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EVALUATION OF FRENCH PRESSUREMETER

by

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for

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1. INTRODUCTION

This eleventh progress report describes the work accomplished during April 1978. Table 1 lists the work tasks and presents the schedule as revised in April 1978. Task A (in Table 1) having been completed, April was devoted to Task B and C as follows:

Task B: Measurement of in situ horizontal stress

Task C: Interpretation of PAFSOR tests

1) Establishement of in situ soil parameters

2) Analysis of pressuremeter (PAFSOR) test data

2. WORK ACCOMPLISHED AND SUMMARY OF RESULTS

The principal activities during April 1978 are summarized in Table 2 and described more fully below.

Task B: Measurement of In Situ Horizontal Stress

Readings on the two earth pressure cells still in operation (the symmetrical and enlarged tips) were taken every two to three days. Figure 1 shows the equilibration rates of horizontal stress (σ_{ho}) and pore pressure (u_o) and estimated values of σ_{ho} and u_o based on other data. At the present time, pore pressures appear slightly low. We will recheck the elevation of the water table and recalibrate the transducer before next insertion. On the other hand, the total horizontal stress measured by the symmetrical cell agrees with the predicted σ_{ho} based on laboratory data at Sta. 246 and as expected, the enlarged tip yielded a much lower σ_h . The longer time required to reach equilibrium with the enlarged cell reflects the increased disturbance caused by insertion of the larger tip. Small changes in σ_{ho} observed in both cells after long periods of time are perhaps due to zero shifts of the transducer and/or variations in the input voltage. The apparent increase in σ_{ho} after 24 days is unexplained but may be due to stress redistribution in the clay surrounding the cell or to moisture slowly permeating through the plastic tubing and affecting electronic signals. To evaluate errors due to electronic shift, the transducers will be rezeroed and recalibrated before next insertion.

The σ_{ho} measured by the symmetrical cell appears much more reasonable than most of the values measured by the PAFSOR pressuremeter tests, as seen in Figure 2. The predicted σ_{ho} values are based on elastic theory applied to actual embankment geometry and values of K_o measured in the laboratory. The total horizontal stress for a uniform K_o value of 0.5 over the entire depth is shown for comparative purposes.

The asymmetrical cell, which had to be pulled out a few days after insertion because of leakage was repaired and checked for new leaks. Since the asymmetrical tip geometry was the main cause for the formation of a crack in the weld, and since the symmetrical and asymmetrical cells yielded approximately the same σ_{ho} (Figure 1), the repaired cell was reshaped to have a symmetrical tip, as shown in Figure 3. Three holes were drilled in the plate to permit addition in the future of enlarged tips with varying thickness ratios if desired.

Retrieval of the two embedded cells and reinsertion of the three devices down to El.-50 ft. are scheduled for May 12-15, 1978.

Task C: Interpretation and Analysis of Pressuremeter Data

Establishment of In Situ Parameters

To investigate the somewhat surprising high values of maximum past pressures, six tests for salt concentration were run. Results will be available in early May.

Interpretation and Analysis of Pressuremeter Tests

To improve the Prevost and Hoeg curve fitting method (which limits peak strains to values no smaller than one percent), their stress-strain equation for strain-softening was generalized by introducing a third independent variable (Prevost and Hoeg's model has only two). This third parameter allows modelling of stress-strain curves with peak strains less than one percent. The method still defines P-ΔV relationships but uses in addition least-square equations to fit more closely the field curves.

The modified version of Prevost and Hoeg's model* was expressed by the following relationships:

1) $\varepsilon_{peak} = \left\{ B+\sqrt{B^2+C} \right\}/C$

where A,B,C, = experimental constants

ε_{peak} = strain at peak

2) $q = A \dfrac{B\varepsilon^2 + \varepsilon}{1 + C\varepsilon^2}$ and $q_{res} = \dfrac{AB}{C}$

where q = shear stress

q_{res} = residual shear stress

ε = strain

3) $P = P_o + \dfrac{AB}{2\sqrt{3}C} \ln(1+C\varepsilon^2) + \dfrac{A}{\sqrt{3C}} \tan^{-1}(\sqrt{C}\ \varepsilon)$

where P = corrected pressure

P_o = initial pressure

Figure 5 presents a few applications of the new curve-fitting model and the effect of varying parameter C on the stress strain curve. (Note that for C=1, all equations reduce to Prevost and Hoeg's expressions).

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* Prevost and Hoeg's model uses the following equations:

(1) $\varepsilon_{peak} = B+\sqrt{1+B^2}$

(2) $q=A \dfrac{B\varepsilon^2+\varepsilon}{1+\varepsilon^2}$, with $q_{res} = AB$

(3) $P = P_o + \dfrac{A}{\sqrt{3}} \left\{ \dfrac{B}{2} \ln (1+\varepsilon^2) + \tan^{-1}(\varepsilon) \right\}$

PAFSOR tests Nos. 1 and 2 were used to evaluate the new method. Progress Report No. 10 (March 1978) has presented the results obtained from direct application of the Prevost and Hoeg curve-fitting procedure to the same two tests:

* Test No. 1, which the Prevost and Hoeg method modelled adequately was fitted slightly better by the new procedure.
* Test No. 2, where the Prevost and Hoeg fit was very unsatisfactory had a somewhat improved fit by the new procedure, but the deviations from the field curve still remain unacceptable.

3. WORK PLANNED FOR NEXT THREE MONTHS

The work items planned for the coming months include:

1) Complete horizontal stress measurement with new earth pressure cells inserted in three holes at Sta. 246, in Saugus, MA (I-95 site where PAFSOR tests were run).
2) Continue summary internal report of all laboratory test results on 1977 specimens of Boston Blue clay.
3) Continue evaluation of the pressuremeter test data.
4) Obtain undrained shear strength and undrained modulus from pressuremeter stress-strain curves.
5) Compare PAFSOR and Camkometer test results.
6) Prepare outline of final research report.

4. COSTS INCURRED

At the end of April 1978, total expenditures amounted to approximately $60,100, exclusive of some of the field testing program costs incurred by the subcontractors hired for the earth pressure cell work task.

Table 2: Principal Activities During March 1978

Task B: Measurement of In Situ Horizontal Stress

1) Continue lateral stress measurements at Sta. 246 using two cells operating satisfactorily.
2) Repair defective third cell.
3) Prepare for second set of measurements.

Task C: Interpretation of PAFSOR Tests

Establishment of In Situ Parameters

1) Stress History at Sta. 246 and 263:

   a) Continue measurements of salt concentration in 1977 samples at Sta. 246 and 263.

Interpretation and Analysis of Pressuremeter Data

1) Extend the Prevost and Hoeg interpretation method to allow peak strains less than 1% (Prevost and Hoeg's model is limited to $\varepsilon_{peak} \gtrsim 1\%$)
2) Extend the existing computer program to include new approach and apply to P-ΔV curve from PAFSOR tests Nos. 1 and 2.
3) Include computation of standard deviation in curve-fit program to evaluate best modelling of in situ curve.