Towards effective standards for monitoring, data-informed safety assessment and maintenance of transport infrastructure

Prof.Dr.ir. Diego Allaix (TNO)

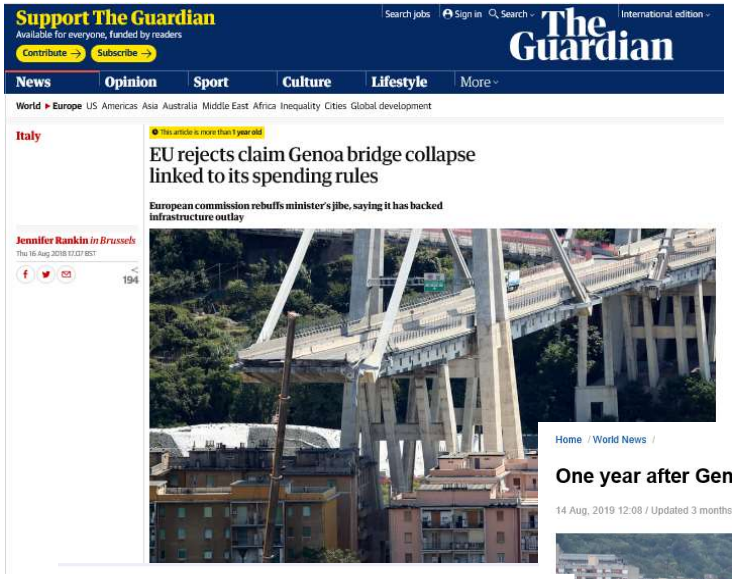
Context

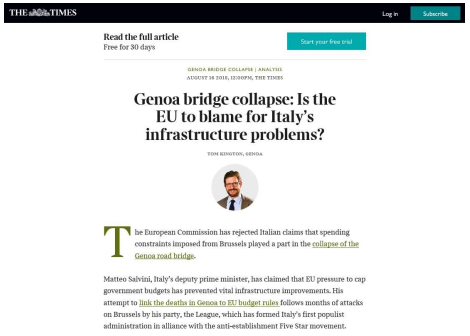
Transport infrastructure is facing **major challenges** due to ageing, rapid growth of traffic loads and natural and man-made resilience threats.

Safety risks have become critical in the recent years and manifested in major disasters caused i.e. by structural failures due to maintenance deficiencies.

Optimal maintenance is only possible with the right policies and decisions enabled by **timely and accurate information.**

Monitoring is recognized as **key enabler** of optimal maintenance strategies to be applied for ensuring the **safety of the infrastructure.**





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- **Digitalization as enabling technology**

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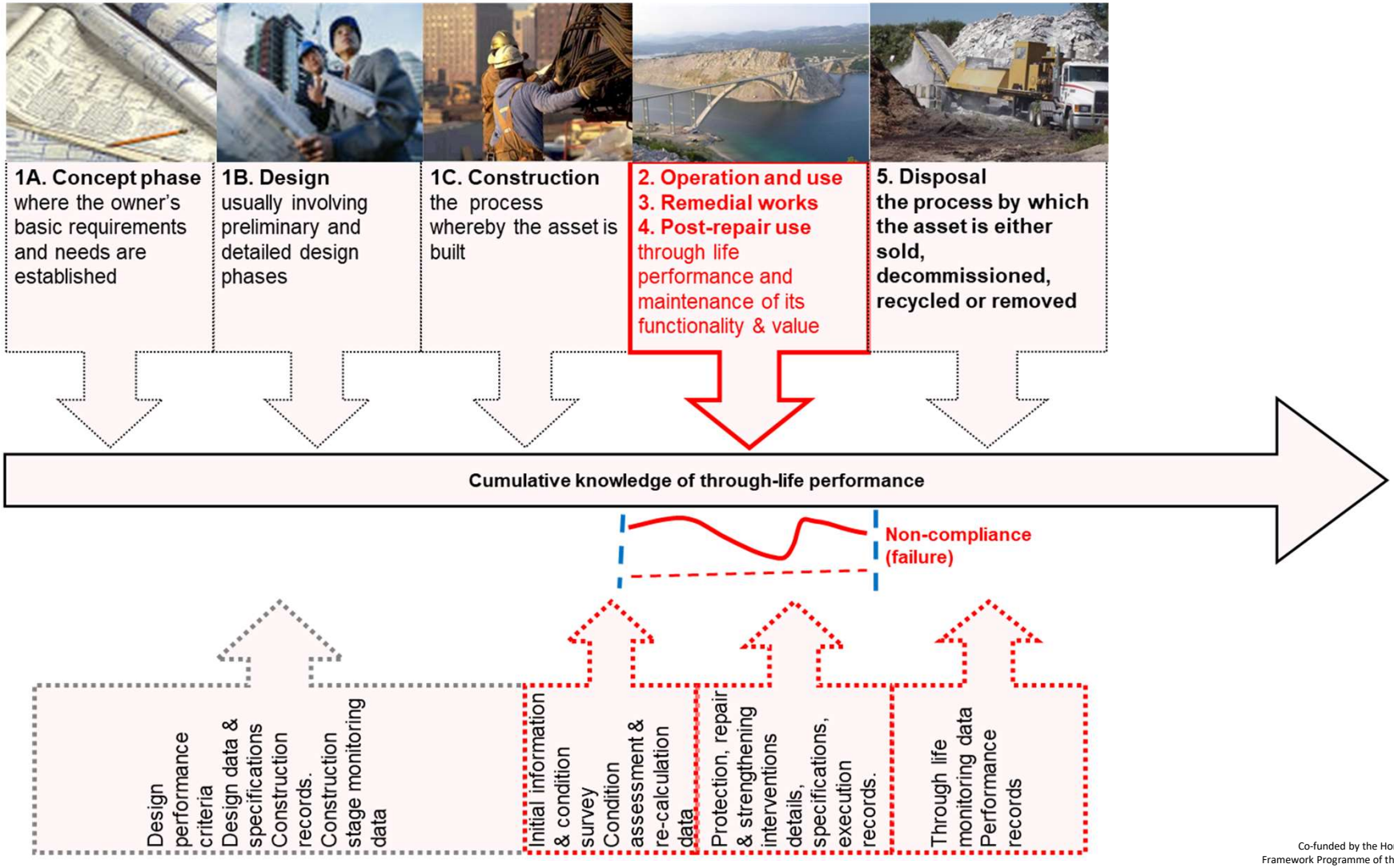
Risk-based & data-informed life cycle management



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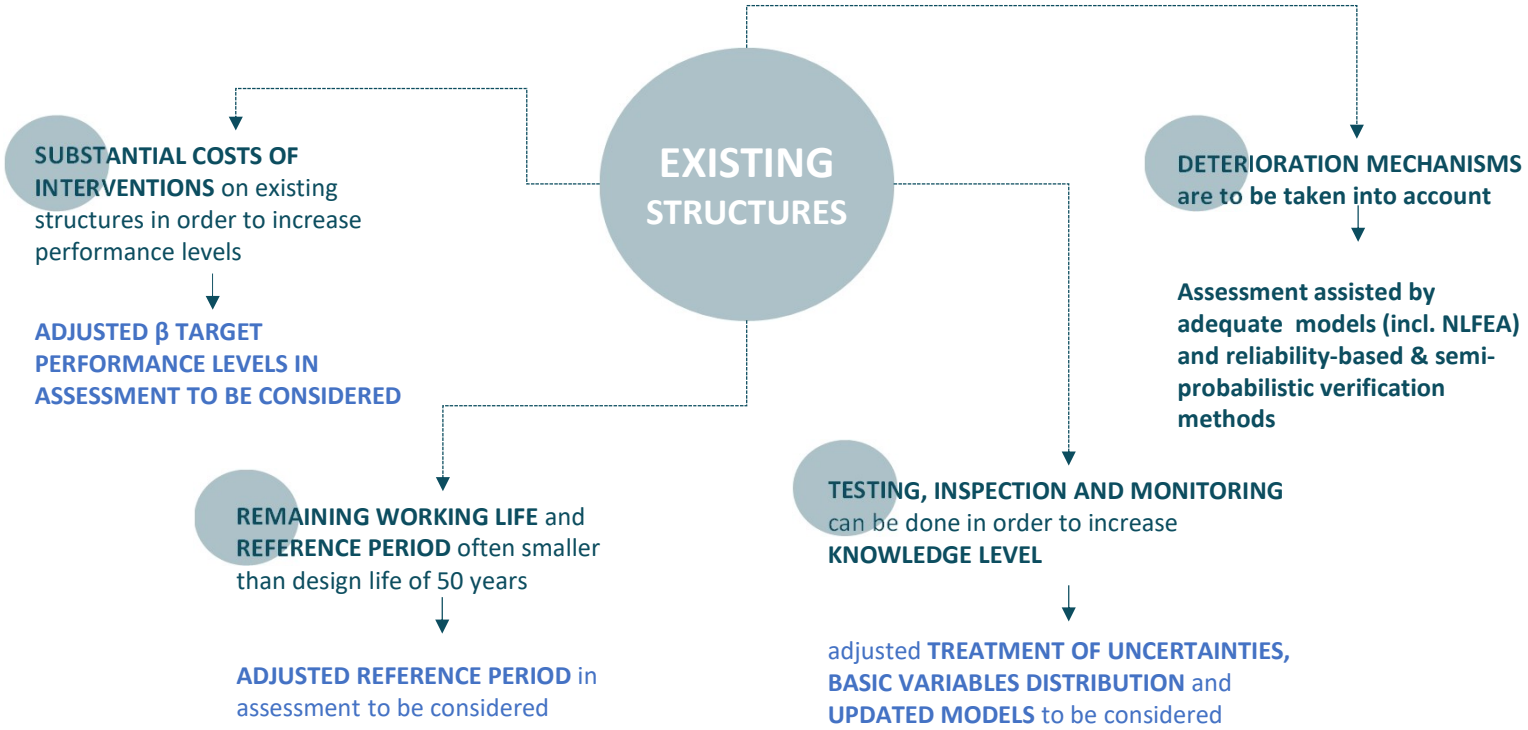
Risk-based & data-informed life cycle management



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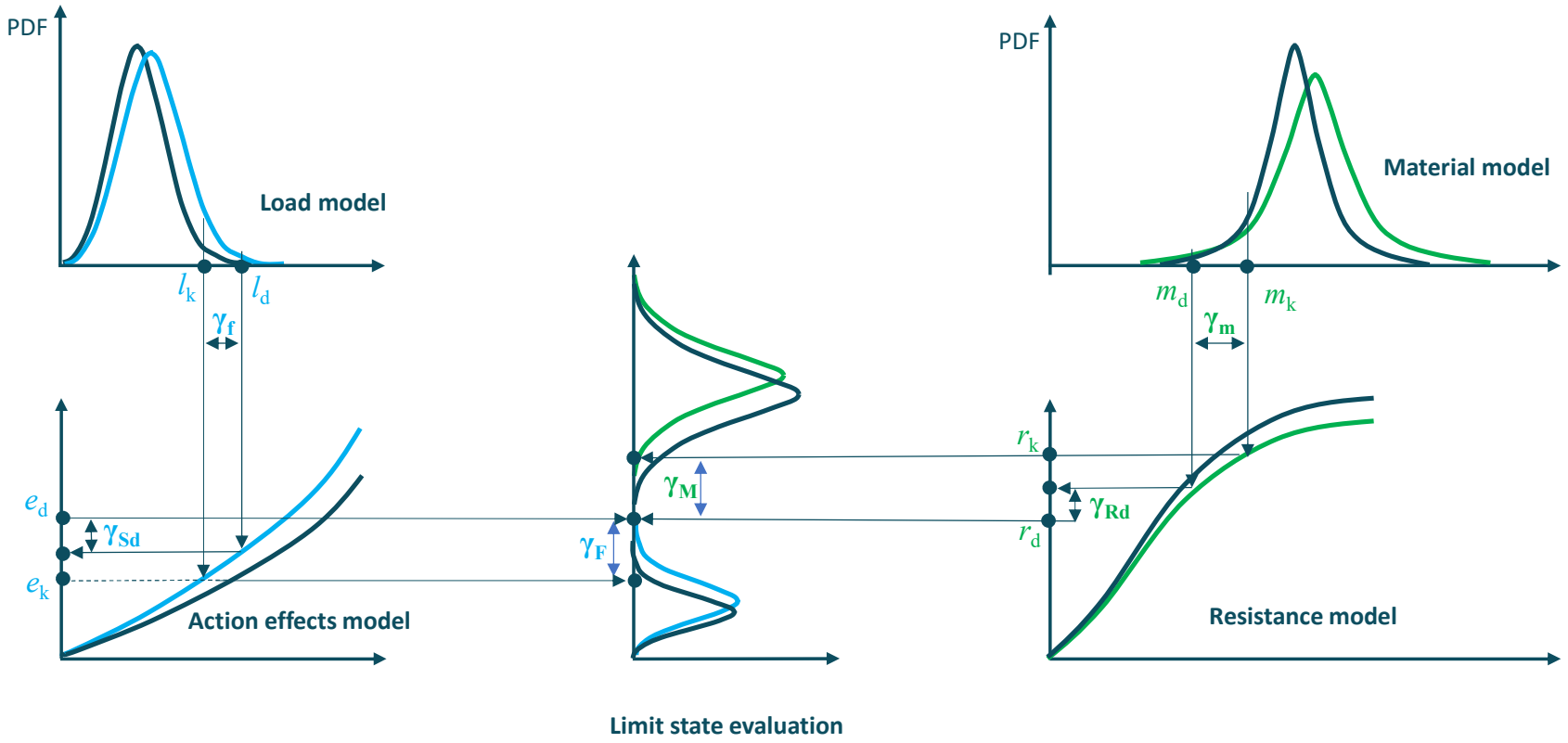
Data-informed assessment

Uncertainty treatment in structural assessment (partial safety factor format)



adopted form [M. Teichgäber, J. Köhler, D. Straub, Hidden safety in structural design codes, Engineering Structures, 2022]

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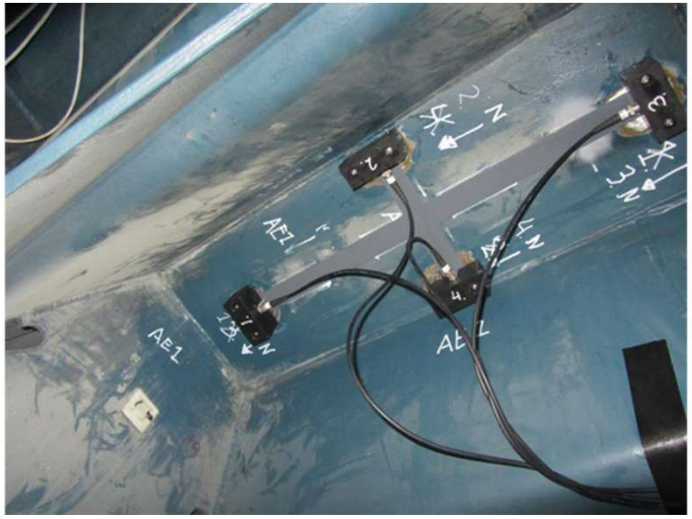
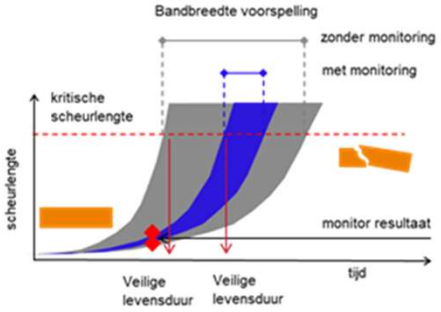
Best practices (example)

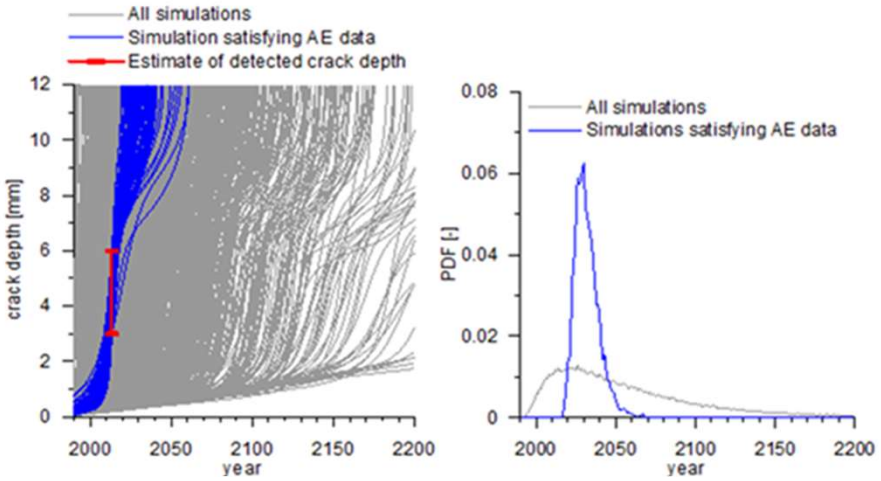
The data-informed service life prediction for fatigue in orthotropic bridge decks

Potential use of data: improving understanding of steel bridges behaviour and improving performance prediction

- detection of fatigue cracks orthotropic bridge decks
- early warning system
- real-time prediction of fatigue service life







Field-lab fatigue service life prediction based on crack growth monitoring and modelling (NL)

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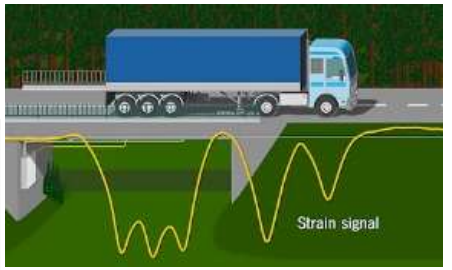
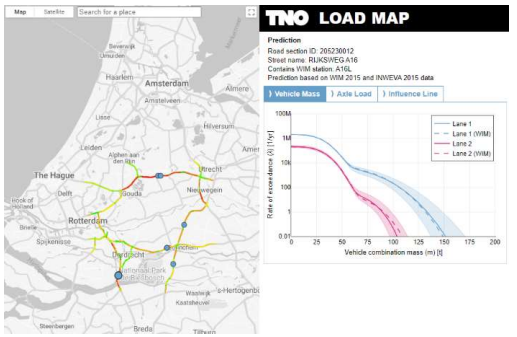
Best practices (example)

The traffic load information for optimized use and maintenance of pavements and structures

Potential use of data: improving understanding of live loads on infrastructure

- Short-term: underpinning development of 'lighter' traffic load model for specific objects
- Medium-term: improved predictive traffic load models for transport networks
- Long-term: real time integration with digital twin models





Application of Loadmap and Bridge-WiM in field-lab Moerdijk (NL)

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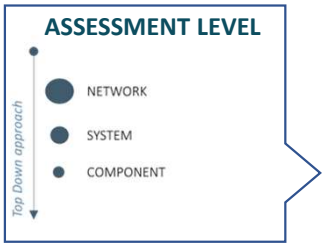
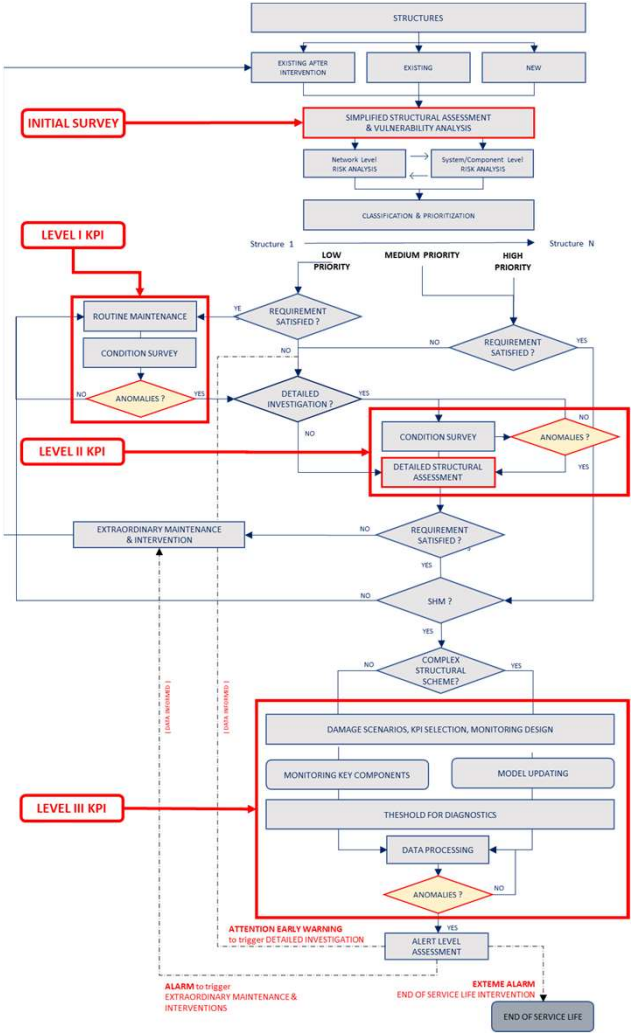
Data-informed decision-making





DATA COLLECTION & STORAGE

ASSESSMENT FLOW INCLUDING INFORMATION FROM INSPECTION MONITORING AND TESTING

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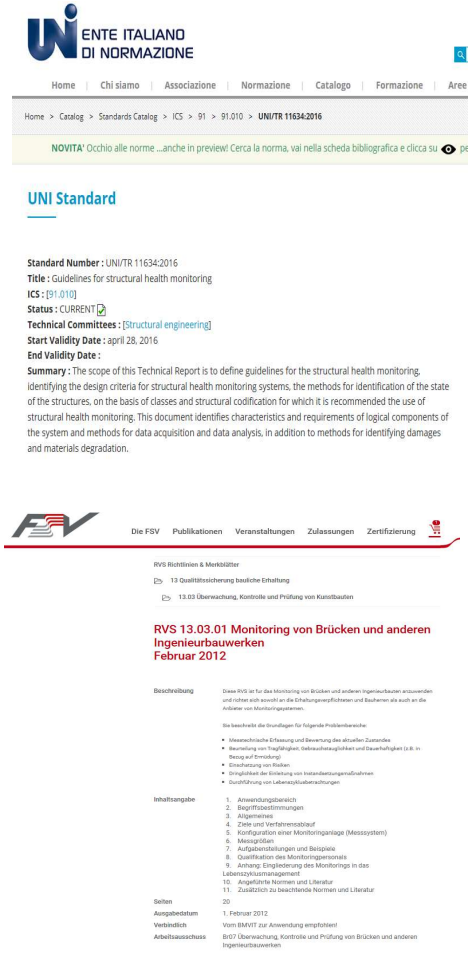
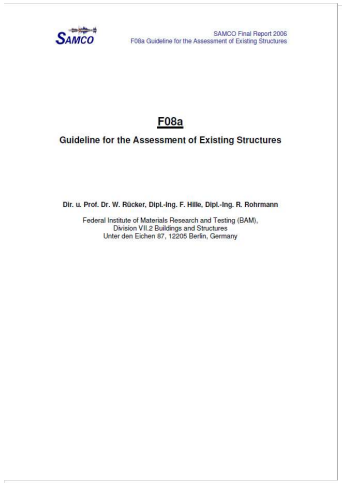
The role of standardization

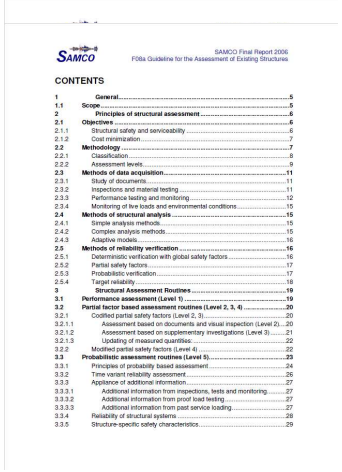
Decision-making regarding maintenance of infrastructure is regulated on national and even on infrastructure operators level.

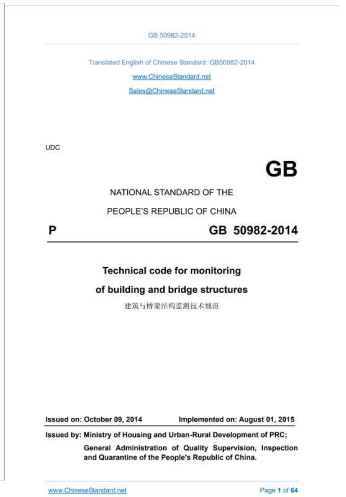
The current guidelines largely differ in how they **include condition information from inspections and monitoring** in the **evaluation of the likelihood of risk events** and in **prioritization of structures for maintenance**.

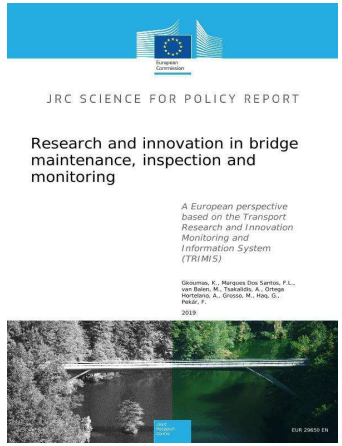
The experience form **R&D and best-practice** are **not consistently interpreted and implemented** in different European countries due to a lack of coherent policies and gaps in knowhow.











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Standardization outlook

- **New standard on structural monitoring**
  - decision-making regarding the design of the monitoring strategy
  - effective use of monitoring data to produce useful and meaningful information relevant for diagnostics of structures, safety assessment and maintenance approaches

- **Further amendment to the existing Eurocodes** on safety assessment taking into account inspections, monitoring and testing
  - full utilisation of structure-specific data in the safety assessment of existing structures
  - assessment of actual safety through consideration of deterioration and damage by models
  - better prediction of end-of-service life by appropriate choice of the safety framework

- **New standard for** risk-based maintenance management and preventive condition-based **maintenance of transport infrastructures**
  - improvement of the decision-making process regarding maintenance at network and object level

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Digitalization as enabling technology

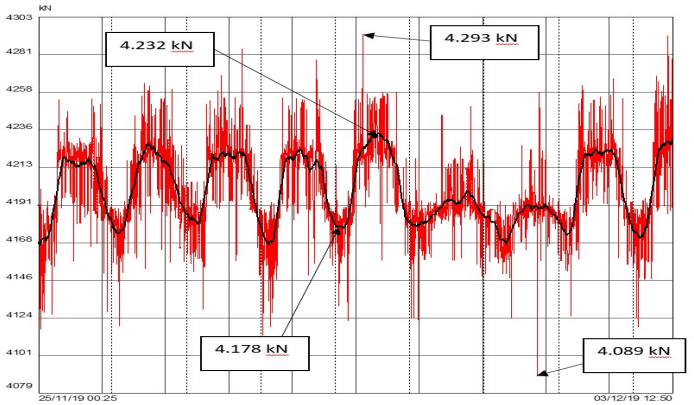
Best practices (example)

The real-time monitoring and analysis platform for infrastructures

Potential use of data: improving understanding of infrastructure condition and performance

- Short-term: construction monitoring
- Medium-term: pathologies monitoring
- Long-term: patterns identification

Stray cable monitoring of the Centenario bridge in Seville (ES)



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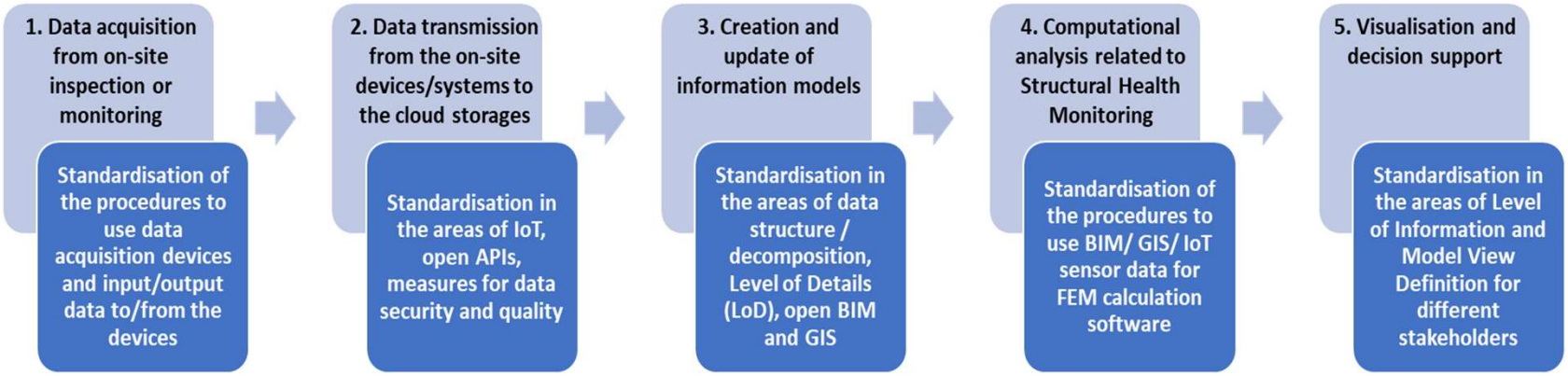
Digitalization as enabling technology

Data should be FAIR :

- Findable - think Internet/WWW
- Accessible - think identification/authentication/authorisation
- Interoperable - think standard data syntax (formats, direct access methods)
- Reusable - think standard data semantics (schemas, ontologies, OTLs)

FAIR approach delivers FutureProof / Scaleable / Sustainable solutions



Standardization domains & workflow from data acquisition till decision support in the context of inspection, monitoring, maintenance and safety of transport infrastructures

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- **Unprecedented technology advances** can enable the change towards new data-informed and risk-based approaches to **safety control and maintenance decision-making** for transport infrastructure, **supported by monitoring systems**.
- There is a **sufficient know-how across Europe** and there is the **common will to reach consensus among the stakeholders**
- Solid basis and recognized needs for **new European standards** in alignment with national standards in monitoring, safety assessment and maintenance, and international standards in BIM and digitalization
- CSA IM-SAFE contributes to **political commitment and societal acceptance** of the future standards at European and national level, by supporting **EC and CEN** in preparing **new standards in monitoring for optimal maintenance and safety of transport infrastructure**

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