Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
INSTRUMENTATION

Pottawattamie County
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Effective Date
April 15, 2014

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

120163.01 DESCRIPTION.

A. Scope.
The work shall consist of installing, maintaining, and monitoring instrumentation designated on the project drawings and as specified herein.

B. Definitions.

1. Inclinometers: 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. The purpose of the inclinometers is to monitor 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.

2. Vibrating Wire Piezometers: Vibrating Wire Piezometers (VWP) 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 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.

3. Multi-point Settlement Extensometers: 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. The purpose of the extensometers is to monitor vertical settlement at multiple points of the extensometers.

4. All boreholes, where either an extensometer, inclinometer or piezometer shall be installed shall be logged and boring log shall be submitted with the extensometer or the inclinometer

installation log. Boring logs shall logged per ASTM D2488 standard with sampling at 5 foot intervals.

5. Real Time Monitoring: Real time monitoring is defined as automated, remote, and web-based monitoring and shall be provided for all instrumentation. The real time monitoring shall be performed 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 real time monitoring shall consist of monitoring all instrumentation, including the strain gauges for the rigid inclusions that have been load tested prior to construction of production rigid inclusions. The real time monitoring frequency shall be of at least twice every 24 hours. All data collected shall be provided to the Engineer to an internet website. Link to the website and access instructions shall be provided to the Engineer. Provide necessary data collection box or points to facilitate real time monitoring. Ensure that any such data collection point(s) has 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 for data on a 72 hour basis.

6. 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 the real time monitoring system. Strain gauges shall be compatible with the real time monitoring system.

7. Any instrumentation that malfunctions or becomes inoperable or unreadable shall be replaced at no additional cost to the Iowa DOT.

8. If excessive lateral or vertical movements are detected during monitoring of the fill placement, the Engineer may elect to hold the grading activities up to 3 weeks to allow excess pore water pressures to dissipate and therefore, foundation soils to gain strength before resuming grading activities. Grading activities shall continue at other locations with no additional compensation to the Contractor or additional working days added.

C. Subsurface Conditions.

1. Borings completed within the limits of the project encountered varying thicknesses of soft to medium stiff alluvial silt and clay. The explorations typically encountered medium dense to very dense alluvial sand and gravel with silt and clay below elevations shown in the plans.

2. Groundwater at the time of boring drilling was recorded between approximately 4 and 10 feet below the natural ground at the time of drilling, which was performed in November and December of 2010. It is anticipated that the groundwater level will rise during prolonged periods of precipitation or flooding, and perched groundwater may be present. For the purpose of installation, assume that the ground water is at the ground surface and make all necessary preparation to complete the installation under this condition at no additional cost to Iowa DOT.

120163.02 MATERIALS.

A. Inclinometers.

1. Inclinometer casing shall be grooved plastic 2.75 inches outside diameter casing that is compatible with the inclinometer being provided. The casing shall be complete 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, adequate cable length to facilitate the real time monitoring, and readout. The inclinometer readout 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 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 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. Vibrating Wire Piezometers.

1. The vibrating wire piezometer (VWP) system shall include a pressure transducer, signal cable, adequate cable length to facilitate the real time monitoring, and real-time readout equipment. The VWP reading shall be obtained at the depth of the sensor specified. The readout equipment shall digitally store, process and report the data.

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

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. 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 sensor 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 monitoring system shall include five levels of settlement sensors. Preliminary settlement extensometer sensor elevations are provided in the Table 120163-3. Final elevation shall be adjusted by the Engineer on site based on the confirmation borings.

Table 120163-3: Extensometer Sensor Level Preliminary Elevations

Approximate Depth (feet)	Approximate Elevation (feet)*	Sub-surface Layer
2.0	976.0	Medium Stiff to Stiff Fat Clay (near ground surface)
12.0	966.0	Medium Stiff to Stiff Fat Clay / Very Soft to Soft Fat Clay
22.0	956.0	Very Soft to Soft Fat Clay/Silt
32.0	946.0	Loose to Medium Dense Sand/Silty

		Sand
42.0	936.0	Medium Dense Sand/Silty Sand

* Approximate elevations for strain gauges are based on an approximate ground surface elevation of 978 feet.

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.

120163.03 CONSTRUCTION.

A. Inclinometers Installation.

1. Install inclinometer casing at the locations shown on Q sheets.

2. The inclinometers shall have a minimum length of 60 feet below existing ground surface plus the height of the fill at the locations of the inclinometer plus 3 feet.

3. Drill, sample, and log soil borings drilled for the purpose of installing inclinometer casing. Borings for inclinometers shall be drilled using 6 inch minimum 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 soil confirmation boring of the location.

4. 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.

5. Flag and protect inclinometer locations. Provide the top of each inclinometer casing with a protective cap, and with a locked protective metal housing extending at least 3 feet below finished grade. All cables shall be protected and routed through a schedule 80 PVC pipe to ensure that these are not damaged during construction activities. Any repairs or replacement shall be done at no additional cost to the Iowa DOT.

B. Vibrating Wire Piezometers Installation.

1. Install VWP at the locations shown on Q sheets.

2. 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. Install the VWP 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. 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.

C. Multi-Point Settlement Extensometers Installation.

1. Install multi-point settlement extensometer at the locations shown on Q sheets.

2. Multi-point settlement extensometers shall have a minimum length of 50 feet below existing ground surface. The extensometers sensors preliminary elevations are provided in Article 120163.02, E, 3

3. Drill, sample, and log borings of soil drilled for the purpose of installing extensometer casing. Borings for extensometer shall be drilled using 6 inch minimum 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 soil confirmation boring of the location.

4. Attach grout tubing to the multi-point settlement extensometer.

5. Place the extensometer into the borehole. Grout the borehole from bottom to top.

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

7. Flag and protect all cables. 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.

D. Contractor Quality Control.

1. Field Quality Control.
The following describes the minimum inspection and testing required in the Contractor's Quality Control (CQC) Plan and Program for the work of this section and is for CQC only. 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. Quality Control: Supervision, Inspection, and Records.

a. The Contractor shall have an onsite field engineer to manage all of the QC activities on 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 on the staff of the Contractor or a sub-consultant to the Contractor.

b. Records.

1) Inclinometer, VWP, and Multi-point Settlement Extensometers Readings: Take initial readings 24 hours after completing installation and testing of each inclinometer, VWP and extensometer. At each inclinometer location, a total of eight, four of which biaxial sensors shall be placed above existing grade and up to the elevation of the finished grade with equal spacing between each other. The remaining four biaxial sensor 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. Pprocess the survey results, graphically plot them, and furnish the results to the Engineer. Based on comparison of the plotted results, the Engineer will determine which survey will represent the initial set of measurements. Typically, the results are approximately the same for the two surveys, and the last set of readings is typically selected. For the VWP and 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.

For the duration of the project, inclinometers and multi-point settlement extensometers shall continue to be monitored after the completion of the fill placement and through 52 weeks from the start of the first reading. VWP shall

continue to be monitored after the completion of the fill placement and through 25 weeks from the start of the first reading. The readings shall consist of real time monitoring with daily monitoring frequency and available online to the Engineer.

2) Real Time Monitoring Strain Gauges: Test rigid inclusion strain gauges shall continue to be monitored after the completion of the load test throughout the fill placement and beyond through a duration of 50 weeks. The readings shall consist of real time monitoring with daily frequency and available online to the Engineer.

120163.04 METHOD OF MEASUREMENT.

Measurement for Installation of instrumentation including Real Time automated and web based monitoring as shown contract documents and herein shall be based on lump sum basis.

120163.05 BASIS OF PAYMENT.

Payment for Instrumentation will be acceptable installation**,** maintenance, and monitoring of instruments, including inclinometers, VWP and multi-point settlement extensometers shall include all materials, labor, installation equipment, real time monitoring, replacement, trouble shooting, and mobilization costs involved to install the instrumentation and protective housings, and to flag and protect each instrumentation location for the duration of the project. Instrumentation shall be paid on a lump sum basis. Instrumentation readings shall include all materials, labor, mobilization, monitoring equipment, and data collection, data reduction, data reporting, and engineering time costs required to present a letter report of the findings. All instrumentation data collection shall be real time monitoring.