VETENSKAP OCH KONST
KUNGL TEKNISKA HÖGSKOLAN

# Driveability studies of vibro-driven model piles in non-cohesive soils

## - laboratory simulations

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# SUMMARY

This thesis deals with the study of driveability and dynamic soil resistance of vibratory driven sheet piles in non-cohesive soils. The primary objective of this study has been divided into two parts; a literature survey and an experimental part.

A survey of previous research has been accomplished by a reported literature survey concerning driveability and bearing capacity of vibro-driven piles and sheet piles, *Viking (1997)*. This survey has revealed the importance of the three principal factors such as vibrator parameters (driving force, bias mass, driving frequency), sheet pile parameters (clutch friction, lateral flexibility) and soil related parameters (relative density, layers of different densities, degree of saturation, lateral stresses, content of fines), which are related to the complexity of predicting the driveability. The understanding of how these parameters affect the derivability are still rather limited due to the complexity of the problem.

The literature survey has resulted in an enhanced understanding of the most important factors influencing the driveability. The conducted survey has also revealed that a better prognostication of the driveability mainly comes from a better assessment of the dynamic soil resistance forces, i.e. a better knowledge of the magnitude of the shear strength reduction of the soil during driving. Studies up to date concerning mechanisms behind the shear strength reduction of the soil show that partial liquefaction together with the volume change characteristics of the sand, are the two main soil parameters that influence the driveability significantly.

The experimental part of this thesis was conducted in order to study and to verify the existence of the fundamental volume changes taking place in the soil surrounding a sheet pile shaft and to analyse the consistency of the experimental hypothesis. To achieve the experimental objectives, a model pile and a test cylinder were constructed. The model pile was attached to a vibrator and allowed to slide through the sand filled test cylinder, in order to simulate a vibro-driven sheet pile. The shaft area exposed to the soil was held constant by using a steering case in the bottom of the test cylinder. The pile was driven at a frequency of about 20 Hz in a dry single graded washed quarts sand. This experimental set-up made it possible to isolate the problem, to study the dynamic shaft resistance and the influence of induced volume changes in the sand by the vertical motion. The only soil parameter which was varied the initial relative density of the sand. The hypothesis was that volume changes took place causing arching at a distance from the shaft, with a decrease of normal stress acting along the shaft as a consequence. The hypothesis has been tested by studies of; *(i)* volume changes in the sand surrounding the shaft at different radial distances and at different depths, before and after vibro-driving using a vane probe; *(ii)* changes of the dynamic shaft resistance characteristics during driving, by digitised time histories of dynamic shaft resistance and displacement records; *(iii)* static shaft resistance characteristics before and after vibro-driving, in experiments by performing small scale laboratory tests.

The conducted driveability studies have resulted in a better understanding of the influence of the soil parameter relative density on the dynamic shaft resistance. The analysis of the tests confirms the reduction of the dynamic shaft resistance versus the static counterpart, however it has not been able to verify the hypothesis of induced volume changes believed to significantly affect the driveability.