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Analysis of Stochastic Loads and Structural Response in Industrial Trucks

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Industrial truck frames are frequently subjected to random, variable loads, which demands reliable methods for predicting and extending their service life. In this study, as a precursor to broader fatigue studies, a preliminary reliability test is undertaken to characterize these stochastic conditions using strain-gauge data and spectral analysis. The goal is to capture a wide range of operational scenarios (for example, obstacle crossing, traveling with or without load) that can introduce complex and fluctuating stress patterns in the welded frame. The methodology comprised the following steps: firstly, the filtering out of static intervals with no external load; secondly, the removal of the mean from each signal; and thirdly, the organization of the data into grouped primary loading cases. The key analyses focused on computing Power Spectral Densities (PSDs) to identify frequency-based features and applying clustering techniques to explore whether a reduced set of strain gauges could adequately map the global stress response. In parallel, various spectral methods were compared to evaluate their relative effectiveness under real-life conditions, balancing accuracy with computational practicality. Despite the absence of definitive conclusions within this study, the preliminary observations underscore the significance of selecting suitable data acquisition strategies and lay the foundation for subsequent experimental validation. The findings of this study are expected to facilitate more comprehensive fatigue-life predictions and contribute to the development of safer and more cost-effective design methodologies for welded components operating under highly variable loading conditions.

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