PROGRESS REPORT NO. 6

NOVEMBER 1977

EVALUATION OF FRENCH PRESSUREMETER

by

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DEPARTMENT OF CIVIL ENGINEERING
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

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1. INTRODUCTION

This sixth progress report describes the work accomplished during November 1977. Table 1 lists the work tasks and presents a revised version of the schedule. Task A (in Table 1) having been completed, November was devoted to Task B and C as follows:

Design of earth pressure cells to measure in situ horizontal stress

Interpretation of PAFSOR tests

1) Establishment of in situ soil parameters
2) Analysis of pressuremeter (PAFSOR) test data.
3) Literature review of pressuremeter test and methods of interpretation.

2. WORK ACCOMPLISHED AND SUMMARY OF RESULTS

The principal activities during November 1977 are summarized in Table 2 and described more fully below.

Measurement of In Situ Horizontal Stress

Conceptual design of three earth pressure cells (shown schematically in Figure 1) was completed. The proposed cells are essentially a flat steel plate penetrating the ground at the bottom of a preaugered hole. Each cell has a specific advancing tip geometry and will be equipped with a total stress sensor and a thermistor; possibly one earth pressure cell will monitor porewater pressure. Final drawings are not yet available though. Machining has been slightly delayed, but is expected to start this month. Material for each cell has however been selected and ordered.

The drilling contractor, Mr. Robert MacGlashan, has been contacted and will be available for installing the cells.

Establishment of In Situ Soil Parameters

The relatively large values of maximum past pressure and virgin compression ratio are still under scrutiny and need to be compared with CALDOT's conventional oedometer test results. These should become available by the end of December.

In order to further check the maximum past pressure at Sta. 246 and to also obtain a value of normalized undrained shear strength,

we ran two additional direct simple shear tests. The K_o consolidation stresses before shear were selected as respectively twice the maximum past pressure and the effective overburden stress.

M.I.T. ran 8 Atterberg limits on specimens next to selected CRSC samples. Figure 2 and 3 summarize the test results and the water contents measured on the CRSC samples. Comparison with existing data at the test site is underway. As of the end of November 1977, 14 oedometer tests on samples from Sta. 246, nine Atterberg limits and 4 specific garavity measurements were completed or near completion by CALDOT. Because of budget limitations, CALDOT will not run any oedometer tests on samples from Sta. 263.

M.I.T. provided CALDOT with guidelines for test procedures and confining stresses for unconsolidated-undrained triaxial compression (UUC) tests on I-95 samples. Several tests have already been completed.

Regarding the stress history at Sta. 246, the Massachusetts Department of Public Works piezometer data show some excess pore pressures at the PAFSOR test location, probably due to the embankment construction and a small artesian pressure in the shale at El. -170 ft. Piezometer readings made in the past years by M.I.T. personnel were also reviewed. Final conclusions and plots of stress history are expected for the end of December. Finalization of maximum past pressure profiles however must await CALDOT's oedometer test results.

Interpretation and Analysis of Pressuremeter Tests

The following plots were obtained for the 20 PAFSOR tests at I-95 :

a) pressure vs log ($\Delta V/V$) (with extrapolation to $\Delta V/V=1$ to obtain the limit pressure)

b) shear stress, τ , vs. radial strain, ε (by subtangent method)

Derivation of the stress-strain curve by curve-fitting techniques was extensively investigated, but results for our PAFSOR tests are not yet finalized. The equations proposed in the literature for both strain-softening and strain-hardening were considered. The curve fitting methods were modified so that the method of least squares could be used to fit the data.

Further effort was devoted to the Camkometer test results; two tests have been digitized. Plotting of the field data should, however, be completed the end of December.

Table 2 summarizes the activities under this work task.

Literature Review

Papers dealing with reduction of field data to stress-strain curves were studied in depth (mainly curve-fitting techniques for strain-softening and strain-hardening materials). Papers by J.M.O. Hughes (of Cambridge University, England) on the Camkometer were also collected.

3. WORK PLANNED FOR NEXT THREE MONTHS

The most immediate work items for the coming months are:

1) Compare CALDOT's conventional oedometer test results to M.I.T.'s CRSC test results. Then decide if additional incremental tests are required along with desirability of running some tests on "horizontal" samples.
2) Continue evaluation of stress changes due to prior construction and finalize stress history computation at location of PAFSOR tests.
3) Complete design of earth pressure cell and follow progress of machining.
4) Continue evaluation of the pressuremeter test data and literature review. During this process, thought will also be given to improved methods of interpretation.
5) Continue plots of stress-strain curves from Camkometer tests at Sta. 263.

4. COST INCURRED

The costs incurred during November were approximately equal to those predicted in Table 5 of Progress Report No. 2.

TABLE 1: WORK TASK AND SCHEDULE

(revised 12/77)

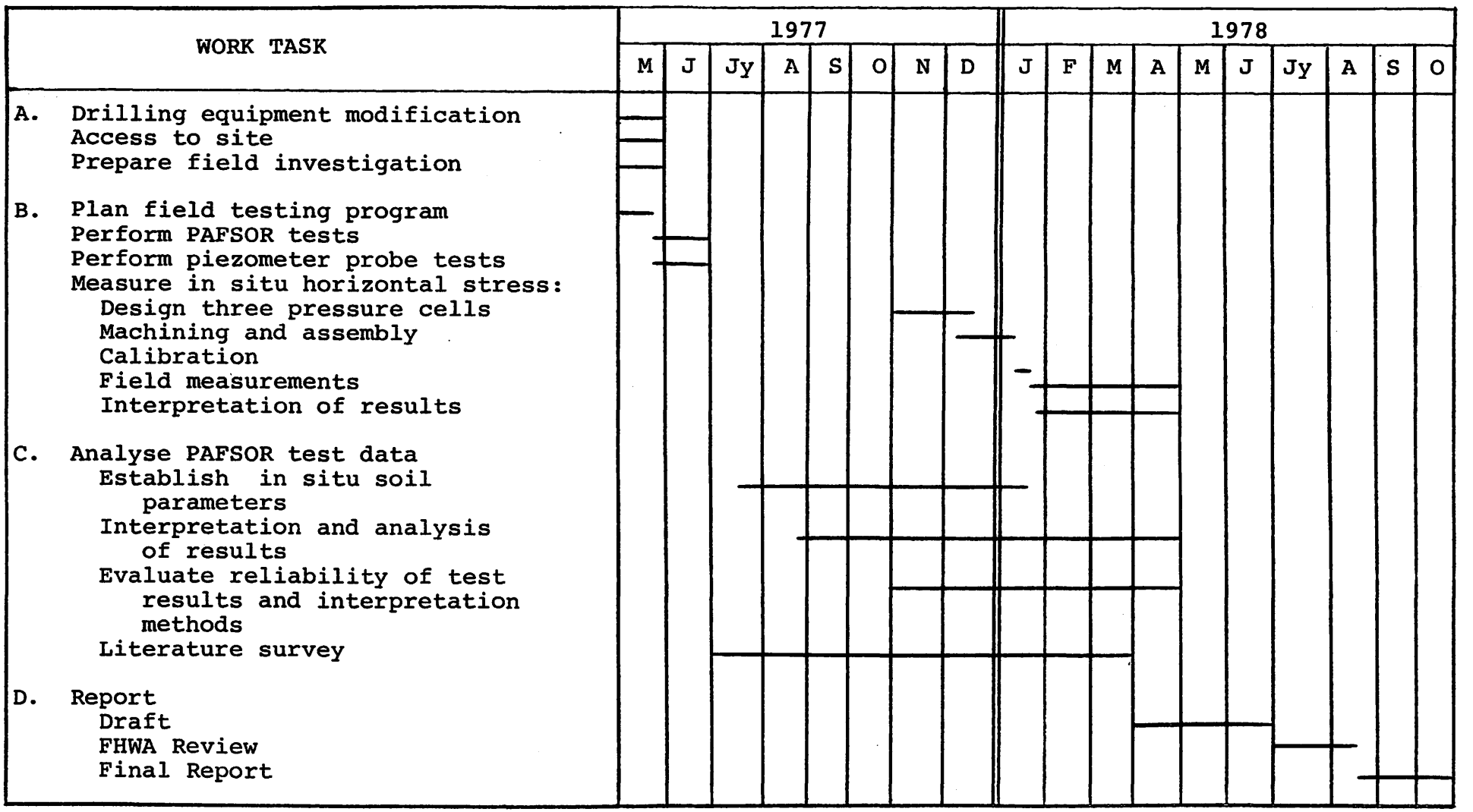

TABLE 2: PRINCIPAL ACTIVITIES DURING NOVEMBER 1977

Task B: Measurement of In Situ Horizontal Stress

1) Conceptual design of three earth pressure cells and ordering of materials

2) Contact drilling contractor

Task C: Interpretation of PAFSOR Tests

Establishment of In Situ Soil Parameters

1) Index properties: ran 8 Atterberg limits on specimens next to selected CRSC test samples

2) Direct Simple Shear (CK_oUDSS) Test

   a) Completed two CK_oUDSS tests.

3) CALDOT Testing Program

   a) Provide CALDOT with testing procedures and suggest confining stress values for UUC tests on I-95 Boston Blue Clay samples.

4) Stress History at Sta. 246 and 263

   a) Summarize water table observations since 1967
   b) Summarize pore pressure measurements taken during 1977 and past measurements made in till and shale strata (to elucidate artesian pressure question)

Interpretation and Analysis of Pressuremeter Data

1) Continue improving plotting program to accomplish the following:

   a) plot unloading data on P vs. log $\Delta V/V$ diagrams
   b) make plots conform with DOT's required margins.

2) Complete plotting of P vs. log ($\Delta V/V$) data for all PAFSOR tests.

3) Complete plotting of τ vs. ε data for all PAFSOR tests (data obtained by subtangent method)

4) Apply curve-fitting techniques described in the literature to obtain stress vs. strain curves for selected PAFSOR tests. Start evaluating fitting methods. In some cases, the equations had to be expanded or corrected.

5) Evaluate sensitivity of curve-fitting equations to assumptions used in derivation.

6) Continue development of finite difference program to model expansion of cylindrical cavity and predict in situ stress-strain behavior based on laboratory stress-strain curves for Boston Blue Clay.

7) Digitize and continue evaluation of data from 1973 Camkometer tests at Sta. 263.

Literature Review

1) Continue synthesis of papers, reports and theses on pressuremeter testing.

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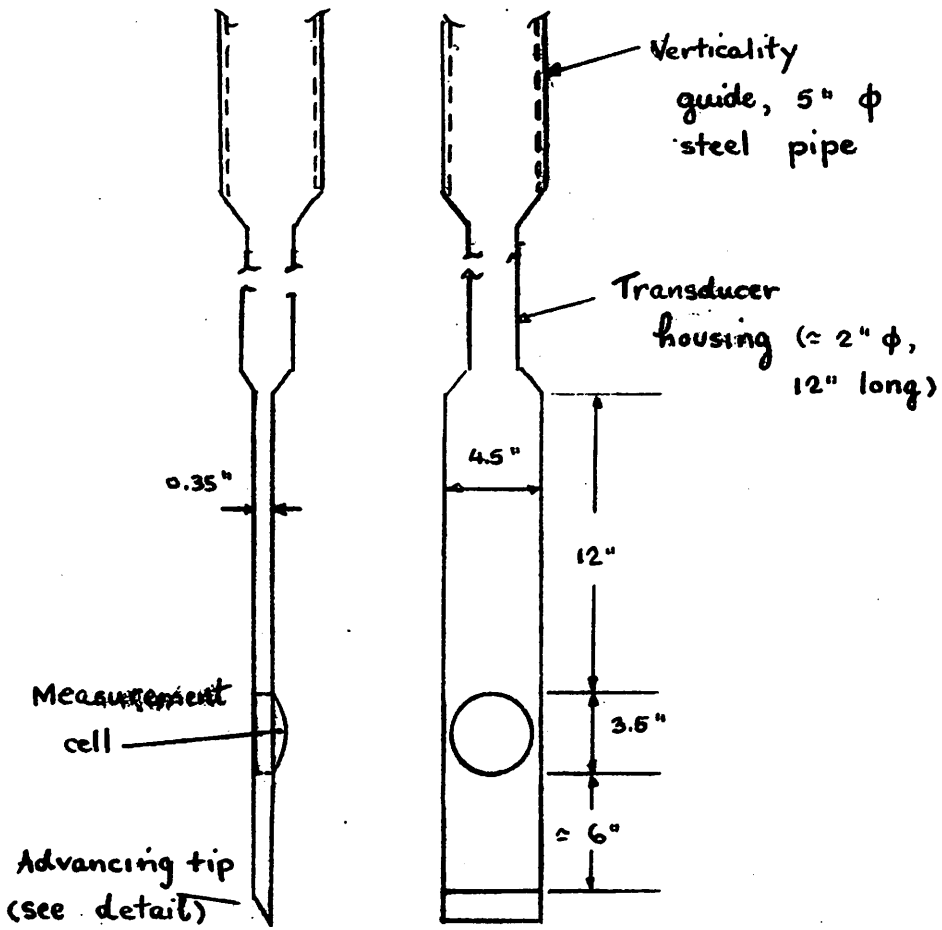
12/10/74

PLATE AND MEASUREMENT CELL



ADVANCING TIPS
(not to scale)

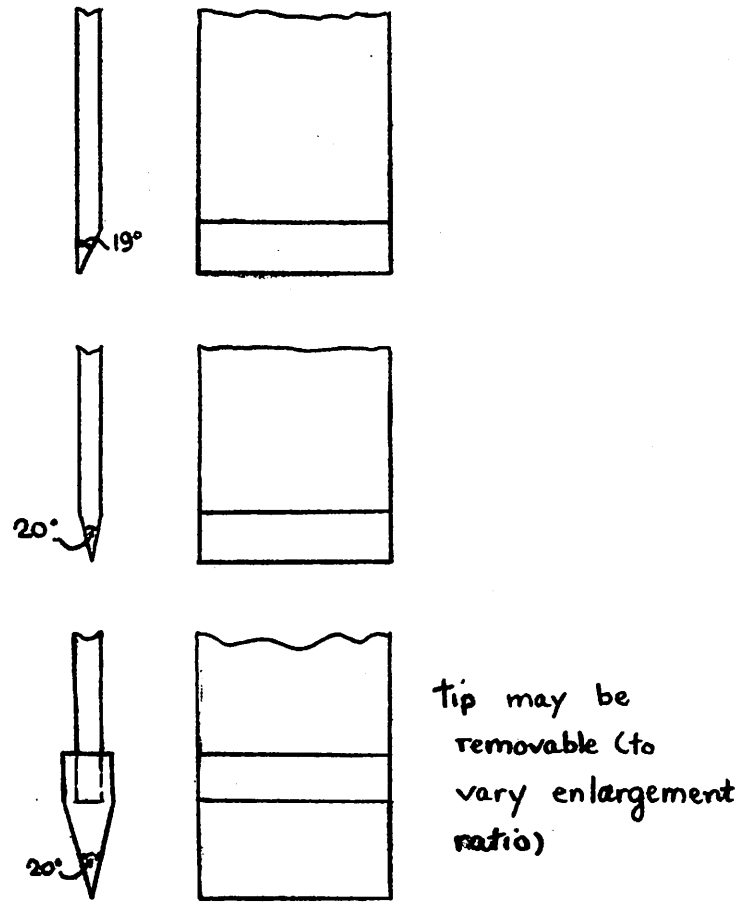
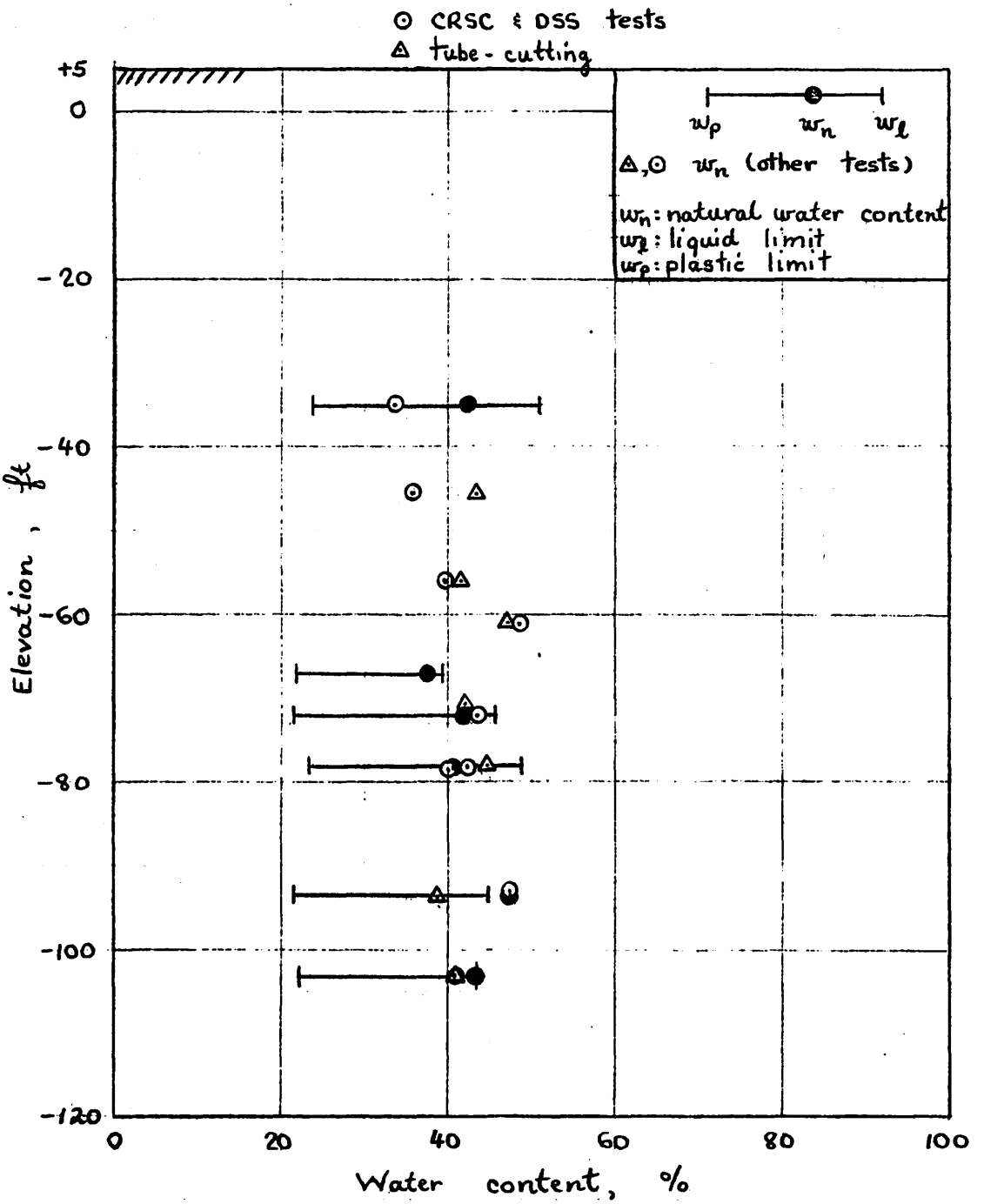


Figure 1

PROPOSED EARTH PRESSURE CELL DESIGNS (SCHEMATIC)
Approximate dimensions shown
1 IN = 2.54 CM



ATTERBERG LIMITS ON BOSTON BLUE CLAY
I-95 EMBANKMENT, STA. 246

Figure 2

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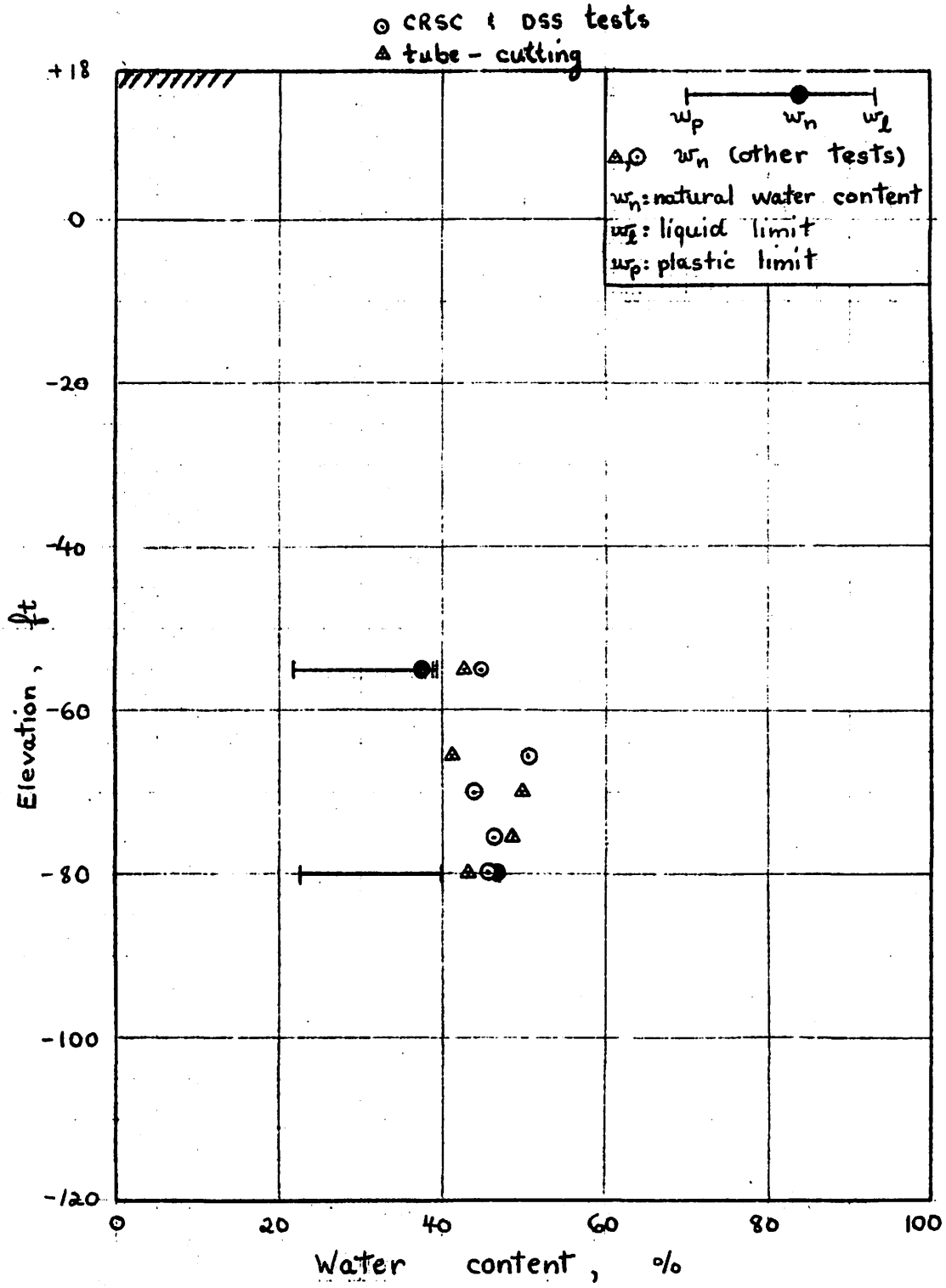

ATTERBERG LIMITS ON BOSTON BLUE CLAY
I-95 EMBANKMENT, STA. 263

Figure 3