



Assessing Concrete Damage Using Thermal Modulation and Coda Wave Interferometry – preliminary results

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Thermal Modulation (TM) is a non-linear technique previously applied to homogeneous materials like steel and aluminium to detect changes caused by damage. While TM has also been tested on concrete (Sun, 2019), research remains limited, making it difficult to fully understand its potential, limitations, and scalability.

TM results can be influenced by several factors, including temperature range, rate of temperature change, humidity, cycle duration, temperature gradients, and material properties. Although tests on various parameters were conducted, this study presents preliminary results focused on one key factor: the water-to-cement (w/c) ratio in concrete.

Six concrete blocks were cast—three with a w/c ratio of 0.45 and three with a ratio of 0.50. Two of these (one from each group) were used as reference samples and kept under constant temperature and humidity conditions. The other four were subjected to increasing uniaxial compression, from 5% to 60% of their estimated maximum strength, in 5% increments. In between each loading step, the blocks underwent at least two 24-hour thermal cycles (from 10°C to 25°C) in a climate chamber set at 60% relative humidity.

During the thermal cycles, ultrasonic pulses were continuously recorded. These signals were used to calculate relative velocity changes (dv/v) via Coda Wave Interferometry (CWI). We then derived Thermal Modulation coefficients, which are known to correlate with damage levels from the dv/v and the internal temperature of the samples.

This experiment explores the combined capabilities of CWI and TM in detecting damage at different stages in concrete considering the material properties. A better understanding of how TM responds to variations in w/c ratio and damage progression helps to define the method's applicability and limitations. These findings contribute as groundwork for future use of TM in the structural health monitoring of concrete structures.

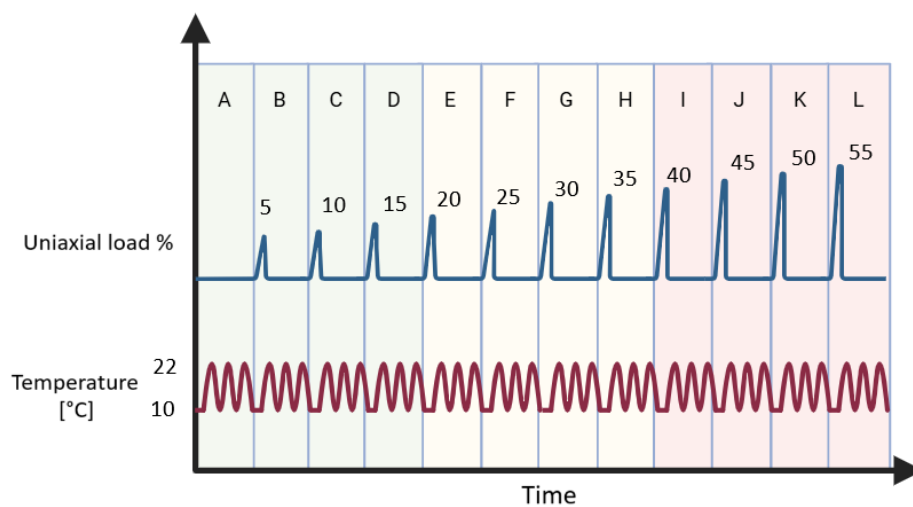


Figure 1:

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