Noise from Wind-Induced Vibrations in a Tall Wood Building

Thesis title: *Wind-Induced Transmission of Low Frequency Vibrations for a Tall Multi-Storey Wood Building*
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How will people be affected by the wind when living in a multi-storey wood building? Will the noise produced be audible, and will the vibrations cause a nuisance for the occupants?

The building industry accounts for a large part of the world's carbon dioxide emissions. At the same time the awareness of sustainable construction and production phase has increased and focus has been directed towards the material wood. Likewise, population growth causes densification of cities, which together with space limitation issues, result in multi-storey buildings being constructed. Specifically, those made of wood are becoming very popular due to the many advantages of this material, e.g. being light, environmental friendly, cheap, etc. However, it also brings along certain difficulties and challenges, specifically some related with vibroacoustic issues. Even if lightweight constructions comply to present regulations, acoustic comfort is sometimes not met and complaints from inhabitants arise.

In this master thesis[1] a 32-storey wood building is modelled to predict noise and vibration created by wind loads at certain floors. The idea is to obtain an indication of what sound pressure levels could occur at a building of this height. The noise is originated from wind, which makes the structure vibrate and thereby propagate sound. Today, there is no existing wood structure of this height and therefore no comparison with measurements can be made. Instead, a modelling procedure to eventually create realistic and time efficient models was developed.

The investigations presented deal with several acoustic phenomena that could occur when wind is acting on the facade and structure. Generally, the procedure of investigating them are time consuming and its accuracy hard to ensure with the prediction tools available today. One of the problems is to understand how the wind will excite the structure. Different wind types and wind spectra will affect the building differently and thus these issues were studied in this master thesis.

The main conclusion drawn from this thesis and for the model considered is that the noise caused by wind-induced vibrations is not exceeding the audible threshold. The thesis presents several parametric tests, and only in an unrealistic case (i.e. too-stiff building as well as absence of dampers and sound insulation) the threshold is exceeded. This concludes that it is unlikely that people will be affected from noise caused by wind-induced vibrations. The sound that people often hear due to noise can come from other phenomena which should be further investigated, for example, due to turbulences, rattling of windows, turbulences due to irregular shapes of the constructions. This is not dealt with in the master thesis.

However, the model in this thesis shows that the vibration levels exceed the guidelines given in the governing norms in the horizontal direction which is one of the main limits.

The proposed method could pave the way towards developing prediction tools of tall wooden multy-storey building at a reduced computational cost. To do so, further calibration against measurements is needed.

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[1] Spjuth, G. Åkesson, L. (2016) Wind-Induced Transmission of Low Frequency Vibrations for a Tall Multi-Storey Wood Building. Faculty of Engineering LTH at Lund