C.4 INSTRUMENTATION AND MONITORING

An instrumentation program consisting of strain gages, earth pressure cells, inclinometers, potentiometers, dial gages and optical survey methods was incorporated to monitor wall deflections, geogrid tensions, and earth pressures during wall loading. The primary objectives of the instrumentation program were as follows:

- Observe stress and strain distribution in the MSE wall.
- Evaluate the change in stress distribution in the MSE mass due to increased surcharge loading.
- Evaluate internal and external stress levels, especially as they relate to earth pressure on the interface between the shoring wall and MSE mass.
- Monitor the deformation response of the test wall.

Two wall sections were instrumented and monitored: one section near the center of the connected wall system, and one section near the center of the unconnected wall section. Figure 51 illustrates the wall instrumentation plan, and table 12 summarizes the specifications of the various instruments installed in the test wall.

Table 12. Specification summary for test wall instrumentation.

Instrument	Manufacturer	Model	Sensitivity	Accuracy	Resolution	Calibrated By
Strain Gage	Micro-Measurements	EP-08-500GB-120	(+0.4±0.2)% at 24 degrees Celsius (^{o}C)	—	—	Gages: Micro-Measurements; Gages and geogrid: University of Colorado-Denver
Pressure Cell	Geokon	4800/4810	—	±0.1%	±0.025% F.S	Geokon
LVDT	Solartron Metrology	DCR/50	3.2 microVolts per Volt per millimeter (mV/V/mm)	—	—	TFHRC with Micro-Measurements system 5000
Potentiometer	Celesco	PT101	—	±0.15% full stroke	—	TFHRC with Micro-Measurements system 5000

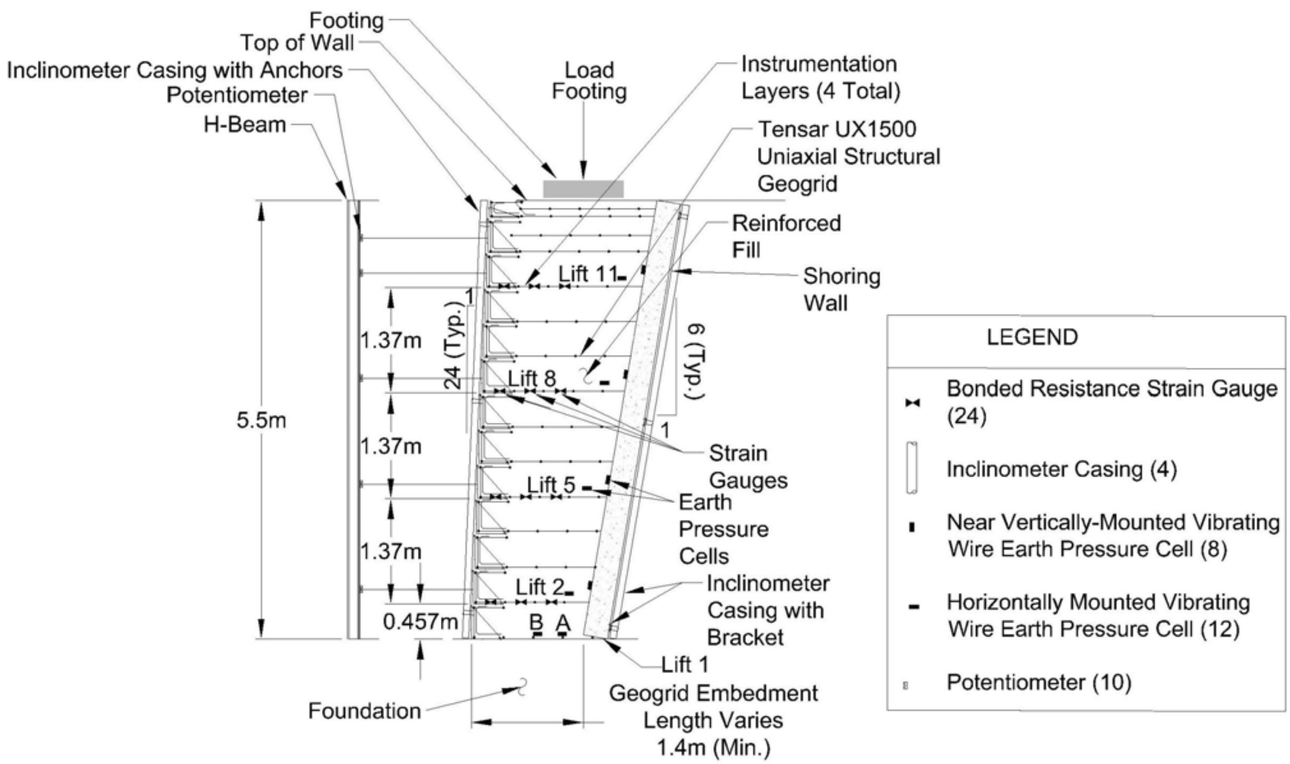

Figure 51. Schematic. Instrumented wall section.

Along each of the instrumented sections, the following instrumentation was installed:

- Bonded resistance strain gages (twelve per instrumented section) – located on four layers of geogrid near the top, middle and bottom of the wall section and near the front, middle and back of each reinforcing element. The purpose of the bonded resistance strain gages was to enable evaluation of local stress and strain distribution in the geogrid reinforcing elements and identify areas of maximum stress. Strain gages manufactured by Micro-Measurements were installed, as shown in figure 52.

- Vertical earth pressure cells (four per instrumented section) – located at the MSE/shoring wall interface near the bottom, middle and top of the wall section. The purpose of this instrumentation was to measure lateral earth pressures at the back of the MSE wall. Geokon 4810 vertical earth pressure cells were employed, as shown in figure 53.

- Horizontal earth pressure cells (six per instrumented section) – two cells located at the base of the MSE mass, and the remainder coupled with the vertical earth pressure cells. The purpose of this instrumentation was to measure vertical earth pressures in the MSE mass as a function of applied surcharge load. Geokon 4800 horizontal earth pressure cells were employed, as shown in figure 53.

- Inclinometer casing (two per instrumented section) – one casing located at the face of the MSE wall and one casing located behind the shoring wall. Inclinometer casing was installed to independently monitor the horizontal movement of the MSE and shoring walls. Figure 54 illustrates the inclinometers installed at the face of the MSE wall.

- Optical survey – Vertical and horizontal deflections of the load footings were monitored by optical survey methods (i.e., total station and level). Figure 55 illustrates total station surveying of footing deflection.

- Linear variable displacement transducers (LVDT) – Vertical deflection of the load footings were measured using LVDTs manufactured by Solartron Metrology, illustrated in figure 56.

- Potentiometers (five per instrumented section) – Lateral displacements at the face of the MSE wall were measured using potentiometers manufactured by Celesco. Figures 57 and 58 illustrate potentiometer installation at the face of the MSE wall.

Figure 52. Photo. Strain gage installed on uniaxial geogrid.

Figure 53. Photo. Earth pressure cells, Model 4800 (left) and Model 4810 (right).

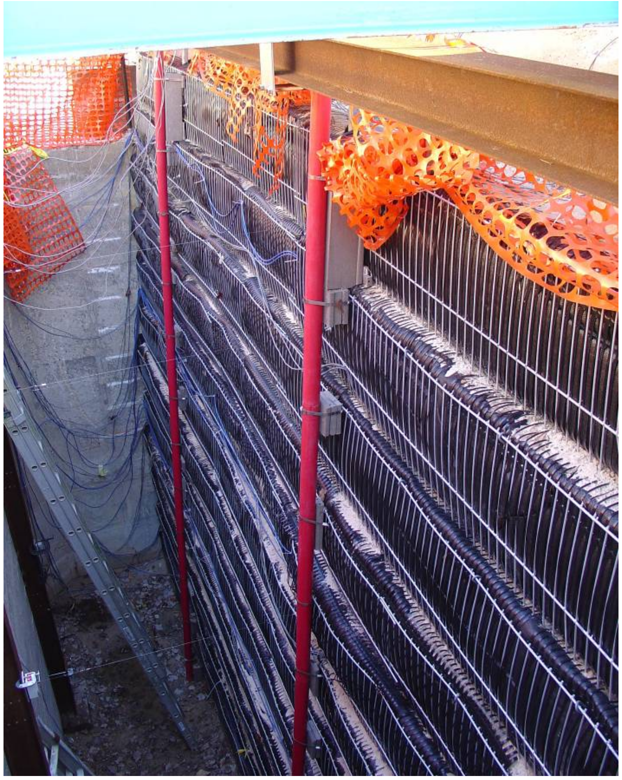

Figure 54. Photo. Inclinometers installed at the face of the MSE wall.

Figure 55. Photo. Total station surveying of footing deflection.

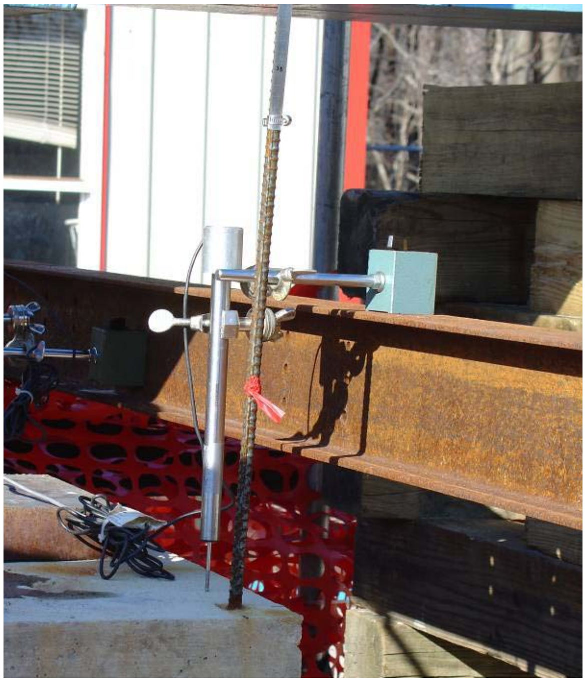

Figure 56. Photo. LVDT instrumentation installation.

Figure 57. Photo. Potentiometer installation showing connection to vertical reference.

Figure 58. Photo. Potentiometer wire connection to welded wire facing.

C.5 WALL LOADING

Upon completion of construction, a dead load of 45 kiloPascal (kPa) was applied in four load increments over the course of one month. The dead load was applied by placing jersey barriers on the concrete footings. Survey total station measurements of the footing settlement recorded during dead loading are presented in figure 59. The dead load was used to remove "slack" from the system so that monitoring instruments could be interpreted with greater sensitivity during wall loading. The dead load was removed prior to setting up the load frame.

Load testing of the field-scale test wall occurred in December 2004. The test loads were applied using jacks, with four jacks applying pressure on each footing (eight jacks total), as shown in figure 60. Each footing was 1 m by 2.5 m, as measured in plan, transmitting load over approximately 35 percent of the surface area of the reinforced fill. The test loads were applied in 22.24 kN per jack increments, equivalent to 89 kN per footing, or an incremental footing pressure of 35.6 kPa. Each test load was maintained for 30 minutes, with inclinometer and survey measurements recorded near the end of each load interval. The wall was loaded to a total load per footing of approximately 890 kN, equivalent to a total footing pressure of 356 kPa. The test wall was unloaded in two stages, with data recorded at 50 percent of the total test load and with the wall completely unloaded.

It is important to note that the test wall was loaded to an extremely high level with a maximum footing pressure of 356 kPa applied to approximately 35 percent of the reinforced fill zone (125 kPa equivalent), equivalent to approximately 10 times the normal traffic loading of 12 kPa.