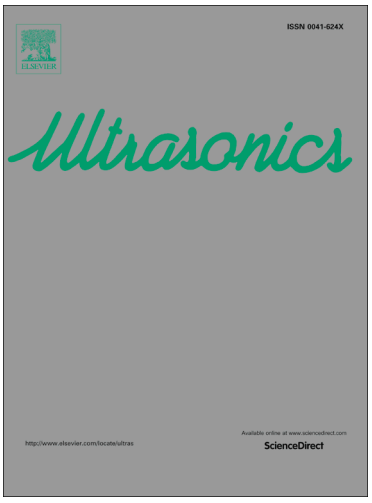

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In Situ Nonlinear Ultrasonic Technique for Monitoring Microcracking in Concrete Subjected to Creep and Cyclic Loading

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Abstract

This research conducts in situ nonlinear ultrasonic (NLU) measurements for real time monitoring of load-induced damage in concrete. For the in situ measurements on a cylindrical specimen under sustained load, a previously developed second harmonic generation (SHG) technique with non-contact detection is adapted to a cylindrical specimen geometry. This new setup is validated by demonstrating that the measured nonlinear Rayleigh wave signals are equivalent to those in a flat half space, and thus the acoustic nonlinearity parameter, β can be defined and interpreted in the same way. Both the acoustic nonlinearity parameter and strain are measured to quantitatively assess the early-age damage in a set of concrete specimens subjected to either 25 days of creep, or 11 cycles of cyclic loading at room temperature. The experimental results show that the acoustic nonlinearity parameter is sensitive to early-stage microcrack formation under both loading conditions – the measured β can be directly linked to the accumulated microscale damage. This paper demonstrates the potential of NLU for the in situ monitoring of mechanical load-induced microscale damage in concrete components.

Keywords: *In situ* NDE, Microcrack detection, Creep, Cyclic loading, Concrete