

Time history dynamic analyses of geotechnical structures



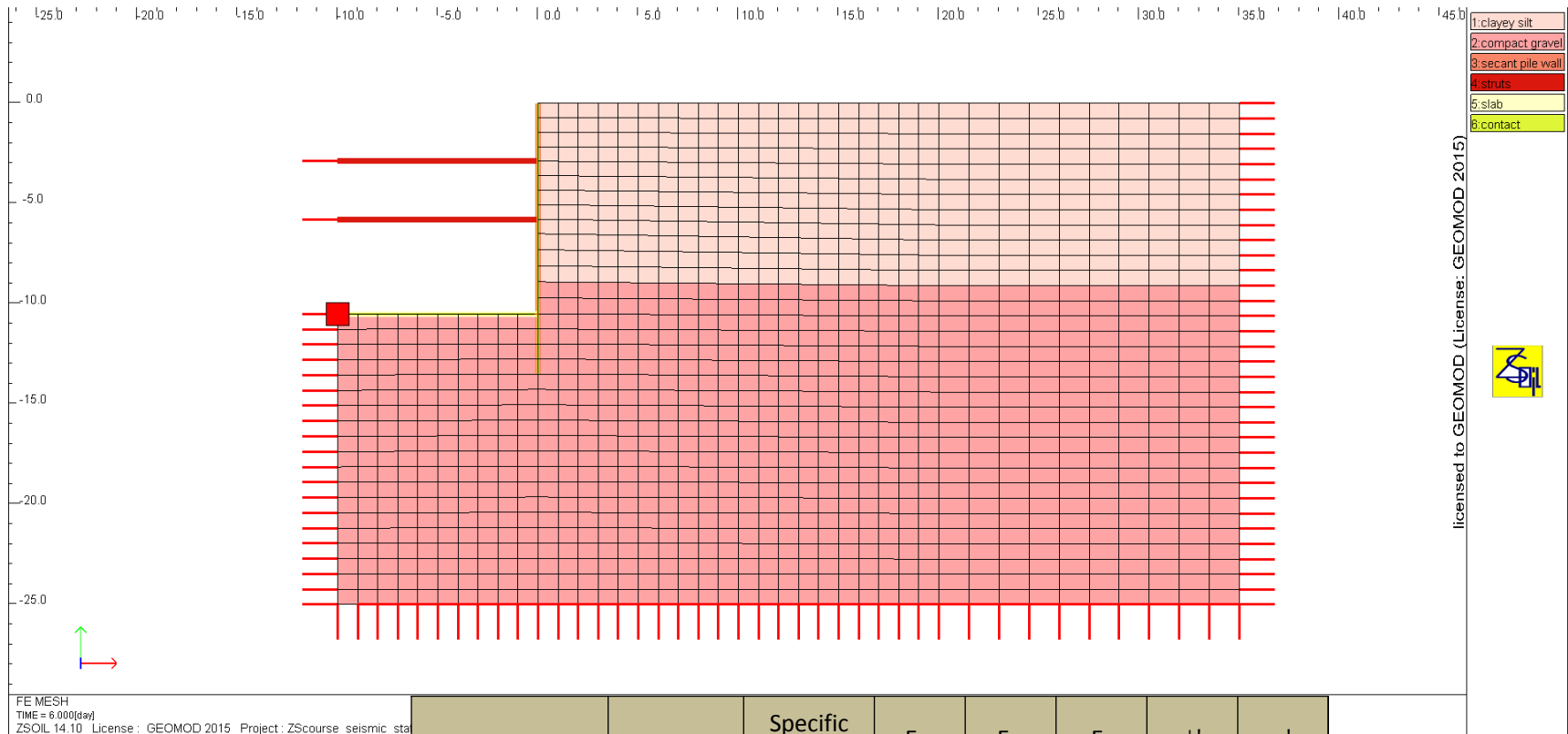
Matthias PREISIG
GeoMod SA, Lausanne

2015

Analysis procedure

- Static problem
- Free-field column
 - Extract from static problem
 - Validate spatial discretization
 - Periodic BC's
 - Apply seismic motion
 - Specify dynamic analysis parameters/drivers
 - Check response spectrum
- Adapt static model for dynamic analysis:
 - Duplicate by symmetry
- Analyze results
 - Validate qualitatively
 - Extract time histories
 - Response spectrum

Static problem: Retaining wall



FE MESH
 TIME = 6.000(day)
 ZSOIL 14.10 License : GEOMOD 2015 Project : ZScourse seismic sta

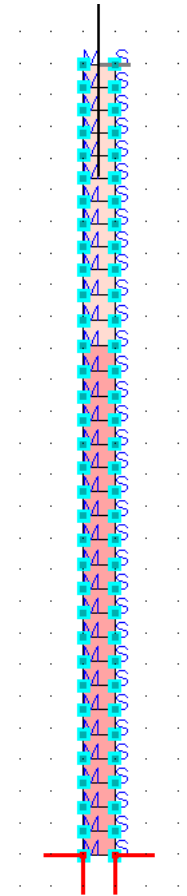
Name	Constitutive model	Specific density	E_{50}	E_{ur}	E_0	ϕ'	c'
		[kN/m ³]	[MPa]	[MPa]	[MPa]	[°]	[kPa]
Clayey silt	HSS	21.5	20	60	200	28	10
Compact gravel	HSS	23.5	100	300	1'000	35	0

Free-field column

- Extract from static problem
- Check discretization:

$$V_s = \sqrt{\frac{G_0}{\rho}} = \sqrt{\frac{E_0}{2(1+\nu)\rho}} = \sqrt{\frac{200e6}{2.4 \times 2150}} \text{ m/s} = 197 \text{ m/s}$$
$$\Delta h < 10 = \frac{v_s}{10 \times f_{max}} = \frac{200}{15 \times 10} \text{ m} \cong 1.3 \text{ m}$$

- Apply periodic BC's



Free-field column

- Estimate fundamental period of layer:

– Soft layer only:

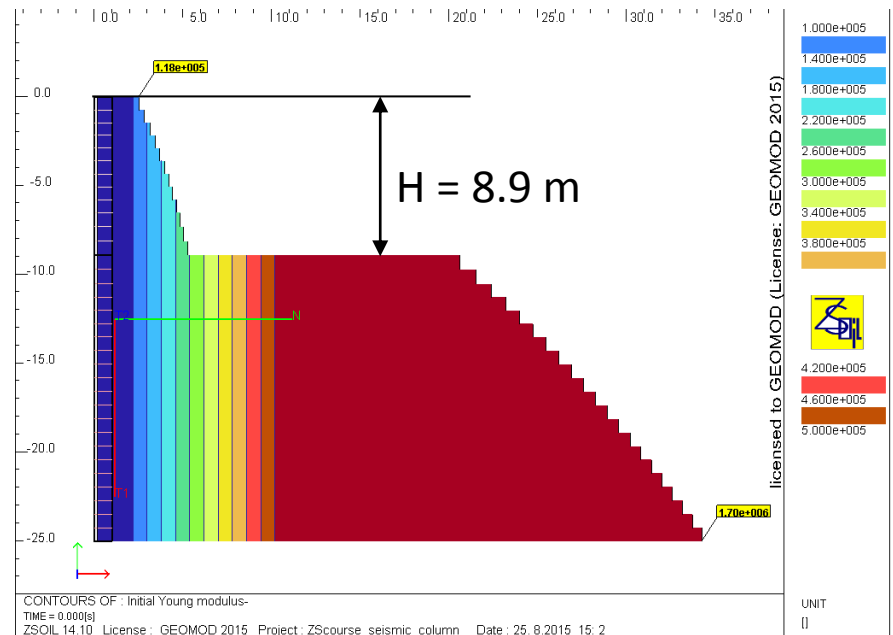
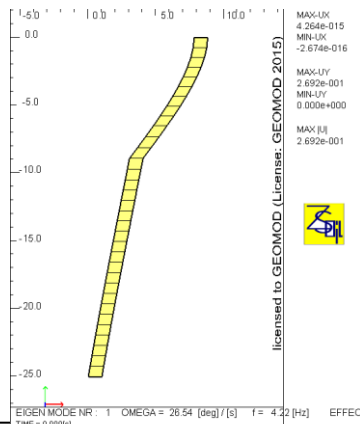
$$E_{0,\text{mean}} \approx 200 \text{ MPa}$$

$$v_s = 200 \text{ m/s}$$

$$T_0 = 4H/v_s \approx 0.18\text{s}$$

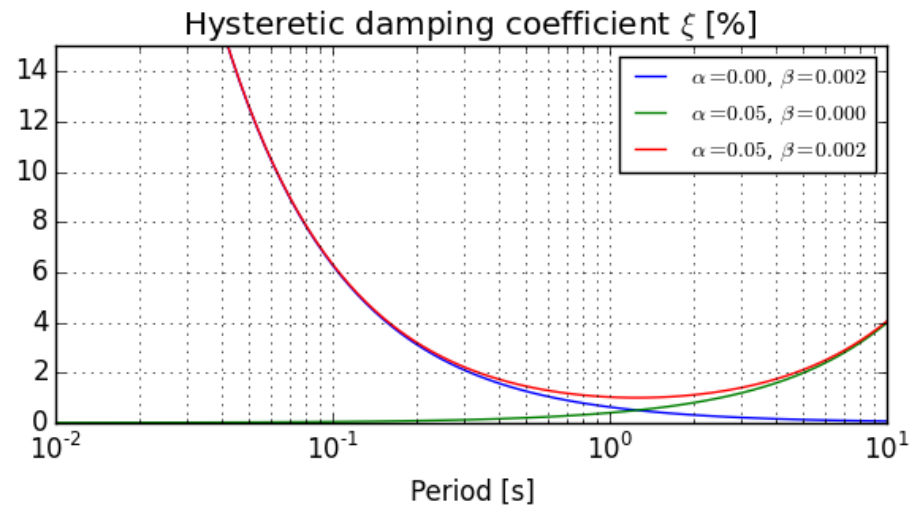
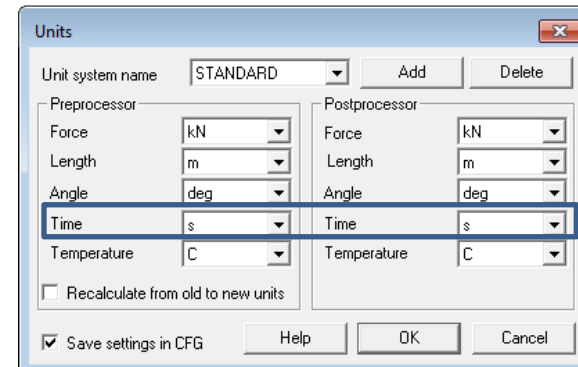
– Eigenvalue analysis:

$$T_0 = 0.24\text{s}$$



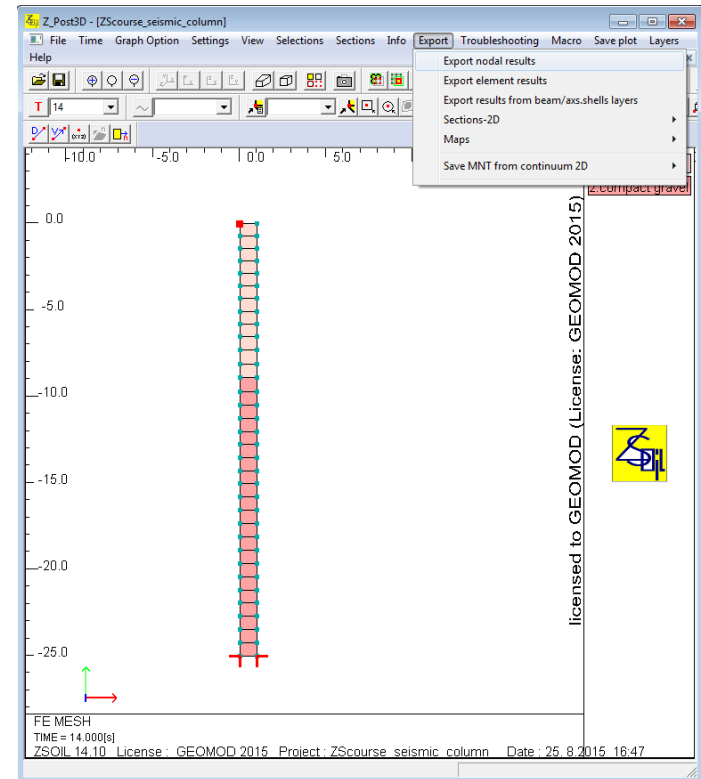
Free-field column

- Change units to seconds
- Select and edit acceleration time history -> acc01.ear, scale by 0.1
- Driver:
 - Rayleigh damping:
e.g. $a_0 = 0.05$, $b_0 = 0$
(slightly damps long periods)
 - Algorithm: HHT
(numerical dissipation at high frequencies)



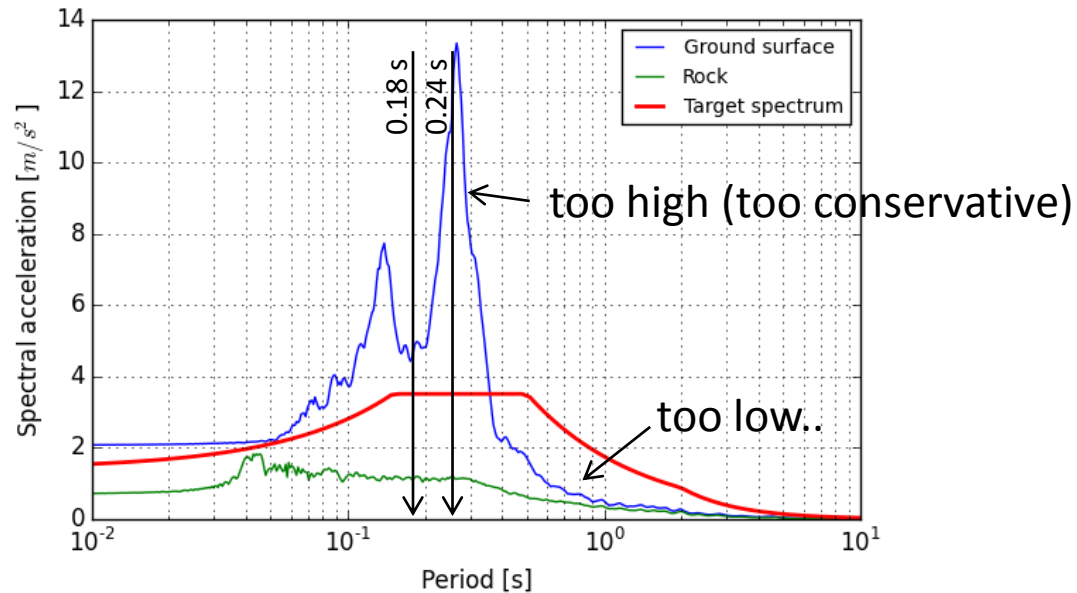
Free-field column

- Run calculation
- Extract acceleration time histories at base and ground surface
- Compute response spectrum, using e.g.:
 - Interactive program (Windows): <http://sem.inha.ac.kr/prism/>
 - Matlab: <http://www.vibrationdata.com/python/srs.py>
 - Python: <https://github.com/arkottke/pyrotd>



Free-field column

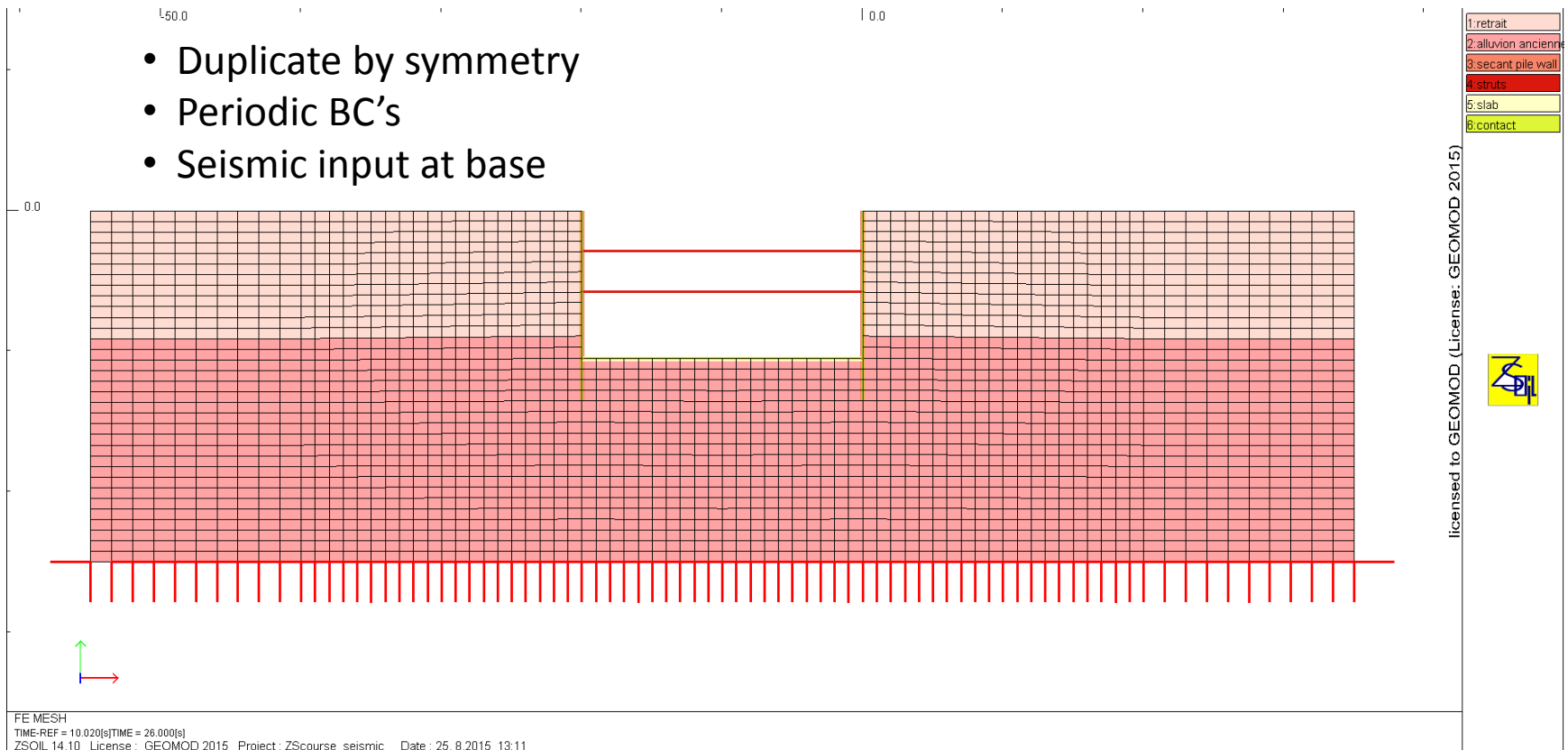
- Verify spectrum at ground surface with demand spectrum



-> Selection of appropriate input motions is crucial!

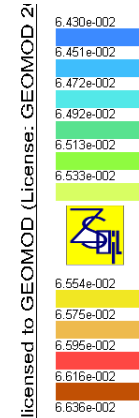
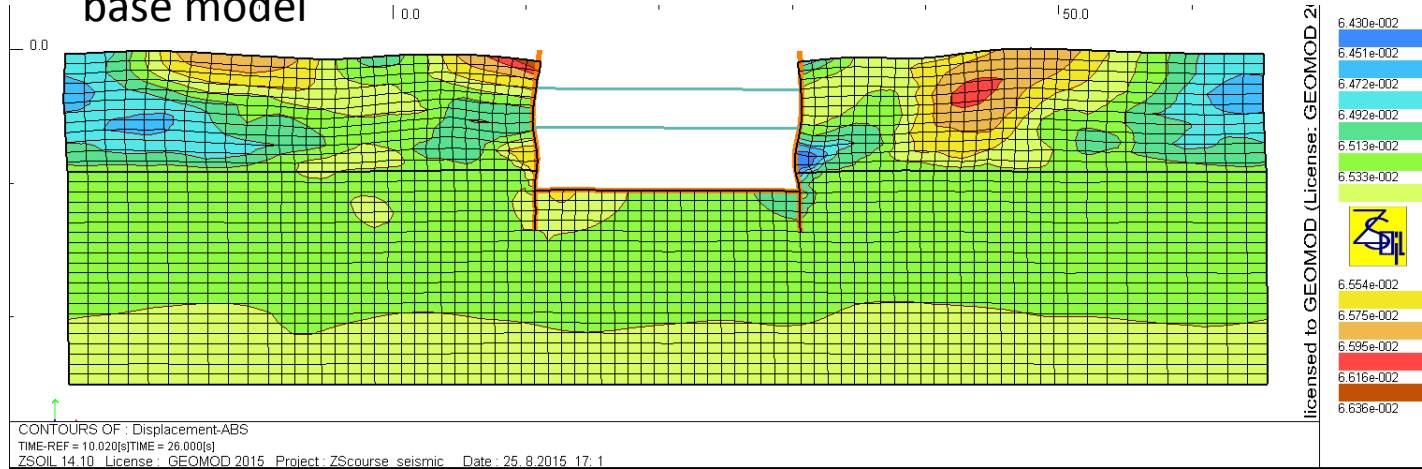
Adapt static model

- Duplicate by symmetry
- Periodic BC's
- Seismic input at base

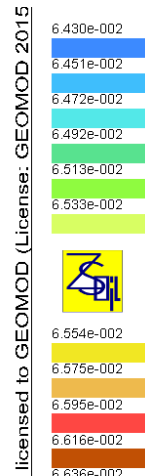


Validation of results

base model



validate with larger model



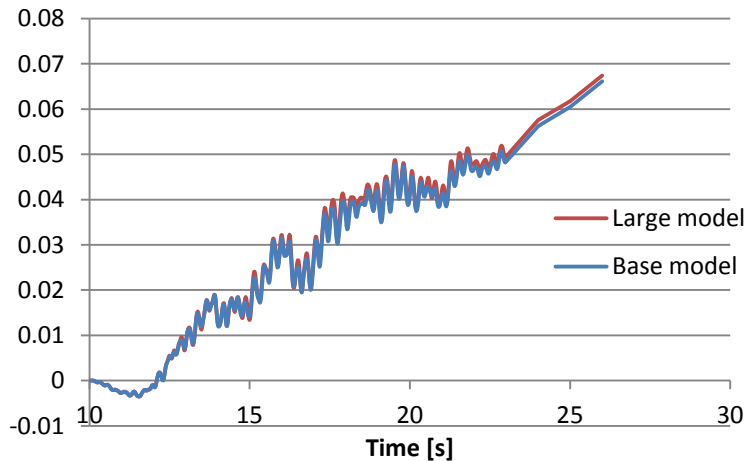
- > looking for absence of:
- boundary effects
 - non-physical behavior

Validation of results

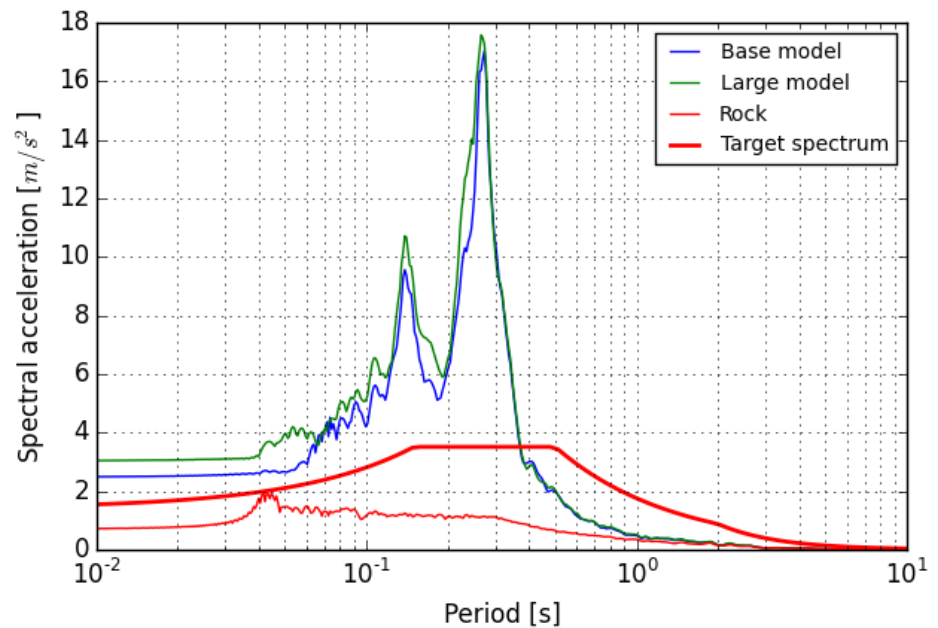
Compare e.g. displacements:

- Export nodal results
- Plot graph in Excel

Horizontal displacement at top of wall [m]



Compute response spectrum at ground surface



Validation of results

