Combined Multibody and Finite Element Modeling of Train-Induced Vibrations in Nearby Buildings

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Abstract:

Ground-borne vibrations from passing trains can cause significant discomfort and interruption to occupants of buildings near train tracks. In more severe cases, the vibrations can fatigue buildings components. This issue is particularly relevant in urban settings, where real estate near tracks can be quite valuable due to its proximity to transportation infrastructure, but vibrations could influence the utility.

In this research, we examine the effects of vibrations on passing building using a coupled finite element model and multibody dynamics simulation to quantify vibrations. The finite element model can capture the detailed geometry surrounding the tracks and structure. To improve efficiency, modal information is extracted from the finite element simulation, and mode shapes truncated so that only the nodes associated with the multibody simulation are input into that multibody model. The multibody code can then efficiently capture the train wheel to rail contact as it passes by the structure and determine the vibration of the modes of the surrounding area. The full response can then be reconstructed from the modal response, and accelerations and displacements of structures can be quantified.

We use this technique to quantify vibrations in the nearby buildings (with some calibration), and use then to explore some mitigation techniques for the vibrations, including trenches and barriers.