REPORT ON DRILLED SHAFT LOAD TESTING (OSTERBERG METHOD)

Broadway Viaduct - Council Bluffs, IA - TS 4
Project Number - LT - 9640-1

Prepared for: **Longfellow Drilling**
1260 County Highway J23
Clearfield, IA 50840

Attention: **Mr. Jay Pool**

Report Date: **May 28, 2010**

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May 28, 2010

Longfellow Drilling
1260 County Highway J23
Clearfield, IA 50840

Attention: Mr. Jay Pool

Load Test Report: Broadway Viaduct - Council Bluffs, IA - TS 4

Dear Mr. Pool,

The enclosed report contains the data and analysis summary for the O-cell test performed on Broadway Viaduct - Council Bluffs, IA - TS 4 (LTI project LT - 9640-1) onMay 21, 2010. For your convenience, we have included an executive summary of the test results in addition to our standard detailed data report.

We would like to express our gratitude for the on-site and off-site assistance provided by your team and we look forward to working with you on future projects.

We trust that this information will meet your current project needs. If you have any questions, please do not hesitate to contact us at (800) 368-1138.

Best Regards,

Robert Simpson
LOADTEST, Inc.

EXECUTIVE SUMMARY

LOADTEST, Inc. tested a 60-inch (1524-mm) drilled shaft on May 21, 2010. Mr. Bill Ryan of LOADTEST, Inc. carried out the test. Longfellow Drilling completed construction of the 75.0-foot (22.9-meter) deep shaft (from ground surface) on May 4, 2010. Sub-surface conditions at the test shaft location consist primarily of sands and silty clay. Representatives of the Iowa Department of Transportation observed construction of the shaft.

The maximum bi-directional load applied to the shaft was 1221 kips (5.43 MN). At the maximum load, the displacements above and below the O-cell were 0.37 inches (9.3 mm) and 5.30 inches (135 mm), respectively. Average unit shear data calculated from strain gages included a calculated net unit side shear of 5.93 ksf (284 kPa), occurring between the Level 2 Strain Gages and the O-cell. We also calculate a maximum applied end bearing pressure of 37.5 ksf (1,700 kPa).

Using the procedures described in the report text and in Appendix C, we constructed an equivalent top load curve for the test shaft. For a top loading of 1,650 kips (7.34 MN), the adjusted test data indicate this shaft would settle approximately 0.250 inches (6.35 mm) (see Figure 8).

LIMITATIONS OF EXECUTIVE SUMMARY

We include this executive summary to provide a very brief presentation of some of the key elements of this O-cell test. It is by no means intended to be a comprehensive or stand-alone representation of the test results. The full text of the report and the attached appendices contain important information which the engineer can use to come to more informed conclusions about the data presented herein.

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SITE CONDITIONS AND SHAFT CONSTRUCTION

Site Sub-surface Conditions: The sub-surface stratigraphy at the general location of the test shaft is reported to consist of sand and silty clay. The generalized subsurface profile is included in Figure A and a boring log indicating conditions near the shaft is presented in Appendix E. More detailed geologic information can be obtained from the Iowa Department of Transportation.

Test Shaft Construction: Longfellow Drilling completed construction of the test shaft on May 4, 2010. The shaft was constructed with a total length of 75.0 feet (22.9 meters) (from ground surface). An auger was used for drilling the shaft. The bottom of the shaft was cleaned with a cleaning bucket after drilling. Concrete was placed by tremie. After curing and prior to testing, the test shaft was post grouted by others. Table B contains a summary of dimensions, elevations and shaft properties used in the data evaluations.

OSTERBERG CELL TESTING

Shaft Instrumentation: Test shaft instrumentation and assembly was carried out under the direction of Andy Skiffington of LOADTEST, Inc. The loading assembly consisted of a single 24-inch (610-mm) diameter O-cell located 14.8 feet (4.50 meters) above the tip of shaft. The Osterberg cell was calibrated to 2,940 kips (13.08 MN) and welded closed prior to shipping by American Equipment and Fabricating Corporation (see Appendix B).

Standard O-cell instrumentation included three LVWDTs (Linear Vibrating Wire Displacement Transducers - Geokon Model 4450 series) positioned between the lower and upper plates of the O-cell assembly to measure expansion (Appendix A, Page 2). Two lengths of ½-inch steel pipe were attached to the rebar cage, diametrically opposed, to measure compression of the shaft between the O-cell and the top of the shaft with traditional telltales that were installed on the day of the test.

Strain gages were used to assess the side shear load transfer along the shaft. One level of four and one level of three sister bar vibrating wire strain gages were installed, equally spaced on each level, in the shaft below the base of the O-cell assembly and five levels of three were installed in the shaft above it. Details concerning the strain gage placement appear in Table B and Figure A. The strain gages were positioned as directed by the Iowa Department of Transportation.

The test shaft assembly also included two lines of steel pipe, starting at the top-of-shaft and terminating at the top of the bottom plate to vent the break in the shaft between upward and downward movement and the resulting annular void. If desired they permit the application of excess fluid pressure to reduce the possibility of soil entering the void.

Earth pressure cells were installed at the shaft tip and monitored by LOADTEST during the test. The data is presented in Appendix A, page 8

Test Arrangement: Throughout the load test, key elements of shaft response were monitored using the equipment and instruments described herein. Shaft compression was measured using telltales (described under Shaft Instrumentation) monitored by Linear Vibrating Wire Displacement Transducers (LVWDT's) (Geokon - 4450). Two automated digital survey levels (Leica NA3003) were used to monitor the top of shaft movement during testing from a distance of approximately 25 feet (7.6 meters) (Appendix A, Page 1).

Both a Bourdon pressure gage and a vibrating wire pressure transducer were used to measure the pressure applied to the O-cell at each load interval. We used the pressure transducer for setting and maintaining loads, data analysis and for real time plotting. The Bourdon gage was used as a check on the pressure transducer. There was close agreement between the Bourdon gage and the pressure transducer throughout the test.

Data Acquisition: All of the movement indicators, LVWDTs and strain gages were connected to a data logger (Data Electronics - Model 615 Datataker®). The data logger, in turn, was connected to a laptop computer. This arrangement allowed movement indicator, LVWDT and strain gage readings to be recorded and stored automatically at 30 second intervals during the test. It also allowed the automatic importation of all test data into a laptop computer for real-time display and additional data back-up. The Leica (NA3003) data was imported real-time directly to the same lap top computer set to the same time as the data logging system.

Testing Procedures: As with all of our tests, we begin by loading the O-cell in order to break the tack welds that hold it closed (for handling and for placement in the shaft) and to form the fracture plane in the concrete surrounding the base of the O-cell. After the break occurs, we immediately release the load and then begin the loading procedure. Zero readings for all instrumentation are taken prior to the preliminary weld-breaking load-unload cycle, which in this case involved a maximum O-cell load of 278 kips (1.2 MN).

The Osterberg cell load test was conducted as follows: The 24-inch (610-mm) diameter O-cell located 14.8 feet (4.50 meters) above the tip of shaft was loaded to assess the base resistance below the O-cell assembly and the side shear above it. The O-cell was loaded in 10 increments to 1,221 kips (5.43 MN). The loading was halted after load interval 1L-10 because the shear resistance was approaching ultimate capacity. The O-cell was then depressurized in four decrements and the test was concluded. It should be noted that the final increment was less than the previous nine due to rapid displacement.

We applied the load increments using the Quick Load Test Method for Individual Piles (ASTM D1143 *Standard Test Method for Piles Under Static Axial Load*), holding each successive load increment constant for eight minutes by manually adjusting the O-cell pressure. We used approximately 60 seconds to move between increments. The data logger automatically recorded the instrument readings every 30 seconds, but herein we report only the one, two, four and eight-minute readings during each increment of maintained load. The various plotted results generally use the one, two, four and eight minute readings, but the creep results use the difference between the four and eight-minute readings.

TEST RESULTS AND ANALYSES

General: The loads applied by the O-cell act in two opposing directions, resisted by the capacity of the shaft above and below. Theoretically, the O-cell does not impose an additional upward load until its expansion force exceeds the buoyant weight of the shaft above the O-cell. Therefore, *net load*, which is defined as gross O-cell load minus the buoyant weight of the shaft above, is used to determine side shear resistance above the O-cell and to construct the equivalent top-loaded load-settlement curve. For this test we calculated a buoyant weight of shaft of 142 kips (0.63 MN) above the O-cell.

Side Shear Resistance: The maximum upward ***net load*** applied to the side shear was 1,079 kips (4.8 MN) which occurred at load interval 1L-10 (Appendix A, Page 3, Figures 1, 2 and 3). At this loading, the total upward movement of the top of the O-cell assembly was 0.37 inches (9.3 mm). The following net unit side shear estimates are based on the strain gage data which appear in Appendix A, Pages 4 to 7 and the shaft stiffnesses computed below.

At the time of testing, the concrete unconfined compressive strength was reported to be 5,630 psi (38.8 MPa). We used the ACI formula ($E_c = 57{,}000\sqrt{f'c}$) to calculate an elastic modulus for the concrete. This, combined with the area of reinforcing steel and shaft diameter, was used to determine a weighted average shaft stiffness of 13,600,000 kips (60,500 MN) for the shaft. The unit stiffnesses vary somewhat throughout the shaft due to diameter (see caliper report) and percent steel variations. Therefore different stiffnesses are used when computing load from different strain gage levels. The various stiffnesses for each zone are given in Table B. Estimated net unit side shear values for the shaft based on the strain gage data, estimated shaft stiffnesses and shaft area are as follows:

Table A: Mobilized Average Net Unit Side Shear Values for 1L-10[1]

Load Transfer Zone	Load Direction	Net Unit Side Shear[2]
Top of Shaft to Strain Gage Level 7	↑ @ 0.35 inches	0.21 ksf (10 kPa)
Strain Gage Level 7 to Strain Gage Level 6	↑ @ 0.35 inches	0.55 ksf (27 kPa)
Strain Gage Level 6 to Strain Gage Level 5	↑ @ 0.35 inches	0.89 ksf (42 kPa)
Strain Gage Level 5 to Strain Gage Level 4	↑ @ 0.36 inches	1.30 ksf (62 kPa)
Strain Gage Level 4 to Strain Gage Level 3	↑ @ 0.36 inches	0.81 ksf (39 kPa)
Strain Gage Level 3 to O-cell	↑ @ 0.36 inches	5.31 ksf (254 kPa)
O-cell to Strain Gage Level 2	↓ @ 5.30 inches	5.93 ksf (284 kPa)
Strain Gage Level 2 to Strain Gage Level 1	↓ @ 5.30 inches	1.56 ksf (75 kPa)[3]

[1]At the maximum displacement either up or down reported herein. See Figures 5 and 6 for net unit shear vs. displacement plots. See note 3.
[2]For upward loaded shear, the buoyant weight of shaft in each zone has been subtracted from the load shed in the respective zone.
[3]Maximum unit shear listed here was recorded at 1L-9. Unit shear decreased after this increment.

Side shear load distribution curves generated from strain gage data are shown in Figure 4. A unit side shear value for the shaft between the Level 2 strain gages and the Level 1 strain gages was calculated for 1L-10 to obtain an estimate of the base shear component of resistance to the downward movement between the Level 1 strain gages and the tip of shaft.

Combined End Bearing and Lower Side Shear Resistance: The maximum O-cell load applied to the base of the shaft was 1,221 kips (5.43 MN) which occurred at load interval 1L-10 (Appendix A, Page 3, Figure 1). At this loading, the total downward movement of the O-cell base was 5.30 inches (135 mm). The base resistance includes a small component of base shear (as discussed above) which must be subtracted to obtain unit end bearing values. The shear component of resistance for the shaft section the between the Level 1 strain gages and the tip of shaft is calculated to be 3.0 kips (13 kN) assuming a unit side shear value of 0.11 ksf (5 kPa) and a nominal shaft diameter of 60 inches (1,524 mm). Note: Although the caliper data indicates that the diameter was 61.5 inches (1,562 mm) at 74 feet (22.6 meters), the average in the bottom fifth of the shaft excavation is closer to 60 inches. The applied load to end bearing is then 736 kips (3.58 MN) and the end-bearing pressure applied at the tip of the shaft is calculated to be 37.5 ksf (1,700 kPa).

Creep Limit: See Appendix D for our O-cell method for determining creep limit. The upward side shear creep data (Appendix A, Page 3) indicate that no creep limit was reached at the maximum measured movement (Appendix D, Figure 1). The combined end bearing and lower side shear creep data (Appendix A, Page 3) indicate that a base creep limit of 900 kips (4.00 MN) was reached at a movement of 0.28 inches (7.1 mm) (Appendix D, Figure 2). The engineer should come to his own conclusions with regard to the suitability of the creep limit analysis to address long term creep which may be an important design consideration.

Equivalent Top Load: Figure 2 presents the equivalent top load curve. The unadjusted lighter curve, described in Procedure Part I of Appendix C, was generated by using the measured upward top of O-cell and downward base of O-cell data. Because it can be an important component of the settlements involved, the equivalent top load curve includes an adjustment for the additional elastic compression which would occur in a top-load test. The darker curve as described in Procedure Part II of Appendix C includes such an adjustment.

We mobilized a combined end bearing and side shear resistance of 2,301 kips (10.2 MN) during the test. For a top loading of 1,650 kips (7.34 MN), the adjusted test data indicate this shaft would settle approximately 0.250 inches (6.35 mm (see Figure 8).

Shaft Compression Comparison: The measured maximum shaft compression, averaged from 2 telltales, is 0.019 inches (0.48 mm). Using the calipered shaft diameters (Table B and Figure A, Caliper Report), a weighted average shaft stiffness of 13,600,000 kips (60,500 MN) and the load distribution in Figure 4, we calculated an elastic compression of 0.016 inches (0.41 mm) over the length of the compression telltales.

LIMITATIONS AND STANDARD OF CARE

The instrumentation, testing services and data analysis provided by LOADTEST, Inc., outlined in this report, were performed in accordance with the accepted standards of care recognized by professionals in the drilled shaft and foundation engineering industry.

Please note that some of the information contained in this report is based on data (i.e. shaft diameter, elevations and concrete strength) provided by others. The engineer, therefore, should come to his or her own conclusions with regard to the analyses as they depend on this information. In particular, LOADTEST, Inc. typically does not observe and record drilled shaft construction details to the level of precision that the project engineer may require. In many cases, we may not be present for the entire duration of shaft construction. Since construction technique can play a significant role in determining the load bearing capacity of a drilled shaft, the engineer should pay close attention to the drilled shaft construction details that were recorded elsewhere.

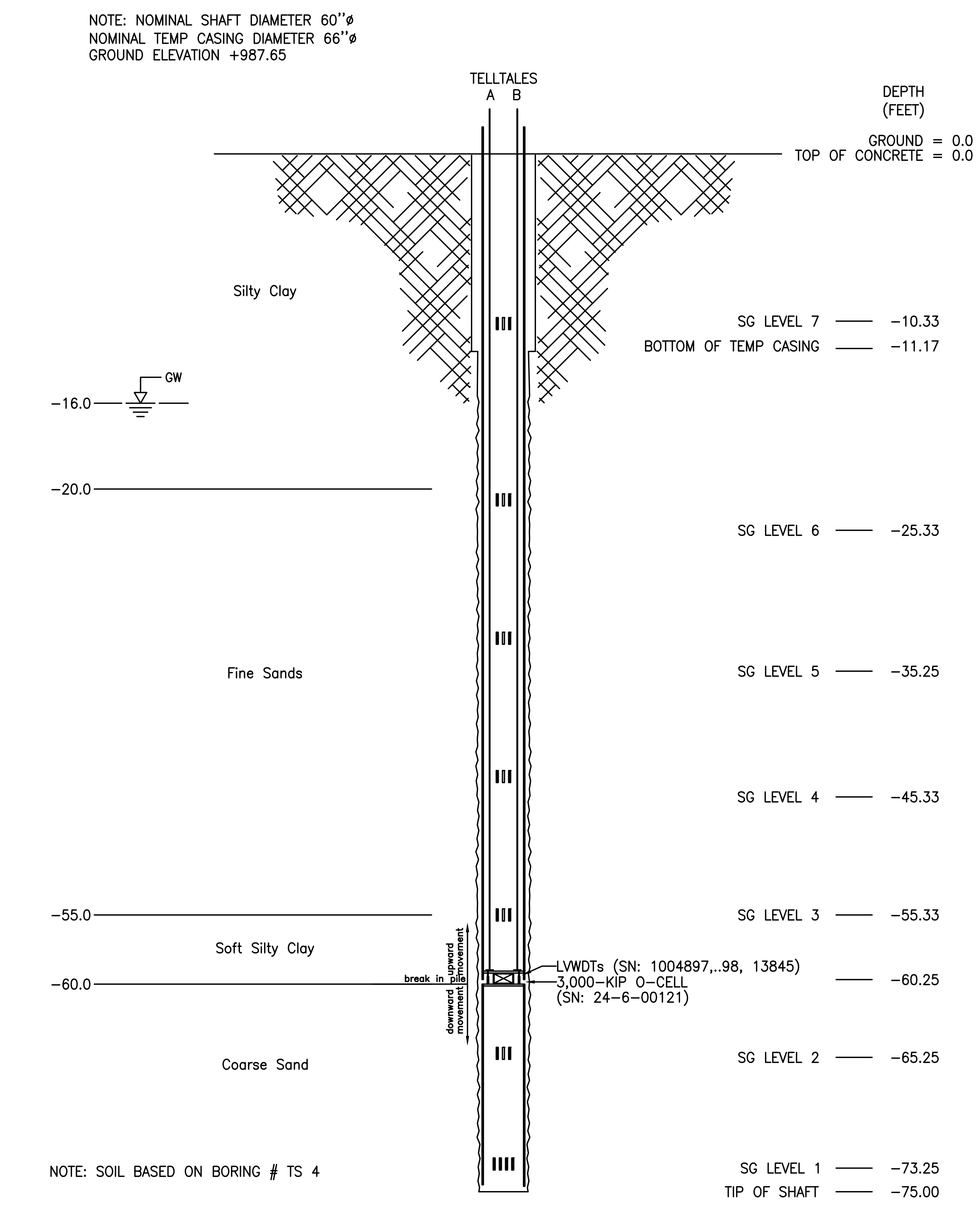
We trust that this information will meet your current project needs. If you have any questions, please do not hesitate to contact us at (800) 368-1138.

Prepared for LOADTEST, Inc. by

Robert C. Simpson
Senior Engineer

Reviewed for LOADTEST, Inc. by

David J. Jakstis, P.E.
Geotechnical Engineer



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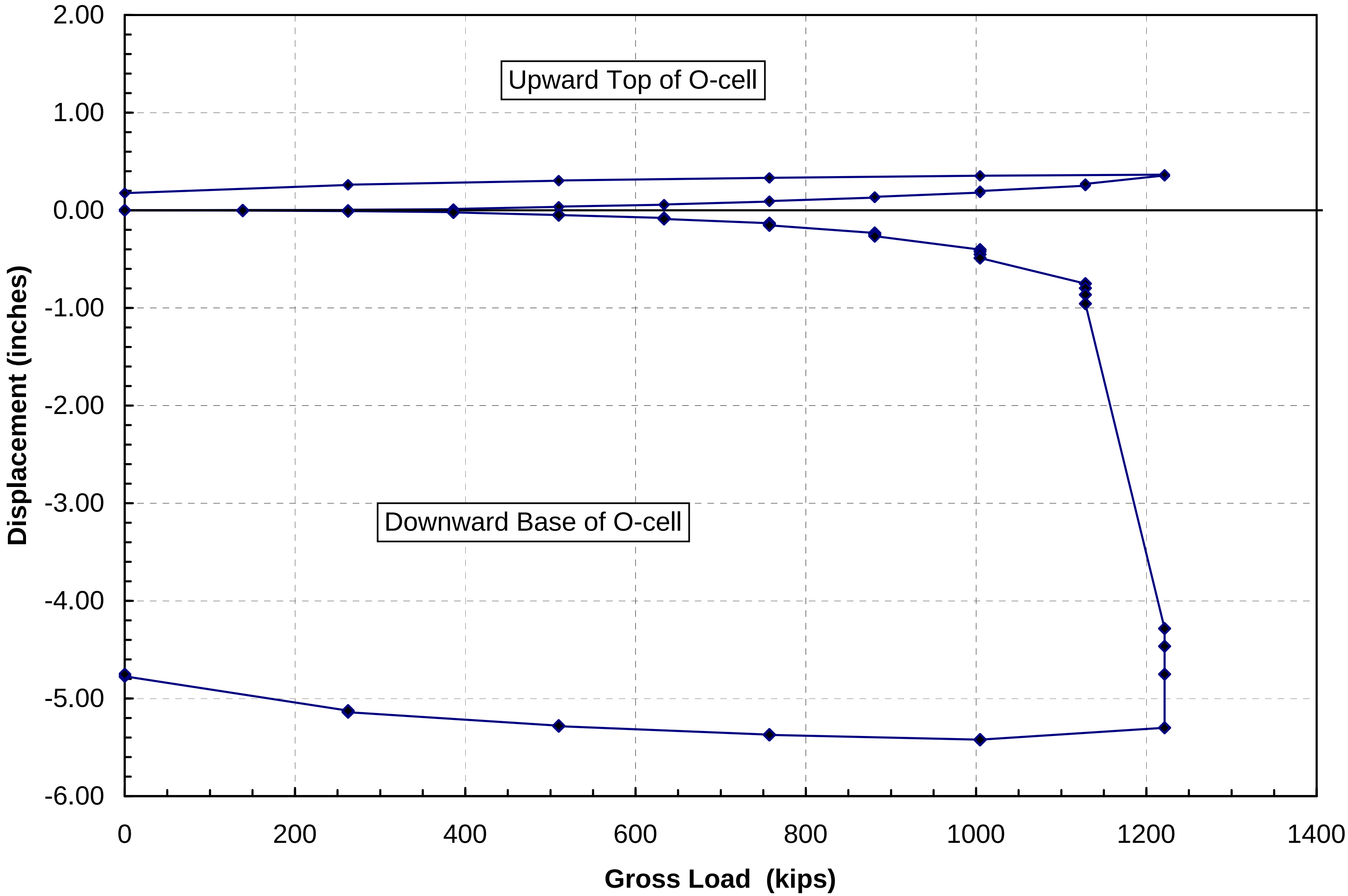
SCHEMATIC SECTION OF TEST SHAFT

Broadyway Viaduct − Council Bluffs, IA

DWN BY: BDH	DATE: 06 Nov 2009	CHECKED BY:	LT−9640−1
REVISED BY: AJS	DATE: 10 May 2010	SCALE: NTS	**FIGURE A**

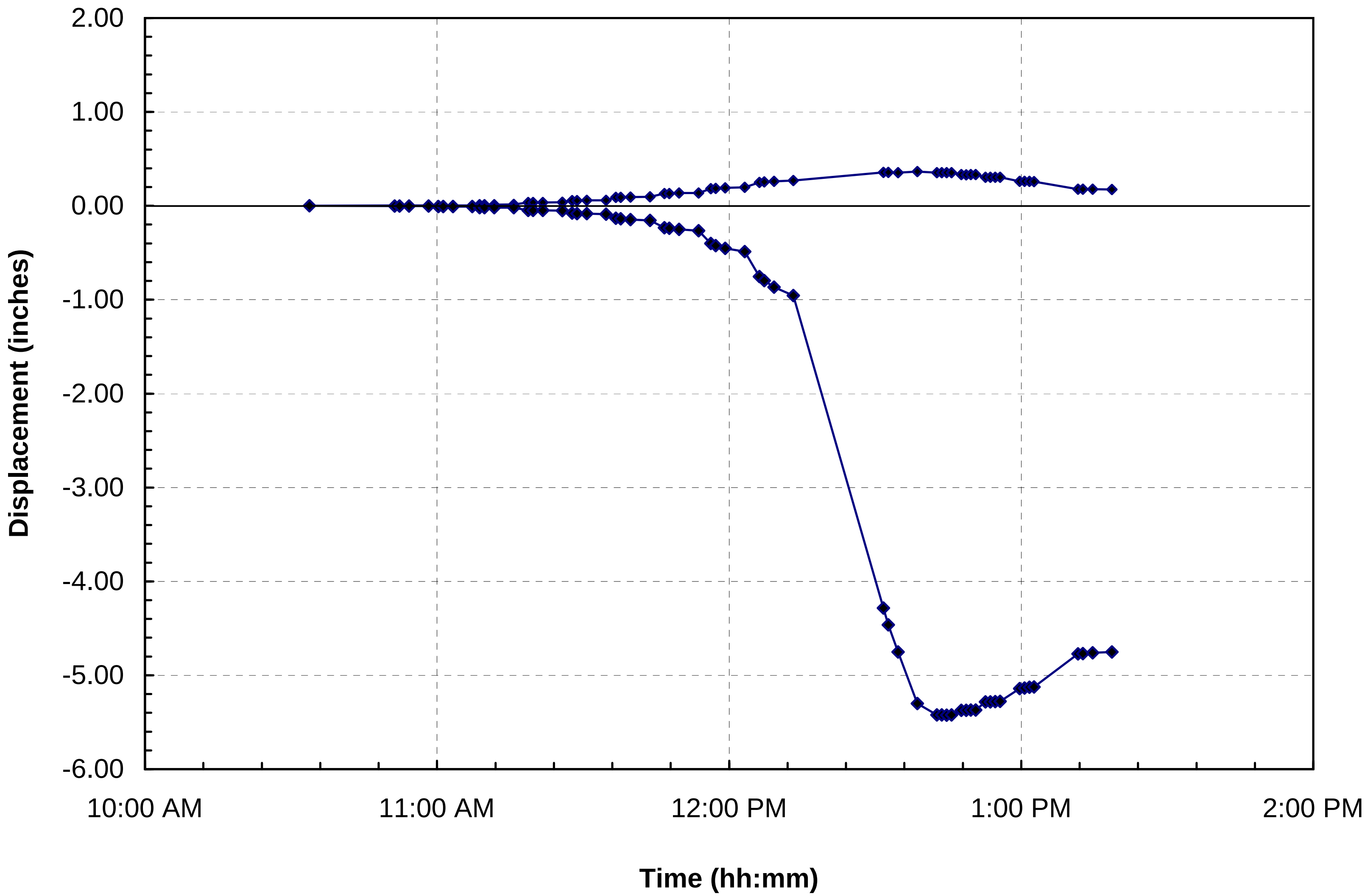
Osterberg Cell Load vs.Displacement Plots

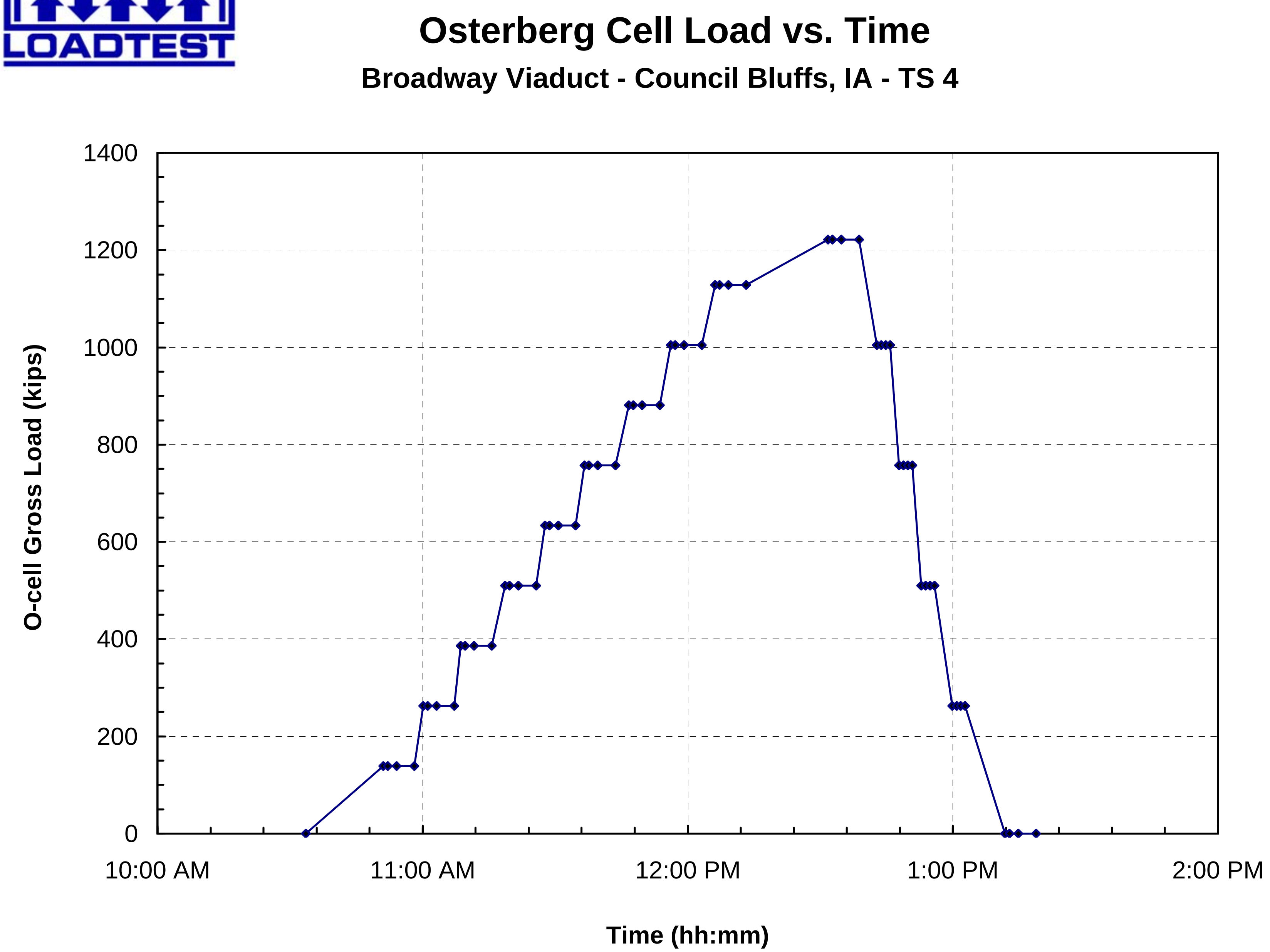
Broadway Viaduct - Council Bluffs, IA - TS 4



Osterberg Cell Time vs. Displacement Plots

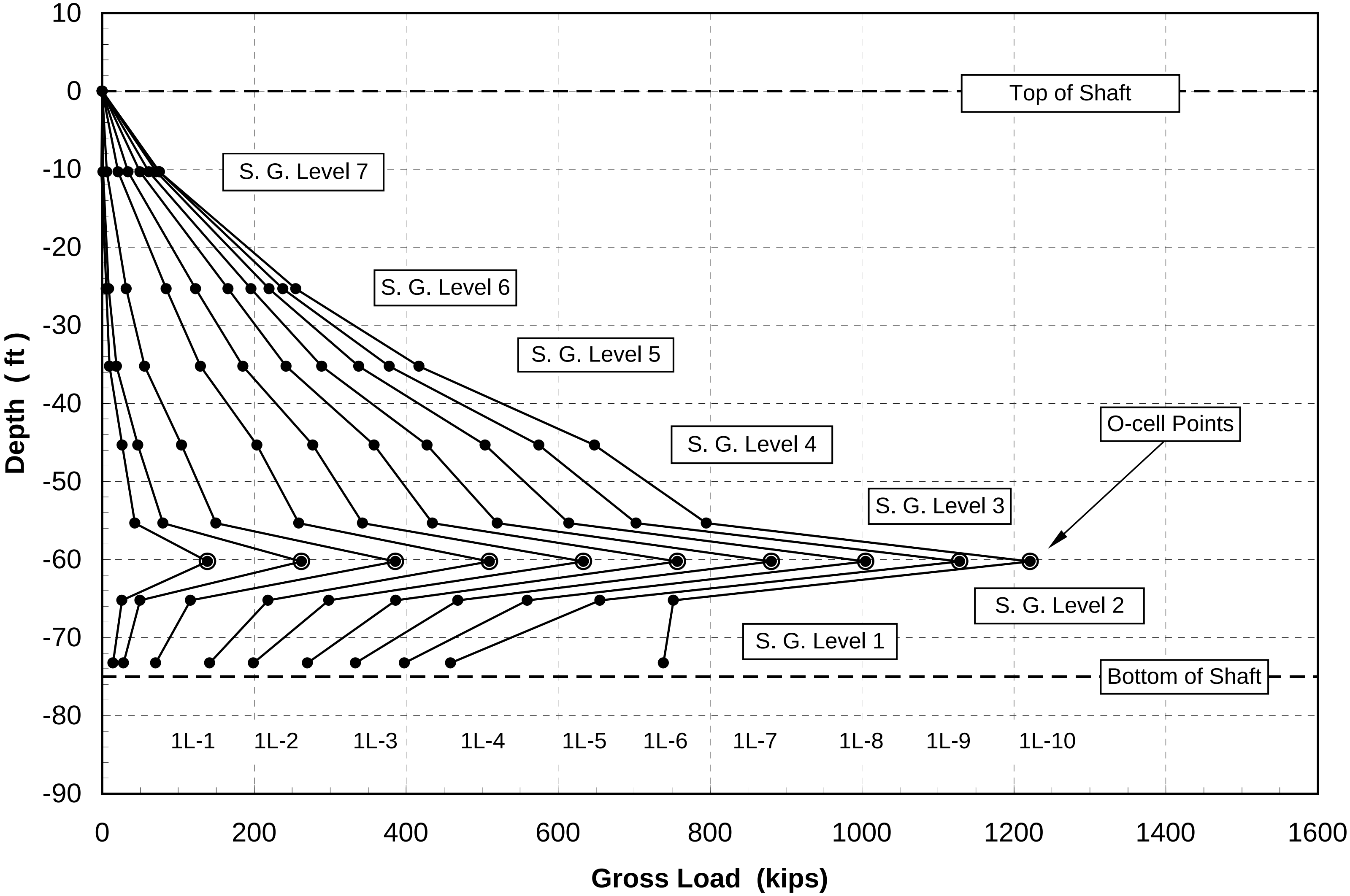
Broadway Viaduct - Council Bluffs, IA - TS 4



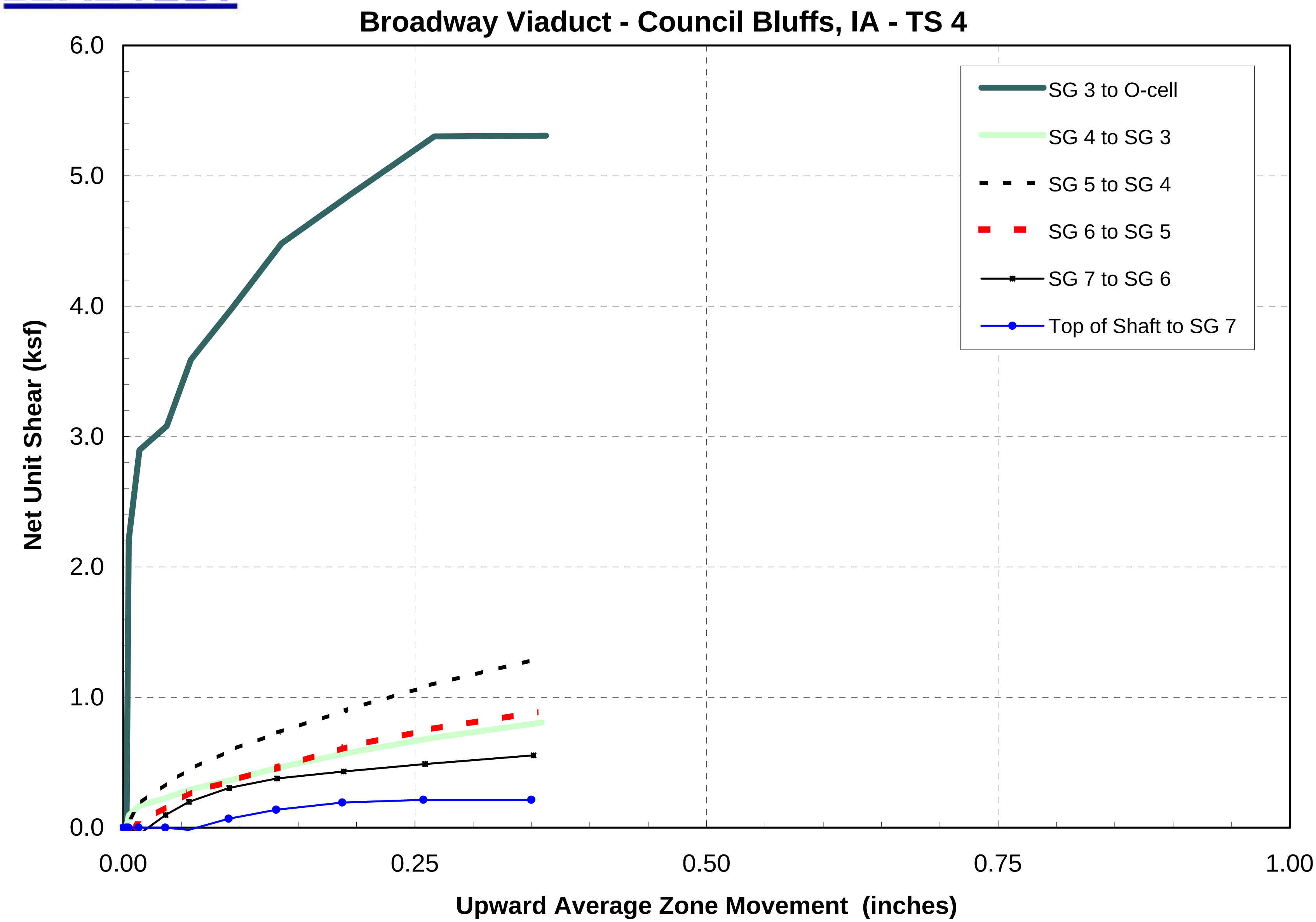

Osterberg Cell Load vs. Time
Broadway Viaduct - Council Bluffs, IA - TS 4
O-cell Gross Load (kips)
1400
1200
1000
800
600
400
200
0
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
Time (hh:mm)

Strain Gage Load Distribution Plots

Broadway Viaduct - Council Bluffs, IA - TS 4

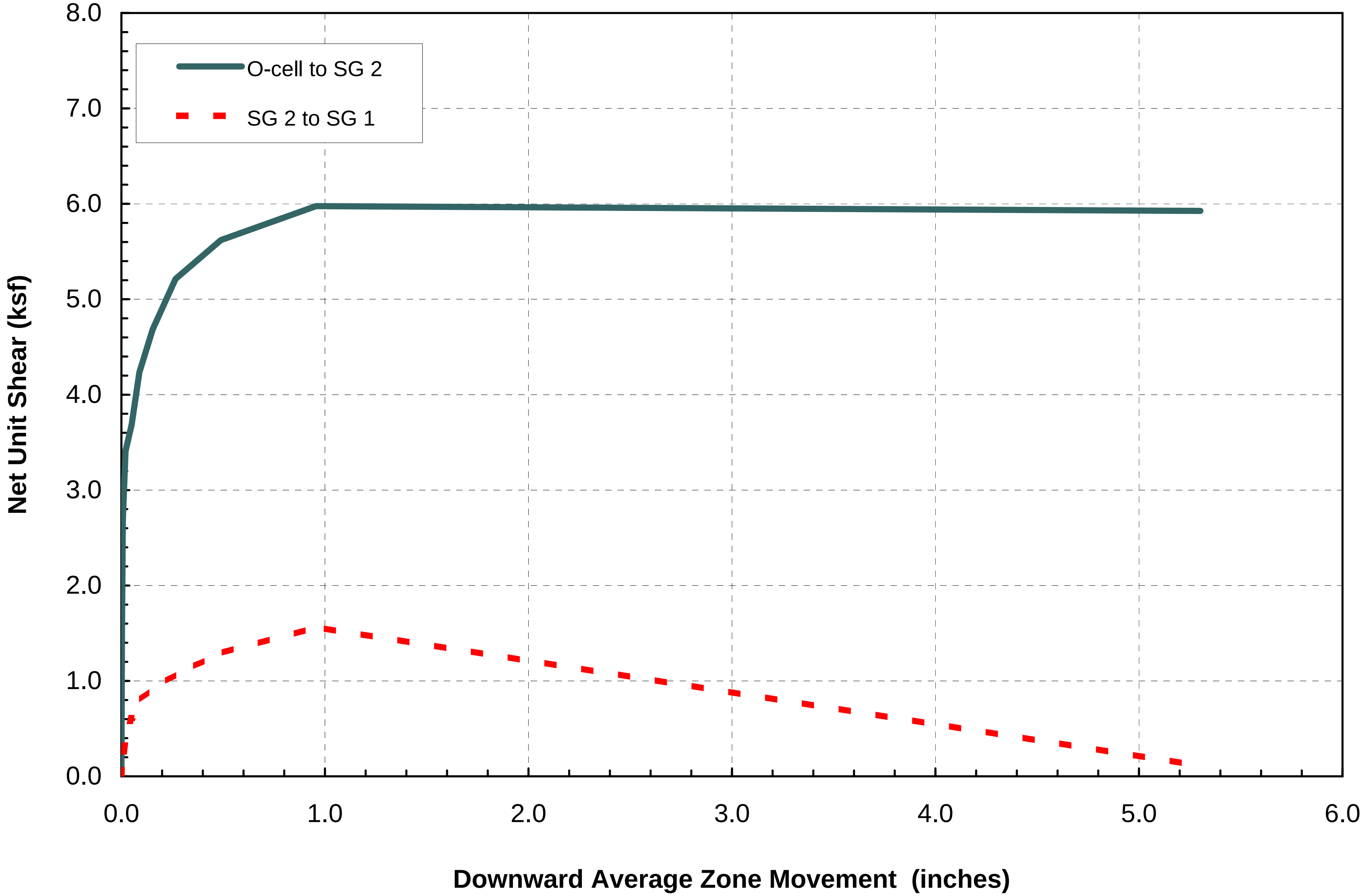


Net Unit Shear vs. Upward Average Zone Movement



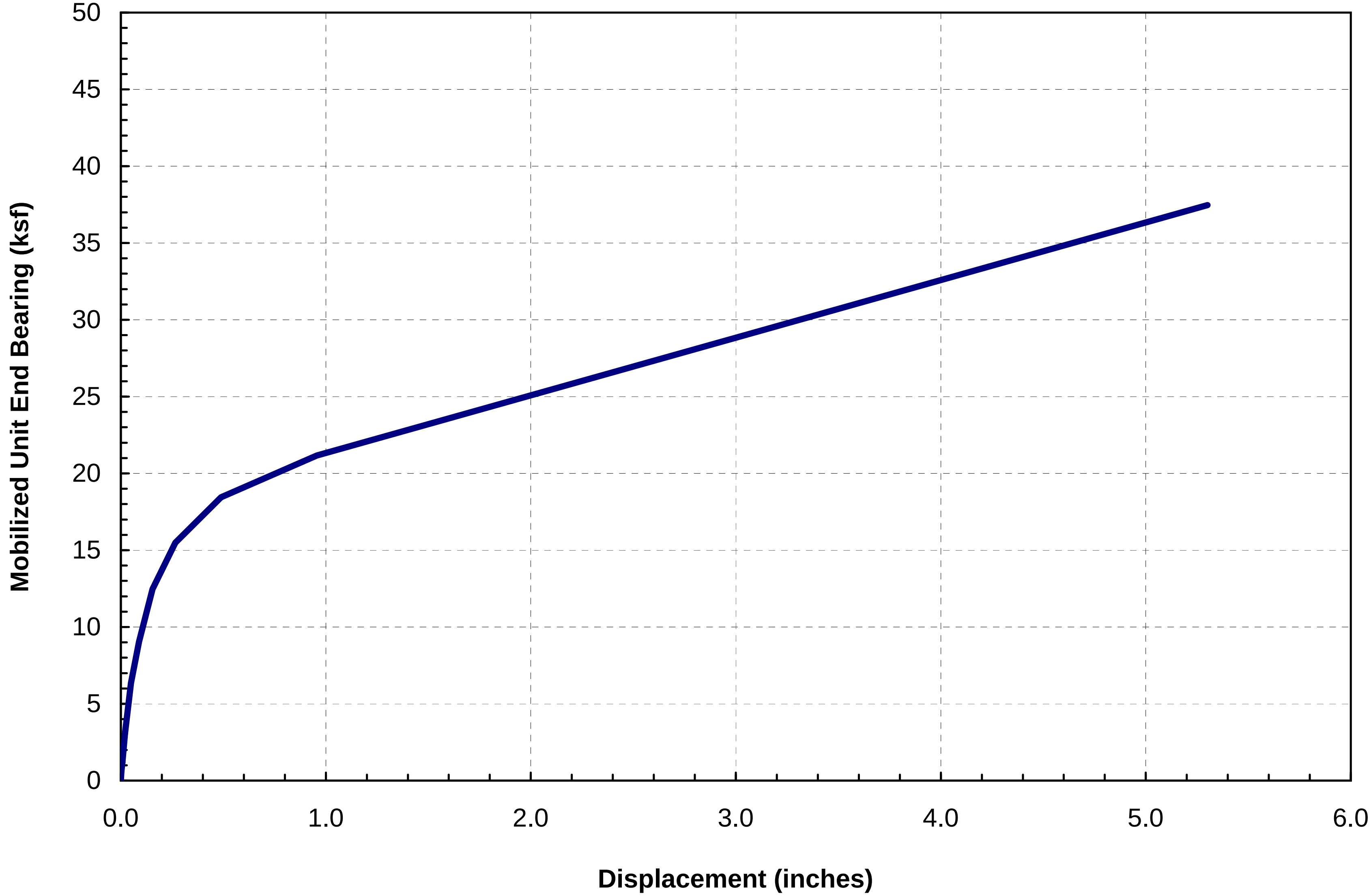
Net Unit Shear vs. Downward O-cell Movement

Broadway Viaduct - Council Bluffs, IA - TS 4



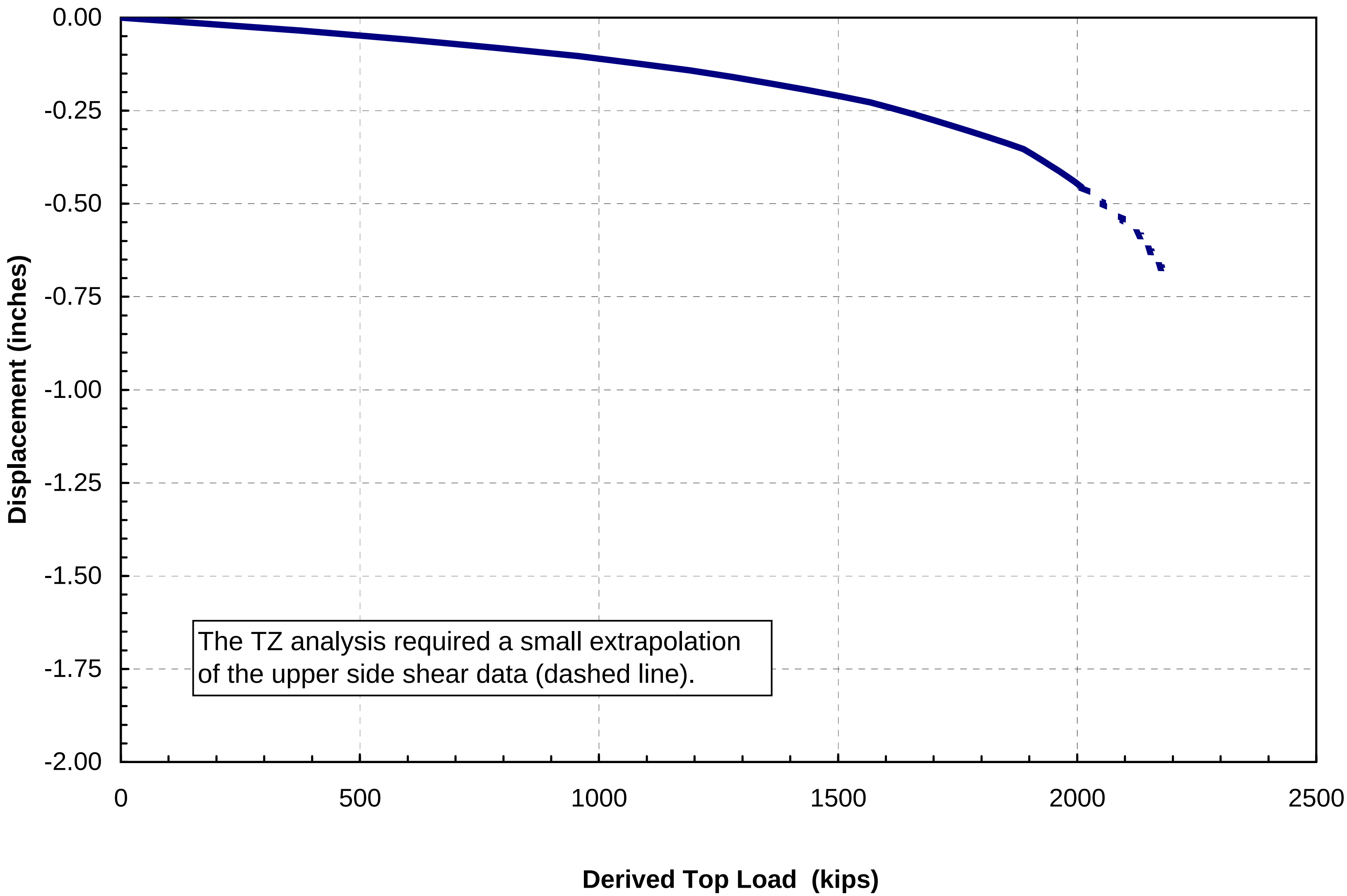
Mobilized Unit End Bearing vs. Downward O-cell Displacement

Broadway Viaduct - Council Bluffs, IA - TS 4



Derived Top Load-Displacement Plots

Broadway Viaduct - Council Bluffs, IA - TS 4



APPENDIX A

FIELD DATA & DATA REDUCTION

Top of Shaft Movement and Compression

Broadway Viaduct - Council Bluffs, IA - TS 4

Load Test Increment	Time (h:m:s)	Time After Start Minutes	O-cell Pressure (psi)	Applied Load (kips)	Net Load (kips)	TOS Indicator Readings Side A (inches)	TOS Indicator Readings Side B (inches)	TOS Indicator Readings Average (inches)	Telltale Compression Side A (inches)	Telltale Compression Side B (inches)	Telltale Compression Average (inches)
1L -0	10:34:00	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000
1L -1	10:51:30	1	400	139	0	0.003	0.002	0.003	0.001	0.000	0.001
1L -1	10:52:30	2	400	139	0	0.002	0.000	0.001	0.001	0.000	0.001
1L -1	10:54:30	4	400	139	0	0.003	0.002	0.003	0.001	0.000	0.001
1L -1	10:58:30	8	400	139	0	0.002	0.002	0.002	0.001	0.000	0.001
1L -2	11:00:30	1	800	262	121	0.003	0.002	0.003	0.001	0.000	0.001
1L -2	11:01:30	2	800	262	121	0.003	0.003	0.003	0.001	0.000	0.001
1L -2	11:03:30	4	800	262	121	0.004	0.004	0.004	0.001	0.000	0.001
1L -2	11:07:30	8	800	262	121	0.004	0.004	0.004	0.001	0.000	0.001
1L -3	11:09:00	1	1,200	386	244	0.010	0.010	0.010	0.002	0.001	0.002
1L -3	11:10:00	2	1,200	386	244	0.010	0.010	0.010	0.003	0.001	0.002
1L -3	11:12:00	4	1,200	386	244	0.011	0.011	0.011	0.003	0.001	0.002
1L -3	11:16:00	8	1,200	386	244	0.012	0.012	0.012	0.003	0.001	0.002
1L -4	11:19:00	1	1,600	510	368	0.030	0.029	0.030	0.006	0.004	0.005
1L -4	11:20:00	2	1,600	510	368	0.031	0.029	0.030	0.006	0.004	0.005
1L -4	11:22:00	4	1,600	510	368	0.032	0.030	0.031	0.006	0.004	0.005
1L -4	11:26:00	8	1,600	510	368	0.033	0.032	0.033	0.007	0.004	0.005
1L -5	11:28:00	1	2,000	634	492	0.050	0.048	0.049	0.009	0.006	0.007
1L -5	11:29:00	2	2,000	634	492	0.049	0.048	0.049	0.009	0.006	0.007
1L -5	11:31:00	4	2,000	634	492	0.052	0.049	0.051	0.009	0.006	0.007
1L -5	11:35:00	8	2,000	634	492	0.051	0.050	0.051	0.009	0.007	0.008
1L -6	11:37:00	1	2,400	757	616	0.079	0.079	0.079	0.012	0.009	0.010
1L -6	11:38:00	2	2,400	757	616	0.081	0.080	0.081	0.012	0.009	0.010
1L -6	11:40:00	4	2,400	757	616	0.084	0.082	0.083	0.012	0.009	0.010
1L -6	11:44:00	8	2,400	757	616	0.086	0.083	0.085	0.012	0.008	0.010
1L -7	11:47:00	1	2,800	881	739	0.118	0.117	0.118	0.014	0.010	0.012
1L -7	11:48:00	2	2,800	881	739	0.120	0.119	0.120	0.014	0.010	0.012
1L -7	11:50:00	4	2,800	881	739	0.123	0.122	0.123	0.014	0.011	0.013
1L -7	11:54:00	8	2,800	881	739	0.125	0.124	0.125	0.014	0.011	0.013
1L -8	11:56:30	1	3,200	1,005	863	0.168	0.167	0.168	0.017	0.012	0.014
1L -8	11:57:30	2	3,200	1,005	863	0.173	0.171	0.172	0.017	0.012	0.015
1L -8	11:59:30	4	3,200	1,005	863	0.177	0.176	0.177	0.017	0.012	0.015
1L -8	12:03:30	8	3,200	1,005	863	0.183	0.181	0.182	0.017	0.012	0.015
1L -9	12:06:30	1	3,600	1,128	987	0.234	0.234	0.234	0.019	0.014	0.017
1L -9	12:07:30	2	3,600	1,128	987	0.240	0.238	0.239	0.019	0.014	0.017
1L -9	12:09:30	4	3,600	1,128	987	0.246	0.244	0.245	0.019	0.014	0.017
1L -9	12:13:30	8	3,600	1,128	987	0.254	0.251	0.253	0.019	0.014	0.017
1L -10	12:32:00	1	3,900	1,221	1,079	0.339	0.338	0.339	0.022	0.015	0.019
1L -10	12:33:00	2	3,900	1,221	1,079	0.338	0.334	0.336	0.022	0.015	0.019
1L -10	12:35:00	4	3,900	1,221	1,079	0.337	0.330	0.334	0.023	0.015	0.019
1L -10	12:39:00	8	3,900	1,221	1,079	0.348	0.346	0.347	0.023	0.015	0.019
1U - 1	12:43:00	1	3,200	1,005	863	0.336	0.334	0.335	0.021	0.015	0.018
1U - 1	12:44:00	2	3,200	1,005	863	0.336	0.333	0.335	0.021	0.015	0.018
1U - 1	12:45:00	3	3,200	1,005	863	0.335	0.333	0.334	0.021	0.015	0.018
1U - 1	12:46:00	4	3,200	1,005	863	0.336	0.334	0.335	0.021	0.015	0.018
1U - 2	12:48:00	1	2,400	757	616	0.318	0.313	0.316	0.019	0.013	0.016
1U - 2	12:49:00	2	2,400	757	616	0.316	0.313	0.315	0.019	0.013	0.016
1U - 2	12:50:00	3	2,400	757	616	0.317	0.314	0.316	0.019	0.013	0.016
1U - 2	12:51:00	4	2,400	757	616	0.318	0.313	0.316	0.019	0.013	0.016
1U - 3	12:53:00	1	1,600	510	368	0.292	0.289	0.291	0.017	0.011	0.014
1U - 3	12:54:00	2	1,600	510	368	0.291	0.288	0.290	0.017	0.011	0.014
1U - 3	12:55:00	3	1,600	510	368	0.291	0.288	0.290	0.017	0.011	0.014
1U - 3	12:56:00	4	1,600	510	368	0.291	0.288	0.290	0.017	0.011	0.014
1U - 4	13:00:00	1	800	262	121	0.252	0.249	0.251	0.013	0.008	0.011
1U - 4	13:01:00	2	800	262	121	0.252	0.249	0.251	0.013	0.008	0.011
1U - 4	13:02:00	3	800	262	121	0.250	0.248	0.249	0.013	0.008	0.011
1U - 4	13:03:00	4	800	262	121	0.250	0.247	0.249	0.013	0.008	0.011
1U - 5	13:12:00	1	0	0	0	0.172	0.169	0.171	0.008	0.005	0.006
1U - 5	13:13:00	2	0	0	0	0.171	0.168	0.170	0.008	0.005	0.006
1U - 5	13:15:00	4	0	0	0	0.171	0.168	0.170	0.008	0.005	0.006
1U - 5	13:19:00	8	0	0	0	0.170	0.167	0.169	0.008	0.005	0.006

O-cell Expansion

Broadway Viaduct - Council Bluffs, IA - TS 4

Load Test Increment	Time (h:m:s)	Time After Start Minutes	O-cell Pressure (psi)	Applied Load (kips)	Net Load (kips)	LVWDT Readings (Expansion) 1004897 (inches)	1004898 (inches)	13845 (inches)	Average[1] (inches)
1L -0	10:34:00	0	0	0	0	0.000	0.000	0.000	0.000
1L -1	10:51:30	1	400	139	0	0.005	0.005	0.005	0.005
1L -1	10:52:30	2	400	139	0	0.005	0.005	0.005	0.005
1L -1	10:54:30	4	400	139	0	0.005	0.005	0.005	0.005
1L -1	10:58:30	8	400	139	0	0.005	0.005	0.005	0.005
1L -2	11:00:30	1	800	262	121	0.011	0.011	0.010	0.011
1L -2	11:01:30	2	800	262	121	0.011	0.011	0.011	0.011
1L -2	11:03:30	4	800	262	121	0.012	0.012	0.011	0.012
1L -2	11:07:30	8	800	262	121	0.012	0.012	0.011	0.012
1L -3	11:09:00	1	1,200	386	244	0.030	0.030	0.028	0.030
1L -3	11:10:00	2	1,200	386	244	0.031	0.032	0.030	0.032
1L -3	11:12:00	4	1,200	386	244	0.033	0.034	0.032	0.034
1L -3	11:16:00	8	1,200	386	244	0.034	0.035	0.033	0.035
1L -4	11:19:00	1	1,600	510	368	0.082	0.083	0.080	0.082
1L -4	11:20:00	2	1,600	510	368	0.083	0.084	0.081	0.084
1L -4	11:22:00	4	1,600	510	368	0.085	0.086	0.083	0.086
1L -4	11:26:00	8	1,600	510	368	0.087	0.088	0.084	0.088
1L -5	11:28:00	1	2,000	634	492	0.134	0.136	0.134	0.135
1L -5	11:29:00	2	2,000	634	492	0.137	0.139	0.137	0.138
1L -5	11:31:00	4	2,000	634	492	0.141	0.143	0.141	0.142
1L -5	11:35:00	8	2,000	634	492	0.146	0.148	0.146	0.147
1L -6	11:37:00	1	2,400	757	616	0.219	0.223	0.220	0.221
1L -6	11:38:00	2	2,400	757	616	0.227	0.231	0.234	0.229
1L -6	11:40:00	4	2,400	757	616	0.237	0.241	0.239	0.239
1L -6	11:44:00	8	2,400	757	616	0.246	0.251	0.248	0.248
1L -7	11:47:00	1	2,800	881	739	0.359	0.366	0.359	0.363
1L -7	11:48:00	2	2,800	881	739	0.369	0.375	0.373	0.372
1L -7	11:50:00	4	2,800	881	739	0.383	0.389	0.383	0.386
1L -7	11:54:00	8	2,800	881	739	0.400	0.406	0.403	0.403
1L -8	11:56:30	1	3,200	1,005	863	0.580	0.587	0.585	0.584
1L -8	11:57:30	2	3,200	1,005	863	0.606	0.613	0.611	0.609
1L -8	11:59:30	4	3,200	1,005	863	0.639	0.647	0.643	0.643
1L -8	12:03:30	8	3,200	1,005	863	0.681	0.689	0.686	0.685
1L -9	12:06:30	1	3,600	1,128	987	0.998	1.008	1.006	1.003
1L -9	12:07:30	2	3,600	1,128	987	1.049	1.057	1.055	1.053
1L -9	12:09:30	4	3,600	1,128	987	1.122	1.132	1.131	1.127
1L -9	12:13:30	8	3,600	1,128	987	1.221	1.230	1.229	1.225
1L -10	12:32:00	1	3,900	1,221	1,079	4.638	4.644	4.655	4.641
1L -10	12:33:00	2	3,900	1,221	1,079	4.816	4.821	4.837	4.819
1L -10	12:35:00	4	3,900	1,221	1,079	5.103	5.104	5.118	5.103
1L -10	12:39:00	8	3,900	1,221	1,079	5.664	5.671	5.684	5.667
1U - 1	12:43:00	1	3,200	1,005	863	5.766	5.786	5.805	5.776
1U - 1	12:44:00	2	3,200	1,005	863	5.765	5.786	5.805	5.775
1U - 1	12:45:00	3	3,200	1,005	863	5.766	5.786	5.805	5.776
1U - 1	12:46:00	4	3,200	1,005	863	5.765	5.786	5.805	5.775
1U - 2	12:48:00	1	2,400	757	616	5.693	5.714	5.734	5.704
1U - 2	12:49:00	2	2,400	757	616	5.693	5.714	5.733	5.703
1U - 2	12:50:00	3	2,400	757	616	5.692	5.713	5.733	5.703
1U - 2	12:51:00	4	2,400	757	616	5.692	5.713	5.733	5.703
1U - 3	12:53:00	1	1,600	510	368	5.577	5.600	5.622	5.588
1U - 3	12:54:00	2	1,600	510	368	5.574	5.597	5.619	5.585
1U - 3	12:55:00	3	1,600	510	368	5.572	5.594	5.617	5.583
1U - 3	12:56:00	4	1,600	510	368	5.570	5.593	5.615	5.582
1U - 4	13:00:00	1	800	262	121	5.391	5.414	5.438	5.403
1U - 4	13:01:00	2	800	262	121	5.387	5.410	5.434	5.399
1U - 4	13:02:00	3	800	262	121	5.374	5.398	5.421	5.386
1U - 4	13:03:00	4	800	262	121	5.373	5.396	5.420	5.384
1U - 5	13:12:00	1	0	0	0	4.937	4.963	4.997	4.950
1U - 5	13:13:00	2	0	0	0	4.931	4.957	5.100	4.944
1U - 5	13:15:00	4	0	0	0	4.924	4.948	4.973	4.936
1U - 5	13:19:00	8	0	0	0	4.914	4.938	4.961	4.926

[1]LVWDT 13845 not included in average due to its orientation. LVWDT 1004897 and 1004898 are oriented 180 degrees opposed.

Upward and Downward Movement and Creep

Broadway Viaduct - Council Bluffs, IA - TS 4

Load Test Increment	Time 0 (h:m:s)	Time After Start Minutes	O-cell Pressure (psi)	Applied Load (kips)	Net Load (kips)	Top O-cell Movement (inches)	Upward Creep (inches)	Bottom O-cell Movement (inches)	Downward Creep (inches)
1L -0	10:34:00	0	0	0	0	0.000		0.000	
1L -1	10:51:30	1	400	139	0	0.003		-0.002	
1L -1	10:52:30	2	400	139	0	0.002		-0.003	
1L -1	10:54:30	4	400	139	0	0.003		-0.002	
1L -1	10:58:30	8	400	139	0	0.003	0.000	-0.002	0.000
1L -2	11:00:30	1	800	262	121	0.003		-0.008	
1L -2	11:01:30	2	800	262	121	0.004		-0.007	
1L -2	11:03:30	4	800	262	121	0.005		-0.007	
1L -2	11:07:30	8	800	262	121	0.005	0.000	-0.007	0.000
1L -3	11:09:00	1	1,200	386	244	0.012		-0.018	
1L -3	11:10:00	2	1,200	386	244	0.012		-0.020	
1L -3	11:12:00	4	1,200	386	244	0.013		-0.021	
1L -3	11:16:00	8	1,200	386	244	0.014	0.001	-0.021	0.000
1L -4	11:19:00	1	1,600	510	368	0.034		-0.048	
1L -4	11:20:00	2	1,600	510	368	0.035		-0.049	
1L -4	11:22:00	4	1,600	510	368	0.036		-0.050	
1L -4	11:26:00	8	1,600	510	368	0.038	0.002	-0.050	0.000
1L -5	11:28:00	1	2,000	634	492	0.056		-0.078	
1L -5	11:29:00	2	2,000	634	492	0.056		-0.082	
1L -5	11:31:00	4	2,000	634	492	0.058		-0.084	
1L -5	11:35:00	8	2,000	634	492	0.059	0.001	-0.088	0.004
1L -6	11:37:00	1	2,400	757	616	0.089		-0.132	
1L -6	11:38:00	2	2,400	757	616	0.091		-0.138	
1L -6	11:40:00	4	2,400	757	616	0.093		-0.145	
1L -6	11:44:00	8	2,400	757	616	0.095	0.001	-0.154	0.008
1L -7	11:47:00	1	2,800	881	739	0.130		-0.233	
1L -7	11:48:00	2	2,800	881	739	0.132		-0.240	
1L -7	11:50:00	4	2,800	881	739	0.135		-0.251	
1L -7	11:54:00	8	2,800	881	739	0.137	0.002	-0.266	0.015
1L -8	11:56:30	1	3,200	1,005	863	0.182		-0.402	
1L -8	11:57:30	2	3,200	1,005	863	0.187		-0.423	
1L -8	11:59:30	4	3,200	1,005	863	0.191		-0.452	
1L -8	12:03:30	8	3,200	1,005	863	0.197	0.005	-0.489	0.037
1L -9	12:06:30	1	3,600	1,128	987	0.251		-0.752	
1L -9	12:07:30	2	3,600	1,128	987	0.256		-0.797	
1L -9	12:09:30	4	3,600	1,128	987	0.262		-0.865	
1L -9	12:13:30	8	3,600	1,128	987	0.269	0.008	-0.956	0.091
1L -10	12:32:00	1	3,900	1,221	1,079	0.357		-4.284	
1L -10	12:33:00	2	3,900	1,221	1,079	0.355		-4.464	
1L -10	12:35:00	4	3,900	1,221	1,079	0.352		-4.751	
1L -10	12:39:00	8	3,900	1,221	1,079	0.366		-5.301	
1U - 1	12:43:00	1	3,200	1,005	863	0.353		-5.423	
1U - 1	12:44:00	2	3,200	1,005	863	0.353		-5.423	
1U - 1	12:45:00	3	3,200	1,005	863	0.352		-5.424	
1U - 1	12:46:00	4	3,200	1,005	863	0.353		-5.422	
1U - 2	12:48:00	1	2,400	757	616	0.332		-5.372	
1U - 2	12:49:00	2	2,400	757	616	0.331		-5.373	
1U - 2	12:50:00	3	2,400	757	616	0.332		-5.371	
1U - 2	12:51:00	4	2,400	757	616	0.332		-5.371	
1U - 3	12:53:00	1	1,600	510	368	0.304		-5.284	
1U - 3	12:54:00	2	1,600	510	368	0.303		-5.282	
1U - 3	12:55:00	3	1,600	510	368	0.303		-5.280	
1U - 3	12:56:00	4	1,600	510	368	0.303		-5.278	
1U - 4	13:00:00	1	800	262	121	0.261		-5.141	
1U - 4	13:01:00	2	800	262	121	0.261		-5.137	
1U - 4	13:02:00	3	800	262	121	0.260		-5.126	
1U - 4	13:03:00	4	800	262	121	0.259		-5.125	
1U - 5	13:12:00	1	0	0	0	0.177		-4.773	
1U - 5	13:13:00	2	0	0	0	0.176		-4.768	
1U - 5	13:15:00	4	0	0	0	0.176		-4.760	
1U - 5	13:19:00	8	0	0	0	0.175		-4.751	

Strain Gage Readings and Loads at Levels 1 and 2

Broadway Viaduct - Council Bluffs, IA - TS 4

Load Test Increment	Time (h:m:s)	Time After Start Minutes	O-cell Pressure (psi)	Applied Load (kips)	Level 1 1004812 με	Level 1 1004813 με	Level 1 1004814 με	Level 1 1004815 με	Level 1 Av. Load (kips)	Level 2 1004820 με	Level 2 1004821 με	Level 2 1004822 με	Level 2 Av. Load (kips)
1L -0	10:34:00	0	0	0	0	0	0	0	0	0	0	0	0
1L -1	10:51:30	1	400	139	0	2	3	-1	14	-4	1	9	24
1L -1	10:52:30	2	400	139	0	2	3	-1	14	-4	1	9	25
1L -1	10:54:30	4	400	139	0	2	3	-1	14	-4	1	9	25
1L -1	10:58:30	8	400	139	0	2	3	-1	14	-4	2	9	26
1L -2	11:00:30	1	800	262	1	4	5	-1	27	-7	3	16	49
1L -2	11:01:30	2	800	262	1	4	5	-1	27	-7	3	16	50
1L -2	11:03:30	4	800	262	1	4	5	-1	28	-7	3	16	49
1L -2	11:07:30	8	800	262	1	4	5	-1	28	-7	3	16	50
1L -3	11:09:00	1	1,200	386	4	8	9	1	68	-4	8	22	110
1L -3	11:10:00	2	1,200	386	4	8	10	1	69	-3	8	22	110
1L -3	11:12:00	4	1,200	386	4	8	10	1	69	-3	8	22	115
1L -3	11:16:00	8	1,200	386	4	8	10	0	70	-3	8	23	116
1L -4	11:19:00	1	1,600	510	9	15	17	4	139	3	16	33	217
1L -4	11:20:00	2	1,600	510	9	15	17	4	140	3	16	33	217
1L -4	11:22:00	4	1,600	510	9	15	17	4	140	3	16	33	218
1L -4	11:26:00	8	1,600	510	9	15	17	4	142	3	16	33	218
1L -5	11:28:00	1	2,000	634	12	19	24	6	195	7	22	41	293
1L -5	11:29:00	2	2,000	634	12	20	24	6	197	7	21	41	294
1L -5	11:31:00	4	2,000	634	13	20	24	6	197	7	22	41	295
1L -5	11:35:00	8	2,000	634	13	20	24	6	199	7	22	42	298
1L -6	11:37:00	1	2,400	757	17	26	32	10	266	13	28	50	380
1L -6	11:38:00	2	2,400	757	17	26	32	10	266	13	28	50	381
1L -6	11:40:00	4	2,400	757	18	26	32	10	268	13	28	50	384
1L -6	11:44:00	8	2,400	757	18	26	32	10	270	14	28	50	386
1L -7	11:47:00	1	2,800	881	22	31	38	13	329	19	34	57	463
1L -7	11:48:00	2	2,800	881	22	32	37	14	331	19	34	57	463
1L -7	11:50:00	4	2,800	881	23	32	38	14	333	20	34	57	466
1L -7	11:54:00	8	2,800	881	23	32	37	14	334	20	34	57	468
1L -8	11:56:30	1	3,200	1,005	28	37	43	17	394	26	40	65	551
1L -8	11:57:30	2	3,200	1,005	28	38	42	17	396	26	40	65	555
1L -8	11:59:30	4	3,200	1,005	28	38	42	17	395	27	41	65	558
1L -8	12:03:30	8	3,200	1,005	29	38	42	18	398	27	41	66	560
1L -9	12:06:30	1	3,600	1,128	33	43	47	21	453	34	47	72	642
1L -9	12:07:30	2	3,600	1,128	33	43	47	21	453	34	47	72	646
1L -9	12:09:30	4	3,600	1,128	34	43	47	21	457	35	47	73	650
1L -9	12:13:30	8	3,600	1,128	34	44	47	21	459	35	48	73	655
1L -10	12:32:00	1	3,900	1,221	52	65	66	35	688	45	51	80	739
1L -10	12:33:00	2	3,900	1,221	53	66	66	35	696	45	51	80	741
1L -10	12:35:00	4	3,900	1,221	54	66	67	35	701	46	50	80	736
1L -10	12:39:00	8	3,900	1,221	58	68	70	38	739	48	50	81	752
1U - 1	12:43:00	1	3,200	1,005	50	62	60	31	639	39	40	69	624
1U - 1	12:44:00	2	3,200	1,005	49	62	59	31	635	39	40	69	623
1U - 1	12:45:00	3	3,200	1,005	49	62	59	31	633	39	40	69	620
1U - 1	12:46:00	4	3,200	1,005	49	62	58	30	626	39	40	69	617
1U - 2	12:48:00	1	2,400	757	41	53	49	24	525	28	29	55	474
1U - 2	12:49:00	2	2,400	757	41	53	49	24	525	28	30	56	476
1U - 2	12:50:00	3	2,400	757	41	53	49	24	525	28	30	56	476
1U - 2	12:51:00	4	2,400	757	41	53	49	24	526	28	30	55	475
1U - 3	12:53:00	1	1,600	510	31	41	36	16	389	16	18	40	308
1U - 3	12:54:00	2	1,600	510	31	41	36	16	389	16	18	40	309
1U - 3	12:55:00	3	1,600	510	31	41	36	16	388	16	17	40	307
1U - 3	12:56:00	4	1,600	510	30	41	36	15	387	16	17	40	308
1U - 4	13:00:00	1	800	262	19	28	23	7	244	5	7	25	150
1U - 4	13:01:00	2	800	262	19	28	23	7	242	4	6	24	143
1U - 4	13:02:00	3	800	262	18	27	22	6	230	3	6	24	137
1U - 4	13:03:00	4	800	262	19	27	22	6	235	4	6	24	138
1U - 5	13:12:00	1	0	0	4	11	5	-3	54	-10	-7	5	-52
1U - 5	13:13:00	2	0	0	4	11	5	-3	52	-10	-7	5	-52
1U - 5	13:15:00	4	0	0	4	11	5	-3	51	-10	-7	4	-54
1U - 5	13:19:00	8	0	0	4	11	5	-3	52	-10	-7	4	-54

Strain Gage Readings and Loads at Levels 3 and 4

Broadway Viaduct - Council Bluffs, IA - TS 4

Load Test Increment	Time (h:m:s)	Time After Start Minutes	O-cell Pressure (psi)	Applied Load (kips)	Level 3: 1004826 με	Level 3: 1004827 με	Level 3: 1004828 με	Level 3: Av. Load (kips)	Level 4: 1004832 με	Level 4: 1004833 με	Level 4: 1004834 με	Level 4: Av. Load (kips)
1L -0	10:34:00	0	0	0	0	0	0	0	0	0	0	0
1L -1	10:51:30	1	400	139	-3	1	11	42	-1	1	5	26
1L -1	10:52:30	2	400	139	-3	1	11	42	-1	1	5	26
1L -1	10:54:30	4	400	139	-3	1	11	42	0	1	5	25
1L -1	10:58:30	8	400	139	-3	1	11	43	0	1	5	26
1L -2	11:00:30	1	800	262	-4	3	19	78	-1	2	8	43
1L -2	11:01:30	2	800	262	-4	3	20	79	0	2	8	46
1L -2	11:03:30	4	800	262	-4	3	19	79	-1	2	8	44
1L -2	11:07:30	8	800	262	-4	3	20	80	0	2	9	47
1L -3	11:09:00	1	1,200	386	0	8	25	142	2	6	13	95
1L -3	11:10:00	2	1,200	386	0	8	25	145	3	7	13	99
1L -3	11:12:00	4	1,200	386	0	8	25	148	3	7	13	102
1L -3	11:16:00	8	1,200	386	0	8	26	150	3	7	13	104
1L -4	11:19:00	1	1,600	510	7	17	35	256	9	14	21	199
1L -4	11:20:00	2	1,600	510	7	17	35	256	9	15	21	201
1L -4	11:22:00	4	1,600	510	7	17	36	258	9	15	21	203
1L -4	11:26:00	8	1,600	510	7	17	36	259	9	15	21	204
1L -5	11:28:00	1	2,000	634	11	23	43	335	14	20	27	271
1L -5	11:29:00	2	2,000	634	12	24	43	338	14	20	27	273
1L -5	11:31:00	4	2,000	634	12	24	43	340	14	20	27	275
1L -5	11:35:00	8	2,000	634	12	24	43	343	14	21	27	277
1L -6	11:37:00	1	2,400	757	17	31	51	426	18	26	33	348
1L -6	11:38:00	2	2,400	757	17	31	51	428	19	27	33	352
1L -6	11:40:00	4	2,400	757	17	31	51	432	19	27	34	355
1L -6	11:44:00	8	2,400	757	17	32	52	435	19	27	34	358
1L -7	11:47:00	1	2,800	881	21	38	59	511	23	32	39	423
1L -7	11:48:00	2	2,800	881	21	38	59	513	23	32	39	422
1L -7	11:50:00	4	2,800	881	21	38	59	517	23	32	40	425
1L -7	11:54:00	8	2,800	881	22	39	60	520	23	33	40	428
1L -8	11:56:30	1	3,200	1,005	26	45	68	605	27	38	46	497
1L -8	11:57:30	2	3,200	1,005	26	46	69	609	27	38	47	499
1L -8	11:59:30	4	3,200	1,005	26	46	69	612	27	38	47	501
1L -8	12:03:30	8	3,200	1,005	26	46	69	614	27	39	47	504
1L -9	12:06:30	1	3,600	1,128	30	53	77	695	30	44	53	568
1L -9	12:07:30	2	3,600	1,128	30	53	77	695	30	44	54	569
1L -9	12:09:30	4	3,600	1,128	30	54	78	700	30	44	54	572
1L -9	12:13:30	8	3,600	1,128	30	54	78	703	30	45	54	575
1L -10	12:32:00	1	3,900	1,221	32	62	85	781	30	52	60	635
1L -10	12:33:00	2	3,900	1,221	32	63	86	783	30	52	61	636
1L -10	12:35:00	4	3,900	1,221	32	63	85	779	29	52	61	634
1L -10	12:39:00	8	3,900	1,221	32	64	87	795	29	54	62	648
1U - 1	12:43:00	1	3,200	1,005	24	54	76	672	23	47	55	560
1U - 1	12:44:00	2	3,200	1,005	24	54	76	669	23	46	55	558
1U - 1	12:45:00	3	3,200	1,005	24	54	76	669	23	46	55	557
1U - 1	12:46:00	4	3,200	1,005	24	54	76	667	23	46	55	556
1U - 2	12:48:00	1	2,400	757	15	42	63	521	17	37	46	448
1U - 2	12:49:00	2	2,400	757	15	42	63	523	17	38	46	449
1U - 2	12:50:00	3	2,400	757	15	42	63	523	17	38	46	449
1U - 2	12:51:00	4	2,400	757	15	42	63	523	17	38	46	451
1U - 3	12:53:00	1	1,600	510	6	27	48	354	9	27	35	320
1U - 3	12:54:00	2	1,600	510	6	27	49	355	9	27	35	319
1U - 3	12:55:00	3	1,600	510	6	28	48	354	9	27	35	319
1U - 3	12:56:00	4	1,600	510	6	27	49	354	9	27	35	319
1U - 4	13:00:00	1	800	262	-3	14	35	200	3	15	25	192
1U - 4	13:01:00	2	800	262	-3	13	35	192	2	14	24	182
1U - 4	13:02:00	3	800	262	-3	12	35	188	2	14	24	181
1U - 4	13:03:00	4	800	262	-3	13	35	190	2	15	24	182
1U - 5	13:12:00	1	0	0	-14	-4	20	10	-6	0	12	27
1U - 5	13:13:00	2	0	0	-14	-4	20	10	-6	0	12	26
1U - 5	13:15:00	4	0	0	-14	-4	20	9	-6	0	12	26
1U - 5	13:19:00	8	0	0	-14	-4	20	9	-6	0	12	27

Strain Gage Readings and Loads at Levels 5 and 6

Broadway Viaduct - Council Bluffs, IA - TS 4

Load	Time	Time After	O-cell	Applied	Level 5				Level 6			
Test		Start	Pressure	Load	1004838	1004839	1004840	Av. Load	1004844	1004845	1004846	Av. Load
Increment	(h:m:s)	Minutes	(psi)	(kips)	με	με	με	(kips)	με	με	με	(kips)
1L -0	10:34:00	0	0	0	0	0	0	0	0	0	0	0
1L -1	10:51:30	1	400	139	1	1	1	10	0	0	0	4
1L -1	10:52:30	2	400	139	0	1	1	10	1	0	0	4
1L -1	10:54:30	4	400	139	1	1	1	10	1	1	0	6
1L -1	10:58:30	8	400	139	0	1	1	10	1	0	0	5
1L -2	11:00:30	1	800	262	1	1	2	18	1	1	0	8
1L -2	11:01:30	2	800	262	1	1	2	19	1	1	0	8
1L -2	11:03:30	4	800	262	1	1	2	19	1	1	0	9
1L -2	11:07:30	8	800	262	1	1	2	19	1	1	0	9
1L -3	11:09:00	1	1,200	386	3	4	4	49	2	2	1	29
1L -3	11:10:00	2	1,200	386	3	4	5	52	2	2	1	30
1L -3	11:12:00	4	1,200	386	3	4	5	54	2	3	2	32
1L -3	11:16:00	8	1,200	386	3	4	5	56	3	2	2	32
1L -4	11:19:00	1	1,600	510	8	10	10	128	6	6	5	81
1L -4	11:20:00	2	1,600	510	8	10	10	129	6	6	5	82
1L -4	11:22:00	4	1,600	510	8	10	11	131	6	6	5	83
1L -4	11:26:00	8	1,600	510	8	10	11	129	6	6	5	84
1L -5	11:28:00	1	2,000	634	12	14	14	180	9	9	7	120
1L -5	11:29:00	2	2,000	634	12	14	15	182	9	9	7	123
1L -5	11:31:00	4	2,000	634	12	14	15	183	9	9	7	123
1L -5	11:35:00	8	2,000	634	12	14	15	185	9	9	7	123
1L -6	11:37:00	1	2,400	757	16	19	18	237	12	12	10	161
1L -6	11:38:00	2	2,400	757	16	19	19	240	12	12	10	164
1L -6	11:40:00	4	2,400	757	16	19	19	241	12	12	10	164
1L -6	11:44:00	8	2,400	757	16	19	19	242	12	12	10	166
1L -7	11:47:00	1	2,800	881	19	23	22	286	14	15	11	195
1L -7	11:48:00	2	2,800	881	19	23	22	286	14	15	11	194
1L -7	11:50:00	4	2,800	881	19	23	22	288	15	15	11	195
1L -7	11:54:00	8	2,800	881	19	23	22	289	15	15	11	196
1L -8	11:56:30	1	3,200	1,005	22	27	26	333	16	17	12	221
1L -8	11:57:30	2	3,200	1,005	22	27	26	334	17	17	12	219
1L -8	11:59:30	4	3,200	1,005	22	27	26	336	17	17	12	220
1L -8	12:03:30	8	3,200	1,005	22	27	26	338	17	17	12	220
1L -9	12:06:30	1	3,600	1,128	24	30	29	375	18	19	13	242
1L -9	12:07:30	2	3,600	1,128	24	31	29	376	18	19	13	242
1L -9	12:09:30	4	3,600	1,128	24	31	29	378	18	18	13	239
1L -9	12:13:30	8	3,600	1,128	24	31	29	378	18	18	13	238
1L -10	12:32:00	1	3,900	1,221	24	35	32	409	19	20	13	252
1L -10	12:33:00	2	3,900	1,221	25	35	32	412	18	20	13	251
1L -10	12:35:00	4	3,900	1,221	24	35	32	409	18	20	13	251
1L -10	12:39:00	8	3,900	1,221	24	36	33	417	19	21	14	255
1U - 1	12:43:00	1	3,200	1,005	21	32	29	367	17	19	12	229
1U - 1	12:44:00	2	3,200	1,005	21	32	29	366	17	19	12	228
1U - 1	12:45:00	3	3,200	1,005	21	32	29	366	17	19	12	228
1U - 1	12:46:00	4	3,200	1,005	21	32	29	366	17	19	12	227
1U - 2	12:48:00	1	2,400	757	17	27	24	305	14	17	10	196
1U - 2	12:49:00	2	2,400	757	17	27	24	306	15	16	10	196
1U - 2	12:50:00	3	2,400	757	17	27	24	306	15	16	10	197
1U - 2	12:51:00	4	2,400	757	17	27	24	306	15	17	10	199
1U - 3	12:53:00	1	1,600	510	12	20	18	229	12	14	7	160
1U - 3	12:54:00	2	1,600	510	12	21	18	231	12	13	7	158
1U - 3	12:55:00	3	1,600	510	12	21	18	230	12	14	7	159
1U - 3	12:56:00	4	1,600	510	13	21	18	230	12	14	7	159
1U - 4	13:00:00	1	800	262	8	14	12	148	9	10	4	114
1U - 4	13:01:00	2	800	262	7	13	11	142	9	10	4	109
1U - 4	13:02:00	3	800	262	7	13	11	142	9	10	4	110
1U - 4	13:03:00	4	800	262	8	13	11	143	9	10	4	111
1U - 5	13:12:00	1	0	0	2	3	2	32	5	4	-1	37
1U - 5	13:13:00	2	0	0	2	3	2	32	5	4	-1	38
1U - 5	13:15:00	4	0	0	2	3	2	32	5	4	-1	38
1U - 5	13:19:00	8	0	0	2	3	2	32	5	4	-1	36

Strain Gage Readings and Loads at Level 7

Broadway Viaduct - Council Bluffs, IA - TS 4

Load Test Increment	Time 0 (h:m:s)	Time After Start Minutes	O-cell Pressure (psi)	Applied Load (kips)	Level 7 1004850 με	1004851 με	1004852 με	Av. Load (kips)
1L -0	10:34:00	0	0	0	0	0	0	0
1L -1	10:51:30	1	400	139	0	0	0	0
1L -1	10:52:30	2	400	139	0	0	0	1
1L -1	10:54:30	4	400	139	0	0	0	0
1L -1	10:58:30	8	400	139	0	0	0	-1
1L -2	11:00:30	1	800	262	0	0	0	1
1L -2	11:01:30	2	800	262	0	0	0	1
1L -2	11:03:30	4	800	262	0	0	0	1
1L -2	11:07:30	8	800	262	0	0	0	1
1L -3	11:09:00	1	1,200	386	1	0	0	7
1L -3	11:10:00	2	1,200	386	1	0	0	7
1L -3	11:12:00	4	1,200	386	1	0	0	7
1L -3	11:16:00	8	1,200	386	1	0	0	6
1L -4	11:19:00	1	1,600	510	2	1	1	21
1L -4	11:20:00	2	1,600	510	2	1	1	22
1L -4	11:22:00	4	1,600	510	2	1	1	22
1L -4	11:26:00	8	1,600	510	2	1	1	21
1L -5	11:28:00	1	2,000	634	3	1	2	33
1L -5	11:29:00	2	2,000	634	3	1	2	33
1L -5	11:31:00	4	2,000	634	3	1	2	34
1L -5	11:35:00	8	2,000	634	4	1	2	34
1L -6	11:37:00	1	2,400	757	5	2	3	48
1L -6	11:38:00	2	2,400	757	5	2	3	48
1L -6	11:40:00	4	2,400	757	5	2	3	48
1L -6	11:44:00	8	2,400	757	5	2	3	50
1L -7	11:47:00	1	2,800	881	6	3	3	61
1L -7	11:48:00	2	2,800	881	6	3	3	62
1L -7	11:50:00	4	2,800	881	6	3	3	62
1L -7	11:54:00	8	2,800	881	6	3	3	62
1L -8	11:56:30	1	3,200	1,005	7	4	3	71
1L -8	11:57:30	2	3,200	1,005	7	3	3	71
1L -8	11:59:30	4	3,200	1,005	7	3	4	71
1L -8	12:03:30	8	3,200	1,005	8	4	3	72
1L -9	12:06:30	1	3,600	1,128	8	3	4	78
1L -9	12:07:30	2	3,600	1,128	8	3	4	78
1L -9	12:09:30	4	3,600	1,128	8	3	4	77
1L -9	12:13:30	8	3,600	1,128	9	3	4	76
1L -10	12:32:00	1	3,900	1,221	8	3	3	74
1L -10	12:33:00	2	3,900	1,221	8	3	3	75
1L -10	12:35:00	4	3,900	1,221	8	3	3	74
1L -10	12:39:00	8	3,900	1,221	8	4	3	76
1U - 1	12:43:00	1	3,200	1,005	8	3	3	70
1U - 1	12:44:00	2	3,200	1,005	8	3	3	68
1U - 1	12:45:00	3	3,200	1,005	8	3	3	70
1U - 1	12:46:00	4	3,200	1,005	8	3	3	67
1U - 2	12:48:00	1	2,400	757	8	2	3	62
1U - 2	12:49:00	2	2,400	757	8	3	3	63
1U - 2	12:50:00	3	2,400	757	8	3	3	63
1U - 2	12:51:00	4	2,400	757	8	3	3	63
1U - 3	12:53:00	1	1,600	510	7	2	2	53
1U - 3	12:54:00	2	1,600	510	7	2	2	53
1U - 3	12:55:00	3	1,600	510	7	2	2	54
1U - 3	12:56:00	4	1,600	510	7	2	2	54
1U - 4	13:00:00	1	800	262	6	1	1	43
1U - 4	13:01:00	2	800	262	6	2	1	43
1U - 4	13:02:00	3	800	262	6	1	1	42
1U - 4	13:03:00	4	800	262	6	1	1	43
1U - 5	13:12:00	1	0	0	4	0	0	20
1U - 5	13:13:00	2	0	0	4	0	0	21
1U - 5	13:15:00	4	0	0	4	0	0	19
1U - 5	13:19:00	8	0	0	4	0	0	20

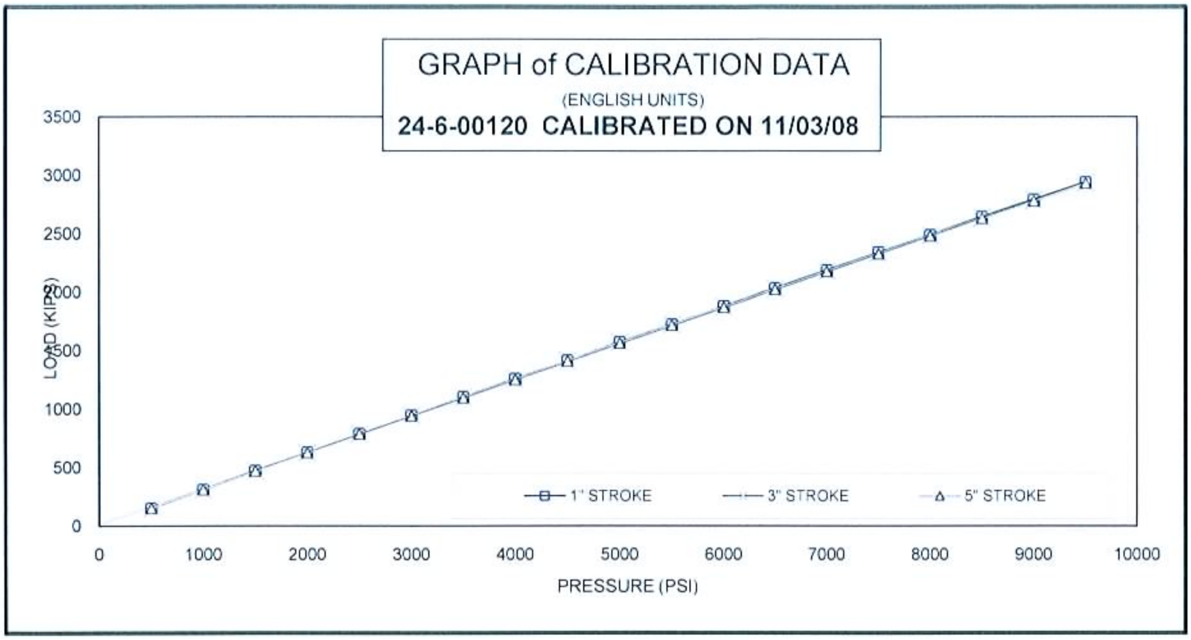
Earth Pressure Cells

Broadway Viaduct - Council Bluffs, IA - TS 4

Load Test Increment	Time 0 (h:m:s)	Time After Start Minutes	O-cell Pressure (psi)	Applied Load (kips)	NAT - EPC 1001598 (psi)	1001599 (psi)	1001600 (psi)	1001601 (psi)
1L -0	10:34:00	0	0	0	0	0	0	0
1L -1	10:51:30	1	400	139	0	1	0	0
1L -1	10:52:30	2	400	139	0	1	0	0
1L -1	10:54:30	4	400	139	0	1	0	0
1L -1	10:58:30	8	400	139	0	1	0	1
1L -2	11:00:30	1	800	262	0	1	0	1
1L -2	11:01:30	2	800	262	0	1	0	1
1L -2	11:03:30	4	800	262	0	1	0	1
1L -2	11:07:30	8	800	262	0	1	0	1
1L -3	11:09:00	1	1,200	386	0	1	0	2
1L -3	11:10:00	2	1,200	386	0	1	0	2
1L -3	11:12:00	4	1,200	386	0	1	0	2
1L -3	11:16:00	8	1,200	386	0	1	0	2
1L -4	11:19:00	1	1,600	510	1	2	1	5
1L -4	11:20:00	2	1,600	510	1	2	1	5
1L -4	11:22:00	4	1,600	510	1	3	1	5
1L -4	11:26:00	8	1,600	510	1	3	1	5
1L -5	11:28:00	1	2,000	634	2	4	1	11
1L -5	11:29:00	2	2,000	634	2	4	1	10
1L -5	11:31:00	4	2,000	634	2	4	1	10
1L -5	11:35:00	8	2,000	634	2	4	1	9
1L -6	11:37:00	1	2,400	757	5	7	2	16
1L -6	11:38:00	2	2,400	757	4	7	2	15
1L -6	11:40:00	4	2,400	757	4	7	2	14
1L -6	11:44:00	8	2,400	757	4	7	2	14
1L -7	11:47:00	1	2,800	881	7	10	2	20
1L -7	11:48:00	2	2,800	881	7	10	2	19
1L -7	11:50:00	4	2,800	881	7	10	2	19
1L -7	11:54:00	8	2,800	881	8	10	3	19
1L -8	11:56:30	1	3,200	1,005	12	14	3	26
1L -8	11:57:30	2	3,200	1,005	12	14	3	25
1L -8	11:59:30	4	3,200	1,005	12	14	4	25
1L -8	12:03:30	8	3,200	1,005	11	14	4	24
1L -9	12:06:30	1	3,600	1,128	16	18	5	34
1L -9	12:07:30	2	3,600	1,128	16	18	5	34
1L -9	12:09:30	4	3,600	1,128	16	19	5	35
1L -9	12:13:30	8	3,600	1,128	16	19	5	35
1L -10	12:32:00	1	3,900	1,221	38	107	27	108
1L -10	12:33:00	2	3,900	1,221	38	120	30	111
1L -10	12:35:00	4	3,900	1,221	37	109	27	107
1L -10	12:39:00	8	3,900	1,221	43	145	36	118
1U - 1	12:43:00	1	3,200	1,005	32	114	28	80
1U - 1	12:44:00	2	3,200	1,005	31	112	28	78
1U - 1	12:45:00	3	3,200	1,005	31	110	27	77
1U - 1	12:46:00	4	3,200	1,005	30	109	27	76
1U - 2	12:48:00	1	2,400	757	23	90	23	62
1U - 2	12:49:00	2	2,400	757	23	90	22	62
1U - 2	12:50:00	3	2,400	757	22	89	22	62
1U - 2	12:51:00	4	2,400	757	22	88	22	62
1U - 3	12:53:00	1	1,600	510	13	67	17	41
1U - 3	12:54:00	2	1,600	510	13	66	16	43
1U - 3	12:55:00	3	1,600	510	13	66	16	44
1U - 3	12:56:00	4	1,600	510	13	65	16	44
1U - 4	13:00:00	1	800	262	4	43	11	25
1U - 4	13:01:00	2	800	262	3	38	9	13
1U - 4	13:02:00	3	800	262	4	41	10	24
1U - 4	13:03:00	4	800	262	4	41	10	25
1U - 5	13:12:00	1	0	0	0	20	5	-2
1U - 5	13:13:00	2	0	0	0	20	5	0
1U - 5	13:15:00	4	0	0	0	20	5	1
1U - 5	13:19:00	8	0	0	0	20	5	2

APPENDIX B

O-CELL AND INSTRUMENTATION
CALIBRATION SHEETS



STROKE:	1 INCH	3 INCH	5 INCH
PRESSURE PSI	LOAD KIPS	LOAD KIPS	LOAD KIPS
0	0	0	0
500	155	155	155
1000	314	315	314
1500	474	475	474
2000	631	631	631
2500	792	792	790
3000	948	948	945
3500	1106	1105	1100
4000	1261	1261	1254
4500	1417	1417	1414
5000	1574	1575	1566
5500	1724	1725	1719
6000	1881	1877	1873
6500	2037	2033	2025
7000	2189	2184	2179
7500	2343	2338	2330
8000	2492	2489	2484
8500	2646	2641	2634
9000	2793	2790	2782
9500	2943	2941	2934

24" O-CELL, SERIAL # 24-6-00120

LOAD CONVERSION FORMULA

LOAD = PRESSURE * 0.3093 + (15.05)
{KIPS} {PSI}

Regression Output:

Constant	15.0471 kips
X Coefficient	0.3093 kip / psi
R Square	0.9999
No. of Observations	57
Degrees of Freedom	55
Std Err of Y Est	8.30
Std Err of X Coeff	0.0004

CALIBRATION STANDARDS:

All data presented are derived from 6" dia. certified hydraulic pressure gauges and electronic load transducer, manufactured and calibrated by the University of Illinois at Champaign, Illinois. All calibrations and certifications are traceable through the Laboratory Master Deadweight Gauges directly to the National Institute of Standards and Technology. No specific guidelines exist for calibration of load test jacks and equipment but procedures comply with similar guidelines for calibration of gages, ANSI specifications B40.1.

* AE & FC CUSTOMER: LOADTEST Inc	* CONTRACTOR.: LONGFELLOW DRILLING
* AE & FC JOB NO: SO5813	* JOB LOCATION: CLEARFIELD, IA
* CUSTOMER P.O. NO.: LT9640	* DATED: 03/23/10

SERVICE ENGINEER: DATE: 3-23-10

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Vibrating Wire Displacement Transducer Calibration Report

Range: 150 mm

Serial Number: 1004897

Calibration Date: February 25, 2010

Temperature: 24.2 °C

Calibration Instruction: CI-4400

Technician: KSRogers

GK-401 Reading Position B

Actual Displacement (mm)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Displacement (Linear)	Error Linear (%FS)	Calculated Displacement (Polynomial)	Error Polynomial (%FS)
0.0	2572	2570	2571	-0.28	-0.19	0.00	0.00
30.0	3530	3528	3529	30.05	0.03	29.99	0.00
60.0	4484	4483	4484	60.27	0.18	60.05	0.03
90.0	5429	5426	5428	90.15	0.10	89.93	-0.04
120.0	6375	6371	6373	120.09	0.06	120.03	0.02
150.0	7309	7309	7309	149.72	-0.19	149.99	0.00

(mm) Linear Gage Factor (G): 0.03166 (mm/ digit) **Regression Zero: 2580**

Polynomial Gage Factors: A: 9.19119E-08 B: 0.03075 C: -79.669

(inches) Linear Gage Factor (G): 0.001246 (inches/ digit)

Polynomial Gage Factors: A: 3.61858E-09 B: 0.001211 C: -3.1366

Calculated Displacement: **Linear, $D = G(R_1 - R_0)$**

Polynomial, $D = AR_1^2 + BR_1 + C$

Refer to manual for temperature correction information.

Function Test at Shipment:

GK-401 Pos. B : 5023 Temp(T_0): 23.2 °C Date: March 24, 2010

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Vibrating Wire Displacement Transducer Calibration Report

Range: 150 mm

Serial Number: 1004898

Calibration Date: February 25, 2010

Temperature: 24.2 °C

Calibration Instruction: CI-4400

Technician: KSRogers

GK-401 Reading Position B

Actual Displacement (mm)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Displacement (Linear)	Error Linear (%FS)	Calculated Displacement (Polynomial)	Error Polynomial (%FS)
0.0	2583	2578	2581	-0.36	-0.24	-0.06	-0.04
30.0	3551	3544	3548	30.14	0.09	30.08	0.05
60.0	4505	4504	4505	60.32	0.21	60.09	0.06
90.0	5451	5449	5450	90.14	0.09	89.91	-0.06
120.0	6395	6397	6396	119.97	-0.02	119.92	-0.05
150.0	7342	7340	7341	149.78	-0.15	150.07	0.04

(mm) Linear Gage Factor (G): 0.03154 (mm/ digit) **Regression Zero: 2592**

Polynomial Gage Factors: A: 9.58426E-08 B: 0.03059 C: -79.631

(inches) Linear Gage Factor (G): 0.001242 (inches/ digit)

Polynomial Gage Factors: A: 3.77333E-09 B: 0.001204 C: -3.1351

Calculated Displacement: **Linear, $D = G(R_1 - R_0)$**

Polynomial, $D = AR_1^2 + BR_1 + C$

Refer to manual for temperature correction information.

Function Test at Shipment:

GK-401 Pos. B : 4936 Temp(T_0): 23.1 °C Date: March 24, 2010

The above instrument was found to be in tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Vibrating Wire Displacement Transducer Calibration Report

Range: 150 mm

Calibration Date: June 30, 2003

Serial Number: 98-952 / 13845

Temperature: 24 °C

Cal. Std. Control Numbers: 373, 344, 529

Technician: KOB

GK-401 Reading Position B

Actual Displacement (mm)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Displacement (Linear)	Error Linear (%FS)	Calculated Displacement (Polynomial)	Error Polynomial (%FS)
0.0	2225	2225	2225	-0.348	-0.23	-0.052	-0.03
30.0	3506	3505	3506	30.15	0.10	30.09	0.06
60.0	4771	4769	4770	60.26	0.18	60.03	0.02
90.0	6025	6024	6025	90.14	0.09	89.91	-0.06
120.0	7281	7280	7281	120.1	0.04	120.0	0.00
150.0	8526	8527	8527	149.7	-0.18	150.0	0.02

(mm) Linear Gage Factor (G): 0.02382 (mm/ digit)

Regression Zero: 2240

Polynomial Gage Factors: A: 5.53644E-08 B: 0.02322 C: -51.993

(inches) Linear Gage Factor (G): 0.0009376 (inches/ digit)

Polynomial Gage Factors: A: 2.1797E-09 B: 0.0009142 C: -2.0469

Calculated Displacement:

Linear, $D = G(R_0 - R_1)$

Polynomial, $D = AR_1^2 + BR_1 + C$

Refer to manual for temperature correction information.

Function Test at Shipment:

GK-401 Pos. B : 5459

Temp(T_0): 23.3 °C

Date: July 07, 2003

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-:

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 9, 2010

Serial Number: 1004812

Cable Length: 93 ft.

Prestress: 35,000 psi

Factory Zero Reading: 7175

Temperature: 23.3 °C

Regression Zero: 7195

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7250	7247	7249		
1,500	7922	7923	7923	674	-0.14
3,000	8657	8657	8657	735	-0.05
4,500	9395	9391	9393	736	0.09
6,000	10124	10122	10123	730	0.04
100	7247				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.346 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Serial Number: 1004813

Prestress: 35,000 psi

Temperature: 21.5 °C

Calibration Instruction: CI-VW Rebar

Date of Calibration: March 9, 2010

Cable Length: 93 ft.

Factory Zero Reading: 6979

Regression Zero: 6994

Technician: Erice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7047	7050	7049		
1,500	7709	7713	7711	663	-0.19
3,000	8431	8437	8434	723	-0.18
4,500	9166	9164	9165	731	0.11
6,000	9887	9885	9886	721	0.06
100	7049				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.349 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 9, 2010

Serial Number: 1004814

Cable Length: 93 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6841

Temperature: 21.6 °C

Regression Zero: 6852

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6905	6905	6905		
1,500	7565	7565	7565	660	-0.12
3,000	8280	8279	8280	715	-0.19
4,500	9004	9004	9004	725	0.09
6,000	9720	9720	9720	716	0.07
100	6906				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.352 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Serial Number: 1004815

Prestress: 35,000 psi

Temperature: 21.7 °C

Calibration Instruction: CI-VW Rebar

Date of Calibration: March 9, 2010

Cable Length: 93 ft.

Factory Zero Reading: 7112

Regression Zero: 7118

Technician: Erica

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7171	7169	7170		
1,500	7833	7836	7835	665	-0.08
3,000	8550	8553	8552	717	-0.15
4,500	9276	9276	9276	725	0.05
6,000	9996	9995	9996	720	0.07
100	7169				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.351 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 9, 2010

Serial Number: 1004820

Cable Length: 85 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6989

Temperature: 21.8 °C

Regression Zero: 7004

Calibration Instruction: CI-VW Rebar

Technician: Erica

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7064	7066	7065		
1,500	7731	7731	7731	666	-0.36
3,000	8475	8476	8476	745	-0.13
4,500	9219	9218	9219	743	0.05
6,000	9957	9963	9960	742	0.18
100	7065				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.344 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Serial Number: 1004821

Prestress: 35,000 psi

Temperature: 21.6 °C

Calibration Instruction: CI-VW Rebar

Date of Calibration: March 9, 2010

Cable Length: 85 ft.

Factory Zero Reading: 7087

Regression Zero: 7101

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7154	7156	7155		
1,500	7816	7819	7818	663	-0.12
3,000	8534	8536	8535	718	-0.20
4,500	9266	9269	9268	733	0.23
6,000	9983	9980	9982	714	0.02
100	7156				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.350 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent
The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 9, 2010

Serial Number: 1004822

Cable Length: 85 ft.

Prestress: 35,000 psi

Factory Zero Reading: 7125

Temperature: 21.8 °C

Regression Zero: 7131

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7193	7190	7192		
1,500	7832	7834	7833	642	-0.34
3,000	8544	8546	8545	712	-0.33
4,500	9267	9268	9268	723	0.05
6,000	9984	9985	9985	717	0.24
100	7192				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.353 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent
The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 9, 2010

Serial Number: 1004826

Cable Length: 70 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6872

Temperature: 22.5 °C

Regression Zero: 6887

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6943	6939	6941		
1,500	7602	7600	7601	660	-0.12
3,000	8317	8318	8318	717	-0.16
4,500	9038	9037	9038	720	-0.08
6,000	9764	9761	9763	725	0.18
100	6940				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.351 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004827

Cable Length: 70 ft.

Prestress: 35,000 psi

Factory Zero Reading: 7083

Temperature: 22.3 °C

Regression Zero: 7111

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7168	7170	7169		
1,500	7835	7836	7836	667	-0.27
3,000	8571	8570	8571	735	-0.18
4,500	9311	9310	9311	740	0.08
6,000	10044	10044	10044	734	0.12
100	7170				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.346 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004828

Cable Length: 70 ft.

Prestress: 35,000 psi

Factory Zero Reading: 7062

Temperature: 22.2 °C

Regression Zero: 7083

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7130	7133	7132		
1,500	7798	7798	7798	667	-0.12
3,000	8528	8522	8525	727	0.19
4,500	9239	9240	9240	715	0.05
6,000	9955	9954	9955	715	-0.06
100	7132				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.351 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004832

Cable Length: 60 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6987

Temperature: 22.2 °C

Regression Zero: 6994

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7055	7053	7054		
1,500	7710	7712	7711	657	-0.24
3,000	8432	8431	8432	721	-0.37
4,500	9170	9170	9170	739	0.13
6,000	9895	9897	9896	726	0.20
100	7053				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.349 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004833

Cable Length: 60 ft.

Prestress: 35,000 psi

Factory Zero Reading: 7059

Temperature: 22.5 °C

Regression Zero: 7110

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7163	7168	7166		
1,500	7814	7814	7814	649	-0.29
3,000	8532	8532	8532	718	-0.10
4,500	9245	9251	9248	716	0.03
6,000	9961	9964	9963	715	0.11
100	7167				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.353 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004834

Cable Length: 60 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6909

Temperature: 22.2 °C

Regression Zero: 6931

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6984	6986	6985		
1,500	7652	7652	7652	667	-0.11
3,000	8376	8376	8376	724	-0.11
4,500	9106	9103	9105	729	0.05
6,000	9832	9829	9831	726	0.11
100	6985				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.349 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004838

Cable Length: 50 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6908

Temperature: 22.4 °C

Regression Zero: 6924

Calibration Instruction: CI-VW Rebar

Technician: Erica

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6983	6980	6982		
1,500	7647	7642	7645	663	-0.31
3,000	8380	8377	8379	734	-0.16
4,500	9115	9114	9115	736	0.07
6,000	9847	9843	9845	731	0.10
100	6980				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.347 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004839

Cable Length: 50 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6906

Temperature: 22.2 °C

Regression Zero: 6916

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6972	6974	6973		
1,500	7632	7635	7634	661	-0.31
3,000	8367	8370	8369	735	-0.02
4,500	9092	9098	9095	727	-0.02
6,000	9826	9826	9826	731	0.14
100	6974				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.348 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Serial Number: 1004840

Prestress: 35,000 psi

Temperature: 22.1 °C

Calibration Instruction: CI-VW Rebar

Date of Calibration: March 10, 2010

Cable Length: 50 ft.

Factory Zero Reading: 6944

Regression Zero: 6965

Technician: Erica

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7025	7021	7023		
1,500	7684	7680	7682	659	-0.20
3,000	8402	8402	8402	720	-0.30
4,500	9135	9136	9136	734	0.06
6,000	9864	9860	9862	727	0.19
100	7021				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.349 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004844

Cable Length: 40 ft.

Prestress: 35,000 psi

Factory Zero Reading: 7022

Temperature: 22.4 °C

Regression Zero: 7043

Calibration Instruction: CI-VW Rebar

Technician: Elice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7096	7097	7097		
1,500	7760	7760	7760	664	-0.18
3,000	8486	8485	8486	726	-0.07
4,500	9213	9212	9213	727	0.10
6,000	9933	9933	9933	721	0.04
100	7096				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.350 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004845

Cable Length: 40 ft.

Prestress: 35,000 psi

Factory Zero Reading: 7078

Temperature: 22.1 °C

Regression Zero: 7097

Calibration Instruction: CI-VW Rebar

Technician: Erica

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7149	7149	7149		
1,500	7805	7807	7806	657	-0.14
3,000	8523	8522	8523	717	-0.01
4,500	9236	9235	9236	713	-0.01
6,000	9952	9950	9951	716	0.09
100	7149				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.353 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004846

Cable Length: 40 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6970

Temperature: 22.4 °C

Regression Zero: 6970

Calibration Instruction: CI-VW Rebar

Technician: ERice

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7027	7024	7026		
1,500	7695	7687	7691	666	-0.18
3,000	8418	8416	8417	726	-0.19
4,500	9149	9146	9148	731	-0.04
6,000	9881	9878	9880	732	0.16
100	7024				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.348 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

<u>Users are advised to establish their own zero conditions.</u>

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004850

Cable Length: 30 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6793

Temperature: 23.2 °C

Regression Zero: 6812

Calibration Instruction: CI-VW Rebar

Technician: Erica

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6869	6869	6869		
1,500	7538	7535	7537	668	-0.19
3,000	8267	8264	8266	729	-0.22
4,500	9005	9002	9004	738	0.06
6,000	9736	9736	9736	733	0.15
100	6869				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.347 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004851

Cable Length: 30 ft.

Prestress: 35,000 psi

Factory Zero Reading: 7055

Temperature: 22.9 °C

Regression Zero: 7068

Calibration Instruction: CI-VW Rebar

Technician: [signature]

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	7119	7123	7121		
1,500	7788	7790	7789	668	-0.18
3,000	8519	8518	8519	730	-0.07
4,500	9250	9250	9250	732	0.10
6,000	9973	9974	9974	724	0.01
100	7123				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.348 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

Users are advised to establish their own zero conditions.

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Sister Bar Calibration Report

Model Number : 4911-4

Date of Calibration: March 10, 2010

Serial Number: 1004852

Cable Length: 30 ft.

Prestress: 35,000 psi

Factory Zero Reading: 6861

Temperature: 22.9 °C

Regression Zero: 6884

Calibration Instruction: CI-VW Rebar

Technician: Erica

Applied Load: (pounds)	Readings				Linearity % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6943	6941	6942		
1,500	7608	7609	7609	667	-0.21
3,000	8339	8340	8340	731	-0.21
4,500	9079	9079	9079	740	0.09
6,000	9809	9814	9812	733	0.15
100	6941				

For conversion factor, load to strain, refer to table C-2 of the Installation Manual.

Gage Factor: 0.347 microstrain/ digit (GK-401 Pos."B")

Calculated Strain = Gage Factor(Current Reading - Zero Reading)

Note: The above calibration uses the linear regression method.

<u>Users are advised to establish their own zero conditions.</u>

Linearity: ((Calculated Load-Applied Load)/ Max.Applied Load) X 100 percent

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Vibrating Wire Pressure Transducer Calibration Report

Type: NAT

Serial Number: 1001598

Pressure Range: 7.5 MPa

Date of Calibration: January 29, 2010

Temperature: 23.4 °C

†Barometric Pressure: 994.9 mbar

Calibration Instruction: VW Pressure Transducers

Technician: ERice

Applied Pressure (MPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8613	8612	8613	0.016	0.21	-0.003	-0.04
1.5	7750	7751	7751	1.500	0.00	1.504	0.06
3.0	6888	6888	6888	2.985	-0.20	2.999	-0.01
4.5	6018	6016	6017	4.485	-0.20	4.498	-0.03
6.0	5141	5140	5141	5.994	-0.08	5.997	-0.04
7.5	4255	4255	4255	7.519	0.25	7.501	0.02

(MPa) Linear Gage Factor (G): 0.001722 (MPa/ digit) **Regression Zero: 8622**

Polynomial Gage Factors: A: -7.030E-09 B: -0.001631 C: 14.570

Thermal Factor (K): 0.001048 (MPa/ °C)

(psi) Linear Gage Factor (G): 0.2496 (psi/ digit)

Polynomial Gage Factors: A: -1.01877E-06 B: -0.2364 C: 2111.7

Thermal Factor (K): 0.1519 (psi/ °C)

Calculated Pressures:

Linear, $P = G(R_0 - R_1)+K(T_1 - T_0)-(S_1 - S_0)$**

Polynomial, $P = AR_1^2 + BR_1 + C +K(T_1 - T_0)-(S_1 - S_0)$**

†Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos. B or F(R_0): 8628 Temp(T_0): 20.0 °C †Baro(S_0): 1011.7 mbar Date: April 14, 2010

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Vibrating Wire Pressure Transducer Calibration Report

Type: NAT

Serial Number: 1001599

Pressure Range: 7.5 MPa

Date of Calibration: January 29, 2010

Temperature: 23.4 °C

†Barometric Pressure: 994.9 mbar

Calibration Instruction: VW Pressure Transducers

Technician: ERice

Applied Pressure (MPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8689	8689	8689	0.016	0.21	-0.002	-0.03
1.5	7824	7825	7825	1.501	0.01	1.505	0.07
3.0	6960	6960	6960	2.985	-0.20	3.000	0.00
4.5	6088	6087	6088	4.484	-0.22	4.497	-0.03
6.0	5208	5207	5208	5.995	-0.07	5.998	-0.03
7.5	4320	4320	4320	7.519	0.26	7.501	0.02

(MPa) Linear Gage Factor (G): **0.001717** **(MPa/ digit)** **Regression Zero:** **8698**

Polynomial Gage Factors: **A: -7.115E-09** **B: -0.001625** **C: 14.653**

Thermal Factor (K): **0.001921** **(MPa/ °C)**

(psi) Linear Gage Factor (G): **0.2489** **(psi/ digit)**

Polynomial Gage Factors: **A: -1.03111E-06** **B: -0.2355** **C: 2123.7**

Thermal Factor (K): **0.2784** **(psi/ °C)**

Calculated Pressures: **Linear, $P = G(R_0 - R_1)+K(T_1 - T_0)-(S_1 - S_0)$****

Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0)-(S_1 - S_0)$**

†Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos. B or F(R_0): 8706 Temp(T_0): 20.0 °C †Baro(S_0): 1011.7 mbar Date: April 14, 2010

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Vibrating Wire Pressure Transducer Calibration Report

Type: NAT

Serial Number: 1001600

Pressure Range: 7.5 MPa

Date of Calibration: January 29, 2010

Temperature: 23.4 °C

†Barometric Pressure: 994.9 mbar

Calibration Instruction: VW Pressure Transducers

Technician: ERice

Applied Pressure (MPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8733	8733	8733	0.007	0.09	-0.002	-0.02
1.5	7866	7866	7866	1.502	0.02	1.503	0.05
3.0	7003	7001	7002	2.992	-0.11	2.997	-0.04
4.5	6132	6131	6132	4.493	-0.09	4.499	-0.01
6.0	5260	5259	5260	5.997	-0.04	5.998	-0.03
7.5	4383	4383	4383	7.509	0.12	7.501	0.01

(MPa) Linear Gage Factor (G): 0.001725 (MPa/ digit) **Regression Zero: 8737**

Polynomial Gage Factors: A: -3.236E-09 B: -0.001682 C: 14.936

Thermal Factor (K): 0.001929 (MPa/ °C)

(psi) Linear Gage Factor (G): 0.2500 (psi/ digit)

Polynomial Gage Factors: A: -4.68971E-07 B: -0.2438 C: 2164.7

Thermal Factor (K): 0.2795 (psi/ °C)

Calculated Pressures:

Linear, $P = G(R_0 - R_1)+K(T_1 - T_0)-(S_1 - S_0)$**

Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0)-(S_1 - S_0)$**

†Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos. B or F(R_0): 8750 Temp(T_0): 20.2 °C †Baro(S_0): 1011.7 mbar Date: April 14, 2010

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Vibrating Wire Pressure Transducer Calibration Report

Type: NAT

Serial Number: 1001601

Pressure Range: 7.5 MPa

Date of Calibration: January 29, 2010

Temperature: 23.4 °C

†Barometric Pressure: 994.9 mbar

Calibration Instruction: VW Pressure Transducers

Technician: ERice

Applied Pressure (MPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8893	8892	8893	0.015	0.21	-0.003	-0.04
1.5	8036	8036	8036	1.500	0.00	1.503	0.05
3.0	7179	7179	7179	2.986	-0.19	3.000	-0.01
4.5	6314	6314	6314	4.485	-0.20	4.499	-0.01
6.0	5443	5443	5443	5.995	-0.07	5.999	-0.02
7.5	4564	4564	4564	7.518	0.25	7.501	0.02

(MPa) Linear Gage Factor (G): 0.001733 (MPa/ digit) **Regression Zero: 8901**

Polynomial Gage Factors: A: -6.964E-09 B: -0.001640 C: 15.130

Thermal Factor (K): 0.001585 (MPa/ °C)

(psi) Linear Gage Factor (G): 0.2512 (psi/ digit)

Polynomial Gage Factors: A: -1.00933E-06 B: -0.2376 C: 2192.7

Thermal Factor (K): 0.2297 (psi/ °C)

Calculated Pressures: **Linear, $P = G(R_0 - R_1)+K(T_1 - T_0)-(S_1 - S_0)$****

Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0)-(S_1 - S_0)$**

†Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos. B or $F(R_0)$: 8907 Temp(T_0): 20.4 °C †Baro(S_0): 1011.7 mbar Date: April 14, 2010

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

APPENDIX C

CONSTRUCTION OF THE EQUIVALENT TOP-LOADED LOAD-SETTLEMENT CURVE

CONSTRUCTION OF THE LOADTEST TOP LOAD PLOT FROM THE RESULTS OF AN O-CELL TEST (March, 2009)

Introduction: The specific advantage of the O-cell load test method is that it separates load displacement responses into multiple zones. End bearing and side shear are separated in many cases. Some engineers find it useful to see the results of an O-cell load test in the more traditional form of a plot showing the load versus displacement of a shaft loaded from the top. Simplified and advanced methods of constructing the top load displacement for this test shaft are described below.

Assumptions: We make the following assumptions, which we consider both reasonable and usually conservative:

1. The upward and downward load displacement plots generated by the O-cell test accurately represent the load bearing capacity for the given shaft installation technique and dimensions, and are similar to load displacement plots which would be generated by a traditional compression or tension load test. For upward O-cell loading, the net load is used to compute the load displacement plot for a given zone (subtract buoyant weight of the given shaft zone above the O-cell).

2. The load displacement plot in a top loaded shaft has the same net shear multiplied by an adjustment factor 'F', for a given downward displacement as occurred in the O-cell test for that same displacement at the top of the O-cell in the upward direction. Unless noted otherwise, we use the following adjustment factors: (a) F = 1.00 in all rock sockets and for primarily cohesive soils in compression (b) F = 0.95 in primarily cohesionless soils (c) F = 0.80 for all soils in top load tension tests.

Advanced Method: Using the advantages of the O-cell load test method to full benefit, a more exact solution of the calculated top load displacement plot can be derived using the t-z method (see references below). The shaft is sub-divided into a number of distinct zones, based on data collected from the embedded strain gauges and load displacement plots. The input for the t-z analysis is the unit shear and end bearing plots presented in Figures 5, 6 & 7 of the Data Report.

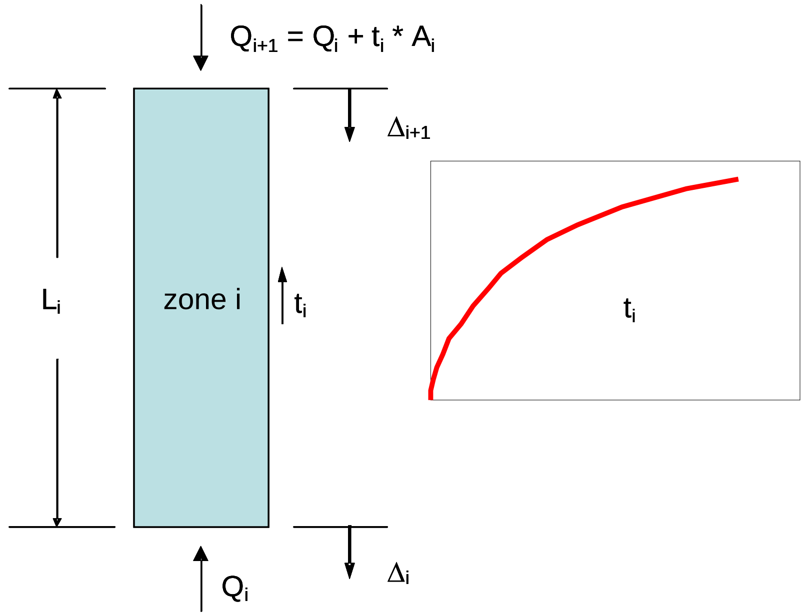


Figure C- 1

Figure C-1 above illustrates a sample shaft segment zone. The zone has an associated unit shear capacity plot t_i (which is a non-linear function of displacement), shaft dimensions and properties L_i and AE_i, computed elastic compression δ_i, and computed loads and displacements at the top and bottom of the zone, Δ_i, Q_i and Δ_{i+1}, Q_{i+1}, respectively. For each zone i, the following three equations are solved in an iterative fashion until the output displacement and load Δ_{i+1} and Q_{i+1} match the input.

$$\text{I)}\quad \delta_i = \frac{(Q_i + Q_{i+1})}{2} \cdot \frac{L_i}{AE_i} \qquad \text{II)}\quad \Delta_{i+1} = \Delta_i + \delta_i \qquad \text{III)}\quad Q_{i+1} = Q_i + t\left(\frac{\Delta_i + \Delta_{i+1}}{2}\right) \cdot A_i$$

The next zone i+1 is then analyzed, until the load transfer mechanism of the full shaft length is modeled. Additionally, there is an end-bearing capacity plot q which must also be considered.

Extrapolation: The TZ curves above the O-cell that are used to generate the LOADTEST top load plot contain an extrapolation. This was done to extend the plot given that the lower shear and end bearing displaced more than the upper shear during the test.

Limitations: The engineer using these results should judge the conservatism, or lack thereof, of the aforementioned assumptions and extrapolation(s) before utilizing the results for design purposes. For example, brittle failure behavior may produce displacement plots with abrupt changes in curvature (not hyperbolic). The presentation of the *Estimated Top Load Plot* in this report is meant to simulate a load test where load is applied from the top for this test shaft only.

References:

Lee, Jong-Sub and Park, Yung-Ho "Equivalent Shaft Load-Head Settlement Curve Using a Bi-Directional Shaft Load Test", *Computers and Geotechnics*, Volume 35, Issue 2, March 2008, Pages 124-133.

Meyer, P. L., Holmquist, D. V. and Matlock, H. "Computer predictions for axially-loaded Shafts with Non-linear Supports", *Proceedings of the 7th Offshore Technology Conference*, Paper No. 2186, Houston, Texas 1975.

APPENDIX D

O-CELL METHOD FOR DETERMINING CREEP LIMIT LOADING

O-CELL METHOD FOR DETERMINING A CREEP LIMIT LOADING ON THE EQUIVALENT TOP-LOADED SHAFT (April, 2000)

<u>Background</u>: O-cell testing provides a sometimes useful method for evaluating that load beyond which a top-loaded drilled shaft might experience significant unwanted creep behavior. We refer to this load as the "creep limit," also sometimes known as the "yield limit" or "yield load".

To our knowledge, Housel (1959) first proposed the method described below for determining the creep limit. Stoll (1961), Bourges and Levillian (1988), and Fellenius (1996) provide additional references. This method also follows from long experience with the pressuremeter test (PMT). Figure 8 and section 9.4 from ASTM D4719-94, reproduced below, show and describe the creep curve routinely determined from the PMT. The creep curve shows how the movement or strain obtained over a fixed time interval, 30 to 60 seconds, changes versus the applied pressure. One can often detect a distinct break in the curve at the pressure P_e in Figure 8. Plastic deformations may become significant beyond this break loading and progressively more severe creep can occur.

<u>Definition</u>: Similarly with O-cell testing using the ASTM Quick Method, one can conveniently measure the additional movement occurring over the final time interval at each constant load step, typically 2 to 4 minutes. A break in the curve of load vs. movement (as at P_e with the PMT) indicates the creep limit.

We usually indicate such a creep limit in the O-cell test for either one, or both, of the side shear and end bearing components, and herein designate the corresponding movements as M_{CL1} and M_{CL2}. We then combine the creep limit data to predict a creep limit load for the equivalent top loaded shaft.

<u>Procedure if both M_{CL1} and M_{CL2} available</u>: Creep cannot begin until the shaft movement exceeds the M_{CL} values. A conservative approach would assume that creep begins when movements exceed the lesser of the M_{CL} values. However, creep can occur freely only when the shaft has moved the greater of the two M_{CL} values. Although less conservative, we believe the latter to match behavior better and therefore set the creep limit as that load on the equivalent top-loaded movement curve that matches the greater M_{CL}.

<u>Procedure if only M_{CL1} available</u>: If we cannot determine a creep limit in the second component before it reaches its maximum movement M_x, we treat M_x as M_{CL2}. From the above method one can say that the creep limit load exceeds, by some unknown amount, that obtained when using $M_{CL2} = M_x$.

<u>Procedure if no creep limit observed</u>: Then, according to the above, the creep limit for the equivalent top-loaded shaft will exceed, again by some unknown amount, that load on the equivalent curve that matches the movement of the component with the maximum movement.

<u>Limitations</u>: The accuracy in estimating creep limits depends, in part, on the scatter of the data in the creep limit plots. The more scatter, the more difficult to define a limit. The user should make his or her own interpretation if he or she intends to make important use of the creep limit interpretations. Sometimes we obtain excessive scatter of the data and do not attempt an interpretation for a creep limit and will indicate this in the report.

Excerpts from ASTM D4719
"Standard Test Method for Pressuremeter Testing in Soils"

9.4 For Procedure A, plot the volume increase readings (V_{60}) between the 30 s and 60 s reading on a separate graph. Generally, a part of the same graph is used, see Fig. 8. For Procedure B, plot the pressure decrease reading between the 30 s and 60 s reading on a separate graph. The test curve shows an almost straight line section within the range of either low volume increase readings (V_{60}) for Procedure A or low pressure decrease for Procedure B. In this range, a constant soil deformation modulus can be measured. Past the so-called creep pressure, plastic deformations become prevalent.

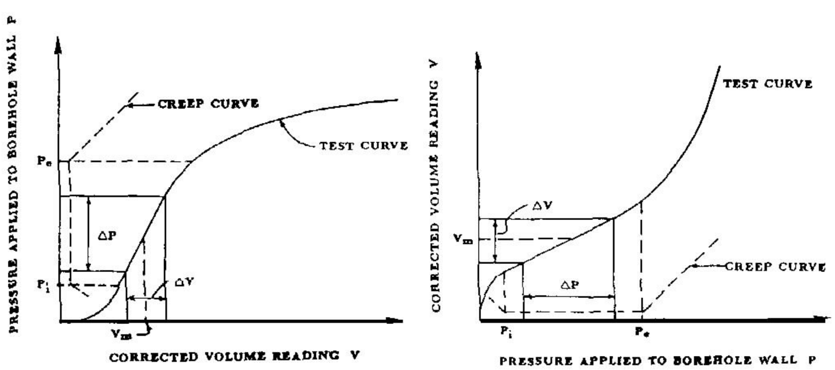


FIG. 8 Pressuremeter Test Curves for Procedure A

<u>References</u>

Housel, W.S. (1959), "Dynamic & Static Resistance of Cohesive Soils", <u>ASTM STP 254</u>, pp. 22-23.

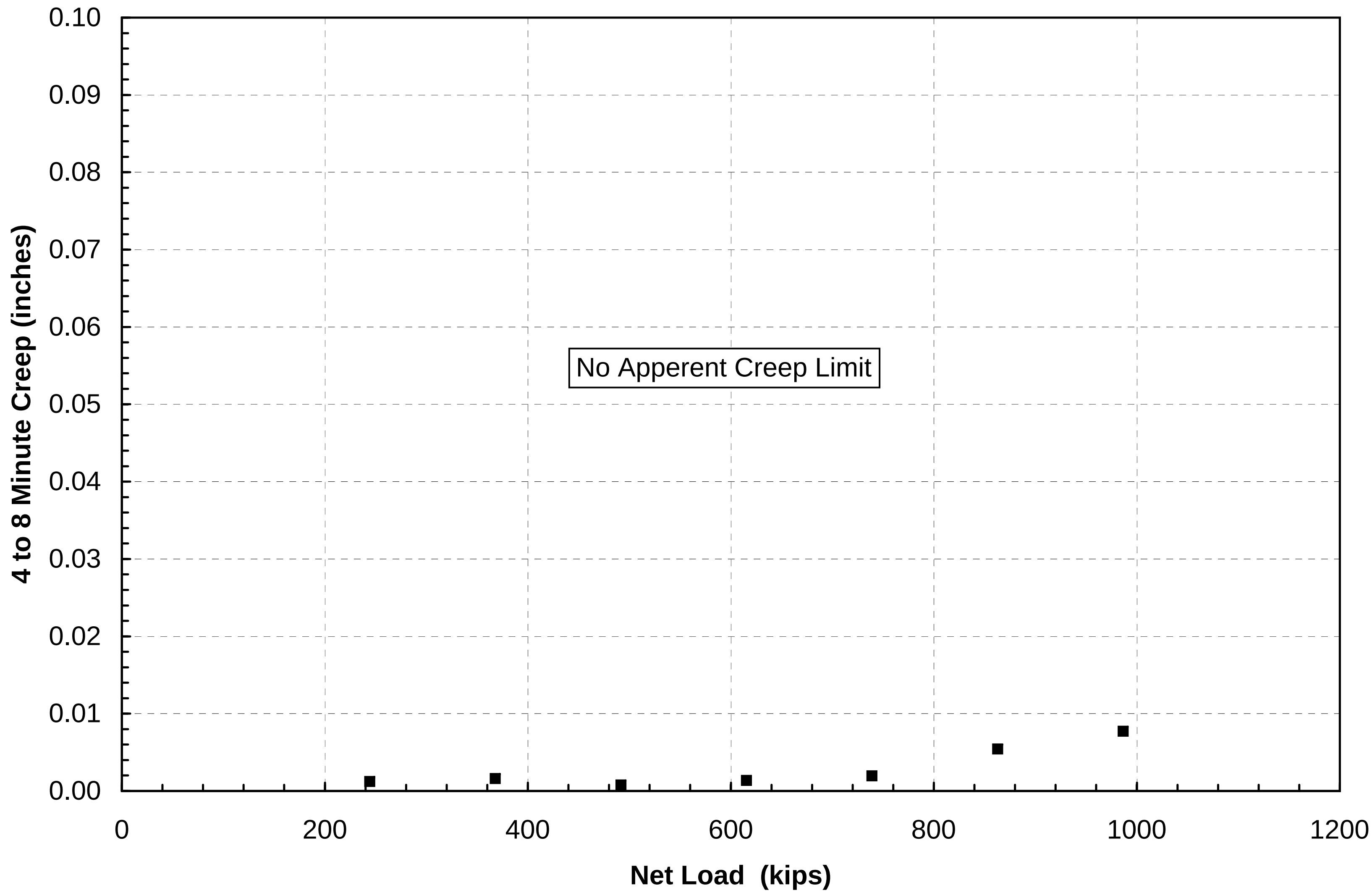
Stoll, M.U.W. (1961, Discussion, Proc. 5th ICSMFE, Paris, Vol. III, pp. 279-281.

Bourges, F. and Levillian, J-P (1988), "force portante des rideaux plans metalliques charges verticalmement," Bull. <u>No. 158</u>, Nov.-Dec., des laboratoires des ponts et chaussees, p. 24.

Fellenius, Bengt H. (1996), <u>Basics of Foundation Design</u>, BiTech Publishers Ltd., p.79.

Side Shear Creep Limit

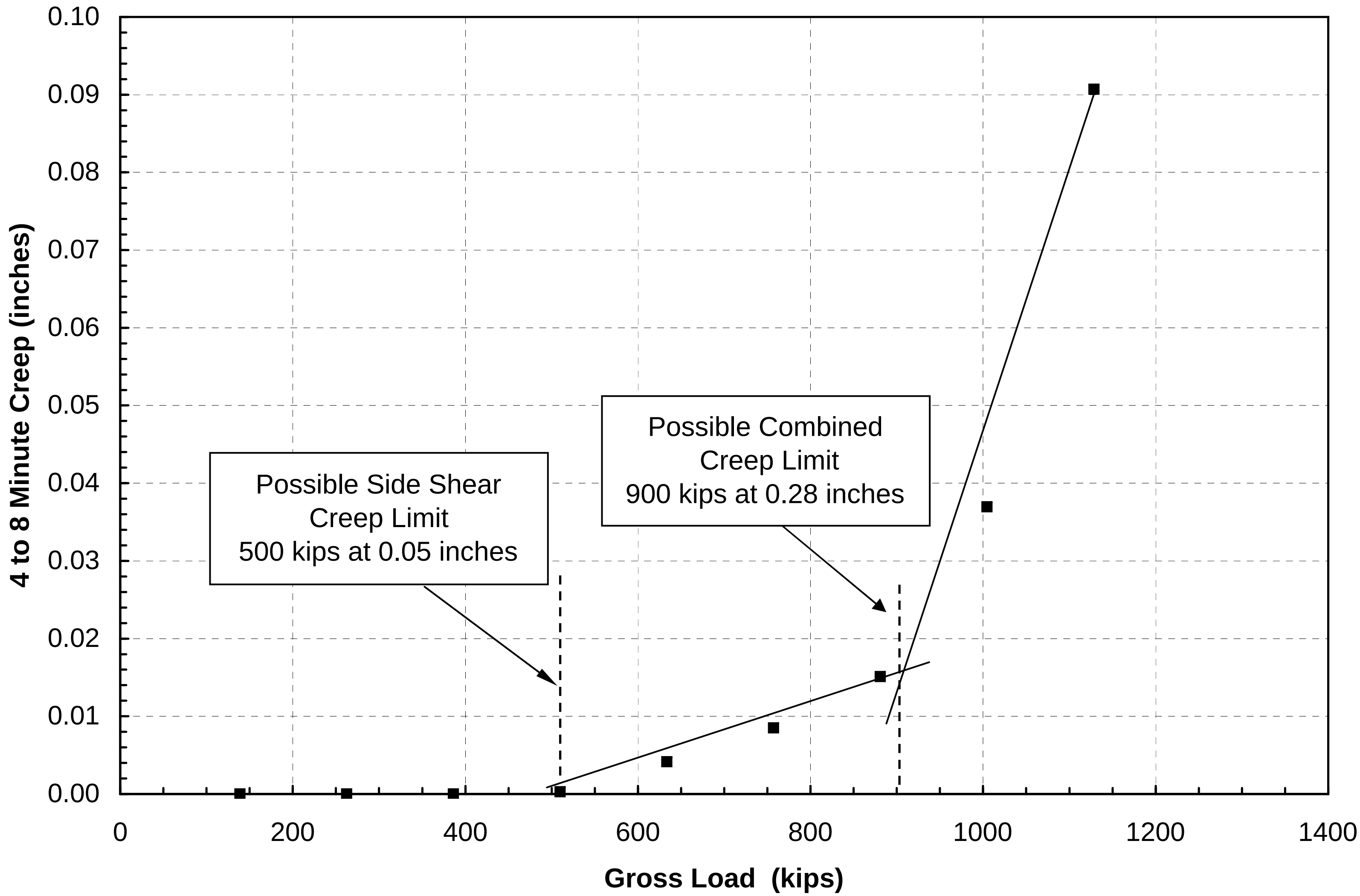
Broadway Viaduct - Council Bluffs, IA - TS 4



LOADTEST, Inc. Project No. 9640-1

Base Creep Limit

Broadway Viaduct - Council Bluffs, IA - TS 4



APPENDIX E

SOIL BORING LOG

LOG OF BORING NO. TS-4

CLIENT: Longfellow Drilling Inc.	
SITE: Council Bluffs, IA	PROJECT: Broadway Viaduct

GRAPHIC LOG (depth, ft)	DESCRIPTION
0–10	**(FILL)LEAN CLAY** with sand, trace root hairs Grayish brown
10–18.5	**FINE SAND** with silt Brown, loose
18.5–23.5	**SILTY CLAY** ∇ Grayish brown, medium stiff
23.5–	**FINE SAND** Brown, loose Medium dense below about 28.5 feet Dense at about 38.5 feet Loose at about 43.5 feet Medium dense at about 48.5 feet Dense at about 53.5 feet

Continued Next Page

DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
			HS					
5		1	SS	13	7			
			HS					
10		2	SS	10	7			
			HS					
15	SP	3	SS	14	5			
			HS					
20	CL	4	SS	18	5			
			HS					
25	SP	5	SS	20	4			
			HS					
30	SP	6	SS	10	11			
			HS					
35	SP	7	SS	18	10			
40	SP	8	HS SS	20	36	/2		
			HS					
45	SP	9	SS	15	6			
			HS					
50	SP	10	SS	15	14			
			HS					
55	SP	11	SS	18	38			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	∇ 20	WD	▼
WL	▼		∇
WL			

Terracon

BORING STARTED	3-26-10		
BORING COMPLETED	3-26-10		
RIG	96	FOREMAN	JM
APPROVED	DAM	JOB #	05105037

LOG OF BORING NO. TS-4

CLIENT	
Longfellow Drilling Inc.	
SITE: Council Bluffs, IA	PROJECT: Broadway Viaduct

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	FINE TO COARSE SAND with silt and gray lean clay Brown, medium dense				HS					
		60	SP	12	SS	18	10			
					HS					
	Trace gray fat clay layer, trace gravel at about 63.5 feet	65	SP	13	SS	18	19			
					HS					
	Trace lignite, trace sandy clay, trace gravel below about 68.5 feet	70	SP	14	SS	18	8			
					HS					
		75	SP	15	SS	14	11			
					HS					
		80	SP	16	SS	18	15			
					HS					
		85	SP	17	SS	15	14			
					HS					
	90	90	SP	18	SS	15	19			
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft		
WL	∇ 20	WD ▼
WL	▼	▼
WL		

Terracon

BORING STARTED	3-26-10		
BORING COMPLETED	3-26-10		
RIG	96	FOREMAN	JM
APPROVED	DAM	JOB #	05105037