# Applications of air-coupled ultrasonic inspection for concrete structures and materials

**John Popovics**[1]

[1]Civil and Environmental Engineering, University of Illinois, USA

Air-coupled ultrasonic measurements can offer advantages to nondestructive inspection efforts, but only if several challenges and barriers are first overcome. This paper presents an overview of air-coupled ultrasonic testing for concrete, where the particular challenges of application are first reviewed, and then solutions to those challenges are presented. Then several successful non-destructive testing applications to concrete are summarized. Most of the applications make use of the frequency-wavenumber (f-k) domain signal processing approach, which is enabled by the characteristics of the air-coupled configuration that enables consistent and frequency measurement of data along scan lines, and considers guided wave data. The application cases include (i) investigation of bonding and interface conditions between steel plates and concrete; (ii) characterization of finely distributed cracking damage owing to alkali-silica deterioration within concrete; (iii) evaluation of additively manufactured (3-D printed) concrete; and (iv) interpretation of guided wavefields using physics-informed neural networks (PINN) to extract spatially local material characteristics. In all the presented applications, experimental data are supported or verified with numerical simulation and analytical evaluations. Collectively the results demonstrate that air-coupled ultrasonic test data, interpreted using advanced processing and analysis methods, can provide sensitive characterization of materials conditions that lead to useful information for in-place condition evaluation of concrete.