TECHNICAL SPECIAL PROVISIONS

FOR

Pore-Pressure Transducers
(Piezometers)

Project Name

Project Number

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SECTION T144

PORE-PRESSURE TRANSDUCERS (PIEZOMETERS)

T144-1 Description

The work specified in this Technical Special Provisions consists of furnishing and installing pore-pressure transducers (piezometers) at the elevations and locations shown in the plans in accordance with these Technical Special Provisions and as directed by the Engineer. The pore-pressure transducer installation shall be performed by an engineering firm pre-qualified in FDOT work groups 9.1, 9.2, 9.3 and 9.4.

T144-2 Materials

Pore-pressure transducers shall be designated for installation in boreholes prior to embankment construction for monitoring pore-pressures in foundation soils. Piezometers installed in drill holes or pressed-in type piezometers will be permitted. Transducers shall convert pore pressure directly into pneumatic pressure utilizing pressurized gas from a portable indicator to flow through tubing against the transducer sensor diaphragm until gas pressure against this diaphragm equalizes the pore pressure outside the diaphragm. Diaphragm shall be of Nitrile rubber (Buna N) or non-corrosive approved equal. Transducer diaphragm movement during monitoring shall not displace more than 0.001cc of water. The transducer is not to be subject to zero shifts and is to be able to monitor pore pressure changes of approximately one inch of water. The transducer shall be capable of providing continuous output and be able to provide a direct profile of pressure changes to operate with recorder. The transducers shall include high air entry porous elements. The transducer shall be supplied with the specified tubing lengths and calibrated graphs. Tubing shall be two-tube heavy wall nylon bundle with waterproofed jacket. Tubing diameter shall be 1/8" minimum for lengths up to 500 feet. The transducer shall be operable with tubing lengths up to 2,000 feet. The transducers shall be laboratory tested prior to delivery to the field. Laboratory test reports shall be submitted to the Engineer for his approval.

The following is a tabulation showing location, tubing lengths and tip elevations of transducers/piezometers which shall be placed in separate boreholes:

Pressure Transducer Number	Station (BL Construction)	Offset (ft)	Tubing Lengths (ft)	Approximate * Tip Elevations (ft NAVD)
PT-1	108+60	125 RT	160	+40
PT-2	109+20	160 RT	210	+50
PT-3	110+00	105 RT	360	+40

Pressure Transducer Number	Station (BL Construction)	Offset (ft)	Tubing Lengths (ft)	Approximate * Tip Elevations (ft NAVD)
PT-4	110+00	160 RT	270	+60
PT-5	110+00	215 RT	340	+60
PT-6	110+80	160 RT	360	+50

* The tip elevations are approximate and will be verified by the Engineer based on the materials recovered during installation of the piezometers.

T144-3 Detailed Installation Procedures for Closed System Piezometer with Remote Readout

The installation of pore pressure transducers shall be made by an engineering firm pre-qualified in FDOT work groups 9.1, 9.2, 9.3 and 9.4. Prior to installation of the pore pressure transducers, a description of the materials to be employed and a plan of the method of installation shall be submitted to the Engineer for approval. No work shall begin on installation of the pore pressure transducers until the proposed materials and installation plan have been approved by the Engineer. Piezometer will be acceptable if the measured water head is within six inches of the actual water head in the casing.

Pore pressure transducer leads shall be mounted in a junction box with quick-connect type fittings conforming to the pore pressure transducer control/readout unit, located as indicated on the plans or as directed by the Engineer.

T144-3.1 Placement of horizontal tubing.

Excavate a trench a minimum of one foot deep and one foot wide from the piezometer location to the readout protection box. The bottom of the trench shall be two feet minimum below future construction (ditches, pipes, etc.). The horizontal tubing shall be laid in a zigzag pattern in the trench on a bed of six inches of clean sand. When more than one tube is used in a trench, the lines shall not cross. Tubing shall be in one continuous length with no connections from the piezometer tip to the readout protection box. Splices shall not be allowed except to repair damage incurred after installation is completed.

Prior to installation, the tubing for pneumatic piezometers shall be immersed in clear water and checked for leaks under pressures exceeding the expected pore pressure. Also, the tubing shall be flushed with high pressure air to clean any dust or moisture from tubing before final connections are made. The air used for flushing should come from a tank which holds only filtered air and which has been bled for excess moisture.

T144-3.2 Piezometers installed in drill holes (Option)

1. The following additional equipment is required for installation of drilled-in piezometers:

a. A tamping hammer, made of a two feet length of seamless steel tubing, 1-5/8 inches O.D. and 5/8 inch I.D. or cast bronze of the same dimensions and weighing at least 25 pounds. These dimensions are for two-inch I.D. casing. Larger hammer dimensions are required for larger casing sizes. At the upper end, a loop of 1/8 inch diameter galvanized steel cable should be firmly attached to the hammer and to a grooved ring. The inside surface of the hammer should be smooth and all edges that touch the tubing should be rounded. This hammer should be supplied with a 1-5/8 inch diameter disc ½ inch thick which can be firmly attached to the bottom. This disc shall have a slot in the center (of suitable size to accommodate the size tubing used) with rounded edges. This hammer-cable assembly is used for the following purposes:

   * To tamp the bentonite layers and thereby assure a water-tight seal between the casing and the risers.

   * To center the risers while the bentonite seal is being tamped into place.

   * To measure depths at various stages of the installation.

b. Galvanized steel cable 1/4 inch diameter of sufficient length to permit installation on the deepest piezometers. This should be securely fastened to one end of a snap-type swivel hook. Mark the cable at five feet intervals, starting at the bottom face of the hammer.

c. A tripod and sheave for operating the tamping hammer.

d. Drive sample drilling equipment.

e. Ottawa sand or a thoroughly washed sand between No. 20 and No. 40 mesh grain size.

f. Commercially available bentonite pellets, or bentonite balls about ½ inch in diameter, which are formed at a water content somewhat above the plastic limit but below the sticky limit (i.e. at a putty-like consistency) rolled in talcum powder to prevent sticking, and stored in glass jars to protect them from drying.

g. Rounded pebbles approximately ½ inch in diameter.

2. Drive casing, two-inch I.D. or larger, to the approximate elevation of the bottom of the piezometer cell. The bottom ten feet long section must be in one piece, without joints or couplings, and it is not to have a drive shoe on the lower end. The casing may be advanced by any means, except for the final 20 feet of penetration. It shall then be advanced in five feet increments, and the casing must be washed out after each five foot advance. The casing shall be kept filled with water at all times and no washing below the casing will be permitted.

3. Obtain a spoon sample of the material for 12 inches below the bottom of the casing and deliver the samples in sealed jars to the Engineer. Drive the casing 12 inches below the piezometer cell elevation and clean out the remaining soil to the bottom of the casing. Replace the water in the casing with clear water by reversing the flow of the pump and using the jet pipe as the intake, with the lower end of the pipe held a few inches above the bottom of the casing. Keep the casing filled with clean water and continue the operation until the return water becomes clear.

4. Pull the casing up one foot, and pour clean sand into the casing to fill up the one foot hole. The top of the sand should be measured by a sounding device.

5. Connect the tubing (in one continuous unspliced length, to extend ten feet above the ground surface) to the piezometer cell. The system should be checked for leaks and the tubing labeled or color coded before installation. Lower the assembly into the casing until the piezometer cell rests on the sand, and center the cell by lowering the tamping hammer to the top of the cell. The cell and readout gage should be checked for accuracy by measuring the pore pressure (equal to the head of water in the casing) at several depths between the top of the casing and the installation depth. Tubing shall then be plugged to prevent entrance of dirt during the remainder of the installation.

6. Pull the casing up so that the bottom of the casing is one foot above the bottom of the cell and at the same time, slowly (if sand is poured too fast, it could fill the pipe such that when the pipe is pulled back, the tip would also move) pour a measured volume of clean sand into the casing so that the sand fills the space around the piezometer tip and to approximately 2-1/2 feet above the bottom of the casing. Maintain tension on the tubing but do not permit any vertical movements of the piezometer tip.

7. Form a one-inch thick layer of ½ inch diameter pebbles on top of the sand in the casing and apply 20 blows to the pebble layer with a six-inch drop of the hammer per blow.

8. Form a bentonite seal of five layers of bentonite balls, each layer three inches thick placed and compacted as follows; while maintaining a constant tension on the tubing.

    a. Lower the water three inches below the top of the casing.

    b. Drop bentonite balls individually into the casing until the water rises to the top of the casing and allow sufficient time for the balls to reach the bottom (about one minute for each ten feet of depth).

    c. Drop enough ½ inch diameter pebbles into the casing to form a layer one inch thick and allow sufficient time for the pebbles to reach the bottom.

d. Slip the tamping hammer over the plastic tubing and, keeping tension on the tubing, apply 20 blows to the pebble layer with a six inch drop of the hammer per blow.

e. Repeat this procedure until a five-layer seal is formed. Whenever the tamper does not move freely, it should be immediately withdrawn and cleaned.

9. Pour enough sand into the casing to form a two foot layer of sand, cover with pebbles and compact with 20 blows of the hammer.

10. Repeat Step (8) forming another bentonite seal.

11. Disconnect the top section of the casing, so that the top of the casing is at least five feet below the ground surface. This can be done by having the upper sections of casing tightened to a lesser degree than the lower sections of casing. Fill the remainder of the casing with sand.

T144-3.3 Alternate installation methods

Alternate installation methods (e.g. - transducers mounted in pressed-in wellpoints, etc.) may be considered, subject to approval by the Engineer. Details for alternate installation methods must be submitted for review at least three weeks prior to installation. The submittal shall, at a minimum, contain the following information:

1. Size, type, weight and configuration of the installation rig.

2. Step by step procedures for installation including details for obtaining an adequate hydraulic seal.

3. Schematic diagram of any special equipment or housings used to install transducer.

Approval will not relieve the Contractor of the responsibility to install piezometers in accordance with the plans and these Technical Special Provisions. If, at any time, the Engineer considers that the method of installation does not produce a satisfactory piezometer, the Contractor shall alter his method and/or equipment as necessary to comply with the plans and these Technical Special Provisions.

The Contractor shall demonstrate that his equipment, method and materials produce a satisfactory installation in accordance with these Technical Special Provisions. For this purpose, the Contractor will be required to install several trial piezometers at locations within the work area designated by the Engineer. The piezometers must meet an acceptance criteria that the measured water head be within six inches of the actual water level in the casing.

T144-4 Contractor's Responsibility

The Contractor shall be responsible for each transducer/piezometer until such time as it has been installed, tested and approved by the Engineer for use by the Department. The Contractor shall protect these units from damage by his equipment throughout the contract period. No payment will be made for a unit which has been rendered useless by the Contractor's construction equipment or activities as determined by the Engineer. Transducer/piezometers that become broken or inoperative shall be repaired or replaced by the Contractor, as directed by the Engineer, at the Contractor's expense.

The Contractor will not be held responsible for repair or replacement or any transducer/piezometer which is made inoperable as a result of instability of the embankment caused by factors, which in the opinion of the Engineer, are beyond the control of the Contractor.

T144-5 Method of Measurement and Basis of Payment

The work to be paid for under this Section shall be made at the contract unit price each for Pore Pressure Transducer (Piezometer) and at the contract unit price per lineal foot for Tubing for Piezometers. Such prices and payments shall be full compensation for all work, materials, testing and incidentals required.

Payments shall be made under:

Item No. 144-71 - Pore Pressure Transducer (piezometer) each.

Item No. 144-72 - Tubing for Piezometers - per linear foot.

Item No. 144-74 - Pore Pressure Transducer (Control/Readout Unit) - each