

204-R-727 GEOTECHNICAL INSTRUMENTATION

(Revised 05-21-26)

The Standard Specifications are revised as follows:

SECTION 204, BEGIN LINE 1, DELETE AND INSERT AS FOLLOWS:

SECTION 204 – GEOTECHNICAL INSTRUMENTATION

204.01 Description

This work shall consist of providing, installing, and maintaining geotechnical instrumentation including settlement plates, settlement stakes, lateral stakes, *vibrating wire settlement systems*, ~~and~~ standpipe piezometers, *settlement monuments*, and *crack gauges* as directed and in accordance with 105.03.

MATERIALS

204.02 Materials

Materials shall be in accordance with the following:

B Borrow	904.06
<i>Bentonite Chips and Powder</i>	<i>913.06</i>
Coarse Aggregate, Class D or Higher, Size No. 53.....	904.03
Ottawa Sand*	AASHTO T 252
<i>Portland Cement, Type I or IL</i>	<i>901.01(b)</i>
Structure Backfill, Size No. 30	904.05
<i>Water</i>	<i>913.01</i>

* Ottawa Sand shall have a minimum permeability of 25 ft/day.

~~Bentonite chips shall consist of commercially processed angular fragments of pure bentonite, without additives. Bentonite-cement grout shall consist of a mixture with the ratio of 25 lb of bentonite powder to 94 lb of portland cement, Type I or IL in accordance with 901.01(b) and 30 gal. of water.~~

Crack gauges shall be in accordance with the type or configuration specified in the Geotechnical Report.

SECTION 204, BEGIN LINE 32, INSERT AS FOLLOWS:

(a) Installation Requirements

Each settlement plate shall be placed on a horizontal plane consisting of a compacted leveling layer of B borrow, whose surface is not less than 1 ft below the elevation of the adjacent area. The first section of pipe shall then be installed by welding to the settlement plate. *A benchmark shall be located outside the influence of the embankment to serve as a reference monument.* The bottom elevation of the settlement plate will be recorded. The area is backfilled with B borrow and thoroughly compacted. The couplings shall be tack welded and the top elevation of the first pipe section will be recorded before starting the first lift of grading operations.

SECTION 204, BEGIN LINE 76, DELETE AS FOLLOWS:

Lateral stakes will be used to monitor horizontal movement of the ground or new fill. If lateral movement is noticed during the construction of the fill, the work will be suspended and the Department's Geotechnical Engineering Division will be contacted. ~~Measurements will be made to the nearest 1/4 in.~~

SECTION 204, AFTER LINE 95, DELETE AND INSERT AS FOLLOWS:

204.04 Vibrating Wire Settlement Systems

A vibrating wire settlement system from the Department's QPL for Vibrating Wire Settlement Systems shall be provided. A vibrating wire settlement system will be considered for inclusion on the QPL by following ITM 806, Procedure U. The settlement system shall consist of a sensor, tubing, and a reservoir system. The system shall also have the capability of being attached to a datalogger and be remotely monitored via a cell phone modem.

Structure backfill shall be No. 30 sand in accordance with 904.05.

The Contractor shall submit the manufacturer's calibration report for the settlement system to the Engineer and to the Department's Geotechnical Engineering Division two weeks prior to beginning construction. The Contractor shall supply the hardware, software, power supply, and monitoring system.

A qualified geotechnical consultant, from the Department's list of Qualified Geotechnical Consultants, shall install these devices as specified by the manufacturer.

(a) Installation Requirements

Prior to installation, the settlement system materials shall be assembled and inspected for defects in accordance with manufacturer's instructions and recommendations. The Contractor shall verify that all cable and tube lengths are of sufficient length to facilitate proper installation and layout. Cables and tubes shall be labeled with a unique instrument number using a permanent marking system at the terminal end, at the sensor end, and at 50 ft intervals in between.

The settlement cells shall be mounted onto rigid plates. The Contractor shall also install at least two survey pins on the plates and provide easy access to the markers for a survey crew to measure elevations using standard tools.

The Contractor shall provide details for protecting the signal cables and tubing at the connection from the reservoir to the settlement plate.

Sharp bends where the signal cable and tubing exit the embankment shall be avoided. All signal cable and tubing shall be run in a 1 ft deep by a minimum 1 ft wide trench using structure backfill for 3 in. under the cable and 3 in. over the cable, or other approved method, to protect the signal cable and tubing from damage. The Contractor shall run cabling and tubing leaving enough slack to provide necessary strain relief for the anticipated movements in accordance with the manufacturer's recommendations.

Only hand tools shall be used to place and compact fill material for a height of 1 1/2 ft above signal cable, tubing, and the settlement plate. The Contractor shall avoid driving heavy equipment that causes rutting deeper than 2 in. over or near the signal cable,

tubing, and settlement plate until the height of the fill over the signal cable, tubing, and settlement plate reaches at least 5 ft.

The signal cable and tubing shall terminate at a datalogger inside a lockable readout enclosure. The enclosure shall be mounted on a post driven into stable ground as close as possible to the right of way line. The Contractor shall keep the fluid reservoir vertical at all times. The sensor and tubing shall be at a lower elevation than the instrument reservoir at all times. The enclosure and instrument tubing from the ground into the reservoir enclosure shall be protected from thermal influence.

After the completion of the installation, a detailed installation log shall be completed. The as-built location in a horizontal position shall be determined for both the sensor and the reservoir to an accuracy of ± 1 ft and the elevation for both the sensor and the reservoir determined to an accuracy of ± 0.01 ft.

After the completion of the installation, a post-installation test shall be performed by the qualified geotechnical consultant to verify the sensors are working correctly. Three independent readings shall be obtained from the sensor in accordance with the manufacturer's recommendations. The test shall be performed prior to backfilling of the trench. This shall be accomplished using a vibrating wire readout compatible with the installed settlement system. Elevations obtained from all three readings shall be within a range of 0.02 ft from each other. The qualified geotechnical consultant shall submit the readings to the Engineer and to the Department's Geotechnical Engineering Division who will review the data from these readings to determine whether the instrument is acceptable.

The Contractor shall be responsible for any damage to the vibratory wire settlement systems.

(b) Instrument Reading and Documentation

Monitoring will be performed by the Department's Geotechnical Engineering Division. Measurements at each instrument will include the raw readings from the settlement cell, the temperature at the settlement cell, and the temperature at the reservoir. Instruments will be read in accordance with 204.03(b), or as recommended by the Engineer.

The Geotechnical Engineering Division will keep a weekly record which lists for each settlement system, sensor elevation, reservoir elevation, and list of pay items. A copy of each weekly report shall be provided to the Engineer. This weekly record will be made available to the Contractor.

204.045 Standpipe Piezometers

SECTION 204, AFTER LINE 197, DELETE AND INSERT AS FOLLOWS:

204.06 Settlement Monument

Physical targets used as settlement monuments shall be concrete, wood, steel, or other material that will maintain its shape throughout the duration of monitoring, as approved by the Engineer. The physical targets shall be 3 in. by 3 in. by 24 in. long, 12 in. of which shall be set firmly in the ground and placed to measure vertical settlement. These

monuments shall be either used alone or in coordination with settlement vibratory gauges or settlement plates.

(a) Installation Requirements

Settlement monuments shall be installed on embankments upon completion of construction of the embankment to determine vertical deformations. The Contractor shall ensure that the settlement monument is protected from damage or impacts from construction traffic. A benchmark shall be located outside the influence of the embankment to serve as a reference monument.

(b) Instrument Reading and Documentation

Conventional survey techniques will be used to determine any changes in elevation. Measurement will be taken at the same interval of other settlement plates or vibratory gauges.

The Engineer will conduct and record readings every seven days until the settlement rate per week is 1/4 in. or less for four consecutive weeks in addition to settlement plates and vibratory gauges. The Engineer will report the data to the Department's Division of Geotechnical Engineering.

204.07 Crack Gauges

Crack gauges shall be provided as shown on the plans and will be used to measure cracks or joints. The crack gauge provided shall be in accordance with the type or configuration specified. Gauges shall be installed by the qualified geotechnical consultant on smooth and clean surfaces over a crack or joint to visually monitor relative vertical and horizontal deformation without requiring the use of survey equipment. Gauges shall be protected from weather. The Engineer will conduct and record readings for the time period as specified but no longer than the date of substantial completion.

SECTION 204, BEGIN LINE 198, DELETE AND INSERT AS FOLLOWS:

204.058 Method of Measurement

Settlement plates, settlement stakes, lateral stakes, vibrating wire settlement systems, settlement monuments, crack gauges, standpipe piezometers, and water monitoring boreholes will be measured by the number of units installed and accepted.

204.069 Basis of Payment

Settlement plates, settlement stakes, lateral stakes, vibrating wire settlement systems, settlement monuments, crack gauges, standpipe piezometers, and water monitoring boreholes will be paid for at the contract unit price per each.

Payment will be made under:

Pay Item	Pay Unit Symbol
<i>Crack Gauge.....</i>	<i>EACH</i>
<i>Settlement Monument.....</i>	<i>EACH</i>
<i>Settlement Plate.....</i>	<i>EACH</i>
<i>Stake, Lateral</i>	<i>EACH</i>
<i>Stake, Settlement.....</i>	<i>EACH</i>

Standpipe Piezometer.....	EACH
<i>Vibrating Wire Settlement System.....</i>	<i>EACH</i>
Water Monitoring Borehole.....	EACH

The cost of furnishing, installing, and maintaining settlement plates, extension pipes, cover pipes, B borrow, structure backfill, coarse aggregate and all necessary incidentals shall be included in the cost of settlement plates.

The cost of furnishing all tools, labor, and materials necessary to complete the installation, maintenance, and baseline reading of vibratory wire settlement systems as specified by the manufacturer shall be included in the cost of the vibratory wire settlement system pay item.

The cost of furnishing, installing, maintaining, and removing crack gauges shall be included in the cost of the crack gauge pay item.

The cost of furnishing, installing, maintaining, and removing settlement monuments shall be included in the cost of the settlement monument pay item.

The cost of backfilling water monitoring boreholes will be included in the cost of water monitoring boreholes.

The cost of handholes, protective covers, bentonite chips, bentonite-cement grout, Ottawa sand, tips, casing, drilling, tubing or PVC pipe, backfilling and measurements will be included in the cost of standpipe piezometers.

No additional compensation will be made for any costs incurred related to the repair of settlement plates, pipes, settlement stakes, lateral stakes, *vibratory wire settlement systems*, or standpipe piezometers as the result of damage by the Contractor.

No payment will be made for unacceptable settlement plates, settlement monuments, pipes, settlement stakes, lateral stakes, vibratory wire settlement systems, crack gauges, or standpipe piezometers. No payment will be made for delays and expenses incurred by the Contractor, through changes necessitated by improper or unacceptable installation, material or equipment.