Numerical Investigation of Evaluating the Degree of Damage in Concrete Plate Cold Joints through Surface Wave Dispersion Velocity Profiles

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This study aims to develop a technology for assessing the interfacial condition of cold joints in concrete plates, focusing on the dispersion velocity profile of surface waves. The methodology employs a small impact hammer embedded with a piezoelectric element and a displacement receiver strategically positioned on either side of the seam. In this initial investigation, numerical models were constructed using ANSYS LS-DYNA. The cold joint zone was simulated by randomly removing elements with a predetermined void ratio. Displacement waveforms at the sensor node underwent analysis using a short-time Fourier Transform and the reassigned method to derive the dispersive velocity profile of surface waves. The study delves into the impacts of varying test-line lengths, impact durations, and void distributions. Numerical findings indicate that cold joints are detectable with a void ratio of 40% or greater. For the 60% and 80% void ratios, surface wave velocities register notably lower for wavelengths below 0.1 m and 0.2 m, respectively. Under the same porosity ratio for surface-observable cold joints, if their extension depth is smaller, the wave velocity on the dispersion curve will be lower than that of a fully penetrated cold joint. The current study reveals that a contact duration of 60 μs and an impactor-receiver distance of 0.82 m yield the most distinguishable results for detecting a cold joint's extension and porosity ratio. Additional information about the joint can be unveiled by tests with a hammer with a contact duration of 20 μs. Finally, various void distributions in the cold joint predominantly influence the wave velocity at shorter wavelengths.