Technische Universität München

Ingenieurfakultät Bau Geo Umwelt

Chair of Structural Mechanics

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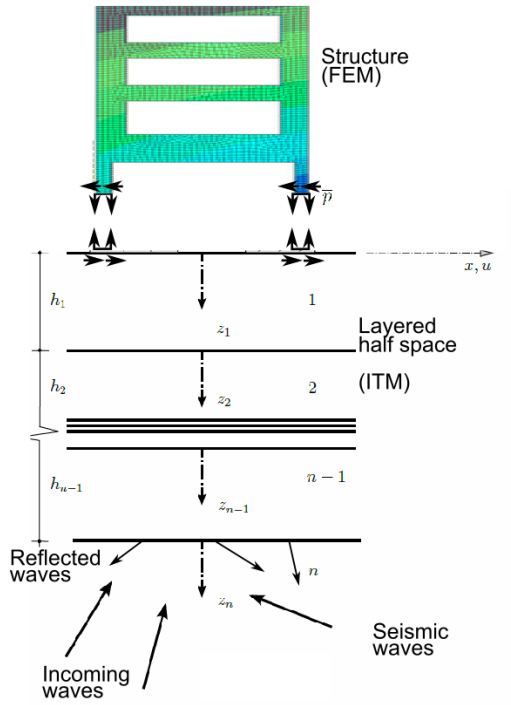
Master Thesis

Seismic soil-structure interaction simulation with the ITM/FEM coupling

Motivation

The assessment of the dynamic soil-structure interaction induced by earthquake in buildings is a challenging task. Due to the infinite boundaries of the soil, the Integral Transform Method (ITM) is an appropriate method, as it provides a semi-analytical solution that fulfills the radiation condition. The finite structure, the building, can be modelled with the finite element method (FEM). For the coupled system, a hybrid ITM/FEM method is used at the Chair of Structural Mechanics. In the current development of the available code, seismic waves propagating from the bottom are not considered. This thesis should fill this gap and extend the method for the simulation of a combination of plane waves propagating from infinite, with different angles and velocities (P- and S-waves).



Lamé´s equation

$$\mu u^i\big|_j^f + (\lambda+\mu)u^j\big|_j^i - \rho\ddot{u}^i = 0$$

BC at the surface

$$\overline{\sigma}_z(z=0,k_x,\omega) = -\overline{p}_z(k_x,\omega)$$

$$\overline{\sigma}_{zx}(z=0,k_x,\omega) = -\overline{p}_x(k_x,\omega)$$

BC at the layer interface

$$\overline{\sigma}_{z_s}(z_s=h_s) = \overline{\sigma}_{z_{s+1}}(z_{s+1}=0)$$

$$\overline{\sigma}_{zx_s}(z_s=h_s) = \overline{\sigma}_{zx_{s+1}}(z_{s+1}=0)$$

$$\overline{u}_s(z_s=h_s) = \overline{u}_{s+1}(z_{s+1}=0)$$

$$\overline{w}_s(z_s=h_s) = \overline{w}_{s+1}(z_{s+1}=0)$$

BC at the n-th interface

Sommerfeld Radiation Condition:

reflected energy at n-th interface

must scatter to infinity

Tasks

The aim of the thesis is the extension of the available ITM/FEM code for seismic simulations. The following tasks represent the thesis-steps:

1) Understanding of the available ITM/FEM code (Matlab+Ansys)
2) Solution for a single vertical harmonic plane wave propagating from infinite
3) Solution for a single horizontal harmonic plane wave propagating from infinite
4) Solution for a single inclined harmonic plane wave propagating from infinite
5) Solution for an arbitrary combination of inclined harmonic plane waves propagating from infinite (complete seismic event)
6) Demonstration of use with the aid of a real case study

[1] Müller G, Buchschmid M, Taddei F. Lecture Notes of the Course of Soil Vibrations, TUM, 2016.

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