Summer School

Thermo-mechanical experiments of RC structures correlated to distributed coda signals

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RUB2

CONCRETE DAMAGE ASSESSMENT BY CODA WAVES

Mechanical

Elaboration of Methods for Measuring Strain Fields

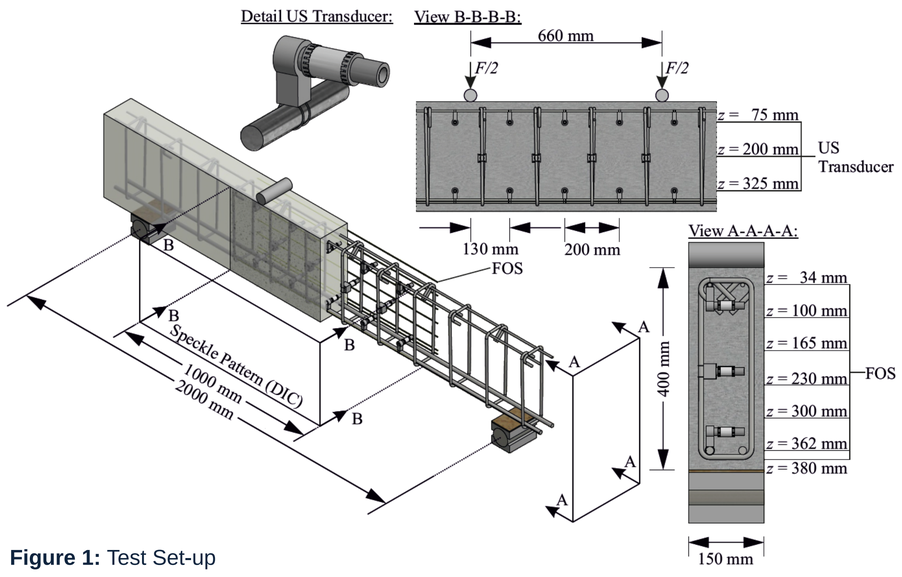


Figure 1: Test Set-up

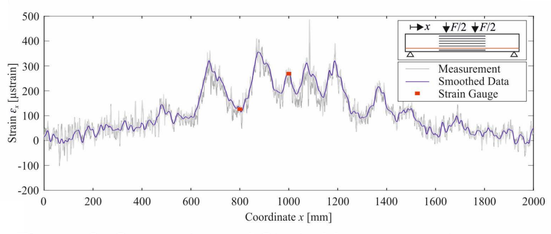


Figure 2: Comparison of Strain Measurements from FOS and Strain Gauges

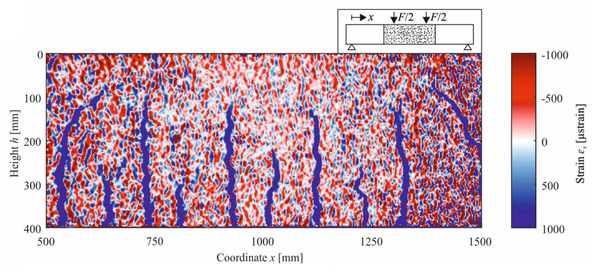


Figure 3: Strain Measurement from DIC

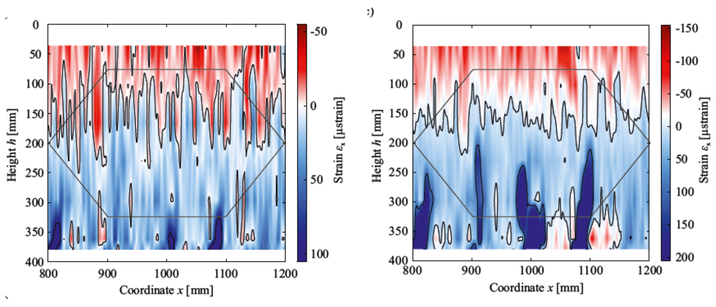


Figure 4: Strain Fields from FOS Strain Measurements (10 kN and 25 kN)

- Two-dimensional strain results from line-like FOS measurements
- First damage already visible at 10 kN (left)

Evaluation of the Accuracy of Strain Measurement Techniques

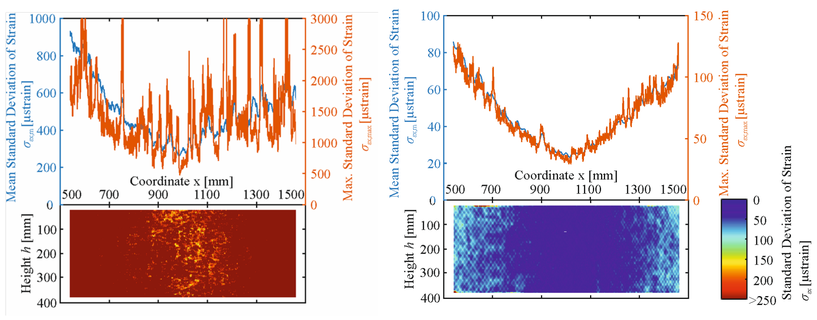


Figure 5: Accuracy Representation of DIC Measurements

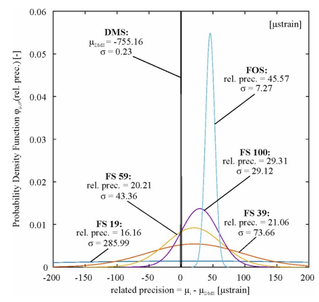


Figure 6: Comparison of Repeatability and Accuracy of DIC, FOS and Strain Gauges

Comparison of Strain Fields and Attribute Maps

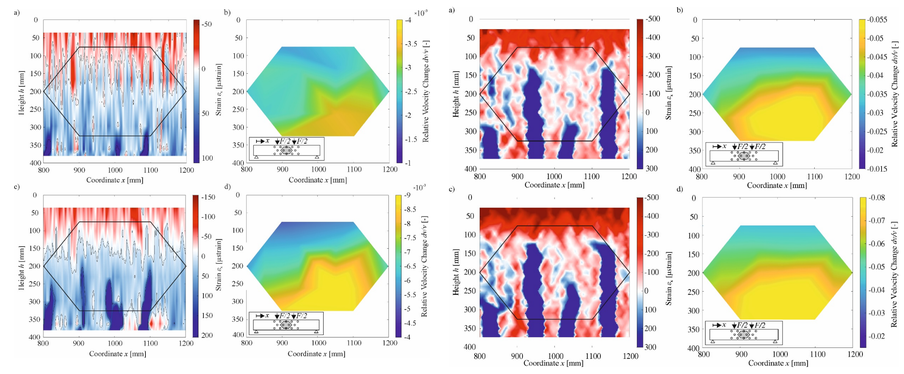
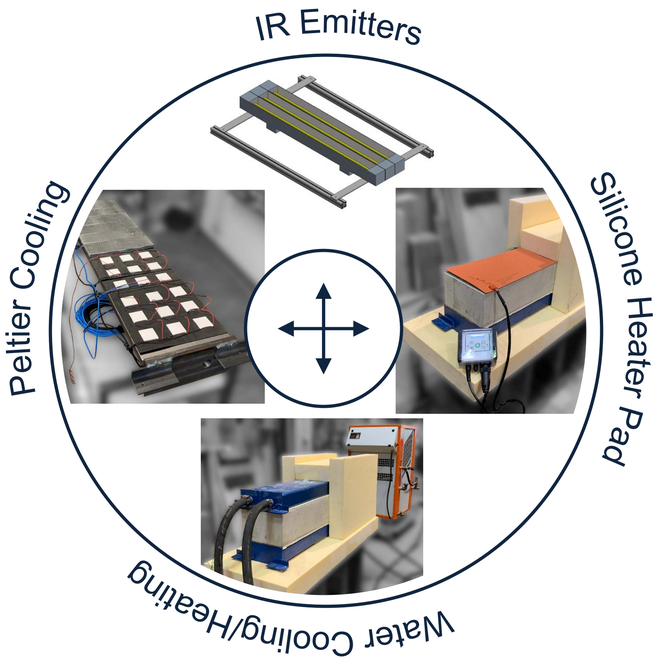


Figure 7: Comparison for Low (left – 5 % and 10 % F_{max}) and High Loads (right – 35 % and 60 % F_{max})

Thermal

Suitable Method for Heat Induction into RC Members



- Juxtaposition of methods for heat induction
- Optimized cooling by combining of water cooling and Peltier elements

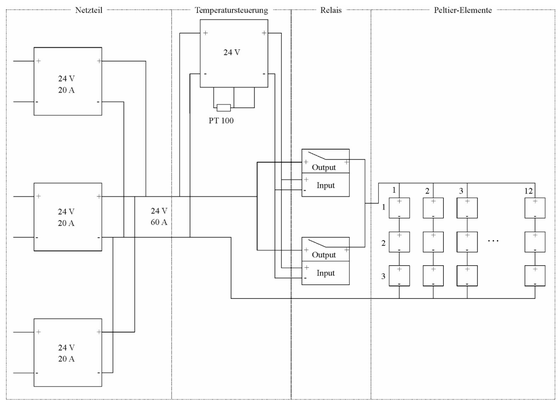


Figure 8: Wiring of the Peltier Elements

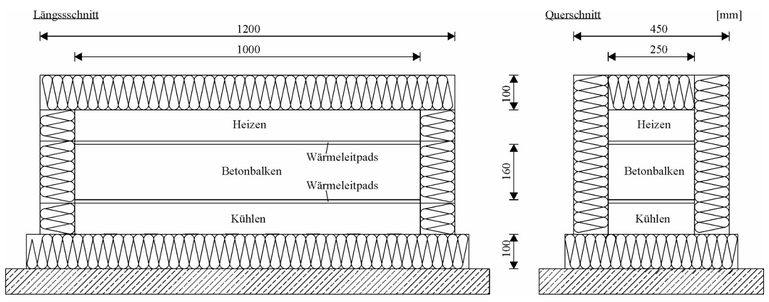


Figure 9: Test Set-up

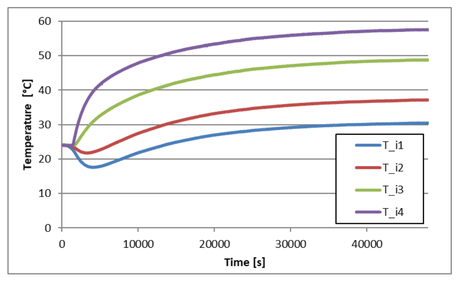
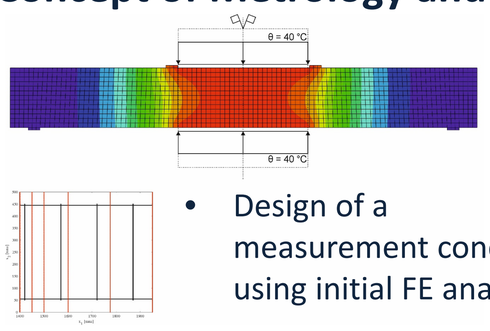


Figure 10: Temperature History for Silicone Heater Pad and Peltier Cooling

- Aim: generate maximum temperature difference between top and bottom
- Thermocouples in 2 cm, 5.5 cm 10.5 cm and 14 cm depth
- Steady state after 8 hours

Concept of Metrology and Processing to Temperature Fields



- Design of a measurement concept using initial FE analysis

Figure 11: Placement of FOS for Temperature Measurement

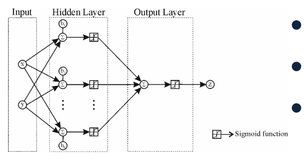


Figure 12: Network Topology of an ANN

- R^2 = 0.995
- RMSE = 0.125
- max. e = 0.485
- Approximation of line-like temperatures (FOS) to temperature fields

Comparison of Temp. Fields and Attribute Maps

- Applying the previously derived concept of metrology on a RC beam
- Generation of constant and linearly variable temperature states

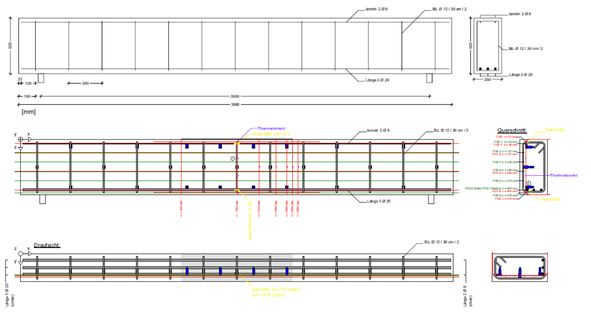


Figure 13: Test Set-up

Publications

(1) Konertz, D.; Löschmann, J.; Clauß, F.; Mark, P.: Faseroptische Messung von Dehnungs- und Temperaturfeldern. Bauingenieur 94, 2019.
(2) Clauß, F.; Epple, N.; Ahrens, M.A.; Niederleithinger, E.; Mark, P.: Comparison of Experimentally Determined Two-Dimensional Strain Fields and Mapped Ultrasonic Data Processed by Coda Wave Interferometry. Sensors 20, 2020.
(3) Löschmann, J.; Clauß, F.; Mark, P.: Verstärken von Stahlbetontragwerken mit Temperaturinduktion. Beton- und Stahlbetonbau 115, 2020.
(4) Clauß, F.; Ahrens, M. A.; Mark, P.: Evaluation of Strain Measuring Techniques in Reinforced Concrete Structures – Evaluation of Application, Accuracy, and Dimensionality. Structural Concrete. (Submitted)