Implementation of New Specification Requirements for Course Backfill Materials for Mechanically Stabilized Earth (MSE) Walls

Technical Memorandum 1

Specifications for Procuring an EIS System

Conducted for

Texas Department of Transportation
P.O. Box 5080
Austin, Texas 78763

October 2015

Center for Transportation Infrastructure Systems
The University of Texas at El Paso
El Paso, TX 79968
(915) 747-6925

Implementation of New Specification Requirements for Course Backfill Materials for Mechanically Stabilized Earth (MSE) Walls

by

Houman Azari, MSEnE
Sergio Rocha, BSEE
Jose Garibay, MSCE
W. Shane Walker, PhD
Arturo Bronson, PhD
and
Soheil Nazarian, PhD, PE

Implementation Project 5-6359-01

Conducted for
Texas Department of Transportation

Technical Memorandum 1

October 2015

Center for Transportation Infrastructure Systems
The University of Texas at El Paso
El Paso, TX 79968-0516

Implementation of New Specification Requirements for Course Backfill Materials for Mechanically Stabilized Earth (MSE) Walls

Introduction

The service life of mechanically stabilized earth (MSE) walls depends on the rate of corrosion of the metallic reinforcements used in their construction. Assessment of corrosion potential requires the accurate evaluation of pH, resistivity, and ionic (e.g., sulfate and chloride) concentrations of aqueous solutions in contact with the surrounding aggregate. Evaluation of the electrochemical parameters of coarse aggregates is challenging because traditional methods utilize only fine-grained material. In-situ, corrosion testing of the MSE metallic reinforcement has been challenging because the large size and high accuracy requirements of the instrumentation needed were obstacles which were difficult to overcome. Advances in electronics and data acquisition systems now allow us to perform in-situ, electrochemical measurements of the metallic reinforcement to more accurately determine the rate of corrosion and thus more precisely assess the service life of an MSE wall.

The deliverable for Task 1 is the specifications for future purchases of an EIS system by TxDOT districts. Table 1 shows the Electric Impedance Spectroscopy (EIS) system specifications that will be used in this study. The access to one vendor that meets such specification is http://www.gamry.com/products/potentiostats/reference-600/.

Table 1 – EIS System Specifications

WEIGHT	3 kg
DIMENSIONS	9 (W) x 19 (H) x 27 (D) cm
SYSTEM	
Max Current	± 600 mA
Current Ranges	11 (60 pA - 600 mA)
Current Ranges (w/Internal Gain applied)	13 (600 fA - 600 mA)
Min Voltage Resolution	1 µV
Min Current Resolution	20 aA
Max Applied Potential	± 11 V
Rise Time	<250 ns
Noise and Ripple	<10 µV rms
Noise and Ripple (typical)	<2 µV rms
Min Time Base	3.333 µs
Max Time Base	715 s
Min Potential Step	12.5 µV
EIS MEASUREMENT	
Frequency Range	10 µHz - 1 MHz
EIS Accuracy	See Accuracy Contour Plot
Max AC Amplitude	3 V max 600 mA max
CONTROL AMP	
Compliance Voltage	± 22 V
Output Current	> ± 600 mA
Speed Settings	5
Unity Gain Bandwidth	980, 260, 40, 4, 0.4 kHz

Table 1 – cont. EIS System Specifications

ELECTROMETER	
Input Impedance	$>10^{14}$ Ω
Input Current	<5 pA
Input Current (typical)	<2 pA
Bandwidth (-3dB) (typical)	>15 MHz
Common Mode Rejection Ratio	>80 dB (3 Hz) >60 dB (1 MHz)
APPLIED POTENTIAL	
Accuracy	± 1 mV ± 0.2% of setting
Accuracy (typical)	± 375 µV ± 0.04% of reading
Resolution	12.5 µV, 50 µV, 200 µV/bit
Drift	<20 µV/°C
Potential Scan Range	± 0.4 V, ± 1.6 V, ± 6.4 V
MEASURED POTENTIAL	
Accuracy	± 1 mV ± 0.2% of reading
Accuracy (typical)	± 250 µV ± 0.05% of reading
Full-Scale Ranges	12 V, 3 V, 300 mV, 30 mV
Resolution	400 µV, 100 µV, 10 µV, 1 µV/bit
Offset Range	± 10 V
CURRENT	
Applied/Measured Accuracy	± 10 pA ± 0.05% of range ± 0.2% of value (600 mA-6 nA) or 0.75% of value (600 pA) or 1.5% of value (60 pA)
Applied/Measured Resolution Bandwidth (-3 dB) NOTE: Bandwidth is current range dependent.	0.0033% full-scale/bit > 10 MHz (600 mA - 600 µA) > 1.5 MHz (60 µA) > 0.15 MHz (6 µA)
Stability Settings	4
Post Offset Gain	1, 10, 100
Offset Range	± 1X full-scale
IR COMPENSATION	
Mode	Current Interrupt and Positive Feedback
Min Interrupt Time	33 µs
Max Interrupt Time	715 s
AUXILIARY A/D INPUT	
Range	± 3 V
Resolution	0.1 mV
Input Impedance	>100 kΩ or >10 GΩ
AUXILIARY D/A OUTPUT	
Range	0-4 V
Resolution	1 mV