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Title:

CNRD 13-2 TENSION PILE STUDY

REVIEW OF ERTEC'S REPORT NO. 82-200-1, "SITE INVESTIGATION AND SOIL CHARACTERIZATION STUDY AT BLOCK 58, WEST DELTA AREA, GULF OF MEXICO"

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Summary:

REVIEW OF ERTEC's REPORT NO. 82-200-1, "SITE INVESTIGATION AND SOIL CHARACTERIZATION STUDY AT BLOCK 58, WEST DELTA AREA, GULF OF MEXICO."

SUMMARY

The following comments follow the list of content of Ertec's report No. 82-200-1. We have already sent a separate list of questions and comments in connection with the McClelland report on the site investigation. (See Appendix A)

We find Ertec's report to give a excellent presentation of the site investigation as well as the findings of the laboratory work carried out by Ertec and McClelland Eng.. The interpretation of the results and characterization of the soil conditions with respect to pile design calculations gives in our opinion a good basis for predictions and further analysis of the planned segment tests as well as the large scale pile test.

Our comments are mainly pointing out minor errors or details where we believe a further clarification could be of value.

The need for a better knowledge of the existing pore pressure conditions in situ is expressed in the report. Veritas as well as its consultants NGI and NTH think that this point is of great importance and need to be stressed further. There is at present, after the completed site and laboratory investigation, still a considerable degree of uncertainty involved in the interpretation of the maximum past overburden pressure. The need for in situ measurements of the existing pore pressure distribution is obvious and should in our opinion be carried out as soon as possible.

A meaningfull interpretation of the segment test results on an effective stress basis will demand precise values of the pore pressure distribution with depth.

For the segment tests the degreee of set-up (reconsolidation) to be required prior to static and/or cyclic loading should be determined before the test program starts. It may turn out to be difficult to estimate the actual degree of reconsolidation without having more precise pore pressure data. The segment test instrumentation provides for pore pressure measure-

ment by means of a pore pressure transducer. The segment test schedule might be too tight to allow a more or less complete dissipation of the excess pore pressure. The deviations between the laboratory results of Ertec, McClelland and NTH regarding the coeficient of consolidation, c_v, of the West Delt clays were considerable and makes an estimate of the required consolidation time somewhat uncertain.

We recommend installation of a separate string of piezometers to monitor the "free field" pore water pressure without interfering with the tight segment test program.

Comments from Veritas

INTRODUCTION

No comments

TEST SITE SELECTION

- General

No comments

- Geology of the Mississippi Delta Region

The geological description of the Mississippi Delta Area is highly interesting and throws light on the general evolution of the soil deposits in this area. What we feel could possibly be included is a more direct correlation between this general description and the investigated soil profile at the test site, especially the age of and the correlation between the three identified strata I, II and III and the clay strata indicated on Plate 3.

DETAILED SITE INVESTIGATION

No comments

LABORATORY TEST PROGRAM

- General

No comments

- Sample Selection and Preparation

No comments

- Classification Tests

No comments

- Physical Property Tests

No comments

- One Dimensional Consolidation Tests

The test results as summarized on Plate 12A regarding etimation of maximum past consolidation stress does still leave a considerable scatter in the values. It is felt that a prediction of the in situ pore pressure distribution with depth based on these data and on comparisons with measured shear strength vs expected shear strength for hydrostatic pore pressure conditions (i.e. normally consolidated soils) is still afflicted with a considerable degree of uncertainty.

In order to allow a prediction as well as an interpretation of the small scale segment tests on an effective stress basis we strongly recommend measurement of the in situ "free field" pore pressure as soon as possible. This point of view is shared by NGI as well as NTH and we refer to previous telexes and discussions on this matter.

Regarding the coefficient of consolidation for the different Strata there are differences in values obtained by the different laboratories. Ertec's laboratory results show in general a considerably higher c_v-value than obtained from the McClelland and NTH tests. The difference is most pronounced for Strata I and III where the Ertec values are 3 to 6 times higher than the values from the other laboratories.

Prediction of set-up time as well as time required for determination of the in situ pore pressure conditions might thus be considerably influenced by the uncertainty involved in the choice of a representative c_v-value.

- <u>K_0 Triaxial Consolidation Tests</u>

  No comments

- <u>Strength Tests</u>
- <u>Miniature Vane Shear Tests</u>

  No comments

- <u>Unconfined Compression (UC) and Unconsolidated Undrained Triaxial Compression (UU) Tests</u>

  The confining pressures used in the UU tests correspond to the estimated overburden pressure for hydrostatic pore pressure conditions and could thus lead to a slight overestimation of the undrained shear strength in this case where we have excess pore pressures and gassy soils.

- Isotropically Consolidated Undrained Triaxial Compression (CIUC) Tests

  Referring to the stress path summary on Plate 18 we find that 3 out of the 4 CIU tests on CH material (i.e. material from Strata I and III) show a friction angle close to 22^o and just one test touches the 25^o failure line.

  Regarding the consolidation pressures shown on Plates 16,17,18, C-16 and C-17 it seems that Sample 61 has been consolidated at too low a pressure compared with the other tests, and that Sample 37 has been consolidated at too high a pressure. Please check if samples or numbers have been mixed.

- K_o Consolidated Undrained Triaxial Compression (CK_oUC) Tests

  No comments

- K_o Consolidated Undrained Direct Simple Shear (CK_oUDSS) Tests

  On Plate 23 and 24 there is some confusion with thecurve symbols, while Plate 25 shows the correct symbols.

- Comparison of Test Results

  The laboratory investigation has been based on the assumption that the strength could be normalized according to the SHANSEP procedure. We agree with Ertec's comment on the importance of knowing the consolidation pressures when using the SHANSEP procedure, which stresses the need for reliable measurements of the in situ pore pressure.

SITE CHARACTERIZATION

- General Site Conditions

  No comments

- Soil Properties

  Stratum I, II and III;

  We agree with the general description given on Page 27 an 28 and as summarized on Plate 29, which gives a clear picture of the index properties and the distribution of undrained shear strength with depth. What possibly could be added is a summary of effective strength parameters and consolidation parameters (i.e. permeability, compressibility and coefficients of consolidation) as well as some data about shear modulus of the different Strata.

- Stress History

The summary of total and effective stress distributions with depth is in our opinion a best estimate based on the information available at present. It is, however, clearly shown on Plate 12A that a considerable degree of uncertainty has to be taken into account.

Based on our evaluation of the set-up process around the pile segments using an axisymmetric FEM program, the set-up time required to reach 90% dissipation of excess pore water pressure at the pile surface can be considerable and in the range of 2 to 6 weeks for the c_v-values determined by McClelland and NTH. If Ertec's values turn out to be more representative a 90% dissipation of excess pore water pressure could take place within 4 days to 2 weeks. See enclosed Figures 1 and 2.

Our experience from the first model pile tests is in general that the pore pressure increase after pile installation is about 3 to 5 times the undrained shear strength.

In the middle of the planned large scale pile the hydrostatic pressure will be close to 500 kPa. The undrained shear strenth is approximately 25 kPa and the expected pore pressure increase due to pile insertion would then be about 100 kPa.

The uncertainty involved in the estimation of the in situ pore pressure based on the present soil data as indicated on Plate 12A will be of the same order of magnitude as the expected pore pressure increase. It might thus turn out to be difficult to make a judgement of the degree of set-up during the field test.

CONVENTIONAL AXIAL PILE DESIGN ANALYSIS

- General

No comments

- API- Method, Lambda Method, Effective Stress Method and Simplified General Effective Stress Method.

  No comments except that assumed/recommended values for α, β (GESM) and β (Burland) could have been presented directly here.

- Interpretation of Soil Properties and Design Parameters

  We do in general agree with the correction factors applied to the different types of shear strength measurements. However, as remarked previously about the Unconsolidated Undrained Triaxial Compression Tests we believe the confining pressures were somewhat high. This seems to lead to a comparatively higher shear strength than the interpreted average shear strength profile (Plata 30) except for the upper meters of the profile. A correction factor of 1.10 for these tests could be too high.

  The unit skin friction distribution curves on Plate 31 represents well founded estimates. The α-factor for the API profile has been taken as 1.0 along the total pile length and represents thus the absolute maximum allovable skin friction according to these rules.

  The β-factor for the General Effective Stress Method (GESM) has as far as we can see been assumed to have a value of 0.25.

  We do not quite see how the difference between the Burland and the GESM methods have been found unless a variation of the friction angle has been assumed along the soile profile. If the same interpreted maximum past pressure (Plate 32) has been used for both methods it seems that Burlands β-value ($\beta = (1-\phi')\cdot \tan\phi'$) has been varied from approximately 0.28 at the top of Stratum III to approximately 0.34 at the bottom of this layer.

  Please inform us about the assumptions leading to the high increase in skin friction with Burland's method in Stratum III.

- Results of Ultimate Pile Capacity Analysis

  No comments.

assumed initial pore pressure distribution

$$\Delta u_0(r) = \Delta u_0 \left(1 - \frac{\ln(r/r_0)}{\ln(R/r_0)} \right)$$

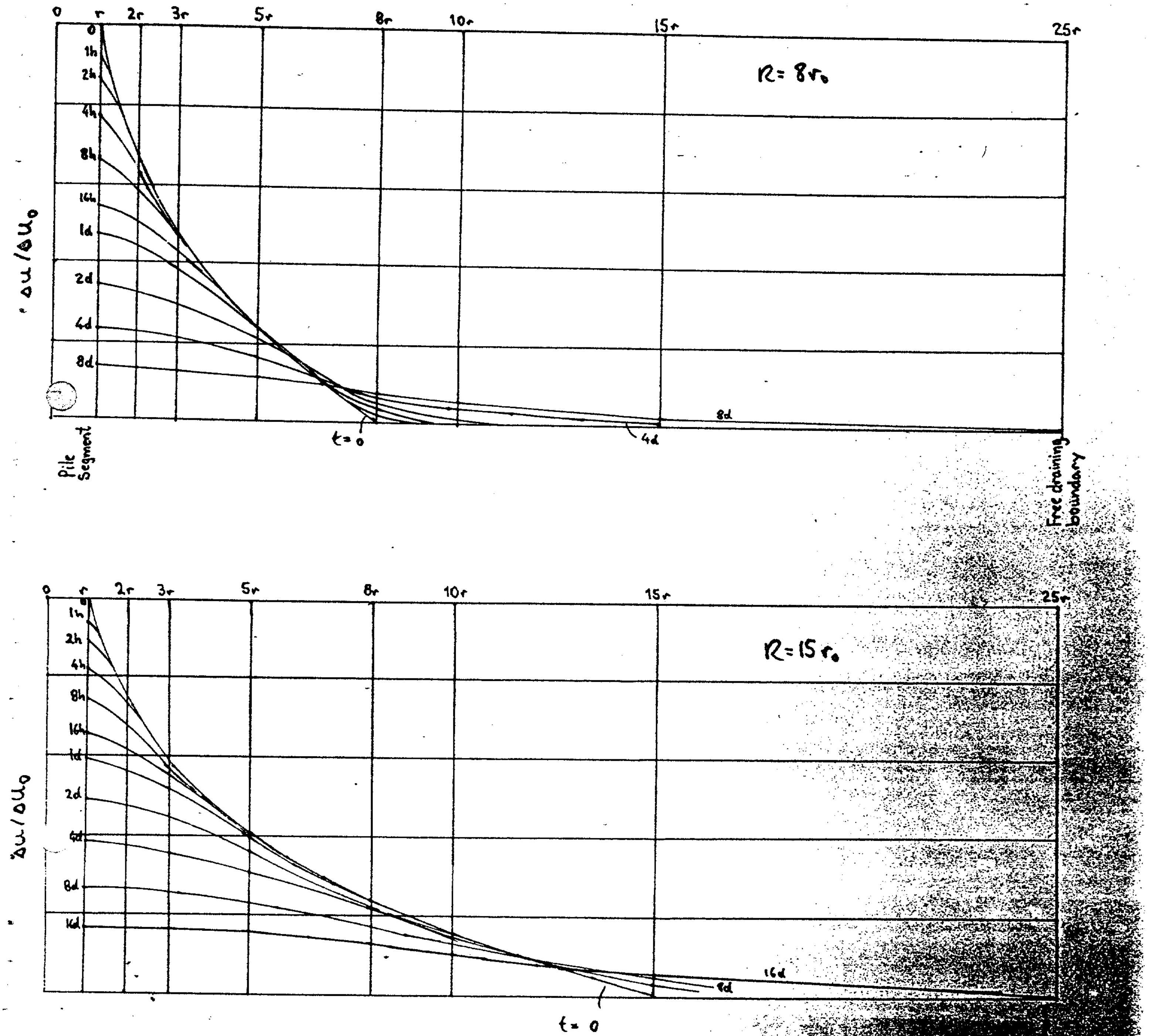

Figure 1. Isochrones of excess pore pressure ratio $\Delta u(t)$ / $\Delta u(t=0)$ for two different assumptions of initial pore pressure distribution ($R = 8\ r_0$ and $R = 15\ r_0$). Calculation performed with permeability $k = 10^{-8}$ cm/sec and compressibility $m_v = 2.0 \cdot 10^{-2}\ m^2/kPa$, i.e. a coefficient of compressibility of $c_v = 1.57\ m^2/year$.

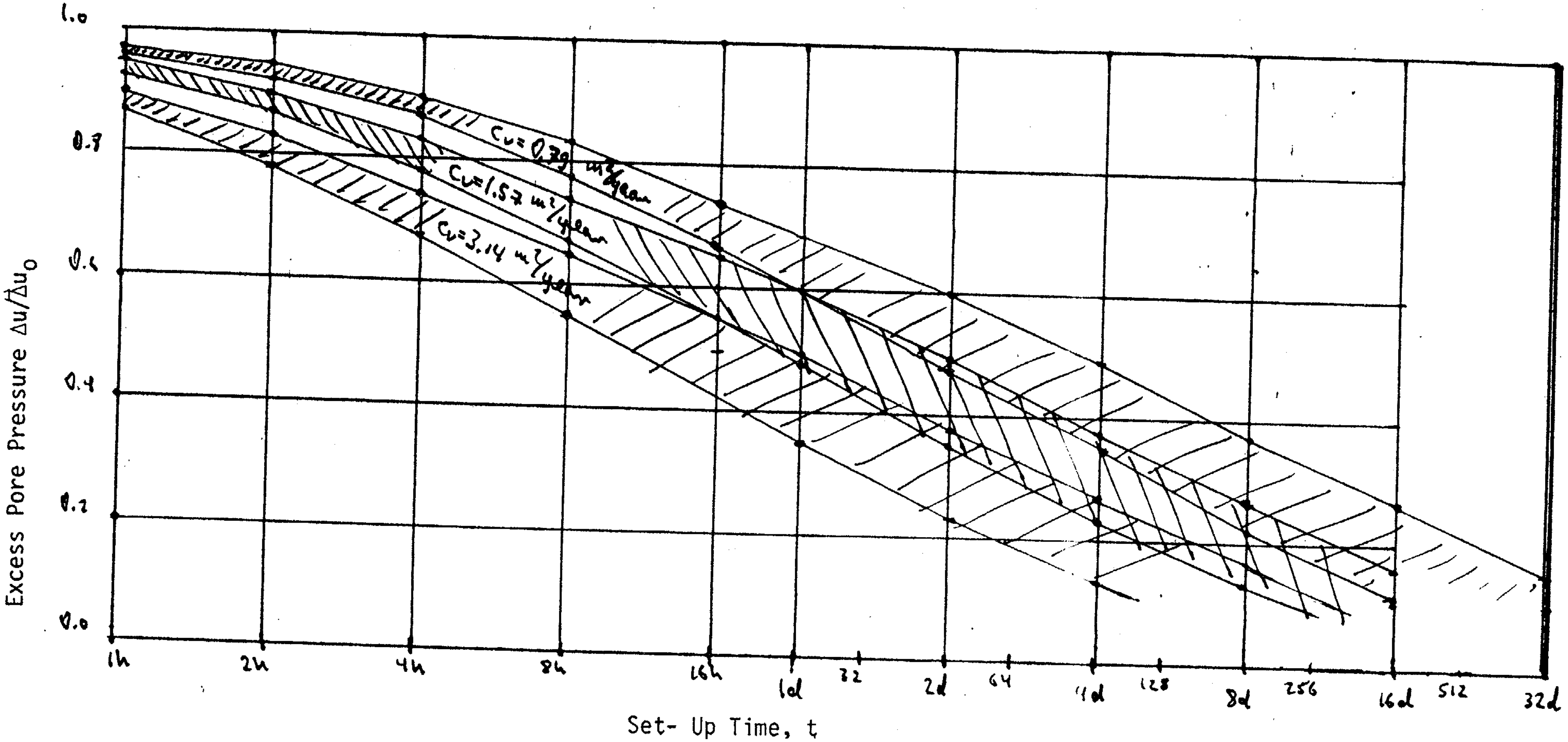

Figure 2. Dissipation of excess pore water pressure at the pile surface vs log time for various values of the coefficient of consolidation and for $R = 8\ r_o$ and $15\ r_o$ respectively.