Blasting effects on buildings from the construction of the West Link project

The new West Link railway in Gothenburg is a 20 billion project that is to be under construction from 2018 to 2026. The railway connection is about eight kilometers long, where six kilometers will be built in a tunnel beneath the city of Gothenburg. The tunnel will pass through both rock (four kilometers) and soil (two kilometers), where the rock sections need extensive blasting. The vibrational effects through blasting will affect about 1600 properties, and may cause damages such as cracking and subsidence problems. These consequences are of course of economic nature, but also important from a historical and cultural point as there are old buildings such as churches that could be irreparably damaged.

The effects on properties from blasting are usually evaluated adopting the recommendations presented in Swedish standard (SS 460 48 66). Here various rules of thumb are presented that may be used to foresee the ground vibrational effects nearby a property from an explosion beneath the ground, and how this vibration may affect the property. The Swedish standard presents formulas that are empirical in nature where the influence from various important parameters (blast load, vibration frequencies, ground material parameters, construction properties, distance, etc.) are considered. The fundamentals of these formulas are not well documented. Moreover, the Swedish standard handles the increased vibrational risks on historical buildings in a rudimentary manner. This causes the acceptable vibrational levels from the Swedish standard to be considerably higher than the levels used in many other parts of Europe. As the tunnel will pass beneath city parts with old buildings, it is of special importance to be observant regarding the vibration levels to minimize damages.
These uncertainties call for other, more refined, methods to model the effects from blasting in tunnels. In this project, there are several issues that are interesting to address, for example:

- Derive a 2D FE model that enables prediction of ground vibrations from blasting in tunnels.
- Conceptually describe the effect that different parameters (e.g. rock and ground material, charge weight, distance, etc.) have on the final vibrations.
- Compare these numerical results to experimental results found in literature.
- Analyze and evaluate the methods used in Swedish standard.

The FE code should thus be able to model the effects from the blast load level, the influence from the frequency distribution in the load (10-200 Hz usually of importance), the distance to ground level, the influence of ground material parameters including damping effects, etc. Recommended FE program is Comsol Multiphysics, but other may also be used.

The project is suitable for 1-2 students from MPSEB and/or MPAME.

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