Dynamic Response to Pedestrian Loads with Statistical Frequency Distribution

Pedestrian loads depend on the regularity and frequency of the footfall process. Traditionally, pedestrian loads have been represented by one or more specific harmonic components with a well-defined frequency, and light footbridges have been investigated for resonance vibration generated by the harmonic components. Measurements indicate that the footfall frequency of a group of pedestrians has a coefficient of variation of the order 0.05–0.1. This is considerably larger than the response bandwidth of a typical lightly damped structure, and at resonance this has a significant influence on the magnitude of the resulting response. A frequency representation of vertical pedestrian load is developed, and a compact explicit formula is developed for the magnitude of the resulting response, in terms of the damping ratio of the structure, the bandwidth of the pedestrian load, and the mean footfall frequency. The accuracy of the formula is verified by a statistical moment analysis using the Lyapunov equations.

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