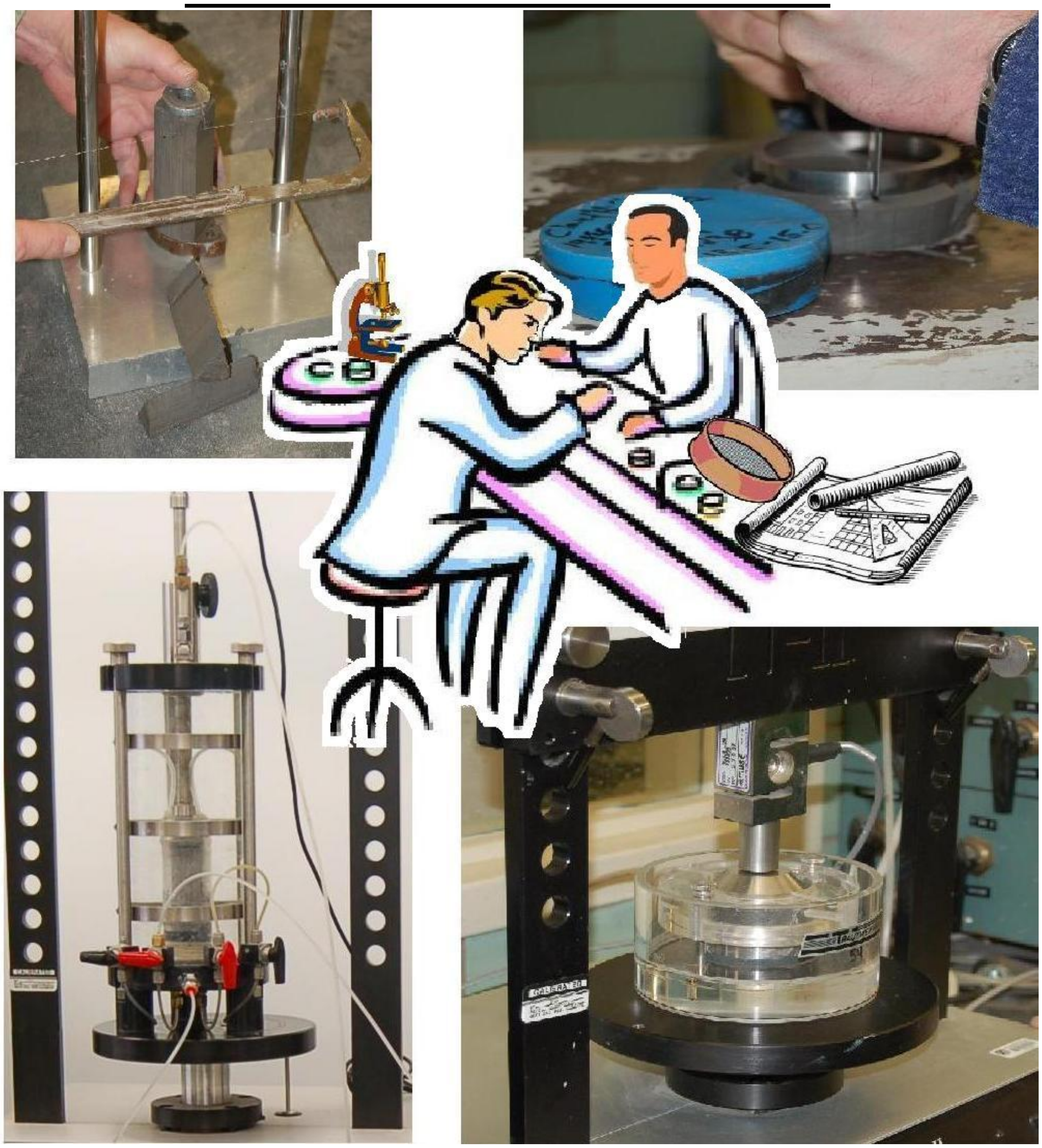
GTP-6

SOIL MECHANICS LABORATORY
<u>TEST PROCEDURES</u>



GEOTECHNICAL TEST PROCEDURE
GTP-6
Revision #4

AUGUST 2015

NEW YORK STATE OF OPPORTUNITY. | Department of Transportation | Office of Technical Services | Geotechnical Engineering Bureau

GEOTECHNICAL TEST PROCEDURE:
SOIL MECHANICS LABORATORY TEST PROCEDURES

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STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING BUREAU

AUGUST 2015

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I. PREFACE

The purpose of this manual is to present the geotechnical test methods used by the Soil Mechanics Laboratory of the New York State Department of Transportation's Geotechnical Engineering Bureau. The intent is to present the mechanics of performing each test, not the theory behind the test.

The triaxial test procedures have been developed from those which are described in Soil Testing for Engineers by T. W. Lambe and The Measurement of Soil Properties in the Triaxial Test by A. W. Bishop and D. J. Henkel. The consolidation test procedures have been developed from those in Lambe's book.

Other methods, such as those related to geotextiles, block permeability, and membrane fabrication, are relatively new areas in the geotechnical field. The methods and procedures included have essentially been developed, along with the equipment, by the Geotechnical Engineering Bureau.

In some cases it has been necessary to make modifications to existing methods in order to accommodate the conditions and equipment in the Soil Mechanics Laboratory, along with the properties of New York State soils.

II. GENERAL

A. STANDARD PROCEDURE FOR THE PROCESSING OF SOIL SAMPLES IN THE SOIL MECHANICS LABORATORY

1. Introduction

1.1 The following procedures are intended for the orderly and accurate handling of disturbed and undisturbed samples received in the Soil Mechanics Laboratory.

2. Undisturbed Sample Procedures

2.1 Log-In Procedure

2.1.1 Note the manner in which the tubes were shipped. If they were not transported vertically in a proper rack, or if they were subject to freezing weather, notify the laboratory supervisor. Transport the tubes into the lab using a tube rack. Handle tubes with care at all times.

2.1.2 Arrange tubes in order of hole number and tube number. Assign a shelf number to all of the tubes using the shelf listings. All information (PIN, project name, drill hole number, tube number, depth, shelf number and number of tubes) must be ready to enter at time of log-in.

2.1.3 Enter password to access first menu. Menu I will appear as follows:

MENU I
END PROGRAM
JAR SAMPLES
TUBE SAMPLES
ROCK CORE SAMPLES
END OF THE MONTH TOTALS
SEARCH FOR SAMPLES
ARCHIVE RECORDS

Use the down arrow key to select TUBE SAMPLES and press ENTER. The next menu will appear. Select the LOG-IN NEW SAMPLES option. All information may be entered on the next screen. When all information is entered, select the ALL CORRECT option to advance to the next screen. On this screen, enter the drill hole number and number of tubes in the hole. Advance to the next screen and enter the tube number, depth and shelf number. The information will be stored and 3 copies of the information will be printed. Send one copy to the Highway Design and Construction Section, one copy to the Structures Foundation Section and one copy is filed in PIN order in the Laboratory Samples Received notebook.

2.2 X-Ray Preparation

2.2.1 Remove the top and bottom plastic caps. Remove and discard the filler material using a spatula, taking care not to push the wax into soil. Inspect the tubes for any damage and fill out Form No. SM-403, “Undisturbed Sample Evaluation”.

2.2.2 Measure the distance from each end of the tube to the wax and add these together. This measurement will be used for the top of soil line of the scale on From SM-288b, “Undisturbed Sample Log”. Check the length of each tube and make necessary adjustments to the scale. Fill out a sample log form for each tube including all pertinent information.

2.2.3 Mark the outside of each tube indicating the location of the top of the soil. Indicate PIN, hole number and tube number on the caps. Replace and tape the plastic capes. Remove tape from labels on tubes. Tape lead markers 90° apart over the top of the soil line on the outside of the tube. Mark the lead pellets A and B respectively.

2.2.4 Enter all pertinent information in the lab’s x-ray book. Write the x-ray number on each corresponding tube with a permanent marker, keeping in sequence with the last number in the x-ray log book.

2.2.5 Indicate on a piece of memorandum paper all of the information pertaining to the tube samples. Send it with the tube samples to the Materials Testing Laboratory’s X-Ray Department. If the tubes cannot be x-rayed immediately, inquire as to when they can be and store them in the moist room.

2.3 X-Ray Completion

2.3.1 After receiving the x-rays, fill out (on small gummed labels) the hole number, tube number, and either “A” or “B” to identify the exposure. Place these labels in the top left corner of the x-ray. Do not cover the code numbers or any part of the x-ray.

2.3.2 Place the x-rays into appropriate envelope. Indicate on the envelope the PIN, job name, hole number, tube number, and x-ray number.

e.g.	5935.56.101	Oak Point	DNB-1
	Tube No. XX	X-ray No. XXX	

2.3.3 After the tubes have been x-rayed, place them on the assigned shelf in the moist room.

2.3.4 Notify the Laboratory Supervisor and the Supervisor of Drilling Operations that the x-rays are ready for review. Any disturbance seen during the review of the x-rays must be entered on Form SM-403.

2.3.5 Because the x-rays become faded over a period of time, a picture of each x-ray must be taken to ensure a permanent record. Mount the 35 mm camera either on the copying stand or the tripod. Place both x-rays from each tube on the light table and photograph.

2.3.5.1 Place the exposed film in its canister and send to reproduction with the label specifying “negatives only”. Record in the x-ray log book which tubes have been photographed.

2.3.6 When the negatives return, cut them apart and mount them in 35 mm slide frames. Put these in the appropriate file.

2.4 Profiling Tubes

2.4.1 Prepare the following for profiling tubes:

2.4.1.1 Tare out scale.

2.4.1.2 Number tares with PIN, tube and hole numbers.

2.4.1.3 Arrange tubes on lab table or cart in order of tube number.

2.4.1.4 Set up camera.

2.4.1.5 Have x-rays and partially prepared tube log sheets and tube condition sheets ready.

2.4.1.6 Fill out Moisture/ Density sheets with appropriate information.

2.4.1.7 Make sure cutting wire, metal screed, ring and plate are clean.

2.4.2 Notify Design Engineer that you are ready to begin profiling tubes. When ready, jack enough soil out to remove the top wax. Measure thickness of the wax and record on log sheet.

2.4.3 Take a sample for the purpose of determining density, moisture content and visual description. After removing from the density ring, the sample is cut vertically through the middle, opened and placed in a tare. This is immediately weighed and the mass recorded on the Moisture Content/Wet Density sheets, and placed in an oven at 230±9° F (110±5° C) for a minimum of 16 hrs.

NOTE: Do not touch soil in tare once it has been weighed as this will affect the test results.

2.4.4 Photograph the sample making sure the PIN, hole and tube numbers are visible. Make a visual description of the soil and record on tube log in appropriate depth area. Draw a small circle in test column across from visual description for Moisture Content and Density results to be entered.

2.4.5 Remove tube from the jack and measure distance from bottom of tube to the bottom wax. Record on tube log, measuring from the TOP location on the log. Replace and re-tape the caps on tube and return to moist room.

2.4.6 After samples have dried for 16 hours, remove from the oven. Tare out the scale and weigh the sample. Record on the Moisture/ Density sheet. Compute the Moisture Content using:

Equation (1)

$$\frac{W_w}{W_s} x\,100 = Moisture\,Content$$

where:
W_w = Mass of Water in the Specimen
W_s = Mass of Dry Soil
2.4.6.1 Compute the wet density using:

Equation (2)

$$W_T \ x\, K = Wet\, Density\, (\gamma_T)$$

where:
K = Density Constant for Ring, 1.01 (for lb/ft^3) or 16.18 (for kg/m^3)
W_T = Total Wet Mass of the Specimen

2.4.7 After computations have been checked by Section Supervisor, enter values in appropriate areas on individual tube log sheets. Prepare undisturbed sample summary log sheet with all appropriate information. Have the summary log reviewed and signed by the Soils Engineering Laboratory Supervisor.
2.4.8 After summary log has been signed by Laboratory Supervisor, have two copies made. Send one copy to the project file and one copy to the Regional Geotechnical Engineer.
2.4.9 Complete the Tube Condition sheet, make 2 copies and send both to Supervisor of Drilling Operations. Staple original to tube log sheets and place in appropriate basket on lab table. All original data sheets are kept in the laboratory.
2.4.10 Prepare a folder with PIN and hole number on outside cover. Place original summary log in folder and file by PIN in Undisturbed Test Data file drawers.

3. Jar Samples

3.1 Log-In Procedure
3.1.1 Note the manner in which they were received. If boxes are in unsuitable condition for proper and neat storage they must be replaced and relabeled.
3.1.2 Arrange boxes in order of PIN and drill hole number. Assign each box a shelf number using the shelf listings for jar samples. PIN, job name, region, county, number of drill holes, number of jars, number

of boxes and shelf numbers must be ready to enter at time of log-in.

3.1.2.1 Enter password to access first menu. Select the JAR SAMPLES option and press ENTER. Select LOG-IN NEW SAMPLES option on the next screen. Information about the jar samples is entered on the following screens. The information is stored and 3 copies printed out. One copy is sent to the Highway Design and Construction Section, one copy to the Structures Foundation Section, and one copy is filed in PIN order in the Laboratory Samples Received notebook.

3.2 Requested Moisture Contents

3.2.1 Moisture content determinations may often be requested on jar samples. Fill out the Moisture Content Sheet with all available information from jars. Write your initials and date in upper right hand corner. Number tares with hole and jar number for each sample. Tare out scale.

3.2.2 Empty the contents of the jar into a large open container. Remove a representative portion of the sample and place it in a tare. Do not use all of the sample for a moisture content determination as the sample may be needed for other tests. Weigh the sample immediately and record the mass on the Moisture Content sheet.

NOTE: Do not touch soil in tare once it has been weighed as this will affect the test results.

3.2.3 Place tares in oven at 230±9° F (110±5° C) to dry for a minimum of 16 hours. After drying, remove tares from oven. Tare out scale and weigh each sample. Record the mass and compute the moisture content using Equation 1. Enter the date and your initials in the upper right hand corner. Have the computations checked by the Section Supervisor.

3.2.4 Distribute copies of results as directed by requester.

3.2.5 Total number of moisture contents must be recorded and reported on the end of the month totals.

3.2.6 Store boxes in appropriate shelf slots in the cage in the basement of Building 7A.

3.3 Test Request Procedure for Jar Samples

3.3.1 Check laboratory "Samples Received" log book to determine whether jars have been received or emptied. <u>Make sure the Design Engineer</u> has checked jars and knows the soil type. Also, check to make sure visuals and moisture contents have been done on all jars at some point. Determine if there is sufficient material in each jar for the test request and if material is appropriate for the test requested.

3.3.2 Enter test request information on Form SM-205 b. Write date, Project, PIN, hole and sample numbers and tests requested on the form.

3.3.3 Make a copy of Form SM-205 b and send it to the General Soils Laboratory with the jar samples.

3.3.4 The number of samples sent to the General Soils Laboratory must be recorded. Log into the computer and select "Search for Samples" option. Enter the region number and PIN. Move the cursor down to the hole number desired and then enter the number of jars sent to the General Soils Lab for each test.

3.3.5 Fill out the appropriate summary sheet, and after all results are received and sheet is completed, file it in a folder under its PIN in the disturbed test data file drawer. Bring all test result forms to the Engineer requesting the tests.

3.4 Procedure for Emptying Shelby Tubes or Brass Liners

3.4.1 Determine which tubes are to be emptied by circulating an inventory list through each Design Section and the Highway Design and Construction Section. Obtain log sheet for appropriate PIN and hole numbers.

3.4.1.1 Get x-rays from drawer;

3.4.1.2 Find status of the sample on the inventory sheet;

3.4.1.3 Obtain tubes form the moist room;

3.4.1.4 Do visual and bottom wax measurement as the tube is emptied;

3.4.1.5 Write in the visual in the appropriate location on the sample log sheet;

3.4.1.6 Indicate the date emptied on the individual tube log sheet;

3.4.1.7 Return log sheet and x-rays to their appropriate location;

3.4.1.8 Delete emptied samples from computer and print out a new inventory list.

3.5 Procedure for Emptying Jars

3.5.1 Determine which jars are to be emptied by circulating an inventory list of jars through each Design Section, the Highway Design and Construction Section and the Regional Geotechnical Unit.

3.5.1.1 Empty jars into large trash barrel downstairs;

3.5.1.2 Bring jars to the Jar Wash Room downstairs to be washed and reused;

3.5.1.3 Delete samples from computer and print out a new inventory list.

3.5.2 Obtain a list, by Region, of projects for which samples were disposed of. The Soils Engineering Laboratory Supervisor will prepare a letter to the Region listing the above information.

4. General Procedures

4.1 Turn off scales at night;

4.2 Keep x-ray light off when not in use;

4.3 Return all tubes to moist room;

4.4 Make sure oven is on or off as needed.

B. STANDARD PROCEDURE FOR FABRICATING RUBBER MEMBRANES FOR USE IN THE SOIL MECHANICS LABORATORY

1. Scope

1. 1 There is a need in the Soil Mechanics Laboratory for rubber membranes that have specific characteristics of strength, durability, and elasticity. The membrane must be sensitive so as not to deform the soil sample onto which it is applied, e.g. the square corners on a cubical sample. It is also important that a membrane for a triaxial test not add any significant strength to the soil.

1.2 There are many benefits to fabricating one's own membranes in the laboratory. Primarily, a constant supply can be readily available and made to the desired specifications. It is also very economical, as custom-made membranes can be quite expensive when purchased from a manufacturer.

2. Summary of Method

2.1 A mandrel of the desired shape is dipped into a saturated solution of calcium nitrate and methanol and then placed in a temperature regulated oven to cure. The mandrel is then dipped into a container of liquid latex for a predetermined time and then removed and placed back in the oven to allow the latex to cure. The membrane is then trimmed from the mandrel, soaked in water as a final curing stage, dried and trimmed.

3. Materials and Apparatus

3.1 Latex – the liquid latex shall be Vultex Formulation 1-V-731-A. The proper viscosity of the liquid latex is achieved by the addition of distilled water.

3.2 Coagulant – The coagulant shall be a saturated solution of four (4) parts methanol to one (1) part powdered calcium nitrate.

3.3 Storage containers – Two (2) storage containers are required to store the liquid latex and the coagulant. They shall be Lucite cylinders, 5.5 in. (139.7 mm) in diameter by 13.5 in. (342.9 mm) high, each with a stationary base. The top must be able to be sealed air-tight.

3.4 Mandrels – The mandrels, for dipping into the coagulant and liquid latex, shall conform in shape to the soil sample to be tested, the top stone cap and the bottom stone pedestal over which the finished membrane will be fitted.

- 3.4.1 The mandrel used to fabricate membranes used for the 2 in. (50.8 mm) cube block permeability test shall be made of polyurethane coated cherry wood and shall have a handle at the top.
- 3.4.2 Two (2) mandrels are used to fabricate membranes used for the 3.375 in. (85.72 mm) full diameter triaxial test. They shall be polished stainless steel cylinders (modified Shelby Tubes), 3.5 in. (88.9 mm) O.D. by 9.75 in. (247.65 mm) long, with rubber stoppers at both ends and a handle at the top.

3.4.3 The mandrel used to fabricate membranes for the 2.875 in. (73.02 mm) triaxial test shall be 3 in. (76.2 mm) O.D. by 9.75 in. (247.65 mm) long, with rubber stoppers at both ends and a handle at the top.

NOTE 1: Mandrels cannot contain the element copper (e. g. brass), as it reacts with and deteriorates the rubber.

NOTE 2: Additional mandrels may be constructed to fit future needs of the Soil Mechanics Laboratory.

3.5 Oven shall maintain a temperature of 158±9° F (70±5°C).

3.6 Talcum powder – to coat the cured membrane when stripping the membrane from the mandrel.

3.7 Razor blades or Exact-o-knife – to cut along upper and lower edges of the cured membrane in order to strip the membrane from the mandrel.

3.8 Scissors – to trim the membrane after final curing stage.

3.9 Wooden base – to mount block permeability test sample mandrels on while oven-curing.

3.10 Detergent – to clean the mandrel prior to immersing in the coagulant.

4. Preparation and Maintenance

4.1 Coagulant – The solution consists of four (4) parts methanol to one (1) part calcium nitrate.

4.1.1 Crush the calcium nitrate crystals into a powder form.

4.1.2 Mix the calcium nitrate powder into the methanol and stir thoroughly. Thereafter solution requires only periodic stirring.

4.2 Latex

4.2.1 Stir the latex and allow it to settle for 45 minutes before dipping the mandrel into it so that any bubbles caused by the stirring action will be dispersed.

NOTE 3: The latex must be stirred well before each use because a thick film of concentrated latex will form on the top. Inadequate stirring will cause non-uniformity in the membrane thickness.

4.2.2 Keep the latex at a workable viscosity as the latex may tend to thicken after a time, making it difficult to obtain a thin membrane. To overcome this, small amounts of distilled water may be added as needed.

NOTE 4: A small amount of distilled water will decrease the viscosity of latex considerably. Therefore, use caution when performing this step.

NOTE 5: Always be sure there is enough coagulant and latex in the containers to cover the largest mandrel, but not so much as to cause overflow during the dipping process.

4.2.3 Store the latex away from any light source.

5. Fabrication Procedure

5.1 Initial Steps.

5.1.1 Regulate the oven to 158±9° C (70±5°C).

5.1.2 Be sure the proper amounts of coagulant and latex are in their respective containers (see Section 4.2.2, NOTE 5).

5.1.3 Stir the latex vigorously (see Section 4. 2.1).

5.2 Clean the mandrel(s) to be dipped.

5.2.1 Wash mandrels with detergent.

5.2.2 Rinse mandrels thoroughly in warm water.

5.2.3 Place mandrels in the oven to dry. A 15-20 minute drying time is usually sufficient.

NOTE 6: Place Full Diameter Triaxial Test sample mandrels in small tares to catch run-off. Place Block Permeability Test sample mandrels in the wooden base which is provided for this purpose.

5.3 Dip the mandrel in the coagulant while the mandrel is still warm from the drying process.

5.3.1 Immerse the entire mandrel briefly into the coagulant.

5.3.2 Allow excess coagulant to drip off the mandrel.

5.3.3 Inspect the mandrel for unwetted spots.

NOTE 7: In the event there are any unwetted spots, the procedure must be stopped here and restarted beginning with Section 5.2.

5.3.4 Place the mandrel back into the oven for 25 minutes.

NOTE 8: This step drives off the methanol and leaves a sticky film of calcium nitrate on the surface of the mandrel. An oven-curing time of more than 25 minutes will cause the calcium nitrate to crystallize, resulting in spotty concentrations of latex on the mandrel.

5.4 Dip the mandrel in the latex immediately after removing the mandrel from the oven in Section 5.3.4.

5.4.1 Prior to dipping the mandrel in the latex, inspect the surface of the latex in the container to make sure it is free from air bubbles and impurities. A spoon can be used to scoop the surface clean.

5.4.2 Slowly immerse the mandrel into the latex. Take care not to trap air between the latex and the mandrel surface.

5.4.3 Dwell time begins when the mandrel is completely submerged.

NOTE 9: A dwell time of ten seconds is sufficient to obtain a thin membrane with good strength and sensitivity. This is the type normally used by the Geotechnical Engineering Bureau. However, because membrane thickness is directly proportional to dwell time, a thinner or thicker membrane may be obtained by decreasing or increasing the dwell time.

5.4.4 Slowly remove the mandrel from the latex and allow the excess to drip off.

5.4.5 Inspect the latex coating on the mandrel for any uncovered areas.

NOTE 10: A very small hole can be repaired by gluing a small patch of rubber membrane over the hole with rubber cement. Do this after the membrane has oven cured (Section 5.5) and while the membrane is still on the mandrel. A patch with rounded corners is most effective. A large uncovered area is difficult to repair. The procedure should be restarted beginning at Section 5.2.

5.5 Initial curing stage.

5.5.1 Place the mandrel in the oven at 158±9° F (70±5°C) for three hours.

5.6 Strip the membrane off of the mandrel.

5.6.1 With the membrane still on the mandrel, cut along the top and bottom edges of the membrane with a sharp razor blade or Exact-o-knife. The cut must be smooth and even. Apply a thin coat of rubber cement 0.5 in. (12.7 mm) wide along each edge. Allow the cement to become tacky, then carefully roll the membrane edges down 0.5 in. (12.7 mm). This procedure creates strong, tear resistant edges.

5.6.2 Dust the membrane with talcum powder. This prevents the membrane from sticking to itself when being stripped from the mandrel.

5.6.3 Carefully pull the membrane down the mandrel, stopping at intervals to dust the inside portion of the membrane with talcum powder.

NOTE 11: Avoid excessively stretching the membrane as it is not fully cured and will tear easily.

5.7 Final curing stage.

5.7.1 Completely submerge the membrane in warm water for three hours or in cold water overnight. This will remove any latent ammonia from the membrane.

5.7.2 Remove the membrane from the water and allow it to air-dry.

NOTE 12: Do not subject the membrane to stretching until it is completely dry. It is very weak and will tear quite easily.

5.7.3 Trim any rough edges from the membrane.

5.7.4 Store the membrane in a dry place away from any light source.

NOTE 13: Petroleum products will destroy natural rubber. Therefore, do not expose the membranes to petroleum based oils, petroleum jelly, etc.

NOTE 14: Tight closing cardboard boxes of sufficient size would be a good way to store the membranes.

C. STANDARD PROCEDURE FOR TACT STAND CALIBRATION

1. Start up the computer according to the procedure for "Computer Start Up".

2. Station Preparation

2.1 Turn the power on at all the stations.

2.2 Reset the mercoid control switches.

2.3 Using the airline in the cart, check setting of S-1 and S-2 regulators. The quick connects for these regulators are located on the inside of the front bottom doors. Reading the gauge on the cart, S-1 should read 30 psi (206.8 kPa) and S-2 15 psi (103.4 kPa).

2.4 Leave the airline connected to quick connect marked R-3.

2.5 Let station warm up about 20 minutes.

3. Station Exercise

3.1 Spray the platen and shaft with silicone spray.

3.2 Check to make sure that the platen spins freely.

3.3 Place a dummy load block, carefully, on the platen. DO NOT DROP.

3.4 Flip the "Mode" toggle switch (inside top front door) to "Set Mode".

3.5 Place the set pint selector switch on set point 1.

3.6 Press "Control On" (on outside of front top door).

3.7 Press "Initiate" (yellow button inside door).

3.7.1 Check air pressure on gauge on the cart (should not exceed 42 psi (289.6 kPa).

3.7.2 As the pressure approaches 40 psi (275.8 kPa), the platen with dummy load will start to rise.

3.8 After the platen stops rising, carefully push down with 3 fingers on each hand on the dummy block.

3.9 If there is any drag or sticking felt, then spray the roller bearings with silicone spray.

3.10 Repeat Step 3.8, 2 or 3 more times.

3.10.1 Check free DVM, do not let it exceed 10 lbs. (44.5 N) of force while pressing down on the dummy load.

3.11 Press down on the dummy load one more time and hold it down with right hand.

3.12 With the left hand press control off (front door).

3.13 Press "System Exhaust" (still holding load down with right hand).

4. Calibration

4.1 Lower the platen with dummy load block using the elevating mechanism.

4.2 Place the low range load cell form the cart on the station.

4.3 Lock in place with the pins.

4.4 Put the range switch located on the cart on "50" for low range "250" for medium and "2,500" for high.

4.5 Unlock the "zero adjust" knob on the cart and zero out the reading on the cart DVM.

4.6 Raise the platen until the dummy load block just touches the load point of the load cell.

 4.6.1 Watch the cart DVM.

 4.6.2 When a load is read on the DVM, back down the platen until the cart reads zero again.

4.7 Zero the free DVM, located on the front of the station.

4.8 Log in at terminal and follow instructions for "Calibrate A Station".

4.9 When the load is applied, record the values from the cart DVM and free DVM, in the record book. Make adjustments and record new values.

4.10 Press "Return" at the keyboard when ready for next load.

4.11 Repeat steps 4.9 and 4.10 for load #3.

4.12 Press "Return" again. Follow instruction on screen.

4.13 Press "Control Off" and "System Exhaust".

4.14 Remove the low-range load cell.

4.15 Mount the mid-range load cell on the station and repeat steps 4.1 through 4.7.

4.16 Follow the instructions on the screen for the mid range for loads 4, 5 and 6 (Steps 4.9 through 4.13).

4.17 Remove the mid-range load cell and mount the high-range load cell. Repeat Steps 4.1 through 4.7 and 4.9 through 4.13.

4.18 When done with load 10, press "Return".

4.19 Follow instructions on the screen.

4.20 Press "Control Off" and "System Exhaust".

4.21 Flip toggle switch to "Manual Mode".

4.22 Set Point selection on SP 7.

4.23 Control on and initiate for 30 seconds.

4.24 Press "Control Off" and exhaust.

4.25 Repeat steps 4.23 and 4.24 until pressure is about 10 psi (69 kPa).

4.26 Station power off.

4.27 Remove the high-range load cell and proceed to next station.

III. SOIL TEST

A. STANDARD TEST METHOD FOR THE UNCONSOLIDATED-UNDRAINED STRENGTH TESTING OF SOILS

1. Scope

1.1 This procedure outlines the method used by the NYSDOT, Geotechnical Engineering Bureau in the unconsolidated-undrained strength testing of soils.

2. Applicable Documents

2.1 ASTM Standard: D653 Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics.

3. Terminology

3.1 Description of Terms Related to this Standard

3.1.1 For terms related to this standard refer to ASTM D653.

4. Summary of Method

4.1 A full diameter specimen of soil, taken from either a pressed or driven soil sampler, is placed in a chamber with the appropriate confining pressure applied to it. The height to diameter ratio is to range between 2 and 3.

4.2 An axial load is applied to the specimen with data being recorded for stress and strain on the specimen.

4.3 The results are presented in the form of a stress versus percent axial strain. The peak values are determined. The compressive strength of the specimen is taken as one half of peak stress of the specimen.

5. Significance and Use

5.1 The unconsolidated-undrained strength test provides a fairly good representation of the strength of highly plastic soils and well precompressed medium plastic soils up to a depth of 30 ft. (9.144 m) below the ground surface.

5.1.1 For medium and low plastic soils not well precompressed, and for highly plastic soils below a depth of 30 ft. (9.144 m) below the ground surface, sampling disturbance will cause a drastic reduction in the unconsolidated-undrained strength test results.

6. Apparatus

6.1 Loading Device - The device shall be a constant rate of strain apparatus capable of being adjusted to multiple rates of strain. The normal strain rate for this test is 0.05 in./min. (0.021 mm/s).

6.2 Confining Chamber - The chamber shall be capable of accepting a full diameter specimen as described in Section 4.1. The chamber shall be capable of holding a confining liquid at a maximum pressure of 90 psi (620.5 kPa) without leakage occurring.

6.3 Measuring Device - The load measuring device shall be either a proving ring or load cell capable of measuring to the nearest 1 lb. (4.45 N).

6.4 Strain Indicator - The device shall be either an extensometer or deflection transducer capable of being read to the nearest 0.001 in. (0.0254 mm).

6.5 Rubber Membrane - The membrane for confining the specimen shall be of such thickness as to add negligible strength to the specimen being tested. It shall fit snugly around the specimen and extend at least 1 in. (25.4 mm) above and below the specimen. For guides as to the fabrication of membranes refer to Section II of this manual.

6.6 Balance - The balance shall be capable of weighing to the nearest 0.01 g.

6.7 Drying Oven - The oven shall be maintained at a temperature of 230±9° F (110±5° C).

6.8 Miscellaneous Equipment, including elastic bands, spatulas, trimming wire, moisture content tares, and membrane applicator.

7. Sampling

7.1 Either a driven soil sample or a relatively undisturbed soil sample obtained by standard NYSDOT Geotechnical Engineering Bureau methods shall be used in this test.

7.2 Laboratory Sample - The project Engineer shall select the appropriate laboratory sample from which the test specimen is to be obtained.

8. Specimen Preparation

8.1 The test specimen shall be a full diameter specimen with a height to diameter ratio of between 2 and 3. The specimen is trimmed carefully with a cutting wire such that both ends have a relatively smooth and flat surface, perpendicular to the sides.

8.2 Weigh and record the initial wet mass of the specimen. If moisture tares are used, either record the mass of the empty tare or tare out the balance prior to weighing the specimen.

8.3 Place the specimen on the pedestal of the confining chamber base. Carefully place the confining membrane on the specimen.

8.4 Carefully assemble the confining chamber, including filling with the confining fluid.

8.5 Apply the designated confining pressure.

DISCUSSION: This pressure is designated by the project Engineer.

9. Procedure

9.1 After applying the confining pressure, record the zero readings of all extensometers and/or transducers.

9.2 Select the designated strain rate, usually 0.05 in./min. (0.021 mm/s), and start the load application.

9.3 Readings of stress and strain shall be taken at 0.5, 1, 1.5, 2, 4, 6, 8, 10, 12, 15 and every five minutes thereafter until failure or ten percent strain is reached.

DISCUSSION: Failure is defined as reaching a peak load followed by a continual decrease in the recorded load.

10. Calculations

10.1 Calculate the initial moisture content, wet density, and void ratio using specimen masses, dimensions, and specific gravity.

10.2 Calculate percent strain, using Equation 1, for each time increment.

Equation (1)

$$\frac{|Line\ C - \sum of\ \ Column\ 1|}{Line\ C}\ x\ 100 \leq 0.4\%$$

where:

H_o = initial specimen height in (in. (mm)

H = total change in specimen height for time increment in in. (mm)

ε = percent strain

10. 3 Calculate the initial cross sectional area of the specimen using Equation 2.

Equation (2)

$$\frac{|Line\ C - \sum of\ \ Column\ 1|}{Line\ C}\ x\ 100 \leq 0.4\%$$

where:

π = constant = 3.14

r = radius of the test specimen in in. (mm)

A = the cross sectional area in in^2 (mm^2)

10.4 Calculate the corrected cross sectional area for each value of strain using Equation 3.

Equation (3)

$$\frac{|Line\ C - \sum of\ \ Column\ 1|}{Line\ C}\ x\ 100 \leq 0.4\%$$

where:

A = initial cross sectional area of specimen in in^2 (mm^2)

1-ε = 1 minus the strain in decimal form for each strain value

K = units correction factor, 144 in^2/ft^2 ($1x10^6\ mm^2/m^2$)

A_c = corrected cross sectional area for each strain value

10.5 Calculate the stress on the test specimen for each strain value using Equation 4.

Equation (4)

$$\frac{|Line\,C - \sum of\;\; Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

L = recorded load for time increment, in lb. (N)

A_c = corrected cross sectional area for each strain value, in ft^2 (m^2)

K = unit correction factor, 1 lb/ft^2 (1000 Pa/kPa)

σ = stress, in lb/ft^2 (kPa) for each strain value

DISCUSSION: The above calculations may be done by using the program for Unconsolidated Undrained Strength on the HP 87 XM computer.

11. Report

11.1 The report shall include the following:

11.1.1 The initial void ratio, moisture content, wet density, and specific gravity.

11.1.2 The visual description of the material tested.

11.1.3 The project identification including project name, PIN, hole number, sample number, and depth.

11.1.4 The Atterberg limit information, if obtained.

11.1.5 Plot of stress versus strain from which peak stress, peak strain and compressive stress using Equation 5 is determined.

Equation (5)

$$\frac{|Line\,C - \sum of\;\; Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

Q_q = peak stress in lb/ft^2 (kPa)

11.1.6 The chamber (confining) pressure in psi (kPa).

11.1.7 The rate of deflection in in./min. (mm/s).

11.1.8 The failure angle, in degrees, along with a sketch of the failure.

11.1.9 Any deviation from this described method.

B. STANDARD TEST METHOD FOR THE CONSOLIDATED-UNDRAINED STRENGTH OF SOILS

1. Scope

1.1 This procedure outlines the method used by the NYSDOT, Geotechnical Engineering Bureau for determining the consolidated-undrained strength parameters of soils.

2. Applicable Documents

2.1 ASTM Standards: D653 Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics.

3. Terminology

3.1 Description of Terms Related to this Standard

3.1.1 For terms related to this standard refer to ASTM D653.

4. Summary of Method

4.1 A relatively undisturbed sample is trimmed into three specimens of equal height and diameter. The height to diameter ratio shall be between 2 and 3.

4.2 Each specimen is confined in a separate chamber having a confining pressure as designated by the project Engineer.

4.3 After a period during which consolidation is allowed to take place (100% primary consolidation) an axial load is applied to each specimen with data for deflection and load applied being recorded.

4.4 The reduced data is presented on two plots, one being stress versus strain, the other a Mohr Circle plot of shearing stress versus normal stress.

4.5 The undrained strength parameters of friction φ and cohesion C are determined from the Mohr Circle plot.

5. Significance and Use

5.1 In most cases, the time during which construction takes place is critical from the standpoint of strength. Generally there is strength gain in the soil once consolidation due to loading has taken place. It is this period during consolidation when overloading may take place causing a strength failure of the foundation soil.

5.2 This method reports the consolidated-undrained strength parameters of the soil being tested. The results of this test give an approximation of the short term strength of the soils being tested; the strength which can be counted on during the construction phase of the project.

6. Apparatus

6.1 Loading Device - The loading device shall be capable of operating at a constant rate of strain of 0.05 in./min. (0.021 mm/s). The device shall have a load range from 0 to 200 lbs. (889.6 N).

6.2 Confining Chamber - The confining chamber shall accept a specimen with a minimum diameter of 1.4 in. (35.56 mm). It shall be capable of holding a confining liquid, without leakage at a maximum of 90 psi (620.5 kPa) with a safe minimum working pressure of 150 psi (1034.2 kPa).

6.3 Load Measuring Device - The load measuring device shall be a load cell capable of measuring to the nearest 1 lb. (4.45 N). The load shall be recorded on a strip chart recorder connected to the load cell.

6.4 Strain Measuring Device - The load ram of the loading device shall be connected to a strip chart recorder which is traveling at the same speed (0.05 in./min. (0.021 mm/s)) .

6.5 Porous Stones - The porous stones shall be of material which is inert to attack by the soils tested. The grade of stones will be such as to not allow migration of fines into the pores, yet allow drainage of the soil pore water.

6.6 Rubber Membrane - The membrane for confining the test specimen shall be of such thickness as to add negligible strength to the specimen. It shall fit snugly around the specimen and extend at least 1 in. (25.4 mm) above and below the specimen.

DISCUSSION: Generally, Trojan brand prophylactics are used as the specimen membranes.

6.7 Balance - The balance shall be capable of weighing to the nearest 0.01 g.

6.8 Oven Drying - The oven shall be capable of maintaining a temperature of 230±9° F (110±5° C).

6.9 Sample Trisector - The device shall trisect the laboratory sample into three equal sections.

6.10 Specimen Trimmer - The device shall be capable of producing three test specimens, each 1.4 in. (35.56 mm) in diameter by 4 in. (101.6 mm) high, from the trisected laboratory sample.

6.11 Miscellaneous Equipment - trimming wires, spatulas, elastic bands, moisture content tares, and membrane applicator.

7. Sampling

7.1 A relatively undisturbed soil sample obtained by standard NYSDOT Geotechnical Engineering Bureau methods shall be used in this test.

7.2 Laboratory Sample - The project Engineer shall select the appropriate laboratory sample from which the test specimens are to be obtained.

8. Specimen Preparation

8.1 An 3.375 in. (85.72 mm) laboratory sample shall be trisected in three sections using the sample trisector.

8.2 Each of the three sections shall be trimmed to a 1.4 in. (35.56 mm) diameter by 4 in. (101.6 mm) high test specimen using the specimen trimmer and trimming wire.

DISCUSSION: A 3 in. (76.2 mm) high specimen will be allowed when an untrimmable layer does not allow a 4 in. (101.6 mm) specimen to be obtained.

8.3 Weigh and record the wet mass, height, and diameter of each specimen as it is trimmed. The trimmings from Section 8.2 are placed in a plastic bag and tagged with: a visual description, project identification, hole and sample number, depth, and a request for specific gravity, Atterberg limits, hydrometer and % organic, as appropriate to the soil. The bag is sent to the General Soils Laboratory for these tests.

8.4 Place the trimmed specimens, in order by mass from the lightest to the heaviest, on the base pedestals of three confining chambers. Using the membrane applicator, place the membrane on each specimen.

8.5 Assemble the confining chamber and check for membrane leaks. Open the chamber drains and apply 2 psi (13.79 kPa) of confining pressure. If water continues to rise rapidly, or air bubbles appear in the burette, there is a membrane leak. A second membrane may be placed over the first with negligible effect on the test results.

8.6 Fill the confining chamber with confining fluid and apply the designated confining pressure. Open the drains to top and bottom drainage stones to allow consolidation to occur.

9. Procedure

9.1 The test specimens shall remain in the consolidation phase of the test for a minimum of 16 hours. The consolidation phase may be terminated once there is minimal volume change noted in the volume change burette on the test stand (t_{100} has been reached).

9.2 At the end of the consolidation phase the drainage stones are shut and the loading phase begun.

9.3 Apply the axial load at the strain rate of 0.05 in./min. (0.021 mm/s) until one of two failure modes is reached.

9.3.1 The first mode to be considered is the attaining of a peak load followed by a decrease in the applied load. If this occurs the test shall be terminated.

9.3.2 The second mode to be considered is the continual gradual build-up in applied load with no decrease in applied load is noted. When this occurs the test shall be terminated at 10 percent strain.

9.4 The load and deformation are recorded on a strip chart recorder synchronized to move at 0.05 in./min. (0.021 mm/s) with the load ram. When either of the two failure modes described in Section 9.3.1 or Section 9.3.2 is reached, terminate the test.

9.5 Remove the test specimens from the confining chamber, weigh and record final wet mass. Dry the samples for a minimum of 16 hours at 230±9° F (110±5° C).

9.6 Remove the specimens from the oven, weigh and record dry mass.

10. Calculations

10.1 Calculate the initial and final moisture content, initial and final void ratio, initial wet density, initial and consolidated area, initial and consolidated volume, and consolidated height for each of the specimens.

10.2 From the strip chart plots and using a prepared overlay, record values of load for every 0.03 in. (0.762 mm) increment of deflection (or sufficient number of values to obtain the shape of the curve) on the data sheet until failure mode one, or failure mode two is reached.

NOTE 1: Each line on the overlay represents an increment of 0.03 in. (0.762 mm).

10.3 Calculate the corrected area for each load using Equation 1.

Equation (1)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

A_c = consolidated area, in in^2 (mm^2)
ε = strain in decimal form for each load
K = unit correction factor, 144 in^2/ft^2 ($1x10^6\ mm^2/m^2$)
A_{corr} = corrected area in ft^2 (m^2)

10.4 Calculate the deviator stress for each value of load using Equation 2.

Equation (2)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

L = recorded load in lbs (N)
A_{corr} = corrected area in ft^2 (m^2)
K = unit correction factor, 1 lb/ft^2 (1000 Pa/kPa)
σ = c=deviator stress in lb/ft^2 (kPa)

NOTE 2: This total data reduction may be accomplished using the laboratory's HP 97 or 87 XM data reduction program for consolidated undrained triaxial tests.

11. Report

11.1 The report shall consist of the following:

11.1.1 An arithmetic plot of deviator stress versus strain for each specimen.

11.1.2 A Mohr Circle plot for each specimen.

11.1.3 A friction and cohesion parameter value as determined from the Mohr Circles.

11.1.4 A summary of initial and final moisture contents, void ratios, wet densities, visual description, confining pressures, failure mode sketches, specific gravity, Atterberg limits and hydrometer and % organic results, as appropriate to the soil.

11.1.5 Project identification, including name, PIN, boring number, sample number, and depth.

C. STANDARD TEST METHOD FOR THE CONSOLIDATED-UNDRAINED STRENGTH WITH PORE PRESSURE OF SOILS

1. Scope

1.1 This procedure outlines the method used by the NYSDOT Geotechnical Engineering Bureau for determining the effective consolidated-undrained strength parameters of soils.

2. Applicable Documents

2.1 ASTM Standards: D653 Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics.

3. Terminology

3.1 Description of Terms Related to this Standard

3.1.1 For terms related to this standard refer to ASTM D653.

4. Summary of Method

4.1 A relatively undisturbed sample is trimmed into three specimens of equal height and diameter. The height to diameter ratio shall be between 2 and 3.

4.2 Each specimen is confined in a separate chamber having an effective confining pressure as designated by the project Engineer.

4.3 After a period during which consolidation is allowed to take place (100% primary consolidation) an axial load is applied to each specimen with data for deflection, applied load and internal pore pressure being recorded.

4.4 The reduced data is presented on two plots, one being stress versus strain, the other a Mohr Circle plot of shearing stress versus normal stress.

4.5 The effective strength parameters of φ' and C' are determined from the Mohr Circle plot.

5. Significance and Use

5.1 In most cases it is the time during which construction takes place that is critical from the standpoint of strength. Generally there is strength gain in the soil once consolidation due to loading has taken place.

5.2 The results of this method report the effective consolidated-undrained strength parameters of the soil being tested. The results of this test give an approximation of the long term strength of the soils being tested, the strength which can be counted on following the construction phase of the project.

6. Apparatus

6.1 Loading Device - The loading device shall be capable of operating at a constant rate of strain.

6.2 Confining Chamber - The confining chamber shall accept a specimen with minimum diameter of 1.4 in. (35.56 mm). It shall be capable of holding a confining liquid without leakage at a maximum for 90 psi (620.53 kPa) with a safe minimum working pressure of 150 psi (1034.21 kPa).

6.3 Load Measuring Device - The load measuring device shall be a LVDT capable of measuring to the nearest 1 lb. (4.45 N).

6.4 Strain Measuring Device - A LVDT capable of measuring to the nearest 0.0001 in. (0.00254 mm).

6.5 Porous Stones - The porous stones shall be of material which is inert to attack by the soils tested. The grade of stones will be such as to not allow migration of fines into the pores, yet allow drainage of the soil pore water.

6.6 Rubber Membrane - The membrane for confining the test specimen shall be of such thickness as to add negligible strength to the specimen. It shall fit snugly around the specimen and extend at least 1 in. (25 mm) above and below the specimen.

DISCUSSION: Generally Trojan brand prophylactics are used as the specimen membranes.

6.7 Balance - The balance shall be capable of weighing to the nearest 0.01 g.

6.8 Oven Drying - The oven shall be capable of maintaining a temperature of 230±9° F (110±5° C).

6.9 Sample Trisector - The device shall trisect the laboratory sample into three equal sections.

6.10 Specimen Trimmer - The device shall be capable of producing three test specimens, each 1.4 in. (35.56 mm) in diameter by 4 in. (101.6 mm) high, from the trisected laboratory sample.

6.11 Miscellaneous Equipment - trimming wires, spatulas, elastic bands, moisture content tares, and membrane applicator.

7. Sampling

7.1 A relatively undisturbed soil sample obtained by standard NYSDOT Geotechnical Engineering Bureau methods shall be used in this test.

7.2 Laboratory Sample - The project Engineer shall select the appropriate laboratory sample from which the test specimens are to be obtained.

8. Specimen Preparation

8.1 A 3.375 in. (85.72 mm) laboratory sample shall be trisected in three sections using the sample trisector and trimming wire.

8.2 Each of the three sections shall be trimmed to a 1.4 in. (35.56 mm) diameter by 4 in. (101.6 mm) high test specimen using the specimen trimmer and trimming wire.

DISCUSSION: A 3 in. (76.2 mm) high specimen will be allowed when an untrimmable layer does not allow a 4 in. (101.6 mm) specimen to be obtained.

8.3 Weigh and record the wet mass, height, and diameter of each specimen as it is trimmed. The trimmings from Section 8.2 are placed in a plastic bag and tagged with: a visual description, project identification, hole and sample number, depth, and a request for specific gravity, Atterberg limits, hydrometer and % organic, as appropriate to the soil. The bag is sent to the General Soils Laboratory for these tests.

8.4 Place the trimmed specimens, in order by mass from the lightest to the heaviest, on the base pedestals of three confining chambers. Using the membrane applicator, place the membrane on each specimen.

8.5 Assemble the confining chamber and check for membrane leaks. Open the chamber drains and apply 2 psi (13.79 kPa) of confining pressure. If water continues to rise rapidly, or air bubbles appear in the burette, there is a membrane leak. A second membrane may be placed over the first with negligible effect on the test results.

8.6 Record the wet mass of a portion of the specimen trimmings and place in the drying oven for a minimum of 16 hours.

8.7 Compute the moisture content and use as initial moisture content input.

9. Procedure

9.1 Saturation

9.1.1 Prior to placing the trimmed specimens in the chambers, flood all lines and porous stones with de-aired water.

9.1.2 After chamber assembly as per section 8.5, slowly increase the chamber and back pressures simultaneously, at the rate of 5 psi (34.47 kPa) per 15 min., until reaching 100 psi (689.48 kPa).

DISCUSSION: There should be a 1 to 2 psi (6.89 to 13.79 kPa) differential between the chamber pressure and the back pressure to avoid inflation of the specimen membrane.

9.1.3 After reaching 100 psi (689.48 kPa) with the back pressure, slowly decrease the chamber and back pressure at the same rate as in section 9.1.2 until a back pressure of 30 psi (206.84 kPa) is reached.

9.2 Consolidation

9.2.1 Leaving the 30 psi (206.84 kPa) back pressure on the specimen, adjust the chamber pressure to attain the desired effective confining pressures.

9.2.2 Take initial readings from the volume change burettes for each specimen.

9.2.3 The test specimens shall remain in the consolidation phase of the test for a **minimum of 16 hours.** The consolidation phase may be terminated once there is minimal volume change noted in the volume change burette on the test stand (t_{100} has been reached). Take final readings on the volume change burettes.

9.2.4 At the end of the consolidation phase, the drainage stones are shut and the loading phase begun.

9.3 Apply the axial load at the strain rate of 1.2×10^{-3} in./min. (5.0×10^{-4} mm/s) until one of the two failure modes is reached.

9.3.1 The first mode to be considered is the attaining of a peak load followed by a decrease in the applied load. If this occurs, the test shall be terminated.

9.3.2 The second mode to be considered is the continual, gradual build-up in applied load with no decrease noted. When this occurs, the test shall be terminated at 10% strain.

9.4 The load, deformation, and pore pressure are monitored on the HP 87 XM data acquisition system. When either of the two failure modes described above is reached, terminate the test.

10. Data Reduction

10.1 Initiate the data reduction program on the HP 87 XM data acquisition system.

10.2 Input the requested information, including consolidation volume change, initial moisture content, saturation, and specific gravity.

10.3 Obtain a listing of the initial and consolidated sample conditions, and stress-strain, pore pressure, and Mohr Circle plots.

11. Report

11.1 The report shall consist of the following.

11.1.1 An arithmetic plot of deviator stress versus strain for each specimen.

11.1.2 A Mohr Circle plot for each specimen.

11.1.3 Effective strength parameter values as determined from the Mohr Circles.

11.1.4 A summary of initial and final moisture contents, void ratios, wet densities, visual description, confining pressures, failure mode sketches, specific gravities, Atterberg limits, hydrometer and o organic, as appropriate to the soil.

11.1.5 Project identification, including name, PIN, boring number, sample number, and depth.

D. STANDARD TEST METHOD FOR THE LABORATORY DETERMINATION OF MOISTURE CONTENT OF SOILS

1. Scope

1.1 This procedure outlines the NYSDOT Geotechnical Engineering Bureau method of determining the moisture content of soils.

2. Definition

2.1 Moisture Content of Soil - The ratio, expressed as a percentage, of the mass of water to the mass of dry soil in a given mass of soil.

3. Apparatus

3.1 Drying Oven, capable of maintaining a temperature of 230±9° F (110±5° C).
3.2 Balance, readable and accurate to the nearest 0.1 g (Note 1).
3.3 Containers, resistant to mass change due to corrosion or heating and cooling.

4. Procedure

4.1 Weigh a clean, dry container and record the mass. Place the representative soil sample in the container, immediately weigh and record the mass. Place the container with the soil sample in the drying oven at 230±9° F (110±5° C) (Note 2). Remove the dry sample and tare from the oven and allow to cool to room temperature (Note 3). Immediately after cooling, weigh the sample and container to the nearest 0.1 g (Note 1).

5. Calculations

5.1 Calculate the soil moisture using Equation 1 or 2 as follows:

Equation (1)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C} \, x\,100 \leq 0.4\%$$

where:
W_w = Mass of Water g
W_s = Mass of Dry Soil g

Equation (2)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C} \, x\,100 \leq 0.4\%$$

where:
W = Moisture Content (%)
W_{WS+T} = Mass of Wet Soil and Container g

W_{DS+T} = Mass of Dry Soil and Container g
W_T = Mass of Container g

Note 1. When weighing samples of less than 100 g, a balance readable to the nearest 0.01 g should be used, if available.
Note 2. In most cases, drying a soil sample overnight (about 12 to 16 hours) is sufficient. In cases where there is doubt concerning the adequacy of drying, drying should be continued until there is negligible change in mass.
Note 3. Allow to cool in a desiccator, if available.

E. STANDARD TEST METHOD FOR THE ONE DIMENSIONAL CONSOLIDATION TESTING OF SOILS

1. Scope

1.1 The procedures described are those used by the Soil Mechanics Laboratory to determine the one dimensional consolidation properties of the soils tested.

2. Applicable Documents

2.1 ASTM Standards: D653 Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics. D2435 Standard Method for One-Dimensional Consolidation of Soils.

3. Terminology

3.1 Description of Terms Related to this Standard

- 3.1.1 Coefficient of Consolidation - See ASTM D653
- 3.1.2 Compression Index - See ASTM D653
- 3.1.3 Compression Ratio, CR, (D) - The slope of the linear portion of the percent strain versus log pressure plot.
- 3.1.4 Preconsolidation Pressure - See ASTM D653

4. Summary of Method

4.1 An undisturbed specimen of soil is placed in the consolidometer which is then placed in the appropriate loading frame. An initial or zero load reading is taken from the deflection dial gauge. Loads are then applied incrementally to the sample, while deflection readings versus time are taken. Each load is left on for a predetermined length of time, usually 2.5 hours.

4.2 The data is plotted on two curves, one being deflection versus the square root of time, the other, deflection versus the log of time. From these plots, the times for ninety and fifty percent consolidation, respectively, are determined. These are used in the determination of the Coefficient of Vertical Consolidation.

4.3 The data is then further reduced in order to present the results in either a void ratio or percent strain versus log of pressure plot. From these the Compression Index or Ratio is then determined.

5. Significance and Use

5.1 The results of the consolidation tests are parameters which are used to determine the amount of settlement and the time for settlement to occur from the soil layer or layers in question.

5.2 From this the Engineer then determines the methods of construction to be followed in order to complete the project without causing distress to the structure being placed.

6. Apparatus

6.1 Load Device - The device shall be capable of applying incremental, vertical loads either through manual application of loads or computer aided application. Either device shall be capable of sustaining the applied load over long periods of time.

6.2 Consolidometer - The device shall hold the specimen in a ring which is retained within a barrel device clamped to a supporting base device, with porous stones on each face of the specimen. The barrel device shall have a reservoir to which water can be added to keep the specimen in a saturated condition. The base unit shall be capable of allowing drainage from the specimen.

6.3 Specimen Ring - The ring device shall be 2.5 in. (63.5 mm) in diameter by 0.75 in. (19.05 mm) in height. The ring shall be tapered to form a cutting edge for use in pressing the ring into the specimen.

6.3.1 Ring Material - The ring shall be made of a stainless steel grade such that it is inert to attack from the soils tested.

6.4 Porous Stones - The porous stones shall be of a material such that they will be inert to attack by the soils tested. The grade of the stones will be such as to not allow migration of fines into the pores, yet allow drainage of soil pore water.

6.4.1 The diameter of the top stone shall be such that it is able to move through the specimen ring without becoming hung-up on the sides of the ring. It shall also be tapered, with the lesser diameter being the top of the stone.

6.5 Balance - The balance shall be capable of weighing to the nearest 0.01 g.

6.6 Drying Oven - The oven shall be maintained at a temperature of 230±9° F (110±5° C).

6.7 Extensometer - The extensometer shall be capable of measuring the change in height of the specimen to the nearest 0.0001 in. (0.00254 mm).

6.8 Miscellaneous Equipment - trimming wires, screeds, and moisture content tares.

7. Sampling

7.1 A relatively undisturbed soil sample obtained by the standard NYSDOT Geotechnical Engineering Bureau methods shall be used in the consolidation test.

7.2 Laboratory Sample - The project Engineer shall select the appropriate laboratory sample from which the test specimen is to be obtained.

8. Specimen Preparation

8.1 The test specimen shall be trimmed using the specimen ring from the consolidometer assembly. Carefully, with a constant, even pressure, push the ring into the laboratory sample. When the ring is approximately one half filled with soil, trim away the excess soil around the outside of the ring. Continue to push the ring into the sample until the soil is slightly above the top edge of the ring. Carefully, using a trimming wire, trim off the excess soil flush with the top edge of the ring. Cut the specimen and ring from the laboratory sample. Trim away excess soil flush with the cutting edge of the ring. Remove any excess soil from around the outside of the ring. Record the visual description of the specimen determined from these trimmings,

8.2 Weigh the specimen and ring and record the mass on the proper form. The mass of the ring shall be determined prior to trimming a specimen.

8.3 Place the tapered stone, with the larger face on the soil, on top of the specimen. Place the retaining barrel over the ring and stone.

8.4 Place this assembly onto the consolidometer base which has the bottom porous stone in place. Place the retaining ring of the consolidometer over the barrel and fasten to the base.

9. Procedure

9.1 Place the consolidometer assembly into the appropriate load frame and complete assembly. Adjust the extensometer and take a zero reading.

9.2 Fill the top reservoir and bottom drainage port with water. Check the extensometer for soil swelling. If swelling occurs, apply the 125 lb/ft^2 (5.98 kPa) load immediately and recheck for swelling. Apply loads to the specimen until swelling ceases. The loads which are applied to the specimen are 125, 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000, 64,000 lb/ft^2 with each load applied for the specified time, except in the case of swelling outlined above. The values above correspond to 5.98, 11.97, 23.94, 47.88, 95.76, 191.52, 383.04, 766.08, 1532.17, 3064.34 kPa

DISCUSSION: For certain specimens, it may be required to know the recycle Coefficient of Consolidation. In these cases, when the specimen has reached, approximately the preconsolidation pressure, remove three loads, one at a time, for the load time. After the third load has been removed and remained for the specified load time, reapply the loads, one at a time, for the specified load time. Continue the normal loading sequence from there on.

9.3 For all loads applied, record initial and final extensometer readings. For loads specified by the project Engineer take extensometer readings at 1, 2, 4, 6, 8, 10, 12, 15, 20, 30, 45, and 60 seconds, 1.25, 1.50, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 15, 20, 25, 30, 45, 60, 75 and 90 mins. and every 30 mins. thereafter until load time is completed. At the end of each load time apply the next increment of load.

9.4 Following the maximum load in the loading sequence, remove three loads at once, and allow to remain under this load for the specified load time. Record the final reading.

9.5 Remove the remaining loads from the specimen. Remove the consolidometer from the load frame. After disassembling the consolidometer, remove the test specimen from the ring and place in a moisture content tare.

9.6 Oven dry the specimen for a minimum period of 16 hours at 230±9° F (110±5° C). Weigh and record the dry mass of soil.

9.7 The porous stones shall be cleaned periodically by either boiling in water or submerging in the ultrasonic cleaner.

10. Calculations

10.1 Plot the deflection curves for the load increments for which deflection versus time data was taken. These curves shall be plotted during the progression of the test. These plots are the deflection versus log time and square root of time referred to in Section 4.2.

10.2 Determine the 100 percent primary consolidation point on the deflection versus log time plot. The point of 100 percent primary consolidation is determined by first constructing a line tangent to the steepest portion of the curve, then constructing a straight line through the final deflection readings. The point of intersection of the two lines is the point of 100% primary consolidation.

10.3 Determine the point of 50% primary consolidation by determining the mid-point between the first point plotted and 100% consolidation. The point of this intersection on the deflection versus log time plot is the 50% consolidation point. The time corresponding to this point is time for 50% consolidation (t_{50}).

10.4 For each load increment where the above plot was constructed determine the coefficient of consolidation using Equation 1:

<u>Equation (1)</u>

$$\frac{|Line\,C - \sum of\;\; Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

H = the average height of the specimen, for each load increment, for a double drained specimen in in. (mm)

t_{50} = the time for 50% primary consolidation to occur in seconds (min.)

C_v = the coefficient of consolidation in in^2/min (mm^2/s)

10.5 Determine the 90% primary consolidation point on the deflection versus square root of time plot. This point is determined by first constructing the straight line approximated by the initial portion of the curve. Select any point on the square root axis from this straight line. Multiply this value by 1.15. Construct a new straight line through this point back to the t = 0 point of intersection of the first line. Where this line intersects the deflection versus square root curve is the square root of the time for 90% primary consolidation to occur.

10.6 For each load increment when the above plot was constructed determine the coefficient of consolidation using Equation 2:

Equation (2)

$$\frac{|Line\ C - \sum of\ \ Column\ 1|}{Line\ C} x\ 100 \leq 0.4\%$$

where:

H = the average height of the specimen, for each load increment, for a double drained specimen in in. (mm)

t_{90} = the time for 90% primary consolidation to occur in seconds (min.)

C_v = the coefficient of consolidation in in^2/min (mm^2/s)

10.7 Using Equations 3-6, compute the initial void ratio, moisture content, wet density and degree of saturation

Equation (3)

$$\frac{|Line\ C - \sum of\ \ Column\ 1|}{Line\ C} x\ 100 \leq 0.4\%$$

where:

V_v = Volume of Voids

V_s = Volume of Solids

e_o = Initial Void Ratio

Equation (4)

$$\frac{|Line\ C - \sum of\ \ Column\ 1|}{Line\ C} x\ 100 \leq 0.4\%$$

where:

W_w = Mass of Water

W_s = Mass of Solids (Dry Soil)

w = Moisture Content (%)

Equation (5)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

W_t = Total Wet Mass of Soil in lbs (kg)
V_t = Total Volume of Specimen (Volume of Specimen Ring) in ft^3 (m^3)
γ_t = Wet Density in lb/ft^3 (kg/m^3)

Equation (6)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

V_w = Volume of Water
V_v = Volume of Voids
S = Degree of Saturation (%)

Equation (6a)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

e_o = Initial Void Ratio
G = Specific Gravity of Solids
w = Moisture Content
S = Degree of Saturation (%)

DISCUSSION: The following calculations or relationships are used in determining some of the values in the calculations.

V_s= W_s/G when Eq 3 values are in the International System of Units.

V_w= W_w when Eq 6 values are in the International System of Units.

V_v= V_t - V_s Eq 6

10.8 Using the final deflection reading for each load, compute the percent strain using the original specimen height.

Equation (7)

$$\frac{|Line\,C - \sum of\;\; Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

H = Total Change in Specimen Height up to and Including the Load for which the Calculation is Made

H_o = Initial Specimen Height (Specimen Ring Height)

ε = Strain (%)

An alternative method is to compute the final void ratio for each load increment using Equation 3, where the volume of voids will change for each load.

DISCUSSION: The calculations done above are programmed to be done on the Soil Mechanics Laboratory HP Programmable Calculator, and the HP 87 computer. They are also accomplished through the use of the TACT System.

11. TACT Procedure

11.1 Turn on Tact Stations to be used for a 20 minute warm-up period.

11.2 Log in at the computer terminal. Make a note of the test number on the worksheet. Follow the instructions on the screen.

11.3 Trim sample as per Section 8.

11.4 Remove the reaction bar/transducer assembly from the station.

11.5 Lower the platen, using the worm gear screw inside the lower front door.

11.6 Carefully place the consolidometer assembly on the platen.

11.7 Replace the reaction bar/transducer assembly making sure not to load sample.

11.8 Raise the platen and consolidometer until the Lucite just touches the load point of the reaction bar.

11.9 Slowly lower the yoke handle to engage the deflection transducer probe.

11.10 Return to the computer and complete the entries.

11.11 Press the test start button at the station in use. The test ready light will go out, and numbers will appear under load sequence and set point.

NOTE: When the test is complete, the red light on the pedestal will be flashing.

11.12 Stop the test at the computer.

11.13 Press the button on the front of the door marked "Off" (Green Button).

11.14 Press the button marked “System Exhaust” and hold until air in chamber is exhausted. The platen will lower as air escapes.

11.15 Raise the yoke handle to disengage the deflection transducer and pull the pins.

11.16 Remove and disassemble the consolidometer assembly and place the soil sample in a moisture content tare.

11.17 See 9.6

11.18 See 9.7

11.19 If the computer is not running, restart and allow to warm up about 20 minutes.

11.20 Return to the computer and follow the instructions on the screen.

12. Report

12.1 The report of test results shall include the following:

12.1.1 Project identification including name, PIN, hole number, tube number, and depth of sample.

12.1.2 Moisture content.

12.1.3 Degree of saturation.

12.1.4 Initial void ratio.

12.1.5 Wet density.

12.1.6 Specific gravity.

12.1.7 Plot of percent strain or void ratio versus log of applied pressure.

12.1.8 Plot of values of coefficient of consolidation versus log of applied pressure.

12.1.9 Preconsolidation pressure as determined from percent strain or void ratio versus log of applied pressure plot.

12.1.10 Depending on which plot, percent strain or void ratio versus log of applied pressure, determine the compression ratio or compression index respectively.

12.1.11 Any deviation from the procedure described in this method.

F. STANDARD TEST METHOD FOR THE SOILS BLOCK PERMEABILITY TEST

1. Scope

1.1 The purpose of the block permeability test is to determine the ratio of the horizontal to vertical coefficient of permeability, k_H/k_V, on the same sample using the falling head method.

2. Significance and Use

2.1 The block permeability test is a falling head test capable of measuring the vertical as well as the horizontal permeability on the same sample.

2.2 The test equipment will specifically be used in the determination of the ratio of horizontal to vertical permeability, k_H/k_V, which is identical to the ratio of the horizontal to vertical coefficient of consolidation, C_H/ C_V. The C_H/ C_V, ratio is vital for the inclusion of horizontal drainage effects in the determination of time rate of settlement of loaded foundations and for the determination of spacing of vertical sand drains, or wick drains, used to accelerate foundation settlements. The tests are run in a modified high pressure triaxial cell which allows consolidation of the sample and the use of a high back pressure to eliminate the effects of air or gases.

3. Summary of Method

3.1 The development of this test required the fabrication of special pieces of equipment such as a square base pedestal, square top cap, a membrane former, a membrane stretcher and sample trimmer.

3.2 The block permeability test procedure and test apparatus now used in the Bureau (See Figures 1 and 2) are similar to the permeability test developed at M. I. T. by Ladd and Wissa.[1]

3.3 The vertical and horizontal permeability's are achieved on the same sample (in cube form) by rotating the sample into the proper plane.

3.4 Two clear graduated cylinders are used to measure the flow of water into and out of the sample.

4. Apparatus

4.1 A high pressure triaxial chamber was modified by replacing the conventional circular base pedestal and top cap with a base and cap machined out of acrylic (See Figure 2). A 2 in. (50.8 mm) square base and cap system was fabricated for use with samples extruded from a 83.375 in. (5.72 mm) Shelby tube or 2.875 in. (73.02 mm) brass liner.

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[1] S. K. Saxena, J. Hedbery, C. C. Ladd, Results of Special Laboratory Testing Program on Hackensack Valley Varved Clay, June 1974, Research Report R74-66 Soils Publication 342, Department of Civil Engineering, Massachusetts Institute of Technology.

4.2 The membrane (See Figure 4) used in this test is not commercially available and must be made using a special shaped former and liquid latex. The former was machined out of wood with a polyurethane coating. It conforms in shape to the top cap, sample cube, and bottom base. However, it is slightly smaller in dimension thus ensuring a snug fit and seal.

4.3 The membrane stretcher (Figure 3) consists of a square acrylic tube with a longitudinal groove located in each corner of the tube extending from the top to the bottom. These grooves are interconnected around the outside perimeter of the acrylic tube by means of 0.25 in. (6.35 mm) tee fittings and 0.25 in (6.35 mm) plastic tubing at each outside corner. The 0.25 in. (6.35 mm) tubing is connected to a vacuum source which expands the membrane when it is to be placed on a sample.

4.4 The sample trimmer (See Figure 5) consists of a rotating base mounted on a 2 in. (50.8 mm) high pedestal which is permanently located between two 0.375 in. (9.52 mm) vertical rods. The vertical rods are guides for the wire cutter used to trim the sample. A spring loaded locking pin mounted on the side of the pedestal engages the rotating base every 90 degrees.

4.5 The following is required general equipment in addition to that previously mentioned:

a) Two 200 psi (1378.95 kPa) gauges with a 0.25 percent full scale accuracy.

b) Two 200 psi (1378.95 kPa) regulators.

c) Two clear 0.5 in. (12.7 mm) I.D. cylinders – graduated in centimeters and tested to a pressure of 180 psi (1241 kPa) – are used to measure the flow of water into and out of the sample and are referred to in this text as reservoirs.

5. Test Procedure

5.1 To ensure there is no air in the lines, the system should be flushed and recharged with de-aired water. To accomplish this, first detach air pressure lines from both reservoirs, connect drain lines to reservoirs and place loose ends in sink. Pressurize de-aired water tank (located under counter). Open valve marked "main tank to reservoirs". Open reservoir valves to "de-aired water" position. Allow reservoirs to overflow until all air is expelled from lines. Close valves, reconnect air pressure lines to reservoirs, and allow contents of reservoirs to flood back through stones. Refill reservoirs, then reapply vacuum to de-aired water tank. The system should be completely de-aired now. This procedure should be performed before each test.

5.2 Review the x-ray film of an undisturbed sample tube to select the sample to be tested. All undisturbed sample tubes and driven liners used for testing by the Geotechnical Engineering Bureau are x-rayed prior to the extrusion of any material.

5.3 After extruding a selected 3 in. (76.2 mm) sample form the undisturbed sample tube, the sample is placed on the rotating base of the sample trimmer (See Figure 5) and is trimmed to a 2 in. (50.8 mm) square using a wire cutter and rotating the base 90 degrees three times.

5.4 An acrylic tube (See Figure 6) 2 in. (50.8 mm) in height and 2.5 in. (63.5 mm) square inside is carefully placed over the sample. Care should be taken to note which is the top and which is the bottom of the sample. The sample and acrylic tube are then removed from the base and placed on a counter top to finish trimming the top and bottom to a 2 in. (50.8 mm) length. The sample should be weighed.

5.5 The top and bottom stones are flooded with de-aired water. This is accomplished by opening the valves to the stones and applying a slight back pressure. As soon as both stones are flooded, filter paper (Eaton-Dikeman, Grade 615) cut to size is placed on both stones. Next, the sample, orientated in the vertical direction, is placed on the base. Then the top cap is placed on the sample with the quick-disconnect uncoupled (the fluid line from the chamber base to the top cap contains a quick disconnect, which allows for disconnecting the top stone during the application or removal of the membrane).

5.6 The membrane is placed in the stretcher and the vacuum applied. Next, the membrane and stretcher are slowly lowered over the sample, and at the proper position, the vacuum is turned off allowing the membrane to leave the stretcher and encompass the sample, top cap and base. The stretcher is removed and the membrane is sealed top and bottom using flat rubber bands. Open top stone valve and allow water flow while connecting quick disconnect, then close valve. The quick disconnect is reconnected and the triaxial chamber is carefully lowered over the sample and locked in place. The chamber is then filled with a sufficient amount of water to cover the top cap and quick disconnect.

5.7 The confining and back pressures are placed on the sample in 10 psi (68.95 kPa) increments, the first setting being 10 psi (68.95 kPa) confining, and 0 psi (0 kPa) back pressure. Never allow the back pressure to exceed the confining pressure. Each increment is allowed to consolidate and the water levels in the reservoirs are recorded. The maximum confining pressure is 150 psi (1034.21 kPa) and the maximum back pressure is 100 psi (689.48 kPa).

NOTE 1: The level of the chamber fluid should be marked and it should be checked prior to increasing to the next increment. A drop in chamber fluid and rise in reservoir level indicates leakage in the membrane. If this occurs, a new membrane must be applied to sample.

NOTE 2: Start test with reservoir levels even so there will be no flow through sample.

5.8 After the sample has been allowed to consolidate at the last increment, the valves to the top and bottom stones are closed and the two reservoirs are then moved into position to conduct the falling head permeability phase of the test. The reservoir connected to the bottom stone is elevated above the sample chamber and the reservoir connected to the top stone is lowered below the elevation of the sample chamber. Thus the flow of water will be from the bottom of the sample to the top, forcing any trapped air out.

5.9 The initial water level of each reservoir is recorded and the valves are then reopened. The changing water levels are recorded at 1/2 hour intervals until both reservoir levels change consistently. When this occurs, the distance (or initial head) between the two reservoir water levels is measured and recorded with time. The water levels are then recorded from this point, at 1/2 hour intervals for 3-7 hours depending on the type of soil being tested.

5.10 At the completion of the vertical phase of the permeability test the system is shut down. The stone valves are closed, the air pressure is bled off, the reservoirs are returned to the counter, and, after the chamber fluid is removed, the chamber is removed from the base.

5.11 Carefully stretch top of membrane and pull down over sample to bottom pedestal. Remove sample. Then remove membrane from pedestal.

5.12 Steps 5.5 through 5.11 are repeated for the horizontal phase of the permeability test with the rotated sample placed on the base, i.e., the horizontal layers of the sample being in a vertical direction.

5.13 Upon completion of the horizontal phase, the stones are flushed into a tare with the sample. The sample is weighed and oven dried for a final moisture content.

6. Calculations

6.1 The permeability is computed using the formula given below:

Equation (1)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

k_H = Horizontal Permeability in./sec. (cm/sec)

k_v = Vertical Permeability in./sec. (cm/sec)

T = Time (hrs.) form the Initial Head to the Final Head, Starting when Section 5.8 Conditions are Met.

H_f = Final Head, computed (See Figure 7)

H_i = Initial Head, measured

C = A Constant of 5.999 for 2 in. (50.8 mm) sample with 0.5 in. (12.7 mm) Diameter Reservoirs. This is derived from the following:

Equation (2)

$$\frac{|\,Line\ C - \sum of\ \ Column\ 1\,|}{Line\ C}\ x\ 100 \leq 0.4\%$$

where:

a = Cross Sectional Area of the Reservoir 0.5 in. (12.7 mm) Diameter
  = 0.197 in^2 (1.27 cm^2)

A = Cross Sectional Area of the Soil Sample = 4 in^2 (25.81 cm^2)

L = Length of Soil Sample = 2 in. (5.08 cm)

To obtain head measurement using 0.5 in. (12.7 mm) diameter standpipes (reservoirs) when standpipes are in position for the permeability phase of test, the measurement from 1 ft. (30 cm) on the upper reservoir to 1 ft. (30 cm) on the lower reservoir is equal to 4.01 ft. (122.22 cm). See Figure 8 for block permeability data sheet, SM 447.

7. Report

7.1 The report of test results shall be made up of the following:

7.1.1 The identification of the project, Project Identification Number, hole number, sample number, and sample depth.

7.1.2 A visual description of the soil tested.

7.1.3 The results as computed for the horizontal and vertical coefficients of permeability.

7.1.4 Any variations from the method described in this procedure.

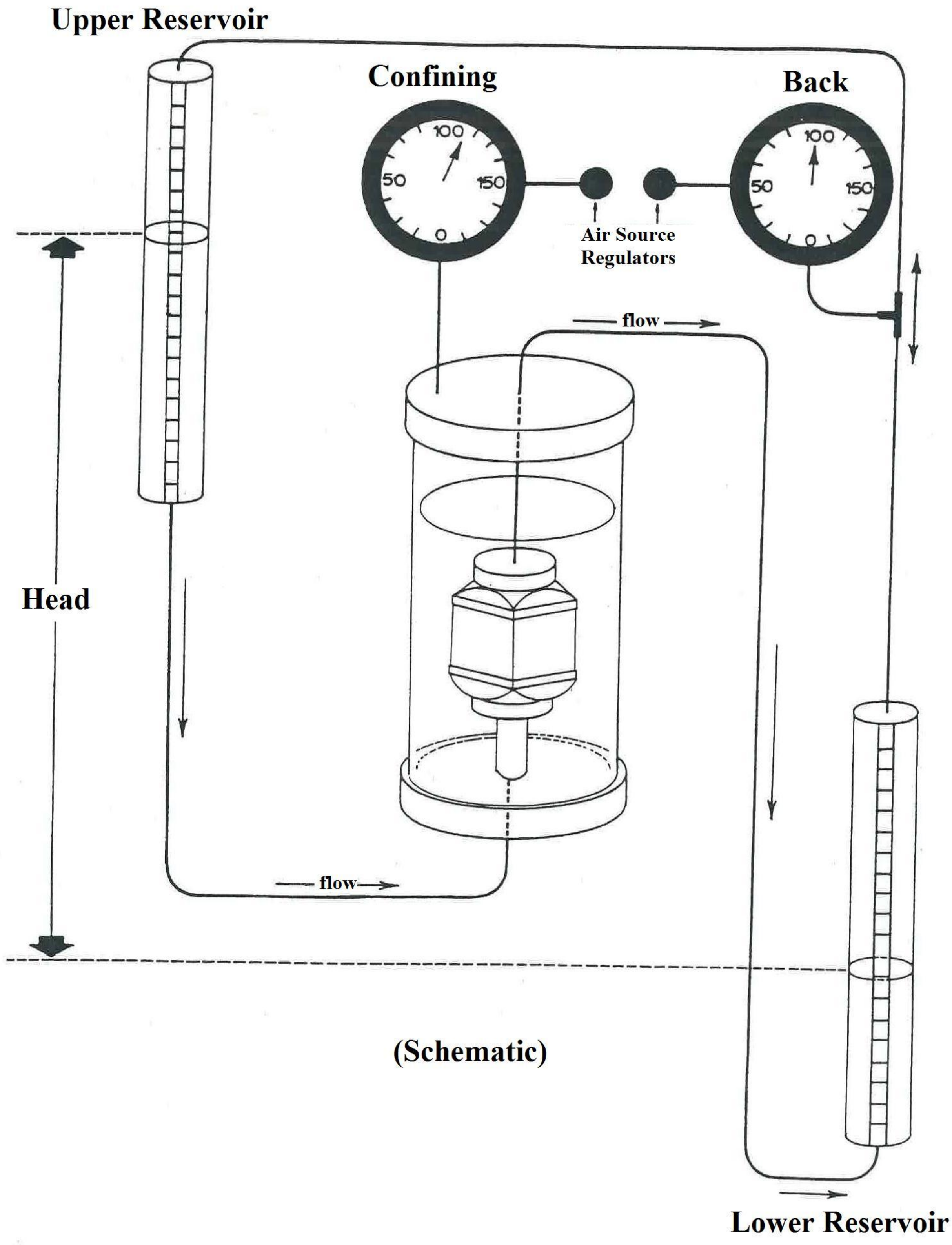


Figure 1 Block Permeability Test Apparatus

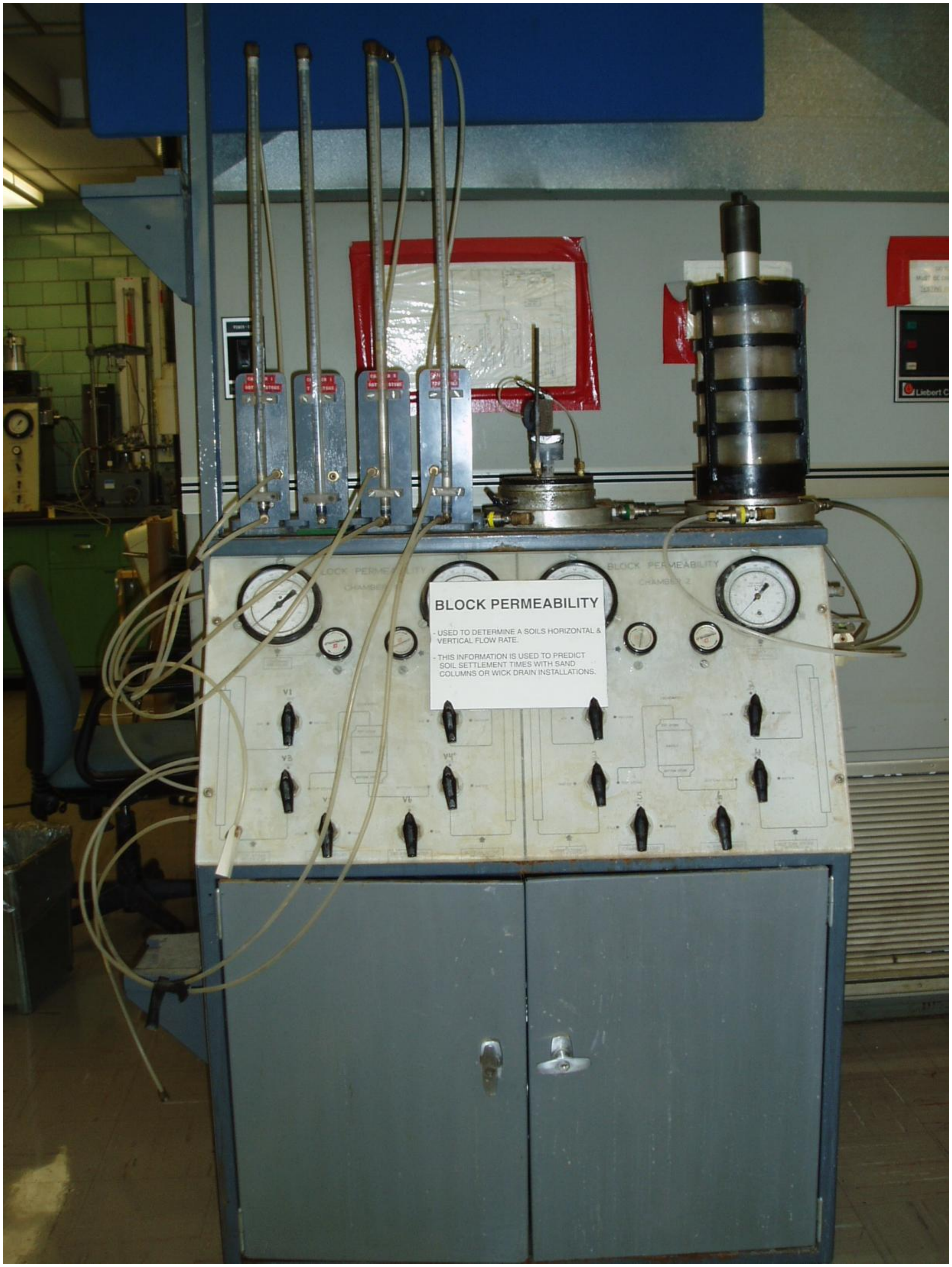


Figure 2 Block Permeability Test Apparatus: Base Pedestal and Top Cap Mounted on Chamber Base (upper middle), Chamber (upper right)

Figure 3 Membrane Stretcher: Rubber membrane is placed inside and pulled over top and bottom edges of stretcher. Vacuum is then applied, pulling membrane outward.

Figure 4 Rubber Membrane

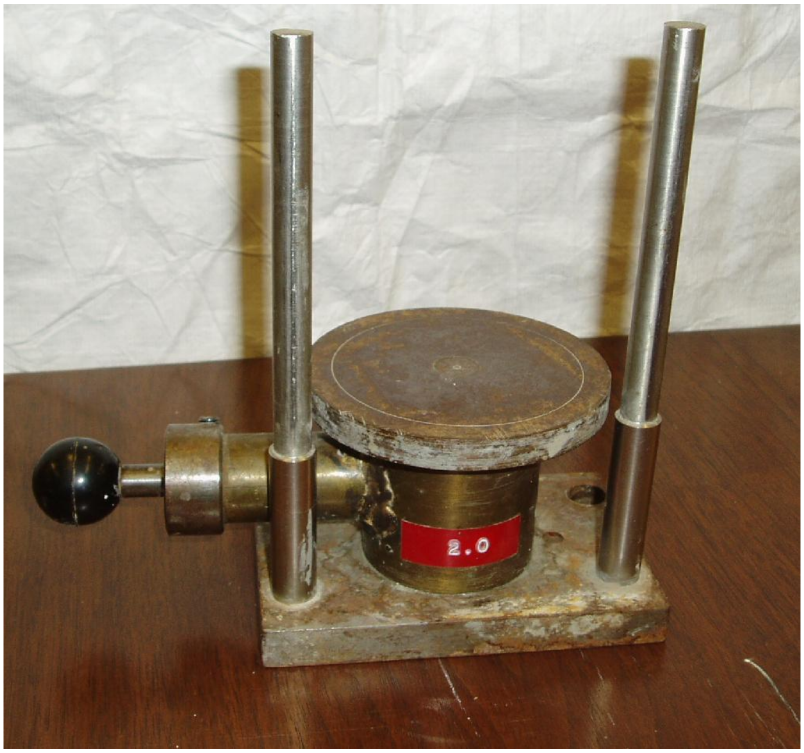


Figure 5 Trimming Device

Figure 6 Acrylic Tube: I.D. is oversized to fit over trimmed sample. Lay tube and sample on side to trim cube.

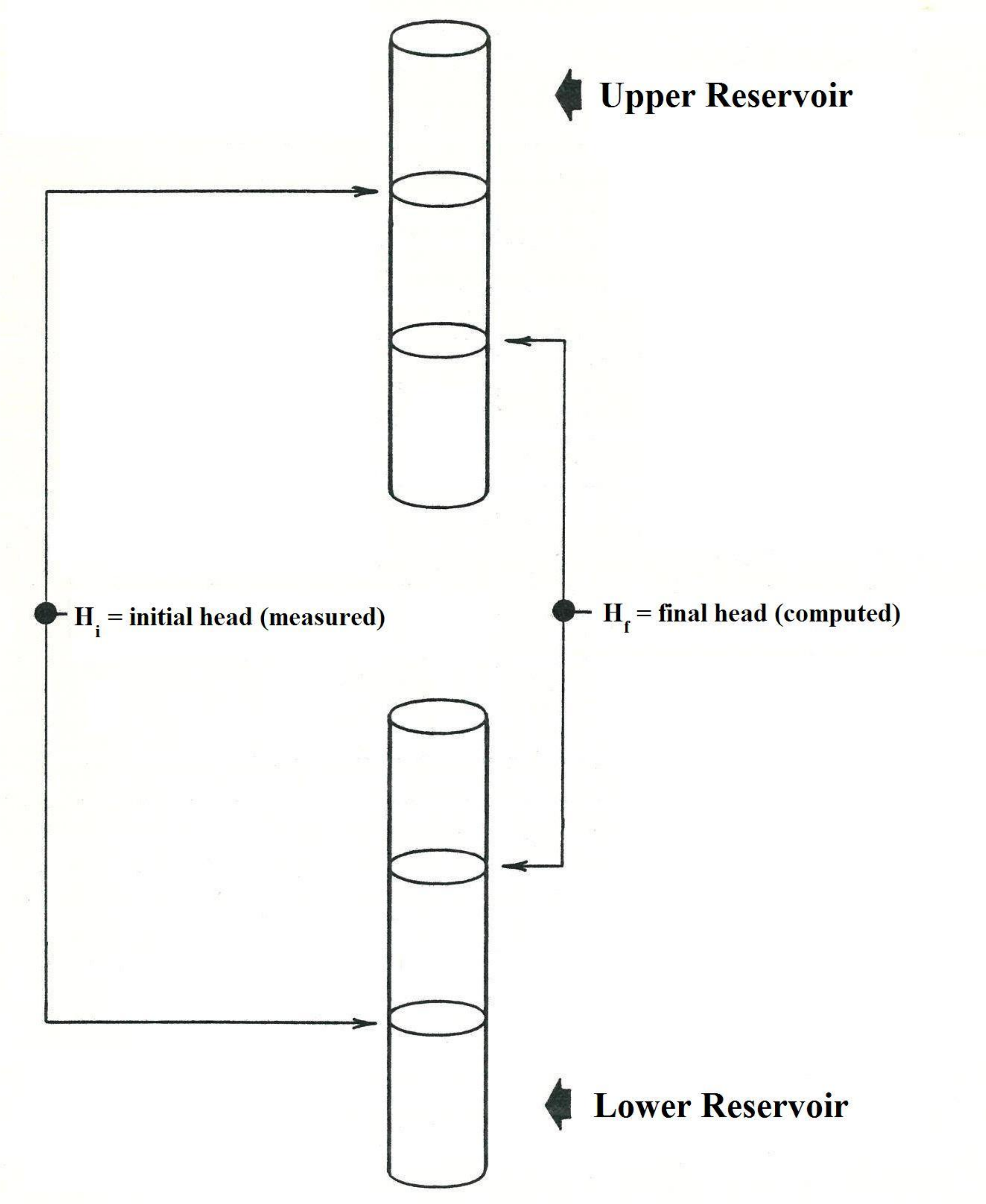


Figure 7 Block Permeability Test (Falling Head)

SM 447 (10/80)

BLOCK PERMEABILITY

PROJECT: ______________________

P.I.N.: __________ HOLE: ________ TUBE: ____

DEPTH: __________

DESCRIPTION: __________

DIRECTION:
☐ VERTICAL
☐ HORIZONTAL

TEST BY: ______________________

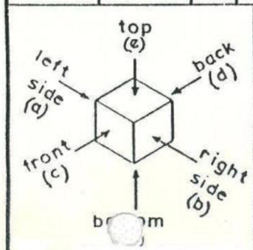
DATE: ______________________

MAX. CONFINING PRESSURE ______ P.S.I.

MAX. BACK PRESSURE ______ P.S.I.

CONSOLIDATION PHASE

DATE / TIME	RESERVOIR LEVEL (CM.)				PRESSURE (P.S.I.)	
	TOP STONE	Δ	BOTTOM STONE	Δ	CON-FINE	BACK



sample measurements:
before test
a⟷b: ______ cm.
c⟷d: ______ cm.
e⟷f: ______ cm.
after test
a⟷b: ______ cm.
c⟷d: ______ cm.
e⟷f: ______ cm.

PERMEABILITY PHASE

DATE / TIME	HEAD	UPPER RES. (CM.)	Δ	LOWER RES. (CM.)	Δ

DATE / TIME	HEAD	UPPER RES. (CM.)	Δ	LOWER RES. (CM.)	Δ

Figure 8 Block Permeability

IV. GEOTEXTILE AND RELATED PRODUCTS TESTS

A. STANDARD TEST METHOD FOR TESTING PREFABRICATED WICK DRAINS IN THE CRIMPED CONDITION

1. Scope

1.1 This method covers the procedure to determine the effectiveness of wick drains under crimped conditions.

2. Introduction

2.1 When testing wick drains by means of a consolidometer (see NYSDOT GEB Wick Drain Consolidation Test) it was discovered that during consolidation of a surrounding soil a folding over or crimping action took place in the drains.

2.2 Crimping in some instances was as much as 90°. After noting that this occurred regularly, a test was devised to determine what effect the crimping had on the flow rate capacity of the drain, since, if the volumetric flow rate decreased to less than that of the soil the wick is placed in, the wick would be ineffective.

3. Apparatus

3.1 The device must be able to maintain a constant head of water on the wick drain being tested, and consists of the following parts: Water Chamber Assembly, Stand and Crimping Device. (See Fig. 1).

3.2 Water Chamber Assembly:

3. 2.1 This assembly consists of a top plate, bottom plate, and cylindrical center section, all constructed of acrylic.

3.2.2 The top and bottom plates are grooved, and each have four holes drilled through them so that the cylindrical center section may be securely clamped between them by means of four threaded rods.

3.2.3 The top plate is 8 in. (203.2 mm) in diameter, 0.75 in. (19.05 mm) thick, and has a 3 in. (76.2 mm) diameter hole through the center to allow de-aired water from a holding tank to enter the chamber.

3.2.4 The bottom plate is 8 in. (203.2 mm) in diameter, 0.75 in. (19.05 mm) thick, and has a 4 in. by 0.25 in. (101.6 mm by 6.35 mm) slot through which the top of the wick drain test sample is placed.

3.2.5 The center section is dipped in an air-drying plastic coating material (P. D. S.) around the bottom for a water tight seal. The cylinder has an inside diameter of 5.5 in. (139.7 mm), and is 9.125 in. high by 0.25 in. thick (231.78 mm high by 6.35 mm).

3.2.6 There is a 1 in. (25.4 mm) diameter drainage pipe located 0.875 in. (22.22 mm) down from the top of the cylinder with a semicircular piece blocking the bottom half of the drain pipe opening. This piece provides a means for maintaining a constant head.

3.2.7 The bottom plate of the water chamber assembly has two sets of opposing 0.25 in. (6.35 mm) diameter holes. Two 0.25 in. diameter x 0.25 in. high (6.35 mm diameter x 6.35 mm high) rods extending up from the top of the vertical stand plate (described in next section) fit into either set of these holes (depending on the thickness of the wick drain).

3.2.8 A clamp, which is bolted through the top of the vertical stand plate brace, swivels over the bottom water chamber assembly plate. This plate and the above mentioned holes and rods are the means by which the water chamber assembly is connected to the stand.

3.3 The Stand

3.3.1 The stand consists of a vertical acrylic plate, 21 in. (533.4 mm) high, 7 in. (177.8 mm) wide and 0.5 in. (12.7 mm) thick, bolted to a horizontal acrylic plate 18 in. (457.2 mm) long, 9 in. (228.6 mm) wide and 0.5 in. (12.7 mm0 thick.

3.3.2 Bolted flush to the vertical plate is another acrylic plate 14 in. (355.6 mm) long, 7 in. (177.8 mm) wide, and 0.875 in. (22.22 mm) thick. This is the guide that the wick drain is placed against.

3.3.3 A 9.25 in. (234.95 mm) by 6 in. (152.4 mm) by 0.5 in. (12.7 mm) acrylic plate is connected by four 3 in. (76.2 mm) bolts to the vertical plate. This plate is drawn snug up against the wick drain to insure the proper cross sectional area.

3.3.4 A Vee (V) is notched into the guide plate 11 in. (279.4 mm) from the top.

3.4 Crimping Device

3.4.1 The crimping device consists of a crimping wedge, a brace that attaches to the vertical stand and a threaded rod with a knob at the end.

3.4.2 The crimping wedge is driven into the Vee notch by means of the threaded rod device, with the black knob rotated counterclockwise.

4. Test Procedure

4.1 Three 24 in. (609.6 mm) samples of the wick drain are cut. Each sample is then wrapped in 3M window insulator plastic and sealed with 1 in. (25.4 mm) wide scotch type tape. Then, the plastic is shrunk around the wick drain with a hair dryer. This is to help insure that the de-aired water is actually passing through the cross sectional area of the drain and so that the water can be collected and measured.

4.2 The plastic wrapped wick drain samples are pre-soaked in tap water for at least two hours.

4.3 The wick-drain is sealed approximately 0.5 in. (12.7 mm) up through the slotted bottom plate of the cylindrical water chamber assembly with Miracle Seal.

4.4 Miracle Seal is used to seal the space around the wick-drain through the slotted bottom plate so that water will not pass through the slot outside of the plastic surrounding the wick drain. The wick is sealed around the slot, both on the top and bottom of the plate.

4.5 The wick drain then passes between the stand and the rectangular acrylic plate. The drain is clamped snug between by means of the four bolts passing through the plate into the stand. This is done so that water does not bulge out between the plastic and drain itself, thus insuring that the water passes through the wick-drain cross sectional area.

4.6 The drain then passes the crimping clamp and is turned horizontally to pass between two Plexiglas plates. The bottom plate is secured to the vertical stand plate by two adjustable threaded rods. The top plate is connected to the bottom plate with two bolts and two wing nuts.

4.7 These two plates are used to maintain a constant head after the wick-drain is crimped. (Since the drain was suspended vertically and then crimped the crimping would raise the bottom end of the drain thus shortening the head). The wick passes between these plates and is bolted snug.

4.8 The distance from the top of the drain pipe in the cylindrical water chamber assembly to the upper surface of the bottom horizontal plate (Section 4.7 above) is 24.6925 in. (627.06 mm).

4.9 The above water is allowed to flow from the holding tank into the water chamber assembly until a level even with the top of the drain pipe is maintained.

4.10 The water passing the wick-drain sample is collected in a glass beaker from the end of the wick protruding between the two horizontal plates.

4.11 Five flow measurements (Q) (ml) over time interval (t) (generally 5 seconds each) are taken.

4.12 The horizontal plates are loosened, the wick-drain sample is then crimped by rotating the black knob counterclockwise until completely tight then backed off half a turn. This pulls the wick horizontally toward the vertical stand through the two horizontal plates. If the wick no longer protrudes from between the plates, they may be adjusted closer to the stand. This insures that the same head is maintained (24.6875 in. (627.02 mm)) for both uncrimped and crimped samples.

4.13 Re-snug the wick between the two horizontal plates and repeat 4.11.

4.14 Repeat above for three samples and measure temperature of de-aired water and 0_2 content into and out of sample wick-drain.

4.15 De-aired water is used to avoid the effects air saturated water has on the permittivity of wick-drains.

5. Calculations

5.1 From the test data, the average (Q, in ml) for each of the five sets of readings is computed.

5.2 The Velocity of Flow (V) (ml/sec) is then computed V = Q/t.

5.3 Then the average (V) form the five Q's measured is computed.

5.4 The above (1, 2, 3) is done first with the uncrimped then the crimped data for each sample.

5.5 Then the average velocity of flow uncrimped (V_{uc}) minus the average velocity of flow crimped (V_c) is computed (for each test sample).

5.6 Then $(V_{uc} – V_c)/V_{uc}$ x 100 is computed: the percent change in (V) due to crimping of the wick drain.

6. Report

6.1 Record the following on Wick Drain Crimp Test Data Sheet:

6.1.1 Head (h) mm, time interval (t) seconds, quantity of flow (Q) ml.

6.1.2 Average quantity of flow (Avg. Q), velocity of flow (V) ml/sec.

6.1.3 Average velocity of flow (Avg. V), Avg. V uncrimped minus Avg. V crimped $(V_{uc} – V_c)$.

6.1.4 Percent change in avg. velocity due to crimping $(V_{uc}-V_c)/V_{uc}$ x 100.

6.1.5 Temperature of de-aired water (T) C.

6.1.6 O_2 content into and out of wick drain.

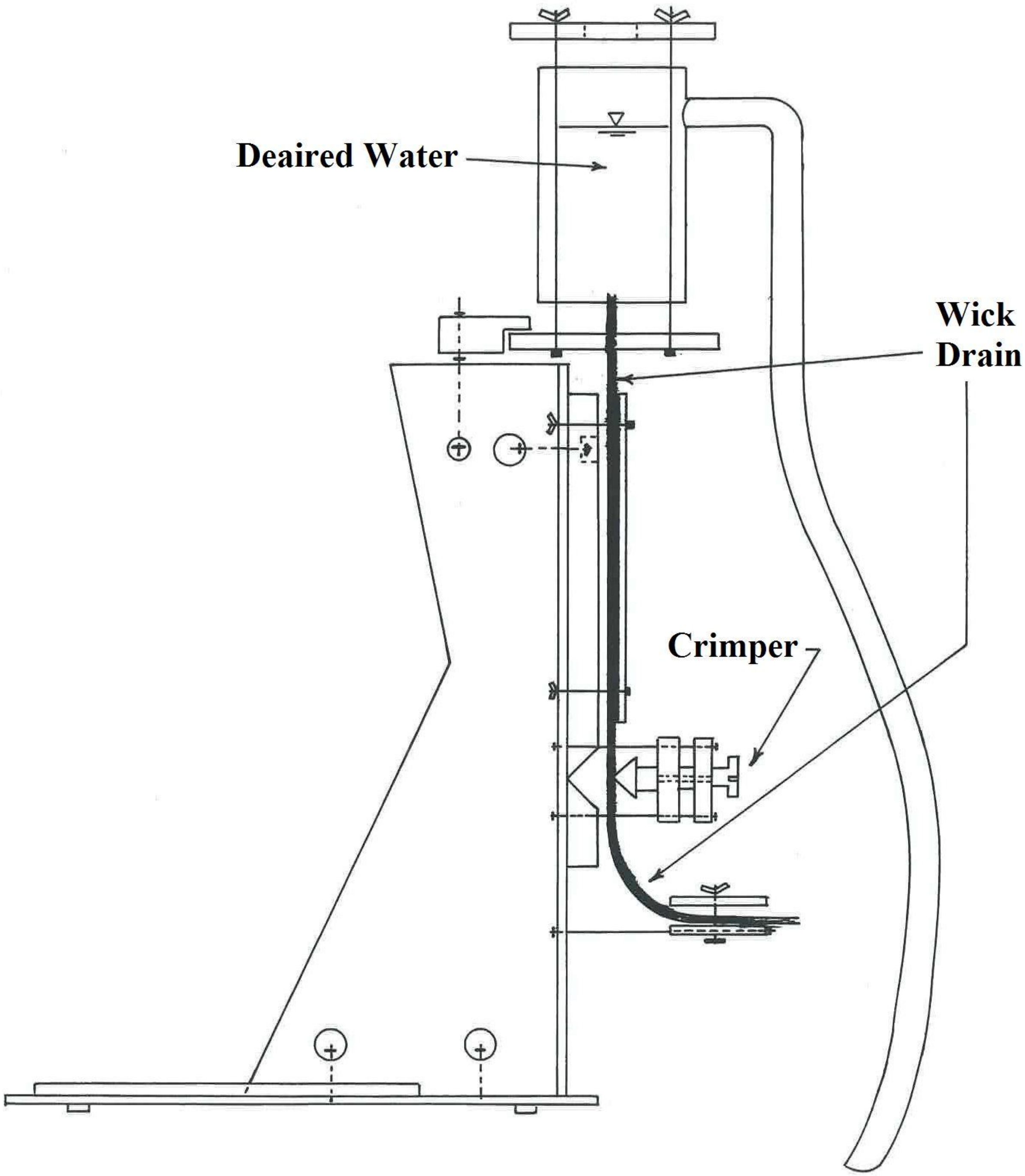


Figure 1 Wick Drain Crimp Test Apparatus

B. STANDARD TEST METHOD FOR THE WICK DRAIN CONSOLIDATION TEST

1. Scope

1.1 This method covers the procedure to determine the effectiveness of wick drains when used under specified soil conditions.

2. Significance and Use

2.1 The purpose of this test is to evaluate the effect that a wick drain has no the time rate of consolidation of compressible soils from a project site.

2.2 The results of the test are stated as an equivalent sand drain diameter.

3. Apparatus

3.1 The following apparatus is a specialty piece of equipment, fabricated at the New York State Department of Transportation for this test.

3.1.1 Test Chamber. A 10 in. (254.0 mm) diameter by 22 in. (558.8 mm) high by 0.5 in. (12.7 mm) wall thickness PVC pipe.

3.1.1.1 Six 0.125 in. (3.18 mm) drainage release ports are located 6 in. (152.4 mm) from the top, equally spaced around the cylinder.

3.1.1.2 The inside tip and bottom edges are routed to the shape of a concave circle to aid in holding rubber O-ring seals in place.

3.1.1.3 Two 0.75 in. (19.05 mm) thick Plexiglas hooks, 180° opposed, are located 1 in. (25.4 mm) from the bottom of the cylinder.

3.1.2 The Base Assembly consists of a 14.25 in. (361.95 mm) diameter circular acrylic plate of 1.5 in. (38.1 mm) thickness.

3.1.2.1 A 0.5 in. (12.7 mm) wide by 0.25 in (6.35 mm) deep concentric groove, having an inside diameter of 10 in. (254.0 mm), is located on the top of the base assembly.

3.2.1.2 A 0.125 in. (3.17 mm) by 9 in. (228.6 mm) diameter rubber O-ring is stretched and placed into this groove.

3.2.1.3 The cylinder is seated into the groove on top of the O-ring.

3.1.3 Equally spaced around the base, 6.25 in. (158.75 mm) form the center, are six 0.375 in. (0.952 mm) diameter threaded tension rods, which fit into holes drilled at those locations. Each tension rod is attached to the base plate by two hex nuts, one being above the plate, the other beneath.

3.1.3.1 Wing nuts on two of the 180° opposed tension rods contact with the Plexiglas hooks to secure the cylinder to the base assembly.

3.1.4 Double Cup Seal Assembly. This assembly consists of the following parts:

3.1.4.1 Two 10 in. (254.0 mm) diameter, 0.3125 in. (4.76 mm) thick cup seals, which are placed back to back. They are sandwiched by two 9.5 in. (241.3 mm) diameter circular Plexiglas plates of

0.5 in. (12.7 mm) thickness.

3.1.4.2 A 0.5 in. (12.7 mm) diameter, 9 in. (228.6 mm) long center rod, centrally located on the cup seal assembly. It is attached to the 9.5 in. (241.3 mm) diameter acrylic plate via a ball and socket device. This will allow a slight wobbling of the cup seals to prevent build-up of stresses in the apparatus.

3.1.4.3 A removable Plexiglas platform, which is attached to the center rod. The follower of the deflection dial, which monitor consolidation of the soil, rests on this platform.

3.1.5 An acrylic plate, identical in shape, dimensions, groove size and location, and locations of holes for the tension rods, to the plate used in the base assembly.

3.1.5.1 A 0.125 in. (3.17 mm) by 9 in. (228.6 mm) diameter rubber O-ring is stretched and placed into the groove before the plate is seated onto the cylinder.

3.1.6 A 0.5 in. (12.7 mm) diameter by 10 in. (254.0 mm) long mounting rod, which is located 6.25 in. (158.75 mm) from the center of the plate, midway between two tension rod holes.

3.1.6.1 A removable Plexiglas arm is attached to the mounting rod. The arm can be moved and affixed to any point on the rod.

3.1.6.2 A deflection dial, graduated in 0.001 in. (0.0254 mm) divisions, with a range of 1 in. (25.4 mm), is bolted to the Plexiglas arm. The follower on the dial should be in a vertical position when the arm is mounted on the mounting rod. The follower rests on the platform mentioned in Section 3.1.4.3.

3.1.7 A brass fitting which accepts a 0.25 in. (6.35 mm) air line. This is the entrance for air pressure between the cup seal assembly and top assembly. The pressure will force the cup seal assembly downward to apply the load to the soil.

3.1.8 A 0.5 in. (12.7 mm) diameter hole is centrally located in the top plate. The center rod of the cup seal assembly fits through this hole when the top assembly is seated on the cylinder.

3.1.8.1 An 0.6875 in. (17.46 mm) O.D., by 0.5 in. (12.7 mm) diameter by 0.094 in. (2.38 mm) thick rubber O-ring is positioned over the center rod hole. This provides an air tight seal around the center rod, while allowing it to move downward as the soil consolidates.

3.1.8.2 The O-ring is held in place by a 2.75 in. (69.85 mm) diameter by 0.5 in. (12.7 mm) thick Plexiglas disk. The disk has a 0.5 in. (12.7 mm) hole centrally drilled. The bottom edge of the hole is routed to a concave 4-circle to better hold the O-ring in place.

3.1.9 A pressure gauge which, is mounted in the top plate. It must be graduated to 2 psi (13.79 kPa) and have a range of at least 0 to 30 psi (206.84 kPa). This indicates the pressure which is built up between the cup seal assembly and the top assembly.

3.1.10 A pressure release valve mounted in the top plate. It must be capable of being set to release pressure at 32 psi (270.63 kPa). In case of a pressure surge, these valves will protect against explosion of the cylinder or over-consolidation of the soil.

3.1.11 Six hex nuts, which thread into the tension rods after the top assembly is seated onto the cylinder, hold the apparatus together.

NOTE 1: If more than one wick drain consolidometer is to be fabricated, all the individual parts (top assembly, cup seal assembly, cylinder base assembly) should bear the same number of the consolidometer which they compose. This will prevent interchanging of parts between consolidometers.

4. Test Preparation

4.1 Compute the total wet mass of the soil to be used by multiplying the desired density by the volume the soil will occupy.

4.2 Select the batch of soil to be used for the test and obtain a small representative sample for a preliminary moisture content. Obtain the wet mass of the soil and record in the "REMARKS" section of Form SM-455. Place the sample in an oven heated to 230±9° F (110±5° C) for a minimum period of 16 hours. Remove the sample from the oven and allow to cool for several minutes. Weigh to obtain the dry mass. Moisture content is determined by Equation 1 in Section 7.1. This moisture content will be used only as a comparison to the calculated initial moisture content.

4.3 Check to be sure that the rubber O-ring is securely seated in the groove in the base. Secure the cylinder to the base by tightening the wing nuts down on to the Plexiglas hooks, which are near the bottom of the cylinder. Cylinder and base numbers must correspond.

4.4 Cut a 20 in. (508.0 mm) long specimen of the wick to be tested. Both ends must be cut square. In one end of the wick, cut three notches, each approximately 0.25 in. (6.35 mm) wide by 0.5 in. (12.7 mm) long. These notches will be located so as to align with the three bolts in the wick drain mount (See Figure 2). Place the notched end into the wick drain mount and tighten the three bolts. Measure 14.75 in. (374.65 mm) on the wick from the bottom of the mount. Place a 1 in. (25.4 mm) wide piece of masking tape around the wick, covering the area from 14.75 to 15.75 in. (374.65 mm to 400.05 mm). This will act as a barrier (See step 11).

4.5 Draw a line around the inside of the cylinder 15 in. (381.0 mm) up from the surface of the base assembly using a permanent marker. This line is the limit for the height of soil.

4.6 Spray silicone on the inside of the cylinder and base until they are thoroughly coated.

4.7 Place the wick mount assembly, with the attached wick specimen, inside the cylinder. Weigh the cylinder, base (with rods) and wick together. Record this mass on line 1 of Form SM-455 under both the INITIAL and FINAL columns. Leave the apparatus on the scale with the scale lock engaged. Set the scale to the sum of this mass plus that of the wet soil to be used (From Step 4.1).

4.8 Distribute the soil in the cylinder evenly around the wick using hand pressure and kneading action to eliminate voids and achieve uniform density. Add the soil in layers of equal thickness. The wick must be kept in a vertical position in the center of the cylinder throughout the soil placement. It is important to avoid bending or crimping the wick during this step. Fill the cylinder with soil up to and level with the top line marked on the inside cylinder wall. Make the soil surface as smooth as possible. Clean the inside cylinder wall from the soil surface to the top of the cylinder.

NOTE 2: The mass of the apparatus with soil should be checked as the top level of the soil reaches several pre-measured points. If the mass of the soil will fall short of the computed mass for the desired density, remove the soil and replace it in a more compact manner. If the mass of the soil will exceed the computed mass, remove the soil and replace it in a less compact manner.

4.9 Obtain the total mass of the cylinder, base, wick and soil. Record this value on line 2 of Form SM-455 under the INITIAL column.

4.10 Re-spray the inside of the cylinder wall with silicone. Avoid spraying the soil.

4.11 Pour a 0.375 to 0.5 in. (9.52 to 12.7 mm) layer of molten wax on the entire soil surface allowing it to seal against the taped section of the wick. Avoid splashing wax on the exposed length of wick and the cylinder wall. Allow the wax to cool for 20 minutes. Fill in any voids formed by contraction at the wick or cylinder wall with molten wax. Be certain the drain ports in the cylinder wall have no soil or wax blockage.

4.12 Using a thin-bladed spatula, carefully cut around the perimeter of the wax to break the bond between the wax and cylinder.

4.13 Place moist (not saturated) silica sand in a uniform 1 in. (25.4 mm) layer on top of the wax. Fold the wick over on top of the sand and place an additional 3 in. (76.2 mm) of moist silica sand over the wick. Level and smooth the sand surface. Measure the initial height of the sand (average of three readings) and record in the "REMARKS" section of Form SM-455.

NOTE 3: Be careful not to crimp the wick or break the wax seal when bending the wick over the sand.

4.14 Clean off any sand which has adhered to the silicone spray on the cylinder wall between the sand surface and the top of the cylinder. After cleaning, re-spray this portion of the cylinder wall with silicone. Place the entire apparatus in a large container to collect the water which will drain from the wall.

4.15 Place the double cup seal assembly inside the cylinder. Keeping it level, push down until it contacts the sand. Spray the center rod of the seal assembly with silicone.

4.16 Apply a coat of rubber cement to the O-ring which is located in the routed groove in the top plate. Slide the top plate down over the center rod and tension rods until it seats on the cylinder. Be sure that the O-ring makes uniform contact with both the top of the cylinder and the top plate. Tighten the nuts on the six tension rods in a cross-alternating pattern to 120 in.-lbs (13.56 N-m).

4.17 Connect the appropriate air line from the pneumatic control panel to the fitting in the top plate.

4.18 Attach the deflection dial platform to the center rod. Attach the deflection dial to the mounting rod on the top plate. The follower of the deflection dial must be in contact with the deflection dial platform and must be fully depressed so that the deflection dial reads 1.0000 (25.4000).

4.19 Set up the remaining two tests following Sections 4.1-4.18.

5. Test Procedure

NOTE 4: Six to seven hours may be required for the Test Completion Section (Section 6) plus the Test Preparation Section (Section 4). Section 5 cannot begin until the following day. This section of the wick drain test must be started as early in the work day as possible in order to collect sufficient data for the early portion of the plots (See Section 5.7).

5.1 The three toggle valves must be in the "OFF" position on the pneumatic control panel (See Figure 3).

5.2 Adjust regulators until corresponding dials indicate 15 psi (103.42 kPa).

5.3 Recheck the reading on the deflection dials and adjust to 1.0000 (25.4000), if necessary. The soil in the cylinder may swell overnight, causing a slight change in the dial reading.

5.4 Simultaneously turn all three toggle valves on the pneumatic control panel to the "ON" position and start the timer.

5.5 Take deflection readings on the following schedule:

First Day: 1-2-5-10-30-45-60-90-120-150-180-210-240 min., then hourly to the end of the work day.

Second Day: Morning-Mid Day-End of the work day.

Remainder of Test: Morning-End of the work day.

5.6 If the capacity of the deflection dial is less than the total amount of anticipated consolidation, the dial must be reset to 1.0000 (25.4000) at the end of the work day so the travel limit will not be exceeded overnight. Before the dial is reset for the first time, the "CORRECTED READING," (Column 9, Form SM-455) is simply the dial reading plus an amount greater than the anticipated settlement. After the dial has been reset to 1.0000 (25.4000), the corrected readings are computed in the following manner:

Corrected Readings=Previous corrected reading - (Previous dial reading - Current dial reading)

5.7 Begin construction of the two plots. The first is a plot of corrected readings versus the logarithm of elapsed time of the test. (See Fig. 4). This plot will be useful in determining the amount of settlement corresponding to certain percentages of primary consolidation.

5.7.1 The second plot is a plot of corrected readings versus the square root of elapsed time of the test. (See Fig. 5). This plot is used to determine when the 15 psi (103.42 kPa) and 30 psi (206.84 kPa) phases of the test are complete. This is determined as the t_{90} point constructed according to the Casagrande construction method for 90% primary consolidation. One data point beyond the t_{90} time should be obtained.

Note 5: It is critical that these plots be constructed while the test is in progress.

5.8 When the 15 psi (103.42 kPa) phase of the test is complete, the 30 psi (206.84 kPa) phase is started in the following manner:

5.8.1 Turn all three toggle valves on the pneumatic control panel off.

5.8.2 Increase the pressure by turning the regulator knobs clockwise until the three gauges indicate 30 psi (206.84 kPa).

5.8.3 Repeat Section 5.3 through 5.7.

6. Test Completion

6.1 Take the final deflection dial reading.

6.2 Release the air pressure by turning the three regulator knobs counterclockwise until the gauges indicate zero pressure. Disconnect the air lines.

6.3 Clean the outside of the apparatus of any moisture or sand which may have passed through the drainage ports. Remove the top plate and cup seal assembly.

6.4 Remove the sand. This will be cleaned for reuse by washing with clean water on the No. 200 (75 μm) sieve. Remove the wax by cutting it in the plane of the wick. Retain the wax for use in Section 6.7.

6.5 Weigh the cylinder base assembly and soil. Enter this value on line 2 in the "FINAL" column of Form SM-455.

6.6 Remove the base assembly from the cylinder.

6.7 Place blocks under the edges of the cylinder. Replace the wax and push down to force the soil from the cylinder.

6.8 Photographs should be taken to record the position of the wick after consolidation. Preparation is done in the following manner:

6.8.1 Slice the soil to expose one edge of the wick. Paint the exposed edge of the wick white. Place a white backdrop behind the soil. Position an identification card bearing the wick type and test number by the soil. Photograph the soil

.

6.9 Take a representative soil sample of approximately 2 lbs. (1 kg), weigh, then place in an oven capable of maintaining a temperature of 230±9° F (110±5° C) for a minimum of 16 hours. Remove from the oven and weigh dry soil. Record these masses in "REMARKS" section of Form SM-455. Compute the final moisture content using Equation 1 from Section 7.1.

6.10 Thoroughly clean all parts of the test apparatus before setting up the next test.

6.11 The soil is placed in an air tight container and kept in a humid environment until remolding for future testing.

7. Computations (Form SM-455)

7.1 Determine the preliminary moisture content using Equation 1

Equation (1)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C} \, x\,100 \leq 0.4\%$$

where:

W_T = Total Mass of Soil and Water, i.e. the Wet Mass of the Soil

W_S = Mass of Soil only, i.e. the Dry Mass of the Soil

MC = Moisture Content

7.1. 1 Enter this in the "REMARKS" section of Form SM-455.

7.2 Subtract the mass from the "INITIAL" column of line 1 from the "INITIAL" column of line 2. Enter this value on line 3 under the "INITIAL" column.

7.2.1 Subtract the mass from the "FINAL" column of line 1 from the "FINAL" column of line 2. Enter this value on line 3 under the "FINAL" column.

7.3 Determine the "FINAL MOISTURE CONTENT" using Equation 1. Use the mass obtained from Section 6.9 in the equation. Enter this value on line 5 in the "FINAL" column.

7.4 Compute the "WT. DRY SOIL" (for the cylinder) using Equation 2.

Equation (2)

$$\frac{|Line\,C - \sum of\;Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

W_S = Mass of Dry Soil

WT_F = Final Mass of Wet Soil (for the Cylinder), line 3 in "FINAL" Column

MC_F = Final Moisture Content in Decimal Form, line 5 in "FINAL" Column

7.4.1 Enter this value on line 4 in both "INITIAL" and "FINAL" columns.

7.5 Compute the "INITIAL MOISTURE CONTENT" using Equation 1. Use the mass from line 3 and 4 in the "INITIAL" column in the equation. Enter this value on line 5 in the "INITIAL" column.

7.6 The "FINAL HT. OF SAMPLE" is obtained using Equation 3.

Equation (3)

$$\frac{|Line\,C - \sum of\;Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

H_F = Final Height of Sample, in ft. (m)

H_I = Initial Height of Sample (1.25 ft., 0.381 m)

C_{15} = Total Consolidation of the Soil from the 15 psi (103.42 kPa) Phase in in. (m)

C_{30} = Total Consolidation of the Soil from the 30 psi (206.84 kPa) Phase in in. (m)

K = 12 in./ft. if using US Customary Units, 1 if using International System of Units.

7.6.1 Record this value on line 6 in the "FINAL" column.

7.7 The "AREA OF SAMPLE" is the inside cross-sectional area of the cylinder. Record 0.545 ft^2 (0.0506 m^2) on line 7 in both "INITIAL and "FINAL" columns.

7.8 Compute the "INITIAL VOLUME OF SAMPLE" using Equation 4.

Equation (4)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C} x\,100 \leq 0.4\%$$

where:

V = Volume of Sample ft^3 (m^3)

A = Area of Sample ft^2 (m^2) from line 7

H = Height of Sample ft. (m) from line 6

7.8.1 Record this value on line 8 in the "INITIAL" column.

7.8.2 Compute the "FINAL VOLUME OF SAMPLE" using Equation 4. Use the values on line 6 and 7 in the "FINAL" column in the equation. Enter this value on line 8 in the "FINAL" column.

7.9 Compute the "INITIAL WET DENSITY" using Equation 5.

Equation (5)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C} x\,100 \leq 0.4\%$$

where:

γ_w = Wet Density in lbs./ft^3 (kg/m^3)

W_T = Weight of Wet Soil in lbs (kg) from line 3

V = Volume of Sample ft^3 (m^3)

Use the values on lines 3 and 8 in the "INITIAL" column in the equation.

7.9.1 Enter this value on line 9 in the "INITIAL" column.

7.9.2 Compute the "FINAL WET DENSITY" using Equation 5. Use the values on lines 3 and 8 in the "FINAL" column in the equation. Enter this value on line 9 in the "FINAL" column of Form SM-455.

7.10 Compute the "INITIAL DRY DENSITY" using Equation 6:

Equation (6)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C} x\,100 \leq 0.4\%$$

where:

γ_D = Dry Density in lbs./ft^3 (kg/m^3)

MC_I = Initial Moisture Content

7.10.1 Enter this value on line 10 in the "INITIAL" column of Form SM-455.

7.10.2 Compute the "FINAL DRY DENSITY" using Equation 6. Use the "FINAL MOISTURE CONTENT". Enter the value on line 10 in the "FINAL" column.

8. Test Soil Remolding Procedure

8.1 The purpose of this procedure is to return the test soil to its initial moisture content to allow reuse in further testing. Since water was expelled from the soil by the process of consolidation, the same amount of water must be remixed back into the soil. The soil sample for the final moisture content determination will not be returned to the amount of soil to be reused, since oven drying may alter its characteristics. Therefore, the following procedure must be followed to calculate the amount of water which must be mixed into the reduced mass of soil after the 30 psi (206.84 kPa) phase is complete (See figure 6).

8.2 Obtain the wet mass of the soil sample used for the final moisture content determination from Section 6.9 in lbs. (kg). This is mass A from Figure 6.

8.3 Obtain the dry mass of the soil sample used for the final moisture content determination from Section 6.9 in lbs. (kg). This is mass B from Figure 6.

8.4 Subtract the mass from Section 8.2 from the "FINAL WT. WET SOIL" (line 3, Form SM-455) under "FINAL" column. This yields the final wet mass of the remaining soil to be remolded and is represented by mass C from Figure 6.

8.5 Multiply the mass from Section 8.3 by (1 + Initial Moisture Content). The Initial Moisture Content is from line 5, Form SM-455 and is expressed in decimal form. This yields the initial wet mass of the sample, which was used for the final moisture content determination and is represented by mass D from Figure 6.

8.6 Subtract the mass from Section 8.5 from the Initial Wet Mass Soil (line 3, Form SM-455). This yields the initial wet mass of the remaining soil to be remolded and is represented by mass E from Figure 6.

8.7 Subtract the mass from Section 8.4 from the mass from Section 8.6. This yields the mass of water which has been expelled from the soil during consolidation and that which must be remixed back in. This is mass E minus mass C from Figure 6.

8.8 To obtain the volume of water in cubic centimeters to be mixed into the soil, multiply the mass from Section 8.7 by 453.6 (water density = 1 g/cc, there are 453.6 g/lb therefore, 453.6 cc/lb of H_20).

8.9 Thoroughly mix the volume of water from Section 8. 8 into the soil which has been retained for remolding. The soil is then placed in an air tight container and set to cure for at least one week in a humid environment before reuse in further testing.

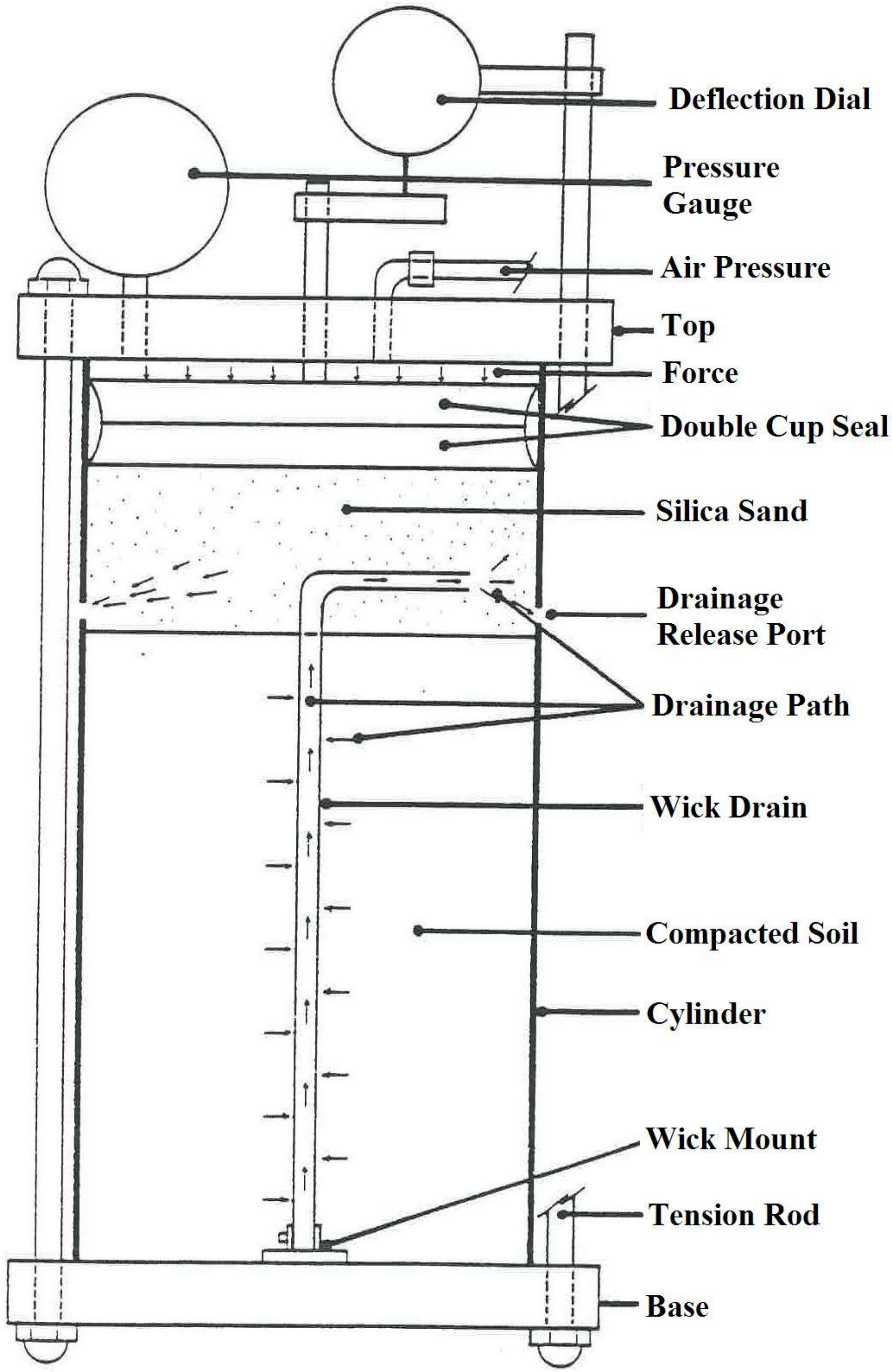


Figure 1 Wick Drain Consolidometer

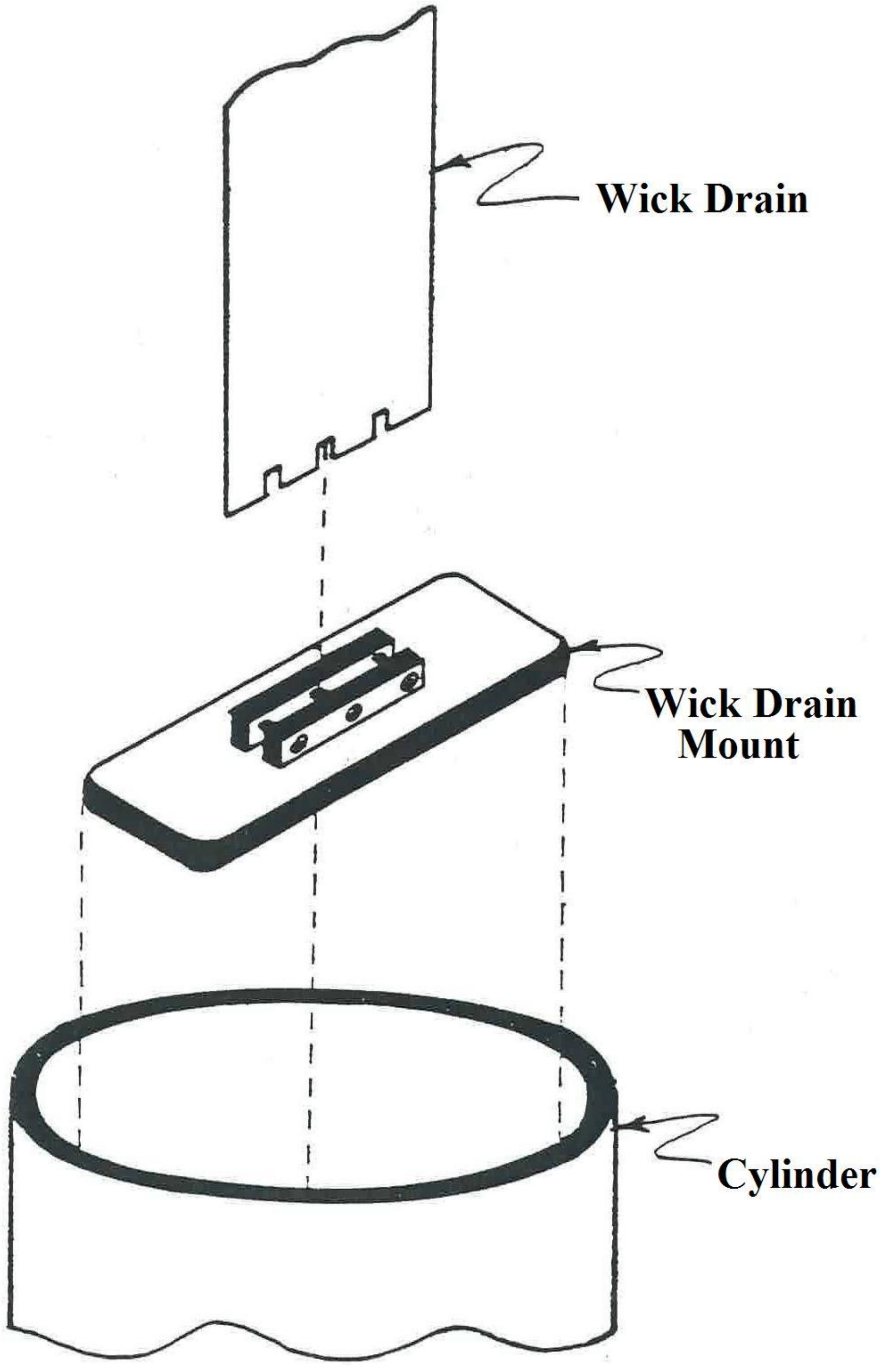


Figure 2 Wick Drain Mount

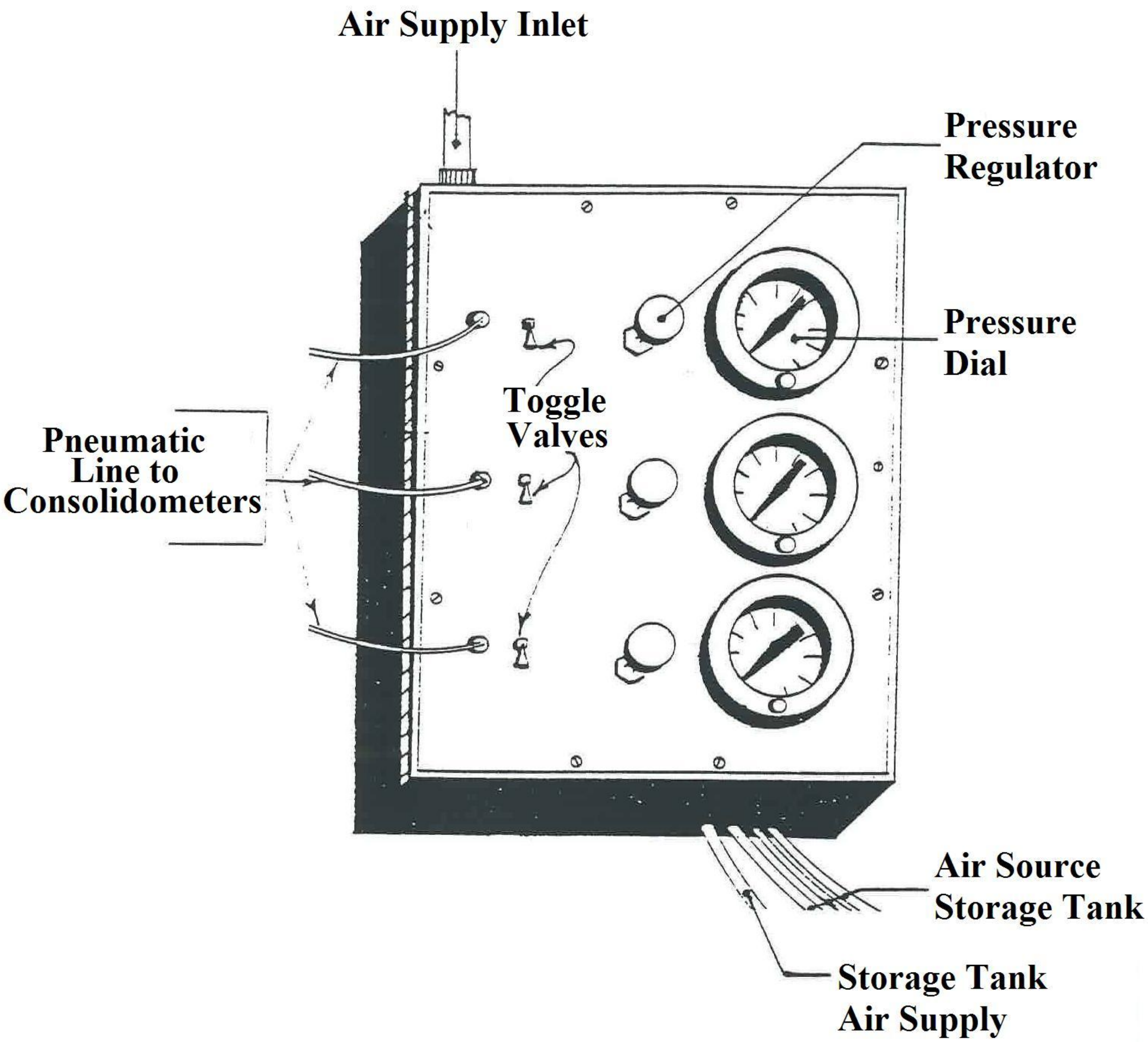


Figure 3 Control Panel

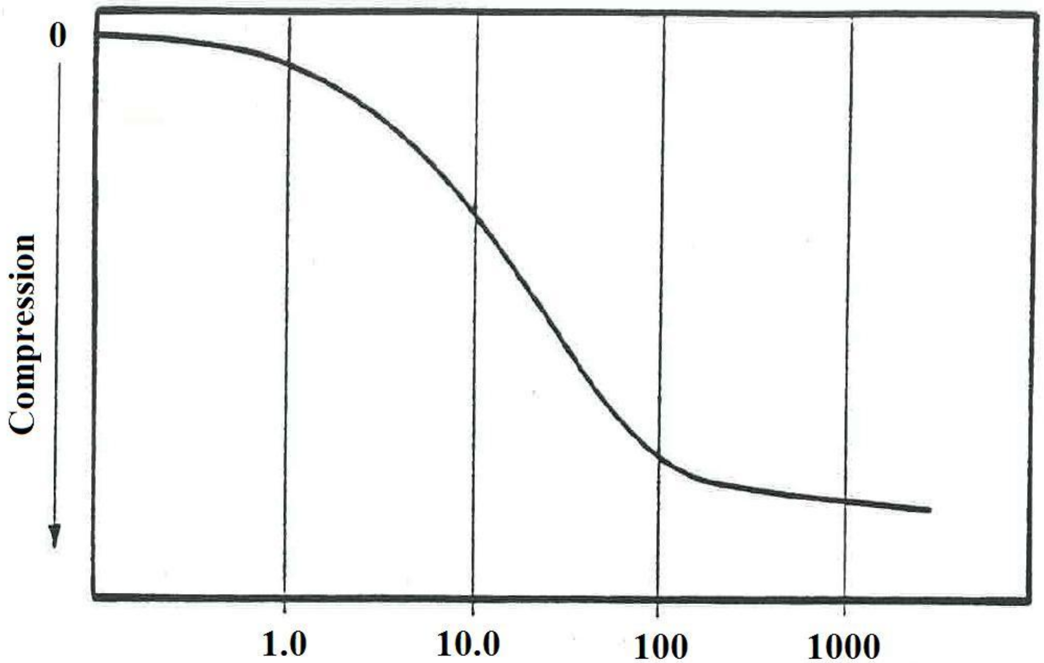


Figure 4 Corrected Reading vs. Log of Elapsed Time

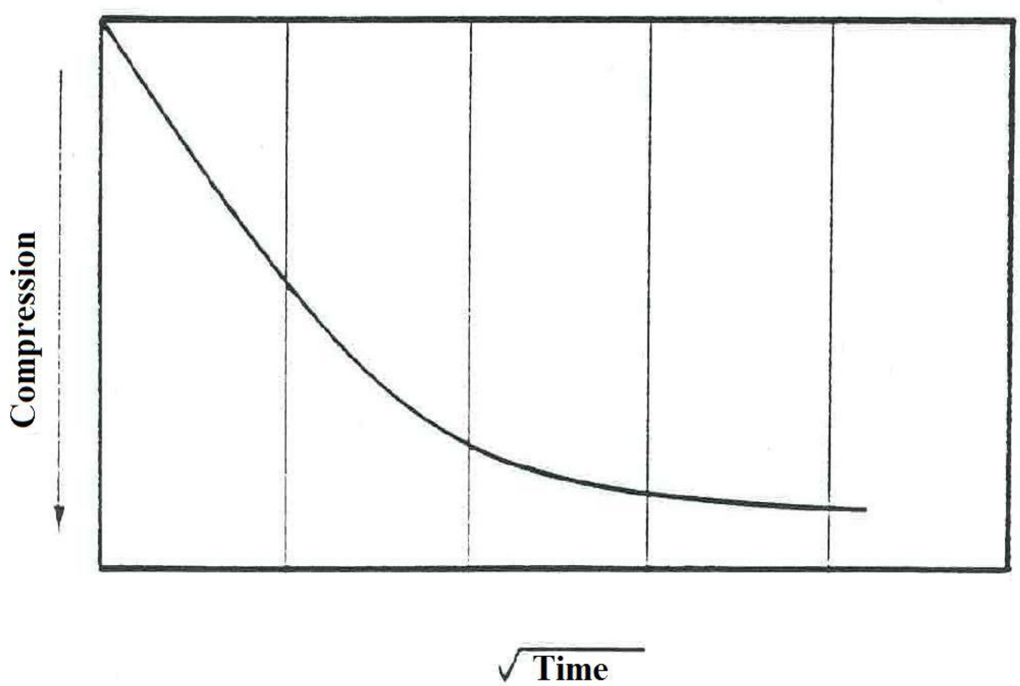


Figure 5 Corrected Reading vs. Square Root of Elapsed Time

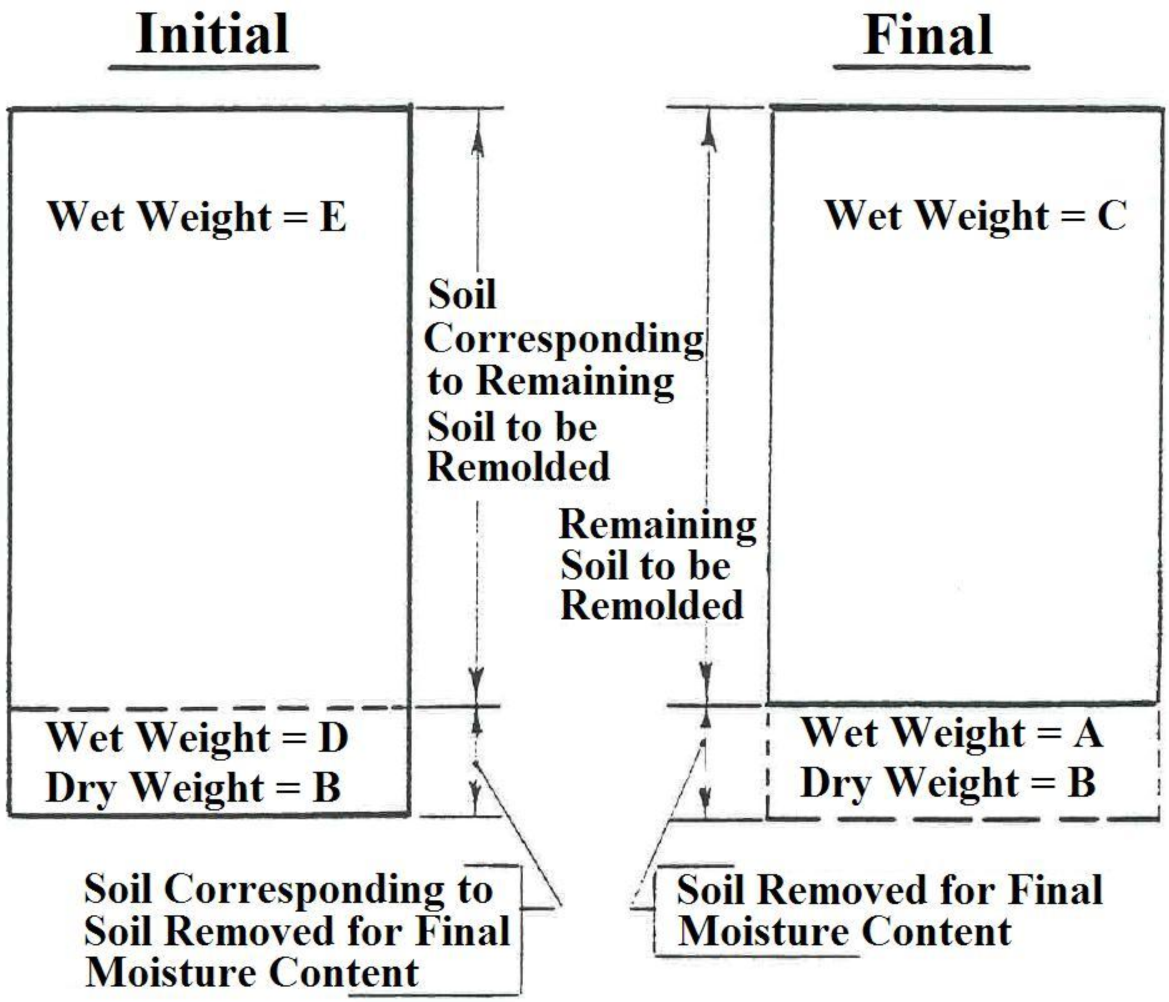


Figure 6 Soil Remold Procedure

C. STANDARD TEST METHOD FOR GEOTEXTILE SOIL RETENTION TEST

1. Scope

1.1 This method provides a laboratory procedure for evaluating the effectiveness of geotextiles (fabrics) to act as silt curtains in a water environment. The fabric filtering effectiveness can be determined by allowing passage of a soil/water slurry.

2. Applicable Documents

2.1 New York State Department of Transportation, Geotechnical Engineering Bureau GTP-2 Soil Description Procedure.

3. Summary of Method

3.1 A soil/water slurry or upstream water is introduced on one side of the geotextile, with clean water or downstream water on the opposite side. By opening the outlet on the downstream side of the apparatus, flow takes place allowing the slurry to flow through the geotextile.

3.2 Knowing the initial dry mass of soil in the slurry and by taking hydrometer readings of the downstream water before and after flow; the amount of soil which passes through the fabric and the percentage of soil passing can be computed.

3.3 A backflushing procedure is included for conditions of rising and falling tide. The backflushing is done to ensure repeatability of flow (i.e., backflushing unclogs the fabric).

4. Apparatus

4.1 The apparatus consists of an acrylic tank with inside measurements of 37.5 in. (952.5 mm) long by 6 in. (152.4 mm) wide by 14 in. (355.6 mm) high. Two slide panels can be inserted at the center of the tank (See Figure 1).

4.2 The two slide panels consist of one panel of solid acrylic 14 in. (355.6 mm) high by 6.25 in. (158.75 mm) wide, and an identical sized panel which has a hole measuring 6 in. (152.4 mm) high by 4 in. (101.6 mm) wide in the bottom half of the panel.

4.2.1 The solid piece or panel is used as a slide gate to prevent flow of water from the downstream to the upstream sections of the test tank. A 0.125 in. (3.175 mm) O-Ring is slightly recessed into the edges of the panel. This ensures that no leakage will take place around the edges of the panel where it is in contact with the tank (See Figure 2).

4.2.2 The second slide panel is the specimen or fabric holder. The geotextile is clamped over the hole with an acrylic clamping ring having the same hole dimensions as the slide panel hole. On the upstream side of the slide panel a second solid slide gate 12.5 in. (317.5 mm) high by 4.25 in. (107.95 mm) wide is inserted to prevent contact of the fabric with the slurry prior to the start of the test (See Figure 3).

4.2.3 On each end of the tank there is located a 1 in. (25.4 mm) inside diameter rotating discharge pipe. This controls the rate of flow (See Figure 1). The drains outlet from underneath and at both ends of the tank.

5. Specimen Selection and Preparation

5.1 From a 28 in. by 25 in. (711.2 mm by 635.0 mm) sample of the geotextile to be tested, randomly draw three 5 in. (127 mm) wide by 7 in. (177.8 mm) high specimens.

5.2 Place the specimen to be tested in the appropriate slide panel. To insure that no leakage occurs at the specimen/panel interface secure the specimen with rubber cement. The geotextile can be easily peeled off the panel after the test is completed.

5.3 Insert the panel into the test tank which has been filled with clean water.

5.4 Allow the specimen to set in the tank in contact with the clean water for a conditioning period of 1 hour with all the slide gates removed.

NOTE 1 : This assumes that the test water has previously been sitting at room conditions for a period of at least 24 hours. If this is not so then additional time should be allowed in the tank for this conditioning period to take place.

6. Procedure

6.1 Insert both solid slide gates into the tank. Obtain a hydrometer and temperature reading of the water on each side of the tank.

6.2 Thoroughly mix 196 grams (dry mass) of soil from the project site and 1 pt (473 ml) of water taken from the upstream side of the tank.

6.3 Thoroughly blend the above mixture with the water on the upstream side of the tank.

6.4 After mixing, obtain a 1.1 qt. (1000 ml) sample of the soil water slurry. Place the sample in a 1.1 qt. (1000 ml) graduated cylinder, mix, and obtain hydrometer and temperature readings.

6.5 Obtain a 1.1 qt. (1000 ml) sample of the downstream water. Place in a 1.1 qt. (1000 ml) graduated cylinder, mix, and obtain hydrometer and temperature readings.

6.6 Return both samples to their respective ends of the tank.

6.7 Thoroughly mix the upstream slurry. Following mixing, allow to stand 2 minutes. After the 2 minute settling period, obtain another 1.1 qt. (1000 ml) sample. Take and record hydrometer and water temperature readings of this sample.

6.8 Return this sample to the upstream end of the tank, thoroughly mix, and allow to settle for 2 minutes.

6.9 Following the 2 minute settling period, remove the slide gates preventing flow.

6.10 Adjust the discharge pipe to obtain the desired flow rate. Provide a means of collecting the discharge.

6.11 Record the change in water elevation versus time for both sides of the tank. Do not allow the water on the upstream end to drop below the top of the fabric. This ensures a constant area of flow.

6.12 Continue to take readings of change in water elevation versus time until the upstream water reaches the top of the fabric or for 10 minutes, whichever occurs first.

6.13 When one of the above conditions is reached, stop flow and insert the slide gates.

6.14 Obtain a 1.1 qt. (1000 ml) sample from the collected discharge. Take and record hydrometer and temperature readings of the sample. Before taking sample, be sure that all of the water and soil in the downstream end of the tank has been emptied into the collector.

6.15 Return the sample to the collected discharge.

6.16 With the slide gates still in position, return the discharge to the downstream end of the tank. When full, open the slide gates to allow backflow and backflushing of the fabric to occur. Continue doing this until all of the discharge has been returned to the tank.

6.17 Repeat the test, followed by a second backflushing and third run.

6.18 Repeat the test for three specimens.

7. Calculations

7.1 Calculate the velocity of flow through the geotextile for each specimen at each time interval using Equations 1 and 2.

Equation (1)

$$\frac{|Line\ C - \sum of\ Column\ 1|}{Line\ C} x\, 100 \leq 0.4\%$$

Equation (2)

$$\frac{|Line\ C - \sum of\ Column\ 1|}{Line\ C} x\, 100 \leq 0.4\%$$

where:

Q_d = Volume of Water Flowing from the Upstream side of the Tank

H_d = Change in Water Height on Upstream side of the Tank

A_{tank} = Area of the Top of the Upstream End of the Tank

V = Velocity of Soil/Water Mixture through the Geotextile

A_f = Area of Geotextile Exposed to Flow (this should remain constant since the water head is not allowed to progress below the top of the fabric opening)

t = Time Interval at which Reading was Taken

7.2 Correct all hydrometer readings to 68° F (20° C).

NOTE 1 : The calibration factor for the hydrometer used is assumed to be known. If not, the factor is to be determined.

7.3 Calculate the percent of solids passing through the fabric for each specimen using Equations 3 and 4.

Equation (3)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

Equation (4)

$$\frac{|Line\,C - \sum of\ Column\,1|}{Line\,C}\,x\,100 \leq 0.4\%$$

where:

W_t = Dry Mass of Soil Passing through the Fabric

Vol = Volume of Soil/Water Slurry form which Outflow Sample was Taken.

G_s = Hydrometer Reading of the Outflow Grab Sample = Specific Gravity of Slurry

G_w = Hydrometer Reading of the "Clean" Water = Specific Gravity of Water

Total Mass = Total Dry Mass of Soil Used to Make-Up Slurry (196 g)

7.4 Calculate the average flow rate and percent passing for the three specimens.

8. Report

8.1 Include the following information when reporting the results of the test:

8.1.1 State that the test was performed according to NYSDOT Geotechnical Engineering Bureau GEOTEXTILE SOIL RETENTION TEST PROCEDURE.

8.1.2 Identify the type of fabric tested by its trade name.

8.1.3 Identify the soil used in the test according to Procedure GTP-2.

8.1.4 A listing of the average percent of total dry mass of soil passing for first run of the 3 specimens.

8.1.5 A listing of the average first run flow rates of the three specimens.

9. Precision

9.1 No justifiable statement as to precision is about to be made at this time as there has been no interlaboratory round robin test program to establish such a precision.

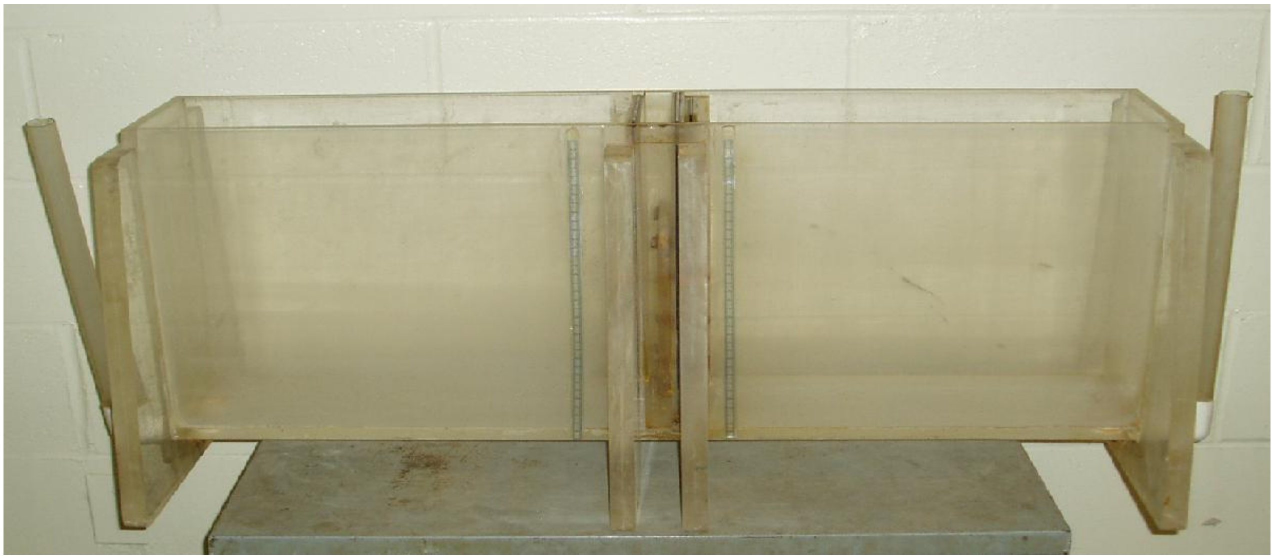


Figure 1 Soil Retention Tank

Figure 2 Slide Gate - Downstream

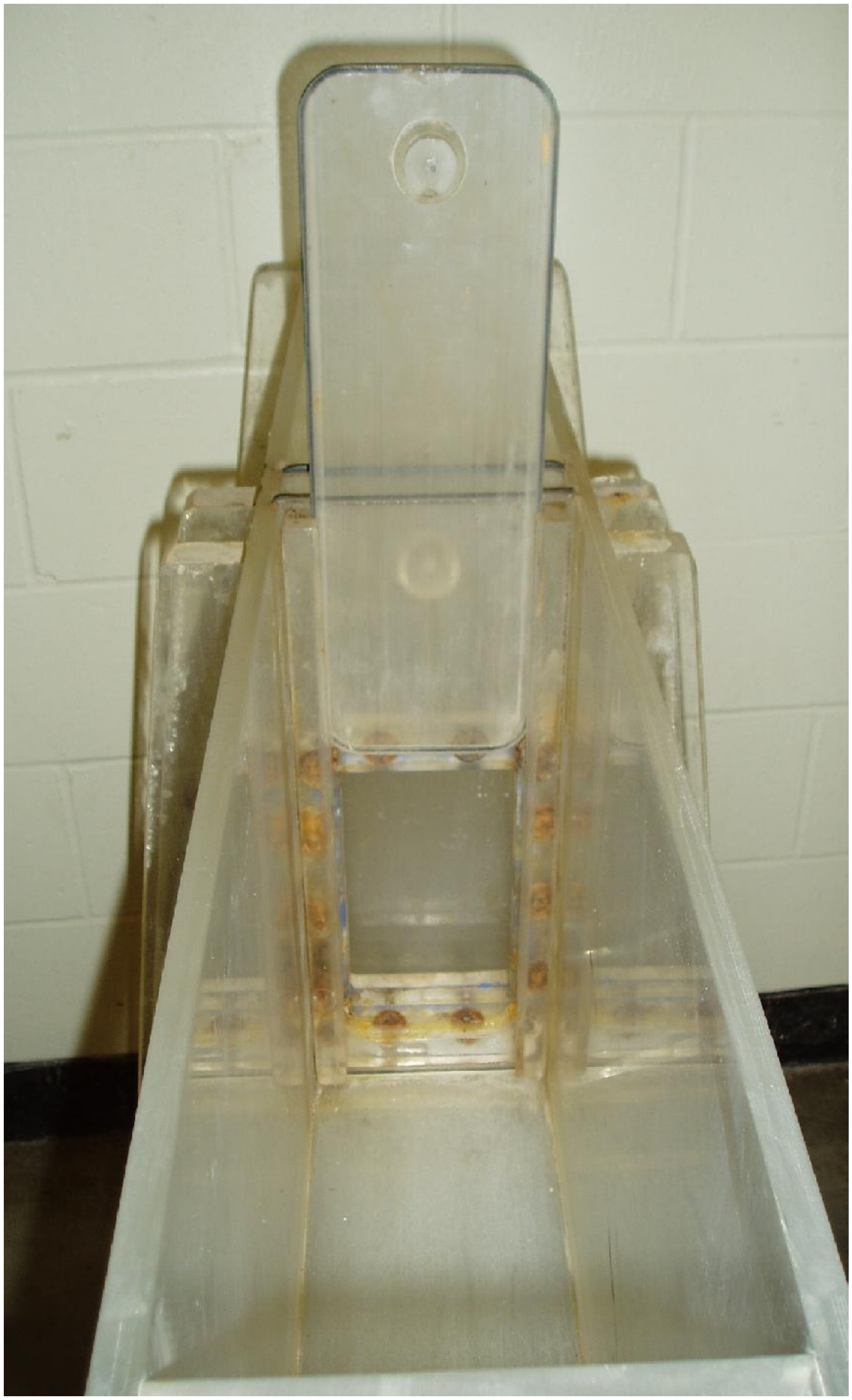


Figure 3 Specimen Holder & Upstream Gate

D. STANDARD TEST METHOD FOR LONG-TERM GEOTEXTILE FLOW TEST

1. Scope

1.1 This test provides a laboratory procedure for evaluating the effectiveness of geotextiles as silt curtains using river water from the project site. The effectiveness is determined by measuring the change in head required to maintain a flow of 50 gal./hr. (5.2×10^{-5} m^3/s) through the fabric over a period of six hours.

2. Summary of Method

2.1 Using water from the project site, a differential head is maintained across the fabric to permit a flow of 50 gal./hr. (5.2×10^{-5} m^3/s) for six hours.

2.2 After remaining in the water filled tank overnight, the direction of flow is reversed by rotating the fabric 180° and the test is repeated.

2.3 The third stage of testing is a repetition of the first.

2.4 During all testing stages, readings are taken of amounts of dissolved oxygen, dissolved solids, the flow rate and the head required to maintain a 50 gal./hr. (5.2×10^{-5} m^3/s) flow rate.

3. Apparatus

3.1 Test tank – An acrylic tank with inside dimensions of 37.5 in. (952.5 mm) long by 6 in. (152.4 mm) wide by 14 in. (355.6 mm) deep. The tank is divided approximately in half by a slide panel which holds the fabric. Each end of the tank is equipped with a 1 in. (25.4 mm) I.D. rotating standpipe to control the water levels. There is a scale fixed to the tank on each side of the fabric to measure the water level. (This is the same apparatus as the geotextile, soil retention test apparatus).

4. Test Preparation

4.1 The test tank is placed on a level surface with its top lower than the bottom of the water storage tanks. The water flows by gravity through a siphon line from the water storage tanks into the test tank until it reaches the top mark (zero) on the scales.

4.2 A 5 in. by 7 in. (127 mm by 177.8 mm) randomly selected fabric specimen is fixed over the rectangular opening in the slide panel and secured along the edges with rubber cement. The panel is inserted into the slide track of the test tank.

5. Procedure

5.1 The valve on the siphon line is opened part way. The outflow from the downstream standpipe is brought to a rate of 50 gal./hr. ($5.2x10^{-5}$ m^3/s) by adjusting the upstream and downstream standpipes and by adjusting the flow rate in the siphon line which feeds the test tank. The water level must remain at the zero mark on the upstream scale throughout the test. This level is maintained by adjusting the upstream standpipe.

5.2 When the upstream water level is adjusted to the zero mark and the outflow from the downstream standpipe is adjusted to 50 gal./hr. ($5.2x10^{-5}$ m^3/s), the test begins. The downstream water level is constantly adjusted to maintain the required outflow rate.

5.3 Readings of upstream and downstream water levels, outflow rate, upstream and downstream water temperatures and upstream and downstream dissolved oxygen contents are taken every ten minutes. Upstream and downstream dissolved solids readings are taken every time a new tank of water is used and again one half hour later. The water is stirred periodically in the storage tank in use to prevent any sediment present in the water from settling out.

5.4 Continue taking readings for six hours. Following the six hour period the fabric should be kept submerged in the water until the start of the reverse flow cycle.

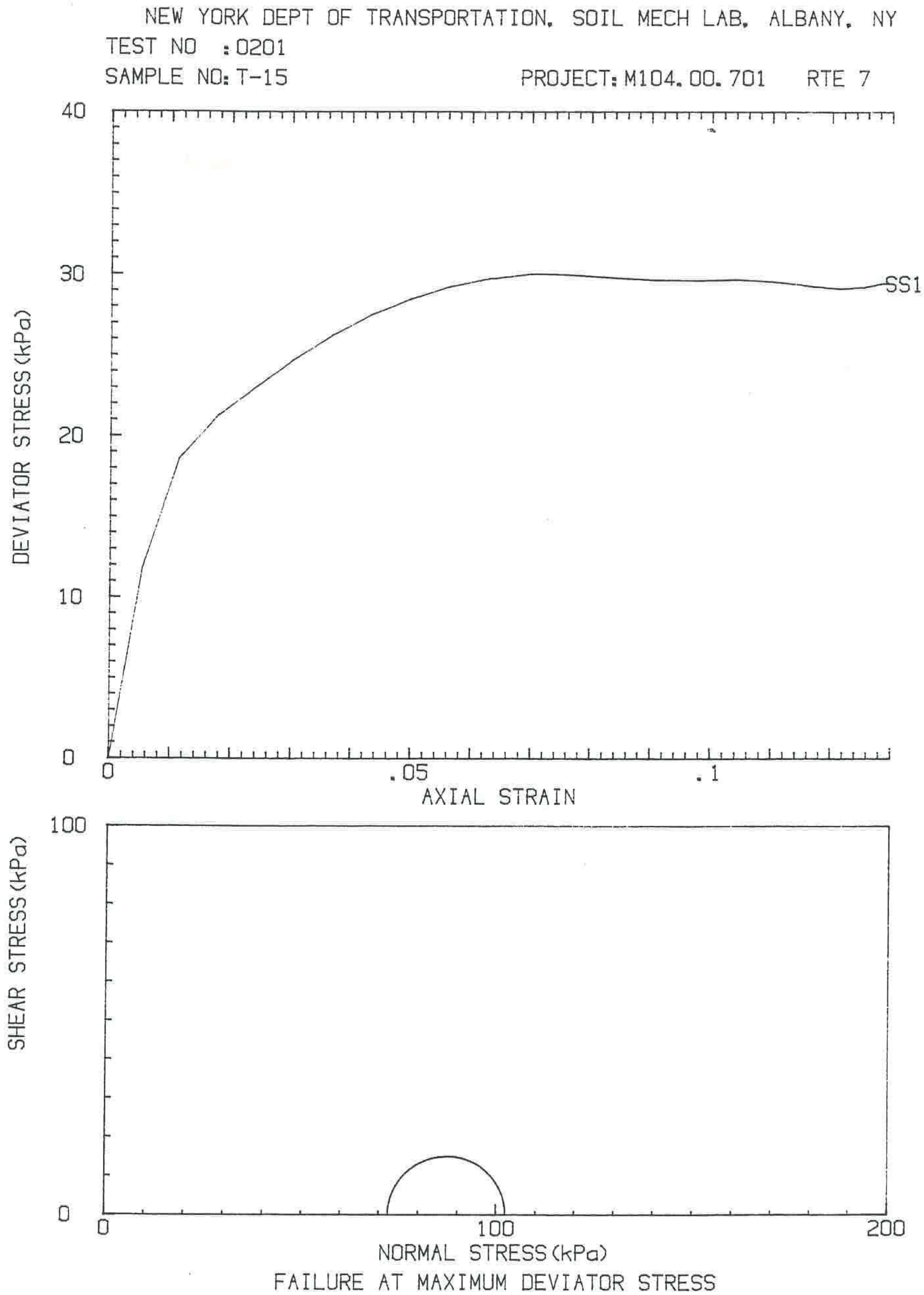
5.5 The center slide panel is carefully removed from the test tank and rotated face to face. It is then replaced into the test tank and retested in the same manner with the flow occurring in the opposite direction to backflush the fabric. After six hours, the fabric is again rotated face to face so that the flow will occur in the initial direction. After the third six hour test, the test is ended.

6. Test

6.1 The test results are presented in the form of a graph of elapsed time vs. the head required to maintain an outflow rate of 50 gal./hr. ($5.2x10^{-5}$ m^3/s).

APPENDIX

APPENDIX A



NEW YORK DEPT OF TRANSPORTATION. SOIL MECH LAB. ALBANY. NY
TEST NO : 0201
SAMPLE NO: T-15
PROJECT: M104.00.701 RTE 7
DEVIATOR STRESS (kPa)
40
30
20
10
0
SS1
0
.05
.1
AXIAL STRAIN
SHEAR STRESS (kPa)
100
0
0
100
200
NORMAL STRESS (kPa)
FAILURE AT MAXIMUM DEVIATOR STRESS

APPENDIX A

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY

TRIAXIAL COMPRESSION TEST
UNCONSOLIDATED-UNDRAINED

TEST # 0201 4/3/91

PROJECT : M104.00.701 RTE 7 BOREHOLE: UDH-1
SAMPLE NO : T-15 DEPTH : 23.8

DESCRIPTION: Gr&Br Incl Layers Silty CLAY W/ Silt Lenses (M-SFT/FM-PL)

INITIAL SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 9	S-2/M- 0	S-3/M- 0	S-4/M- 0	UNITS
WEIGHT, TOTAL :	1807.2	0.0	0.0	0.0	g
WEIGHT, SOLIDS :	1243.8	0.0	0.0	0.0	g
WEIGHT, MOISTURE:	563.4	0.0	0.0	0.0	g
PERCENT MOISTURE:	45.3	0.0	0.0	0.0	%
LENGTH :	177.80	0.00	0.00	0.00	mm
DIAMETER :	85.73	0.00	0.00	0.00	mm
AREA :	5772.	0.	0.	0.	mm^2
VOLUME, TOTAL :	1026.2	0.0	0.0	0.0	cm^3
VOLUME, SOLIDS :	445.8	0.0	0.0	0.0	cm^3
VOLUME, MOISTURE:	564.5	0.0	0.0	0.0	cm^3
SPECIFIC GRAVITY:	2.7900	0.0000	0.0000	0.0000	
VOID RATIO :	1.3019	0.0000	0.0000	0.0000	
SATURATION :	97.27	0.00	0.00	0.00	%
UNIT WET WEIGHT :	1761.	0.	0.	0.	kg/m^3
UNIT DRY WEIGHT :	1212.	0.	0.	0.	kg/m^3

TEST CONDITIONS

CELL PRESSURE :	72.4	0.0	0.0	0.0	kPa
BACK PRESSURE :	0.0	0.0	0.0	0.0	kPa
CONFINING PRESS.:	72.4	0.0	0.0	0.0	kPa

SATURATED SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 9	S-2/M- 0	S-3/M- 0	S-4/M- 0	UNITS
MOISTURE ADDED :	15.9	0.0	0.0	0.0	cm^3
WEIGHT, TOTAL :	1823.0	0.0	0.0	0.0	g
WEIGHT, MOISTURE:	579.2	0.0	0.0	0.0	g
PERCENT MOISTURE:	46.6	0.0	0.0	0.0	%
SATURATION :	100.0	0.0	0.0	0.0	%

APPENDIX A

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY

TRIAXIAL COMPRESSION TEST
UNCONSOLIDATED-UNDRAINED

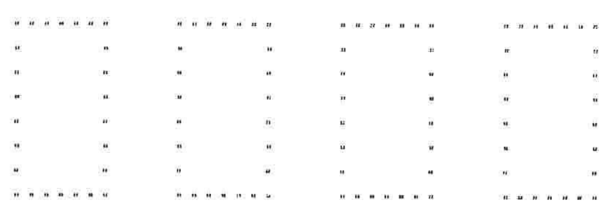
TEST # 0201   4/3/91

PROJECT   : M104.00.701   RTE 7   BOREHOLE: UDH-1
SAMPLE NO : T-15   DEPTH : 23.8

DESCRIPTION: Gr&Br Incl Layers Silty CLAY W/ Silt Lenses (M-SFT/FM-PL)

SAMPLE PARAMETERS AT MAXIMUM DEVIATOR STRESS

SAMPLE/MACH	S-1/M- 9	S-2/M- 0	S-3/M- 0	S-4/M- 0	UNITS
WEIGHT, TOTAL :	1823.0	0.0	0.0	0.0	g
WEIGHT, SOLIDS :	1243.8	0.0	0.0	0.0	g
WEIGHT, MOISTURE:	579.2	0.0	0.0	0.0	g
MOISTURE DRAINED:	0.0	0.0	0.0	0.0	cm^3
PERCENT MOISTURE:	46.6	0.0	0.0	0.0	%
LENGTH :	165.4	0.0	0.0	0.0	mm
DIAMETER :	88.9	0.0	0.0	0.0	mm
AREA :	6205.	0.	0.	0.	mm^2
VOLUME, TOTAL :	1026.2	0.0	0.0	0.0	cm^3
SPECIFIC GRAVITY:	2.7900	0.0000	0.0000	0.0000	
VOID RATIO :	1.3019	0.0000	0.0000	0.0000	
STRAIN RATIO :	.0699	0.0000	0.0000	0.0000	
TIME TO FAILURE :	.148	0.000	0.000	0.000	hours
STRAIN RATE :	47.15	0.00	0.00	0.00	%/hr
DEVIATOR STRESS :	30.0	0.0	0.0	0.0	kPa
MINOR STRESS :	72.4	0.0	0.0	0.0	kPa
MAJOR STRESS :	102.4	0.0	0.0	0.0	kPa
STRESS RATIO :	1.4149	0.0000	0.0000	0.0000	



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FAILURE PROFILES

APPROVAL

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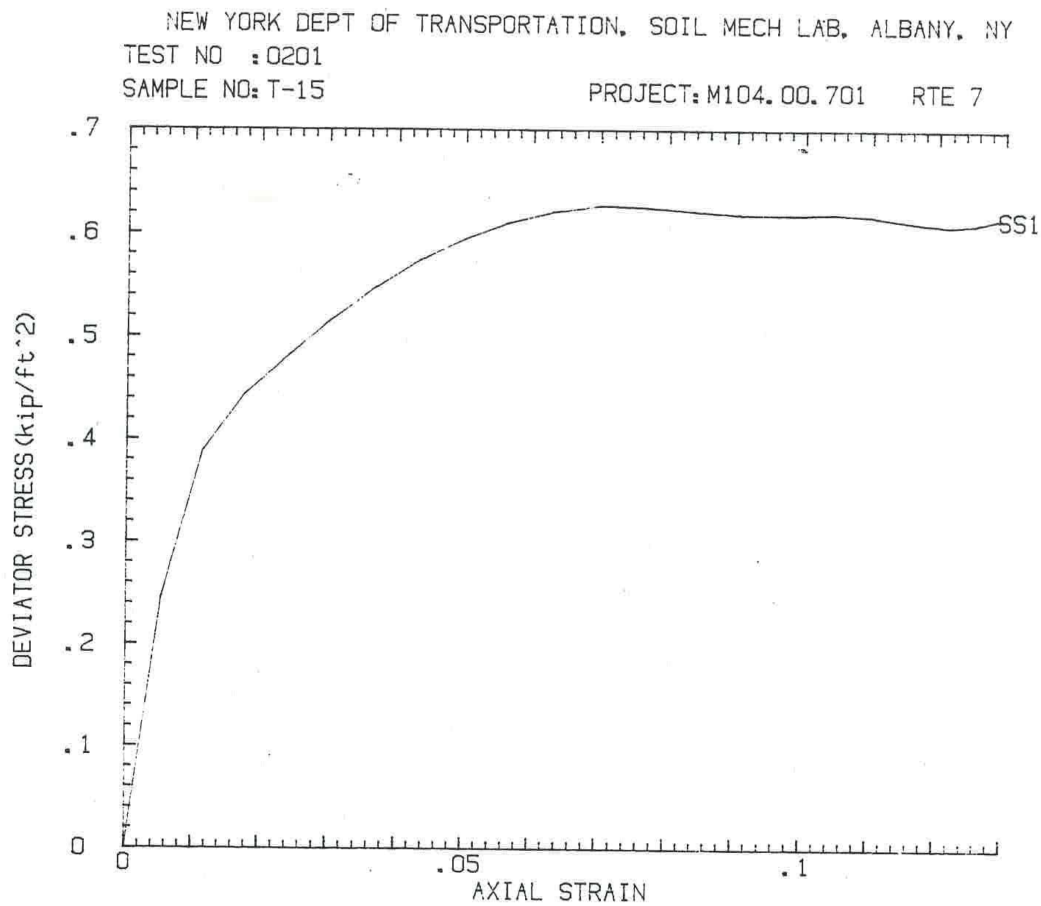
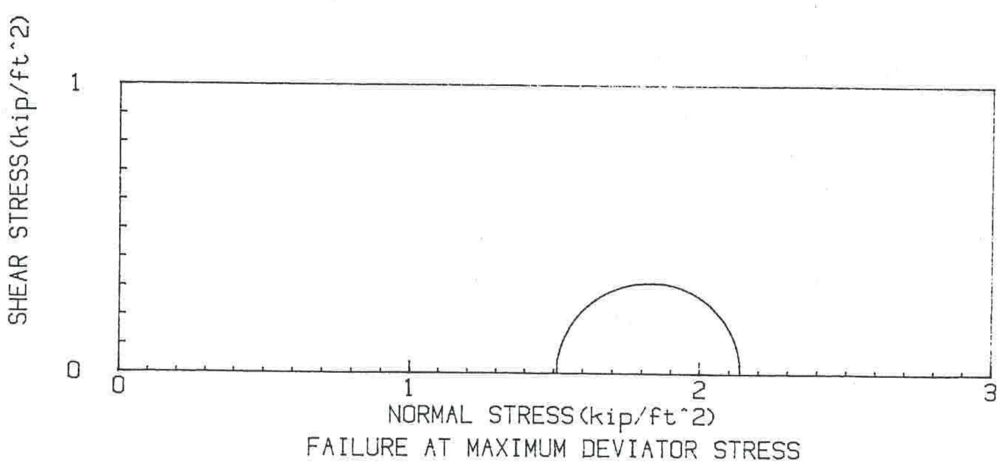

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY
TEST NO : 0201
SAMPLE NO: T-15
PROJECT: M104.00.701 RTE 7
DEVIATOR STRESS (kip/ft^2)
.7
.6
.5
.4
.3
.2
.1
0
0
.05
.1
AXIAL STRAIN
SS1


SHEAR STRESS (kip/ft^2)
1
0
0
1
2
3
NORMAL STRESS (kip/ft^2)
FAILURE AT MAXIMUM DEVIATOR STRESS

APPENDIX A

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY

TRIAXIAL COMPRESSION TEST
UNCONSOLIDATED-UNDRAINED

TEST # 0201 4/3/91

PROJECT : M104.00.701 RTE 7 BOREHOLE: UDH-1
SAMPLE NO : T-15 DEPTH : 23.8

DESCRIPTION: Gr&Br Incl Layers Silty CLAY W/ Silt Lenses (M-SFT/FM-PL)

INITIAL SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 9	S-2/M- 0	S-3/M- 0	S-4/M- 0	UNITS
WEIGHT, TOTAL :	1807.2	0.0	0.0	0.0	g
WEIGHT, SOLIDS :	1243.8	0.0	0.0	0.0	g
WEIGHT, MOISTURE:	563.4	0.0	0.0	0.0	g
PERCENT MOISTURE:	45.3	0.0	0.0	0.0	%
LENGTH :	7.000	0.000	0.000	0.000	inch
DIAMETER :	3.375	0.000	0.000	0.000	inch
AREA :	8.946	0.000	0.000	0.000	in^2
VOLUME, TOTAL :	62.62	0.00	0.00	0.00	in^3
VOLUME, SOLIDS :	27.21	0.00	0.00	0.00	in^3
VOLUME, MOISTURE:	564.53	0.00	0.00	0.00	cm^3
SPECIFIC GRAVITY:	2.7900	0.0000	0.0000	0.0000	
VOID RATIO :	1.3019	0.0000	0.0000	0.0000	
SATURATION :	97.27	0.00	0.00	0.00	%
UNIT WET WEIGHT :	109.9	0.0	0.0	0.0	lb/ft^3
UNIT DRY WEIGHT :	75.7	0.0	0.0	0.0	lb/ft^3

TEST CONDITIONS					
CELL PRESSURE :	10.5	0.0	0.0	0.0	lbf/in^2
BACK PRESSURE :	0.0	0.0	0.0	0.0	lbf/in^2
CONFINING PRESS.:	10.5	0.0	0.0	0.0	lbf/in^2

SATURATED SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 9	S-2/M- 0	S-3/M- 0	S-4/M- 0	UNITS
MOISTURE ADDED :	15.9	0.0	0.0	0.0	cm^3
WEIGHT, TOTAL :	1823.0	0.0	0.0	0.0	g
WEIGHT, MOISTURE:	579.2	0.0	0.0	0.0	g
PERCENT MOISTURE:	46.6	0.0	0.0	0.0	%
SATURATION :	100.0	0.0	0.0	0.0	%

APPENDIX A

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY

TRIAXIAL COMPRESSION TEST
UNCONSOLIDATED-UNDRAINED

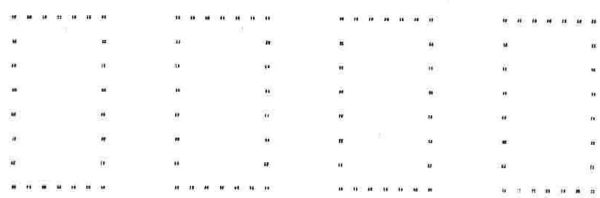
TEST # 0201 4/3/91

PROJECT : M104.00.701 RTE 7 BOREHOLE: UDH-1
SAMPLE NO : T-15 DEPTH : 23.8

DESCRIPTION: Gr&Br Incl Layers Silty CLAY W/ Silt Lenses (M-SFT/FM-PL)

SAMPLE PARAMETERS AT MAXIMUM DEVIATOR STRESS

SAMPLE/MACH	S-1/M- 9	S-2/M- 0	S-3/M- 0	S-4/M- 0	UNITS
WEIGHT, TOTAL :	1823.0	0.0	0.0	0.0	g
WEIGHT, SOLIDS :	1243.8	0.0	0.0	0.0	g
WEIGHT, MOISTURE:	579.2	0.0	0.0	0.0	g
MOISTURE DRAINED:	0.0	0.0	0.0	0.0	cm^3
PERCENT MOISTURE:	46.6	0.0	0.0	0.0	%
LENGTH :	6.511	0.000	0.000	0.000	inch
DIAMETER :	3.499	0.000	0.000	0.000	inch
AREA :	9.618	0.000	0.000	0.000	in^2
VOLUME, TOTAL :	62.62	0.00	0.00	0.00	in^3
SPECIFIC GRAVITY:	2.7900	0.0000	0.0000	0.0000	
VOID RATIO :	1.3019	0.0000	0.0000	0.0000	
STRAIN RATIO :	.0699	0.0000	0.0000	0.0000	
TIME TO FAILURE :	.148	0.000	0.000	0.000	hours
STRAIN RATE :	47.15	0.00	0.00	0.00	%/hr
DEVIATOR STRESS :	.63	0.00	0.00	0.00	kip/ft^2
MINOR STRESS :	1.51	0.00	0.00	0.00	kip/ft^2
MAJOR STRESS :	2.14	0.00	0.00	0.00	kip/ft^2
STRESS RATIO :	1.4149	0.0000	0.0000	0.0000	



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FAILURE PROFILES

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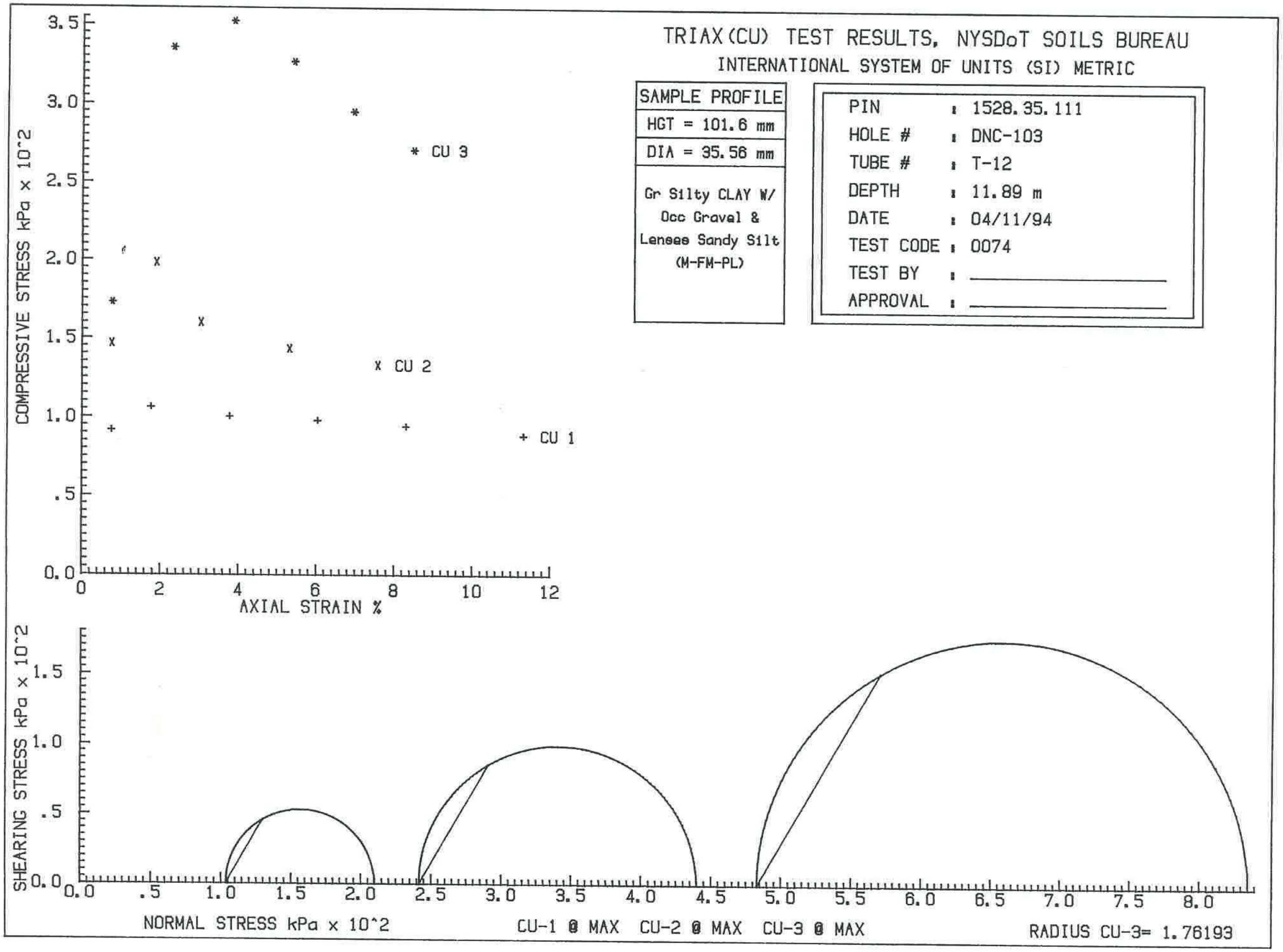

TRIAX(CU) TEST RESULTS, NYSDoT SOILS BUREAU
INTERNATIONAL SYSTEM OF UNITS (SI) METRIC
SAMPLE PROFILE
HGT = 101.6 mm
DIA = 35.56 mm
Gr Silty CLAY W/ Occ Gravel & Lenses Sandy Silt (M-FM-PL)
PIN : 1528.35.111
HOLE # : DNC-103
TUBE # : T-12
DEPTH : 11.89 m
DATE : 04/11/94
TEST CODE : 0074
TEST BY :
APPROVAL :
COMPRESSIVE STRESS kPa x 10^2
AXIAL STRAIN %
CU 1
CU 2
CU 3
SHEARING STRESS kPa x 10^2
NORMAL STRESS kPa x 10^2
CU-1 @ MAX CU-2 @ MAX CU-3 @ MAX
RADIUS CU-3= 1.76193

APPENDIX A

TRIAX(CU) TEST RESULTS, NYSDoT SOILS BUREAU
INTERNATIONAL SYSTEM OF UNITS (SI) METRIC

PROJECT : I-90 Exit 8

P.I.N. : 1528.35.111 DEPTH : 11.89 m

HOLE # : DNC-103 STRAIN RATE : 0.021 mm/sec

TUBE # : T-12 TEST CODE : 0074 DATE : 04/11/94

Gr Silty CLAY W/ Occ Gravel & Lenses Sandy Silt (M-FM-PL)

REMARKS: ______________________________

** INPUT **

		CU- 1	CU- 2	CU- 3	UNITS
INIT WET WGT SOIL	=	172.85	173.41	180.88	g
WGT WET SOIL & TARE	=	211.66	213.65	213.76	g
WGT DRY SOIL & TARE	=	155.67	158.76	170.82	g
WEIGHT OF TARE	=	40.74	43.35	40.79	g
SPECIFIC GRAVITY	=	2.79	2.79	2.79	
SAMPLE HEIGHT	=	101.60	101.60	101.60	mm
CONFINING PRESSURE	=	103.42	241.32	482.63	kPa

** OUTPUT **

		CU- 1	CU- 2	CU- 3	UNITS
INITIAL MOISTURE		50.40	50.26	39.11	%
FINAL MOISTURE	=	48.72	47.56	33.02	%
INITIAL VOID RATIO	=	1.41	1.40	1.09	
FINAL VOID RATIO	=	1.36	1.33	.92	
INITIAL VOLUME	=	9.91E+004	9.94E+004	9.75E+004	mm^3
FINAL VOLUME	=	9.72E+004	9.63E+004	8.95E+004	mm^3
INITIAL WET DENSITY	=	1743.93	1745.14	1855.99	kg/m^3
CONSOLIDATED HEIGHT	=	100.94	100.53	98.77	mm
CONSOLIDATED AREA	=	962.82	957.49	906.58	mm^2

FAILURE SKETCHES --->

ANGLE --->

LIQ LIMIT______ PL LIMIT______ PL INDEX______
ORG CONT ______%
% FINER THAN .020mm_____.002mm_____

TEST BY :______________
APPROVAL :______________

STRESS STRAIN OUTPUT CONTINUED NEXT PAGE

APPENDIX A

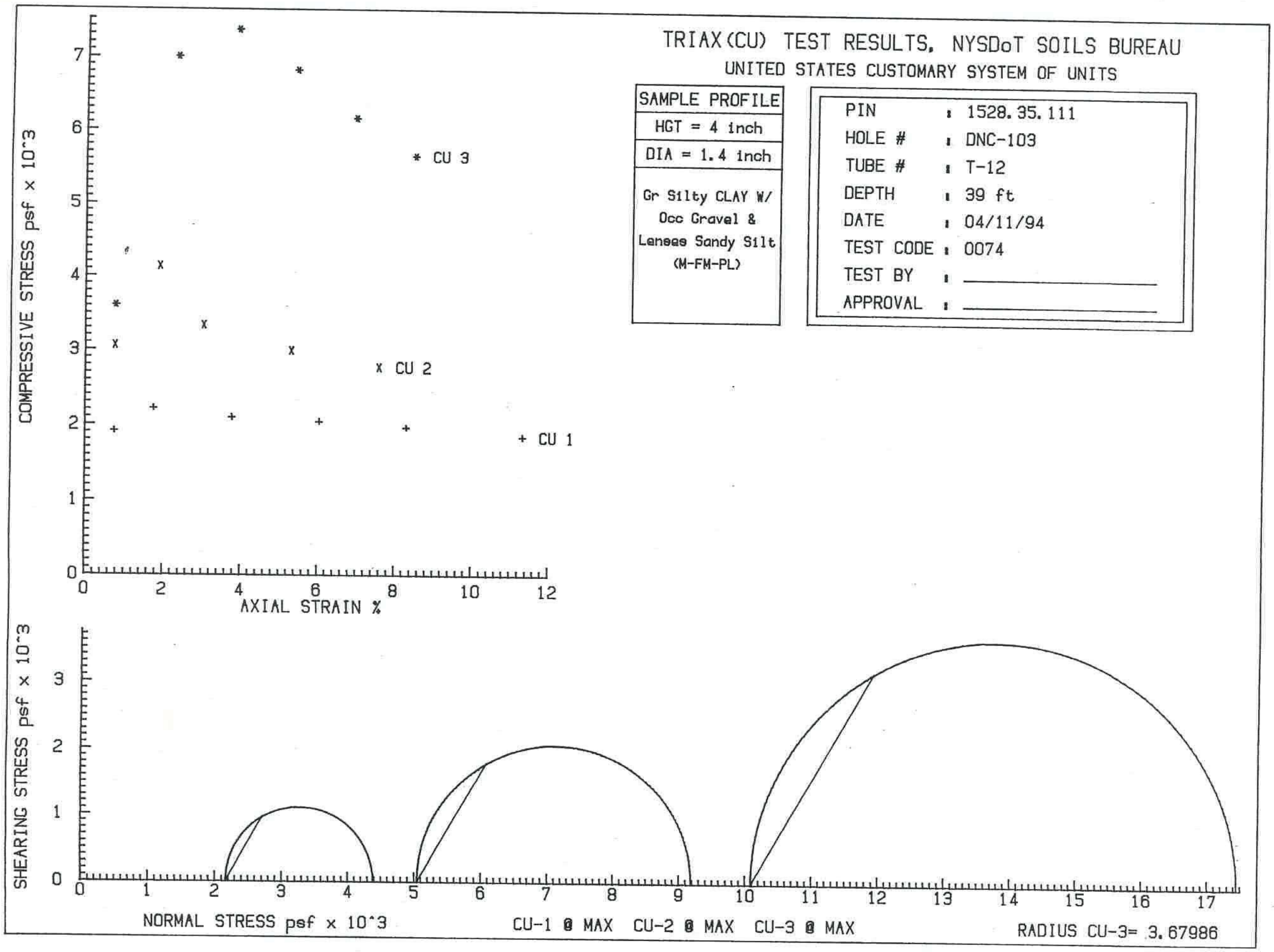
P.I.N. : 1528.35.111 TEST CODE : 0074 TUBE # : T-12
HOLE # : DNC-103 DEPTH : 11.89 m

CU-1	LOAD N	DEFL mm	CRC AREA mm^2	STRAIN %	STRESS kPa
	88.964	.762	970.145	.755	91.702
	104.088	1.778	980.086	1.762	106.203
	100.530	3.810	1000.590	3.775	100.471
	100.530	6.096	1024.708	6.039	98.106
	99.195	8.382	1050.018	8.304	94.470
	96.526	11.430	1085.774	11.324	88.901

CU-2	LOAD N	DEFL mm	CRC AREA mm^2	STRAIN %	STRESS kPa
	141.453	.762	964.806	.758	146.613
	193.498	1.905	975.988	1.895	198.258
	157.912	3.048	987.432	3.032	159.922
	145.012	5.334	1011.144	5.306	143.414
	137.895	7.620	1036.023	7.580	133.100

CU-3	LOAD N	DEFL mm	CRC AREA mm^2	STRAIN %	STRESS kPa
	157.912	.762	913.627	.771	172.841
	311.375	2.286	928.057	2.314	335.514
	332.282	3.810	942.951	3.857	352.386
	313.155	5.334	958.331	5.400	326.771
	287.355	6.858	974.220	6.943	294.959
	268.228	8.382	990.646	8.486	270.761

APPENDIX A



TRIAX(CU) TEST RESULTS, NYSDoT SOILS BUREAU
UNITED STATES CUSTOMARY SYSTEM OF UNITS
SAMPLE PROFILE
HGT = 4 inch
DIA = 1.4 inch
Gr Silty CLAY W/ Occ Gravel & Lenses Sandy Silt (M-FM-PL)
PIN : 1528.35.111
HOLE # : DNC-103
TUBE # : T-12
DEPTH : 39 ft
DATE : 04/11/94
TEST CODE : 0074
TEST BY :
APPROVAL :
COMPRESSIVE STRESS psf x 10^3
AXIAL STRAIN %
* CU 3
x CU 2
+ CU 1
SHEARING STRESS psf x 10^3
NORMAL STRESS psf x 10^3
CU-1 @ MAX CU-2 @ MAX CU-3 @ MAX
RADIUS CU-3= 3.67986

APPENDIX A

TRIAX(CU) TEST RESULTS, NYSDoT SOILS BUREAU
UNITED STATES CUSTOMARY SYSTEM OF UNITS

****

PROJECT : I-90 Exit 8

P.I.N. : 1528.35.111 DEPTH : 39.00 ft

HOLE # : DNC-103 STRAIN RATE : 0.050 in/min

TUBE # : T-12 TEST CODE : 0074 DATE : 04/11/94

Gr Silty CLAY W/ Occ Gravel & Lenses Sandy Silt (M-FM-FL)

REMARKS:____

****

** INPUT **	CU- 1	CU- 2	CU- 3	UNITS
INIT WET WGT SOIL =	172.85	173.41	180.88	g
WGT WET SOIL & TARE =	211.66	213.65	213.76	g
WGT DRY SOIL & TARE =	155.67	158.76	170.82	g
WEIGHT OF TARE =	40.74	43.35	40.79	g
SPECIFIC GRAVITY =	2.79	2.79	2.79	
SAMPLE HEIGHT =	4.00	4.00	4.00	inch
CONFINING PRESSURE =	15.00	35.00	70.00	psi

** OUTPUT **	CU- 1	CU- 2	CU- 3	UNITS
INITIAL MOISTURE	50.40	50.26	39.11	%
FINAL MOISTURE =	48.72	47.56	33.02	%
INITIAL VOID RATIO =	1.41	1.40	1.09	
FINAL VOID RATIO =	1.36	1.33	.92	
INITIAL VOLUME =	6.05	6.06	5.95	in^3
FINAL VOLUME =	5.93	5.87	5.46	in^3
INITIAL WET DENSITY =	108.87	108.95	115.87	lb/ft^3
CONSOLIDATED HEIGHT =	3.97	3.96	3.89	inch
CONSOLIDATED AREA =	.01	.01	.01	ft^2
CONFINING PRESSURE =	2160.00	5040.00	10080.00	psf

FAILURE SKETCHES --->

ANGLE --->

LIQ LIMIT______ PL LIMIT______ PL INDEX______
ORG CONT ______%
% FINER THAN .020mm_____.002mm_____

TEST BY :______________
APPROVAL :______________

STRESS STRAIN OUTPUT CONTINUED NEXT PAGE

APPENDIX A

P.I.N. : 1528.35.111
HOLE # : DNC-103

TEST CODE : 0074

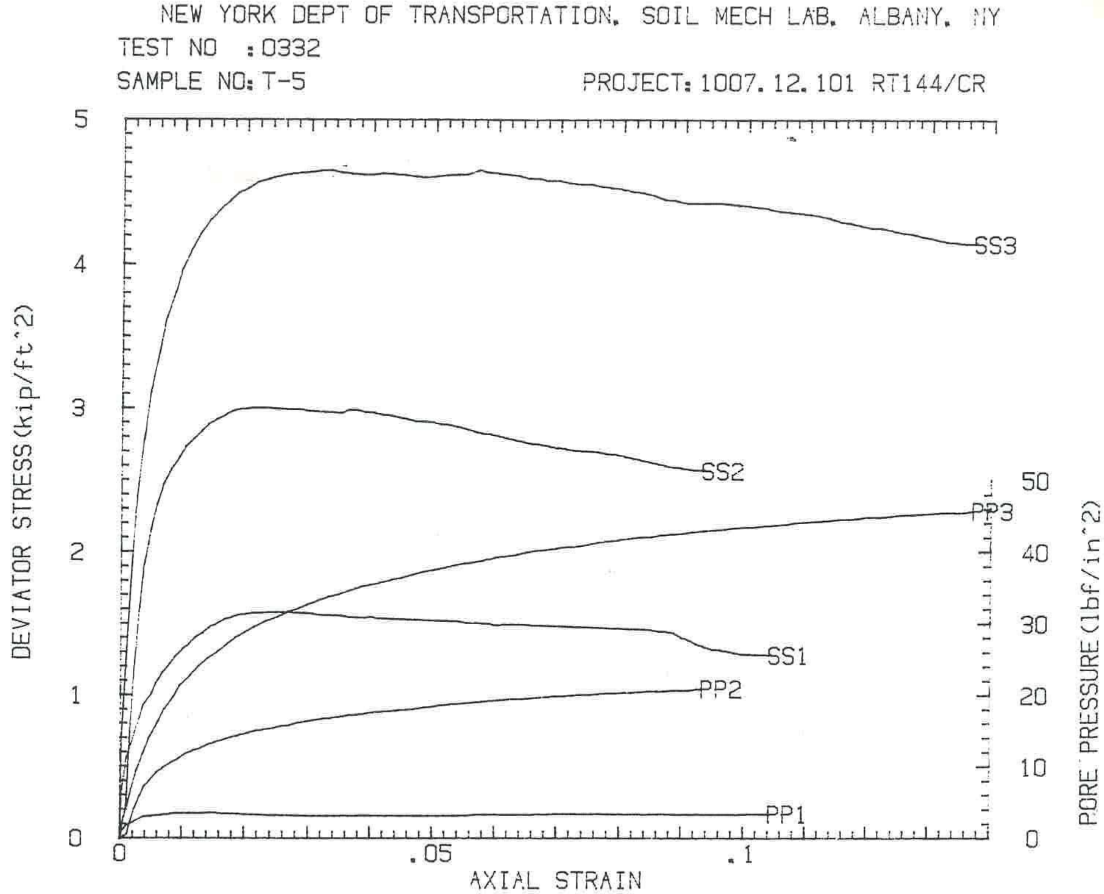
TUBE # : T-12
DEPTH : 39.00 ft

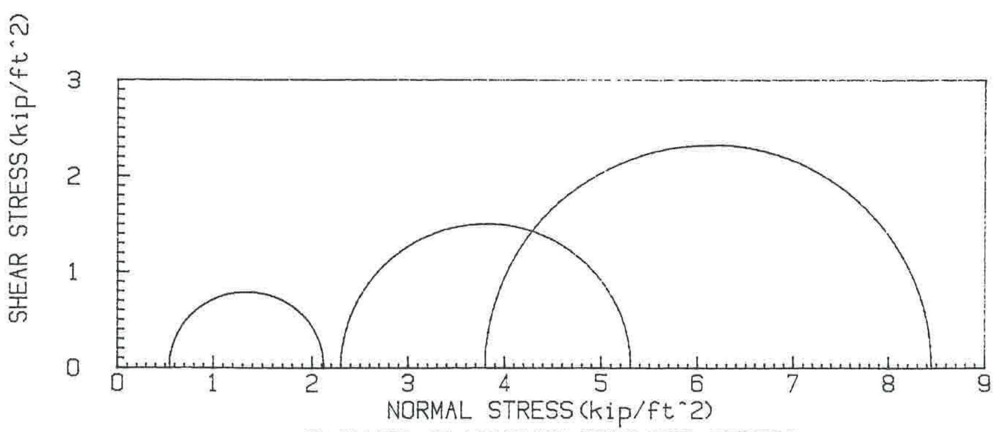
CU-1	LOAD lbf	DEFL inch	CRC AREA ft^2	STRAIN %	STRESS psf
	20.000	.030	.010	.755	1915.239
	23.400	.070	.011	1.762	2218.103
	22.600	.150	.011	3.775	2098.370
	22.600	.240	.011	6.039	2048.982
	22.300	.330	.011	8.304	1973.050
	21.700	.450	.012	11.324	1856.735

CU-2	LOAD lbf	DEFL inch	CRC AREA ft^2	STRAIN %	STRESS psf
	31.800	.030	.010	.758	3062.083
	43.500	.075	.011	1.895	4140.710
	35.500	.120	.011	3.032	3340.037
	32.600	.210	.011	5.306	2995.261
	31.000	.300	.011	7.580	2779.856

CU-3	LOAD lbf	DEFL inch	CRC AREA ft^2	STRAIN %	STRESS psf
	35.500	.030	.010	.771	3609.853
	70.000	.090	.010	2.314	7007.340
	74.700	.150	.010	3.857	7359.722
	70.400	.210	.010	5.400	6824.758
	64.600	.270	.010	6.943	6160.349
	60.300	.330	.011	8.486	5654.952

APPENDIX A





FAILURE AT MAXIMUM DEVIATOR STRESS

APPENDIX A

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY

TRIAXIAL COMPRESSION TEST
EFFECTIVE STRESS
CONSOLIDATED-UNDRAINED

TEST # 0332 4/7/95

PROJECT : 1007.12.101 RT144/CR BOREHOLE: DNB-1
SAMPLE NO : T-5 DEPTH : 20.5' 6.25 m

DESCRIPTION: Layered Br & Gr Silty CLAY W/ Silt Lenses (M-SFT-PL)

INITIAL SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 3	S-2/M- 7	S-3/M-11	S-4/M- 0	UNITS
WEIGHT, TOTAL :	177.1	177.4	177.5	0.0	g
WEIGHT, SOLIDS :	120.2	120.3	120.5	0.0	g
WEIGHT, MOISTURE:	56.9	57.1	57.0	0.0	g
PERCENT MOISTURE:	47.3	47.4	47.3	0.0	%
LENGTH :	4.000	4.000	4.000	0.000	inch
DIAMETER :	1.400	1.400	1.400	0.000	inch
AREA :	1.539	1.539	1.539	0.000	in^2
VOLUME, TOTAL :	6.16	6.16	6.16	0.00	in^3
VOLUME, SOLIDS :	2.64	2.64	2.65	0.00	in^3
VOLUME, MOISTURE:	57.01	57.16	57.09	0.00	cm^3
SPECIFIC GRAVITY:	2.7800	2.7800	2.7800	0.0000	
VOID RATIO :	1.3336	1.3309	1.3272	0.0000	
SATURATION :	98.87	99.22	99.22	0.00	%
UNIT WET WEIGHT :	109.6	109.8	109.8	0.0	lb/ft^3
UNIT DRY WEIGHT :	74.4	74.5	74.6	0.0	lb/ft^3

TEST CONDITIONS

CELL PRESSURE :	37.0	61.0	95.0	0.0	lbf/in^2
BACK PRESSURE :	30.0	30.0	30.0	0.0	lbf/in^2
CONFINING PRESS.:	7.0	31.0	65.0	0.0	lbf/in^2

SATURATED SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 3	S-2/M- 7	S-3/M-11	S-4/M- 0	UNITS
MOISTURE ADDED :	.6	.4	.5	0.0	cm^3
WEIGHT, TOTAL :	177.8	177.8	178.0	0.0	g
WEIGHT, MOISTURE:	57.5	57.5	57.4	0.0	g
PERCENT MOISTURE:	47.9	47.8	47.6	0.0	%
SATURATION :	100.0	100.0	100.0	0.0	%

APPENDIX A

TEST # 0332 CONSOLIDATED SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 3	S-2/M- 7	S-3/M-11	S-4/M- 0	UNITS
PERCENT CONSOLID:	-2.63	-5.57	-11.81	0.00	%
MOISTURE REMOVED:	2.65	5.62	11.92	0.00	cm^3
WEIGHT, TOTAL :	175.1	172.2	166.1	0.0	g
WEIGHT, MOISTURE:	54.9	51.9	45.5	0.0	g
PERCENT MOISTURE:	45.7	43.1	37.8	0.0	%
LENGTH :	3.965	3.924	3.836	0.000	inch
DIAMETER :	1.388	1.374	1.343	0.000	inch
AREA :	1.512	1.482	1.416	0.000	in^2
VOLUME :	6.00	5.81	5.43	0.00	in^3
VOID RATIO :	1.2724	1.2011	1.0524	0.0000	

CONSOLIDATION DATA

TIME(min)	% CONS	TIME(min)	% CONS	TIME(min)	% CONS	TIME(min)	% CONS

NO DATA AVAILABLE

APPENDIX A

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY

TRIAXIAL COMPRESSION TEST
EFFECTIVE STRESS
CONSOLIDATED-UNDRAINED

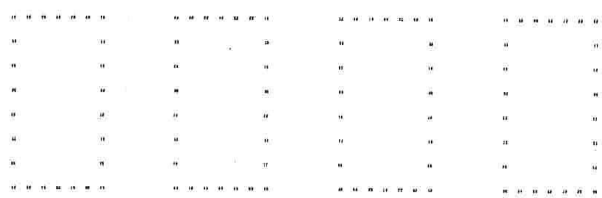
TEST # 0332 4/7/95

PROJECT : 1007.12.101 RT144/CR BOREHOLE: DNB-1
SAMPLE NO : T-5 DEPTH : 20.5' 6.25 m

DESCRIPTION: Layered Br & Gr Silty CLAY W/ Silt Lenses (M-SFT-PL)

SAMPLE PARAMETERS AT MAXIMUM DEVIATOR STRESS

SAMPLE/MACH	S-1/M- 3	S-2/M- 7	S-3/M-11	S-4/M- 0	UNITS
WEIGHT, TOTAL :	175.1	172.2	166.1	0.0	g
WEIGHT, SOLIDS :	120.2	120.3	120.5	0.0	g
WEIGHT, MOISTURE:	54.9	51.9	45.5	0.0	g
MOISTURE DRAINED:	0.0	0.0	0.0	0.0	cm^3
PERCENT MOISTURE:	45.7	43.1	37.8	0.0	%
LENGTH :	3.871	3.839	3.618	0.000	inch
DIAMETER :	1.404	1.389	1.382	0.000	inch
AREA :	1.549	1.514	1.501	0.000	in^2
VOLUME, TOTAL :	6.00	5.81	5.43	0.00	in^3
SPECIFIC GRAVITY:	2.7800	2.7800	2.7800	0.0000	
VOID RATIO :	1.2724	1.2011	1.0524	0.0000	
STRAIN RATIO :	.0237	.0217	.0568	0.0000	
TIME TO FAILURE :	1.141	.965	2.034	0.000	hours
STRAIN RATE :	2.08	2.24	2.79	0.00	%/hr
DEVIATOR STRESS :	1.58	3.00	4.65	0.00	kip/ft^2
MINOR STRESS :	.55	2.30	3.80	0.00	kip/ft^2
MAJOR STRESS :	2.13	5.31	8.45	0.00	kip/ft^2
STRESS RATIO :	3.8871	2.3041	2.2239	0.0000	



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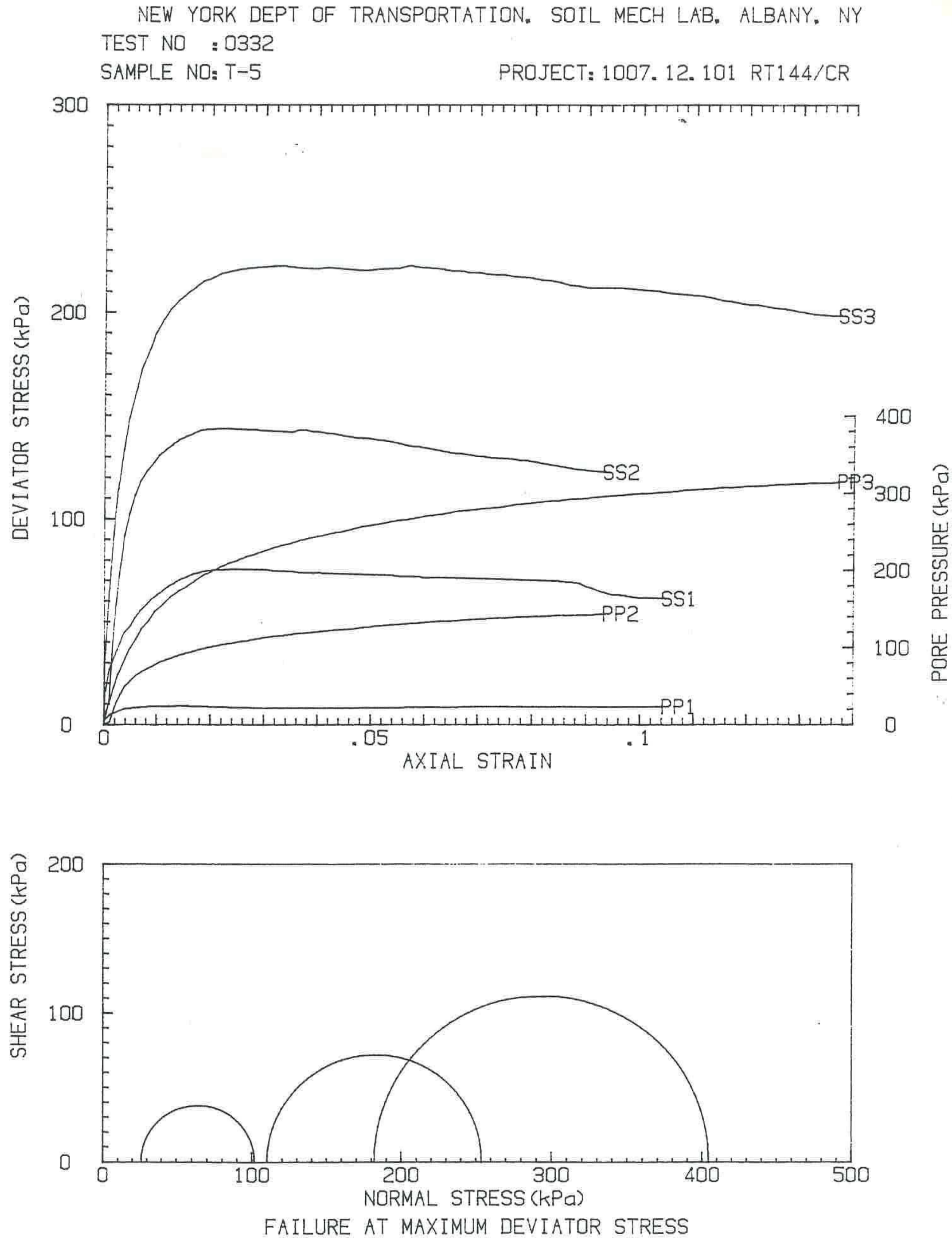
FAILURE PROFILES

APPROVAL

APPENDIX A



NEW YORK DEPT OF TRANSPORTATION. SOIL MECH LAB. ALBANY. NY
TEST NO : 0332
SAMPLE NO: T-5
PROJECT: 1007. 12. 101 RT144/CR
DEVIATOR STRESS (kPa)
300
200
100
0
SS3
SS2
PP3
SS1
PP2
PP1
400
300
200
100
0
PORE PRESSURE (kPa)
0
.05
.1
AXIAL STRAIN
SHEAR STRESS (kPa)
200
100
0
0
100
200
300
400
500
NORMAL STRESS (kPa)
FAILURE AT MAXIMUM DEVIATOR STRESS

APPENDIX A

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY

TRIAXIAL COMPRESSION TEST
EFFECTIVE STRESS
CONSOLIDATED-UNDRAINED

TEST # 0332 4/7/95

PROJECT : 1007.12.101 RT144/CR BOREHOLE: DNB-1
SAMPLE NO : T-5 DEPTH : 20.5' 6.25 m

DESCRIPTION: Layered Br & Gr Silty CLAY W/ Silt Lenses (M-SFT-PL)

INITIAL SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 3	S-2/M- 7	S-3/M-11	S-4/M- 0	UNITS
WEIGHT, TOTAL :	177.1	177.4	177.5	0.0	g
WEIGHT, SOLIDS :	120.2	120.3	120.5	0.0	g
WEIGHT, MOISTURE:	56.9	57.1	57.0	0.0	g
PERCENT MOISTURE:	47.3	47.4	47.3	0.0	%
LENGTH :	101.60	101.60	101.60	0.00	mm
DIAMETER :	35.56	35.56	35.56	0.00	mm
AREA :	993.	993.	993.	0.	mm^2
VOLUME, TOTAL :	100.9	100.9	100.9	0.0	cm^3
VOLUME, SOLIDS :	43.2	43.3	43.4	0.0	cm^3
VOLUME, MOISTURE:	57.0	57.2	57.1	0.0	cm^3
SPECIFIC GRAVITY:	2.7800	2.7800	2.7800	0.0000	
VOID RATIO :	1.3336	1.3309	1.3272	0.0000	
SATURATION :	98.87	99.22	99.22	0.00	%
UNIT WET WEIGHT :	1755.	1758.	1759.	0.	kg/m^3
UNIT DRY WEIGHT :	1191.	1193.	1195.	0.	kg/m^3

TEST CONDITIONS					
CELL PRESSURE :	255.1	420.6	655.0	0.0	kPa
BACK PRESSURE :	206.8	206.8	206.8	0.0	kPa
CONFINING PRESS.:	48.3	213.7	448.2	0.0	kPa

SATURATED SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 3	S-2/M- 7	S-3/M-11	S-4/M- 0	UNITS
MOISTURE ADDED :	.6	.4	.5	0.0	cm^3
WEIGHT, TOTAL :	177.8	177.8	178.0	0.0	g
WEIGHT, MOISTURE:	57.5	57.5	57.4	0.0	g
PERCENT MOISTURE:	47.9	47.8	47.6	0.0	%
SATURATION :	100.0	100.0	100.0	0.0	%

APPENDIX A

TEST # 0332 CONSOLIDATED SAMPLE PARAMETERS

SAMPLE/MACH	S-1/M- 3	S-2/M- 7	S-3/M-11	S-4/M- 0	UNITS
PERCENT CONSOLID:	-2.63	-5.57	-11.81	0.00	%
MOISTURE REMOVED:	2.65	5.62	11.92	0.00	cm^3
WEIGHT, TOTAL :	175.1	172.2	166.1	0.0	g
WEIGHT, MOISTURE:	54.9	51.9	45.5	0.0	g
PERCENT MOISTURE:	45.7	43.1	37.8	0.0	%
LENGTH :	100.70	99.68	97.43	0.00	mm
DIAMETER :	35.25	34.89	34.10	0.00	mm
AREA :	976.	956.	913.	0.	mm^2
VOLUME :	98.3	95.3	89.0	0.0	cm^3
VOID RATIO :	1.2724	1.2011	1.0524	0.0000	

CONSOLIDATION DATA

TIME(min)	% CONS	TIME(min)	% CONS	TIME(min)	% CONS	TIME(min)	% CONS

NO DATA AVAILABLE

APPENDIX A

NEW YORK DEPT OF TRANSPORTATION, SOIL MECH LAB, ALBANY, NY

TRIAXIAL COMPRESSION TEST
EFFECTIVE STRESS
CONSOLIDATED-UNDRAINED.

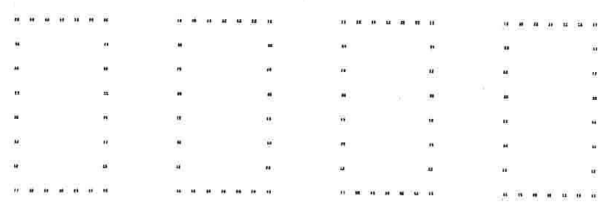
TEST # 0332 4/7/95

PROJECT : 1007.12.101 RT144/CR BOREHOLE: DNB-1
SAMPLE NO : T-5 DEPTH : 20.5' 6.25 m

DESCRIPTION: Layered Br & Gr Silty CLAY W/ Silt Lenses (M-SFT-PL)

SAMPLE PARAMETERS AT MAXIMUM DEVIATOR STRESS

SAMPLE/MACH	S-1/M- 3	S-2/M- 7	S-3/M-11	S-4/M- 0	UNITS
WEIGHT, TOTAL :	175.1	172.2	166.1	0.0	g
WEIGHT, SOLIDS :	120.2	120.3	120.5	0.0	g
WEIGHT, MOISTURE:	54.9	51.9	45.5	0.0	g
MOISTURE DRAINED:	0.0	0.0	0.0	0.0	cm^3
PERCENT MOISTURE:	45.7	43.1	37.8	0.0	%
LENGTH :	98.3	97.5	91.9	0.0	mm
DIAMETER :	35.7	35.3	35.1	0.0	mm
AREA :	999.	977.	968.	0.	mm^2
VOLUME, TOTAL :	98.3	95.3	89.0	0.0	cm^3
SPECIFIC GRAVITY:	2.7800	2.7800	2.7800	0.0000	
VOID RATIO :	1.2724	1.2011	1.0524	0.0000	
STRAIN RATIO :	.0237	.0217	.0568	0.0000	
TIME TO FAILURE :	1.141	.965	2.034	0.000	hours
STRAIN RATE :	2.08	2.24	2.79	0.00	%/hr
DEVIATOR STRESS :	75.7	143.9	222.8	0.0	kPa
MINOR STRESS :	26.2	110.3	182.0	0.0	kPa
MAJOR STRESS :	101.9	254.2	404.8	0.0	kPa
STRESS RATIO :	3.8871	2.3041	2.2239	0.0000	



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FAILURE PROFILES

APPROVAL

APPENDIX A

New York State Department of Transportation --- Soil Mechanics Bureau --- Albany, New York 12232

AUTOMATIC CONSOLIDATION TEST RESULTS

PROJECT: RT 31 OVER SENECA RIVER **PIN:** 3037.52.101

Date: 19-DEC-1994 **Test Number:** 801 **PSN:**

Drill Hole: UDH 11 **Tube Number:** T-12 **Depth (Ft.):** 17.40

» TEST DETAILS «

Test Start Date 14-DEC-1994
Station Assigned ... 1
Operator .... EW
Load Interval(min) . 150
Ring Height (in.) .. 0.7455

» SPECIMEN DATA «

Initial Moisture Content (%) .	88.00
Initial Wet Density (PCF)	87.75
Height of Solids (in.)	0.2550
Percent Saturation	100.00
Specific Gravity	2.19
Initial Void Ratio	1.9234

» LOAD SUMMARY «

LOAD	PSF	FVoidR	%Strain
1	125	1.8654	1.99
2	250	1.8105	3.86
3	500	1.7340	6.48
4	1000	1.6301	10.03
5	2000	1.4987	14.53
6	4000	1.3446	19.80
7	8000	1.1830	25.33
8	16000	1.0117	31.19
9	32000	0.8442	36.91
10	4000	0.8834	35.57

SOIL DESCRIPTION: Gr MARL W/ Shells M-FM-NPL

>>> TIME CURVE SUMMARY <<<

LOAD	From	To	Cv50	Cv90	C-Alpha(e)	C-Alpha(%)
3	250	500	0.096	0.065	0.013	0.004
4	500	1000	0.108	0.063	0.019	0.007
5	1000	2000	0.086	0.058	0.025	0.009
6	2000	4000	0.062	0.048	0.026	0.009
7	4000	8000	0.063	0.048	0.027	0.009
8	8000	16000	0.059	0.044	0.021	0.007
9	16000	32000	0.066	0.041	0.020	0.007

# = Operator assisted in computation.
.nc. = Value is unresolvable.

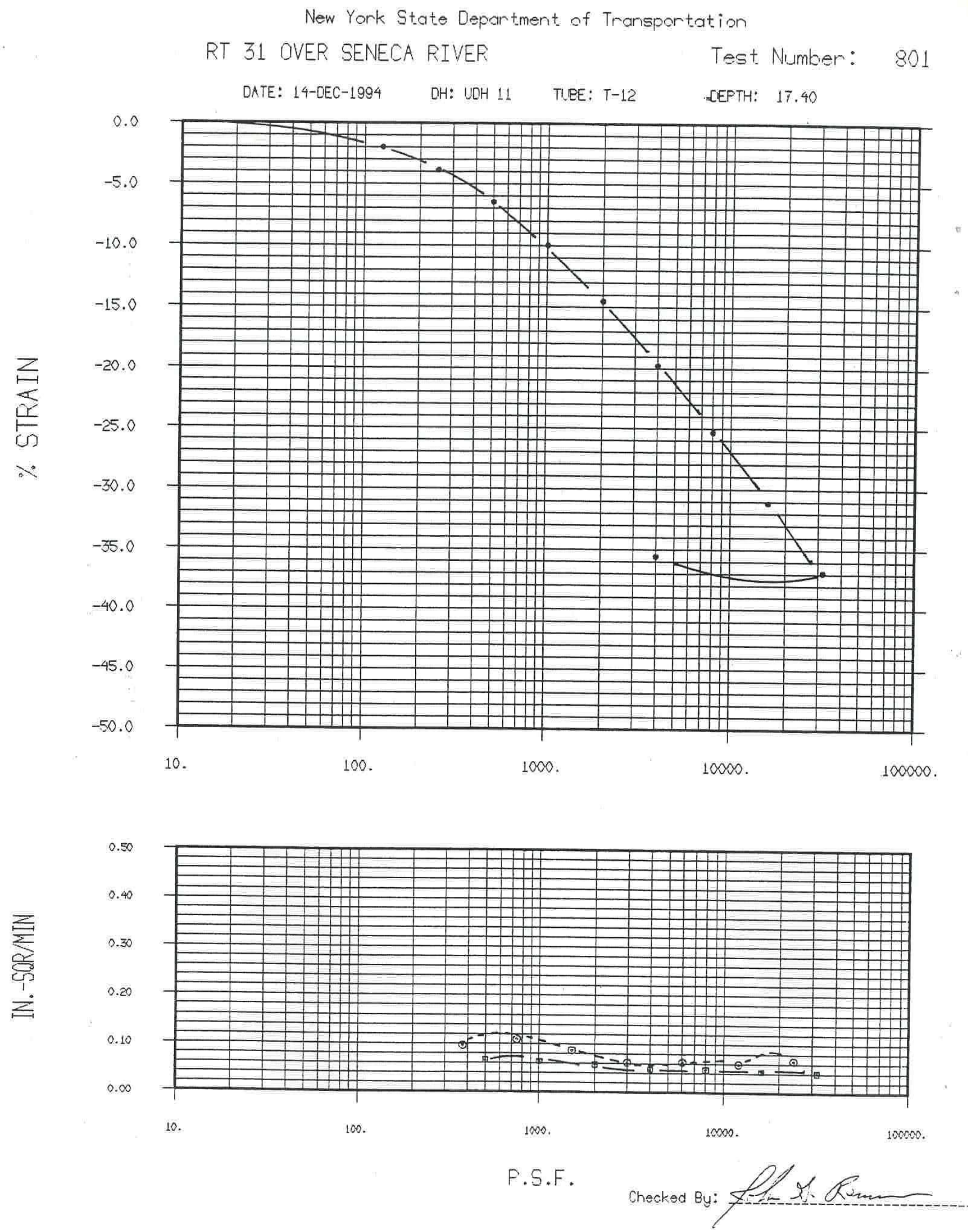
C-Alpha(e) = Slope of Secondary / Height of Solids
C-Alpha(%) = Slope of Secondary / Ring Height

Units: Loads = P.S.F. Cv's = In.-Sqr/Min.

Checked By: *[signature]*

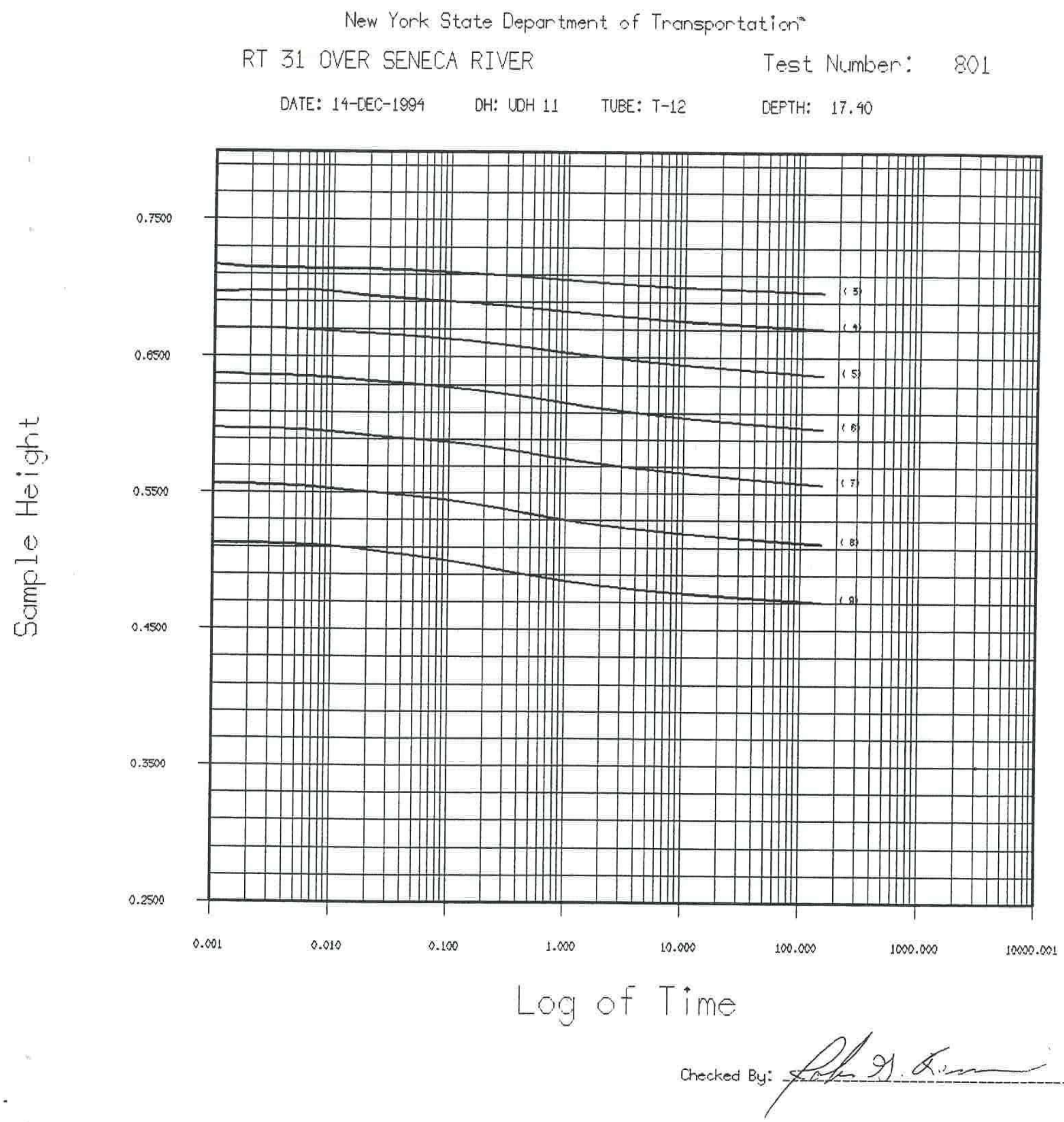
This test was performed, computed and summarized in its entirety by New York's
TOTALLY AUTOMATED CONSOLIDATION TEST SYSTEM [TACT].

APPENDIX A



New York State Department of Transportation
RT 31 OVER SENECA RIVER
Test Number: 801
DATE: 14-DEC-1994
DH: UDH 11
TUBE: T-12
DEPTH: 17.40
% STRAIN
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
-50.0
10.
100.
1000.
10000.
100000.
IN.-SQR/MIN
0.50
0.40
0.30
0.20
0.10
0.00
P.S.F.
Checked By:

APPENDIX A


New York State Department of Transportation
RT 31 OVER SENECA RIVER
Test Number: 801
DATE: 14-DEC-1994
DH: UDH 11
TUBE: T-12
DEPTH: 17.40
Sample Height
0.7500
0.6500
0.5500
0.4500
0.3500
0.2500
(3)
(4)
(5)
(6)
(7)
(8)
(9)
0.001
0.010
0.100
1.000
10.000
100.000
1000.000
10000.001
Log of Time
Checked By:

APPENDIX A

*** BLOCK PERMEABILITY TEST RESULTS ***

TEST NO. : 14 DATE : 17-JAN-95

PROJECT : Rte.9W/Coxsackie Creek
P.I.N. : 1039.24.102
DRILLHOLE : DNB-3
TUBE NO. : T-12
DEPTH (ft.) : 55.9 ft.
VISUAL : Lyrd.Lt.&Dk.Gr.silty CLAY (M-FM-PL)

DIRECTION : VERTICAL
CONF.PRESS. : 119.50
BACK.PRESS. : 100.00
EFFECTIVE PRESSURE (PSI): 19.50

MOISTURE CONTENT (%) : 61.40

WET DENSITY : 110.40

Kv : 7.62E-08 cm/sec

Approved By : [signature]

APPENDIX A

==

*** BLOCK PERMEABILITY TEST RESULTS ***

==

TEST NO. : 15 DATE : 17-JAN-95

PROJECT : Rte.9W/Coxsckie Creek

P.I.N. : 1039.24.102

DRILLHOLE : DNB-3

TUBE NO. : T-12

DEPTH (ft.) : 55.9 ft.

VISUAL : Lyrd.Lt.&Dk. Gr.silty CLAY (M_FM_PL)

##

DIRECTION : HORIZONTAL

CONF.PRESS. : 119.50

BACK.PRESS. : 100.00

EFFECTIVE PRESSURE (PSI): 19.50

MOISTURE CONTENT (%) : 61.40

WET DENSITY : 110.40

Kh : 1.01E-07 cm/sec

Approved By : John D. Remm

APPENDIX A

BLOCK PERMEABILITY

PROJECT: Rte. 9W / Coxsackie Creek
P.I.N.: 1039.24.102 HOLE: DNB-3 TUBE: T-12
DEPTH: 55.9 FT.
DISCRIPTION: LYRD LT. & DK. BR. SILTY CLAY (M-FM-PL)

DIRECTION:
☒ VERTICAL
☐ HORIZONTAL

TEST BY: R. J. Duma
DATE: 1/4/95
MAX. CONFINING PRESSURE 119.5 P.S.I.
MAX. BACK PRESSURE 100.0 P.S.I.

CONSOLIDATION PHASE

DATE / TIME	RESERVOIR LEVEL (CM.) TOP STONE	Δ	BOTTOM STONE	Δ	PRESSURE (P.S.I.) CON-FINE	BACK
1/4/95 9:00	30.0		30.0		19.5	0
9:30	28.0		28.4		19.5	0
10:00	27.5		28.1		19.5	0
11:30	27.1		27.7		19.5	0
1:20	27.0		27.6		19.5	0
1:20	27.3		27.8		29.5	10
3:00	27.2		27.7		29.5	10
1/5/95 5:50	27.1		27.4		29.5	10
6:50	27.2		27.5		39.5	20
8:00	27.3		27.5		39.5	20
8:00	27.3		27.6		49.5	30
9:00	27.4		27.6		49.5	30
9:00	27.4		27.7		59.5	40
9:45	27.5		27.7		59.5	40
9:45	27.5		27.8		69.5	50
11:00	27.6		27.8		69.5	50

DATE / TIME	RESERVOIR LEVEL (CM.) TOP STONE	Δ	BOTTOM STONE	Δ	PRESSURE (P.S.I.) CON-FINE	BACK
11:00	27.6		27.9		79.5	60
11:30	27.6		27.9		79.5	60
11:30	27.7		28.0		89.5	70
12:00	27.7		28.0		89.5	70
12:00	27.8		28.1		99.5	80
1:40	27.8		28.1		99.5	80
1:40	27.9		28.2		109.5	90
2:50	27.9		28.2		109.5	90
2:50	28.0		28.3		119.5	100.0
1/6 7:00	28.0		28.3		119.5	100.0

MOISTURE CONTENT

	SAMPLE	TRIMMINGS
WET WT. & TARE		115.6A
TARE	C-24	6.19
WET WT.	231.83	
DRY WT. & TARE	237.28	
TARE	93.44	
FILTERS	.70	
DRY WT.	143.64	
WT. OF WATER	88.19	
w	61.4	

PERMEABILITY PHASE

DATE / TIME	HEAD	UPPER RES. (CM.)	Δ	LOWER RES. (CM.)	Δ
1/6 7:00	122.22	30.0		30.0	
7:30		30.1	.1	29.9	.1
9:00	121.92	30.1	0	29.8	.1
10:00		30.2	.1	29.8	0
11:00		30.2	0	29.7	.1
12:30		30.3	.1	29.6	.1
2:00		30.4	.1	29.5	.1
3:00		30.5	.1	29.4	.1
			.4		.4
				.8	

HI = 121.92
HF = 121.12
T = 6 HRS