Accepted Manuscript

Characterization of steel-concrete interface bonding conditions using attenuation characteristics of guided waves

Homin Song, John S. Popovics

PII: S0958-9465(17)30228-7

DOI: 10.1016/j.cemconcomp.2017.07.001

Reference: CECO 2850

To appear in: *Cement and Concrete Composites*

Received Date: 7 March 2017

Revised Date: 20 June 2017

Accepted Date: 4 July 2017

Please cite this article as: H. Song, J.S. Popovics, Characterization of steel-concrete interface bonding conditions using attenuation characteristics of guided waves, *Cement and Concrete Composites* (2017), doi: 10.1016/j.cemconcomp.2017.07.001.

Characterization of steel-concrete interface bonding conditions using attenuation characteristics of guided waves

Homin Song[1] and John S. Popovics[2]

Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, 205 N. Mathews Ave., Urbana, IL 61801, USA

[1]hsong36@illinois.edu

[2]johnpop@illinois.edu (corresponding author)

Abstract

This paper presents an air-coupled ultrasonic nondestructive evaluation approach based on the attenuation characteristics of guided waves to characterize interface bonding conditions of steel-clad concrete structures. Analytical guided wave modal solutions for various interface bonding conditions are obtained using the global matrix technique. The analytical results indicate that attenuation behavior of the fundamental symmetric (S0) guided wave mode is sensitive to interface bonding condition. A signal processing scheme is proposed to extract a dimensionless damage index, the normalized S0 mode magnitude, which reflects the attenuation behavior of the S0 mode. A series of numerical simulations are performed to verify the utility of the parameter to characterize interface bond condition. The feasibility of the testing approach is then established by experiments on steel-clad concrete specimens with different interface bonding conditions. The numerical simulation and experimental results demonstrate that interface bonding conditions of steel-clad concrete structures can be quantitatively evaluated using the proposed approach.

Keywords: Global matrix technique, Lamb wave, attenuation, air-coupled sensing, nondestructive testing, ultrasonic scanning, frequency-wavenumber (*f-k*) domain signal analysis

1. Introduction

Steel-concrete composite (steel-clad concrete) structures are increasingly being incorporated into the civil infrastructure because of favorable structural performance and construction efficiency. Common examples of steel-concrete composite structures are concrete-filled steel tubular (CFST) columns, where an inner concrete core is confined within a steel tubular structure, and steel-concrete-steel (SCS) sandwich beams, where a concrete bulk is sandwiched by two steel plates that serve as top and bottom