SP-150502
(New)

# SPECIAL PROVISIONS
# FOR
# INSTRUMENTATION AND MONITORING

**Pottawattamie County**
**IM-NHS-029-3(171)48--03-78**

**Effective Date**
**June 18, 2019**

**THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.**

## 150502.01 DESCRIPTION.

**A. Scope of Work.**

The work shall consist of installing, maintaining, and monitoring instrumentation designated on the plans and as specified herein. The settlement plates will be installed by the grading contractor; however, the monitoring of the settlement plates, shall be included in this work and monitored in accordance with Article 2526.03, G of the standard specification.

**B. Definitions.**

Inclinometers: Inclinometers are devices capable of monitoring potential slope/embankment/MSE wall lateral movements. It shall consist of Geokon, Micro-Electro-Mechanical Sensor (MEMS) 6150 In-Place Inclinometer with biaxial tilt sensors, RST Digital MEMS Inclinometer System ICB0021W, or approved equivalent. Inclinometers shall be installed by a qualified instrumentation specialist as subcontractor to the Contractor with minimum 5 years of experience and installation of at least three similar projects within the last 3 years.

Vibrating Wire Piezometers: Vibrating Wire Piezometers (VWP) shall be installed by a qualified instrumentation specialist with minimum 5 years of experience and installation of at least 3 similar projects within the last 3 years. The purpose of the VWP is to monitor excess pore water pressures in the soil to confirm that primary consolidation is complete, the rate has stabilized, and that clay gained enough shear strength to allow staged construction.

Multi-point Settlement Extensometers: The multi-point settlement extensometer is a device capable of measuring vertical settlement at multiple points along its length. Extensometers shall be installed by a qualified instrumentation specialist as subcontractor to the Contractor with minimum 5 years of experience and installation of at least three similar projects within the last 3 years.

Real Time Monitoring: Real time monitoring is defined as an automated, remote, and web-based monitoring system. This system shall be provided for all the instrumentation but the settlement plates and including the strain gauges for the rigid inclusions that have been load tested. The real time monitoring shall be installed by a qualified instrumentation specialist as subcontractor to the Contractor with minimum 5 years of experience and installation of at least three similar projects within the last 3 years. The readings shall be taken at least twice every 24 hours. All data collected shall be provided to the Engineer using an internet website. The data collection box(es) or point(s) should have a protective housing to prevent damage due to weather related events, vandalism, theft, etc. Any repairs or replacement to the real time monitoring system or the protective housing shall be done at no additional cost to the Iowa DOT. The collection data box shall contain full backup power and backup to store data for at least 72 hours. Manual readings for the inclinometers will be acceptable only during fill placement as long as the frequency of reading is achieved.

**C. Subsurface Conditions.**

**1.** Borings completed within the limits of the project encountered varying thicknesses of soft to medium stiff alluvial silt and clay overlaying medium stiff to stiff clay as shown in the Q sheets.

**2.** Groundwater at the time of boring drilling, which was performed between 2010 and 2018, is shown in the Q sheets. It is anticipated that the groundwater level will rise during prolonged periods of precipitation or flooding, and perched groundwater may be present. For installation, assume that the ground water 5 feet below existing grade and make all necessary preparation to complete the installation under this condition at no additional cost to Iowa DOT.

**D. Submittals.**

**1.** Provide means and methods for installation of all instrumentation. Means and methods shall include a map with the locations of inclinometers, extensometers, and remote station for data loggers. This information shall be provided to the Engineer at least 20 days prior to installation.

**2.** Instrumentation type/model including ranges, operating principle, advantages and limitations shall be submitted to the Engineer at least 20 days prior to installation or with sufficient time to be able to replace any instrumentation without impacting the construction schedule. No additional time will be granted for any delays due to replacing type or range of instrumentation.

**150502.02 MATERIALS.**

**A. Inclinometers.**

**1.** Inclinometer casing shall be a grooved plastic with 2.75 inches outside diameter casing that is compatible with the inclinometer being provided. The casing shall be completed with necessary rigid self-aligning couplings and end plugs.

**2.** The inclinometer monitoring system shall include a suspension and wheel assemble, a support cable, string of biaxial tilt sensors, universal joint, spacer tubings, and adequate cable length to facilitate real time monitoring. The inclinometer shall measure inclinations at any depth selected by the operator and shall digitally store, process, and report the data (by display and downloadable digital files) as lateral movements from a stored baseline reading.

**3.** All cables connected to the real-time monitoring device shall be protected and routed through schedule 80 PVC pipe to ensure that these are not damaged during construction activities.

**4.** The suspension assembly guide pulley shall mount to the top of the inclinometer casing.

**5.** Any other devices needed to facilitate and achieve the required real time monitoring shall be furnished and installed.

**B. Multi-point Settlement Extensometers.**

1. The multi-point settlement extensometers monitoring system shall include adequate cable length to facilitate the monitoring readout. The extensometer readout shall measure multi-point settlements at the specified preliminary depth of the extensometer and shall digitally store, process and report the data (by display and downloadable digital files) as settlement movements from a stored baseline reading.

2. The multi-point settlement extensometers shall be capable of measuring up to 24 inches of settlement.

3. All cables connected to the real-time read out equipment shall be protected and routed through schedule 80 PVC pipe to ensure that these are not damaged during construction activities.

4. Any other devices needed to facilitate and achieve the required real time monitoring shall be furnished and installed.

**C. Vibrating Wire Piezometers (VWP).**

1. The vibrating wire piezometer system shall include a pressure transducer and signal cable. Adequate cable length to facilitate the monitoring, cable relief, pulley assembly, cable hold, and readout. The VWP reading shall be obtained with a portable readout or data logger that shall measure multi-point settlements at the specified preliminary depth of the extensometer sensor and shall digitally store, process and report the data (by display and downloadable digital files).

2. Each VWP location shall include two transducers levels sensors and shall be installed at 15 feet and 25 feet below ground surface. Final depth shall be adjusted by the Engineer on site based on the confirmation borings.

3. The cable connecting the sensor and indicator shall have a stranded steel core to take the stress of pulling so as not to break any connectors or wires. The cable shall be jacketed with a waterproof material and marked externally at 1 foot intervals for accurate depth determination. All cables connected to the real-time read out equipment shall be protected and routed through schedule 80 PVC pipe to ensure that these are not damaged during construction activities.

4. The cable guide pulley shall mount to the top of the VWP casing.

5. Any other devices needed to facilitate and achieve the required real time monitoring.

**150502.03 CONSTRUCTION.**

**A. General.**

1. All boreholes shall be logged and boring logs submitted with the installation log of the instrument where either an extensometer, or inclinometer are installed. Boring logs shall be logged per ASTM D2488 standard with sampling at 5 foot intervals.

2. All instrumentation data collection. with the exception of the settlement plate. shall be real time monitoring.

3. Real Time Monitoring for Strain Gauges on Rigid Inclusions: Monitoring of the strain gauges for rigid inclusion load tested prior to construction shall be in accordance with Special provisions for Ground Improvement with Rigid Inclusions. After monitoring of the strain gauges during the load tests, the strain gauges wiring shall be routed through a buried schedule 80 PVC pipe and

shall be connected to a real time monitoring system. Strain gauges shall be compatible with the real time monitoring system.

**B. Inclinometers Installation.**

**1.** Drill, sample, and log soil borings drilled for the purpose of installing inclinometer casing. Borings for inclinometers shall be drilled using at least a 6 inch inside diameter casing and water or, where ground conditions permit, using drilling mud in a 6 inch diameter borehole. This boring shall be used as a soil confirmation boring.

**2.** Install inclinometer casings prior to the embankment fill being placed and extend as the embankment construction progresses. Install the inclinometer monitoring system for the depth of the casing before the casing is extended. This will include the biaxial sensors, joints, wheel assembly, spacer tubings, and any other parts as necessary. In case of damage to the inclinometer casing or any other instruments, the damaged part(s) shall be replaced at no additional cost to Iowa DOT. The casing shall protrude 3 feet above finished grade.

**3.** Flag and protect inclinometer locations. Provide the top of each inclinometer casing with a protective cap, and with protective metal housing that can be locked extending at least 3 feet below finished grade.

**4.** Cable splicing is acceptable.

**C. Multi-Point Settlement Extensometers Installation.**

**1.** Drill, sample, and log borings of soil drilled for the purpose of installing extensometer casing. Borings for extensometer shall be drilled using at least a 6 inch inside diameter casing and water or, where ground conditions permit, using drilling mud in a 6 inch diameter borehole. This boring shall be used as a soil confirmation boring.

**2.** Attach grout tubing to the multi-point settlement extensometer.

**3.** Place the extensometer into the borehole. Grout the borehole from bottom to top.

**4.** After grout cures and installation is stable, install the readout unit system and take the initial readings.

**5.** Flag and protect all cables.

**6.** Cable splicing is acceptable.

**D. Vibrating Wire Piezometers Installation**

**1.** Install Vibrating Wire Piezometers (VWP) at the locations shown on Q sheets.

**2.** The Contractor shall drill, sample, and log borings of soil drilled for the purpose of installing the piezometers casing. The borehole shall be drilled below the required depth of the piezometer. This boring shall be used as soil confirmation boring of the location.

**3.** The VWP shall be installed prior to the embankment fill being placed. In case of damage to the VWP and cables, the damaged items shall be replaced at no additional cost to the Iowa DOT.

**4.** The Contractor shall flag and protect VWP locations. The cables connecting to the real-time read out equipment shall be routed through a buried schedule 80 PVC pipe to ensure that these are not damaged or cut off during construction activities.

**E. Contractor Quality Control.**

**1.** The following describes the minimum inspection and testing required in the Contractor's Quality Control (CQC) Plan and Program for the work described in this provision. The implementation of the Contractor Quality Control Program does not relieve the Contractor from the responsibility to provide the work in accordance with the contract documents, applicable codes, regulations, and governing authorities.

**2.** The Contractor shall have an onsite field engineer to manage all of the QC activities of the project. The installation of the inclinometers and extensometers shall be done under the direct supervision of a professional geotechnical engineer registered in the State of Iowa hired by the Contractor.

**3.** The initial reading for all the instrumentation should be taken 24 hours after completing the installation and testing of each instrument. Each inclinometer has a total of eight biaxial sensors. Four of these shall be placed above existing grade with equal spacing between each other and the other four shall be placed below existing grade. The elevation of the inclinometers will be determined based on the confirmation borings drilled prior to installation of the inclinometer. For the Inclinometers, readings shall consist of a minimum of two reading surveys per 24 hours using real time remote and automated monitoring operation, with each survey consisting of a set of readings in each of the two primary orientations. Manual readings for the inclinometers will be acceptable only during fill placement as long as the frequency of reading is achieved. Process the results, plot them, and furnish the results to the Engineer. The Engineer will determine which survey will represent the initial set of measurements. For the multi-point extensometers, readings shall consist of a minimum of two readings surveys per 24 hours using real time remote and automated monitoring operations for each sensor.

**150502.04 METHOD OF MEASUREMENT.**

Measurement for Instrumentation and Monitoring will be lump sum.

**150502.05 BASIS OF PAYMENT.**

**A.** Payment for Instrumentation and Monitoring will be at the contract unit price per lump sum.

**B.** Payment is full compensation for:

- Furnishing and installing inclinometers and multi-point settlement extensometers.
- Furnishing and installing all devices needed for real time monitoring
- Furnishing and installing protective housings
- Maintenance and monitoring of instruments, including inclinometers, multi-point settlement extensometers, strain gauges for rigid inclusions, and settlement plates.
- Performing real time monitoring
- Repair and replacement for the instruments and monitoring system
- Data collection, data reduction, data reporting and engineering time required to present a letter report of the findings.

**C.** Settlement plate installation shall be compensated per Article 2106.05 of the Standard Specifications.