(119)

Guided Wave Propagation in Pipes Embedded in Concrete

Eli Leinov, Michael JS Lowe, and Peter Cawley, NDE Group, Department of Mechanical Engineering, Imperial College, London SW7 2AZ, United Kingdom

Long-range guided wave testing (GWT) is routinely used for detection of corrosion defects in industrial pipelines. The application of the method to pipes embedded in concrete results in unpredictable test ranges due to different contact conditions between the pipe and the embedding concrete. When the coupling is intact GWT test ranges tend to be considerably reduced compared with pipes in air due to very high attenuation rates resulting from energy leakage into the embedding concrete; while in cases where the contact between the concrete and pipe is partial, e.g. due to the concrete cracking, the attenuation would be smaller, resulting in increased practical inspection ranges.

In this study, we investigate the influence of the acoustic coupling between the pipe and concrete on the guided wave attenuation. Full-scale guided wave tests have been conducted on two 8”-dia., 6-meters long steel pipes fully- and partially-embedded in concrete over an axial length of 0.4-meters. Measurements of attenuation of the T(0,1) guided wave mode are performed over a frequency range of 10-35 kHz. Tests are compared with model predictions, explicit 3D finite-element (FE) and semi-analytical finite-element (SAFE) simulations. The attenuation is found to be very large in a fully-embedded pipe while much smaller in partially-embedded pipes. It is shown that the attenuation is not linearly proportional to the extent of the circumferential fraction embedded in concrete. This is due to mode conversion in which the ultrasonic energy is concentrated in modified guided wave modes in the free fraction of the pipe in the partly-embedded cases; model studies are being used to investigate the physics of this behavior. The extent of circumferential contact between the pipe and the concrete governs the propagation of the guided waves. For a pipe fully embedded in concrete practically no signal would be transmitted past a relatively short propagation distance due to leakage of energy. However, for a pipe partially embedded in concrete, measurable signal propagates.