2019 EAGE ANNUAL
81ST CONFERENCE + EXHIBITION
LONDON | THE UNITED KINGDOM

WS02_05

Seismic Inversion for Geotechnical Problems

R.T. Klinkvort[1]*, G. Sauvin[1], M. Vanneste[1], M.E. Vardy[2], C.F. Forsberg[1]

[1] Norwegian Geotechnical Institute; [2] SAND Geophysics

Summary

For foundation design the geotechnical analyses and interpretations often rely on isolated 1D boreholes and the geophysical data is only used to confirm horizontal layering. The great amount of information capture in the geophysical data, not only related to layering but also related to soil parameters, are therefore not used. Geophysical data are collected in 2D lines and/or 3D volumes and therefore provides the natural link to re-populate geotechnical properties found in the 1D boreholes onto a larger area and thereby build a consistent and robust ground model. There is therefore a great potential in using this data in a quantitative way during all phases of a project.

Seismic inversion for geotechnical problems

Rasmus T. Klinvort, Guillaume Sauvin, Maarten Vanneste, Carl Fredrik Forsberg, NGI Oslo, Norway

Mark E. Vardy, SAND Geophysics, Southampton, UK

For foundation design the geotechnical analyses and interpretations often rely on isolated 1D boreholes and the geophysical data is only used to confirm horizontal layering. The great amount of information capture in the geophysical data, not only related to layering but also related to soil parameters, are therefore not used. Geophysical data are collected in 2D lines and/or 3D volumes and therefore provides the natural link to re-populate geotechnical properties found in the 1D boreholes onto a larger area and thereby build a consistent and robust ground model. There is therefore a great potential in using this data in a quantitative way during all phases of a project.

This presentation will discussed the use of seismic inversions but from a perspective of a geotechnical engineer. The focus will be on the prediction of geotechnical properties and associated modelling uncertainties and how this can be used throughout the development of a project.

The publically available data from the Holland Kust Zuid wind farm site in the Dutch sector of the North Sea is here used as an example of how different methods can be used. Together with good colleagues we have developed a workflow to build quantitative ground models following three approaches: (i) a geometric model in which the seismic data interpretations guide the prediction of geotechnical properties; (ii) a geostatistical approach in which in addition to the structural constraints, we used the seismic velocities to guide the prediction; and (iii) a multi-attribute regression using an artificial neural network (ANN). The result of the workflow yields maps or sub-volumes of geotechnical or geomechanical properties across the development site that can be used in further planning or engineering design.

In this study, we use the tip resistance from a CPT as an example. The tip resistance derived using all methods generally give good results. Validation against randomly selected CPT shows good correlation between predicted and measured tip resistance. The ANN performs better than the geostatistical approach. However, these two approaches require good data quality and a rather large dataset to be effective. Therefore, using a global dataset not restricted to the Holland Kust Zuid site may improve the prediction. Moreover, using existing empirical correlation and calibration through laboratory testing or by training another ANN model, the geotechnical stiffness/strength parameters such as angle of friction or undrained shear strength could be derived.

The presentation will discuss following points:

- What is a quantitative ground model
- Planning your geophysical and geotechnical site investigations and establish ground model
- Early phase development, use you ground model to guide your site Investigation
- Early phase development, use the ground model to determine foundation concept
- Update ground model and make optimal foundation design