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DAMAGE IDENTIFICATION IN COMPLEX WAVEGUIDES USING WAVE-BASED APPROACHES

Subject: Structural health monitoring has become a critical problem in mechanical and civil engineering. This aims at detecting and preventing the deteriorations of structures at an early stage. Usually, non-destructive testing (NDT) techniques are applied to waveguide systems like pipelines with or without internal fluids (e.g., gas, oil,…). The strategy consists in generating guided waves and measuring their reflection to determine the occurrence, type and localization of defects. For engineering applications, waveguides are often made up of straight and curved complex-shaped joints which penalize the detection of damages via a classic wave propagation analysis. In terms of modeling, wave-based approaches are able to predict the wave properties of waveguides, as well as the wave reflection/transmission properties of damages and joints at a reduced numerical cost. Among these approaches, one can mention the wave finite element (WFE) method, the spectral element (SE) method and the semi-analytical finite element (SAFE) method. The objective of this thesis is to investigate the potential of those wave-based approaches to identify damages in complex waveguides. A whole scattering matrix which takes into account the reflection/transmission properties of waves (in the frequency domain) around damages and curved joints will be developed and updated from measured experimental data. Single and multi-layered pipes, without and with internal fluids, will be analyzed. An integrated experimental/numerical tool to identify damages in practical waveguides will be developed. Ultimately, an optimization procedure of the design of curved joints will be proposed so as to improve the magnitude of the scattered signals at the receiving points.

Keywords: waveguides, non-destructive testing, damage detection, vibration, finite element

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Additional information: This subject is part of the research topics developed inside the Dynamics Group of the LaMé Laboratory.