Blast induced waves: Coupling between buildings and ground – West Link project

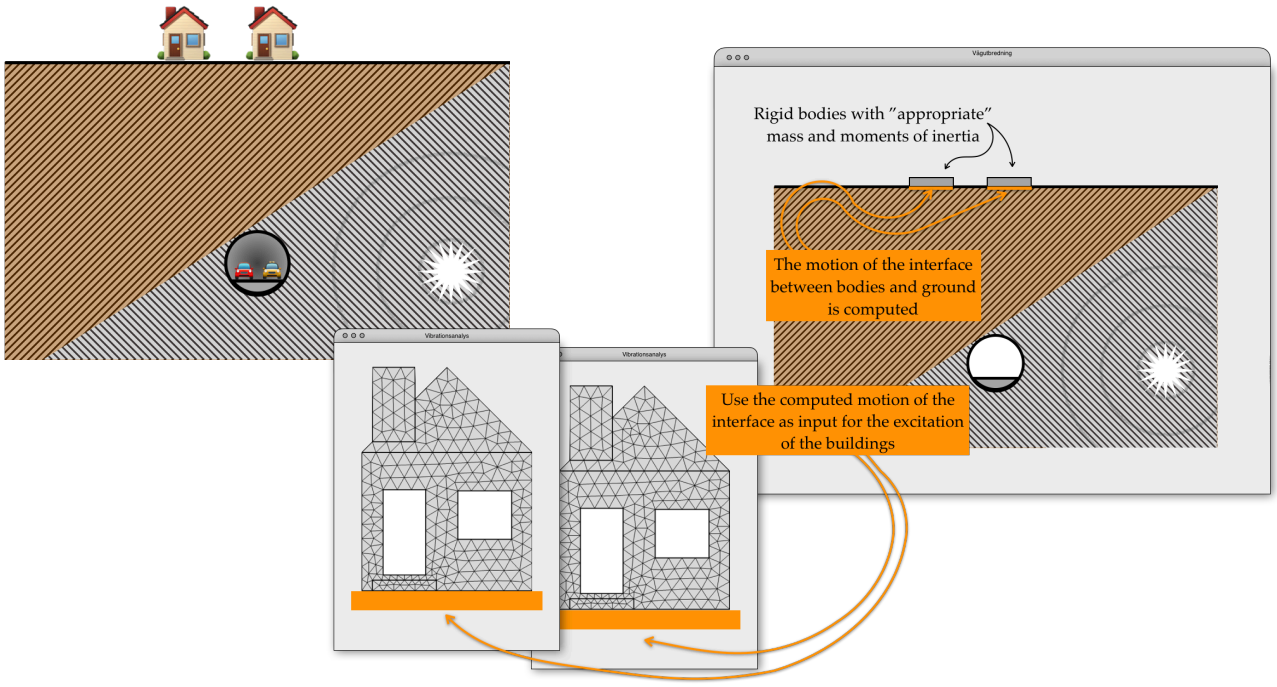
The West Link railway project, involving the construction of roughly 6 km of tunnels beneath the Gothenburg area, is under way. During the construction of these tunnels through both soil and rock, underground blasting will induce ground waves that may potentially cause structural damage to ground level buildings.

Safety bounds on the intensity of the blasts are regulated by a Swedish standard, based on distance and overburden type. However, the formulation of the Swedish bounds differs from those of several international blasting standards. Several actors in the field have expressed an interest in updating the Swedish standard to more realistic guidance levels for vibrations and base this on vibration frequency instead of using levels based on distance and overburden type. To this end, a better understanding of the mechanisms involved in causing structural damage from blast induced ground waves is sought.

At Chalmers, the Department of Architecture and Civil Engineering, Division of Structural Engineering, and the Department of Mechanics and Maritime Sciences, Division of Dynamics, have started a collaboration to shed some light of these mechanism and couplings. In a recent Master Thesis project (”Assessment of the Swedish Standard for blasting induced vibrations,” by Mattis Dahl Eriksson and August Jansson, 2018) the propagation of mechanical ground waves from subsurface explosions was modelled by means of the commercial finite element software package COMSOL Multiphysics™. The influence of various geometric and constitutive configurations of rock and softer soil may be modelled by the approach developed. The present proposal for a Master Thesis project is in some respects a suggested continuation of that project.

In the present project the focus would be on finding out whether it is possible to use simplified models for the coupling between the blast waves in the (soil/rock) ground beneath buildings, and the buildings themselves. If some such simplified model could be shown to work well, it could potentially lead to faster and numerically less demanding strategies for predicting safe blasting levels, thus providing a tool for evaluating any suggested new Swedish blasting standard.

A sketch of a suggested simplified coupling model might look something like this:



In addition to the present suggested Master Thesis project, a proposed parallel Master Thesis project (”Effects on buildings from blast induced vibrations – West link project”) is focussing on the mechanisms of structural damage to buildings, and it is expected that a mutually beneficial flow of ideas, suggestions, and data between that project and the present one is possible.

The present project could in part consist of the following steps:

- Litterature survey.
- A study and implementation of the blast wave model in the previously mentioned project ”Assessment of the Swedish Standard for blasting induced vibrations”.
- Formulation and implementation of some simplified coupling model, allowing for a step-by-step computaion where ground waves are computed in a first step and the structural response in a second step.
- Comparison between the simplified and a fully coupled model FE with repect to results and performance.
- A detailed computation of some significant model case, which might be constructed in cooperation with the parallel Master Thesis project (”Effects on buildings[…]”) and/or possibly be based on experimental test blasting capabilities of The Swedish Transport Administration.

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