A Study of Time Effects on Pile Capacity

Presentation for YGEC 31. May 2010

NGI

Agenda

- Introduction
- Participants
- Test Sites
- Testing arrangements
- Load Testing program
- Factors contributing to Time Effects
- Previous Work on Time Effects on Pile Capacity

Introduction

- Main objective of this R&D project is to establish practical design procedures that account for effects of time on bearing capacity of piles

- Five different test sites with different ground conditions are established for execution of pile load tests

Introduction - Motivation

- None of the present design methods or codes account for the potential gain in pile capacity after the normal set-up or re-consolidation period
- Pile tests after normal set-up show extremely low capacity for piles in low plastic clays
- Many piled structures (bridges and offshore structures) will first experience their full design load until ½ to 2 years after pile installation, wheras full re-consolidation is normally reached within 2-3 months
- Many structures may warrant upgrading and needs to accommodate larger loads after some years of operation
- Removal of pile foundations warrants realistic assessment of capacity at time of removal

Introduction - Objective: Establish practical design procedures that account for effects of time on bearing capacity of piles

Sub-objectives:

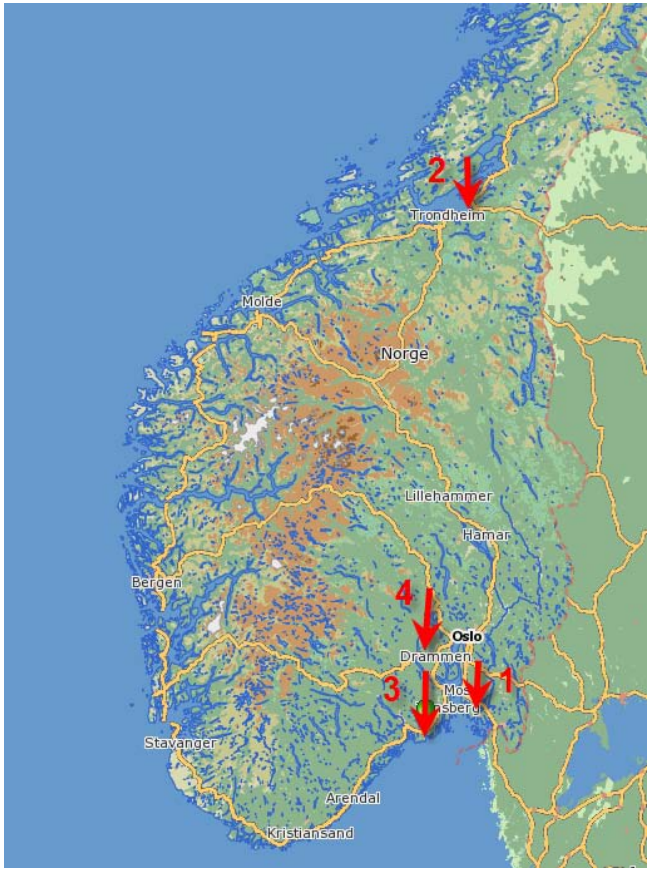
- Establish state-of-the-art on time effects on pile bearing capacity
- Perform new pile load tests in the field, with specific focus on time effects
- Develop new design procedures
- Disseminate results to ensure that they get incorporated into national and international design guidelines and codes

The participants role in the project

- The Research Council of Norway- financing
- Multiconsult acts as the Project Owner and formal contract partner against the RCN on behalf of the participants
- NGI is Project Responsible with overall responsiblity for all technical activities and liasson with participants
- Participants are:
    - Companies that both contribute with technical support for execution of the projects tasks and funding
    - Or industry partners that primarily contribute with funding

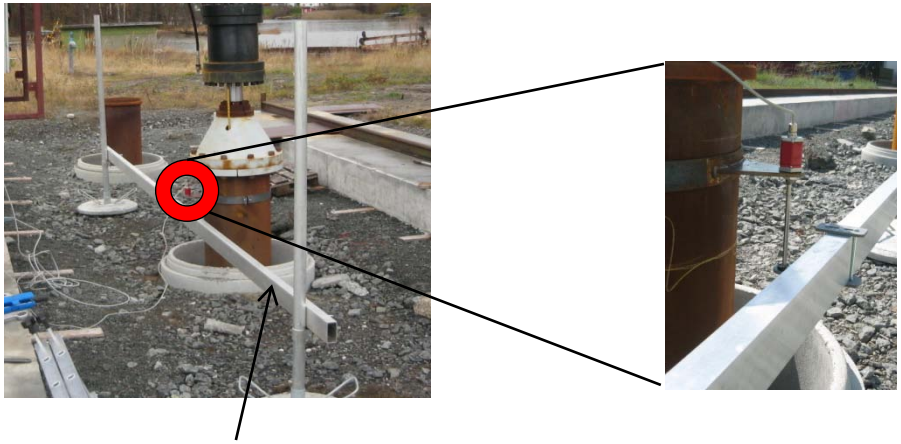
Test Sites

	Site	Type of soil
1	Onsøy	High Ip-NC clay
2	Stjørdal	Low Ip-NC clay
3	Larvik	Loose fine sand
4	Ryggkollen	Dense medium to fine sand
5	Cowden, UK	Low Ip OC clay (Glacial till)

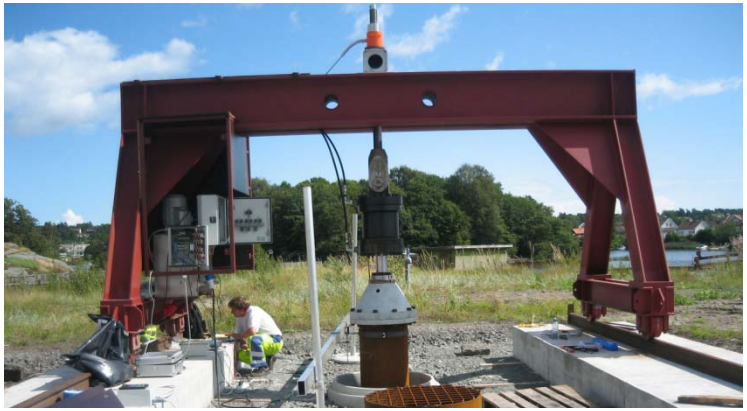


Testing Arrangements

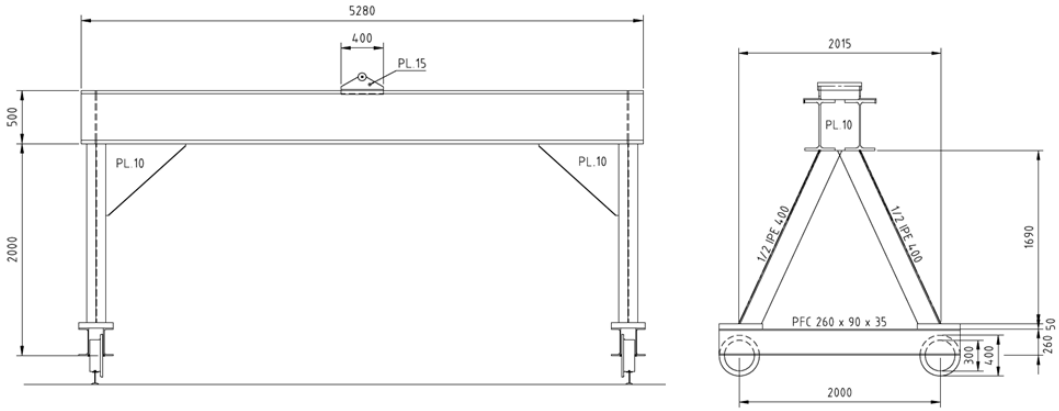
- 6 test piles at each site
- Tubular steel piles with diameter of about 40-50 cm and length 19-25 m
- One pile at each site is instrumented with earth pressure sensors
- Displacements at the pile top are measured with LVDT displacement transducers mounted to a reference beam



Testing Arrangements - Loading Frame



- Piles are loaded in tension
- Loads are applied though hydraulic cylinder using a specially designed actuator
- The same equipment is used to apply maintained load over 2 year period on one pile



Load testing program at each site

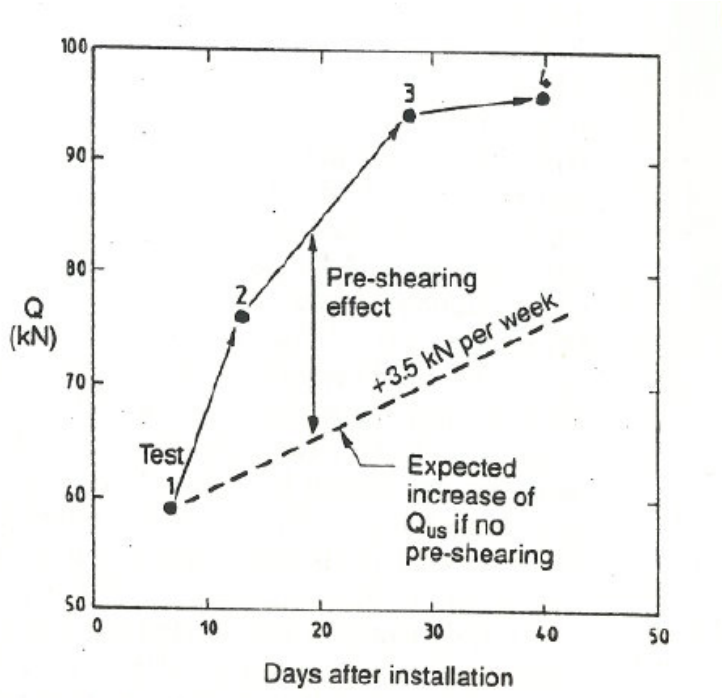
Pile No.	1(2) Month	3(4) Months	6 Months	12 Months	24 Months
1	x	x	x	x	x
2		x	x	x	x
3			x	x	x
4				x	x
5					x
6		x	Sust. at 60%	Sust. at 60%	x

Factors contributing to time effects

- Long term increase in earth pressures against the pile surface due to creep of the soil structure.
- A long-term build up of new diagnetic bonds between soil particles
- Chemical bonding due to the interaction between the steel pile surface and the soil minerals (cation exchange)
- The effects of sustained loads on the piles, gradually causing a more stable soil structure and increased strength
- The effects of previous loading and unloading cycles of the piles, which can have a similar effect as sustained loading

Some Previous work on Time Effects on Pile Capacity

- Haga-Piles – *Axial Static Capacity of Steel Model Piles in Overconsolidated Clay*



Effects of several load test on Capacity of Haga Piles

Some Previous work on Time Effects on Pile Capacity

- The Oromieh case - *Evidence of Long Term Aegeing Effects on Pile Capacity of Piles in Soft Clay*

  - Two Piles – 1 new and 1 old (innstalled 15 years earlier)
    The two piles have different diameters and length

  - Piles were loaded incrementally and subjected to an unloading and reloading sequense after failure was first approach

  - Pile that had been in the ground for 15 years (without carrying any loads) showed 2.3 times the skin friction of the new test pile installed in 2002.

Results

Results are at this time classified and will be published as soon the project is finished.