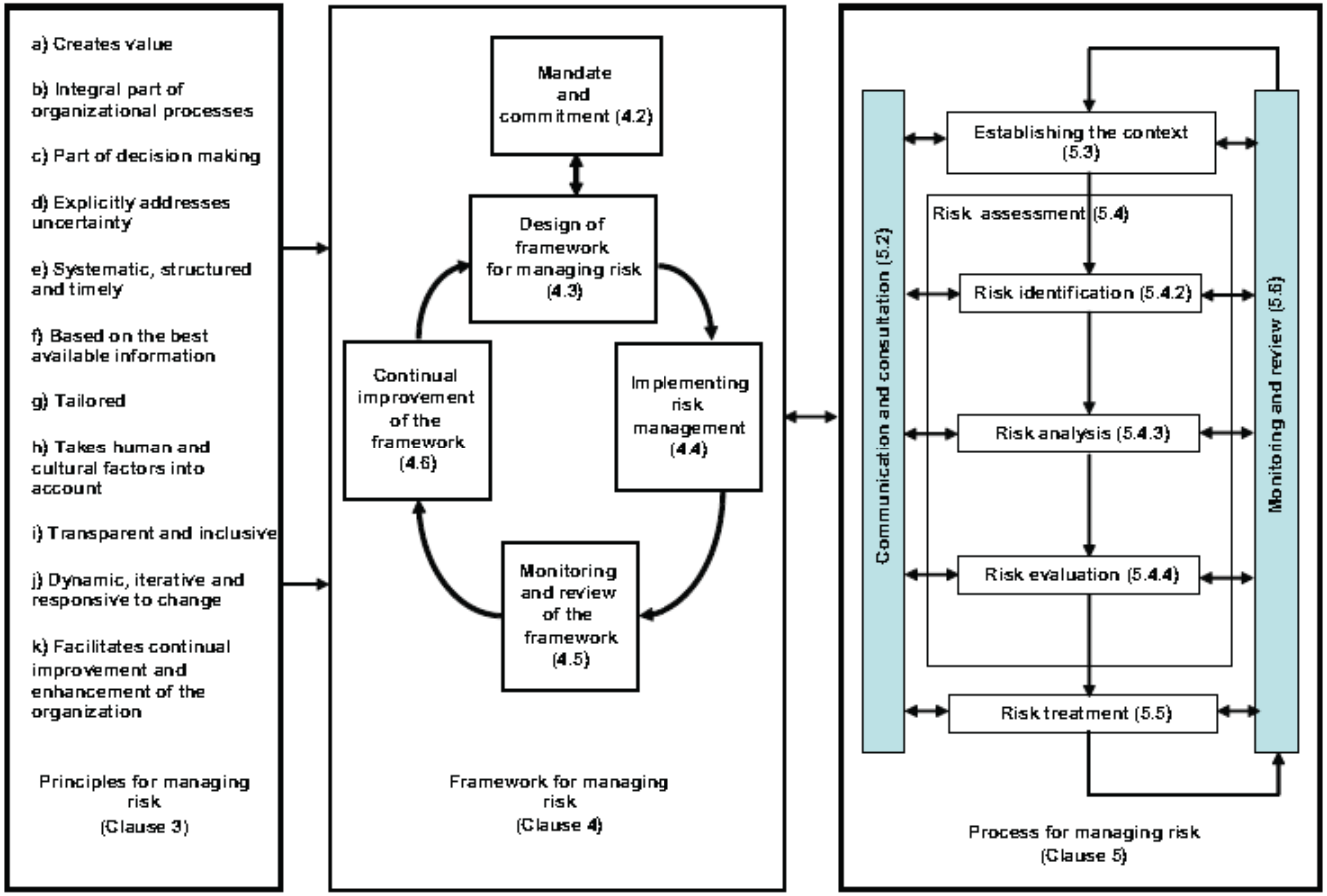
Risk management — Principles and guidelines

Management du risque — Principes et lignes directrices

Reference number
ISO/FDIS 31000:2009(E)

Risk management principles, framework and process

ISO 31000

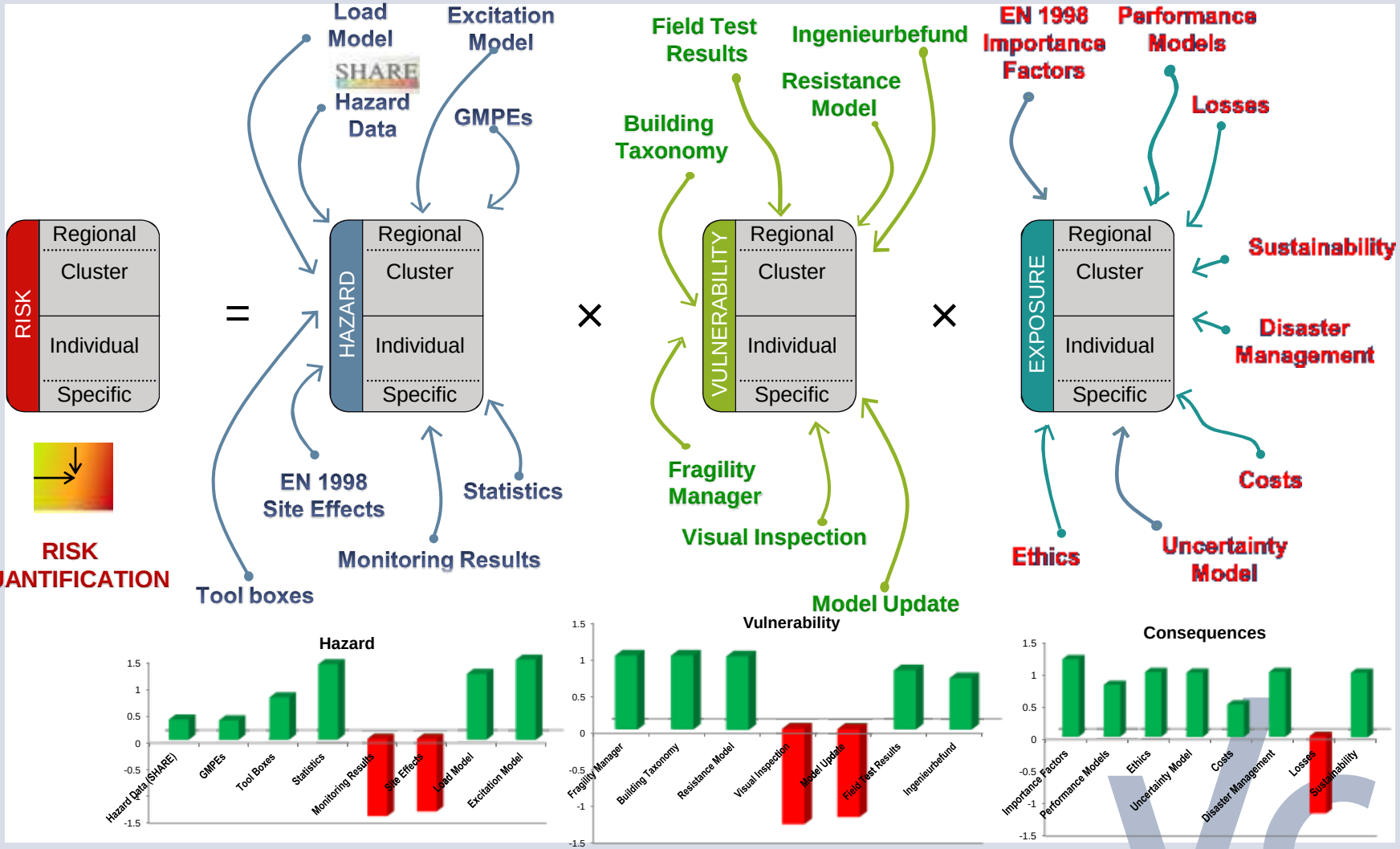


RISK

Risk is the **effect of uncertainty on objectives**

→ Reducing the uncertainty, reduces the risk

RISK MANAGEMENT FRAMEWORK: Elements and Uncertainties



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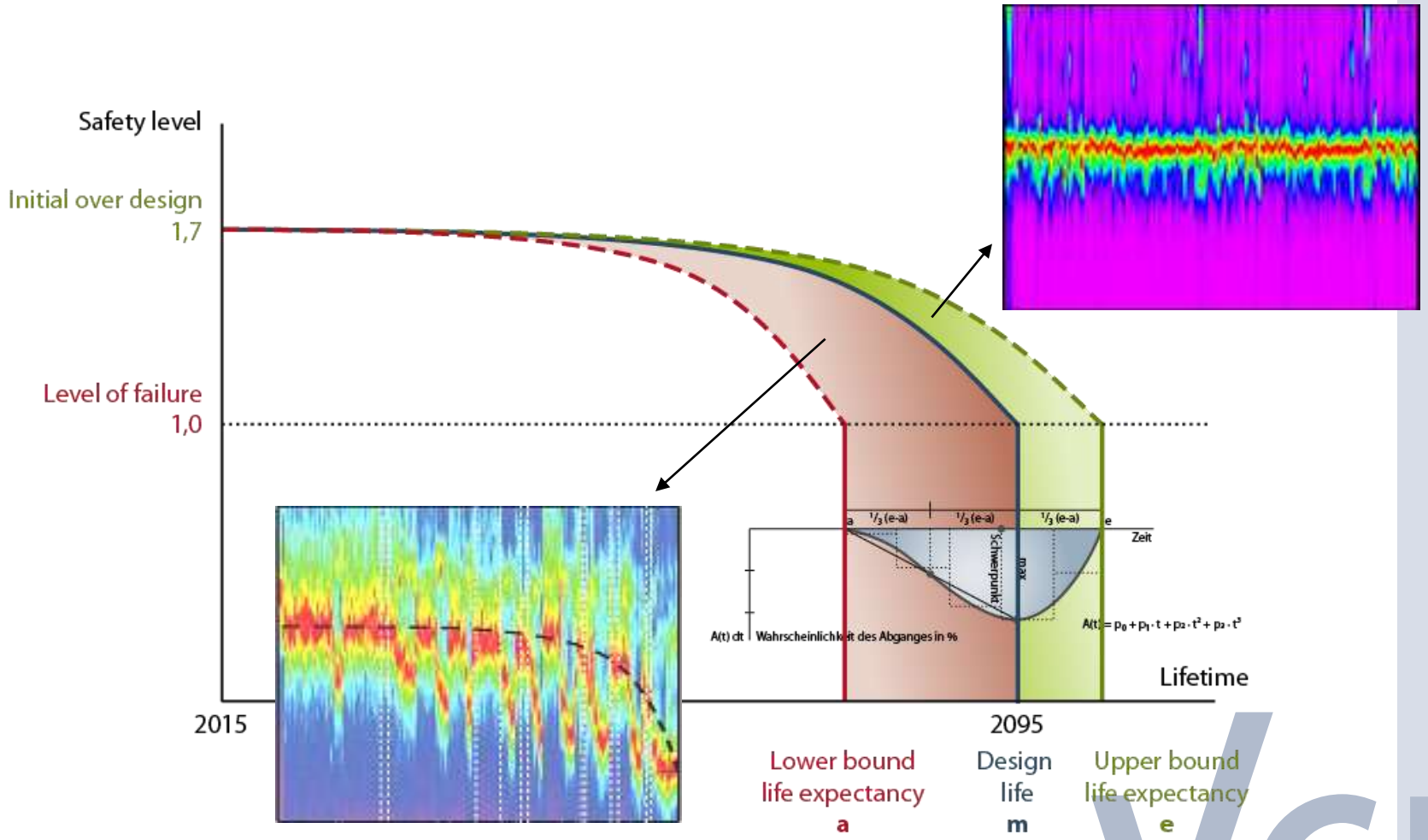

Existing Standards

SAMCO

SAMCO Final Report 2006
F08b Guideline for Structural Health Monitoring

F08b

Guideline for Structural Health Monitoring

Dir. u. Prof. Dr. W. Rücker, Dipl.-Ing. F. Hille, Dipl.-Ing. R. Rohrmann

Federal Institute of Materials Research and Testing (BAM),
Division VII.2 Buildings and Structures
Unter den Eichen 87, 12205 Berlin, Germany

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Unter den Eichen 87, 12205 Berlin, Germany

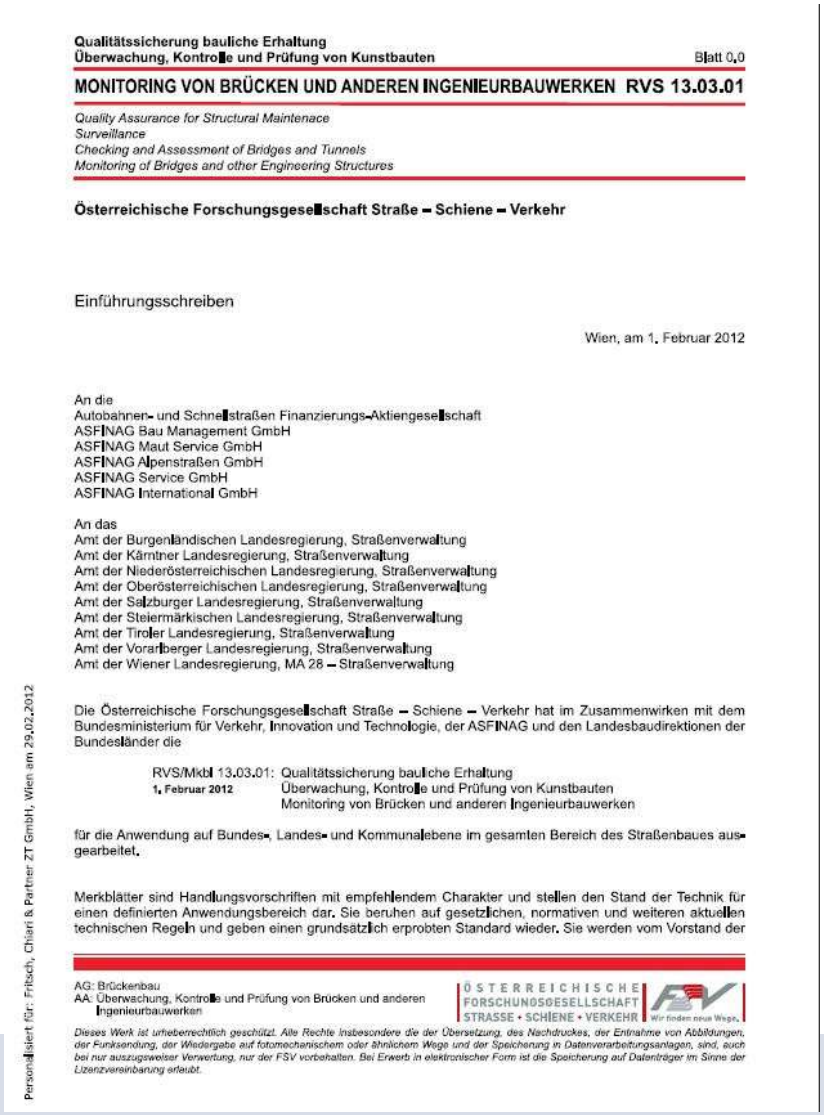
Existing Standards

ISIS Educational Module 5:

An Introduction to Structural Health Monitoring

Prepared by ISIS Canada
A Canadian Network of Centres of Excellence
www.isiscanada.com
Principal Contributor: L.A. Bisby, Ph.D., P.Eng.
Department of Civil Engineering, Queen's University
Contributor: M.B. Briglio
August 2004

Existing Standards



Qualitätssicherung bauliche Erhaltung
Überwachung, Kontrolle und Prüfung von Kunstbauten Blatt 0.0

MONITORING VON BRÜCKEN UND ANDEREN INGENIEURBAUWERKEN RVS 13.03.01

Quality Assurance for Structural Maintenace
Surveillance
Checking and Assessment of Bridges and Tunnels
Monitoring of Bridges and other Engineering Structures

Österreichische Forschungsgesellschaft Straße – Schiene – Verkehr

Einführungsschreiben

Wien, am 1. Februar 2012

An die
Autobahnen- und Schnellstraßen Finanzierungs-Aktiengesellschaft
ASFINAG Bau Management GmbH
ASFINAG Maut Service GmbH
ASFINAG Alpenstraßen GmbH
ASFINAG Service GmbH
ASFINAG International GmbH

An das
Amt der Burgenländischen Landesregierung, Straßenverwaltung
Amt der Kärntner Landesregierung, Straßenverwaltung
Amt der Niederösterreichischen Landesregierung, Straßenverwaltung
Amt der Oberösterreichischen Landesregierung, Straßenverwaltung
Amt der Salzburger Landesregierung, Straßenverwaltung
Amt der Steiermärkischen Landesregierung, Straßenverwaltung
Amt der Tiroler Landesregierung, Straßenverwaltung
Amt der Vorarlberger Landesregierung, Straßenverwaltung
Amt der Wiener Landesregierung, MA 28 – Straßenverwaltung

Die Österreichische Forschungsgesellschaft Straße – Schiene – Verkehr hat im Zusammenwirken mit dem Bundesministerium für Verkehr, Innovation und Technologie, der ASFINAG und den Landesbaudirektionen der Bundesländer die

RVS/Mkbl 13.03.01: Qualitätssicherung bauliche Erhaltung
1. Februar 2012 Überwachung, Kontrolle und Prüfung von Kunstbauten
Monitoring von Brücken und anderen Ingenieurbauwerken

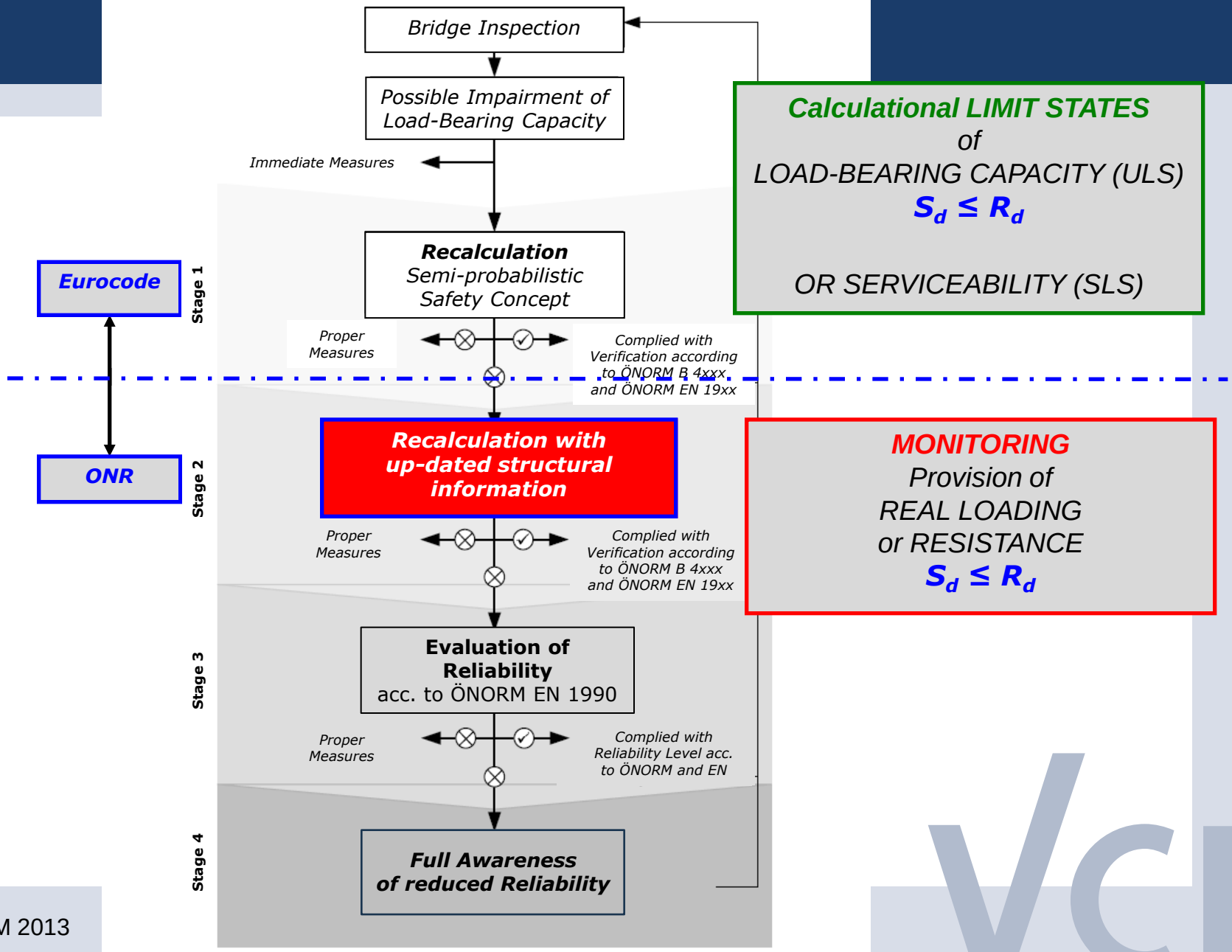
für die Anwendung auf Bundes-, Landes- und Kommunalebene im gesamten Bereich des Straßenbaues ausgearbeitet.

Merkblätter sind Handlungsvorschriften mit empfehlendem Charakter und stellen den Stand der Technik für einen definierten Anwendungsbereich dar. Sie beruhen auf gesetzlichen, normativen und weiteren aktuellen technischen Regeln und geben einen grundsätzlich erprobten Standard wieder. Sie werden vom Vorstand der

AG: Brückenbau
AA: Überwachung, Kontrolle und Prüfung von Brücken und anderen Ingenieurbauwerken

ÖSTERREICHISCHE FORSCHUNGSGESELLSCHAFT STRASSE • SCHIENE • VERKEHR Wir finden neue Wege.

Incorporation into the process of structural evaluation based on codes/standards



Proposed Procedure

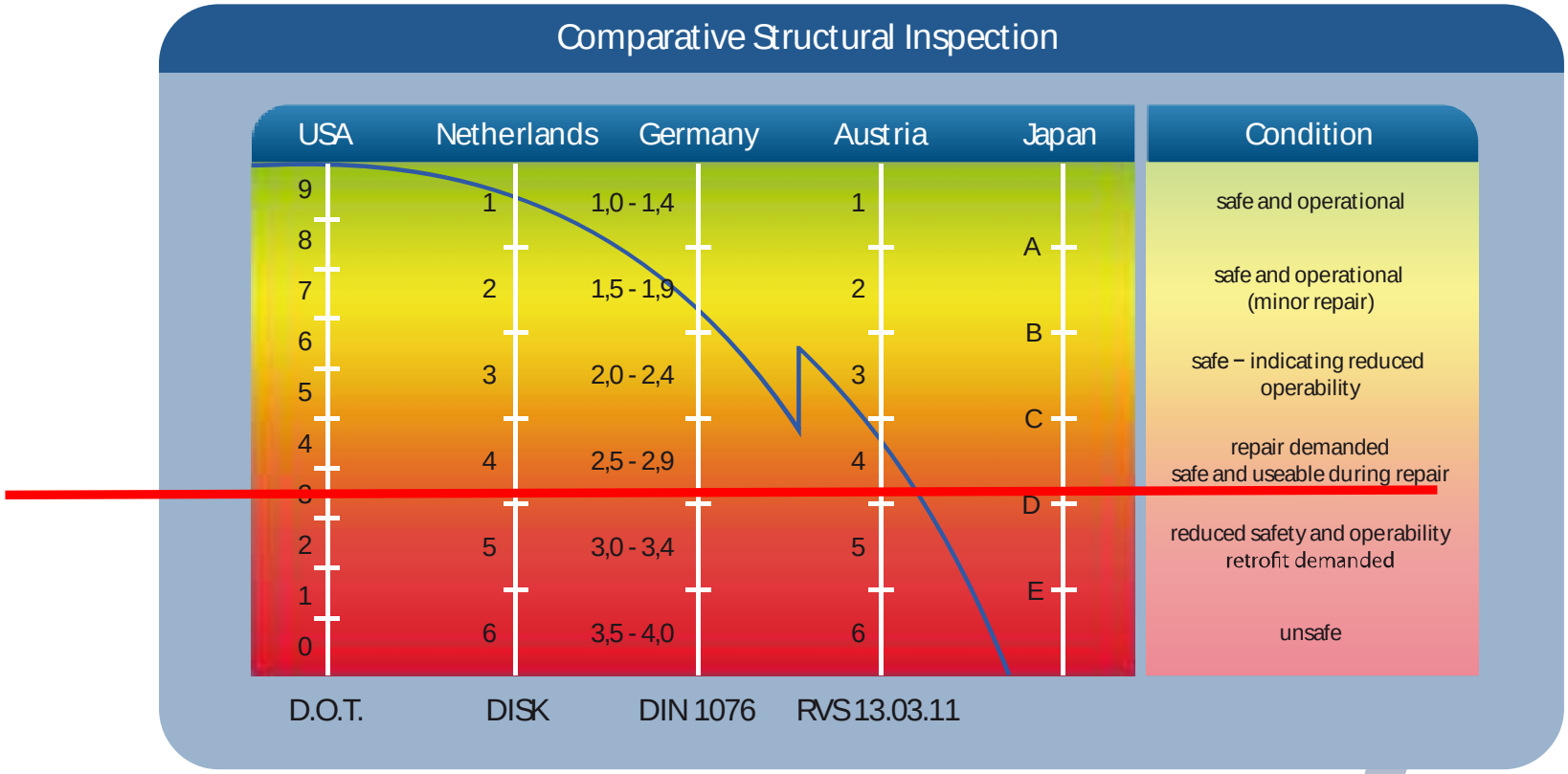
- Let’s build an international core group of decisive members
- Make a priority of issues for international standardisation
- Find a group of engaged young collaborators for elaboration of the text
- Standardize it in a CEN Workshop and relate it to national activities
- If accepted transfer it to ISO

Issues for Standardization

4 Issues to start with

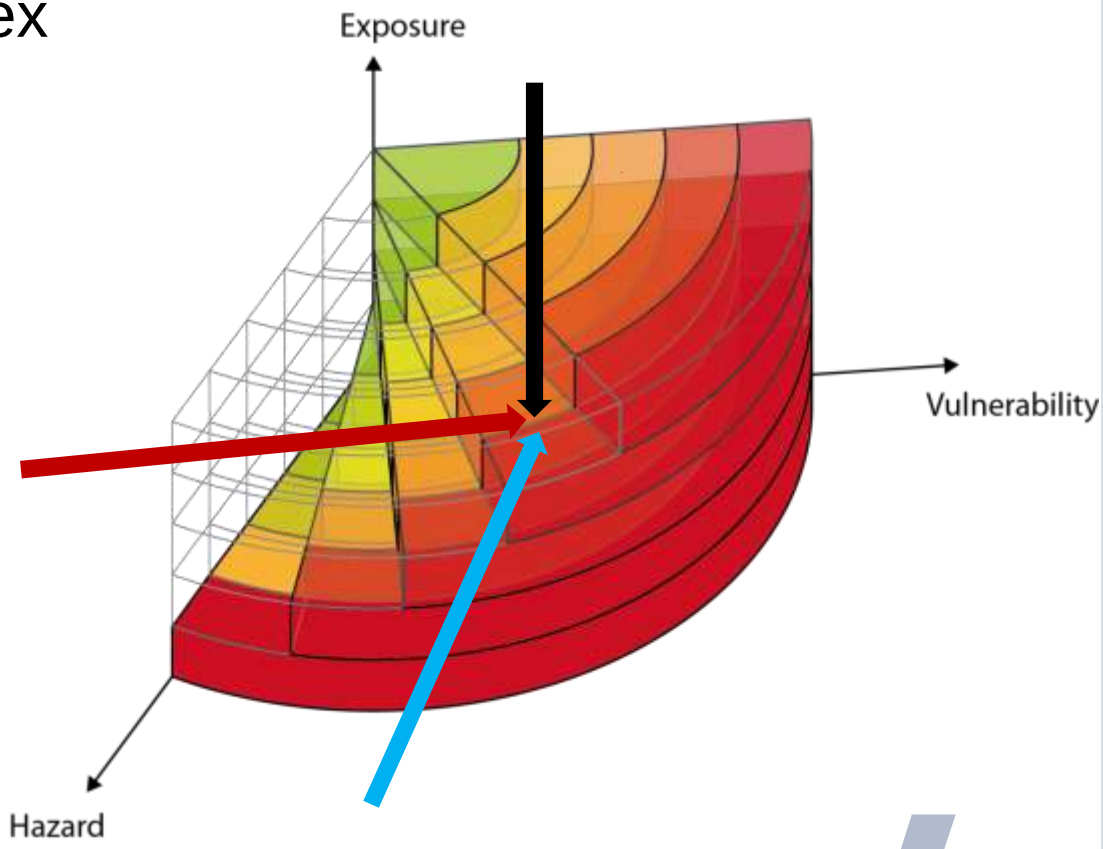
1. Definition of the colour scheme for risk rating (simple and complex)
2. Compensation of environmental and loading influences on monitoring field data
3. Procedure for fatigue life monitoring and assessment
4. Format for data exchange and meta data, joint multi lingual glossary

Inspection Result
International Comparison



RISK MANAGEMENT FRAMEWORK: Risk Quantification #2

- Complex Risk Index



SHM Standardization Activities in Europe

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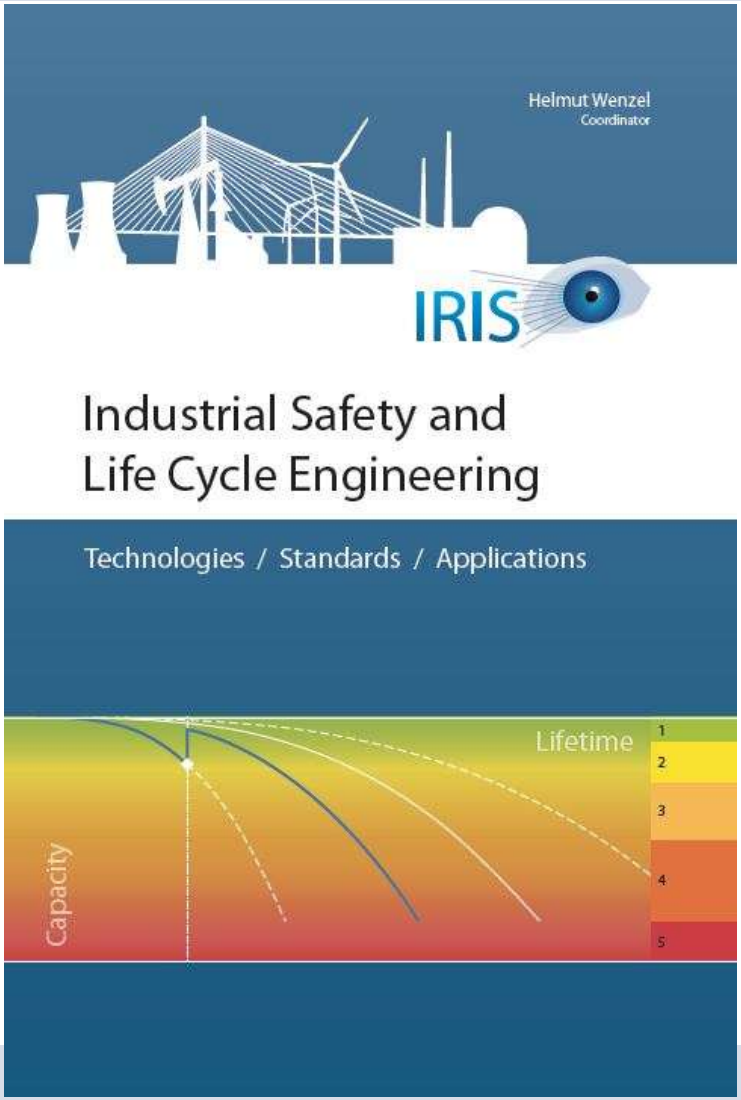


Compensation basics in frequency analysis

- Temperature
- Moving loads
- Wind
- Impact energy
- Instrumentation
- Boundary conditions
- Geometry
- Pavement
- Utilities
- Natural sources
- Transfers

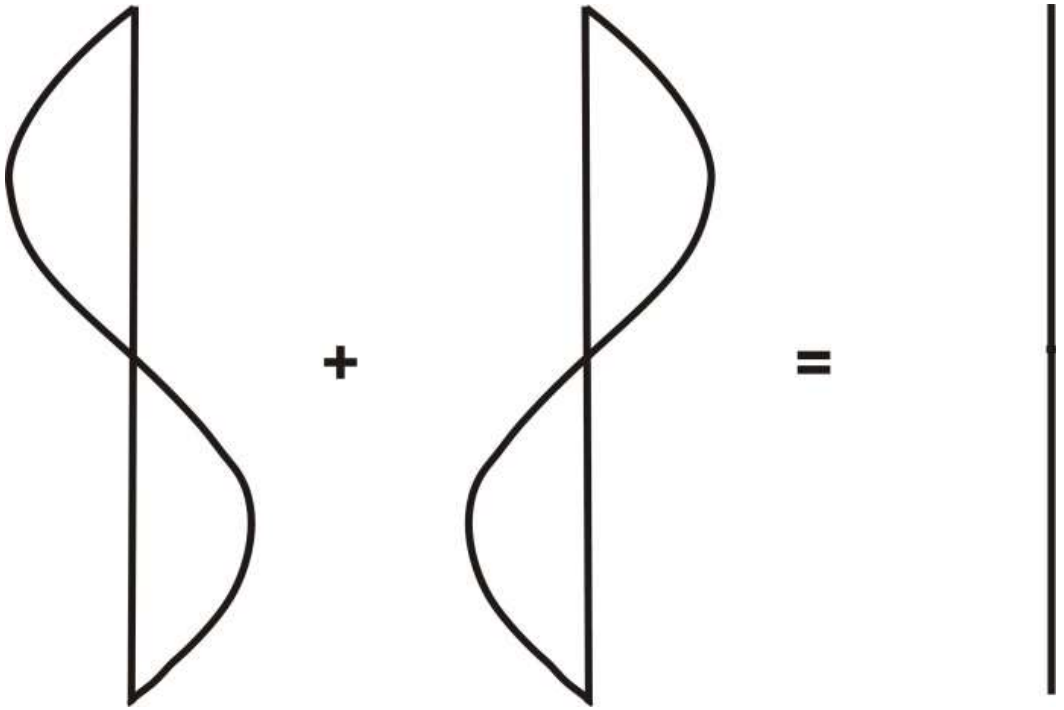
or

- Damage

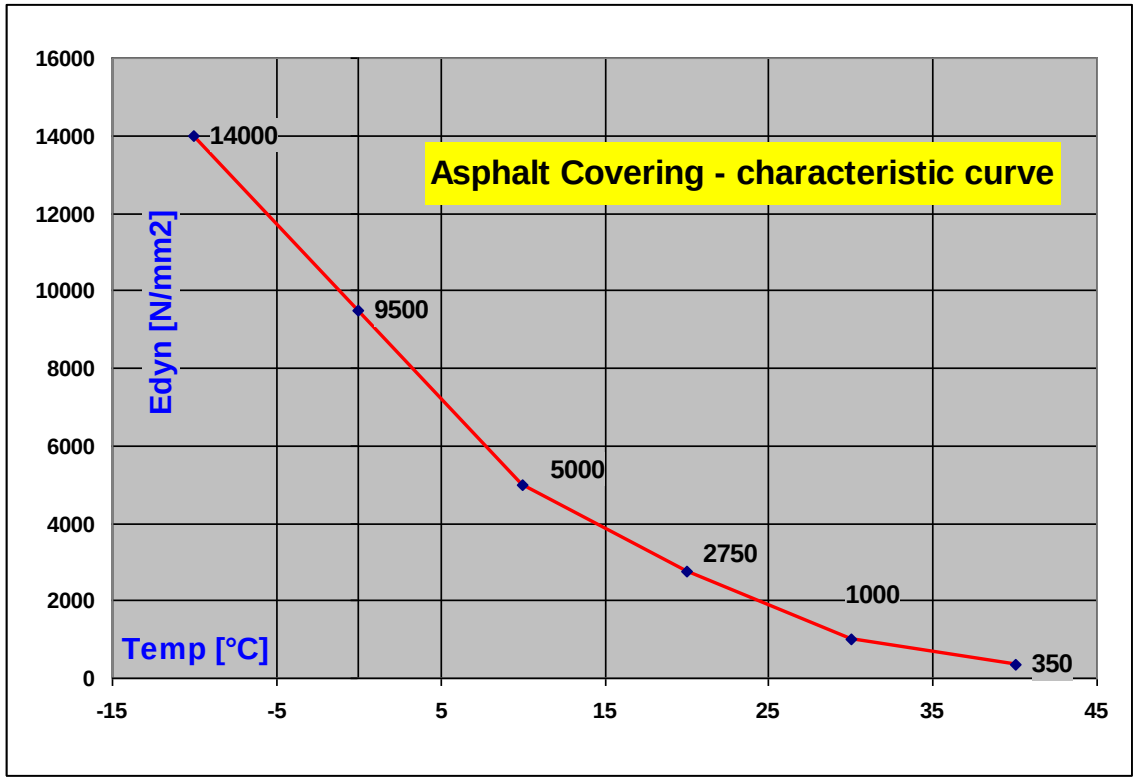
$$f_{total} = f_0 + \sum_{i \in factors} f_i \quad ,$$

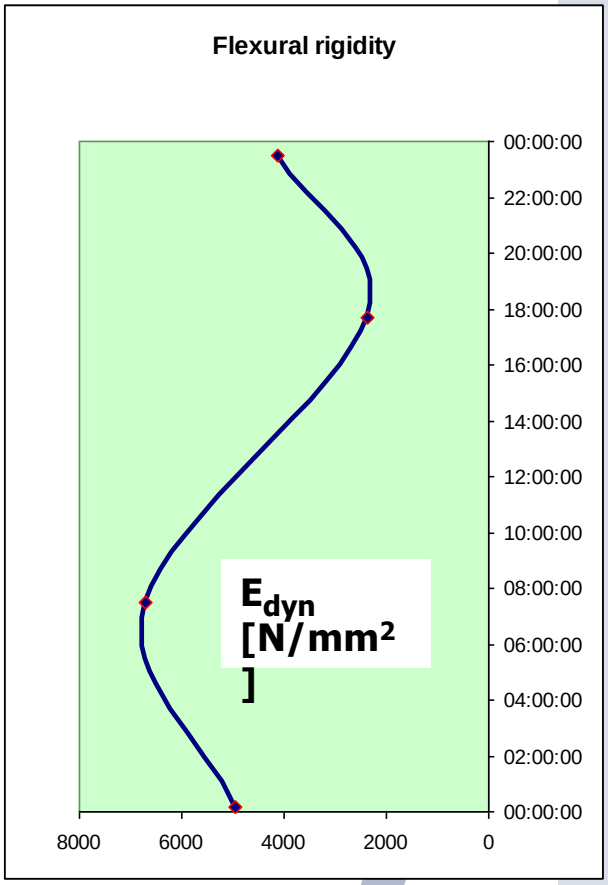
1st Eigenfrequency Basing Point Europabrücke 18_03_2004

Pre-assumed consequence of temperature-compensation to the eigenfrequency pattern

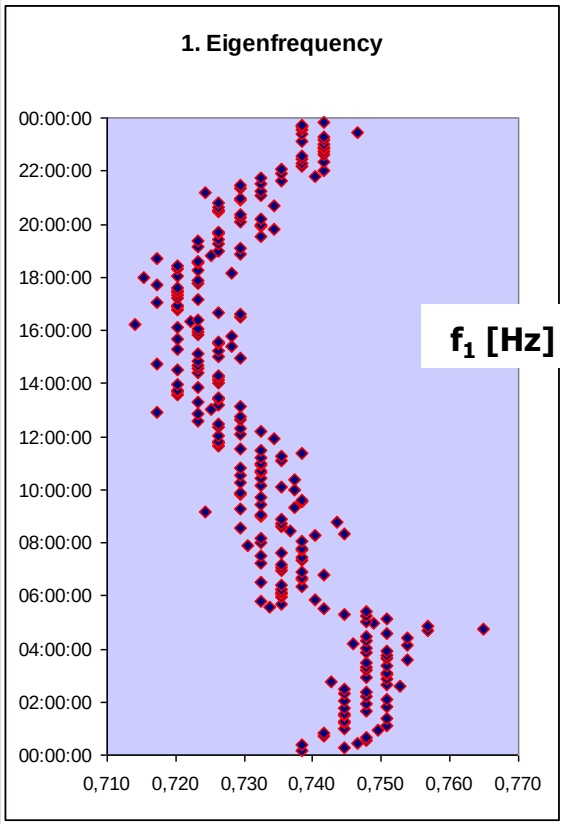


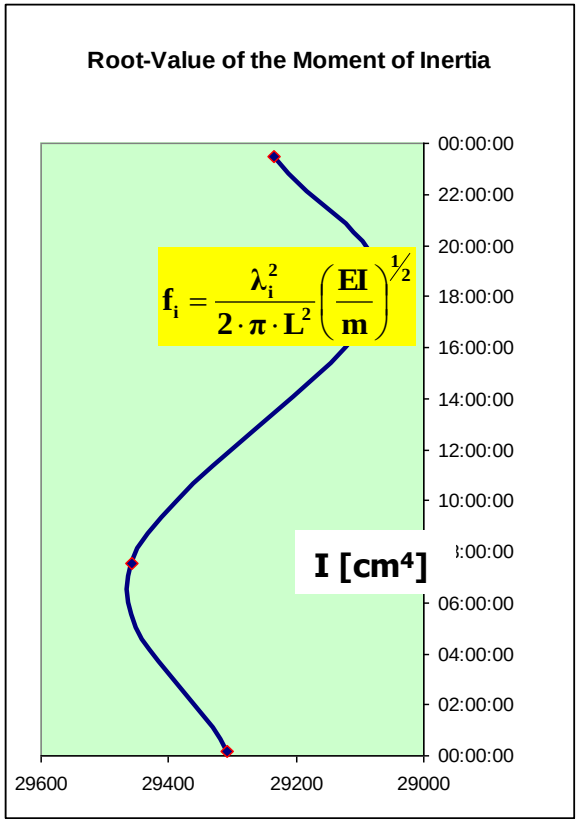
Pattern of the asphalt layer`s flexural rigidity in dependence of temperature

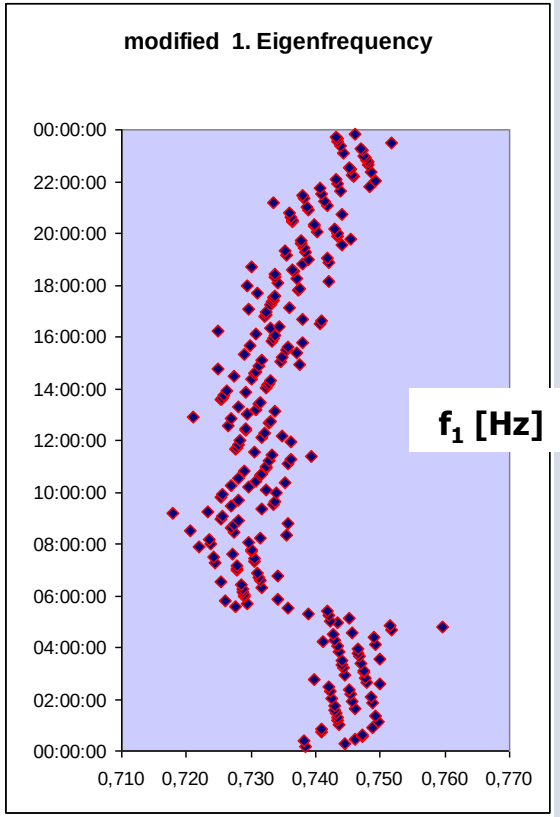




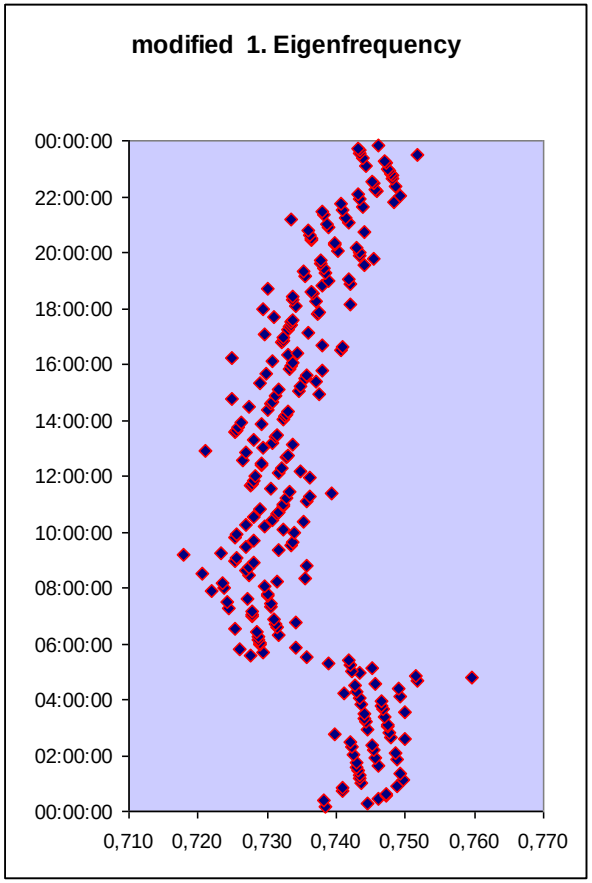
Pattern of 1st Eigenfrequency before and **after compensation of temperature**

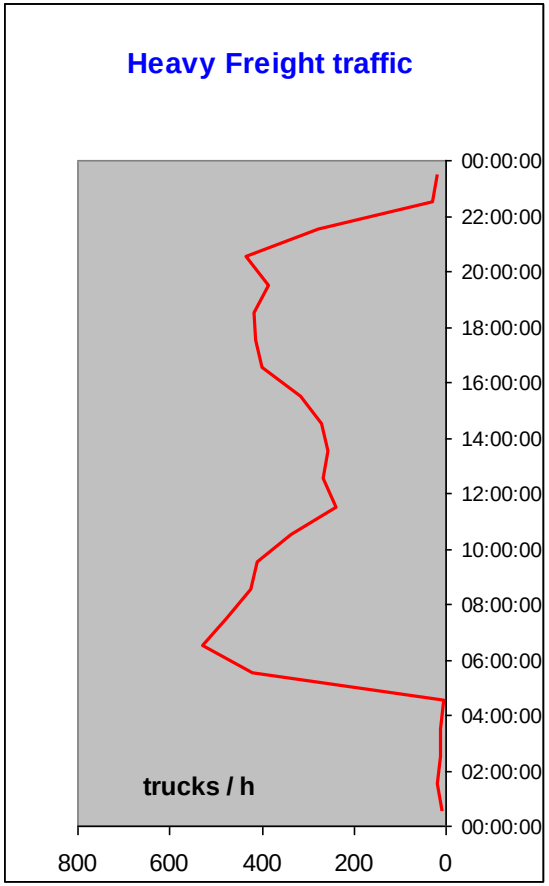


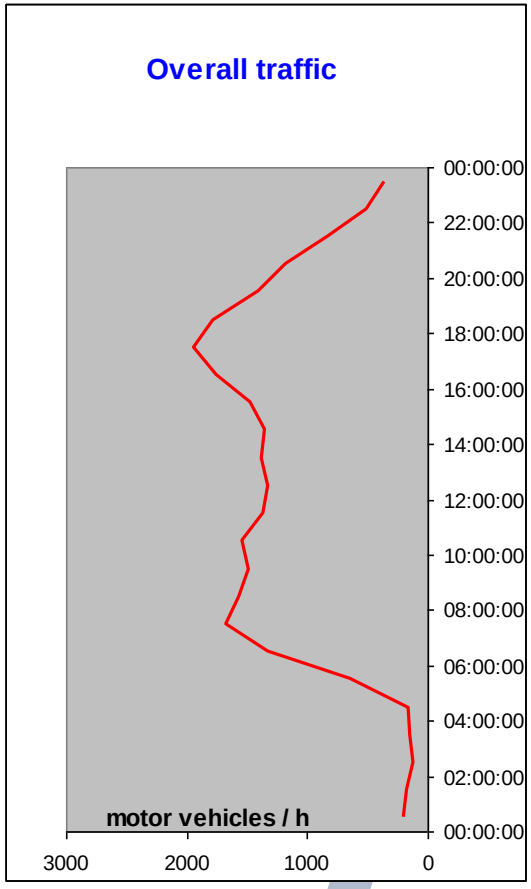




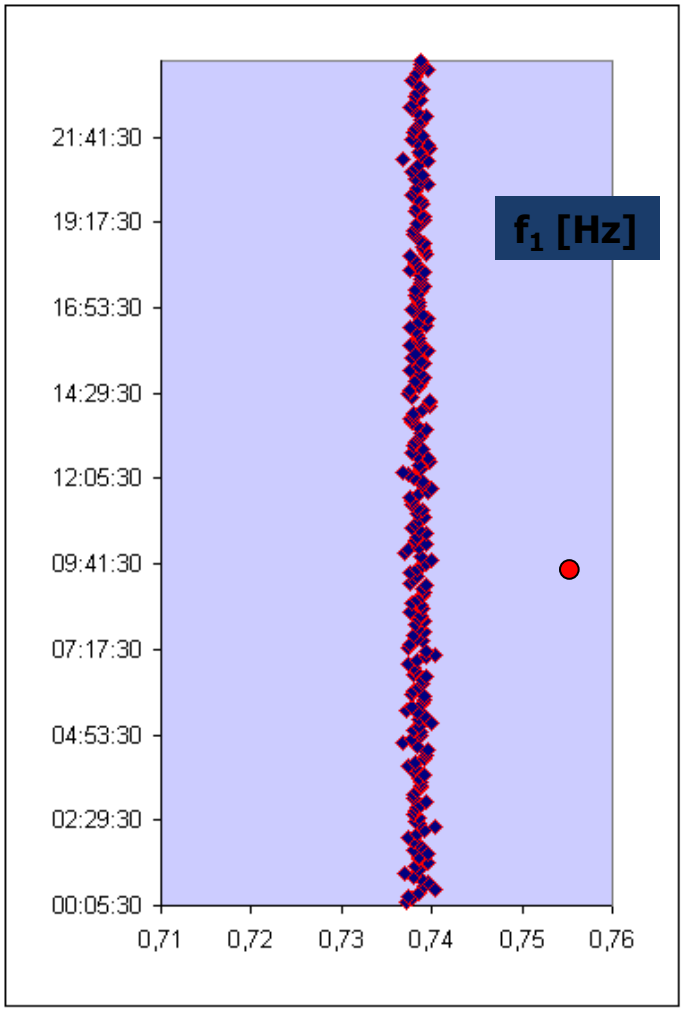
Pattern of the modified 1st eigenfrequency being strongly affected by the progression of freight traffic as well as the overall traffic







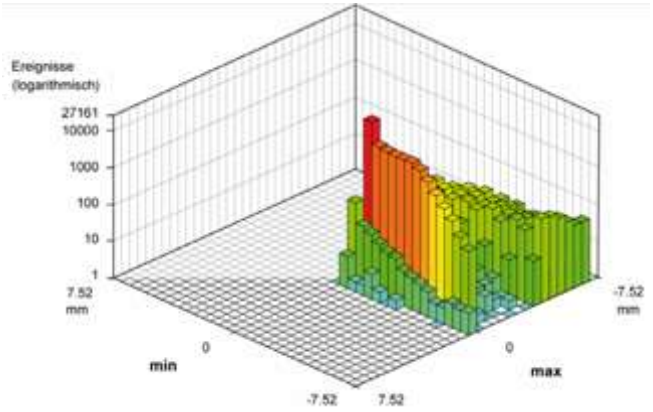
Pattern of 1st Eigenfrequency after compensation of all major impacts

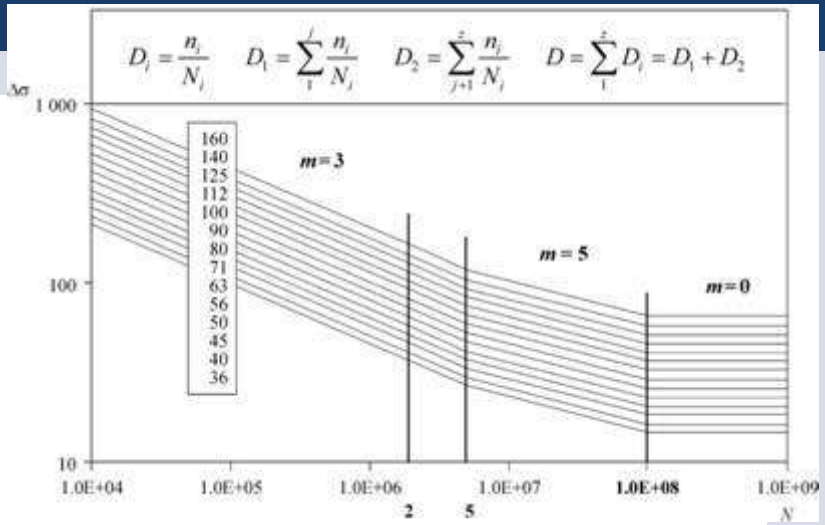


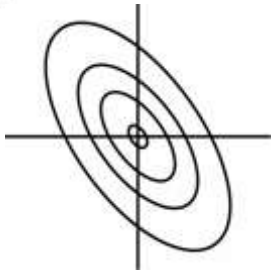
Clear signs of damage

Fatigue Life Determination

Rainflow Matrix
Fatigue relevant response cycles at the analysed structural detail

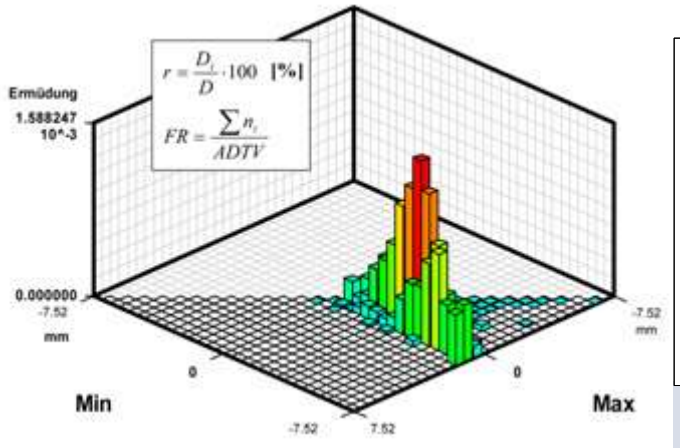


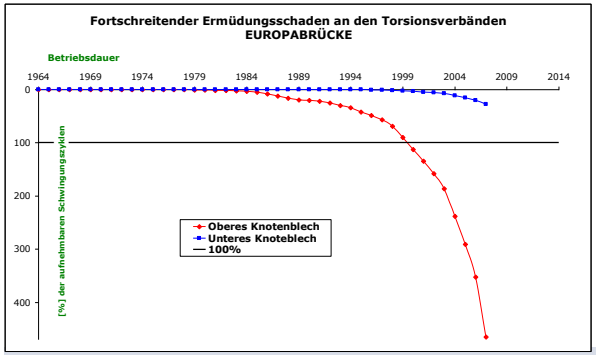


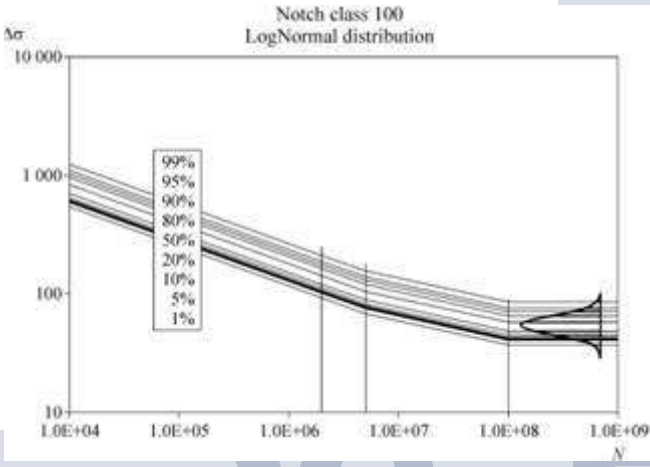


Damage Matrix
Damage Quantification
(consumption of remaining response cycles)

Wöhler Curves
considering statistical scatter







Funding

- A CEN Workshop lasts 2 years maximum and costs 40.000 US$ in fees
- All partners shall carry their own costs for participation and elaboration from national funds
- We have a project to support this activity and could offer the organisation and lead
- We should have a draft/final document ready by the next IWSHM in 2015

Summary

- Civil SHM fell behind other sectors
- The community is too fragmented
- Standards could help to break through

Let’s do it !

- Volunteers welcome !!!!
- Join our lunch meeting (here in Memorial Auditorium) and become a member of the team

wenzel@vce.at