

Steady-State Wavefield Analysis: Predominant Wavenumber Removal for Enhanced Structural Damage Detection

Hyeonwoo Nam¹, Bu-Gon Kim¹, Gyuhae Park¹, Min-Sung Kim², Chan-Yik Park³

¹School of Mechanical Engineering, Chonnam National University, Republic of Korea, ¹Aerospace Technology Research Institute, Agency for Defense Development, Republic of Korea, ¹Aerospace Technology Research Institute, Agency for Defense Development, Republic of Korea

In this study, we propose the predominant wavenumber removal (PWR) as a technique within steady-state wavefield analysis to enhance the detection of structural damage. Recently, several studies have suggested employing the full steady-state wavefields instead of guided wavefields for structural imaging. These studies showed that various types of structural defects could be detected using wavenumber estimation with steady-state wavefields. In the process of wavenumber estimation, damage sensitive ultrasonic wave modes are identified and isolated using mode isolation techniques, and it detects damage well in most cases. However, despite the efficient use of steady-state wavefields, there are instances where the accuracy of wavenumber estimation decreases in the presence of a low signal-to-noise ratio. The proposed PWR technique offers a novel filtering approach, distinct from conventional methods, that can effectively address this issue. This technique selectively removes the predominant wavenumber components in the wavenumber domain, retaining those wavenumber components changed by damage. Creating a multi-frequency notch filter is included in this technique by multiplying the same number of notch filters as the number of ultrasonic wave modes present in the steady-state wavefields. Ultimately, only the wavenumber components induced by the damage are transformed into the spatial domain, and imaging is performed utilizing the magnitude of the wave components. The technique is validated through experiments on composite and aluminum plates with various types of damage.