

ITEM 17554.99M MSES CORROSION MONITORING

DESCRIPTION

This work shall consist of supplying and installing a corrosion monitoring system as described in this specification; of using the Linear Polarization Resistance (LPR) measurement technique to monitor the corrosion rate of selected reinforcing members and additional test coupons in the Mechanically Stabilized Earth Structure; and of reporting the results. The required number and approximate location of corrosion monitoring stations is shown on the Contract Plans.

For this work, the Contractor shall engage the services of a Subcontractor qualified and experienced in the performance of the specified tasks. One firm meeting these requirements is:

CC Technologies
6141 Avery Road
Dublin, Ohio 43016-8761
Phone: (614) 761-1214
Fax: (614) 761-1633

If the Contractor elects to have another firm perform this work, the firm's record of qualifications and experience shall be submitted to the Engineer for review and evaluation by the Geotechnical Engineering Bureau (G.E.B.). The G.E.B. will render a decision within 14 working days of receipt of the required information. The Subcontractor will not be permitted to begin installation without approval by the G.E.B.

MATERIALS AND EQUIPMENT

1. **Working electrode and counter electrode reinforcing members.** One of each is required at each monitoring station. The electrodes may be actual reinforcing members or they may be "dummy" reinforcing members positioned in the wall. In either case, they shall be electrically isolated from each other and the working electrode shall be isolated from other reinforcing members attached to the same facing panel. The surface area of the working electrode reinforcing member shall be accurately determined and recorded.
2. **Test coupons.** Two test coupons of plain steel, two of galvanized steel and two of zinc, having a cross-section approximately equal to that of the reinforcing members and 0.5m long shall be provided for placement in the MSES backfill at each monitoring station. Steel shall be of the same ASTM designation and grade as used for the reinforcing members. Zinc shall consist of the same alloy composition of that used to galvanize the reinforcing members.
3. **Multimeter.** A multimeter with a high impedance (Fluke 77 or equivalent) shall be used to verify electrical isolation of the reinforcing members and test coupons.
4. **Corrosion rate instrument.** A corrosion rate instrument having the capability of measuring linear polarization resistance (LPR) in high resistivity environments shall be used to take all measurements. The minimum specifications for the instrument are:

Signal Processing Circuitry:

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Input Impedance

10^{12} ohms

Maximum Output Voltage

10 volts

Short Circuit Output Current

100mA

Current Measurement Resolution

300 μ A: 5 mA<i

3 μ A: 50 μ A<i<5mA

30 nA*:0.5 μ A<i<50 μ A

30 nA*: i<0.5 μ A

* Varies with electrical noise of operating environment

Polarization Resistance Range

0 - 100K ohm

Solution Resistance Range

0 - 100K ohm

Scan Voltage Range

\pm 2.5V

Minimum Voltage Step Size

1.2mV

Seconds Between Steps

5 to 999 Seconds

Time Between Scans

0 to 32000 Minutes

Maximum Number of Scans

999

Measurements/Computations:

Polarization Resistance

Solution Resistance

Free Corrosion Potential

Linear Regression

Corrosion Rate

General

A corrosion rate instrument meeting these requirements is manufactured by CC Technologies.

5. **Junction boxes.** One weather-proof junction box shall be supplied and installed for each monitoring station. Junction boxes shall accommodate connections to the working and counter electrodes and to the test coupons and shall cover holes in the MSES facing providing access for temporary soil contact with the copper/copper sulfate reference electrode.

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6. **Miscellaneous.** Electrical connectors, wiring, insulation and other supplies needed to install the corrosion monitoring system. Equipment to support the instrument and protect it from exposure to precipitation or direct sunshine during monitoring operations. All wires shall have its insulation color coded in the following manner, connect red wires to the working electrode, blue wires to the counter electrode, green wires to the zinc coupon, white wires to the galvanized steel coupon and black wires to the plain steel coupon.

CONSTRUCTION DETAILS

At each monitoring location, one full-length reinforcing member shall be selected to be the working electrode and another to be the counter electrode. In addition, at each monitoring location a set of six test coupons shall be placed within the MSES backfill -- three (one each of plain steel, galvanized steel and zinc) near the facing panels and three at the far end of the reinforcing members from the facing panels. The surface area of the working and the counter electrodes and of the test coupons shall be accurately determined and recorded.

An access hole in the facing panels shall be provided at each monitoring station for the electrical leads attached to the reinforcing members and test coupons to be monitored and for the reference electrode. The access hole may be formed at the time the panels are cast or cored in the field. The electrical leads or connections in each junction box shall be clearly identified. The access hole shall be protected by a weather-proof junction box.

The electrical isolation of the working electrode from other reinforcing members within the same test panel shall be ensured at the time of installation. A high impedance multimeter shall be used to establish that continuity does not exist between members by performing two separate tests. First, measure the potential (voltage) between the two elements by connecting the common (black) lead of the multimeter to one, and the test (red) lead to the other. The potential between the two reinforcing elements must be greater than 0.005 volts to verify that continuity (short) does not exist. For secondary assurance, keep the same lead connections and switch the multimeter to measure resistance. A resistance greater than 5.0 ohms between reinforcing elements confirms the electrical isolation. If electrical isolation is not confirmed by both measurements, a "dummy" reinforcing member shall be used as the working electrode.

Permanent connections shall be made to the working electrode reinforcing member, to an additional reinforcing member to be used as a counter electrode and to the test coupons for corrosion monitoring. All hard wire connections shall be soldered and/or firmly clamped to the reinforcing element. All connections, clamps, wire, and other wiring appurtenances shall be fully insulated from both the backfill soil and the facing panel. This shall be accomplished with 3M Scotchcast 85-14CP multi-mold resin splicing kit for underground use, or equivalent.

Corrosion rate measurements shall be made at each test location. A three electrode linear polarization resistance (LPR) measurement with accurate solution resistance (or IR drop) correction is the specified method. The working electrode reinforcement member shall be confirmed to be isolated from any other structural element as described above. The counter electrode reinforcement member does not have to be isolated as long as a three electrode method

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is employed and the instrument working electrode lead is isolated from electrical ground. To perform the measurements, a CSE (copper/copper sulfate electrode) reference electrode shall be placed in the access hole. The corrosion potential shall be measured at the same time as the corrosion rate. One week’s notice shall be given to the Engineer prior to making measurements, so as to enable State personnel to participate and gain experience in the measurement procedure to monitor the MSES installation after completion of the Contract. The Engineer shall notify the Geotechnical Engineering Bureau within 24 hours from receiving such notice.

The Subcontractor shall prepare an Instrumentation and Monitoring Report and furnish it to the Engineer two weeks after installation of the monitoring system and completion of the measurements. The Report shall include:

1. Details of the installed monitoring system.
 - a. Location of monitoring locations and stations.
 - b. Location of the working and counter electrodes, of the test coupons and of the connections thereto in plan and in profile to the nearest 0.1m.
 - c. Sketch(es) and photo(s) of typical connections to above electrodes and coupons.
 - d. The routing of the test leads to the junction boxes.
2. Instructions for operating the corrosion rate instrument to perform corrosion rate measurements.
3. Set up and data files, in a format readable by the Geotechnical Engineering Bureau Corrosion Instrumentation system provided by CC Technologies, from the initial set of measurements.
4. Results of the initial set of measurements and conclusions drawn.

METHOD OF MEASUREMENT

The fixed price lump sum shown in the proposal for this item shall be considered as the price bid and shall not be altered in any manner. It consists of the price to be paid to the Subcontractor plus fifteen percent of this price. Should the amount be altered, the new figure shall be disregarded and the original price will be used to determine the total amount bid for the Contract.

BASIS OF PAYMENT

The fixed price lump sum shall include the cost of all labor, materials and equipment necessary to complete the work, including the preparation of the report. Also included in this price is the cost of providing access holes in appropriate facing panels, the cost of supplying and installing full length reinforcing members to serve as working and counter electrodes and the cost of delays these or other corrosion monitoring operations may cause to the Contractor.

<u>Item No.</u>	<u>Item</u>	<u>By Unit</u>
17554.99M	MSES Corrosion Monitoring	Fixed Price Lump Sum