FINAL REPORT ON DRILLED SHAFT LOAD TESTING (OSTERBERG METHOD)

Load Test No. LT-8276
F.A.U. Route 6265 (CH-15)
CH-15 Over the Illinois River
Marseilles, LaSalle County, Illinois

Prepared for: Case Foundation Company
1325 West Lake Street
Roselle, Illinois 60172

Attention: Mr. Bill Lederer

LOADTEST, Inc. PROJECT No. LT-8276, September 1996

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PREFACE

PROJECT INFORMATION: A drilled shaft foundation for the CH-15 replacement bridge over the Illinois River in Marseilles, LaSalle County, Illinois is currently being constructed by Case Foundation Company. An Osterberg Cell (O-cell) testing program was conducted on one drilled test shaft, at a production shaft location selected by the Geotechnical Engineer.

In conjunction with Case Foundation Company (Contractor), LOADTEST, Inc. (LTI), performed an Osterberg Cell load test on the designated test shaft within the limits of the proposed bridge realignment.

PURPOSE OF TEST: The purpose of the load test was to assess the drilled shaft side shear characteristics in the Francis Creek Shale to verify the project drilled shaft design.

FINAL REPORT: A preliminary report of the load test results was submitted to Mr. Bill Lederer of Case Foundation Company on May 23, 1996. Further review and analysis of the test data led to the production of this final report that revises and replaces the preliminary report. This final report is referenced as load test No. LT-8276.

LIMITATIONS: Services with respect to geotechnical engineering design, preparation of project specifications, means and methods and observation of the test shaft construction were provided by others. Any interpretive information provided with this report is not to be applied to the design or construction of the project, except as directed by the project Geotechnical Engineer. The various elevations contained herein are based on information supplied by others and are assumed to be correct within ± 50 mm (2 inches).

BIBLIOGRAPHY: This report ends with a bibliography for those readers who are unfamiliar with the O-Cell testing or who would like to expand their knowledge of this method. LTI can assist with obtaining one or more of the items in the bibliography, if requested.

1.0 INTRODUCTION

1.1 **GENERAL INFORMATION:** An Osterberg cell load test was performed by LOADTEST, Inc. on the west drilled shaft of Pier 2, Station 1+353.000. The construction of the test shaft was completed by Case Foundation Company, under the direction of Field Superintendent Mr. Tom Stitt, on May 13, 1996.

The Osterberg cell load test was conducted on May 20, 1996 by LOADTEST, Inc. under the direction of Mr. Jeff Goodwin, P.E. Senior personnel present to observe the shaft construction and load testing were Mr. David Lindeman, P.E. and Mr. Steve Kuhn of the Illinois Department of Transportation and Mr. Bernard Hertlein, P.E. of STS Consultants, Ltd.

1.2 **GEOLOGY AND SITE CONDITIONS:** Figure 1 of this report shows the location of the test shaft in relation to the proposed bridge realignment.

The sub-surface stratigraphy encountered while drilling the test shaft consisted of approximately 1.0 m (3.3 ft.) of overburden soils underlain by an upper 5.5 m (18.0 ft.) thick layer of interbedded sandstone, shale and limestone. The Pleasantville Sandstone was encountered below the upper interbedded rock in a layer approximately 5.0 m (16.4 ft.) thick. Final bearing for the drilled shaft was in the Francis Creek Shale which was encountered below the Pleasantville Sandstone and extended to the limit of the drilled shaft excavation. Ground water slowly seeped into the top of the drilled shaft from approximately EL+149.2 m (+489.5 ft). A copy of a test boring (SB-39) provided as drawing No. S-67 in the contract drawings is included as Appendix F. The geotechnical data compiled by the Illinois D.O.T. should be referred to for more detailed geologic information. Photographs in Appendix E show the test site area, O-cell assembly and reference instrumentation.

2.0 INSTALLATION OF TEST SHAFT AND OSTERBERG CELL

2.1 SHAFT CONSTRUCTION: The contractor constructed the test shaft over the period of May 8 - 13, 1996. A crane mounted drill rig was utilized to construct the test shaft. Using dry excavation techniques, the shaft was advanced by employing rock auger bits and core barrels. The resulting shaft diameter was 1570 mm (62-inches). A reaction socket 5.82 m (19.1 ft.) long was drilled below plan bottom of the shaft to provide additional reaction for the load test. The bottom of shaft (EL+128.3 m/+421.0 ft.)was cleaned out using a flat bottom cleanout bucket.

Following the final shaft inspection and approval by the Engineer, the reaction socket was filled with approximately 6.7 m (22 ft.) of fluid concrete.

The reinforcing steel cage and O-cell assembly were then lowered into the shaft with the base of the bottom O-cell bearing plate allowed to settle into the fresh concrete to EL. +134.1 m (+440.0 ft.). The balance of the concrete was placed by centralized free fall using a length of tremmie pipe. The top of shaft concrete was, on completion, at EL+151.2 m (+496.0 ft.). Figure 2 is a schematic section of the completed test shaft.

2.2 OSTERBERG CELL AND INSTRUMENTATION: O-cell serial No. 5168-5 was installed in the test shaft. The O-cell was 305 mm (12 inches) high and 865 mm (34 inches) diameter. Steel bearing plates 1370 mm (54 inches) diameter and 50 mm (2 inches) thick were attached to the top and bottom of the O-cell.

Linear vibrating wire displacement transducers (LVWDT's) (Geokon Model No. 4450-6) were attached, at two diametrically opposed positions, to the bottom and top of the O-cell to measure the O-cell expansion.

To measure the compression of the shaft from the top of the O-cell to the top of shaft, two telltale casings (1/2-inch steel pipe) were set in diametrically opposed positions. For measurement of the downward movement of the base of the reaction socket, two telltales casings set in diametrically opposed positions extended from the base of the reaction socket to the ground surface. The telltale rods placed in the casings consisted of unstressed, 5/16-inch diameter stainless steel, flush-jointed, threaded rods in 1.5 m (5 feet) lengths.

The upper test shaft socket was instrumented with diametrically opposed pairs of sister bar vibrating wire strain gages (Geokon Model No. 4911) attached to the reinforcing steel cage. The sister bars were set at distances of 1.5 m (5.0 ft.), 3.05 m (10.0 ft.), 4.57 m (15.0 ft.), 6.10 m (20.0 ft.), 8.23 m (27.0 ft.), 10.4 m (34.0 ft.), and 12.5 m (41.0 ft.) above the top of the upper O-cell bearing plate.

A schematic illustrating the O-cell, telltale, LVWDT and sister bar locations is included as Figure 2 of this report.

2.3 CALIBRATION OF INSTRUMENTATION: O-cell serial No. 5168-5 was installed in the test shaft. Calibration data for the O-cell is included in Appendix A. The calibration was performed by American Equipment and Fabricating Corporation in East Providence, Rhode Island to a load of approximately 5.3 MN (600 tons). A linear extrapolation of the calibration results was then performed between 5.3 MN and the maximum load per our standard procedures. Based upon the results of a 26.7 MN (3000 ton) calibration of a similar Osterberg cell, conducted at the National Institute for Standards and Technology, our standard calibration procedure for the O-cell was approved for use by the FHWA.

Calibration of the sister bars, LVWDT's and the hydraulic pressure transducer were performed by Geokon, Inc. prior to their shipment to the site. The Bourdon gage calibration was performed by PSI, Inc. Complete calibration records are contained in Appendix A at the end of this report.

3.0 LOAD TEST PROCEDURES

3.1 **GENERAL INFORMATION:** The Osterberg test method loads the shaft in two directions by hydraulically pressurizing the installed O-cell. The O-cell load is determined by relating the applied hydraulic pressure to the O-cell load calibration curve. A calibrated Bourdon gage and electronic pressure transducer were used to read the applied hydraulic pressure. Pressurizing the O-cell simultaneously loaded the reaction socket below the O-cell in combined side shear and end bearing which resisted downward movement and loaded the shaft above the O-cell in side shear which resisted upward movement (negative shear) (Osterberg, 1989).

The O-cell load test was performed in accordance with *ASTM D1143 Quick Load Test Procedures* (ASTM, 1996). Load was applied through the hydraulic pressure system, in increments of approximately 1.4 MN (160 tons) for loading, and 6.5 MN (730 tons) for unloading. Pressure was held at each loading increment for a total of 4.0 minutes. Gages were read at 1.0, 2.0 and 4.0 minutes after the load was applied, with an average of 1.0 minute then used to increase the O-cell pressure to the next load increment.

3.2 **FIELD MEASUREMENTS:** Schematic sections on Figures 2 and 3 show the locations of the telltales, digital indicators, sister bars and LVWDT's.

The upward vertical movement of the top of the shaft was measured using digital indicators A and B attached to the reference beam and set over the shaft. These digital indicators have a travel of 4 inches and were read to the nearest 0.0001-inch division. The stems of the indicators were plumbed to ensure accurate vertical measurement. The digital indicators were attached to a steel reference beam which was provided by Case Foundation Company.

Shaft compression between the top of the O-cell and the top of the shaft was directly measured using digital indicators C and D attached to the frame extending from the shaft rebar cage. The upward vertical movement of the telltale rods was read using 4-inch travel digital indicators read to the nearest 0.0001-inch division. The stem of the indicators was plumbed to ensure accurate vertical movements.

The expansion of the O-cell was measured by using vibrating wire displacement transducers (LVWDT) with a maximum travel of 6 inches and read to a 0.0001 inch precision. The calculated downward movement of the base of the O-cell was equal to the expansion of the O-cell minus the upward movement of the top of the shaft and the upper shaft compression.

The downward movement of the base of the reaction socket was monitored directly using digital indicators E and F attached to the reference beam. The downward vertical movement of the telltale rods was read using 1-inch travel digital indicators read to the nearest 0.0001-inch division. The stem of the indicators was plumbed to ensure accurate vertical movements.

All the digital indicators, sister bars and LVWDT's were connected through multiplexers to a CR-10 data logger. The logger was, in turn, connected to a laptop computer. This arrangement allowed digital gage, sister bar and LVWDT readings to be recorded and stored automatically at 1 minute intervals during the test.

The reference beam and instrumentation were protected from direct sunlight by a tarp and were monitored for movement during the load test.

3.3 **POST TEST GROUTING:** Since this shaft was drilled at a production shaft location, the O-cell hydraulic system and annular space around the outside of the O-cell was grouted by the contractor. Grouting of the O-cell system allows load transfer through the Osterberg cell without compressing the O-cell during loading.

4.0 LOAD TEST RESULTS

4.1 **GENERAL INFORMATION:** The O-cell load test LT-8276 began on May 20, 1996, at about 2:00 P.M. CDST; 7 days after concrete placement. At the time of testing, concrete cylinders formed during the construction of the shaft were tested by others and found to have an average unconfined compressive strength of 36.4 MPa (5280 psi). We derived an approximate concrete modulus value of **E= 28,600 MPa (4,142 ksi)** using the standard ACI formula for determining the concrete modulus, $E = 57{,}000^* \sqrt{(fc)}$, where (fc) is the concrete compressive strength in psi (ACI, 1989). Reinforcing steel from the cage accounted for approximately 1.8% of the shaft cross-sectional area, yielding a combined shaft modulus, **E=31,700 MPa (4,600 ksi)**. Tabulations of all field data, including calculations, corrections and computed averages are included in Appendix B.

The O-cell was installed in a fully closed condition. Loading was carried out in two cycles. The first load cycle reached a maximum applied load of 8.38 MN (942 tons) at which point a hydraulic leak developed in the system. After fixing the leak the load was uniformly increased until a load of 27.7 MN (3,110 tons) was applied to the shaft in each direction at load increment 2L-17, resulting in a vertical downward movement at the base of the O-cell of 3.7 mm (0.146 inches). The average upward top of O-cell movement at this point was 2.5 mm (0.100 inches) as calculated by adding top of shaft movement measured by indicators A and B and shaft compression measured by indicators C and D. The LVWDT's indicated an average total O-cell expansion of 6.3 mm (0.246 inches).

Corrections to Applied Load: In calculating the upward load applied, the 0.49 MN (55 tons) buoyant weight of the shaft above the O-cell was subtracted from the load at the O-cell. The maximum side shear load applied to the shaft was 27.2 MN (3,055 tons) (i.e. 3,110 tons minus the buoyant weight of shaft of 55 tons).

The downward load-bearing capacity included the contribution of a 5.8 m (19.1 ft.) long shear zone between the bottom of the O-cell and the bottom of the shaft. To obtain a very rough estimate of end bearing capacity, we assumed that the side shear from this zone contributed 19.3 MN (2,170 tons) to the bottom resistance based on characteristics of the load-movement curve shown in Figure 4 and discussed in **Section 4.3**. The estimated 19.3 MN side shear load correction, subtracted from the O-cell load of 27.7 MN (3,110 tons) resulted in an estimated net downward end bearing load of 8.4 MN (940 tons). Tabulations of all field data, including corrections and computed averages are included in Appendix B.

4.2 **LOAD-MOVEMENT CURVES:** The engineer obtains various load-movement curves from an Osterberg Cell load test. The load-movement curve for the bottom of the device moving downward and the top of the O-cell moving upward can be obtained directly from (Figure 4). A computed top load settlement curve (Figure 5) can then be derived from these direct measurements. One can also construct creep movement curves (Figure 6 and 7) to make an estimate of the creep load limit. These curves are discussed in the following sections.

4.3 **MEASURED LOAD MOVEMENT CURVES:** Since the upper section of the test shaft (above the O-cell) moved only 2.5 mm (0.100 inches) at a load of 27.2 MN (3,055 tons), the full side shear capacity of this section was not mobilized in this test. The average unit side shear at the maximum applied load along the shaft within the Francis Creek Shale (EL+134.5 m to +140.6 m / EL+440.1 ft. to +461.3 ft.) was calculated to be 0.67 MPa (7.0 tsf).

Assuming that the estimate of the side shear contribution to the base capacity is correct, we estimate that the load applied to end bearing at the bottom of the shaft was 8.3 MN (941 tons). The corrected unit end bearing load applied to the test shaft (which was not ultimate capacity), appears to be 4.3 MPa (45 tsf). We could not test beyond the applied load since the maximum capacity of the O-cell system specified for this test had been reached.

4.4 COMPUTED TOP LOAD-SETTLEMENT CURVE: Figure 5 shows a computed equivalent top load-settlement curve for the top of the shaft for the load test. We based the construction of Figure 5 on the method described in Appendix C. The computed total capacity of the shaft is 49.5 MN (5,560 tons) at a settlement of approximately 2.5 mm (0.10 inches).

4.5 CREEP LIMITS: Figures 6 and 7 show the amount of movement measured over the 2 to 4 minute interval vs. the load applied for the top-of-shaft and bottom-of-O-cell, respectively. As described in Appendix D such graphs form the basis for estimating test component, and their equivalent top-loaded, creep limits. The point on these curves where one might interpret a distinct upward break, or abrupt increase in the rate of shaft movement at constant load over the 2 minute time interval, denotes a creep limit. This limit indicates a load below which creep movement of the shaft is unlikely to occur.

The top of O-cell creep data indicates the side shear creep limit was not reached and therefore exceeds 27.2 MN (3,060 tons). Also, no creep limit could be defined from the base creep data. Therefore, a top loaded shaft will begin significant creep only when both components begin creep movement. This will occur at the maximum of the movements required to reach the creep limit for each component. In this case, the test data indicates that the shaft would not begin significant creep until a load of at least 54.9 MN (6,170 tons) at a movement of 2.5 mm (0.10 inches) was exceeded.

4.6 SHAFT COMPRESSION: As shown in Table 3 & 4 in Appendix B, the telltale data indicates an average shaft compression of 1.9 mm (0.074 inches) with an applied shear load of 27.2 MN (3,060 tons). Based upon the results of the strain gage data, we computed a theoretical compression of 1.6 mm (0.064 inches). This agreement is consistent with our experience on other load tests of this type.

4.7 **STRAIN GAGE RESULTS:** The strain gages indicated the point strain at the level of monitoring. Table Nos. 13 - 15 in Appendix B list the detailed data. Differences from the zero load reading were taken and corrected to the true strain by the formula:

Strain (γ) $= (R_1 - R_0)F + 1.3(T_1 - T_0)$

where
R_0 = Initial Zero Load Strain Reading
R_1 = Strain Reading at Load Increment
F = Strain Gage Calibration
T_0 = Temperature at Zero Load (degrees C)
T_1 = Temperature at Load Increment

The thermistor readings indicated that the change in concrete temperature during the test was less than 0.1 degree Celsius. Therefore temperature corrections were not required.

The induced shaft load at each strain gage level was computed using the following equation to solve for load P:

$P = (\gamma)AE$

where
A = shaft cross-sectional area
E = estimated modulus of elasticity
γ = strain

The average load at each strain gage level was computed based on average strain values at each level. Average modulus of elasticity, based on a weighted average of steel and concrete moduli and their respective cross-sectional areas were used. (See Section 4.1) The effective cross-sectional area for our analysis was based on a shaft diameter of 1570 mm (62.0 inches). Figure 8 shows the resulting load distribution curves. Based upon the strain gage results, the average shear capacity from the bottom of the O-cell to the top of the shaft are as follows:

- Top of shaft (EL+151.2 m) to strain gage level 7 (EL+147.0 m) 0.07 MPa (0.7 tsf)
- Strain gage level 7 (EL+147.0 m) to strain gage level 6 (EL+144.9 m) 0.05 MPa (0.5 tsf)
- Strain gage level 6 (EL+144.9 m) to strain gage level 5 (EL+142.7 m) 0.11 MPa (1.1 tsf)
- Strain gage level 5 (EL+142.7 m) to strain gage level 4 (EL+140.6 m) 0.26 MPa (2.7 tsf)
- Strain gage level 4 (EL+140.6 m) to strain gage level 3 (EL+139.1 m) 0.55 MPa (5.8 tsf)
- Strain gage level 3 (EL+139.1 m) to strain gage level 2 (EL+137.6 m) 0.23 MPa (2.4 tsf)
- Strain gage level 2 (EL+137.6 m) to strain gage level 1 (EL+136.0 m) 0.75 MPa (7.8 tsf)
- Strain gage level 1 (EL+136.0 m) to bottom of O-cell (EL+134.1 m) 1.05 MPa (11.0 tsf)

5.0 CONCLUSIONS

5.1 **TEST ASSESSMENT:** Our experience, and all the data accumulated and presented in detail in this report, indicate that the O-cell expanded properly and loaded the two parts of the test shaft in accordance with its calibration. We loaded the test shaft to the capacity of the O-cell system and all of the instrumentation performed properly. After repairing the hydraulic leak encountered during load interval one, the test ran smoothly without incident until the maximum capacity of the Osterberg cell was reached.

5.2 **END BEARING:** The maximum load applied to the reaction socket below the O-cell, was 27.7 MN (3,110 tons) at load interval 2L-17. At this loading, the average measured downward movement at the base of the O-cell was 3.71 mm (0.146 inches). The corrected end bearing load (as described in Section 4.3) was estimated to be 8.4 MN (940 tons). Therefore the estimated unit end bearing load was 4.3 MPa (45 tsf), based on a 1570 mm (62.0 inch) diameter shaft. The engineer should use good judgment when considering these estimated values since they are based on an assumed allocation of the side shear and end bearing for the base section of the test shaft and since the load test did not reach the ultimate capacity of the rock system.

5.3 **SIDE SHEAR:** The maximum side shear load applied to the shaft was 27.2 MN (3,060 tons) after the correction for the buoyant weight of shaft was made. This shear load resulted in an upward shaft movement of 2.54 mm (0.100 inches) at load interval 2L-17. The average unit side shear within the Francis Creek Shale mobilized along the 6.5 m (21.2 ft.) section of shaft above the bottom of the O-cell was 0.67 MPa (7.0 tsf). The full side shear capacity was not mobilized in this test, although a unit shear if 1.05 MPa (11.0 tsf) was estimated from the strain gage data between EL 136.0 m and 134.1 m.

5.4 **CREEP LIMITS:** We believe that significant creep for this shaft will not begin until a top-loading exceeds 54.9 MN (6,170 tons) by an undetermined amount.

5.5 **EQUIVALENT TOP LOAD:** Our constructed equivalent top load-settlement curve (Figure 5) gave a computed total capacity of the test shaft of 49.5 MN (5,560 tons) at a settlement of 2.5 mm (0.10 inches).

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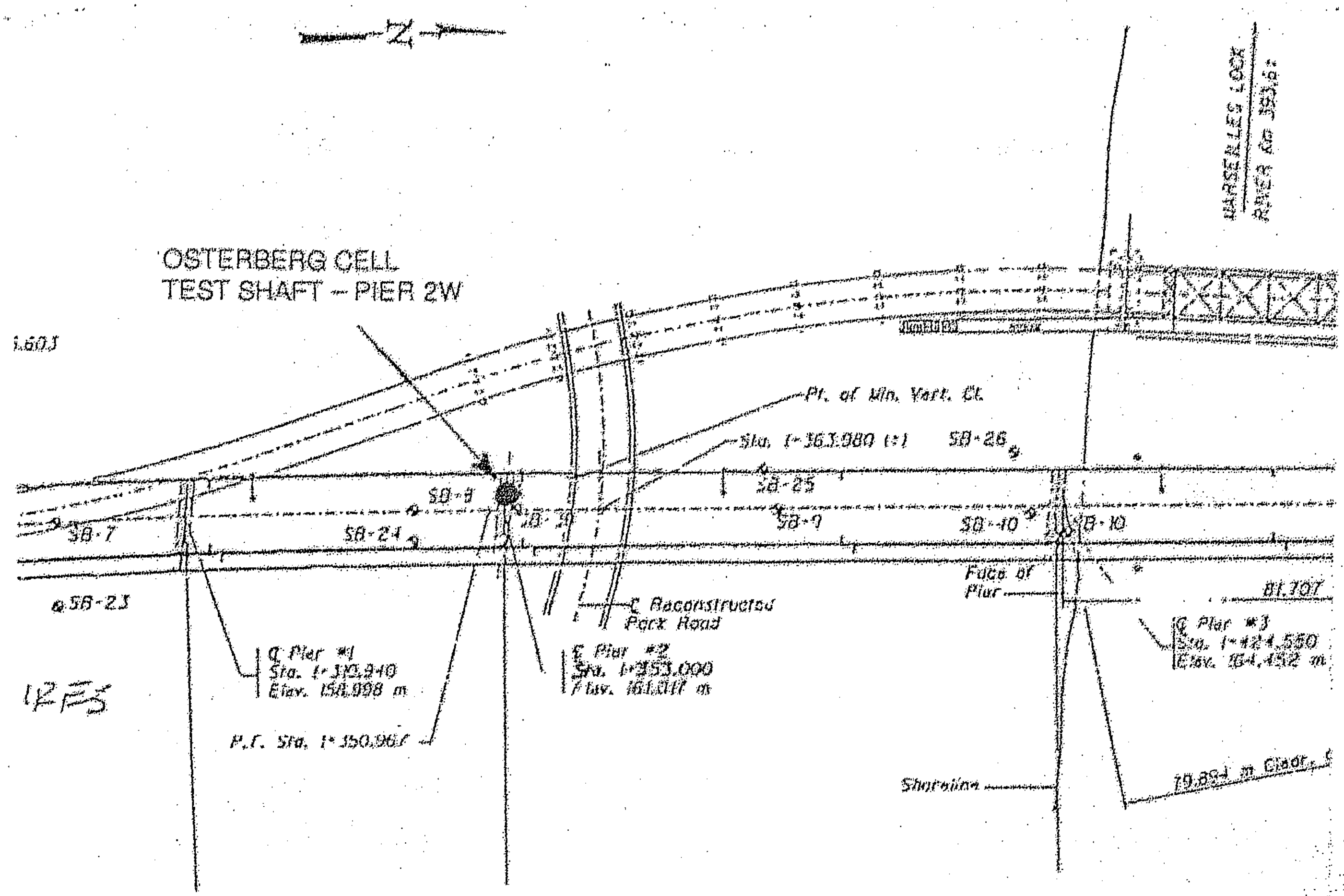
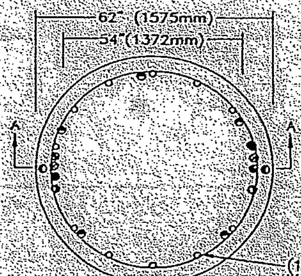
SUMMARY OF DIMENSIONS, ELEVATIONS, AREAS & PROPERTIES FOR ANALYSIS

Diameter of test shaft	62.0 in (1570 mm)
Elevation of ground surface	EL+501.0 ft (152.7 m)
Elevation of top of shaft	EL+496.0 ft (151.2 m)
Elevation of strain gage level 7	EL+482.3 ft (147.0 m)
Elevation of strain gage level 6	EL+475.3 ft (144.9 m)
Elevation of strain gage level 5	EL+468.3 ft (142.7 m)
Elevation of strain gage level 4	EL+461.3 ft (140.6 m)
Elevation of strain gage level 3	EL+456.3 ft (139.1 m)
Elevation of strain gage level 2	EL+451.3 ft (137.6 m)
Elevation of strain gage level 1	EL+446.3 ft (136.0 m)
Elevation of top of upper O-cell bearing plate plate - 54" (1372 mm) diameter X 2" (51 mm) thick	EL+441.3 ft (134.5 m)
Elevation of top of O-cell	EL+441.1 ft (134.4 m)
Elevation of bottom of O-cell (break between upper side shear and reaction socket)	EL+440.1 ft (134.1 m)
Elevation of bottom of shaft	EL+421.0 ft (128.3 m)
Shaft end bearing area	21.0 ft^2 (1.95 m^2)
Length of shaft above bottom of O-cell	55.9 ft. (17.0 m)
Length of shaft below bottom of O-cell	19.1 ft. (5.82 m)
Socket side shear area above bottom of O-cell	907 ft^2 (84.3 m^2)
Socket side shear area below bottom of O-cell	310 ft^2 (28.8 m^2)
Buoyant weight of shaft above bottom of O-cell	55.7 tons (0.496 MN)
Concrete strength at time of load testing	5.28 ksi (36.4 MPa)
Steel as a percent of shaft cross sectional area	1.8 %
Approximate shaft modulus at time of load testing	4,600 ksi (31,700 MPa)

TABLE 1

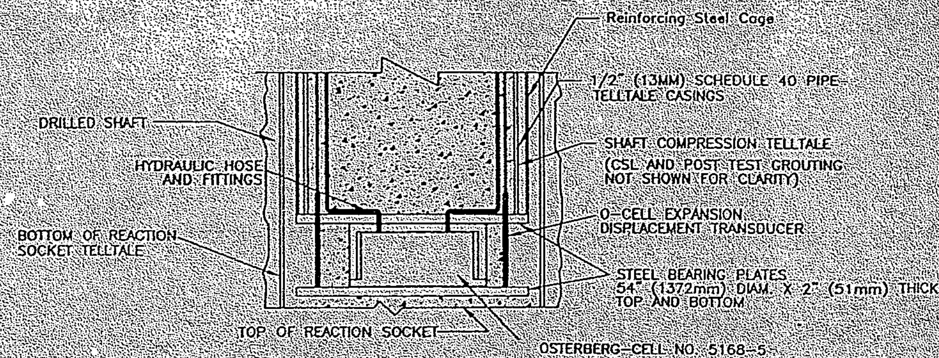


LOADTEST	LOADTEST PERFORMED BY: Loadtest, Inc. 12011 Guilford Road, Suite 105 Annapolis Junction, Maryland (800) 436-2355 FAX: (410) 792-7270	OSTERBERG CELL OSTERBERG CELL LOAD TEST LOCATION PLAN	LT8276 · NOT TO SCALE · 1 OF 8

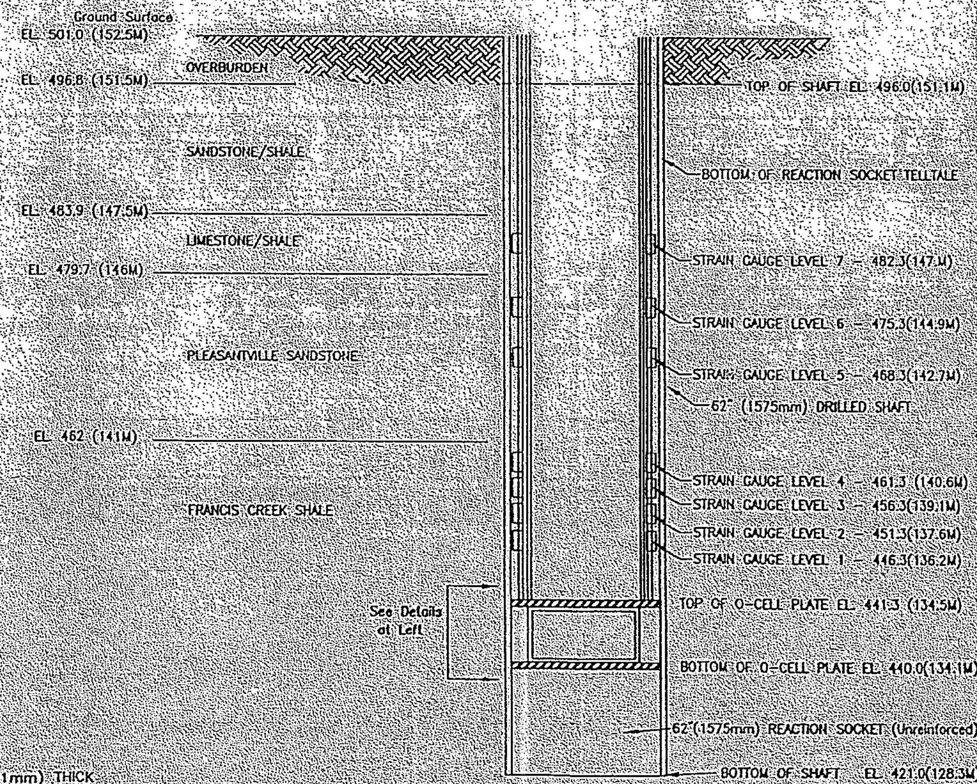


SHAFT PLAN

KEY
- SHAFT COMPRESSION TELLTALE (2)
- HYDRAULIC LINE (2)
- O-CELL EXPANSION DISPLACEMENT TRANSDUCER (2)
- BOTTOM OF REACTION SOCKET TELLTALE (2)
- POST TEST GROUTING TUBE (2)
- CSL ACCESS TUBE (5)

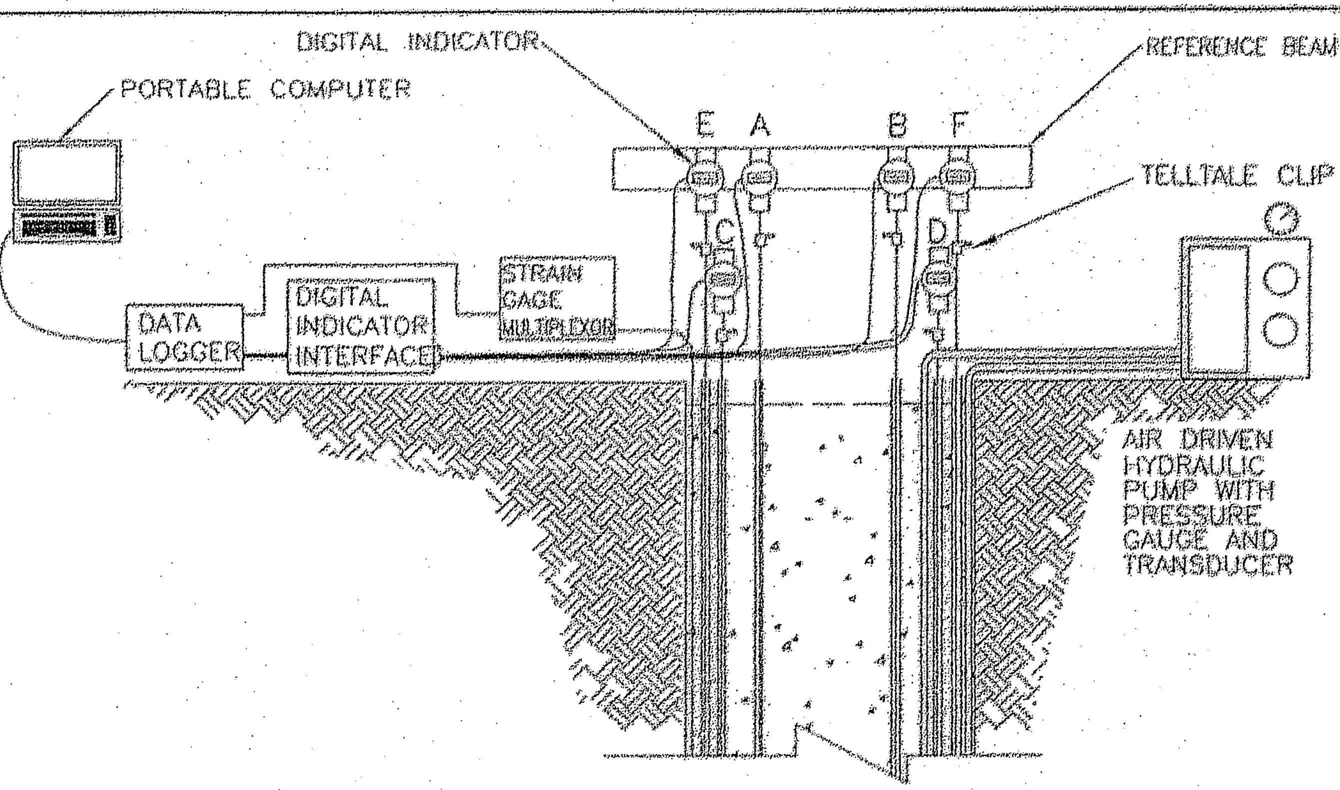


SCHEMATIC OF OSTERBERG CELL ASSEMBLY



DRILLED SHAFT WITH OSTERBERG CELL
AT STATION 1+353.000 (PIER-2 WEST SHAFT)

LOADTEST	LOAD TEST PERFORMED BY: LOADTEST, INC. 12011 GUILFORD RD., SUITE 105 ANNAPOLIS JUNCTION, MD 20701 (800) 434-2355	STATE PROJECT. NO. F.A.U. RTE. 6265 (CH-15) ROAD NO. CH-15 OVER ILLINOIS RIVER COUNTY/ST LA SALLE/ILLINOIS FILE NAME: MARSEILLES BRIDGE	FILE NUMBER: C:\CADD\LOADTEST\H4015C JOB NUMBER: LT8276 SCALE: N.T.S. FIGURE: 2 OF 8	REVISED DATE: DRAWN BY: R.T.S. APPROVED BY: JEFFREY W. GOODWIN DATE: 5/14/98	SCHEMATIC OF TEST SHAFT DETAILS CH-15 OVER THE ILLINOIS RIVER



Monitoring of Shaft Movement

* Top of Shaft Upward Movement – Digital Indicator Nos. A&B read to the nearest 0.0001 inch division directly measuring the upward movement of the top of the shaft.
* Compression of Upper Shaft Socket – Digital indicator Nos. C&D read to the nearest 0.0001 inch division directly measuring the compression of the upper socket between the top of the Osterberg Cell and the top of the shaft.
* Bottom of Lower Socket Downward Movement – Digital indicator Nos. E&F read to the nearest 0.0001 inch division directly measuring the downward movement of the bottom of the reaction socket.
* Expansion of the Osterberg Cell– Sacrificial LVWDT's having a travel of 6 inches to the nearest 0.0001 inch division. The downward movement of the base of the Osterberg Cell is equal to the expansion of the O–Cell minus the Top of the Shaft Upward Movement and the Compression of the Upper Shaft Socket.
* Telltales and Telltale Casings – Telltale casings were 1/2–inch diameter steel pipes set in diametrically opposed pairs. Telltale rods were unstressed 5/16–inch diameter stainless steel, flush jointed, threaded rods in 5 foot lengths.

Strain Gauge Instrumentation

* 14–GEOKON Model 4911 sister bar vibrating wire strain installed at the locations indicated on Figure 2.

Data Acquisition

* GEOKON Micro–10 Data Logger
* GEOKON Model 8020–30 Digital Indicator Interface (16–Channel)
* GEOKON Strain Gauge Multiplexor (32 Channel)
* TEXAS INSTRUMENTS Model 4000M Portable Computer

Osterberg Cell, Pump and Hydraulic Pressure Monitoring

* 34–inch diameter, 3,000 ton capacity Osterberg Cell
* Air actuated 10,000 psi hydraulic pump
* Pressure monitored at pump using analog 10,000 psi Bourdon Gauge
* Pressure monitored at return line using digital 10,000 psi Senzotec transducer

LOADTEST

LOADTEST PERFORMED BY:
ANNAPOLIS JUNCTION, MD 20701
FAX: (410)792-7370

OSTERBERG CELL

TOP–OF–SHAFT REFERENCE INSTRUMENTATION

	LT8276
DATE	5/12/96
SCALE	N.T.S.
	3 of 8
	Jeff Goodwin

Osterberg Cell Load-Movement Curves

Marseille Bridge over Illinois River
Lasalle, Illinois

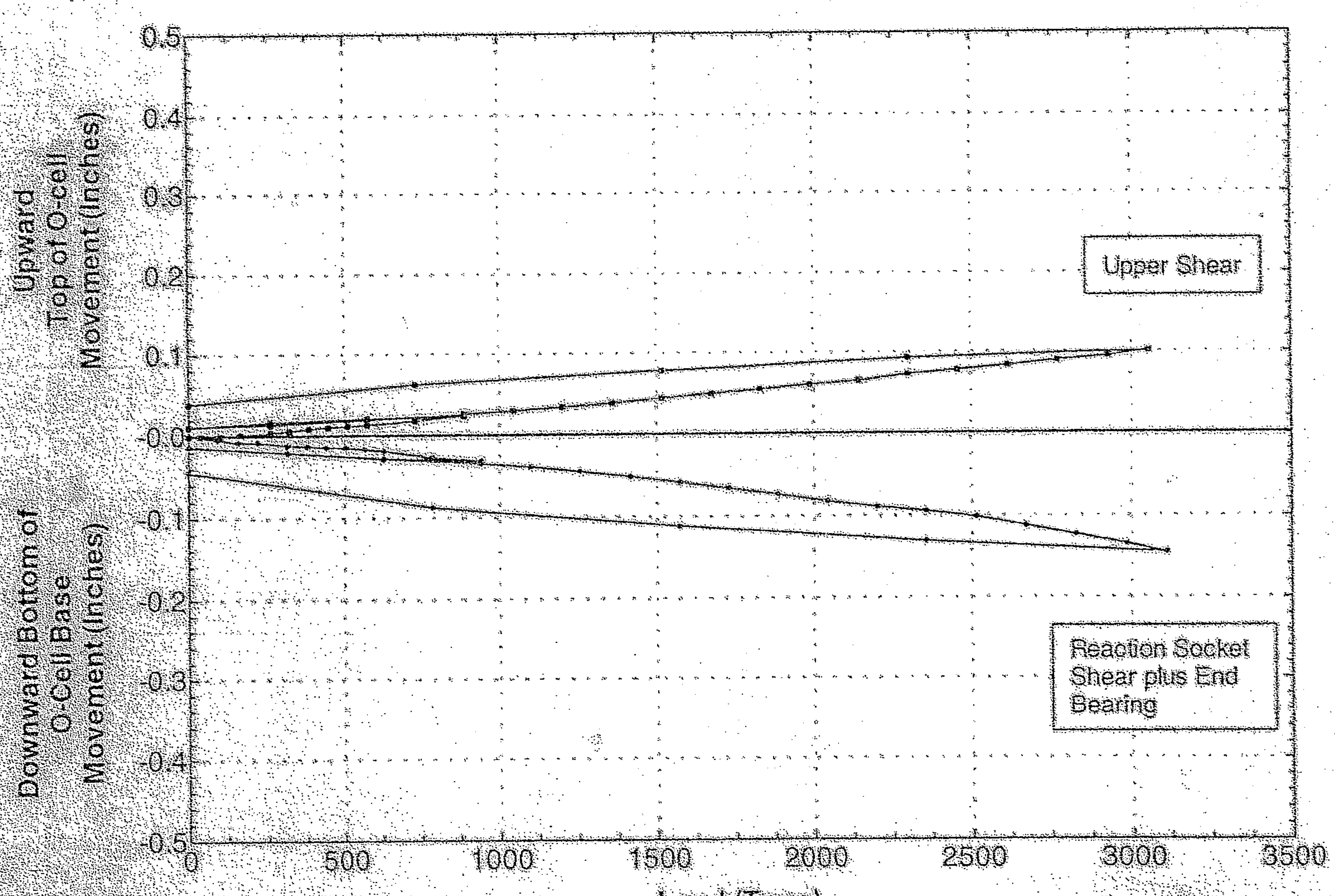


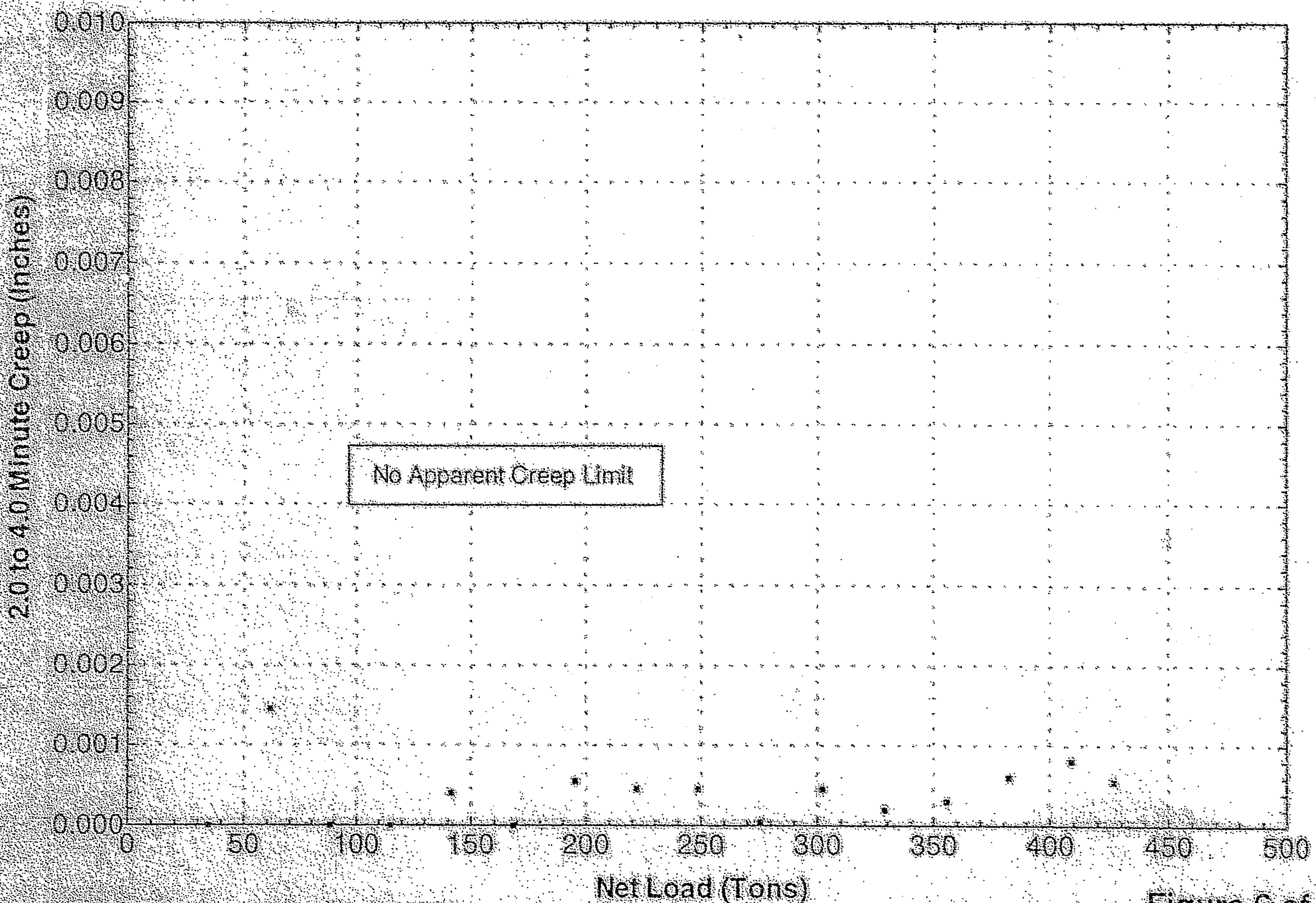
Figure 4 of 8

LOADTEST, Inc. Project No. LT-8276

Side Shear Creep Limit Curve

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.



LOADTEST, Inc. Project No. LT-8276

Figure 6 of 8

End Bearing Creep Limit Curve

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

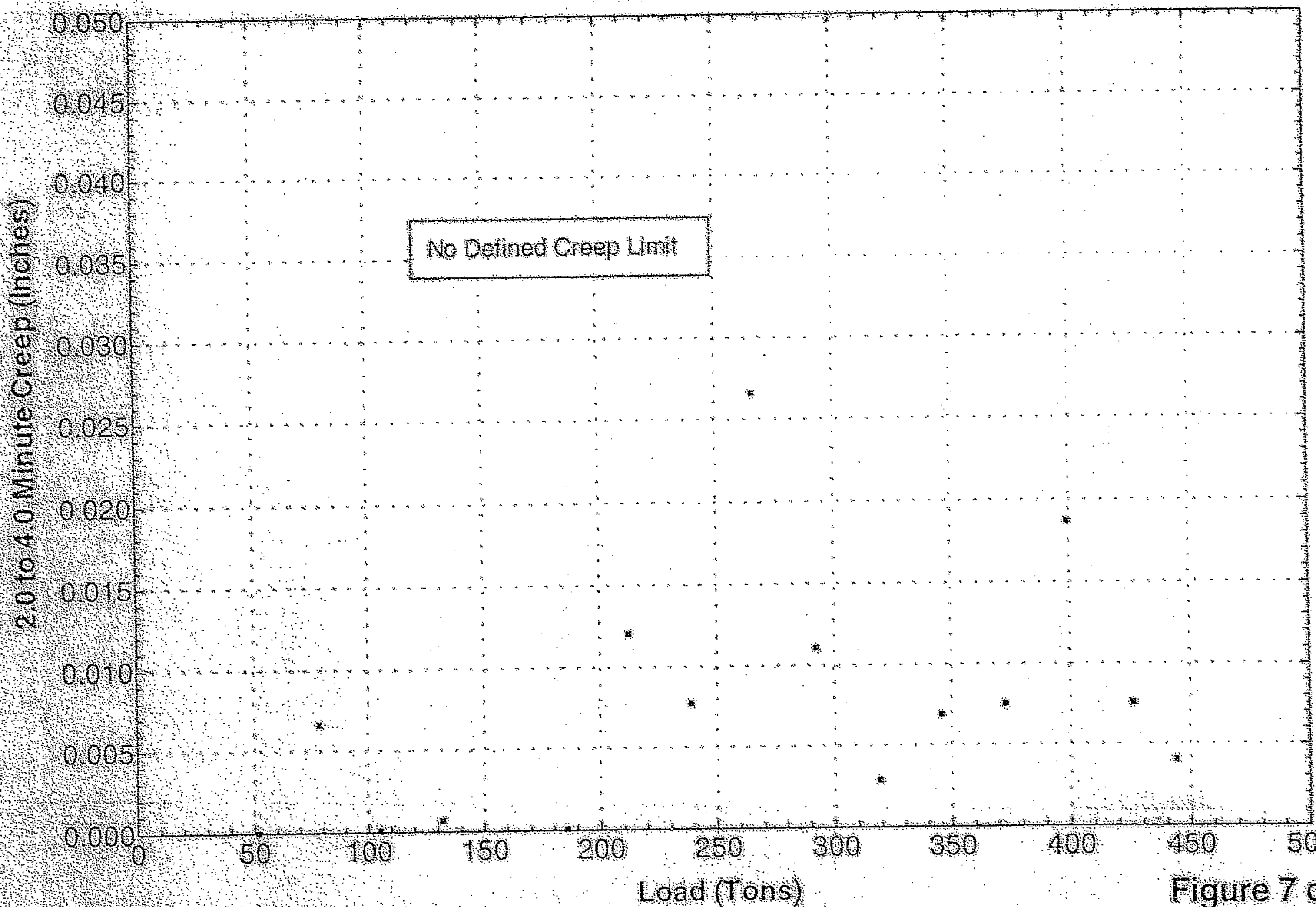
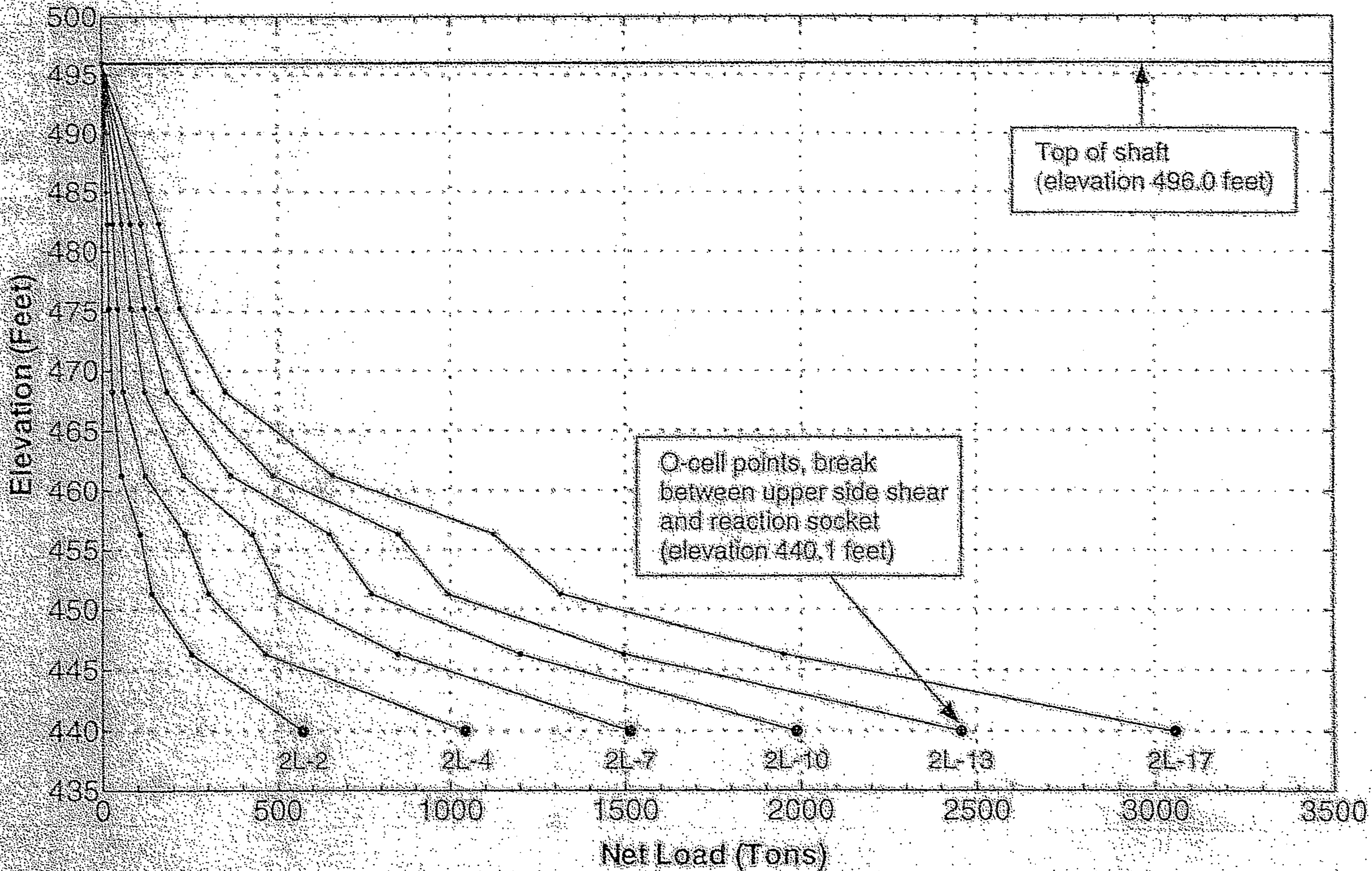


Figure 7 of 8

LOADTEST, Inc. Project No. LT-8276

Side Shear Load Distribution Curves from Strain Gage Data

CH-15 over the Illinois River
Marseilles, LaSalle County, Illinois.



LOADTEST, Inc. Project No. LT-8276

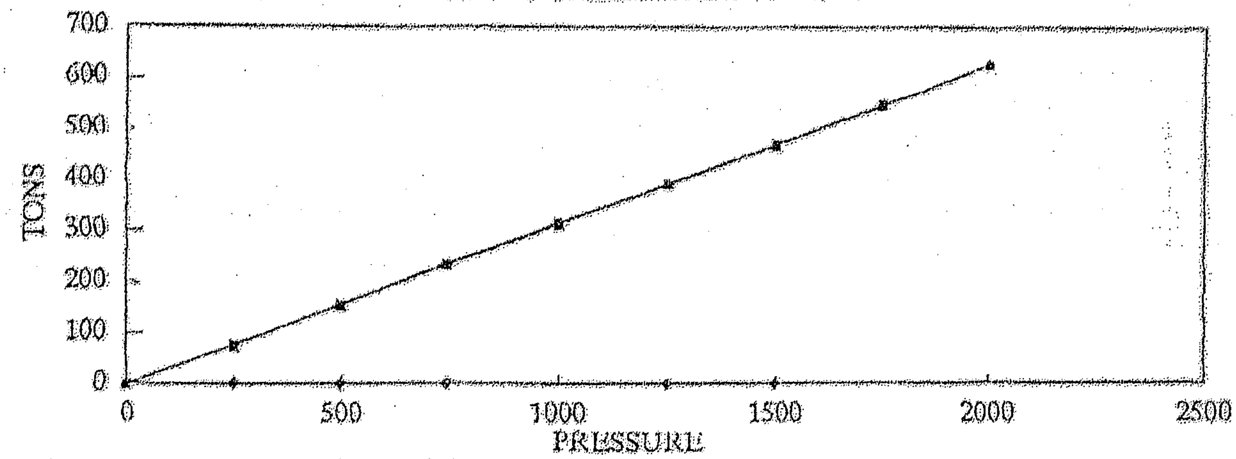
Figure 8 of 8

APPENDIX A

CALIBRATION OF O-CELL , BOURDON GAGE, SISTER BARS AND LVWDT'S

LOAD TEST GRAPH

5168—5 CALIBRATED ON 08/01/95



TONS = X Coefficient*(PRESSURE)+CONSTANT

34" OSTERBERG CELL, SERIAL # 5168—5

STROKE:	1 INCH	3 INCH	5 INCH
PRESSURE	TONS	TONS	TONS
0	0.00	0.00	0.00
250	76.62	75.38	75.38
500	155.30	154.17	154.92
750	235.22	231.82	232.95
1000	314.77	310.98	314.02
1250	392.05	388.64	390.53
1500	470.08	466.25	467.05
1750	550.00	546.59	548.11
2000	626.14	626.89	627.27

Regression Output:	1 INCH
Constant	-1.204
Std Err of Y Est	1.113716
R Squared	0.999971
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	0.314412
Std Err of Coef.	0.000681

Regression Output:	3 INCH
Constant	-1.67966
Std Err of Y Est	1.021424
R Squared	0.999973
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	0.314466
Std Err of Coef.	0.000607

Regression Output:	5 INCH
Constant	-2.71916
Std Err of Y Est	1.367922
R Squared	0.999961
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	0.314065
Std Err of Coef.	0.000807

CALIBRATION STANDARDS:

All data presented is 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 gauges, ANSI specifications B40.1.

# CUSTOMER P.O.#:	15-8276
# DATA#:	36173
# JOB LOCATION:	MOSKLER, IL
# CONTRACTOR:	CASE FOUNDATION

Service Engineer   Date

[signature]   8/1/95

PSI Environmental · Geotechnical · Construction
Consulting · Engineering · Testing

CALIBRATION REPORT

TESTED FOR: AMERICAN EQUIPMENT & FAB. CORP
100 WATER STREET
EAST PROVIDENCE, RI 02914-5?2

PROJECT: HYDRAULIC JACK & GAUGES

DATE: July 13, 1995

OUR REPORT NO.: 440-50042-00004

REMARKS:

TESTED EQUIPMENT: WILKA TEST GAUGE #2100799
0 - 10,000 PSI W/ 50 PSI SUBDIVISIONS

CALIBRATION EQUIPMENT: ASHCROFT PORTABLE GAUGE-TESTER
SERIAL #1 KX-3186000

PSI CALIBRATION NUMBER: PSI 713951

CALIBRATION RESULTS

WILKA GAUGE (PSI)	ASHCROFT TESTER
1000	1000
2000	2000
3000	3000
4000	4000
5000	5000
6000	6000
7000	7000
8000	8000
9000	9000

RESPECTFULLY SUBMITTED:

RICHARD A. STAPLES
BRANCH MANAGER
PSI, INC.

geokon
incorporated

Sister Bar Calibration

Model Number : 4911

Serial Number: 10454

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.4 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6592

Regression Zero: 6603

Cable Length: 12m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6648	6650	6649		
1,500	7303	7307	7305	656	0.05
3,000	8006	8006	8006	701	0.07
4,500	8704	8709	8707	701	0.07
6,000	9406	9402	9404	698	-0.03
100	6649				

Gage Factor:

0.3698 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

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Sister Bar Calibration

Model Number : 4911

Serial Number: 10455

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.2 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6491

Regression Zero: 6495

Cable Length: 12m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6542	6554	6548		
1,500	7226	7236	7231	683	-0.13
3,000	7968	7982	7975	744	0.00
4,500	8713	8727	8720	745	0.17
6,000	9455	9453	9454	734	-0.03
100	6555				

Gage Factor:

0.35562 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

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Sister Bar Calibration

Model Number : 4911

Date of Test: 4/23/96

Serial Number: 10456

Testing Machine: Tinius Olsen

Customer: Loadtest

Technician: Stuart P. Edson

Job Number: 8932

Zero Reading: 6610

Cust. I.D. No.: n/a

Regression Zero: 6628

Prestress: 35,000 psi

Cable Length: 12m

Temperature: 22.2 °C

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity*
	Cycle #1	Cycle #2	Average	Change	% Max Load
100	6679	6676	6678		
1,500	7327	7330	7329	651	-0.10
3,000	8032	8035	8034	705	-0.05
4,500	8737	8743	8740	707	0.06
6,000	9443	9441	9442	702	0.01
100	6676				

Gage Factor:

0.36868 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

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Sister Bar Calibration

Model Number : 4911

Date of Test: 4/23/96

Serial Number: 10456

Testing Machine: Tinius Olsen

Customer: Loadtest

Technician: Stuart P. Edson

Job Number: 8932

Zero Reading: 6610

Cust. I.D. No.: n/a

Regression Zero: 6628

Prestress: 35,000 psi

Cable Length: 12m

Temperature: 22.2 °C

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6679	6676	6678		
1,500	7327	7330	7329	651	-0.10
3,000	8032	8035	8034	705	-0.05
4,500	8737	8743	8740	707	0.06
6,000	9443	9441	9442	702	0.01
100	6676				

Gage Factor:

0.36868 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

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Sister Bar Calibration

Model Number : 4911

Serial Number: 10457

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.2 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Steven P. Edson

Zero Reading: 6497

Regression Zero: 6512

Cable Length: 12m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max Load
	Cycle #1	Cycle #2	Average	Change	
100	6564	6558	6561		
1,500	7222	7226	7224	663	-0.06
3,000	7939	7940	7940	716	0.01
4,500	8655	8652	8654	714	0.03
6,000	9368	9365	9367	713	0.01
100	6559				

Gage Factor:

0.36493 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

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Sister Bar Calibration

Model Number : 4911

Serial Number: 10458

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.0 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6339

Regression Zero: 6340

Cable Length: 12m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity*
	Cycle #1	Cycle #2	Average	Change	% Max Load
100	6389	6398	6394		
1,500	7070	7082	7076	683	-0.18
3,000	7820	7827	7824	748	0.02
4,500	8560	8572	8566	743	0.06
6,000	9302	9310	9306	740	0.01
100	6399				

Gage Factor:

0.35514 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

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Sister Bar Calibration

Model Number : 4911

Serial Number: 10459

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.2 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6471

Regression Zero: 6486

Cable Length: 12m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6527	6528	6528		
1,500	7186	7189	7188	660	0.10
3,000	7889	7887	7888	701	0.17
4,500	8585	8582	8584	696	0.06
6,000	9275	9277	9276	693	-0.16
100	6533				

Gage Factor:

0.37052 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

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Sister Bar Calibration

Model Number : 4911

Serial Number: 10460

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.1 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6504

Regression Zero: 6524

Cable Length: 15m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings Cycle #1	Cycle #2	Average	Change	Linearity* % Max.Load
100	6570	6569	6570		
1,500	7222	7222	7222	653	0.02
3,000	7919	7922	7921	699	0.05
4,500	8618	8617	8618	697	0.03
6,000	9313	9313	9313	696	-0.04
100	6573				

Gage Factor:

0.37092 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

geokon incorporated

Sister Bar Calibration

Model Number : 4911

Serial Number: 10461

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.2 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6500

Regression Zero: 6517

Cable Length: 15m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6564	6566	6565		
1,500	7215	7215	7215	650	-0.01
3,000	7915	7915	7915	700	0.04
4,500	8615	8615	8615	700	0.10
6,000	9307	9314	9311	696	-0.01
100	6566				

Gage Factor:

0.37059 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

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Sister Bar Calibration

Date of Test: 4/23/96

Model Number : 4911

Testing Machine: Tinius Olsen

Serial Number: 10462

Technician: Steven P. Edson

Customer: Loadtest

Zero Reading: 6462

Job Number: 8932

Regression Zero: 6483

Cust. I.D. No.: n/a

Cable Length: 18m

Prestress: 35,000 psi

Temperature: 22.4 °C

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6534	6527	6531		
1,500	7192	7193	7193	662	0.02
3,000	7902	7901	7902	709	0.02
4,500	8612	8610	8611	710	0.04
6,000	9319	9319	9319	708	0.00
100	6527				

Gage Factor:

0.36661 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

geokon incorporated

Sister Bar Calibration

Model Number : 4911

Serial Number: 10463

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.2 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6500

Regression Zero: 6513

Cable Length: 18m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6562	6560	6561		
1,500	7210	7212	7211	650	0.00
3,000	7905	7911	7908	697	-0.03
4,500	8608	8612	8610	702	0.12
6,000	9303	9306	9305	695	-0.01
100	6560				

Gage Factor:

0.37078 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

geokon incorporated

Sister Bar Calibration

Model Number : 4911

Date of Test: 4/23/96

Serial Number: 10464

Testing Machine: Tinius Olsen

Customer: Loadtest

Technician: Stuart P. Edson

Job Number: 8932

Zero Reading: 6473

Cust. I.D. No.: n/a

Regression Zero: 6484

Prestress: 35,000 psi

Cable Length: 21m

Temperature: 22.1 °C

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6528	6544	6536		
1,500	7204	7213	7209	673	-0.12
3,000	7937	7946	7942	733	0.05
4,500	8663	8671	8667	726	-0.04
6,000	9388	9409	9399	732	0.07
100	6546				

Gage Factor:

0.35974 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

geokon incorporated

Sister Bar Calibration

Model Number : 4911

Serial Number: 10465

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.3 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6431

Regression Zero: 6437

Cable Length: 21m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max Load
	Cycle #1	Cycle #2	Average	Change	
100	6478	6483	6481		
1,500	7138	7139	7139	658	0.11
3,000	7837	7833	7835	697	0.05
4,500	8533	8539	8536	701	0.14
6,000	9225	9229	9227	691	-0.12
100	6484				

Gage Factor:

0.37061 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

geokon incorporated

Sister Bar Calibration

Model Number : 4911

Serial Number: 10466

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.3 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6471

Regression Zero: 6490

Cable Length: 24m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6536	6546	6541		
1,500	7214	7222	7218	677	-0.05
3,000	7943	7949	7946	728	-0.11
4,500	8673	8689	8681	735	0.08
6,000	9403	9414	9409	728	0.01
100	6547				

Gage Factor:

0.35922 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

geokon incorporated

Sister Bar Calibration

Model Number : 4911

Serial Number: 10467

Customer: Loadtest

Job Number: 8932

Cust. I.D. No.: n/a

Prestress: 35,000 psi

Temperature: 22.2 °C

Date of Test: 4/23/96

Testing Machine: Tinius Olsen

Technician: Stuart P. Edson

Zero Reading: 6574

Regression Zero: 6599

Cable Length: 24m

Readout System (DL) Control Number: 398

Applied Load: (Pounds)	Readings				Linearity* % Max.Load
	Cycle #1	Cycle #2	Average	Change	
100	6649	6647	6648		
1,500	7290	7292	7291	643	-0.06
3,000	7985	7988	7987	696	0.00
4,500	8680	8684	8682	696	0.06
6,000	9375	9375	9375	693	0.03
100	6647				

Gage Factor:

0.37237 Microstrain/Digit (GK-401 Pos."B")

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 per cent

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

geokon incorporated

Vibrating Wire Displacement Transducer Calibration

Model Number: 4450-6-6"

Range: 6"

Serial Number: 9305

Mfg. Number: 95-1134

Customer: Loadtest

Temp: 21 °C

Cust. I.D. #: n/a

Baro: 1001 mbar.

Job No.: 8932

Date: 12/14/95

Indicator Control#: 163

Technician: Stuart P. Edson

Displacement (inches)	GK 401 Reading Position B Cycle 1	Cycle 2	Average	Change	% Linearity
0.0	2387	2385	2386		
1.5	3949	3947	3948	1562	0.37
3.0	5493	5486	5490	1542	0.41
4.5	7016	7009	7013	1523	0.15
6.0	8550	8548	8549	1537	0.11

Calibration Factor (C): 0.0009746 (Inches/Digit)

Refer to manual for temperature correction information.

GK-401 Reading at Shipment (with PVC spacer in shipping position)

Position "B":* 5477

Date: 4/23/96

or

Position "F":* ______

Temperature: 20.1 °C

Wiring Code: Red and Black: Gage White and Green: Thermister

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A.

geokon incorporated

Vibrating Wire Displacement Transducer Calibration

Model Number: 4450-6-6"

Range: 6"

Serial Number: 9306

Mfg. Number: 95-1135

Customer: Loadtest

Temp: 21.5 °C

Cust. I.D. #: n/a

Baro: 997 mbar.

Job No.: 8932

Date: 12/15/95

Indicator Control#: 163

Technician: Stuart P. Edson

Displacement (inches)	GK 401 Reading Position B Cycle 1	Cycle 2	Average	Change	% Linearity
0.0	2448	2455	2452		
1.5	4010	4018	4014	1563	0.32
3.0	5564	5560	5562	1548	0.41
4.5	7087	7093	7090	1528	0.17
6.0	8623	8631	8627	1537	0.07

Calibration Factor (C): 0.0009723 (Inches/Digit)

Refer to manual for temperature correction information.

GK-401 Reading at Shipment (with PVC spacer in shipping position)

Position "B":* 5581

Date: 4/23/96

or

Position "F":* ______

Temperature: 20.7 °C

Wiring Code: Red and Black: Gage White and Green: Thermister

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with MIL-STD-45662A

APPENDIX B

FIELD DATA & DATA REDUCTION

Upward, Top of Shaft Movements

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	Net * Load (tons)	Digital Indicator A Readings 1 min (inches)	2 min (inches)	4 min (inches)	Digital Indicator B Readings 1 min (inches)	2 min (inches)	4 min (inches)	Average top of shaft 1 min (inches)	2 min (inches)	4 min (inches)	Creep 2-4 min (inches)
1 L - 0	14:03	0	0	-0.0003			-0.0005			0.0000			
1 L - 1	14:06	300	37	-0.0007	-0.0008	-0.0010	-0.0005	-0.0006	-0.0006	-0.0002	-0.0003	-0.0004	-0.0001
1 L - 2	14:11	500	100	-0.0010	-0.0010	-0.0010	-0.0007	-0.0007	-0.0007	-0.0005	-0.0005	-0.0005	0.0000
1 L - 3	14:16	700	163	-0.0019	-0.0019	-0.0017	-0.0007	-0.0007	-0.0007	-0.0009	-0.0009	-0.0008	0.0001
1 L - 4	14:25	1,000	257	-0.0017	-0.0015	-0.0011	-0.0007	-0.0007	-0.0009	-0.0008	-0.0007	-0.0006	0.0001
1 L - 5	14:30	1,200	320	-0.0006	-0.0005	0.0000	-0.0005	-0.0004	-0.0001	-0.0002	-0.0001	0.0004	0.0004
1 L - 6	14:38	1,400	383	0.0013	0.0014	0.0016	0.0012	0.0013	0.0014	0.0017	0.0018	0.0019	0.0002
1 L - 7	14:43	1,600	446	0.0021	0.0022	0.0023	0.0020	0.0020	0.0021	0.0025	0.0025	0.0026	0.0001
1 L - 8	14:49	1,800	509	0.0026	0.0026	0.0026	0.0024	0.0024	0.0024	0.0029	0.0029	0.0029	0.0000
1 L - 9	14:54	2,000	572	0.0026	0.0026	0.0026	0.0024	0.0024	0.0024	0.0029	0.0029	0.0029	0.0000
1 L - 10	15:00	2,500	729	0.0034	0.0036	0.0038	0.0033	0.0035	0.0036	0.0038	0.0040	0.0041	0.0002
1 L - 11	15:06	3,000	886	0.0052	0.0056	0.0062	0.0052	0.0055	0.0061	0.0056	0.0060	0.0066	0.0006
1 U- 1	15:12	2,000	572	0.0065	0.0065		0.0065	0.0065		0.0069	0.0069		
1 U- 2	15:15	1,000	257	0.0065	0.0065		0.0061	0.0061		0.0067	0.0067		
1 U- 3	15:18	0	0	0.0060		0.0056	0.0046		0.0046	0.0057		0.0055	

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

Upward, Top of Shaft Movements

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	Net * Load (tons)	Digital Indicator A Readings 1 min (inches)	2 min (inches)	4 min (inches)	Digital Indicator B Readings 1 min (inches)	2 min (inches)	4 min (inches)	Average top of shaft 1 min (inches)	2 min (inches)	4 min (inches)	Creep 2-4 min (inches)
2 L- 0	15:34	0	0	0.0056			0.0046			0.0055			
2 L- 1	15:37	1,000	257	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0054	0.0054	0.0054	0.0000
2 L- 2	15:42	2,000	572	0.0050	0.0050	0.0054	0.0051	0.0053	0.0056	0.0055	0.0056	0.0059	0.0004
2 L- 3	15:47	3,000	886	0.0064	0.0066	0.0070	0.0065	0.0067	0.0071	0.0069	0.0071	0.0075	0.0004
2 L- 4	15:52	3,500	1,043	0.0074	0.0077	0.0078	0.0075	0.0078	0.0079	0.0079	0.0082	0.0083	0.0001
2 L- 5	15:57	4,000	1,201	0.0083	0.0083	0.0083	0.0085	0.0085	0.0085	0.0088	0.0088	0.0088	0.0000
2 L- 6	16:02	4,500	1,358	0.0091	0.0093	0.0093	0.0093	0.0095	0.0095	0.0096	0.0098	0.0098	0.0000
2 L- 7	16:07	5,000	1,515	0.0102	0.0103	0.0105	0.0104	0.0105	0.0107	0.0107	0.0108	0.0110	0.0002
2 L- 8	16:12	5,500	1,672	0.0114	0.0116	0.0120	0.0116	0.0118	0.0122	0.0119	0.0121	0.0125	0.0004
2 L- 9	16:17	6,000	1,830	0.0126	0.0126	0.0128	0.0129	0.0129	0.0131	0.0132	0.0132	0.0134	0.0002
2 L- 10	16:22	6,500	1,987	0.0136	0.0138	0.0141	0.0136	0.0142	0.0144	0.0140	0.0144	0.0147	0.0003
2 L- 11	16:27	7,000	2,144	0.0148	0.0151	0.0153	0.0151	0.0154	0.0157	0.0154	0.0157	0.0159	0.0003
2 L- 12	16:32	7,500	2,301	0.0163	0.0165	0.0168	0.0169	0.0169	0.0172	0.0170	0.0171	0.0174	0.0003
2 L- 13	16:37	8,000	2,458	0.0177	0.0181	0.0187	0.0182	0.0186	0.0192	0.0184	0.0188	0.0194	0.0006
2 L- 14	16:43	8,500	2,616	0.0196	0.0198	0.0199	0.0202	0.0203	0.0206	0.0203	0.0205	0.0207	0.0002
2 L- 15	16:48	9,000	2,773	0.0211	0.0214	0.0214	0.0217	0.0222	0.0222	0.0218	0.0222	0.0222	0.0000
2 L- 16	16:53	9,500	2,930	0.0222	0.0222	0.0225	0.0233	0.0233	0.0238	0.0232	0.0232	0.0236	0.0004
2 L- 17	17:00	9,900	3,056	0.0243	0.0246	0.0252	0.0256	0.0259	0.0266	0.0254	0.0257	0.0263	0.0006
2 U- 1	17:06	7,500	2,301	0.0255	0.0255		0.0265	0.0265		0.0264	0.0264		
2 U- 2	17:10	5,000	1,515	0.0234	0.0234		0.0238	0.0239		0.0240	0.0241		
2 U- 3	17:14	2,500	729	0.0220	0.0219		0.0226	0.0223		0.0227	0.0225		
2 U- 4	17:17	0	0	0.0182	0.0181	0.0176	0.0187	0.0185	0.0177	0.0189	0.0187	0.0181	

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

LOADTEST

DEEP FOUNDATION TESTING, EQUIPMENT & SERVICES • SPECIALIZING IN OSTERBERG CELL TECHNOLOGY

Shaft Compression (Top of O-cell)

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	Net * Load (tons)	Digital Indicator C Readings 1 min (inches)	Digital Indicator C Readings 2 min (inches)	Digital Indicator C Readings 4 min (inches)	Digital Indicator D Readings 1 min (inches)	Digital Indicator D Readings 2 min (inches)	Digital Indicator D Readings 4 min (inches)	Average shaft compression 1 min (inches)	Average shaft compression 2 min (inches)	Average shaft compression 4 min (inches)
1 L - 0	14:03	0	0	-0.0002			-0.0003			0.0000		
1 L - 1	14:06	300	37	-0.0002	-0.0002	-0.0002	-0.0004	-0.0004	-0.0004	-0.0001	-0.0001	-0.0001
1 L - 2	14:11	500	100	0.0005	0.0005	0.0006	-0.0004	-0.0004	-0.0005	0.0003	0.0003	0.0003
1 L - 3	14:16	700	163	0.0019	0.0019	0.0020	0.0016	0.0016	0.0017	0.0020	0.0020	0.0021
1 L - 4	14:25	1,000	257	0.0040	0.0043	0.0044	0.0034	0.0039	0.0039	0.0040	0.0044	0.0044
1 L - 5	14:30	1,200	320	0.0054	0.0054	0.0054	0.0048	0.0048	0.0049	0.0054	0.0054	0.0054
1 L - 6	14:38	1,400	383	0.0066	0.0066	0.0066	0.0059	0.0059	0.0059	0.0065	0.0065	0.0065
1 L - 7	14:43	1,600	446	0.0075	0.0075	0.0076	0.0068	0.0069	0.0070	0.0074	0.0075	0.0076
1 L - 8	14:49	1,800	509	0.0087	0.0088	0.0088	0.0081	0.0082	0.0083	0.0087	0.0088	0.0088
1 L - 9	14:54	2,000	572	0.0100	0.0100	0.0101	0.0094	0.0094	0.0095	0.0100	0.0100	0.0101
1 L - 10	15:00	2,500	729	0.0134	0.0135	0.0135	0.0126	0.0127	0.0127	0.0133	0.0134	0.0134
1 L - 11	15:06	3,000	886	0.0171	0.0171	0.0171	0.0155	0.0155	0.0155	0.0166	0.0166	0.0166
1 U - 1	15:12	2,000	572	0.0137	0.0137		0.0134	0.0133		0.0138	0.0138	0.0003
1 U - 2	15:15	1,000	257	0.0095	0.0095		0.0095	0.0095		0.0098	0.0098	0.0003
1 U - 3	15:18	0	0	0.0046		0.0046	0.0050		0.0050	0.0051		0.0051

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

Shaft Compression (Top of O-cell)

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	Net * Load (tons)	Digital Indicator C Readings 1 min (inches)	Digital Indicator C Readings 2 min (inches)	Digital Indicator C Readings 4 min (inches)	Digital Indicator D Readings 1 min (inches)	Digital Indicator D Readings 2 min (inches)	Digital Indicator D Readings 4 min (inches)	Average shaft compression 1 min (inches)	Average shaft compression 2 min (inches)	Average shaft compression 4 min (inches)
2 L- 0	15:34	0	0	0.0046			0.0050			0.0051		
2 L- 1	15:37	1,000	257	0.0071	0.0073	0.0074	0.0074	0.0075	0.0076	0.0075	0.0077	0.0078
2 L- 2	15:42	2,000	572	0.0125	0.0126	0.0126	0.0123	0.0123	0.0124	0.0127	0.0127	0.0128
2 L- 3	15:47	3,000	886	0.0181	0.0183	0.0186	0.0164	0.0166	0.0167	0.0175	0.0177	0.0179
2 L- 4	15:52	3,500	1,043	0.0214	0.0221	0.0222	0.0188	0.0193	0.0193	0.0204	0.0210	0.0210
2 L- 5	15:57	4,000	1,201	0.0259	0.0262	0.0262	0.0222	0.0224	0.0224	0.0243	0.0246	0.0246
2 L- 6	16:02	4,500	1,358	0.0302	0.0305	0.0305	0.0251	0.0253	0.0253	0.0279	0.0282	0.0282
2 L- 7	16:07	5,000	1,515	0.0341	0.0346	0.0350	0.0287	0.0290	0.0294	0.0317	0.0321	0.0325
2 L- 8	16:12	5,500	1,672	0.0382	0.0388	0.0392	0.0319	0.0324	0.0326	0.0353	0.0359	0.0362
2 L- 9	16:17	6,000	1,830	0.0431	0.0433	0.0440	0.0360	0.0361	0.0367	0.0398	0.0400	0.0406
2 L- 10	16:22	6,500	1,987	0.0475	0.0479	0.0484	0.0392	0.0395	0.0399	0.0436	0.0440	0.0444
2 L- 11	16:27	7,000	2,144	0.0516	0.0520	0.0524	0.0419	0.0422	0.0426	0.0470	0.0474	0.0478
2 L- 12	16:32	7,500	2,301	0.0564	0.0566	0.0566	0.0515	0.0518	0.0518	0.0542	0.0545	0.0545
2 L- 13	16:37	8,000	2,458	0.0596	0.0598	0.0602	0.0543	0.0546	0.0547	0.0572	0.0575	0.0577
2 L- 14	16:43	8,500	2,616	0.0643	0.0648	0.0650	0.0580	0.0583	0.0585	0.0614	0.0618	0.0620
2 L- 15	16:48	9,000	2,773	0.0685	0.0695	0.0698	0.0614	0.0618	0.0621	0.0652	0.0659	0.0661
2 L- 16	16:53	9,500	2,930	0.0732	0.0732	0.0736	0.0655	0.0655	0.0660	0.0696	0.0696	0.0701
2 L- 17	17:00	9,900	3,056	0.0758	0.0760	0.0763	0.0694	0.0699	0.0711	0.0729	0.0732	0.0740
2 U- 1	17:06	7,500	2,301	0.0676	0.0675		0.0633	0.0633		0.0657	0.0657	
2 U- 2	17:10	5,000	1,515	0.0548	0.0547		0.0518	0.0516		0.0536	0.0534	
2 U- 3	17:14	2,500	729	0.0405	0.0399		0.0387	0.0381		0.0399	0.0393	
2 U- 4	17:17	0	0	0.0207	0.0204	0.0201	0.0207	0.0204	0.0200	0.0210	0.0207	0.0203

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

Upward, Top of O-cell Movement (calculated)

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	Net * Load (tons)	Top of shaft (table 1)			Shaft compression (table 2)			Top of O-cell Movement			Creep
				1 min (inches)	2 min (inches)	4 min (inches)	1 min (inches)	2 min (inches)	4 min (inches)	1 min (inches)	2 min (inches)	4 min (inches)	2-4 min (inches)
1 L - 0	14:03	0	0	0.0000			0.0000			0.0000			
1 L - 1	14:06	300	37	-0.0002	-0.0003	-0.0004	-0.0001	-0.0001	-0.0001	-0.0003	-0.0004	-0.0005	-0.0001
1 L - 2	14:11	500	100	-0.0005	-0.0005	-0.0005	0.0003	0.0003	0.0003	-0.0002	-0.0002	-0.0002	0.0000
1 L - 3	14:16	700	163	-0.0009	-0.0009	-0.0008	0.0020	0.0020	0.0021	0.0011	0.0011	0.0013	0.0002
1 L - 4	14:25	1,000	257	-0.0008	-0.0007	-0.0006	0.0040	0.0044	0.0044	0.0032	0.0037	0.0038	0.0002
1 L - 5	14:30	1,200	320	-0.0002	-0.0001	0.0004	0.0054	0.0054	0.0054	0.0052	0.0053	0.0058	0.0004
1 L - 6	14:38	1,400	383	0.0017	0.0018	0.0019	0.0065	0.0065	0.0065	0.0082	0.0083	0.0084	0.0002
1 L - 7	14:43	1,600	446	0.0025	0.0025	0.0026	0.0074	0.0075	0.0076	0.0099	0.0100	0.0102	0.0002
1 L - 8	14:49	1,800	509	0.0029	0.0029	0.0029	0.0087	0.0088	0.0088	0.0116	0.0117	0.0117	0.0000
1 L - 9	14:54	2,000	572	0.0029	0.0029	0.0029	0.0100	0.0100	0.0101	0.0129	0.0129	0.0130	0.0001
1 L - 10	15:00	2,500	729	0.0038	0.0040	0.0041	0.0133	0.0134	0.0134	0.0170	0.0173	0.0175	0.0001
1 L - 11	15:06	3,000	886	0.0056	0.0060	0.0066	0.0166	0.0166	0.0166	0.0222	0.0225	0.0231	0.0006
1 U - 1	15:12	2,000	572	0.0069	0.0069		0.0138	0.0138		0.0207	0.0207		
1 U - 2	15:15	1,000	257	0.0067	0.0067		0.0098	0.0098		0.0165	0.0165		
1 U - 3	15:18	0	0	0.0057		0.0055	0.0051		0.0051	0.0108		0.0106	

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

Upward, Top of O-cell Movement (calculated)

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	Net * Load (tons)	Top of shaft (table 1) 1 min (inches)	Top of shaft (table 1) 2 min (inches)	Top of shaft (table 1) 4 min (inches)	Shaft compression (table 2) 1 min (inches)	Shaft compression (table 2) 2 min (inches)	Shaft compression (table 2) 4 min (inches)	Top of O-cell Movement 1 min (inches)	Top of O-cell Movement 2 min (inches)	Top of O-cell Movement 4 min (inches)	Creep 2-4 min (inches)
2 L- 0	15:34	0	0	0.0055			0.0051			0.0106			
2 L- 1	15:37	1,000	257	0.0054	0.0054	0.0054	0.0075	0.0077	0.0078	0.0129	0.0131	0.0132	0.0001
2 L- 2	15:42	2,000	572	0.0055	0.0056	0.0059	0.0127	0.0127	0.0128	0.0181	0.0183	0.0187	0.0004
2 L- 3	15:47	3,000	886	0.0069	0.0071	0.0075	0.0175	0.0177	0.0179	0.0244	0.0248	0.0254	0.0006
2 L- 4	15:52	3,500	1,043	0.0079	0.0082	0.0083	0.0204	0.0210	0.0210	0.0282	0.0291	0.0293	0.0001
2 L- 5	15:57	4,000	1,201	0.0088	0.0088	0.0088	0.0243	0.0246	0.0246	0.0331	0.0334	0.0334	0.0000
2 L- 6	16:02	4,500	1,358	0.0096	0.0098	0.0098	0.0279	0.0282	0.0282	0.0375	0.0380	0.0380	0.0000
2 L- 7	16:07	5,000	1,515	0.0107	0.0108	0.0110	0.0317	0.0321	0.0325	0.0424	0.0429	0.0435	0.0006
2 L- 8	16:12	5,500	1,672	0.0119	0.0121	0.0125	0.0353	0.0359	0.0362	0.0472	0.0480	0.0487	0.0007
2 L- 9	16:17	6,000	1,830	0.0132	0.0132	0.0134	0.0398	0.0400	0.0406	0.0530	0.0531	0.0540	0.0008
2 L- 10	16:22	6,500	1,987	0.0140	0.0144	0.0147	0.0436	0.0440	0.0444	0.0576	0.0584	0.0591	0.0007
2 L- 11	16:27	7,000	2,144	0.0154	0.0157	0.0159	0.0470	0.0474	0.0478	0.0624	0.0630	0.0637	0.0006
2 L- 12	16:32	7,500	2,301	0.0170	0.0171	0.0174	0.0542	0.0545	0.0545	0.0712	0.0716	0.0719	0.0003
2 L- 13	16:37	8,000	2,458	0.0184	0.0188	0.0194	0.0572	0.0575	0.0577	0.0756	0.0762	0.0771	0.0009
2 L- 14	16:43	8,500	2,616	0.0203	0.0205	0.0207	0.0614	0.0618	0.0620	0.0817	0.0823	0.0827	0.0004
2 L- 15	16:48	9,000	2,773	0.0218	0.0222	0.0222	0.0652	0.0659	0.0661	0.0870	0.0881	0.0863	0.0002
2 L- 16	16:53	9,500	2,930	0.0232	0.0232	0.0236	0.0696	0.0696	0.0701	0.0928	0.0928	0.0936	0.0009
2 L- 17	17:00	9,900	3,056	0.0254	0.0257	0.0263	0.0729	0.0732	0.0740	0.0982	0.0989	0.1003	0.0014
2 U- 1	17:06	7,500	2,301	0.0264	0.0264		0.0657	0.0657		0.0921	0.0921		
2 U- 2	17:10	5,000	1,515	0.0240	0.0241		0.0536	0.0534		0.0776	0.0775		
2 U- 3	17:14	2,500	729	0.0227	0.0225		0.0399	0.0393		0.0626	0.0618		
2 U- 4	17:17	0	0	0.0189	0.0187	0.0181	0.0210	0.0207	0.0203	0.0398	0.0394	0.0384	

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

O-cell Expansion

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	O-cell Load (tons)	LVWDT 8149 1 min (inches)	LVWDT 8149 2 min (inches)	LVWDT 8149 4 min (inches)	LVWDT 8150 1 min (inches)	LVWDT 8150 2 min (inches)	LVWDT 8150 4 min (inches)	Average Expansion 1 min (inches)	Average Expansion 2 min (inches)	Average Expansion 4 min (inches)	Creep 2-4 min (inches)
1 L - 0	14:03	0	0	0.0000			0.0000			0.0000			
1 L - 1	14:06	300	93	0.0030	0.0027	0.0029	0.0064	0.0065	0.0066	0.0047	0.0046	0.0047	0.0001
1 L - 2	14:11	500	156	0.0051	0.0053	0.0054	0.0102	0.0103	0.0105	0.0076	0.0078	0.0079	0.0001
1 L - 3	14:16	700	219	0.0054	0.0070	0.0063	0.0134	0.0134	0.0135	0.0094	0.0102	0.0099	-0.0003
1 L - 4	14:25	1,000	313	0.0117	0.0123	0.0129	0.0180	0.0190	0.0191	0.0148	0.0156	0.0160	0.0004
1 L - 5	14:30	1,200	376	0.0158	0.0159	0.0162	0.0216	0.0220	0.0217	0.0187	0.0190	0.0190	0.0000
1 L - 6	14:38	1,400	439	0.0193	0.0195	0.0197	0.0247	0.0248	0.0263	0.0220	0.0221	0.0230	0.0009
1 L - 7	14:43	1,600	502	0.0218	0.0221	0.0225	0.0283	0.0278	0.0280	0.0250	0.0250	0.0253	0.0003
1 L - 8	14:49	1,800	565	0.0256	0.0258	0.0262	0.0309	0.0313	0.0316	0.0282	0.0285	0.0289	0.0004
1 L - 9	14:54	2,000	628	0.0296	0.0299	0.0306	0.0342	0.0343	0.0347	0.0319	0.0321	0.0327	0.0006
1 L - 10	15:00	2,500	785	0.0398	0.0404	0.0411	0.0477	0.0478	0.0485	0.0438	0.0441	0.0448	0.0007
1 L - 11	15:06	3,000	942	0.0511	0.0509	0.0516	0.0574	0.0572	0.0580	0.0542	0.0540	0.0548	0.0008
1 U- 1	15:12	2,000	628		0.0471			0.0513			0.0492		
1 U- 2	15:15	1,000	313	0.0382	0.0382		0.0369	0.0369		0.0376	0.0376		
1 U- 3	15:18	0	0	0.0254		0.0252	0.0225		0.0231	0.0239		0.0241	

LOADTEST

DEEP FOUNDATION TESTING, EQUIPMENT & SERVICES • SPECIALIZING IN OSTERBERG CELL TECHNOLOGY

O-cell Expansion

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	O-cell Load (tons)	LVWDT 8149 1 min (inches)	LVWDT 8149 2 min (inches)	LVWDT 8149 4 min (inches)	LVWDT 8150 1 min (inches)	LVWDT 8150 2 min (inches)	LVWDT 8150 4 min (inches)	Average Expansion 1 min (inches)	Average Expansion 2 min (inches)	Average Expansion 4 min (inches)	Creep 2-4 min (inches)
2 L- 0	15:34	0	0	0.0252			0.0231			0.0241			
2 L- 1	15:37	1,000	313	0.0337	0.0341	0.0343	0.0338	0.0344	0.0345	0.0337	0.0342	0.0344	0.0002
2 L- 2	15:42	2,000	628	0.0456	0.0446	0.0459	0.0499	0.0501	0.0502	0.0478	0.0473	0.0480	0.0007
2 L- 3	15:47	3,000	942	0.0570	0.0569	0.0584	0.0619	0.0625	0.0632	0.0595	0.0597	0.0608	0.0011
2 L- 4	15:52	3,500	1,099	0.0638	0.0659	0.0662	0.0697	0.0711	0.0719	0.0668	0.0685	0.0690	0.0006
2 L- 5	15:57	4,000	1,256	0.0753	0.0762	0.0765	0.0801	0.0810	0.0815	0.0777	0.0786	0.0790	0.0004
2 L- 6	16:02	4,500	1,414	0.0860	0.0874	0.0876	0.0917	0.0926	0.0931	0.0888	0.0900	0.0903	0.0003
2 L- 7	16:07	5,000	1,571	0.0972	0.0975	0.1010	0.1030	0.1041	0.1056	0.1001	0.1008	0.1033	0.0025
2 L- 8	16:12	5,500	1,728	0.1089	0.1108	0.1119	0.1143	0.1170	0.1184	0.1116	0.1139	0.1152	0.0012
2 L- 9	16:17	6,000	1,885	0.1208	0.1219	0.1244	0.1288	0.1297	0.1324	0.1248	0.1258	0.1284	0.0026
2 L- 10	16:22	6,500	2,042	0.1334	0.1343	0.1369	0.1417	0.1436	0.1463	0.1376	0.1390	0.1416	0.0027
2 L- 11	16:27	7,000	2,200	0.1441	0.1455	0.1470	0.1559	0.1578	0.1596	0.1500	0.1517	0.1533	0.0017
2 L- 12	16:32	7,500	2,357	0.1588	0.1596	0.1599	0.1723	0.1724	0.1730	0.1656	0.1660	0.1665	0.0004
2 L- 13	16:37	8,000	2,514	0.1684	0.1700	0.1711	0.1835	0.1851	0.1855	0.1760	0.1776	0.1783	0.0007
2 L- 14	16:43	8,500	2,671	0.1835	0.1853	0.1862	0.2003	0.2026	0.2042	0.1919	0.1940	0.1952	0.0013
2 L- 15	16:48	9,000	2,829	0.1981	0.2006	0.2022	0.2168	0.2193	0.2224	0.2075	0.2100	0.2123	0.0023
2 L- 16	16:53	9,500	2,986	0.2141	0.2154	0.2173	0.2340	0.2367	0.2403	0.2241	0.2261	0.2288	0.0027
2 L- 17	17:00	9,900	3,111	0.2291	0.2300	0.2329	0.2533	0.2553	0.2587	0.2412	0.2427	0.2458	0.0032
2 U- 1	17:06	7,500	2,357	0.2130	0.2127		0.2343	0.2343		0.2237	0.2235		
2 U- 2	17:10	5,000	1,571	0.1803	0.1805		0.1979	0.1977		0.1891	0.1891		
2 U- 3	17:14	2,500	785	0.1442	0.1429		0.1575	0.1560		0.1509	0.1495		
2 U- 4	17:17	0	0	0.0852	0.0840	0.0831	0.0862	0.0853	0.0839	0.0857	0.0846	0.0835	

Downward, Reaction Socket Movements (calculated)

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	O-cell Load (tons)	O-cell expansion (table 4) 1 min (inches)	O-cell expansion (table 4) 2 min (inches)	O-cell expansion (table 4) 4 min (inches)	Top of O-cell (table 3) 1 min (inches)	Top of O-cell (table 3) 2 min (inches)	Top of O-cell (table 3) 4 min (inches)	Downward R.S. Movement 1 min (inches)	Downward R.S. Movement 2 min (inches)	Downward R.S. Movement 4 min (inches)	Creep 2-4 min (inches)
1 L - 0	14:03	0	0	0.0000			0.0000			0.0000			
1 L - 1	14:06	300	93	0.0047	0.0046	0.0047	-0.0003	-0.0004	-0.0005	0.0049	0.0049	0.0052	0.0002
1 L - 2	14:11	500	156	0.0076	0.0078	0.0079	-0.0002	-0.0002	-0.0002	0.0078	0.0080	0.0081	0.0001
1 L - 3	14:16	700	219	0.0094	0.0102	0.0099	0.0011	0.0011	0.0013	0.0083	0.0091	0.0086	-0.0005
1 L - 4	14:25	1,000	313	0.0148	0.0156	0.0160	0.0032	0.0037	0.0038	0.0117	0.0120	0.0122	0.0002
1 L - 5	14:30	1,200	376	0.0187	0.0190	0.0190	0.0052	0.0053	0.0058	0.0135	0.0137	0.0132	-0.0004
1 L - 6	14:38	1,400	439	0.0220	0.0221	0.0230	0.0082	0.0083	0.0084	0.0138	0.0139	0.0146	0.0007
1 L - 7	14:43	1,600	502	0.0250	0.0250	0.0253	0.0099	0.0100	0.0102	0.0152	0.0150	0.0151	0.0001
1 L - 8	14:49	1,800	565	0.0282	0.0285	0.0289	0.0116	0.0117	0.0117	0.0167	0.0169	0.0172	0.0003
1 L - 9	14:54	2,000	628	0.0319	0.0321	0.0327	0.0129	0.0129	0.0130	0.0190	0.0193	0.0197	0.0005
1 L - 10	15:00	2,500	785	0.0438	0.0441	0.0448	0.0170	0.0173	0.0175	0.0268	0.0268	0.0274	0.0005
1 L - 11	15:06	3,000	942	0.0542	0.0540	0.0548	0.0222	0.0225	0.0231	0.0321	0.0315	0.0317	0.0002
1 U - 1	15:12	2,000	628		0.0492		0.0207	0.0207			0.0285		
1 U - 2	15:15	1,000	313	0.0376	0.0376		0.0165	0.0165		0.0211	0.0211		
1 U - 3	15:18	0	0	0.0239		0.0241	0.0108		0.0106	0.0132		0.0136	

Downward, Reaction Socket Movements (calculated)

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	O-cell Load (tons)	O-cell expansion (table 4) 1 min (inches)	2 min (inches)	4 min (inches)	Top of O-cell (table 3) 1 min (inches)	2 min (inches)	4 min (inches)	Downward R.S. Movement 1 min (inches)	2 min (inches)	4 min (inches)	Creep 2-4 min (inches)
2 L- 0	15:34	0	0	0.0241			0.0106			0.0136			
2 L- 1	15:37	1,000	313	0.0337	0.0342	0.0344	0.0129	0.0131	0.0132	0.0208	0.0212	0.0212	0.0001
2 L- 2	15:42	2,000	628	0.0478	0.0473	0.0480	0.0181	0.0183	0.0187	0.0297	0.0291	0.0294	0.0003
2 L- 3	15:47	3,000	942	0.0595	0.0597	0.0608	0.0244	0.0248	0.0254	0.0351	0.0349	0.0355	0.0005
2 L- 4	15:52	3,500	1,099	0.0668	0.0685	0.0690	0.0282	0.0291	0.0293	0.0386	0.0394	0.0398	0.0004
2 L- 5	15:57	4,000	1,256	0.0777	0.0786	0.0790	0.0331	0.0334	0.0334	0.0446	0.0452	0.0456	0.0004
2 L- 6	16:02	4,500	1,414	0.0888	0.0900	0.0903	0.0375	0.0380	0.0380	0.0513	0.0521	0.0524	0.0003
2 L- 7	16:07	5,000	1,571	0.1001	0.1008	0.1033	0.0424	0.0429	0.0435	0.0577	0.0580	0.0598	0.0019
2 L- 8	16:12	5,500	1,728	0.1116	0.1139	0.1152	0.0472	0.0480	0.0487	0.0644	0.0660	0.0665	0.0005
2 L- 9	16:17	6,000	1,885	0.1248	0.1258	0.1284	0.0530	0.0531	0.0540	0.0718	0.0727	0.0744	0.0017
2 L- 10	16:22	6,500	2,042	0.1376	0.1390	0.1416	0.0576	0.0584	0.0591	0.0799	0.0806	0.0826	0.0020
2 L- 11	16:27	7,000	2,200	0.1500	0.1517	0.1533	0.0624	0.0630	0.0637	0.0876	0.0886	0.0897	0.0010
2 L- 12	16:32	7,500	2,357	0.1656	0.1660	0.1665	0.0712	0.0716	0.0719	0.0943	0.0944	0.0946	0.0001
2 L- 13	16:37	8,000	2,514	0.1760	0.1776	0.1783	0.0756	0.0762	0.0771	0.1004	0.1014	0.1013	-0.0001
2 L- 14	16:43	8,500	2,671	0.1919	0.1940	0.1952	0.0817	0.0823	0.0827	0.1102	0.1117	0.1126	0.0009
2 L- 15	16:48	9,000	2,829	0.2075	0.2100	0.2123	0.0870	0.0881	0.0883	0.1205	0.1219	0.1240	0.0021
2 L- 16	16:53	9,500	2,986	0.2241	0.2261	0.2288	0.0928	0.0928	0.0936	0.1313	0.1333	0.1352	0.0019
2 L- 17	17:00	9,900	3,111	0.2412	0.2427	0.2458	0.0982	0.0989	0.1003	0.1430	0.1438	0.1456	0.0018
2 U- 1	17:06	7,500	2,357	0.2237	0.2235		0.0921	0.0921		0.1316	0.1315		
2 U- 2	17:10	5,000	1,571	0.1891	0.1891		0.0776	0.0775		0.1116	0.1117		
2 U- 3	17:14	2,500	785	0.1509	0.1495		0.0626	0.0618		0.0883	0.0877		
2 U- 4	17:17	0	0	0.0857	0.0846	0.0835	0.0398	0.0394	0.0384	0.0459	0.0453	0.0451	

LOADTEST

DEEP FOUNDATION TESTING, EQUIPMENT & SERVICES • SPECIALIZING IN OSTERBERG CELL TECHNOLOGY

Downward Bottom of Shaft (End Bearing) Movements

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	O-cell Load (tons)	Digital Indicator E Readings 1 min (inches)	2 min (inches)	4 min (inches)	Digital Indicator F Readings 1 min (inches)	2 min (inches)	4 min (inches)	Average E.B. movement 1 min (inches)	2 min (inches)	4 min (inches)	Creep 2-4 min (inches)
1 L - 0	14:03	0	0	0.0005			-0.0006			0.0000			
1 L - 1	14:06	300	93	0.0012	0.0014	0.0014	0.0000	0.0000	0.0000	0.0007	0.0008	0.0008	0.0000
1 L - 2	14:11	500	156	0.0021	0.0021	0.0024	0.0008	0.0009	0.0011	0.0015	0.0016	0.0018	0.0003
1 L - 3	14:16	700	219	0.0046	0.0064	0.0064	0.0033	0.0051	0.0051	0.0040	0.0058	0.0058	0.0000
1 L - 4	14:25	1,000	313	0.0054	0.0054	0.0054	0.0042	0.0042	0.0042	0.0049	0.0049	0.0049	0.0000
1 L - 5	14:30	1,200	376	0.0056	0.0056	0.0056	0.0044	0.0044	0.0044	0.0051	0.0051	0.0051	0.0000
1 L - 6	14:38	1,400	439	0.0058	0.0058	0.0058	0.0044	0.0044	0.0044	0.0051	0.0051	0.0051	0.0000
1 L - 7	14:43	1,600	502	0.0060	0.0061	0.0062	0.0048	0.0048	0.0049	0.0055	0.0055	0.0056	0.0001
1 L - 8	14:49	1,800	565	0.0074	0.0076	0.0078	0.0063	0.0066	0.0066	0.0069	0.0072	0.0073	0.0001
1 L - 9	14:54	2,000	628	0.0093	0.0096	0.0100	0.0080	0.0083	0.0086	0.0087	0.0090	0.0094	0.0004
1 L - 10	15:00	2,500	785	0.0134	0.0136	0.0139	0.0120	0.0121	0.0125	0.0128	0.0129	0.0133	0.0004
1 L - 11	15:06	3,000	942	0.0181	0.0181	0.0187	0.0164	0.0164	0.0169	0.0173	0.0173	0.0179	0.0005
1 U- 1	15:12	2,000	628	0.0169	0.0169		0.0150	0.0150		0.0160	0.0160		
1 U- 2	15:15	1,000	313	0.0136	0.0135		0.0114	0.0113		0.0125	0.0125		
1 U- 3	15:18	0	0	0.0084		0.0084	0.0062		0.0062	0.0074		0.0074	

Downward Bottom of Shaft (End Bearing) Movements

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	O-cell Load (tons)	Digital Indicator E Readings 1 min (inches)	Digital Indicator E Readings 2 min (inches)	Digital Indicator E Readings 4 min (inches)	Digital Indicator F Readings 1 min (inches)	Digital Indicator F Readings 2 min (inches)	Digital Indicator F Readings 4 min (inches)	Average E.B. movement 1 min (inches)	Average E.B. movement 2 min (inches)	Average E.B. movement 4 min (inches)	Creep 2-4 min (inches)
1 L - 0	14:03	0	0	0.0005			-0.0006			0.0000			
1 L - 1	14:06	300	93	0.0012	0.0014	0.0014	0.0000	0.0000	0.0000	0.0007	0.0008	0.0008	0.0000
1 L - 2	14:11	500	156	0.0021	0.0021	0.0024	0.0008	0.0009	0.0011	0.0015	0.0016	0.0018	0.0003
1 L - 3	14:16	700	219	0.0046	0.0064	0.0064	0.0033	0.0051	0.0051	0.0040	0.0058	0.0058	0.0000
1 L - 4	14:25	1,000	313	0.0054	0.0054	0.0054	0.0042	0.0042	0.0042	0.0049	0.0049	0.0049	0.0000
1 L - 5	14:30	1,200	376	0.0056	0.0056	0.0056	0.0044	0.0044	0.0044	0.0051	0.0051	0.0051	0.0000
1 L - 6	14:38	1,400	439	0.0056	0.0056	0.0056	0.0044	0.0044	0.0044	0.0051	0.0051	0.0051	0.0000
1 L - 7	14:43	1,600	502	0.0060	0.0061	0.0062	0.0048	0.0048	0.0049	0.0055	0.0055	0.0056	0.0001
1 L - 8	14:49	1,800	565	0.0074	0.0076	0.0078	0.0063	0.0066	0.0068	0.0069	0.0072	0.0073	0.0001
1 L - 9	14:54	2,000	628	0.0093	0.0096	0.0100	0.0080	0.0083	0.0086	0.0087	0.0090	0.0094	0.0004
1 L - 10	15:00	2,500	785	0.0134	0.0136	0.0139	0.0120	0.0121	0.0125	0.0128	0.0129	0.0133	0.0004
1 L - 11	15:06	3,000	942	0.0181	0.0181	0.0187	0.0164	0.0164	0.0169	0.0173	0.0173	0.0179	0.0005
1 U- 1	15:12	2,000	628	0.0169	0.0169		0.0150	0.0150		0.0160	0.0160		
1 U- 2	15:15	1,000	313	0.0136	0.0135		0.0114	0.0113		0.0126	0.0125		
1 U- 3	15:18	0	0	0.0084		0.0084	0.0062		0.0062	0.0074		0.0074	

Downward Bottom of Shaft (End Bearing) Movements

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	O-cell Load (tons)	Digital Indicator E Readings 1 min (inches)	Digital Indicator E Readings 2 min (inches)	Digital Indicator E Readings 4 min (inches)	Digital Indicator F Readings 1 min (inches)	Digital Indicator F Readings 2 min (inches)	Digital Indicator F Readings 4 min (inches)	Average E.B. movement 1 min (inches)	Average E.B. movement 2 min (inches)	Average E.B. movement 4 min (inches)	Creep 2-4 min (inches)
2 L- 0	15:34	0	0	0.0084			0.0082			0.0074			
2 L- 1	15:37	1,000	313	0.0116	0.0119	0.0120	0.0092	0.0096	0.0098	0.0105	0.0108	0.0110	0.0002
2 L- 2	15:42	2,000	628	0.0164	0.0164	0.0164	0.0141	0.0141	0.0141	0.0153	0.0153	0.0153	0.0000
2 L- 3	15:47	3,000	942	0.0204	0.0206	0.0209	0.0182	0.0185	0.0187	0.0194	0.0196	0.0199	0.0003
2 L- 4	15:52	3,500	1,099	0.0240	0.0248	0.0251	0.0217	0.0226	0.0229	0.0229	0.0238	0.0241	0.0003
2 L- 5	15:57	4,000	1,256	0.0298	0.0306	0.0308	0.0272	0.0280	0.0283	0.0286	0.0294	0.0296	0.0003
2 L- 6	16:02	4,500	1,414	0.0358	0.0363	0.0366	0.0331	0.0337	0.0341	0.0345	0.0351	0.0354	0.0003
2 L- 7	16:07	5,000	1,571	0.0417	0.0425	0.0434	0.0391	0.0396	0.0405	0.0405	0.0411	0.0421	0.0009
2 L- 8	16:12	5,500	1,728	0.0477	0.0492	0.0499	0.0452	0.0469	0.0472	0.0465	0.0481	0.0486	0.0005
2 L- 9	16:17	6,000	1,885	0.0568	0.0573	0.0580	0.0529	0.0536	0.0552	0.0549	0.0555	0.0567	0.0012
2 L- 10	16:22	6,500	2,042	0.0634	0.0644	0.0657	0.0604	0.0614	0.0628	0.0620	0.0630	0.0643	0.0014
2 L- 11	16:27	7,000	2,200	0.0709	0.0720	0.0734	0.0675	0.0689	0.0703	0.0693	0.0705	0.0719	0.0014
2 L- 12	16:32	7,500	2,357	0.0805	0.0813	0.0816	0.0774	0.0782	0.0785	0.0790	0.0798	0.0801	0.0003
2 L- 13	16:37	8,000	2,514	0.0874	0.0884	0.0897	0.0843	0.0855	0.0865	0.0859	0.0870	0.0882	0.0012
2 L- 14	16:43	8,500	2,671	0.0984	0.1003	0.1016	0.0952	0.0972	0.0984	0.0969	0.0988	0.1002	0.0013
2 L- 15	16:48	9,000	2,829	0.1098	0.1119	0.1141	0.1064	0.1086	0.1107	0.1082	0.1103	0.1125	0.0022
2 L- 16	16:53	9,500	2,986	0.1236	0.1244	0.1270	0.1201	0.1216	0.1233	0.1219	0.1231	0.1252	0.0022
2 L- 17	17:00	9,900	3,111	0.1357	0.1369	0.1390	0.1315	0.1331	0.1351	0.1337	0.1351	0.1371	0.0021
2 U- 1	17:05	7,500	2,357	0.1309	0.1309		0.1270	0.1270		0.1290	0.1290		
2 U- 2	17:10	5,000	1,571	0.1175	0.1172		0.1133	0.1128		0.1155	0.1151		
2 U- 3	17:14	2,500	785	0.0969	0.0967		0.0934	0.0927		0.0952	0.0948		
2 U- 4	17:17	0	0	0.0673	0.0666	0.0660	0.0635	0.0628	0.0623	0.0655	0.0648	0.0642	

LOADTEST

DEEP FOUNDATION TESTING, EQUIPMENT & SERVICES • SPECIALIZING IN OSTERBERG CELL TECHNOLOGY

Strain Gage Readings at Elevations 446.3, 451.3 and 456.3 feet

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test	Time	O-cell Pressure	Net * Load	Elevation 446.3 feet			Elevation 451.3 feet			Elevation 456.3 feet		
				# 10467	# 10466	Load	# 10465	# 10464	Av. Load	# 10463	# 10462	Av. Load
Incr.	(h:m)	(psi)	(tons)	mic. in/in	mic. in/in	tons	mic. in/in	mic. in/in	tons	mic. in/in	mic. in/in	tons
2 L- 0	15:35	0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
2 L- 1	15:41	1,000	257	13.0	17.3	105	6.8	9.2	56	5.9	6.1	42
2 L- 2	15:46	2,000	572	31.6	41.4	254	18.2	22.3	141	14.7	16.2	107
2 L- 3	15:51	3,000	886	53.7	70.1	430	32.7	37.8	245	25.3	27.6	184
2 L- 4	15:56	3,500	1,043	64.6	89.3	465	40.1	46.7	302	32.2	35.5	235
2 L- 5	16:01	4,000	1,201	77.1	102.1	623	49.6	57.6	372	40.1	45.1	296
2 L- 6	16:06	4,500	1,358	90.7	119.4	730	61.0	69.0	452	49.1	53.1	355
2 L- 7	16:11	5,000	1,515	105.4	139.1	849	68.8	76.8	506	58.3	64.7	427
2 L- 8	16:16	5,500	1,672	117.0	154.6	944	79.5	92.7	598	66.6	75.8	495
2 L- 9	16:21	6,000	1,830	130.7	177.3	1070	89.7	105.9	680	78.0	87.5	575
2 L- 10	16:26	6,500	1,987	149.2	196.1	1200	102.5	119.4	771	88.0	98.1	650
2 L- 11	16:31	7,000	2,144	160.4	212.9	1297	112.6	129.9	842	96.3	109.2	714
2 L- 12	16:36	7,500	2,301	171.4	229.2	1392	122.2	140.7	913	105.0	122.5	790
2 L- 13	16:41	8,000	2,458	184.4	246.6	1497	132.9	152.4	991	113.8	130.6	849
2 L- 14	16:47	8,500	2,616	200.6	267.9	1628	145.1	167.0	1084	125.5	143.0	932
2 L- 15	16:52	9,000	2,773	215.8	288.1	1751	157.6	181.3	1177	135.5	154.5	1007
2 L- 16	16:57	9,500	2,930	228.1	306.1	1856	167.2	193.0	1251	142.9	164.7	1069
2 L- 17	17:04	9,900	3,056	240.7	320.8	1951	174.5	204.4	1316	149.5	174.2	1125
2 U- 1	17:08	7,500	2,301	191.9	264.8	1587	144.2	173.2	1103	127.4	151.4	969
2 U- 2	17:12	5,000	1,515	133.8	195.4	1144	89.9	136.7	777	100.1	121.4	770
2 U- 3	17:16	2,500	729	72.5	117.9	661	64.9	87.8	530	70.0	86.3	543
2 U- 4	17:21	0	0	12.5	29.8	147	18.5	32.2	176	29.1	39.9	240

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

Strain Gage Readings at Elevations 461.3, 468.3 and 475.3 feet

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	Net * Load (tons)	Elevation 461.3 feet # 10461 mic. in/in	# 10460 mic. in/in	Av. Load tons	Elevation 468.3 feet # 10459 mic. in/in	# 10458 mic. in/in	Av. Load tons	Elevation 475.3 feet # 10457 mic. in/in	# 10456 mic. in/in	Av. Load tons
2 L- 0	15:35	0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
2 L- 1	15:41	1,000	257	2.5	3.6	21	1.5	2.9	15	1.2	1.2	8
2 L- 2	15:46	2,000	572	6.6	9.0	54	3.2	4.9	28	2.8	3.0	20
2 L- 3	15:51	3,000	886	11.6	16.9	99	5.1	7.4	43	5.0	5.0	35
2 L- 4	15:56	3,500	1,043	15.0	20.0	122	7.0	9.9	59	6.3	6.3	44
2 L- 5	16:01	4,000	1,201	19.2	26.2	158	8.9	12.6	75	7.9	8.1	56
2 L- 6	16:06	4,500	1,358	23.8	32.1	194	12.3	15.9	98	9.5	9.8	67
2 L- 7	16:11	5,000	1,515	29.1	37.4	231	15.6	18.6	119	11.0	12.5	82
2 L- 8	16:16	5,500	1,672	33.7	43.2	267	19.0	21.0	139	12.9	14.4	95
2 L- 9	16:21	6,000	1,830	40.5	50.4	316	21.7	24.5	161	15.0	16.5	109
2 L- 10	16:26	6,500	1,987	47.6	57.8	366	24.8	28.0	183	16.6	17.9	120
2 L- 11	16:31	7,000	2,144	52.2	62.9	400	28.0	32.2	209	18.5	19.6	132
2 L- 12	16:36	7,500	2,301	58.6	69.9	446	31.7	35.9	235	20.4	21.1	144
2 L- 13	16:41	8,000	2,458	64.1	75.5	485	34.9	39.5	258	22.3	22.8	157
2 L- 14	16:47	8,500	2,616	71.7	84.0	541	38.8	44.3	289	24.6	25.0	172
2 L- 15	16:52	9,000	2,773	78.7	91.4	591	42.1	48.1	313	27.1	27.1	186
2 L- 16	16:57	9,500	2,930	81.3	98.9	626	48.0	46.9	330	28.7	30.0	207
2 L- 17	17:04	9,900	3,056	84.5	104.2	656	52.7	47.6	348	32.1	31.5	221
2 U- 1	17:08	7,500	2,301	72.4	88.6	559	46.9	42.4	310	29.0	28.9	201
2 U- 2	17:12	5,000	1,515	55.3	72.9	445	40.3	34.9	261	24.8	25.0	173
2 U- 3	17:16	2,500	729	39.6	52.7	321	32.8	27.5	209	20.3	20.9	143
2 U- 4	17:21	0	0	18.5	24.2	148	21.9	16.6	134	14.1	15.5	103

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

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Strain Gage Readings at Elevation 482.3 feet

CH-15 over the Illinois River

Marseilles, LaSalle County, Illinois.

Load Test Incr.	Time (h:m)	O-cell Pressure (psi)	Net * Load (tons)	Elevation 482.3 feet # 10455 mic. in/in	# 10454 mic. in/in	Av. Load tons
2 L- 0	15:35	0	0	0.0	0.0	0
2 L- 1	15:41	1,000	257	0.8	1.3	7
2 L- 2	15:46	2,000	572	2.1	2.5	16
2 L- 3	15:51	3,000	886	3.5	4.0	26
2 L- 4	15:56	3,500	1,043	4.3	4.9	32
2 L- 5	16:01	4,000	1,201	5.4	6.1	40
2 L- 6	16:06	4,500	1,358	6.3	7.2	47
2 L- 7	16:11	5,000	1,515	7.4	8.7	56
2 L- 8	16:16	5,500	1,672	8.9	9.4	64
2 L- 9	16:21	6,000	1,830	9.8	11.1	73
2 L- 10	16:26	6,500	1,987	11.1	12.1	81
2 L- 11	16:31	7,000	2,144	12.8	14.0	91
2 L- 12	16:36	7,500	2,301	13.7	15.6	102
2 L- 13	16:41	8,000	2,458	14.5	17.4	111
2 L- 14	16:47	8,500	2,616	16.0	19.2	122
2 L- 15	16:52	9,000	2,773	17.4	21.2	134
2 L- 16	16:57	9,500	2,930	18.2	24.5	148
2 L- 17	17:04	9,900	3,056	19.4	27.1	162
2 U- 1	17:08	7,500	2,301	17.7	24.7	147
2 U- 2	17:12	5,000	1,515	15.5	21.8	130
2 U- 3	17:16	2,500	729	13.1	18.4	109
2 U- 4	17:21	0	0	9.3	14.0	81

* Net load calculated as O-cell load minus bouyant weight of shaft : 55.7 tons

APPENDIX C

CONSTRUCTION OF EQUIVALENT TOP-LOADED CURVE

CONSTRUCTION OF THE EQUIVALENT TOP-LOADED LOAD-SETTLEMENT CURVE FROM THE RESULTS OF AN O-CELL TEST

Introduction: Some engineers find it useful to see the results of an O-cell load test in the form of a curve showing the load versus settlement of a top-loaded shaft. We believe that an O-cell test can provide a good estimate of this curve when using the method described herein.

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

1. The end bearing load-movement curve in a top-loaded shaft has the same loads for a given movement as the end bearing load-movement curve developed by the bottom of the O-cell when placed at or near the bottom of the shaft.

2. The side shear load-movement curve in a top-loaded shaft has the same shear for a given downward movement as occurred in the O-cell test for that same movement in the upward direction. The same applies to the upward movement in a top-loaded tension test.

3. The shaft behaves as a rigid body.
   (The typical shaft compression equals less than 0.05 inches.)

Procedure: Please refer to the attached Figure A showing O-cell test results and to Figure B, the constructed equivalent top loaded settlement curve. Note that each of the curves shown has points numbered from 1 to 12 such that the same point number on each curve has the same magnitude of movement. For example, point 4 has an upward and downward movement of 0.40 inches in Figure A and the same 0.40 inches downward in Figure B.

Using the above assumptions, construct the equivalent curve as follows: Select an arbitrary movement such as the 0.40 inches to give point 4 on the shaft side shear load movement curve in Figure A and record the 1040 ton load in shear at that movement. Because we have a rigid shaft, the top of the shaft moves downward the same as the bottom. Therefore, find point 4 with 0.40 inches of downward movement on the end bearing load movement curve and record the corresponding load of 2140 tons. Adding these two loads will give the total load of 3180 tons due to side shear plus end bearing at the same movement and thus gives point 4 on the Figure B load settlement curve for an equivalent top-loaded test.

One can use the above procedure to obtain all the points in Figure B up to the component that moved the least at the end of the test, in this case point 5 in end bearing. To take advantage of the fact that the test produced side shear movement data up to point 12, we need to make an extrapolation of the end bearing curve. We usually use a convenient and suitable hyperbolic curve fitting technique for this extrapolation. Deciding on the maximum number of data points to provide a good fit (a high r^2 correlation coefficient) requires some judgement. In this case we omitted point 1 to give an $r^2 = 0.999$ (including point 1 gave $r^2 = 0.965$) with the result shown as points 6 to 12 on the dotted extension of the measured end bearing curve. Using the same movement matching procedure described earlier we can then extend the equivalent curve to points 6 to 12. The results, shown in Figure B as a dashed line, signify that this part of the equivalent curve depends partly on extrapolated data.

Sometimes, if the data warrants, we will use extrapolations of both side shear and end bearing to extend the equivalent curve to a greater movement than the maximum measured (point 12). An appendix in this report gives the details of the extrapolation(s) used with the present O-cell test and shows the fit with the actual data.

Other Tests: The example illustrated in Figure A has the maximum component movement in side shear. The procedures remain the same if the maximum test movement occurred in end bearing. Then we would have extrapolated side shear to produce the dashed-line part of the reconstructed top-load settlement curve.

The example illustrated also assumes a shaft top-loaded in compression. For a shaft top-loaded in tension we would, based on assumptions 2. and 3., use the upward side shear load curve in Figure A for the equivalent top-loaded displacement curve.

Expected Accuracy: We know of only four series of tests that provide the data needed to make a direct comparison between actual, full scale, top-loaded pile movement behavior and the equivalent behavior obtained from an O-cell test by the method described herein. These involve three sites in a variety of soils, all in Japan, with two compression tests on drilled shafts, one compression test on a driven pile and one tension test on a drilled shaft. The largest shaft had a 1.2 m diameter and a 37 m length. The pile had a 1-m increment modular construction and a 9 m length.

The following references detail the aforementioned tests and the results therefrom:

> Kishida H. et al., 1992, "Pile Loading Tests at Osaka Amenity Park Project," Paper by Mitsubishi Co., also briefly described in Schmertmann (1993, see bibliography). Compares one drilled shaft in tension and another in compression.
>
> Ogura, H. et al., 1995, "Application of Pile Toe Load Test to Cast-in-place Concrete Pile and Precast Pile," special volume 'Tsuchi-to-Kiso' on Pile Loading Test, Japanese Geotechnical Society, Vol. 3, No. 5, Ser. No. 448. Original in Japanese. Translated by M. B. Karkee, GEOTOP Corporation. Compares one drilled shaft and one driven pile, both in compression.

We compared the predicted equivalent and measured movement behavior at three top movements in each comparison, ranging from ¼ inch (6 mm) to 40 mm, depending on the data available. The (equiv./meas.) ratios averaged 1.03 in the 12 comparisons with a coefficient of variation of 9.4%. We believe that these available comparisons help support the practical validity of the equivalent top-load method described herein.

Limitations: The engineer using these results should judge the conservatism of the aforementioned assumptions and extrapolation(s) before utilizing the results for design purposes. For example, brittle failure behavior may produce movement curves with abrupt changes in curvature (not hyperbolic). However, we believe the hyperbolic fit used usually produces reasonable extrapolations.

Example of the Construction of a Equivalent Top-Loaded Settlement Curve (Figure B) From Osterberg Cell Test Results (Figure A).

Figure A

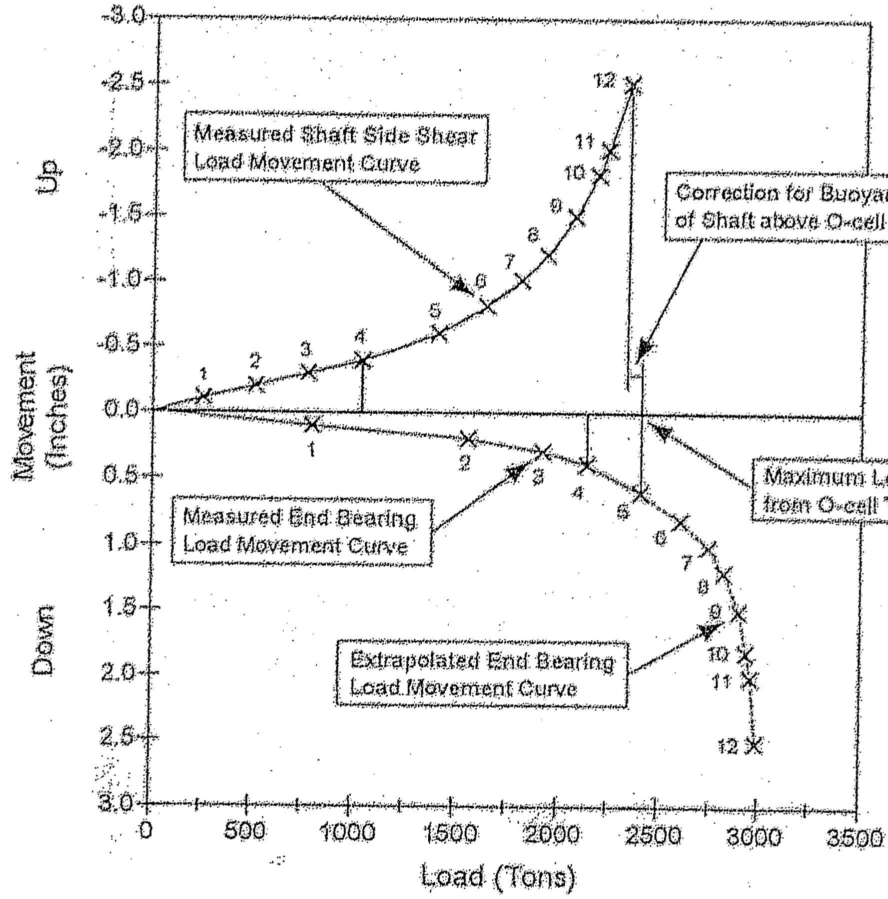
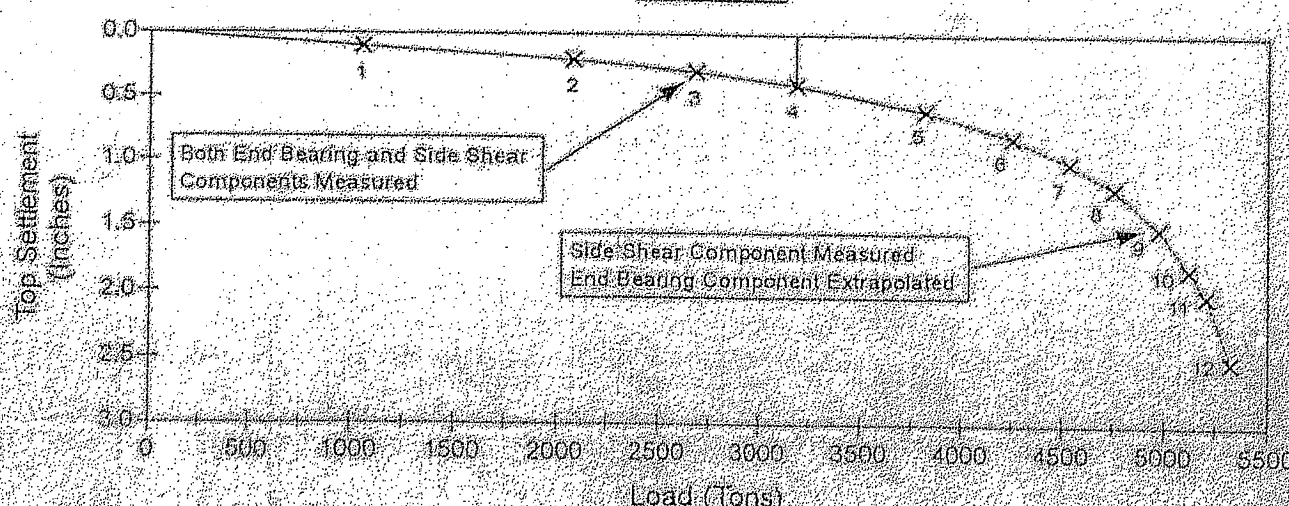


Figure B



APPENDIX D

O-CELL METHOD FOR DETERMINING CREEP LIMIT

O-CELL METHOD FOR DETERMINING A CREEP LIMIT LOADING ON THE EQUIVALENT TOP-LOADED SHAFT

Background: 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.

This method follows from long experience with the pressuremeter test (PMT). Figure 8 and section 9.4 from ASTM D4719, copied 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 become significant beyond this break loading and progressively more severe creep can occur.

Definition: 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.

Procedure if both M_{CL1} and M_{L2} available: 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}.

Procedure if only M_{CL1} available: 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 $M_{CL2} = M_x$.

Procedure if no creep limit observed: 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.

Limitations: 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.

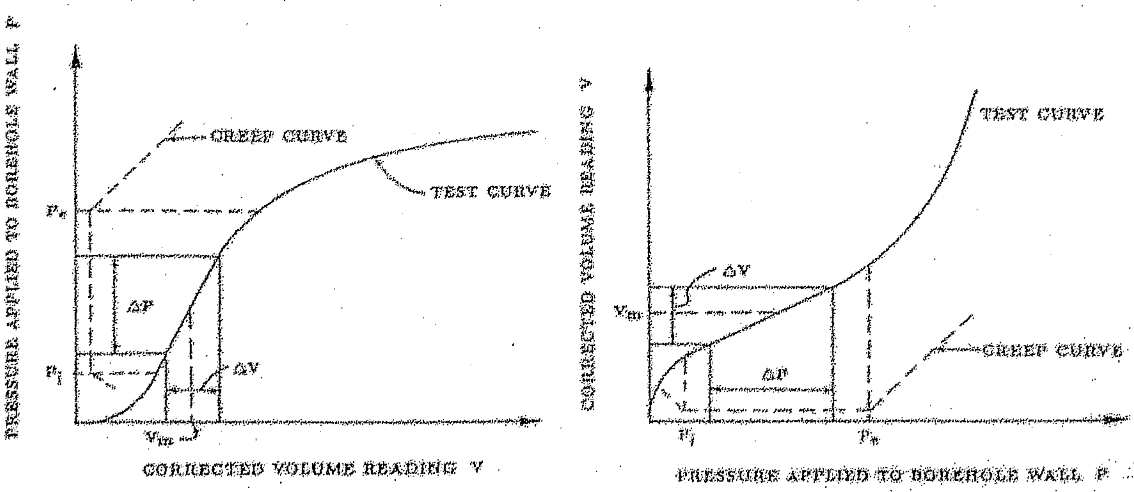


FIG. 8 Pressuremeter Test Curves for Procedure A

APPENDIX E

PHOTOGRAPHS OF TEST SHAFT INSTALLATION AND INSTRUMENTATION SET-UP

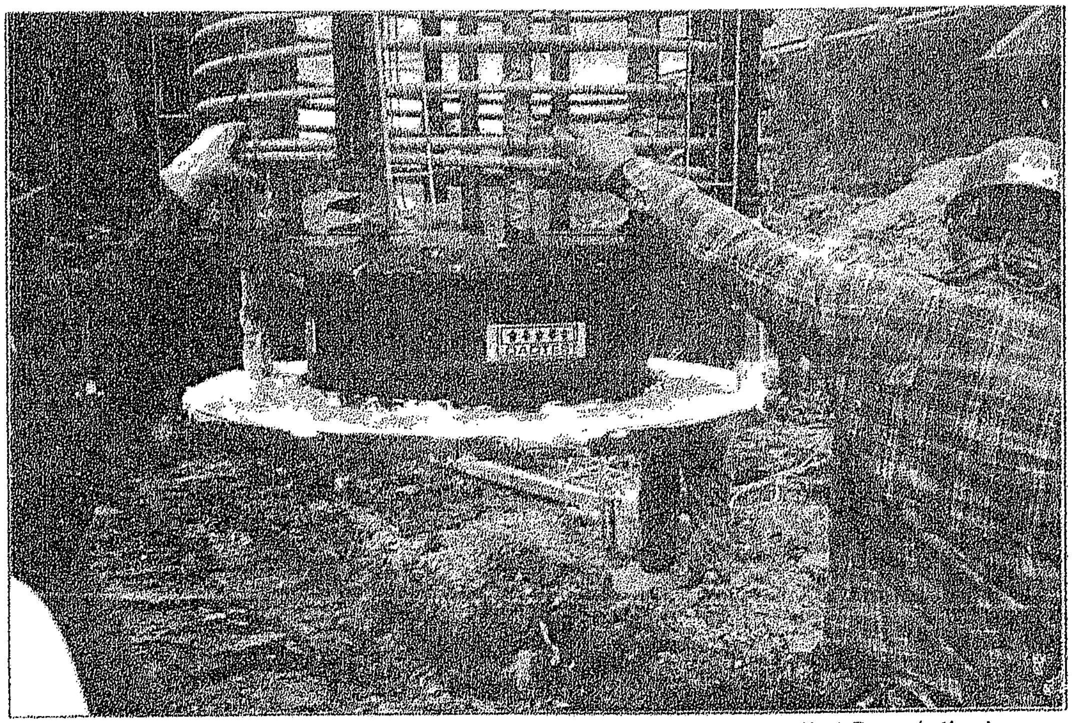


Photo 1: Osterberg Cell Test Assembly (See Figure 2 for Detailed Description)

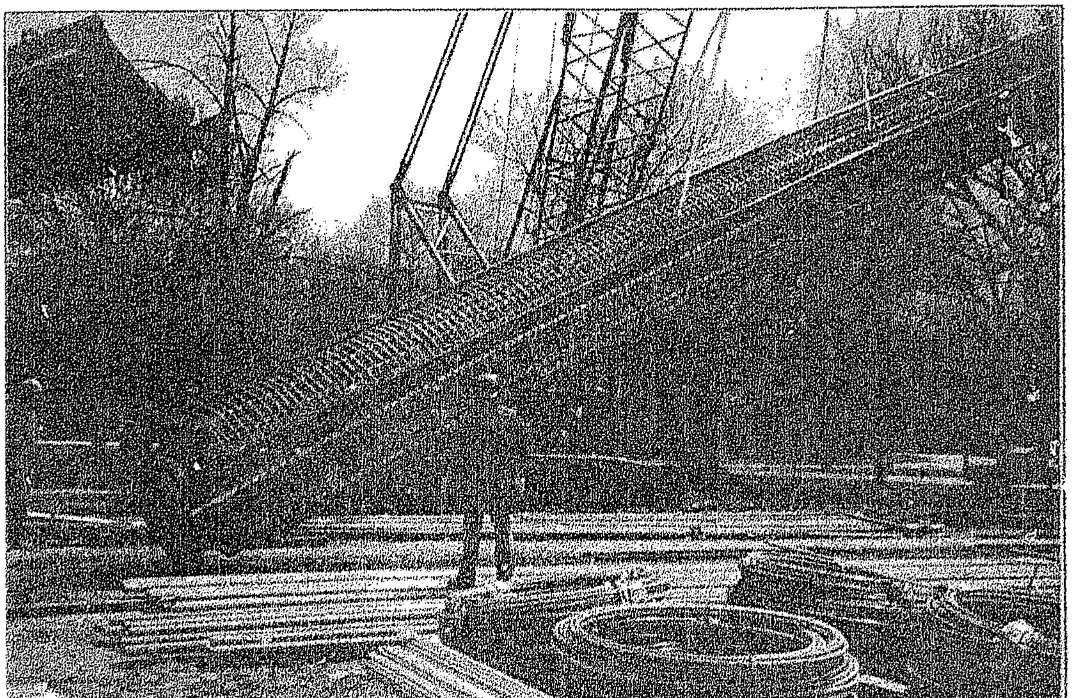


Photo 2: Osterberg Cell and Reinforcing Steel Cage Being Lifted Prior to Installation

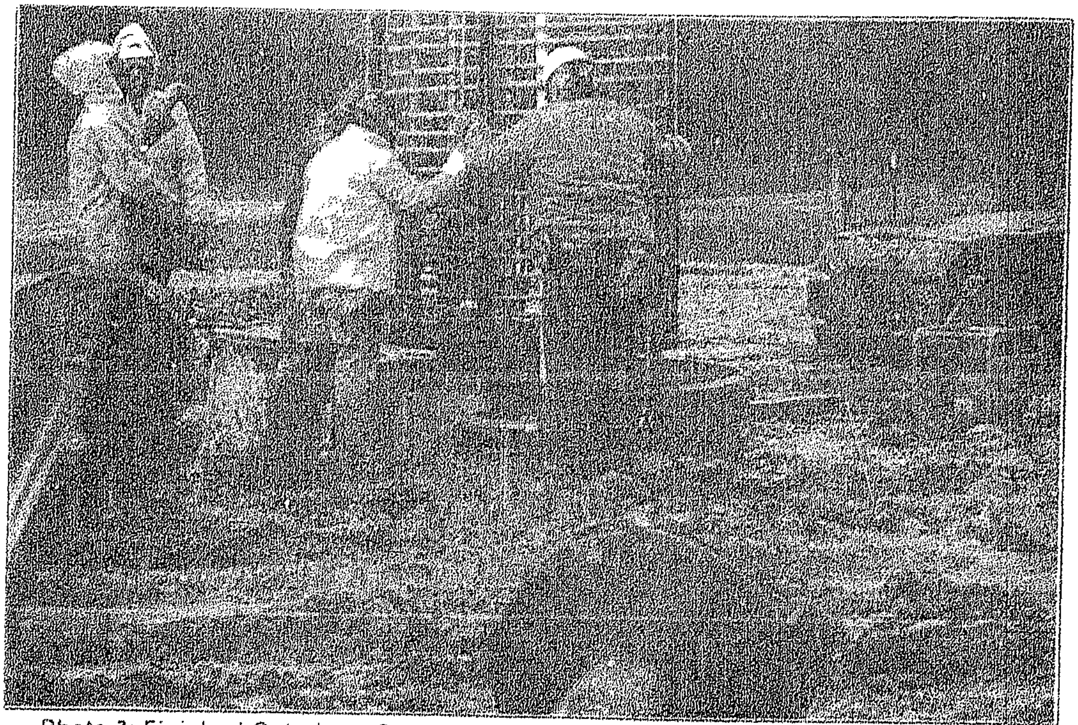


Photo 3: Finished Osterberg Cell Assembly Being Lowered into Test Pier No. 2-West

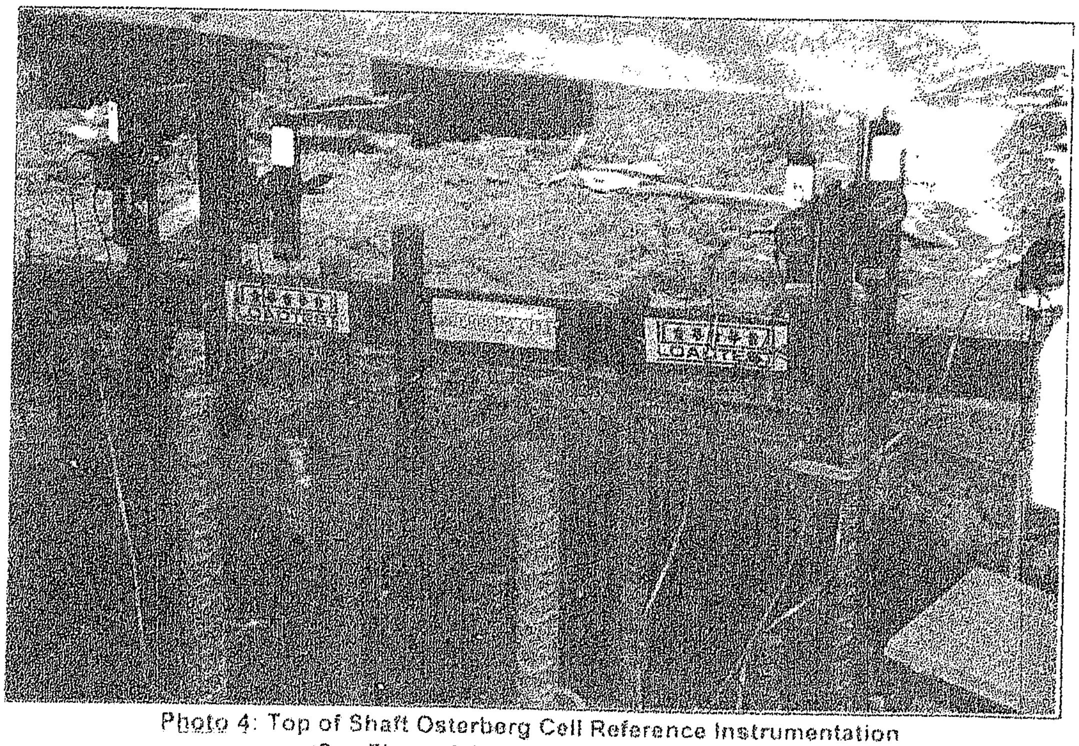


Photo 4: Top of Shaft Osterberg Cell Reference Instrumentation
(See Figure 3 for Detailed Description)

APPENDIX F

COPY OF TEST BORING LOG (SB-39)
PROVIDED BY CLARK-DIETZ, INC.

CLAUDE H. HURLEY COMPANY

BORING LOG

PROJECT NO. 3-010-D2 — BORING NO. SB-39

PROJECT: ILLINOIS RIVER BRIDGE REPLACEMENT FAU 6265 (CH-15) SECTION 1 BR-1

LOCATION: BRIDGE NO. 050-0219 (STRUCTURE) 1+353.0 (STATION) C.L. (OFFSET) (STREET) MARSEILLES, (CITY) ILLINOIS (STATE)

DRILLING CONTRACTOR: D & G DRILLING, INC.

DATE OF DRILLING: STARTED 9-27-93 COMPLETED 9-30-93 SURFACE ELEVATION 152.58

DRILLED BY: L. KODITEK — LOGGED BY: J. DUDLICEK

GROUNDWATER DATA

	DATE	DEPTH	HOUR
DD	9-27	1.7	-
AAR	9-27	1.7	0
-	10-1	0.9	24

DRILLING METHOD

RIG TYPE: MOBILE B-57
AUGER TYPE-DEPTH: 102mm FA-1.6m
CASING TYPE-DEPTH: NX-2.3m
SAMPLER TYPE: FA-SS-NX

Elev / Classification	Depth	N bpm/3	Qu 100kPa	w %	Td 100g/cc
FILL - BLK & BR CLAY LOAM, A-6 W/ROOTS		AU	-	22	-
		11	-	37	-
152.13 BR TO DK BR SANDY LOAM, A-4		22	-	19	-
151.67 BR TO YEL BR & GR WEAKLY CEMENTED SANDSTONE	1	100/0.20m	-	16	-
	5	100/0.05m	-	17	-
151.00 GR LAMINATED SHALE	2	NX	REC = 100% RQD = 50%		
w = 12% γ_d = 225 100g/cc Qu = 0.8MPa					
149.69 GR TO DK GR & BLK LAMINATED SHALE	3, 10	NX	REC = 100% RQD = 0%		
		NX	REC = 0% RQD = -		
GR TO DK GR & BLK LAMINATED SHALE	4	NX	REC = 0% RQD = -		
148.01 GR LIMESTONE	15	NX	REC = 100% RQD = 0%		
147.86 GR TO LT GR LAMINATED SHALE	5	NX	REC = 100% RQD = 40%		
147.40 GR LIMESTONE		NX	REC = 100% RQD = 0%		
147.25 GR TO GRN GR MASSIVE SHALE		NX	REC = 0% RQD = -		
146.64 GR LIMESTONE	6	NX	REC = 100% RQD = 0%		
146.49 GR MASSIVE SHALE	20	NX	REC = 0% RQD = -		

CLAUDE H. HURLEY COMPANY

BORING LOG

PROJECT NO. 3-010-D2 — BORING NO. SB-39 (CONT)

PROJECT: ILLINOIS RIVER BRIDGE REPLACEMENT FAU 6265 (CH-15) SECTION 1 BR-1

LOCATION: BRIDGE NO. 050-0219 (STRUCTURE) 1+353.0 (STATION) C.L. (OFFSET) (STREET) MARSEILLES, (CITY) ILLINOIS (STATE)

DRILLING CONTRACTOR: D & G DRILLING, INC.

DATE OF DRILLING: STARTED 9-27-93 COMPLETED 9-30-93 SURFACE ELEVATION 152.58

DRILLED BY: L. KODITEK — LOGGED BY: J. DUDLICEK

GROUNDWATER DATA

	DATE	DEPTH	HOUR
DD	9-27	1.7	-
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DRILLING METHOD

RIG TYPE: MOBILE B-57
AUGER TYPE-DEPTH: 102mm FA-1.6m
CASING TYPE-DEPTH: NX-2.3m
SAMPLER TYPE: FA-SS-NX

Elev / Classification	Depth	N bpm/3	Qu 100kPa	w %	Td 100g/cc
GR MASSIVE SHALE		NX	REC = 0% RQD = -		
145.88 GRN GR TO GR LAMINATED SHALE		NX	REC = 100% RQD = 100%		
145.72 GR TO GRN GR MASSIVE SHALE	7	NX	REC = 100% RQD = 63%		
w = 16% γ_d = 233 100g/cc Qu = 0.4MPa					
145.11 LT GR TO GRN GR LAMINATED SHALE	25	NX	REC = 100% RQD = 71%		
w = 7% γ_d = 243 100g/cc Qu = 0.8MPa E = 19.3MPa u = 0.47	8				
144.20 GR TO GRN GR MASSIVE SHALE	9, 30	NX	REC = 94% RQD = 0%		
143.29 LT GR TO GR LAMINATED SILTY SHALE	10	NX	REC = 100% RQD = 36%		
LT GR TO GR LAMINATED SILTY SHALE	35	NX	REC = 100% RQD = 36%		
141.76 w = 6% γ_d = 238 100g/cc Qu = 10.7MPa	11				
LT GR TO GR MASSIVE SILTY SHALE		NX	REC = 100% RQD = 75%		
141.00 GR & DK GR MASSIVE SILTY SHALE	12, 40, 13	NX	REC = 100% RQD = 49%		

CLAUDE H. HURLEY COMPANY

BORING LOG

PROJECT NO. 3-010-D2 — BORING NO. SB-39 (CONT)

PROJECT: ILLINOIS RIVER BRIDGE REPLACEMENT FAU 6265 (CH-15) SECTION 1 BR-1

LOCATION: BRIDGE NO. 050-0219 (STRUCTURE) 1+353.0 (STATION) C.L. (OFFSET) (STREET) MARSEILLES, (CITY) ILLINOIS (STATE)

DRILLING CONTRACTOR: D & G DRILLING, INC.

DATE OF DRILLING: STARTED 9-27-93 COMPLETED 9-30-93 SURFACE ELEVATION 152.58

DRILLED BY: L. KODITEK — LOGGED BY: J. DUDLICEK

GROUNDWATER DATA

	DATE	DEPTH	HOUR
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DRILLING METHOD

RIG TYPE: MOBILE B-57
AUGER TYPE-DEPTH: 102mm FA-1.6m
CASING TYPE-DEPTH: NX-2.3m
SAMPLER TYPE: FA-SS-NX

Elev / Classification	Depth	N bpm/3	Qu 100kPa	w %	Td 100g/cc
GR & DK GR MASSIVE SILTY SHALE		NX	REC - 100% RQD - 49%		
139.02 END OF BORING	45, 14, 15, 50, 16				
	55, 17, 18, 60, 19				