Excitation Energy Distribution of Measured Walking Forces

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Abstract

For vibration serviceability of floors, current design guidelines propose different force models to represent human walking on structures. Those models have been derived based on many assumptions to simplify the real force induced by human walking. One of those assumptions states that the force is assumed periodic. Other simplification is that the spectrum of the force is assumed to have very low energy beyond a certain frequency limit, hence it can be neglected in that higher frequency region. Those assumptions have been verified and validated over time for conventional floor structures. However, modern floors are slender, made of lightweight materials, and have strong orthotropic properties and low point stiffness. Hence they feature localized higher modes that could be excited even with small amount of energy. In this paper, real walking forces are used to demonstrate the excitation energy distribution over frequency range of 0–60 Hz. A unique database of 852 vertical continuous ground reaction forces (GRF) measured on an instrumented treadmill due to walking is used for that purpose. Excitation energy is calculated by summing the power of the measured force in the frequency domain. It is found that there are considerable amounts of excitation energy well beyond the frequency limits proposed by the current floor design procedures. Boxplots are presented showing the realistic energy distribution which could excite the higher modes of lightweight and slender floors.