Vibration-Based NDT Techniques for Selected Civil Engineering Applications

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Abstract

The need for in-situ condition assessment of aging civil infrastructure and quality assurance of newly constructed structures using non-destructive testing (NDT) methods has never been more critical. Most NDT techniques used in civil engineering are derived from manufacturing engineering. However, adapting these methods requires modifications to test instrumentation and development of diagnostic procedures specifically suited for civil structures. Among various NDT techniques, vibration-based methods are among the most widely used. In this regard, this talk introduces two selected applications of the vibration-based approach for concrete structural members. The first part of the talk presents an innovative vibration-based method for inspecting precast concrete foundation piles. This method offers an alternative to conventional wave-based pile integrity testing by replacing the instrumented impact hammer with a portable shaker for improved repeatability. Furthermore, advanced signal processing techniques based on higher-order spectrum analysis (HOSA) are employed to detect and quantify nonlinearities in pile vibrations, which serve as key indicators of damage. Experimental results obtained from real-scale foundation piles are presented to demonstrate the effectiveness of the method. The second part focuses on adapting a vibration-based approach to detect corrosion-induced damage in reinforced concrete. Diagnostic procedures are developed and validated through experimental tests on lab-scale concrete specimens. Both traditional and adaptive higher-order spectral analyses are applied to analyse transient vibration signals generated by an impact hammer. A comparison of results shows that adaptive HOSA improves damage discrimination by over 40% compared to traditional HOSA.