A study on the modal properties of sediment on base rock

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Introduction

The study of the ground behavior cannot only give an insight on the structure of the ground bus also on the expected impacts of an earthquake. Being able to estimate the structure using non-destructive methods is useful in different areas of interest in civil and geological engineering.In this research the objective was therefore the identification of the boundary shape of a two-layered media from an output-only system. In order to assess its feasibility though, a parameter study on a known input-system is conducted.

Models

The modelled area and its parameter can be seen in fig. 1. It is modelled using the finite difference method (FDM).The FDM is a numerical method for solving differential equations. The area of interest is discretized into a grid with connecting nodes and simple properties.In this first estimation, only the SH-wave, a elastic body shear wave in horizontal direction,is considered. In total 5 different shapes and depths and 6 different velocities of the sediment layer, as well as some special cases, are considered, resulting in over 60 models whose singular value power spectrum density (SV PDS) and the first 4 eigenmodes are compared.

The SV PDS and the modal parameters were calculated using the frequency domain decomposition (FDD) method. In the FDD method, assuming white noise input, the solution becomes independent from the input. Its formulation is similar to the singular value decomposition, which allows for estimating the eigenfrequencies through peak picking. The similarities also allow for estimation of the mode shapes.

Results

Comparing the results of the parameter study, some clear regularities can be seen. As visible in fig:2 (mode 1), an estimation on the ground shape can be seen. While the mode shape of a triangular sediment layer is independent on the wave velocity, this is not true for a more rectangular shape. By comparing the SV PDS, some estimates about the shape, wave velocity and depth can be stated, which can be confirmed and enhanced by evaluating the modal shapes as well.

The peak frequencies belonging to the eigenfrequencies can be seen in fig.3. There seems to be a correlation between the frequencies. Further investigation and quantification seem to be fruitful.

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Conclusion

It could be shown, that a rough estimate of the ground structure from the modal parameter is possible. The estimation will be more certain when comparing it to a before acquired large database. It is important to keep in mind, that real ground conditions do not show that clear shapes, homogeneity and distinction between the layers.

Further study and quantification of the relationship is advisable.

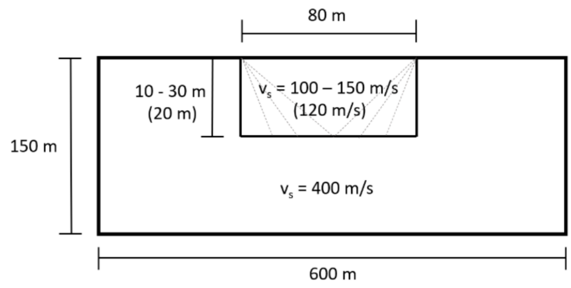

Figure 1: Model representation

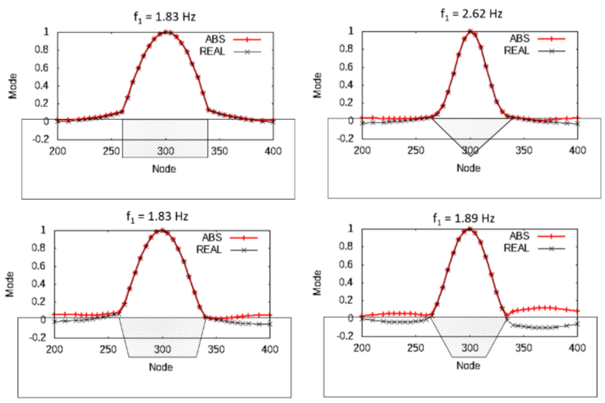

Figure 2: Mode 1 (v_s = 150 m/s, h = 20 m)

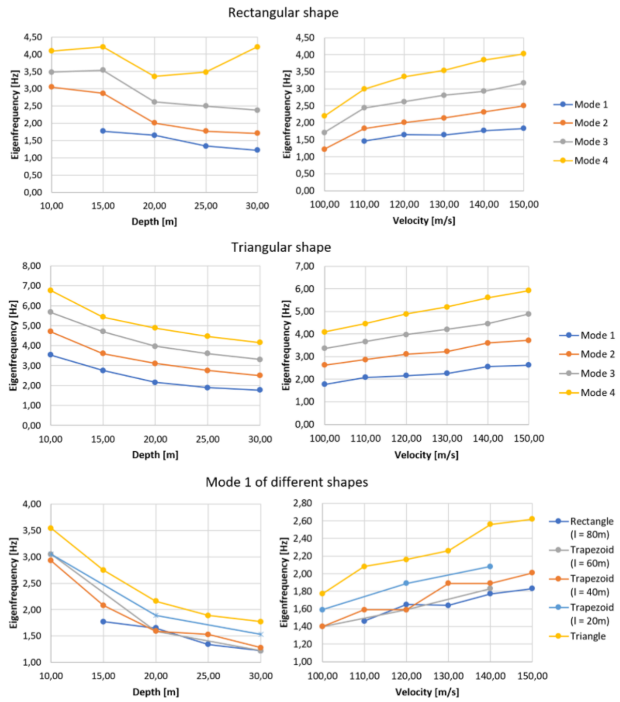

Figure 3: Visualisation of Eigenfrequencies

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