Kentucky Method 64-503-08
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Dated 01/08/03

MEASUREMENT OF PORE PRESSURE IN SOILS

1. SCOPE:

1.1. This method covers procedures for determining field pore pressure measurements in the natural soils.

1.2. This does not include methods of pore pressure measurements in the laboratory or field installations in dams.

2. APPARATUS:

2.1. Vibrating Wire Piezometer. This consists of a transducer constructed of a sensitive diaphragm with a vibrating wire element attached to it. The transducer is covered by a porous stone that allows fluid to pass through but prevents soil particles from contacting the transducer. Fluid pressure acting on the diaphragm changes the tension and frequency of the vibrating wire. This change is sensed and transmitted to a readout device by means of an electrical coil acting through the walls of the capsule. Two types of vibrating wire piezometers are available; standard and drive point.

2.2. Pneumatic Piezometer. This consists of a pneumatic pressure transducer in a plastic or stainless steel case with a porous, ceramic, plastic or metal opening to allow the pore water to reach the transducer diaphragm. Two small diameter plastic air leads are connected to the transducer. A supply of compressed air, bottle compressed or liquefied gas, (clean and without moisture) is required to operate the transducer. An air pressure gage of sufficient capacity to record the existing pressure at the depth of the piezometer tip plus the expected pore pressure is needed.

2.3. Observation Well: Consists of an open hole supported by perforated casing.

3. INSTALLATION EQUIPMENT:

3.1. Any drilling equipment that provides a reasonably clean bore hole a minimum of 4 inches in diameter before insertion of the piezometer or casing. If a drive point piezometer is used, a special attachment is needed to push the piezometer into the soil.

3.2. Tamping hammer of sufficient size for tamping the bentonite layers, thereby assuring a watertight seal. Galvanized airplane cable 1/8 inch diameter should be securely fastened to one end of the hammer and marked at 5 foot intervals, starting at the bottom face of the hammer. This will make it possible to measure depths at various stages of installation.

3.3. Ottawa sand or a thoroughly washed sand passing the no. 20 sieve and retained on the no. 40 sieve.

3.4. Bentonite balls or compressed bentonite pellets for sealing the hole above the piezometer.

3.5. Rounded pebbles approximately 1/2 inch diameter.

3.6. Splicing kits and tools for splicing lines. Any means of splicing is suitable as long as it makes an air tight seal.

3.7. Casing for observation wells.

4. INSTALLATION PROCEDURES:

4.1. Pneumatic and standard vibrating type wire piezometers:

4.1.1. Prepare the piezometer for installation. Connect the riser tubes to the piezometer in such a manner that they will not easily become disconnected. The tubing should be of sufficient length without splices to extend at least 10 feet above the ground surface. Measure from the tip of the piezometer to a point on the tubing a distance that will be 1 foot above the ground surface and mark this point on the tubing. This may be used as a future reference point during installation. Plug the end of the tube or tubes to prevent the entrance of foreign matter during installation. Mark the tubes to distinguish between the in tube and out tube.

4.1.2. Advanced the hole to the approximate elevation of the top of the piezometer cell. Obtain a spoon sample of the material for 18 inches below this elevation. After removal of the sample examine it for possible sand lenses. If sand lenses exists if may be necessary to install the piezometer at another depth since the sand may act as drainage paths for the clay layer. The sample should be sealed in a jar for future study or testing. Advance the hole to 2 feet below the approximate piezometer tip elevation. In most cases soil conditions permit the hole to remain open encased. Therefore, withdraw the augers or casing from the hole in such a way to cause a minimum amount of disturbance to the hole. Examine the hole to make sure it is open. If the hole does not stay open, then advance the augers or casing again, and install the piezometer through the casing.

NOTE: When installing inside the casing, follow the same procedure as outlined, withdrawing the casing as the respective layers are put in place. Piezometers can be installed faster and with less difficulty in most cases in an uncased hole.

4.1.3. Pour approximately 2 feet of sand into the hole. This amount can be calculated when the diameter of the hole is known. When installing below an existing water table the sand shall be saturated.

4.1.4. Lower the piezometer into the hole and pour in sand to an approximate elevation of 2 feet above the top of the piezometer while maintaining tension on the tubing but do not permit any vertical movement of the piezometer. Add enough 1/2 inch diameter pebbles to form a 1 inch thick layer on top of the sand and tamp adequately. Maintain the tension on the tubing at all times.

4.1.5. Drop bentonite balls or compressed bentonite pellets into the hole to form a 6 inch thick layer, then cover with a 1 inch thick layer of 1/2 inch diameter pebbles. (When using compressed pellets, volume charts are usually available from the manufacturer. When installing under the water table it may be possible to measure the thickness of the layer by the increase in height of the water table.) Lower the tamper into the hole and tamp.

4.1.6. Repeat step 4.1.5 until at least a 4 layer seal is formed. (Whenever the tamper does not move freely, it should be withdrawn and cleaned.) The remaining depth may be filled with competent material of low permeability.

4.1.7. The piezometer lines may be extended in one of two ways:

4.1.7.1. Vertically through the embankment fill in any suitable manner provided that (1) adequate protection is provided.

4.1.7.2. Excavate a trench at least 2 feet deep by 1 foot wide from the piezometer location to the read-out area. (This area shall be out of the construction limits.) The lines shall be layered in a zigzag pattern in the trench. Tubing or wires must not be stretched taut prior to backfill. Before backfilling slack of 1 to 3 feet per 100 feet of trench length should be left in the wire or tubing to prevent differential settlement to damage the tubing or wire. When the soil underlying the lines is not free of rock or material that might cause injury to the lines, 6 inches of sand shall be used as a bedding and cover. The remainder of the trench shall be backfilled with excavated material. The lines shall be extended up a post at the end of the trench and an elevation marked at some point on the post. The lines should be stored within a protective cover where they are accessible to the pore pressure readout indicator.

4.1.8. Saturation:

4.1.8.1. After installation, apply a vacuum to the end of the tube and plug the in tube. Vacuum for 15 minutes in order to remove the air from the piezometer and tubing. Submerge the in tube in clear water and continue vacuuming until the tubing is void of air. The pore pressure may be calculated after equalization by measuring the

elevation of the water in the tubes. Bourdon tube gages may be installed as a means of observing the pore pressures. When freezing conditions exists, some form of antifreeze shall be added to the lines.

4.1.8.2. For vibrating wire type piezometers the piezometer should be placed in water for 15 minutes. After saturation connect the wires to readout box to ensure proper functioning of piezometer, and take an initial reading.

4.2. Drive Point Vibrating Wire Piezometer:

4.2.1. Advance sample hole through subject soil strata to be monitored, sampling every 5 feet or when soil characteristics change. Record depths of soil layers desired for piezometer installation. A separate bore hole will need to be drilled for each piezometer to be installed, unless standard type vibrating wires will be installed above the drive point piezometer.

4.2.2. Locate each bore hole for each of the Drive Point Vibrating Wire Piezometers to be installed approximately 3 feet apart from initial bore hole and other piezometers. Each bore hole is to be advanced to a depth of 5 feet above the intended level of the piezometer installation depth. Withdraw the casing or augers from the bore hole, and ensure that the hole is open. If hole has closed off or an obstruction has fallen into the hole re-advance the augers or casing and install piezometer through hollow center of casing or auger.

NOTE: DO NOT damage the wire or protective plastic coating during installation of piezometer. If any damage occurs to wire or cover it must repaired by waterproofing the cover or splicing the wire.

4.2.3. The piezometer should be connected to the specially designed push rod with the wire from the piezometer fed through the center of the rod. Attach the push rod to the required number of drill extension rods needed to achieve the depth of penetration needed to install the piezometer at the correct elevation. Place the piezometer into the hole and attach the extension rods to the drill rig. Adjust the pressure controls of the drill so that the piezometer can be pushed into the soil in a smooth continuous action that will not over stress the piezometer. To ensure proper functioning of the piezometer and that it is not overstressed the readout box needs to be attached and monitored during installation.

4.2.4. Once piezometer is located at desired depth, rotate the extension rods counter-clock wise to unscrew the piezometer and push rod from the extension rods. Raise the extension rods out of the bore hole. Drop bentonite balls or pellets into the bore hole to form a 6 inch thick layer and tamp bentonite into place with tamper.

4.2.5. Additional Standard type vibrating wire or pneumatic piezometers can be installed in the bore hole.

4.2.6. Backfill the bore hole with the natural soil taken from site, including auger trailings and trench excavation. Take special care to separate large rocks that might damage the piezometer from the backfill soil.

4.2.7. Follow same procedures as 4.1.7 and 4.1.8.2 for extending piezometer lines, and testing of the piezometer.

4.3. Observation Wells: Advance the hole to the soil layer in which pore pressure is to be obtained, and install perforated casing. Perforations shall be not larger than 3/8 inch diameter. The hole shall be backfilled to within approximately 3 feet of the surface. Granular backfill material is desirable, if available. However, local material may be used if granular material is not available. The hole shall be capped to prevent the entrance of foreign matter and sealed to prevent the entrance of surface water.

5. INTERPRETATION OF DATA: Corrections to Pore Pressure Reading:

5.1. Vibrating Wire Type: The pore pressure head is determined by inputting the reading and temperature differences from initial reading and temperature into an equation. The piezometer manufacturer provides this equation, with the needed factors to convert the readings to pressure head.

5.2. Pneumatic: The excess pore pressure head is determined by subtracting the difference in elevation between the piezometer tip and the elevation obtained from the pore pressure readout indicator.

5.3. Observation Wells: The excess pore pressure head is the difference between the elevation of the water in the well and the general water table elevation.

6. SPECIAL PROBLEMS: The following special problems occur with sufficient frequency to warrant discussion:

6.1. Gas Lock: In many organic soils, the gas generated around the piezometer tip is sufficient to block entrance of the pore water through the filter into the measuring device. Where this is expected to be a problem special piezometers are available with flushing devices to remove the gas from the piezometer tip.

6.2. Large settlements: In areas where large foundation settlements occur, numerous problems have developed.

6.2.1. Crimping of the riser tube below the end of a permanent casing installation: This is eliminated by installing the piezometer inside the casing.

6.2.2. Crimping of the riser at the top of the permanent casing: This is eliminated by removing the top section of casing to about 5 feet below ground surface and backfilling with sand.

6.2.3. Stretching of the horizontal leads: This is acceptable for most installations provided that no connections are made in the horizontal leads and the leads are made of materials having yield before rupture.

APPROVED _____

DIRECTOR
DIVISION OF MATERIALS

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