CONOCO TENSION PILE

CNRD 13-1

NTH comments submitted
to CONOCO NORWAY, INC.
through Det Norske Veritas

0.81.16

NTH, sept. 1981

UNIVERSITETET I TRONDHEIM
NORGES TEKNISKE HØGSKOLE
INSTITUTT FOR GEOTEKNIKK
OG FUNDAMENTERINGSLÆRE

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EXTRACT:

This report contains the NTH comments on the Tension Pile Planning Study CNRD 13-1.

NTH recommends greater emphasis laid on the site investigation and subsequent laboratory tests (cyclic triaxial and simple shear). The permanent tensile pile load should be closer simulated on the large diameter pile.

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PREFACE

Current practice in pile design of tension piles can be greatly improved through a better knowledge of the pile-soil interaction. If carrid out, the CONOCO Tension Pile project will form an important and most needed contribution to an improved understanding and a more confident design.

An overall evaluation of the project leaves an impression that the crucial point may be to link the pile-model segment and large-diameter pile tests to basic soil parameters describing stiffness, strength and dilatancy. We therefore strongly recommend to enforce the site investigation and soil reference. This also includes soil parameters describing repeated loading (cyclic) behaviour.

SCOPE OF WORK

Aug. 1981 Det Norske Veritas assigned the Geotechnical Division at the Department of the Civil Engineering at the Norwegian Institute of Technology to carry out consultance work on project CNRD 13-1.

Information made available to NTH so far is:

ERTEC reports:

1. INTERIM TECHNICAL REPORT (CNRD 13-1)
   Tasks 1, 2, 4 & 6 dated June 16, 1981
   Received Sept.3, 1981.

2. DRAFT 8/21/81
   FINAL TECHNICAL REPORT (CNRD 13-1)
   Dated Aug. 28, 1981
   Received Sept. 9, 1981.

DNV reports:

3. VERITAS report no.80-0587
   Interim report dated July 20, 1981
   Received Sept. 3, 1981.

4. VERITAS report no.81-0587
   Final report dated Aug. 28, 1981
   Received Sept. 9, 1981.

Attended meetings:

Aug. 20, 1981 DNV, NGI & NTH
Project presentation by Kvalstad

Sept. 9, 1981 CONOCO, ERTEC, DNV, NGI and NTH
Information on the project.

In the Sept. meeting NGI and NTH were invited to comment on the project proposal.

Basically CNRD 13-1 consists of

1.	Literature survey	ERTEC/DNV
2.	Selection of analytical methods	"
3.	Site investigation planning	ERTEC
4.	Laboratory test planning	DNV
5.	Field test planning	ERTEC

The NTH comments following, are grouped in this order regardless of the subject numbering used in the ERTEC and DNV reports.

1. LITERATURE SURVEY

NTH comments:

a) Soil stresses set up during pile driving may be fairly temporary. The influence on long term pile behaviour should not be underestimated.

b) Most of the formulas predict the same ultimate friction values for compression and tension piles. This does not hold for long term (drained) conditions.

c) $K_0 = (1-\sin\phi) = \tan^2 (\frac{\pi}{4}-\rho_0)$
describes the stress increment ratio $\frac{\Delta\sigma_3'}{\Delta\sigma_1'}$ in shear tests with no lateral strain ε_3. Under limited conditions (normally consolidated attractionless soil, horizontal terrain) K_0 may also describe the principal stress ratio $\frac{\sigma_3'}{\sigma_1'} = \frac{\sigma_h'}{\sigma_v'}$
However, K_0 does not properly describe the stress ratio $\frac{\sigma_h'}{\sigma_v'}$ when the horizontal and vertical planes no longer are principal planes adjacent to a loaded pile.

2. SELECTION OF ANALYTICAL METHODS

Computer-based methods are chosen. Comments can not be made with present documentation.

In addition methods intended for short hand estimates should be of great value.

(NTH will also utilize own methods of predictions).

3. SITE INVESTIGATION PLANNING

Site investigation is planned to be performed through:

a) One CPT
b) Soil sampling with push sampler
   23 samples dia 3" length 2'
c) Field vane tests, 7 levels
d) Lab.tests
   Atterberg limits, oedometer, triaxial and simple shear tests.

NTH remarks:
The objective is:

A. To produce "standard" soil parameters as reference to current design practice.
   These parameters may preferably be of current offshore type and quality.

B. To produce high quality "basic" soil parameters to enable a best possible understanding of the model pile and field tests.
   Has the use of onshore equipment been evaluated? (NGI/NTH are scheduled to perform site investigations at 15 m waterdepth this fall. Standard onshore equipment will be used).

a) CPT: cone resistance, pore pressure and sleeve friction should all be recorded. Standard cone geometry is highly recommended.

b) Samples: A piston sampler may deliver less disturbed samples. The number of samples should be increased to at least 50 to cover DNV request and a more ambitious lab program.

c) Field vane: NGI commented on this in the Sept. meeting.

Moreover NTH suggests at least 4 multistage cyclic triaxial tests in addition to the ERTEC proposal. The tests may be run where feasible (NTH could run them for nkr.5000.- each). NTH would appreciate to take part in the test planning.

4. LABORATORY TEST PLANNING

The DNV lab.program consists of

a) Model pile tests
b) Triaxial tests
c) Torsional simple shear tests

NTH comments:

a) Static and cyclic t-z curves in the model pile test may be effected by soil disturbance, imperfections in simulation of stress and strain fields and scaling effects. However, the importance of these possible effects are not known beforehand. Even if these effects should be greater than expected, the tests can be interpreted for their own being by the analytical adjustments of these, provided high quality soil data from triaxial, oedometer and shear tests are available.

b) and c) Test programs are not fixed yet. No comments.

Additional cyclic simple shear tests should be run on request from NGI, preferrably at NGI.

5. FIELD TEST PLANNING

The field tests consist of:

a) segment tests
b) large-diameter pile test

NTH remarks:

a) The segment tests may also suffer from imperfect stress and strain fields and scaling effects. However, the advantage of the in situ testing technique makes these tests highly desireable.

b) The large-diameter pile represents the most ideal simulation. One defect may however be that the pile is unloaded prior to the load test sequences. A constant tensile pile force will unload the adjacent soil which in long term may consolidate to a lower vertical effective stress level. The effect on the soil strength may be small but is on the unsafe side.

This possible effect may be accounted for by applying a constant tensile load on the pile simulating the static boyancy of the TLP, even outside the load test periods.

SUMMARY

As a whole the tension pile planning study project has produced an adequate framework to proceed in. An attempt has here been made to look into the project from outside, and to pin-point possible weak sides. The most difficult part; to establish a rational design philosophy, does not lend itself to comments easily. However, the tension pile project will, if carried out, provide the main prerequisite for success:

Well documented data for a wide geometrical range. The urgent need for characterizing the soil behaviour through an enlarged soil investigation program is underscored.