Risk & Safety

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Non-Destructive Testing of Concrete Elements and Investigation of the Data using Statistical Methods

Background

Corrosion is one of the main reasons for failure of concrete structures. The purpose of non-destructive tests is to identify, whether corrosion in a reinforced concrete element has initiated or not and based on the results of these tests to decide if the investigated structure still ensures safety for all its users.

Why are non-destructive test methods used?
- Advantages: Concrete remains undamaged, investigation is quite fast and there is not much equipment needed.
- Disadvantages: There is always an uncertainty remaining.

Approach

The assessment of the condition of the concrete element consists of three parts:
- Localization of the reinforcement
- Measurement of several properties of the concrete element
- Statistical analysis of the measurement results

Accomplished tests:
- Concrete cover depth
- Compressive strength (Schmidt Hammer test)
- Electrical resistivity (Four Probe Wenner test)
- Half-cell potential

Statistical Analysis

Process flow:
1. Evaluation of main characteristics of the data and graphical representations using descriptive statistics
2. Drawing of probability papers to identify the family of distribution
3. Estimation of parameters for the chosen distribution family with the Method of Moment
4. Checking the plausibility of the model with the Goodness-of-fit Test (Chi-Square)

Conclusion

There is a very low risk of corrosion in this element!

The results of the tests and the statistical analysis lead to the conclusion that corrosion has not initiated at this point of time.
Considering the colour maps, the grey fields show higher risk for corrosion concerning the half-cell potential values. Since these fields are mainly situated in the lower region of the element, future corrosion is most likely to initiate at the bottom.
For the future, in order to reassess the condition of this concrete element, it is recommended to particularly pay attention to the lower region of the element.

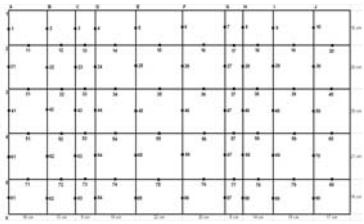
Corrosion

Corrosion is an electrochemical reaction between a metallic material and its environment, which leads to a significant modification of the concrete structure. Different environmental damaging agents such as chorides affect the steel. As a consequence, the volume of the reinforcement increases which creates tension and induces cracks.

Corroded Reinforcement Bars

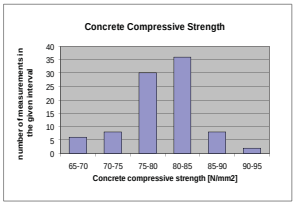
Measurements

Investigated Concrete Element while conducting the Electrical Resistivity Test

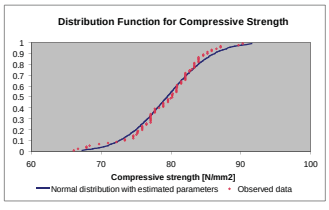


Arrangement of the Reinforcement Bars and the Measurement Points

Probabilistic Modelling



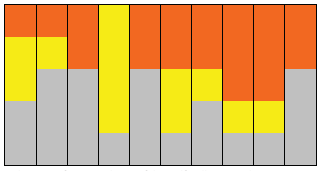
Histogram for Compressive Strength



Comparison of the observed Data and modelled Distribution Function with estimated Parameters

Colour Maps

Colour Map for horizontal Bars of the Half-Cell Potential Measurement



Colour Map for vertical Bars of the Half-Cell Potential Measurement