Sustainable Civil Infrastructures

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Innovations for Sustainable and Resilient Infrastructure

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Hilbert-Huang Transform Applied to Structural Damage Detection for Framed Structure Using Acoustic Emission Technique

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Abstract. Detecting damage in framed structures is crucial for ensuring performance and safety, as unnoticed damage can lead to catastrophic failures and costly repairs. The present study explores the application of Hilbert-Huang Transform (HHT) for damage detection using Acoustic Emission (AE) techniques. A lab-scaled framed structure was monitored with a suitable piezoelectric sensor positioned at different locations. The damage was simulated with Pencil Lead Break (PLB) at certain points on the frame. The collected AE waveforms were analyzed using HHT, determining the instantaneous amplitude at specific joints through the Hilbert transform of the Intrinsic Mode Functions (IMFs) of the response. The commonly used methods such as Fourier transform, often struggle to resolve non-linear and non-stationary signals. In contrast, HHT provides precise characterization of signal features and moments of energy release. In this research, the endeavor is to precisely localize the damage using AE response signal obtained from simulated damage and applying it in time-frequency domain through HHT. It was found that, HHT excels in analyzing non-stationary signals, making it an effective tool for structural health monitoring and damage assessment. By describing the frequency distribution of IMF components over time, HHT facilitates the calculation of instantaneous energy, aiding in recognizing damage location effectively. The challenges of detecting damage in framed structures include the complexity of accurately capturing and interpreting the signals associated damage localization. However, HHT's advanced capabilities in signal analysis offer significant advantages in overcoming these challenges, providing a more detailed and accurate assessment for structural integrity.

Keywords: Hilbert-Huang Transform · Acoustic Emission · Damage Detection · Damage Localization · Framed Structure

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