Deterioration of Concrete Structures – the challenges of risk based management

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The Management of the build infrastructure involves activities:

- Operate
- Plan
- Investigate
- Design
- Inspect
- Maintain
- Deconstruct

These activities involve decisions!
Context

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**Constraints:**

- Safety for Personnel
- Safety for Environment
- Cost Efficient
Decisions and Uncertainties

Examples Concrete Design:
- What is a proper cross section?
- What is a proper concrete cover?

Examples Concrete maintenance:
- When to inspect / what to measure?
- Acceptable safety?
- Repair or reconstruct?
Decision making and structural engineering

But, how safe is safe enough?

How to find a balance between

Investment into more safety  and  Expected Consequences

e.g. increased cross section of a structural component, inspection, repair

\[ R = P_f \cdot C_f \]
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Phenomena

- Network failure
- Road closure
- Bridge failure
- Failure of segment
- Failure of the beam
- Failure of the rebar
- Loss of diameter
- Corrosion onset

Decisions

Priorisation?
- Severe Condition
- Crucial in the Network

Repair/strengthen and if yes how?
- Rebuild?

Protection?
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Challenges on the Network level

- Priorisation of activities
- Importance of different elements
- Common cause effects
- Discounting, renewal

[Faber, Kohler, Schubert, 2010]
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Challenges on the Multi-scale and multi-physics

Steel corrosion, ASR in concrete, ...

Modelling (FEM)

Assessment of Structural effects

Multi-scale
Multi-physics
Predictive (time)

[Esposito, Hendriks] [Frissen, Hendriks, et al]
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Challenges on the Object level

- Spatial Distribution and System Effects
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Challenges on the Object level

• Spatial Distribution and System Effects

• Probability of Corrosion and Failure

[Hackl, Kohler, 2013]

[Quin, 2011]

[Hackl, Kohler, 2013]
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Challenges on the Object level

• Spatial Distribution and System Effects

• Probability of Corrosion and Failure

• Effect of Inspections on the Estimation

[Quin, 2011]

[Hackl, Kohler, 2013]
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- Risk Assessment
- Structural Reliability
- Strength Degradation
- Materials Deterioration

Probabilistic Modeling

Decision Support

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