Study of railway-induced structural vibrations

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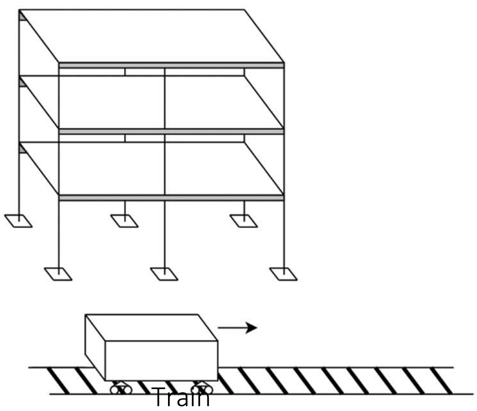
By using state-of-the-art computational methods, vibration levels in a concrete and wooden buildings exposed to railway vibrations can be compared in significantly less time than previous methods. When constructing buildings near railways, the choice of building materials is in part based on the assumption that heavy concrete buildings will have lower vibration levels than lighter wooden buildings. However, it was concluded in the study that a wooden building can experience significantly lower vibration levels in certain conditions. Furthermore, higher energy losses within the buildings can result in higher vibration levels overall.

This work aims to improve the knowledge surrounding how wooden and concrete buildings, respectively, behave when exposed to vibrations caused by trains travelling nearby. By using a newly developed computational framework that include models for a building, soil and railway, several important parameters of the models could be investigated.



Illustrative image of the problem that was examined.

The primary research questions studied were as follows:

- What changes can be made to the model to cause significant differences in vibration levels?
- How does a wooden building withstand traffic-induced vibrations in comparison to a concrete building?
- How does a simple model of the external load compare to a complicated moving train load?

Vibrations in buildings are an important factor to consider when near railways. Vibrations can affect both the mental and physical health of building occupants, as well as sensitive equipment in e.g. hospitals.

When constructing buildings near railways, it is commonly assumed within the construction industry that heavy-weight concrete buildings will perform better than lighter wooden ones.

The scientific evidence for this assumption is however lacking. By running simulations on concrete and wooden buildings using a state-of-the-art computational framework the comparison could be made without the use of supercomputers or costly measurements. A total of 11 different parameters were studied, such as the type of soil, the distance to the track, the speed of the train and the size of the buildings.

It was found that there are several situations in which wooden buildings experience lower vibration levels than concrete ones. For example, when the buildings were placed on a very elastic soil or the building was placed very close to the railway track, the vibration levels in the wooden building were substantially lower than in the concrete building.

Another result of note was found when changing a property of the building known as damping. This property determines how much of the movement energy which is lost to heat. When increasing the damping, and thus increasing the energy losses, it was found that the vibration levels also increased for some frequencies. This result is counterintuitive, as the expected behavior is for higher damping to result in lower vibration levels, which has been seen in another study. This is highlighted as an interesting suggestion for future work.

The studies also showed which properties in a track-soil-building system that had a significant impact on the vibration levels, and which ones that weren't as important to consider.

Master dissertation completed 2024: ***Parameter study of railway-induced structural vibrations*** *- Report TVSM-5268. Supervisor Peter Persson.*