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TECHNICAL NOTE

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Note no.:	Date:	Distributed by:
FDIV/23-82-04	July 28, 1982	Tore J. Kvalstad

Title:

SUBPROJECT CNRD 13-2 TENSION PILE STUDY

REVISED MODEL PILE TEST PROGRAM

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Summary:

This technical note describes the revised model pile test program as per end of July 1982. The revision has been based on the experience gathered during the first part of the laboratory model test program.

The main factor leading to this revision has been the very low value of the coefficient of consolidation of the remoulded and reconsolidated material used for the model pile test. The measured value during these tests has been close to one tenth of the estimated value on which the original schedule was based. Even though measures have been taken to reduce the consolidation time we have not succeeded in keeping up with the planned schedule.

Other delays due to problems with the instrumentation caused by leakage and accidental overstressing of the electrical cables and some initial adjustments of the mechanical equipment have as well been experienced. We feel, however, that these problems have been solved and to further avoid such delays a second model pile has been designed and is now nearly ready for use.

The revised test program incorporates most of the features of the original program. Reduction of duplicate tests and a concentration on testing of material from the two lower strata is the main difference between the new and the tentative original program.

CONTENT: Page No.

LIST OF TABLES

1. BACKGROUND

The first part of the model pile test programme has been carried out at the geotechnical laboratory at Veritas. The program has till now covered a series of static tests and a series of multistage cyclic tests. A tentative test program comprising in total some 23 tests was outlined in Veritas' "Final Report" of the Planning Study, Subproject CNRD 13-1, see Table 2, page 65 of that report. This preliminary and tentative test program had been based on certain assumptions with respect to the speed with which the testing could be carried out. Our experience so far is that these assumptions were somewhat optimistic and a revision of the program either with respect to the number of tests or regarding the time schedule seems to be required.

In the following a proposal for a revised program and a revised testing schedule is presented together with a summary of our experience so far regarding time requirements for the different stages of the model pile tests.

2. SAMPLE PREPARATION AND CONSOLIDATION

Sample preparation has so far not introduced problems with respect to time needed. However, the consolidation process in the large consolidometer takes considerably longer time than estimated during the planning study. Our estimate was about one week for approximately 90% degree of consolidation based on an assumed value of the cofficient of consolidation in the order of 3 m**2/year

$$\text{Consolidation time} \quad t = \frac{T * H^{**}2}{cv}$$

where, T = time factor equal to 0.8 to 1.0 for 90 to 95% consolidation
H = length of drainage path, about .25 to .30m for consolidometer drained on top and bottom
cv= coefficient of consolidation

giving consolidation time required in the order of 6 to 11 days.

This would allow about 3 tests to be conducted per month and leave sufficient time for modifications to equipment if needed as well as some additional cyclic triaxial and torsional simple shear testing within the time available.

It turned out however that the coefficient of consolidation of the remoulded and reconsolidated material was considerably lower than assumed. Even though measures have been taken to reduce the filter plates in the sample during consolidation the time required is still between 15 to 20 days to achieve about 80 to 90 % degree of consolidation.

We have thus not been able to carry out more than maximum 2 tests per month, and it is in our opinion not desirable to divide the samples by additional filter plates. The rate with which the tests can practically be carried out will thus be maximum 2 per month also for the rest of the test program

3. RECONSOLIDATION AND SET-UP IN MODEL PILE CHAMBER

Reconsolidation of the sample after installation in the pile chamber after application of the relevant vertical and radial chamber presures as well as set-up after pile insertion takes places at approximately the same speed as in the consolidometer. Although drainage is mainly radial the drainage path is of the same order of magnitude. The coefficient of consolidation is probably somewhat lower at the final stress level than in average during consolidation in the consolidometer, and the time factor for 90% degree of consolidation is lower than for vertical drainage.

The time needed for reconsolidation and set up will thus not be considerably lower than for the consolidation in the consolidaometer. In addition the time needed for the pile loading program has to be added. This time will be in the order of 1 to 3 days in general.

4. OTHER FACTORS CAUSING DELAYS

The first trial tests on Drammen Clay material revealed that certain modifications to test equipment and procedures where necessary. And also during the following tests minor modifications to the mechanical equipment has been required, causing delays in the test programme.

One of the main problems with the equipment has been leakage into the instrumented section of the pile through the seals around the normal pressure cell and in one case also through the seal of the upper axial cell. This has caused damage to the instrumentation and has led to down time waiting for repairs to be carried out.

In order to eliminate this type of problem a second pile with somewhat different design of seals has been developed and is at the moment of writing nearly ready for use.

5. FINDINGS OF THE THEORETICAL EVALUATIONS

The findings of the parametric study presently being conducted indicates that degradation of skin friction not necessarily is the main problem to be investigated. The calculated distributions of shear stress along the pile indicates that high static load levels combined with cyclic loading which is generally assumed to cause "cyclic creep" may be equally important to investigate.

Although a first check of the creep behavior carried out during one test indicates that high stress levels are required to cause static creep, and that cyclic loading around a static level of about 33% of the pile capacity shows no significant creep before failure, a relaxation test indicated relative strong reductions in shear stress at constant displacement. We see thus a strong need for clarification of the effects of static creep/relaxation as well as "cyclic creep" effects.

6. PROPOSAL FOR REVISED TEST PROGRAMME

According to the above remarks and comments and with the aim of keeping the laboratory model test program within the time and cost limits agreed upon in the contract we propose to reduce the number of tests somewhat. With the present test rate we expect to be able to conduct 8 to 10 tests in addition to the 8 tests already carried out on West Delta clay from Stratum II and III.

So far a series of static, constant rate of displacement tests and a series of multistage cyclic tests at moderate static load levels have been carried out. These tests include also degradation testing.

We propose to concentrate on evaluation of static creep/relaxation and "cyclic creep" at high static load levels combined with cylic loading during the next series of tests. The following test program is proposed:

- 2 to 3 creep tests on material from Strata II and III
- 4 multistage cyclic tests at .50 and .75 static load level two tests on material from Stratum II and two on material from Stratum III.
- 2 stormloading tests on material from Stratum II and III.

(see Table 1) the major deviation is the elimination of tests on material from Stratum I. It would in our opinion certainly be advantageous if this Stratum could be investigated as well. Nevertheless, we feel that since the major part of the pile capacity will be located to the lower parts of a pile, at least for soil conditions similar to the West Delta site, the data from Stratum I will have less importance compared with the data from the two lower Strata. The revised program is shown in Table 2.

We are also confident that load-displacement and degradation parameters can be extrapolated from the results of the testing of the lower Strata II and III without introducing serious errors in the evaluation of the overall program.

TABLE 1 Preliminary and tentative model pile test program proposed in the "Final Report" of the Planning Study.

Test type	Consolidation stress, kPa	Number of tests	Test details		Comments
Static tests	100 300 500	1 2 1	Constant rate of displacement		Define ultimate static capacity and static t-z curves
			Load level		
Creep tests, multi-stage	100 300 500	1 2 1	.10 .20 .30..... .10 .20 .30..... .10 .20 .30.....		Define creep load, i.e. the load where displacements show a rapid increase
			static load level	cyclic load level	
Multistage cyclic tests	100,300,500 100,300,500 100,300,500 100,300,500	3 3 3 3	.20 .33 .50 .75	.10 .20 .30.. .11 .22 .33.. .12 .25 .37.. .05 .10 .15..	Define cyclic t-z curves as a function of permanent and cyclic load level as well as the effect of the number of cycles
Storm-loading tests	300 300 300	1 1 1	.20 .33 .50	.20 .33 .50	Deformation behaviour under realistic load history

TABLE 2. Revised test program per end of July 1982.(F=Test already finished, N=Test not yet finished)

Test type		Consolidation stress, kPa	Number of tests	Test details		Comments
Static tests	F	300	2	Constant rate of displacement		Define ultimate static capacity and static t-z curves
	F	500	2			
Creep tests, multi-stage				Load levels		Define creep load, i.e. the load where displacements show a rapid increase
	N	300	2	.10 .20 .30....		
	N	500	1	.10 .20 .30....		
				static load level	cyclic load level	Define cyclic t-z curves as a function of permanent and cyclic load level as well as the effect of the number of cycles
Multistage cyclic tests	F	300,500	2	.20	.10 .20 .30..	
	F	300,500	2	.33	.11 .22 .33..	
	N	300,500	2	.50	.12 .25 .37..	
	N	300,500	2	.75	.05 .10 .15..	
Storm loading tests	N	300	1	.33	.33	Deformation behaviour under realistic load history
	N	500	1	.33	.33	