Applied Foundation Testing

April 20, 2018
Revised: April 30, 2018

Final Report of Lateral
STAT*NAMIC* Load Testing
I-10 Mobile River Bridge
Mobile, Alabama
AFT Project No.: 518009

Authored By:

Katherine Shaw
Staff Mechanical Engineer

For: **Mr. Curtis Johnson**
Jordan Pile Driving, Inc.
301 N. Water Street
Mobile, Alabama 36652

Donald T. Robertson, P.E.
Principal Geotechnical Engineer
Alabama License No.: 22873

ALABAMA LICENSED No. 22873 PROFESSIONAL ENGINEER DONALD T. ROBERTSON

Digitally signed by Donald T Robertson
DN: c=US, o=APPLIED FOUNDATION TESTING, ou=APPLIED FOUNDATION TESTING, cn=Donald T Robertson, 0.9.2342.19200300.100.1.1=A01097C000001617C717FAC0000EEB3
Date: 2018.05.11 10:11:59 -04'00'

REVISIONS 04/27/2018

Introduction

- 1st Paragraph – Interstate 10 over Mobile River – I 10 is the bridge – please reword
  - Changed to I10 Mobile River Bridge

Generalized Soil Conditions

- Boring no was MB-1 not MB-11
  - Corrected
- Did not find the boring referenced in Appendix A
  - Soil Boring record added to Appendix B, reference in document revised.

Geometry Description

- Please double check the bottom elevation of the cage/load cell. It may have been closer to 11 feet above the bottom of the drilled shaft with consideration of the original ground surface resurveyed. Also raised an additional 2 feet in consideration of undercutting soil for lateral testing apparatus -All elevations checked with available records.

Lateral Statnamic Test Setup and Test Pile Instrumentation

- 1st Paragraph – we applied a load up to approximately 1500 kips I thought…not 1000 kips
  - Corrected
- 6th Paragraph – calibration sheets are located in Appendix C not B
  - Corrected
- Table 1 – please double check elevations for sensor locations -see Geometry Description

Page 8 Table 2

- There is not a table 2 identification on the table.
  - Table identification added.
- Table 2 – Effective unit weights should be pcf not pci for the values provided in the table
  - Corrected

Summary and Conclusions

- 1st Paragraph - We did not have a rock socket.
  - Corrected

Appendix A

- Graph on Page 10 needs a legend
- Graph on Page 15 needs a legend
- LPile Graph on Page 23 needs a title
  - All Graphs corrected.
- On the LPile (Figure 14) output following Figure 13, appears to be the Linear model. Please identify the graph with a title and include the graph for the non-linear LPile analyses. Confirm “load case” on the legend Figure 14 is the same as the load cases on Figure 13. There appears to be more load scenarios for the Linear/Nonlinear curve on Figure 13 than presented in Figure 14.
  - Graphs and legends were adjusted to reflect actual test loads, and loads added for analysis. Also added additional pile head deflection plot for Type 1 Case.

- To better understand the measured vs modeled displacement profile vs elevation, it would be helpful to have Figure 6 overlayed with the L Pile analyses (Figure 14-Linear and Figure 15-Nonlinear).

- For understanding, individual plots for each load case were added comparing raw data, Type 1, and Type 2 deflections.

Appendix B

- Please double check elevations based upon as constructed and surveyed -see Geometry Description

REVISIONS 05/07/2018

1. Boring Log MB-1 has not been included in Appendix B and is not labeled on Appendix B cover sheet
   a. Soil Boring added to Appendix B and Cover sheet
2. Figure 6 needs editing as the cycles in the legend seem to be mislabeled.
   a. Corrected.

INTRODUCTION

This report is provided to summarize the results of the lateral Statnamic load testing performed for the load test program being performed as part of the proposed new Interstate 10 Mobile River Bridge Project in Mobile County, Alabama. The bridge will replace the existing tunnel currently in service. The load test program will consist of installation and testing of 11 driven piles and 1 drilled shaft. Foundation types include HP 14 x 89 piles, 18" PPC square piles, a 60" diameter steel open-ended pipe pile, a 72" diameter drilled shaft, 54" diameter PPC cylindrical piles, and a 30" PPC square pile.

In accordance with our scope of services, Applied Foundation Testing (AFT) performed lateral Statnamic load testing on the test drilled shaft. The test shaft had a design diameter of 72-inches and was constructed with a total overall length of 180 feet. Please refer to the project source documents for a site plan of the actual location of the test shaft. This report only contains the analysis and results of the lateral Statnamic load testing for the referenced test shaft. Results of all other testing (bi-directional load testing, CSL, etc.) performed on the test shaft are provided under separate covers.

Jordan Pile Driving, was the general contractor and provided necessary office and field support to carry out the lateral Statnamic load testing. A.H. Beck was the drilled shaft contractor responsible for the installation of the test shaft and supplied field support to carry out the lateral Statnamic load testing. Applied Foundation Testing (AFT) was the specialty engineering firm performing the lateral Statnamic load testing. Field instrumentation and set up of the Statnamic load test was performed by AFT Technician Mr. Jason Frederick. Data acquisition during testing was performed by Mr. Joseph Bailey, P.E, and Katherine Shaw. Katherine Shaw also performed the data reduction and reporting. Mr. Donald T. Robertson, P.E is the overall project manager and responsible Engineer for the project and provided quality assurance oversight for the data analysis and reporting.

GENERALIZED SOIL CONDITIONS

A soil test boring (Boring No. MB-1) was performed at the shaft location and is included in <u>Appendix B</u>.

In general, the overburden soils at this location consisted of compacted gravel from original ground surface elevation to approximately +3.0 feet. From elevation +3.0 feet to -83.0 there were alternating layers of poorly graded sand/silt and very dense sandy silt. Following this was a layer of fat clay from approximately -83 feet to -98 feet. Below this elevation poorly graded sand sand/silt combinations were present to an approximate elevation of -123.0 feet. Another fat clay layer was present from elevation -128.0 feet to -132.0 feet. Poorly graded sand/silt was present until shaft termination at -170 feet.

These descriptions of soil conditions represent a summary of conditions as indicated in the provided materials and is included only to assist in evaluation of the load test data. For details regarding the soil conditions at the test site and elsewhere, the reader should reference the project source documents.

GEOMETERY DESCRIPTION

Longitudinal shaft reinforcement for the test shaft consisted of thirty-six (36) #11 reinforcement bar pairs from an approximate elevation of +9.88 feet to -118.2 feet and eight (8) #11 reinforcement bars from approximate elevation -10.0 feet to the bi-directional cell assembly. All longitudinal shaft reinforcement was surrounded by #7 spiral shear hoops from approximate elevation of -118.2 feet to -161.6 feet.

The reinforcement cage was constructed with two bi-directional load testing assemblies the upper cell assembly was located at approximately elevation -118.2 feet. The lower cell assembly was located at approximately -161.6 feet in elevation. Please reference project source documents for further details regarding the bi-directional load testing. The reinforcement cage contained eight (8) steel CSL access tubes for integrity testing. Prior to the reinforcement cage being lowered into the excavation AFT tied multiple levels of embedded “sister bar” strain gages to the reinforcement steel to measure the bending strains in the test shaft during the lateral load test. In addition to the embedded strain gage instrumentation, AFT also cast an inclinometer casing into the drilled shaft to allow access for the down-hole accelerometers.

The reinforcement cage was inserted into the excavation and temporarily supported from the permanent casing. A pump and 10.0-inch tremie pipe was used to place concrete. The concrete was pumped from the base of the shaft until sound concrete was observed at the top of the drilled shaft (EL. $^{+}$10.2 feet).

AFT was not under contract to document the test shaft installation, but we have provided this summary based on our onsite observations and information as provided by the Contractor and the Owner’s representatives. For more information on the test shaft construction, the reader should reference the project source documents.

LATERAL STATNAMIC TEST SETUP AND TEST PILE INSTRUMENTATION

Preparation for the Statnamic lateral load test included embedment of strain gage instrumentation and inclinometer casing during construction of the test shaft, and assembly of the Statnamic equipment and instrumentation at the top of the test shaft. Test shaft preparation prior to testing included attaching a hemispherical bearing on the test shaft to transfer the load without restraining the shaft to rotation. Loading was applied in four successively increasing load cycles using a Statnamic device, capable of delivering an applied load to 1,500 kips, and the shaft displacement response measured. Lateral load testing for the test shaft was performed on April 12 and 13, 2018.

The Statnamic device was horizontally mounted on a sled for lateral testing. The device uses a controlled burn of fuel to generate gas pressure inside a cylinder and ram (analogous to a gas actuated jack). As the pressure builds, it reacts against a mass. The pressure eventually builds high enough to propel the reaction mass horizontally away from the foundation; in turn an equal and opposite load is applied horizontally to the test shaft.

The Statnamic device produces a time dependent load on the order of 1/2 second or less. The load produced is not an impact, which makes the Statnamic analysis very simplified and more reliable than dynamic techniques. The applied Statnamic load is measured with a ring type electronic resistance load cell, located between the foundation and the Statnamic piston.

Displacement measurements were provided by double integration of accelerometers. Three accelerometers were mounted on the test shaft at external positions. One accelerometer was mounted at or near the point of load application. The other accelerometers were mounted approximately 7.0 inches and 9.25 inches above the point of load application as a means of redundant top of shaft displacements. Survey measurements (provided by Jordan Pile Driving) were taken before and after each load cycle as a measure of permanent displacement. A string of eight subsurface accelerometers were installed via individual guide mounts, which were lowered into the grooved inclinometer casing that was cast into the test shaft. These accelerometers were oriented to detect lateral motion in the direction of applied load.

Four levels of strain gages (four gages per level) were monitored during testing which was an indication of bending in the test shaft. Sister bar quarter bridge electronic resistance strain gages were manufactured by AFT in our laboratory using Micro-Measurements gauge type CEA-06-125UW-350. The gages were installed on the reinforcement cage prior to its placement inside the excavation.

All of the test shaft data were monitored via a National Instruments data acquisition system with a sampling rate of 10,000 samples per second for each channel. Data reduction and analyses were performed using Matlab® software for each loading cycle. Table 1 below contains a summary of the instrumentation locations. Calibration data on the instrumentation is included in Appendix C.

Table 1. Test Shaft Instrumentation and Key Locations

General Shaft Information	
Top of Permanent Casing Elevation (feet)	+10.2
Bottom of Permanent Casing Elevation (feet)	-46.8
Shaft Tip Elevation (feet)	-170.0
Shaft Diameter (EL. +9.92 to -46.8 feet) (inches)	77.0
Shaft Diameter (EL. -46.8 to -170.0 feet) (inches)	72.0
Top of Concrete Elevation (feet)	+9.9
Concrete Strength used for Analysis (psi)	6,468
Top of Shaft Instrumentation	
Point of Load Application Elevation (feet)	+6.9
ACCEL_1 Elevation (feet)	+6.9
ACCEL_2 Elevation (feet)	+7.1
ACCEL_3 Elevation (feet)	+9.6
Strain Gage Levels Locations	
Strain Gage Level 1 Elevation (feet)	-57.6
Strain Gage Level 2 Elevation (feet)	-77.8
Strain Gage Level 3 Elevation (feet)	-99.1
Strain Gage Level 4 Elevation (feet)	-135.8
Down-Hole Accelerometers Locations	
DH1 Elevation (feet)	+0.3
DH2 Elevation (feet)	-6.3
DH3 Elevation (feet)	-12.3
DH4 Elevation (feet)	-18.3
DH5 Elevation (feet)	-24.3
DH6 Elevation (feet)	-30.3
DH7 Elevation (feet)	-36.3
DH8 Elevation (feet)	-42.3

LATERAL STATNAMIC TEST RESULTS

The lateral Statnamic loads applied to the test shaft are shown as a function of time in Figure 1, while displacement measurements from the double integration of the shaft accelerometer located at the load point are shown as a function of time in Figure 2. An example of all the top of shaft displacements made from double integration of the three external accelerometers are provided in Figure 3 for load cycle number 4; others were similar.

Top of shaft displacements measured from the external accelerometers were corrected to include the permanent displacement measured by a Jordan Pile Driving surveyor between load cycles. The magnitude of permanent displacement has been added to the top displacement measured from the external accelerometers.

The plots in Figures 4 and 5 are an example of the acceleration and displacement time histories derived from the uppermost four and the lowermost four, respectively, down-hole accelerometer measurements for load cycle number 4; others were similar. The peak values of displacement at each accelerometer location (load point at top of shaft, and the lower 7 internal down-hole locations) are presented in Figure 6 as a function of depth for each of the load cycles. Note the decreasing amplitude of motion of the down-hole accelerometers (below grade) coincides with increasing depth. The strain gage data versus time and the peak strain gage data with depth are shown in Figures 7 and Figure 8, respectively.

The relatively large difference between the magnitude of the tensile strains (+) and the magnitude of the compression strains (-) measured around strain gage level 1 (EL. -57.62) during load cycles 3 and 4 is indicative of significant concrete cracking. The data obtained from the lower strain gage level indicates little to no change in strain during the load testing.

Derived Static Load Procedure

Using a simple single degree of freedom system, an equivalent static response was derived from the Statnamic lateral test measurements. This model includes a nonlinear static spring resistance, inertia of the shaft rotating about a hinge point, and a viscous damping component.

$$F_{Statnamic} = F_{inertia} + F_{damping} + F_{static}$$

where,

$F_{Statnamic}$ = measured force on the Statnamic load cell
$F_{inertia}$ = inertial resistance from effective mass of the foundation
$F_{damping}$ = effective viscous damping resistance
F_{static} = effective static soil resistance

The inertial resistance is roughly that of a cylinder rotating about its base, with a diameter equal to that of the shaft and a height taken initially as approximately 42.0 feet, based on the observed displacement pattern and bending strain behavior. For such a cylinder of radius r, height h, and mass m, the mass moment of inertia about the base, Iy is:

$$I_y = m\ (r^2/4 + h^2/3)$$

The rotational acceleration of such a cylinder in relation to a displacement *x* at the loading point z would be $\ddot{x}/z$ and thus summing moments about the base,

$$(F_{inertia})z = (I_y)(\ddot{x}/z)$$

Therefore, $F_{inertia} = (I_y)(\ddot{x}/z^2) = m_e\ddot{x}$

Where m_e may be thought of as the effective mass of the foundation. The effective mass for this shaft based on a height taken initially as 42.0 feet was calculated to be approximately 0.046kN·sec^2/mm (3.125 kip·sec^2/ft.). It is common to increase the theoretical effective mass of the foundation for analysis purposes in order to include some mass from the passive earth pressure wedge of surrounding soil. The effective mass utilized in our computations was 0.030 (2.105), 0.040 (2.748), 0.043 (2.963), and 0.042 (2.909) kN·sec^2/mm (kip·sec^2/ft.) for load cycles 1, 2, 3, and 4, respectively.

The damping resistance is presumed to be represented by a viscous damper in which the force $F_{damping}$ is proportional the velocity, $\dot{x}$, by a constant, c (which is in units of force-sec./length). In order to relate this more meaningfully to a system damping parameter, the damping constant is expressed as a percent of the critical damping, c_c, by

$$D = c/c_c = c/[2(km_e)^{½}]; \text{ where } k = \text{static stiffness}$$

thus, $F_{damping} = c\,\dot{x} = D\,[2(km_e)^{½}]$

The static resistance is modeled as a function of displacement, x, using a spring with stiffness, k_s. Because the soil response for lateral loading at large strains is known to be highly nonlinear, this spring may be modeled as a nonlinear stiffness, which decreases as a function of displacement. For the analyses in this report, the stiffness has been taken as a constant, which is derived independently for each Statnamic loading (and decreases with increased loads). This model was back-fitted to the results of the load test measurements, for each load cycle, to obtain the nonlinear spring and viscous damping parameters which best match the observed behavior.

The damping ratio started at a value of 1.1 for load cycle 1, decreased to 0.75 for load cycle 2 and remained constant at 0.6 for load cycles 3 and 4. Figure 9 shows the initial stiffness (kips/in) on a semi-log scale, these values were obtained from the back-fitted data of four load cycles. Note the stiffness is plotted against the maximum test displacement at the load point location of the shaft for each load cycle. The results of the back fitting process (comparison of computed and measured displacement response at the loading point) are illustrated in Figure 10.

Using this nonlinear spring and dashpot model, a derived static load versus displacement response is constructed as indicated in Figure 11. This derived static model is the basis for comparison with a static test result. The actual total soil resistance (static response plus soil damping) is illustrated in the figure as the “Total Soil Response (Static + Damping)”. This total resistance represents the total soil resistance applied to the shaft after consideration of the applied load and the shaft inertia. The equivalent static soil resistance, illustrated in the figure as the “Equivalent Static Load” is comparable to the soil resistance mobilized from a conventional static test.

Derived P-Y Results

For design, it is important to develop a computational model of the soil resistance which provides a good match to the test results. Most designers use a form of “p-y” curve to model the nonlinear static soil resistance for design using a code such as LPILE or FBPIER. For the analysis of a single shaft, LPILE is very convenient; the p-y curves should be the same with either code if the structural foundation is modeled similarly.

The analyses of the test shaft in this manner was complicated by the nonlinear behavior of the composite concrete and steel section which tends to crack and change in effective stiffness (EI) as bending occurs. This model included nonlinear EI as a function of bending. The steel casing (top section only) was modeled using a yield strength of 45 ksi. The rebar was modeled with yield strength of 60 ksi. The inputted concrete strength of the shaft was 6,468 psi, obtained from tests conducted on concrete cylinders a couple days prior to the Statnamic lateral load test. Figure 12 shows the nonlinear EI as a function of bending that would typically be calculated by LPILE.

To back-calculate the soil response from the test measurements, soil parameters are estimated initially from the conditions described in the soil boring and then adjusted to best match the observed load versus deflection response and deflection versus depth response. The soil criteria used for generating the p-y curves used in LPILE to model the test condition are as follows in Table 2. The upper coarse to fine sand and gravel was modeled as “Sand Reese”. The clay layers from approximately -123.0 to -129.0 and -162.0 feet to -169.0 feet were modeled as “Soft Clay”.

The derived static top of shaft response from the Statnamic test along with the LPILE computed results from the back-fitted model, as described above, are presented in Figure 13. Solutions from both the nonlinear (also known as the Type 3 with the older LPILE versions) and linear elastic (also known as Type 1 with the older LPILE versions) LPILE analyses are shown. The linear analysis is close to the equivalent static soil resistance for load cycles 1 shown, indicating the shaft remained in or near the linearly elastic response during this initial load. The nonlinear analysis is more representative of the shaft tested at higher test loads, while the linear analyses is presented at the higher loads for illustration purposes only of the simpler (elastic) solution. The nonlinear analyses allow the shaft to yield at a lateral load of 2,295 kips, while the linear elastic analyses show the pile behavior if it were not allowed to yield. The displacement profiles measured (obtained from double integration of the accelerometers) and obtained from the LPILE model are presented in Figure 14 and 15. Individual plots of each cycle comparing the raw integrated data, Type 1, and Type 3 analyses results are shown in Figures 16 through 19. Comparisons of the load versus deflection response and deflection versus depth response suggest this computational model appears to capture the behavior relatively well within the general range of suitability for design purposes, generally providing for a conservative solution.

Table 2. Summary of Soil Condition Inputs

		Top	Bottom
Sand (Reese)	Layer Elevation (ft)	3.8	5.2
	Effective Unit Weight (pcf)	125.00	125.00
	Friction Angle (degrees)	32.0	32.0
	p-y Modulus "k" (pcf)	60	60
Sand (Reese)	Layer Elevation (ft)	5.2	11.2
	Effective Unit Weight (pcf)	110.0	45.5
	Friction Angle (degrees)	32	32
	p-y Modulus "k" (pcf)	45	45
Sand (Reese)	Top of Layer Elevation (ft)	11.2	24.2
	Effective Unit Weight (pcf)	47.55	47.55
	Friction Angle (degrees)	32	32
	p-y Modulus "k" (pcf)	45	45
Sand (Reese)	Top of Layer Elevation (ft)	24.2	54.2
	Effective Unit Weight (pcf)	47.55	47.55
	Friction Angle (degrees)	38	38
	p-y Modulus "k" (pcf)	65	65
Sand (Reese)	Top of Layer Elevation (ft)	54.2	64.2
	Effective Unit Weight (pcf)	47.55	47.55
	Friction Angle (degrees)	36	36
	p-y Modulus "k" (pcf)	45	2000
Sand (Reese)	Top of Layer Elevation (ft)	64.2	94.2
	Effective Unit Weight (pcf)	67.50	67.50
	Friction Angle (degrees)	42	42
	p-y Modulus "k" (pcf)	120	120
Soft Clay	Top of Layer Elevation (ft)	94.2	109.2
	`Effective Unit Weight (pcf)	55.55	55.55
	Cohesion (lbs/ft^2)	1200	1200
	Strain Factor E50	0.002	0.002
Sand (Reese)	Top of Layer Elevation (ft)	109.2	134.2
	Effective Unit Weight (pcf)	67.50	67.50
	Friction Angle (degrees)	40	40
	p-y Modulus "k" (pcf)	120	120
Soft Clay	Top of Layer Elevation (ft)	134.2	139.2
	Effective Unit Weight (pcf)	55.55	55.55
	Cohesion (lbs/ft^2)	1200	1200
	Strain Factor E50	0.002	0.002
Sand (Reese)	Top of Layer Elevation (ft)	139.2	Shaft Tip
	Effective Unit Weight (pcf)	67.50	67.50
	Friction Angle (degrees)	40	40
	p-y Modulus "k" (pcf)	120	120

SUMMARY AND CONCLUSIONS

A lateral load test has been performed on a nominal 77-inch (72-inch nominal) diameter by 180.0-foot-long drilled shaft using a lateral Statnamic testing device. From the measurements obtained during the Statnamic loadings, an equivalent static response and system damping has been derived. The equivalent static response provides a basis for comparison of predicted static response using the p-y model.

Soil parameters are presented which were obtained from back-fitting the computed results from LPILE to the derived static top of shaft response from the Statnamic test. Comparisons of the load versus deflection response and deflection versus depth response suggest this computational model appears to capture the behavior relatively well within the general range of suitability for design purposes, generally providing for a conservative solution.

The 77-inch diameter drilled shaft exhibited a lateral response that would typically be expected for the soil at the foundation location. The lateral load testing of this large diameter shaft is believed to provide a high degree of reliability with respect to the back-fit model for design purposes for this foundation.

CLOSURE

We would like to thank you for the opportunity to be involved in this project. We also want to express our gratitude for the field and office support provided by your company. Please do not hesitate to call us if you have any questions regarding the information in this report.

LIMITATIONS

This report presents test measurements made by AFT. Interpretations were made based upon the measurements made by AFT with the latest techniques available and currently accepted standards of care recognized by Geotechnical Engineering professionals. AFT is an independent agency and is not the Geotechnical Engineer of Record. The Geotechnical Engineer of Record should ultimately make final recommendations for foundation design and construction.

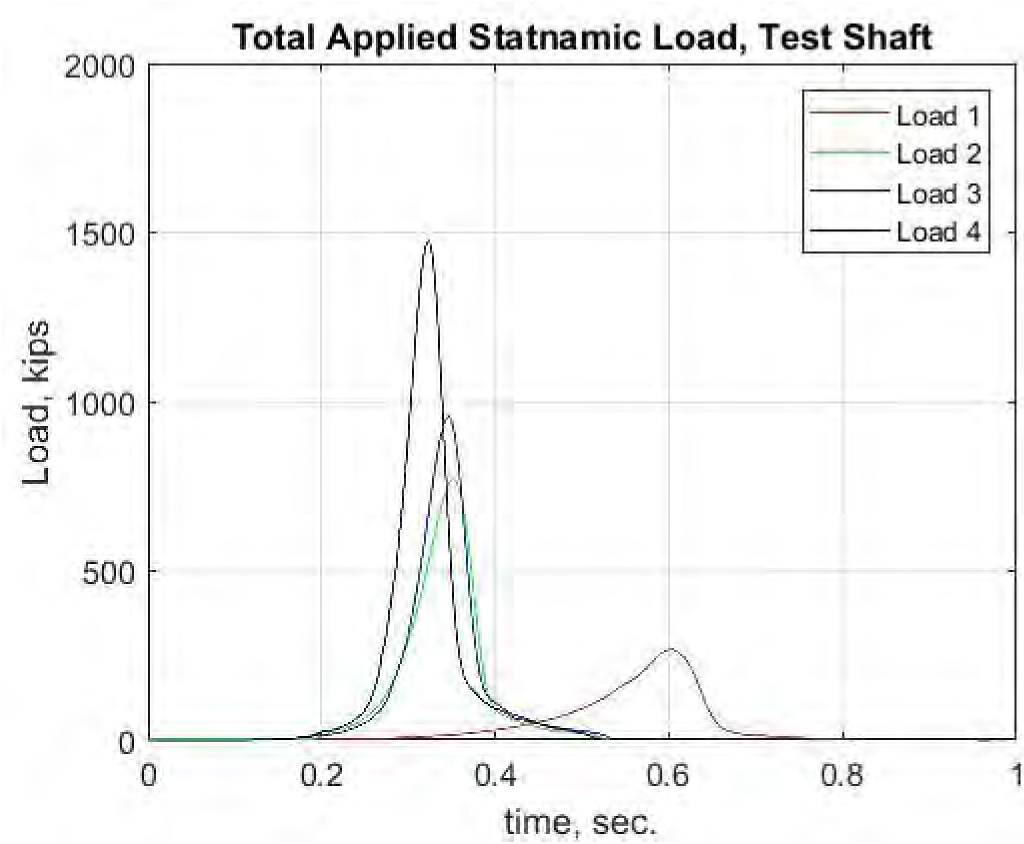


Figure 1 - Lateral Statnamic Loads versus Time for Loads 1 through 4

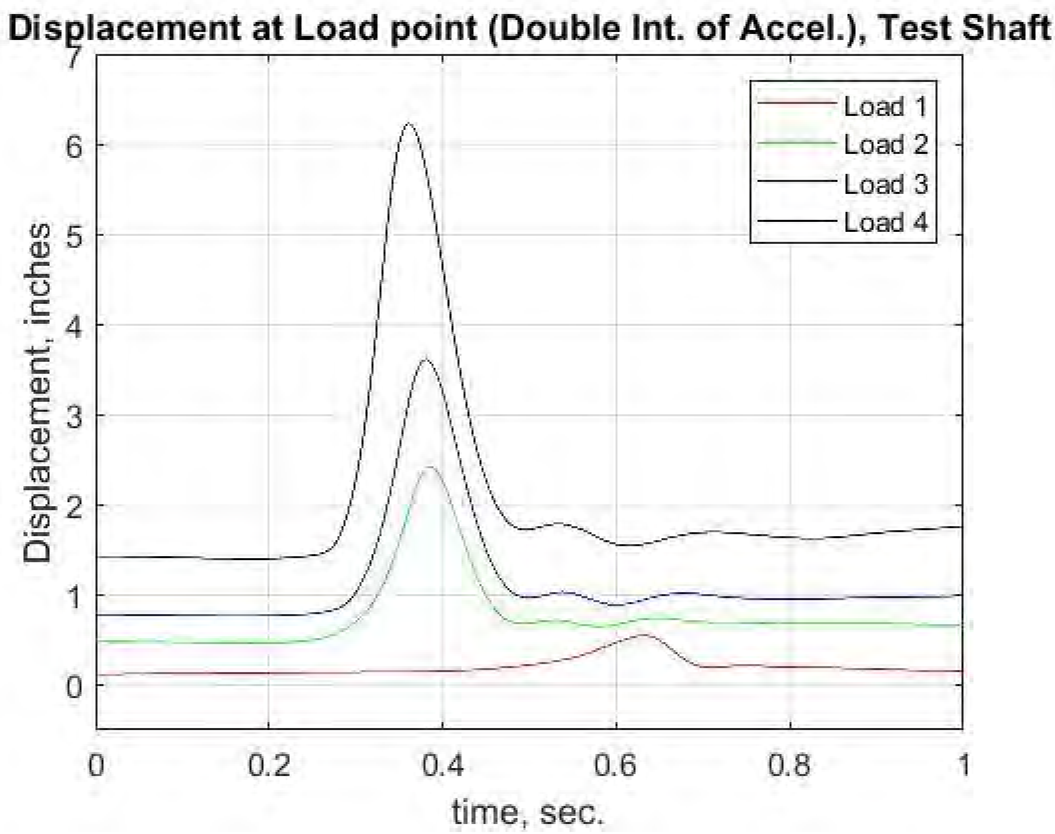


Figure 2 - Displacement at the Load Point versus Time for Loads 1 through 4

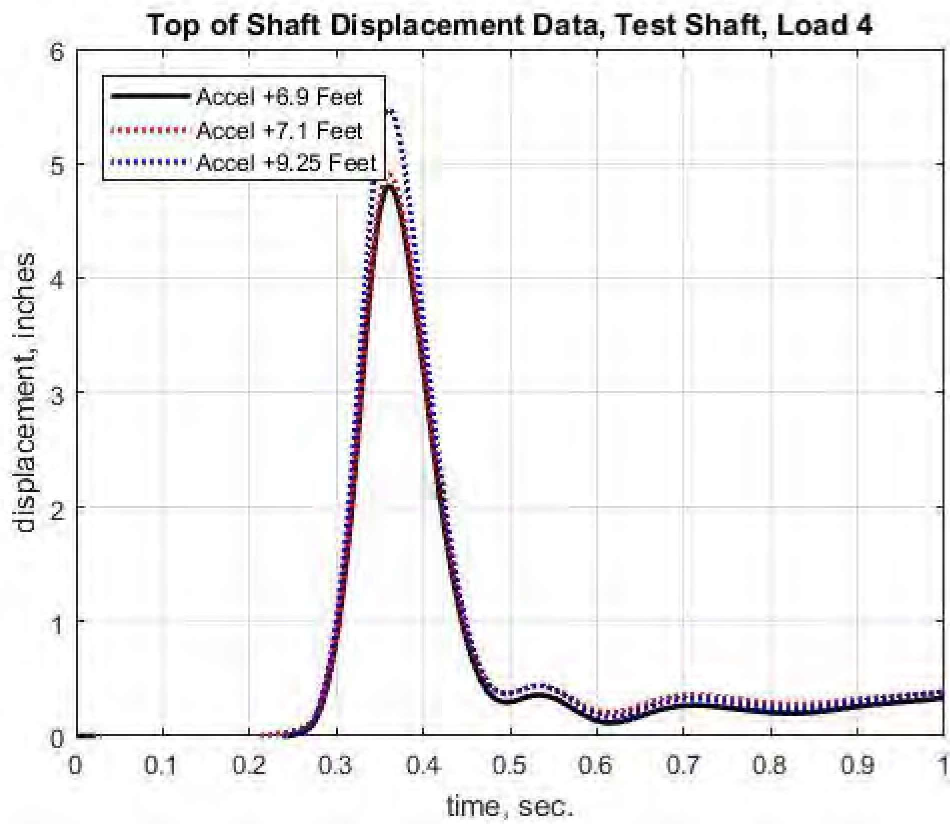


Figure 3 - Example: All Top of Shaft Displacements Measurements for Load 4

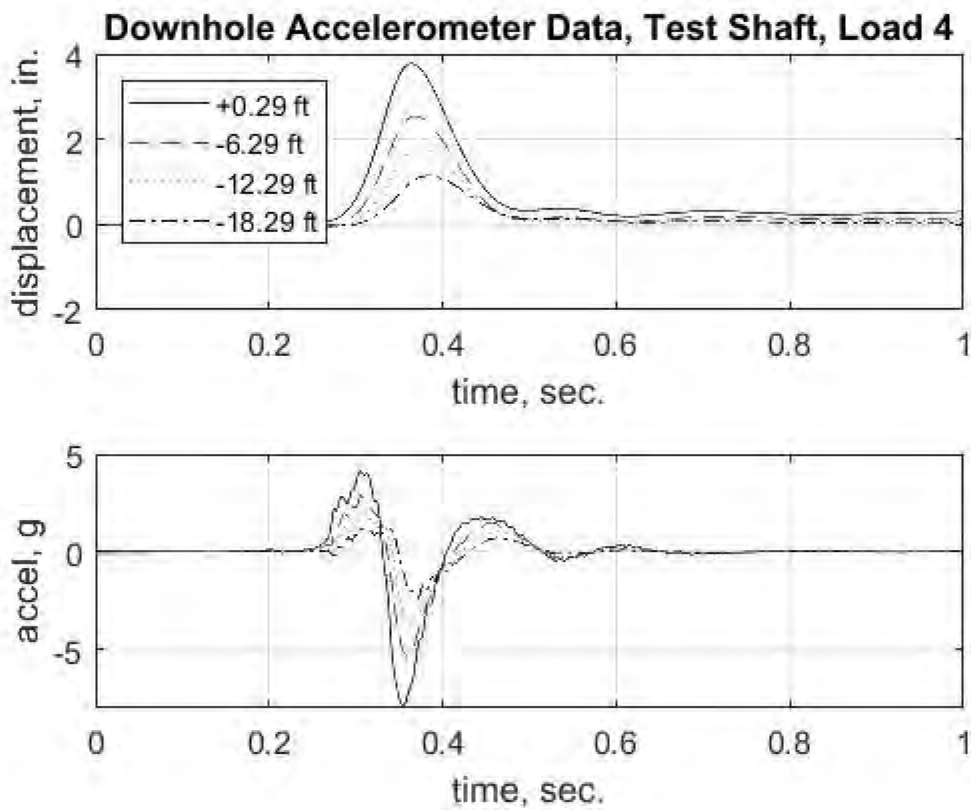


Figure 4 - Example: Displacement and Acceleration vs. Time from the Upper 4 Down-Hole Accelerometers for Load 4

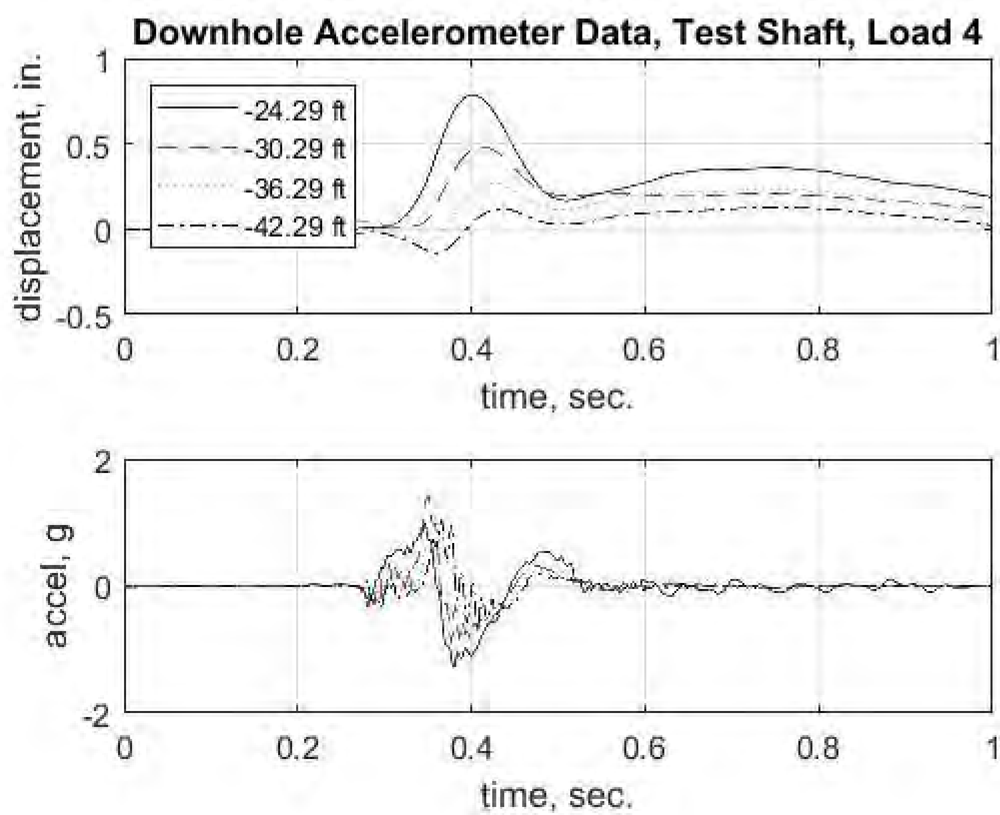


Figure 5 - Example: Displacement and Acceleration versus Time from the Lower 4 Down-Hole Accelerometers for Load 4

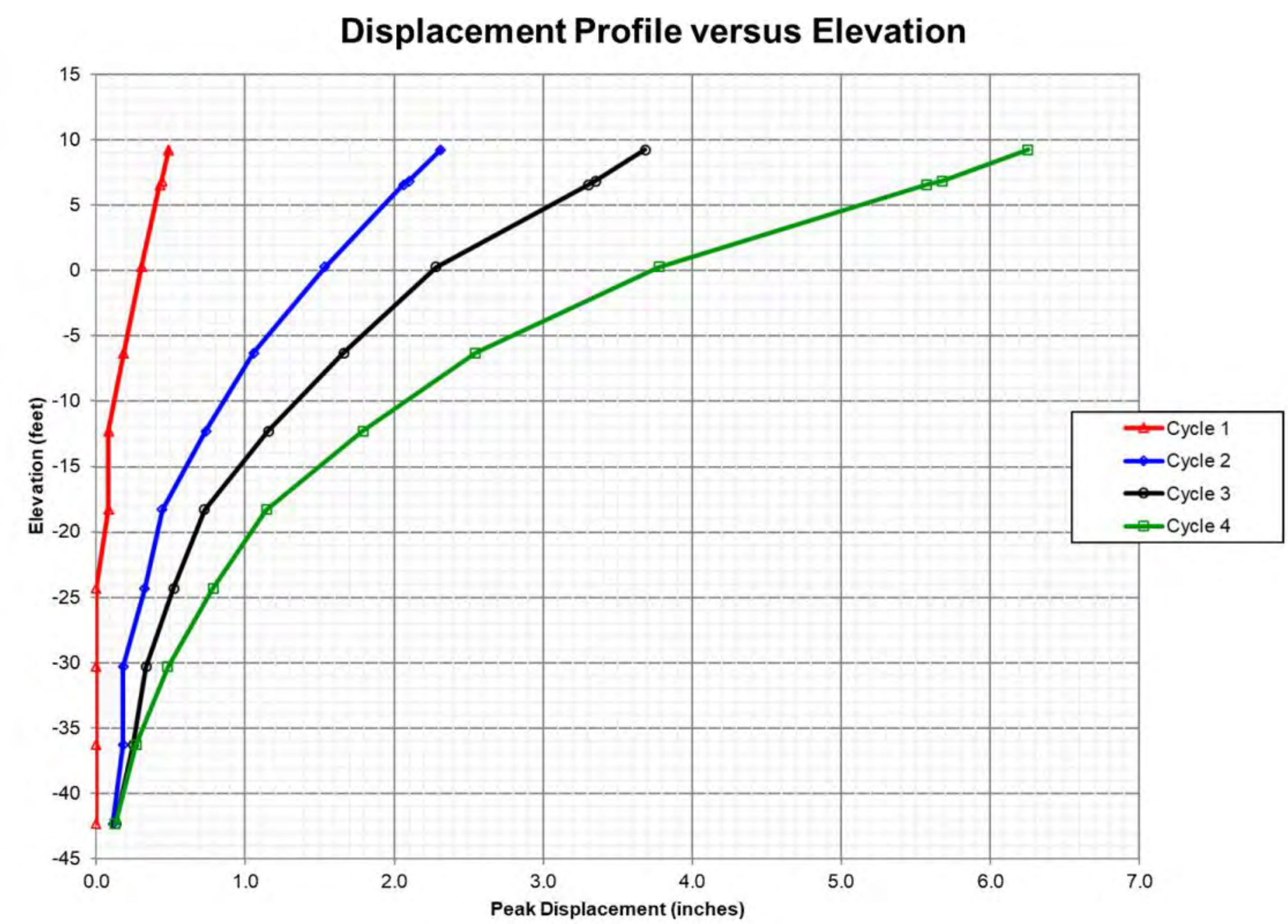


Figure 6 - Displacement versus Elevation for Loads 1 through 4

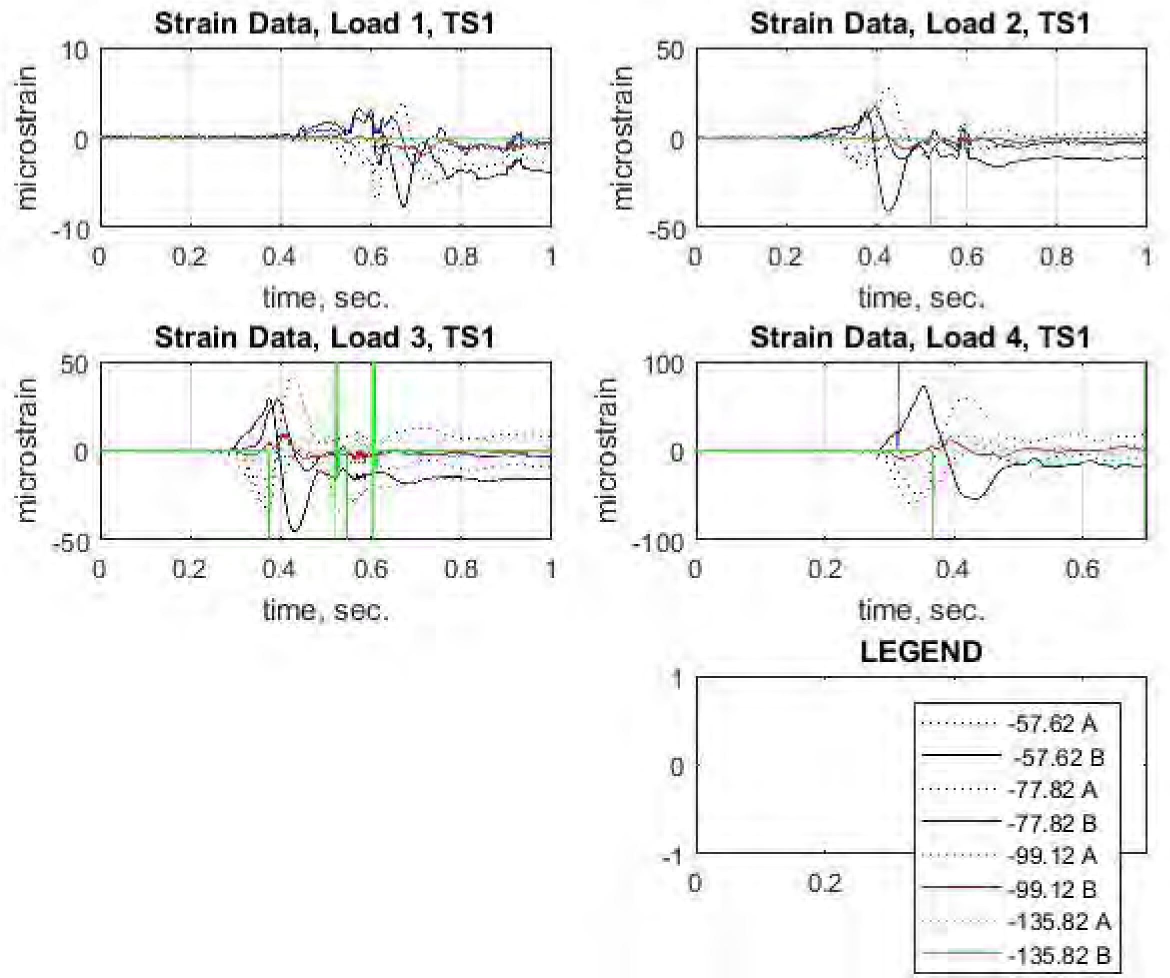


Figure 7 - Strain versus Time for Loads 1 through 4

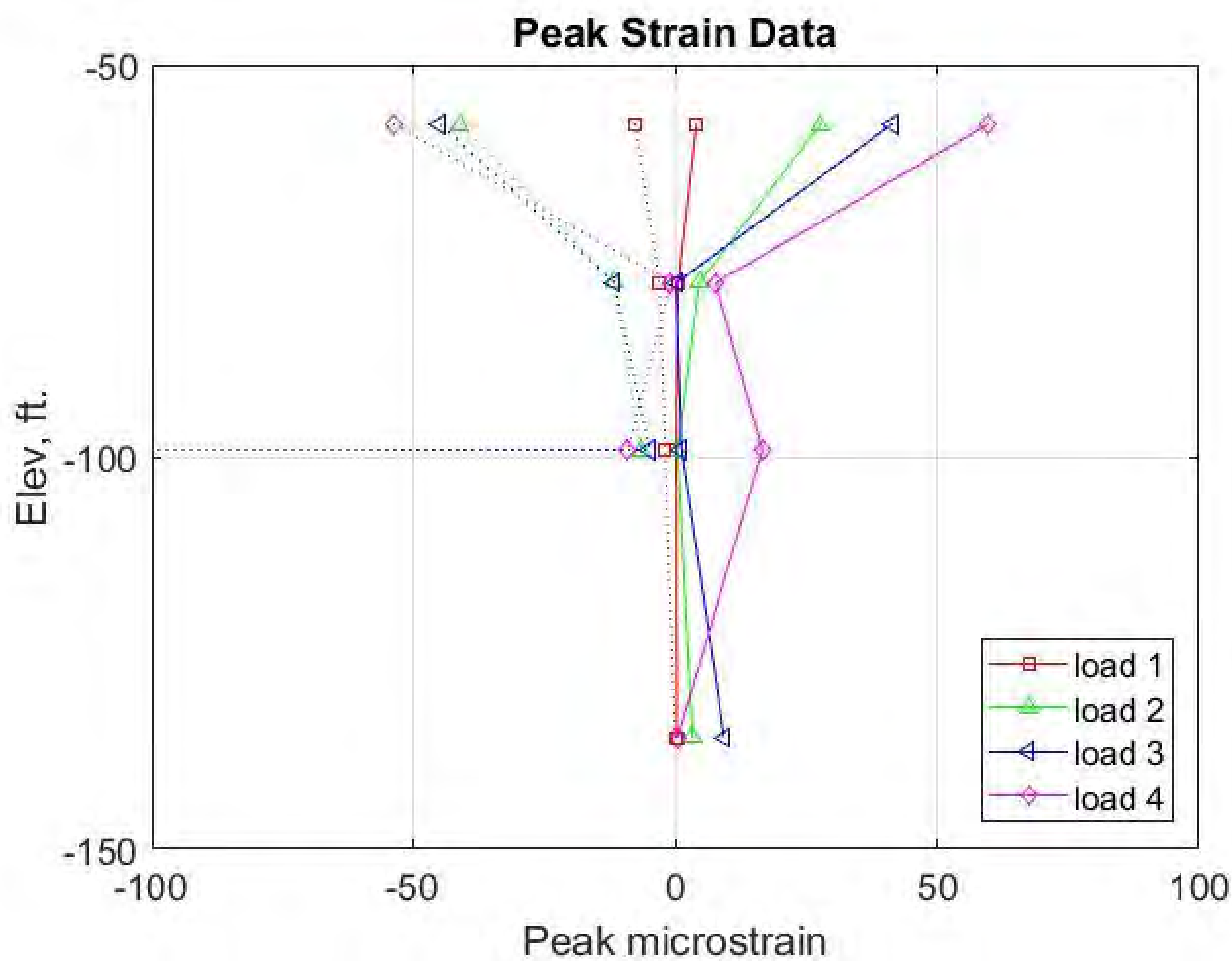


Figure 8 - Peak Strain versus Shaft Elevation for Loads 1 through 4

Figure 9 - Initial Stiffness versus Log of Max Shaft Displacements at the Load Point

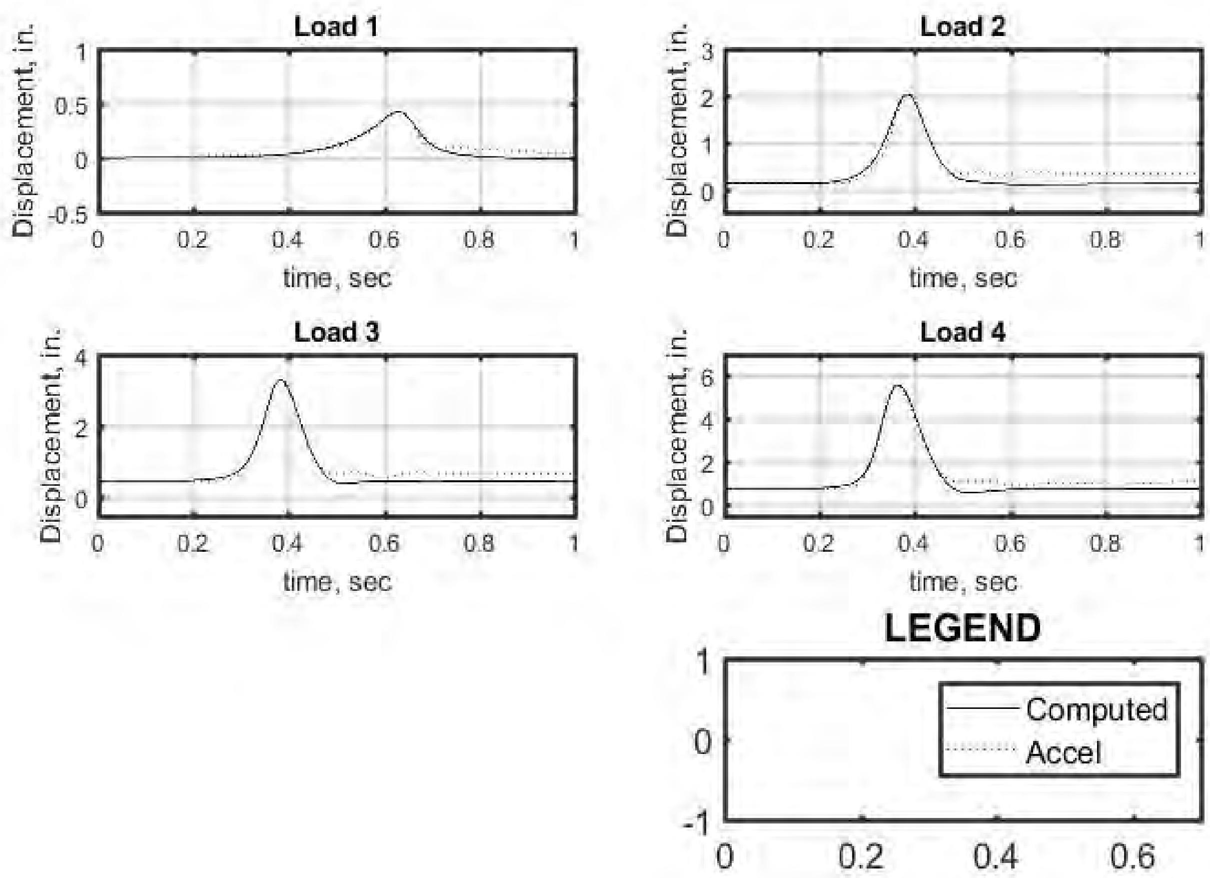


Figure 10 - Comparison of Measured to Modeled Shaft Displacements at Load Point

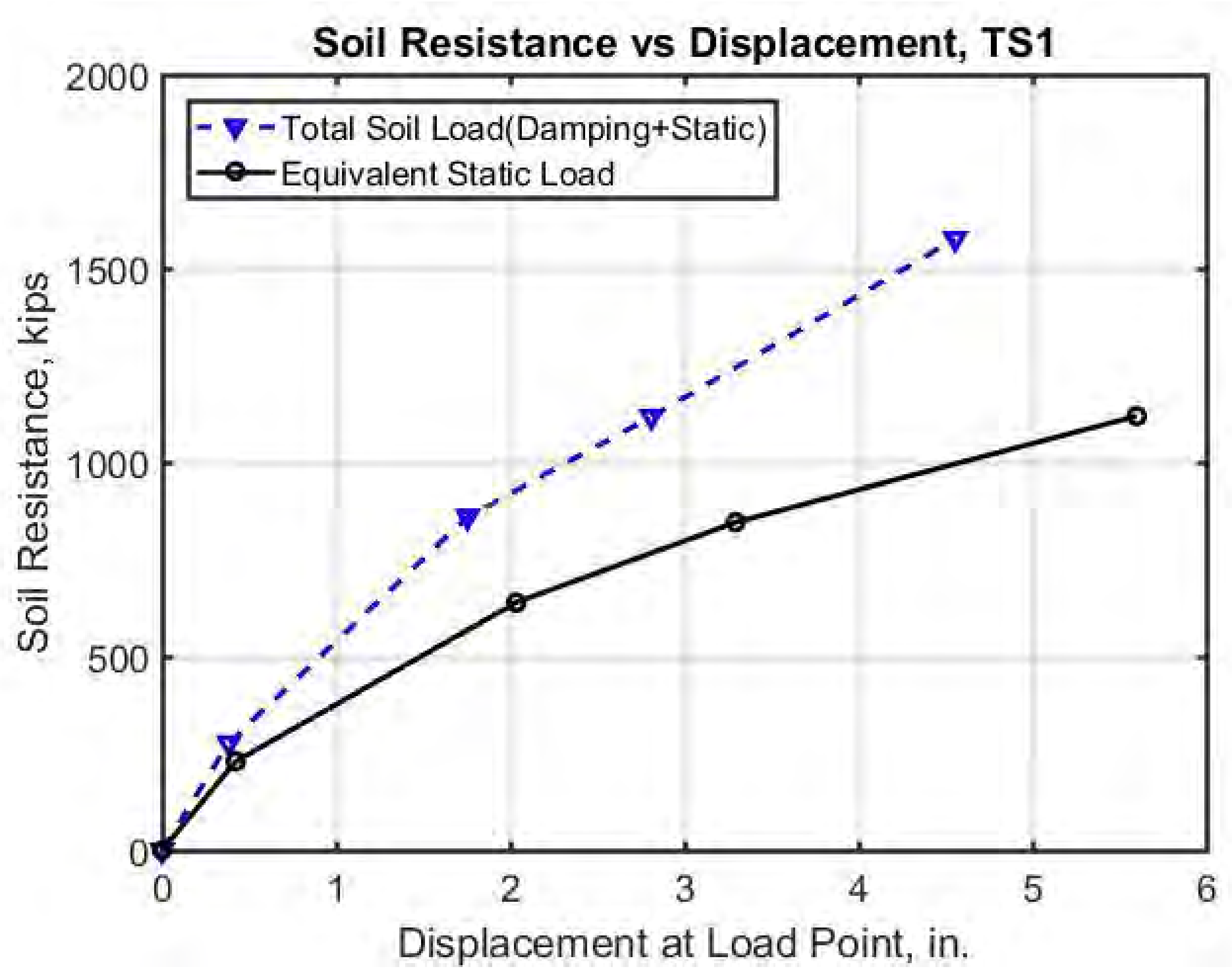


Figure 11- Derived Static Load versus Displacement Response at the Load Point

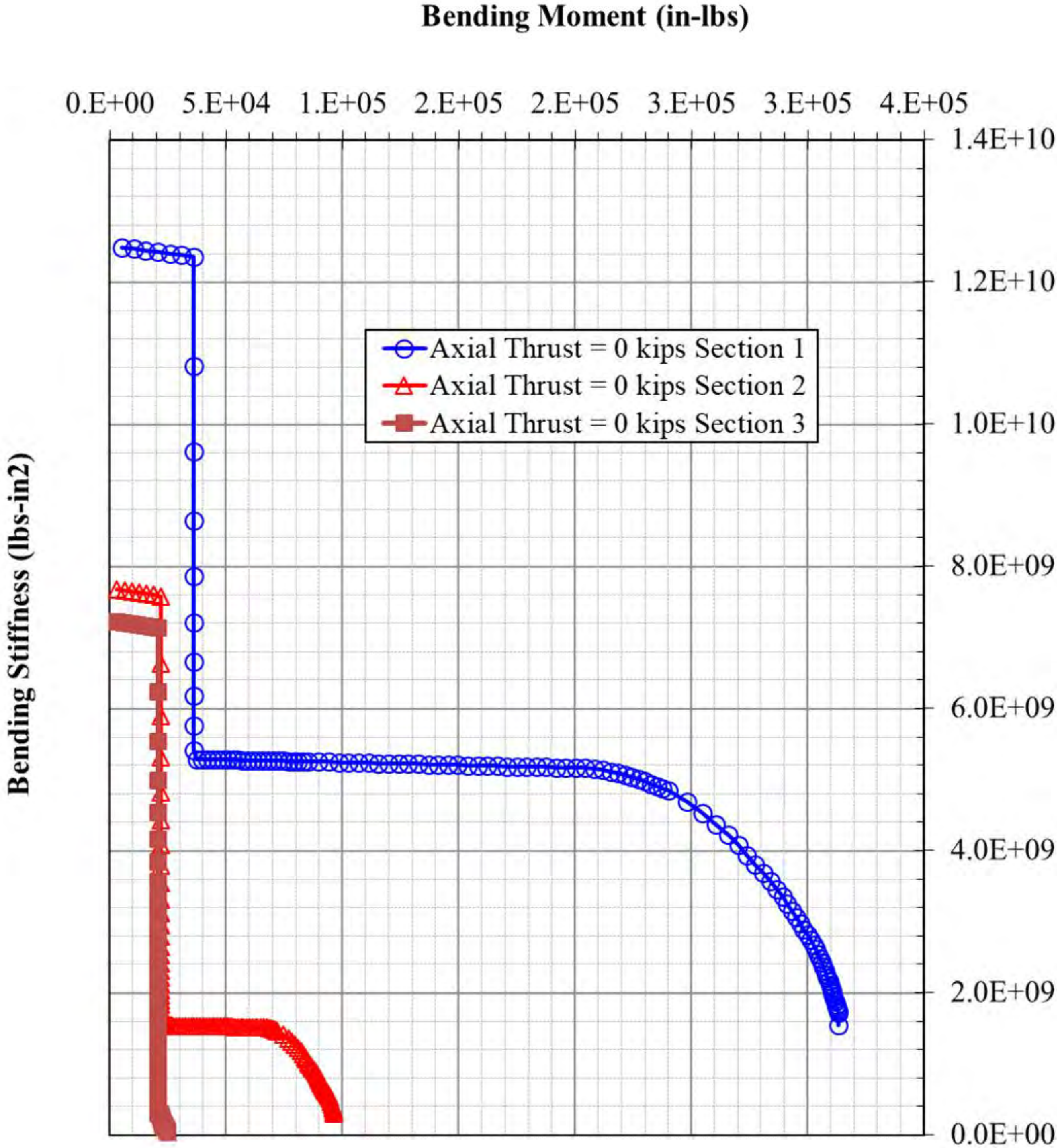


Figure 12 - Non-Linear Stiffness "EI" as a Function of Bending Moment

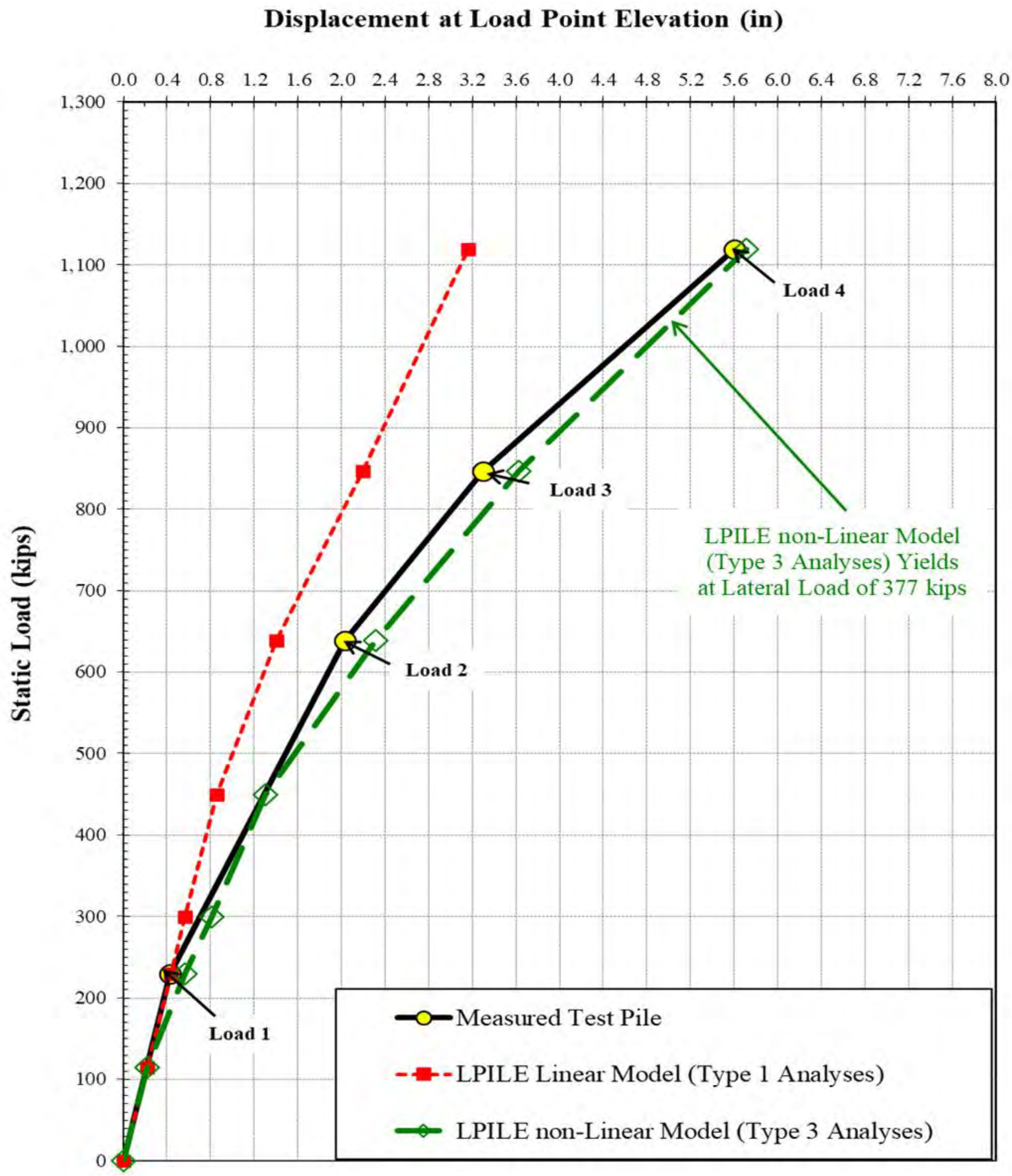


Figure 13 - Derived Static Top of Shaft Response from the Statnamic Test Compared with the LPILE Model Results

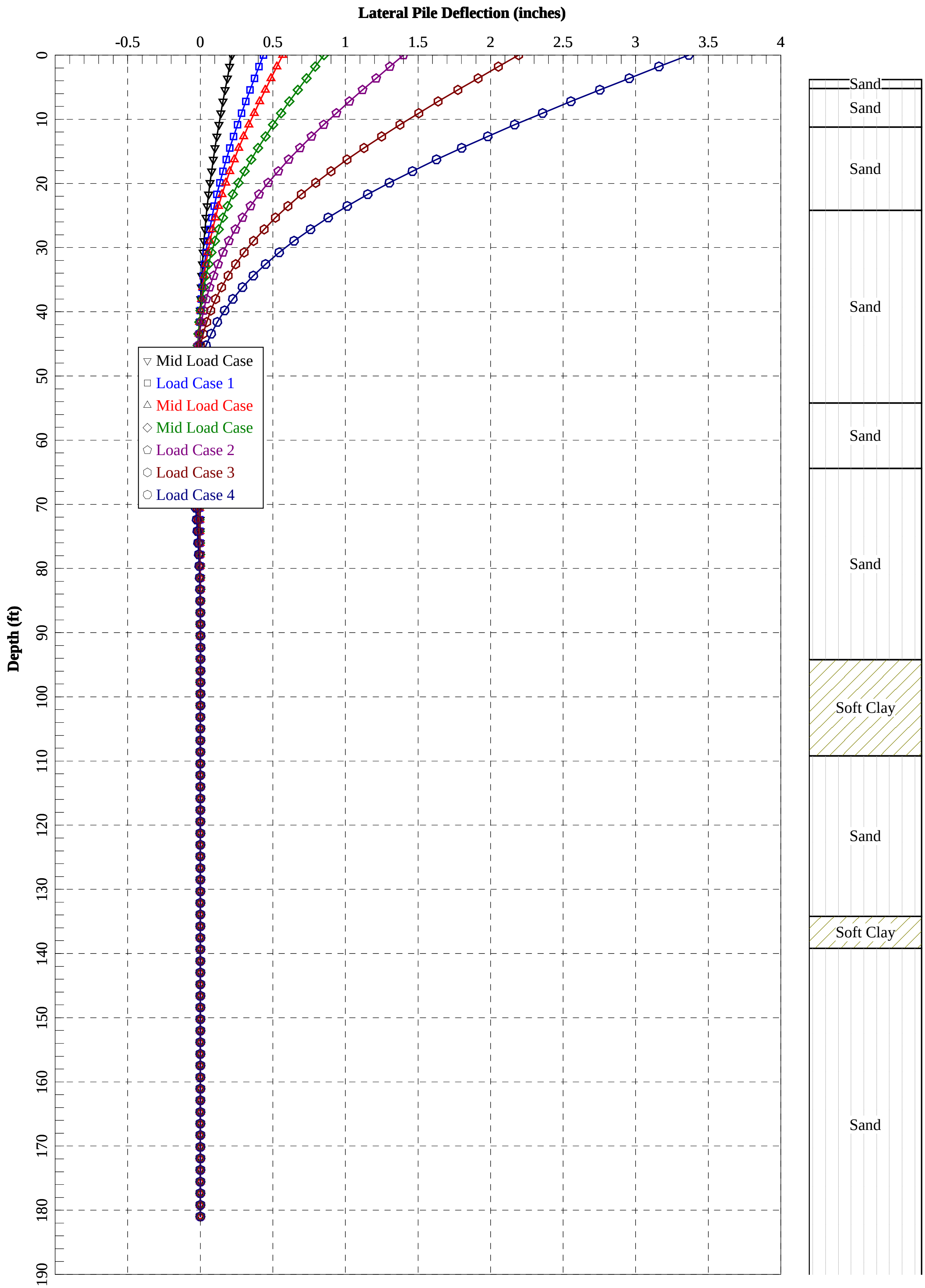


Figure 14 - Type 1 Lateral Pile Head Deflection

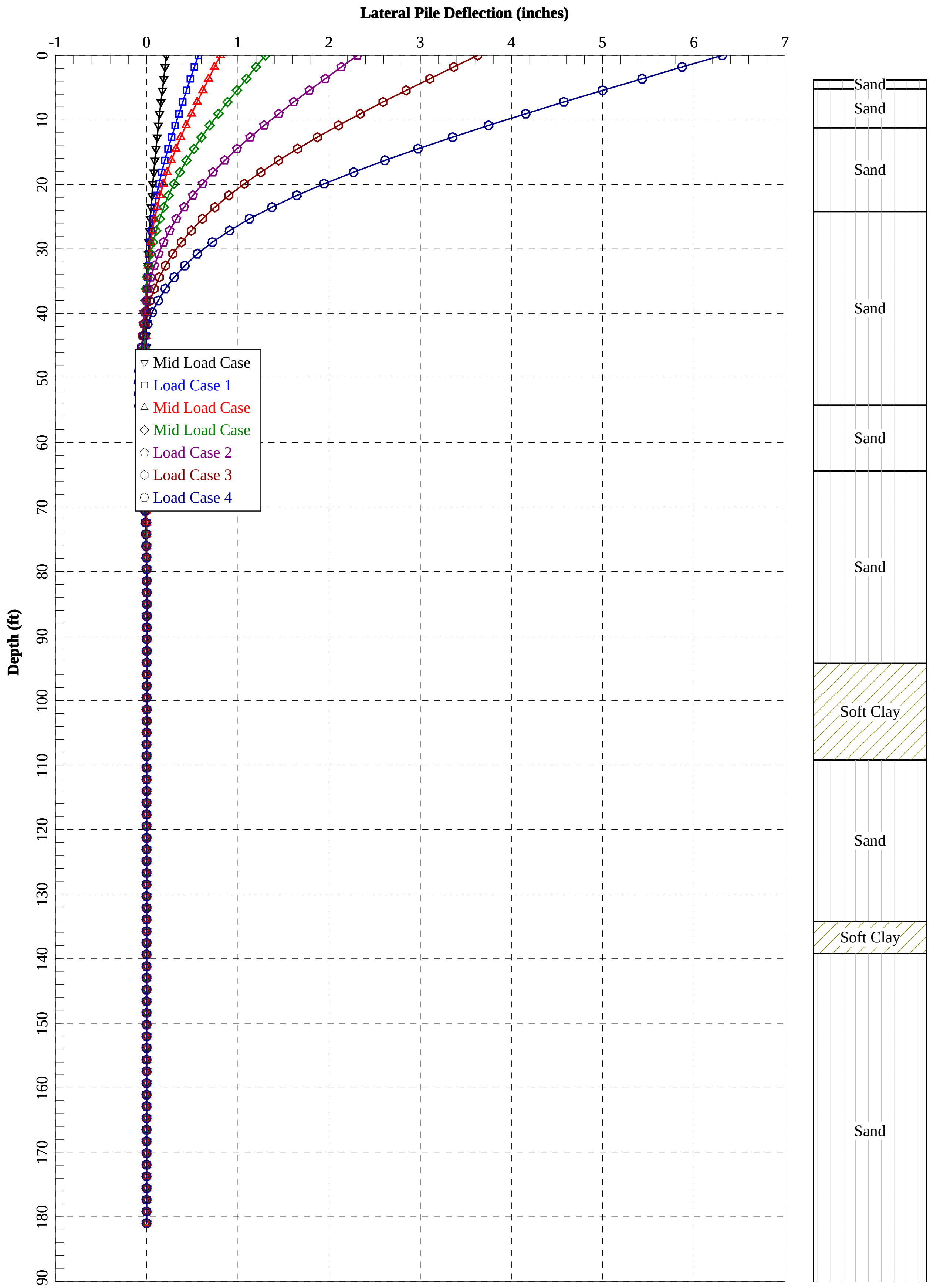


Figure 15 - Type 3 Lateral Pile Head Deflection

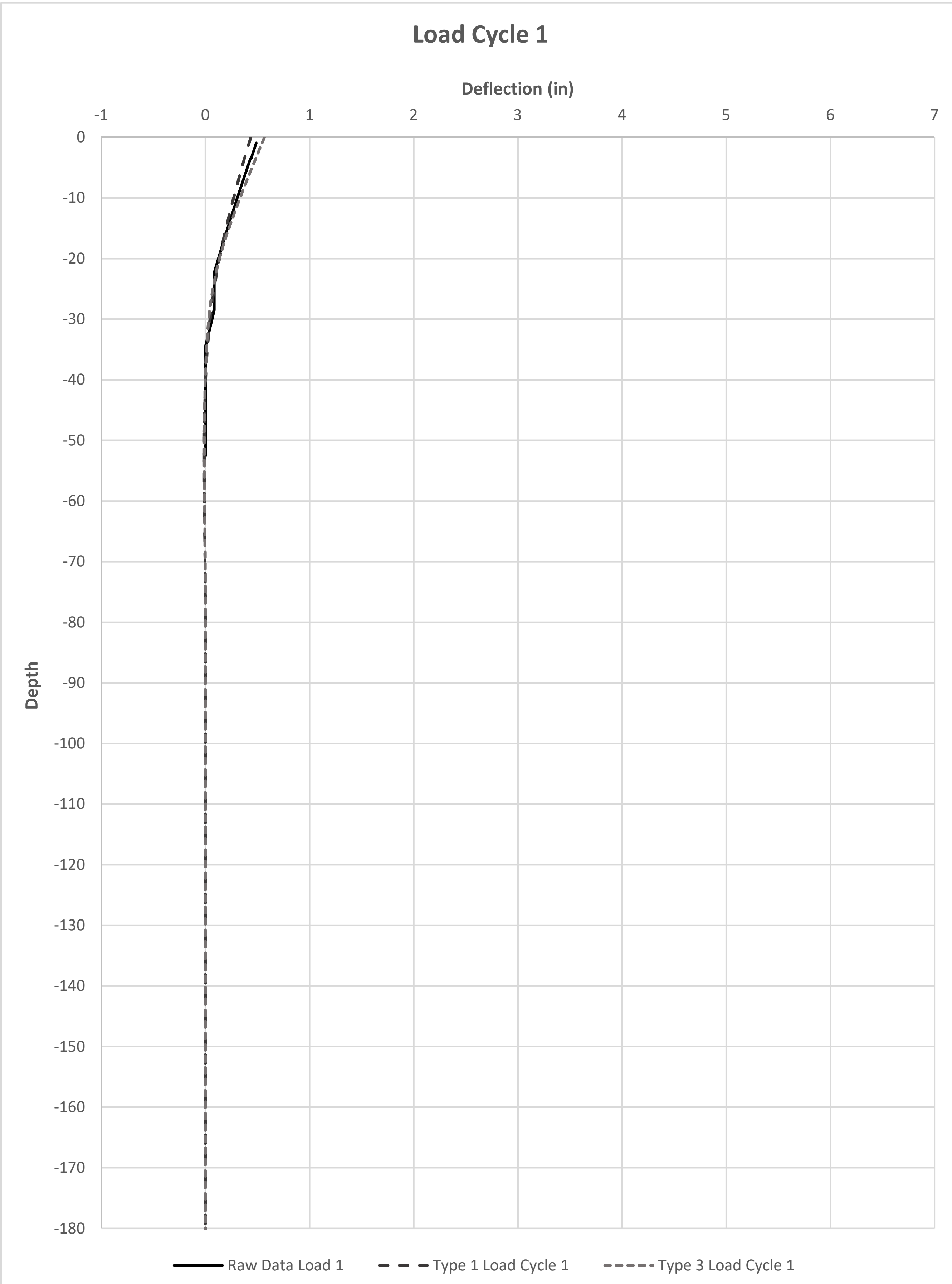


Figure 16 - Comparison of Raw Data, Type 1, and Type 3 for Load 1

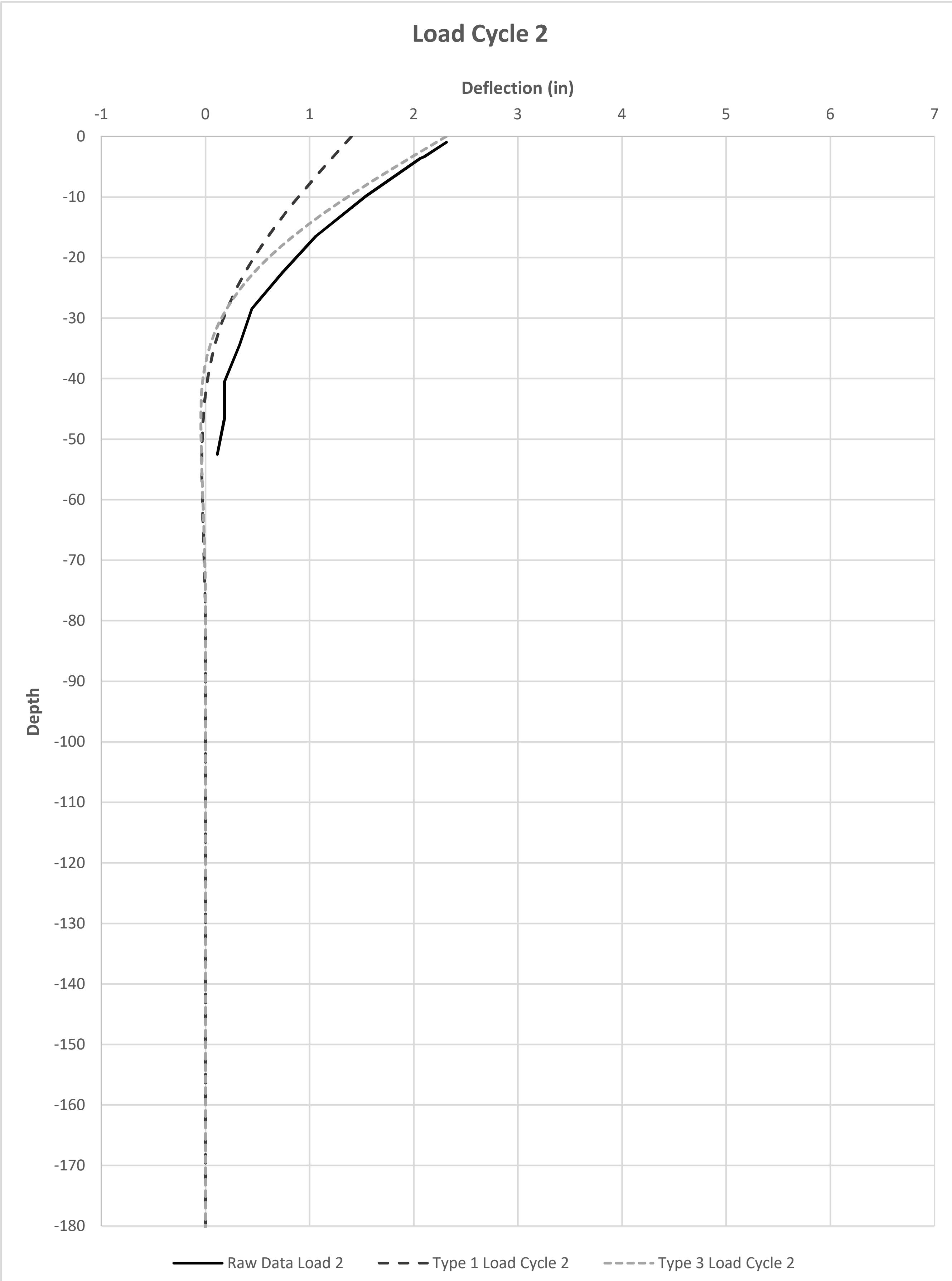


Figure 17 - Comparison of Raw Data, Type 1, and Type 3 for Load 2

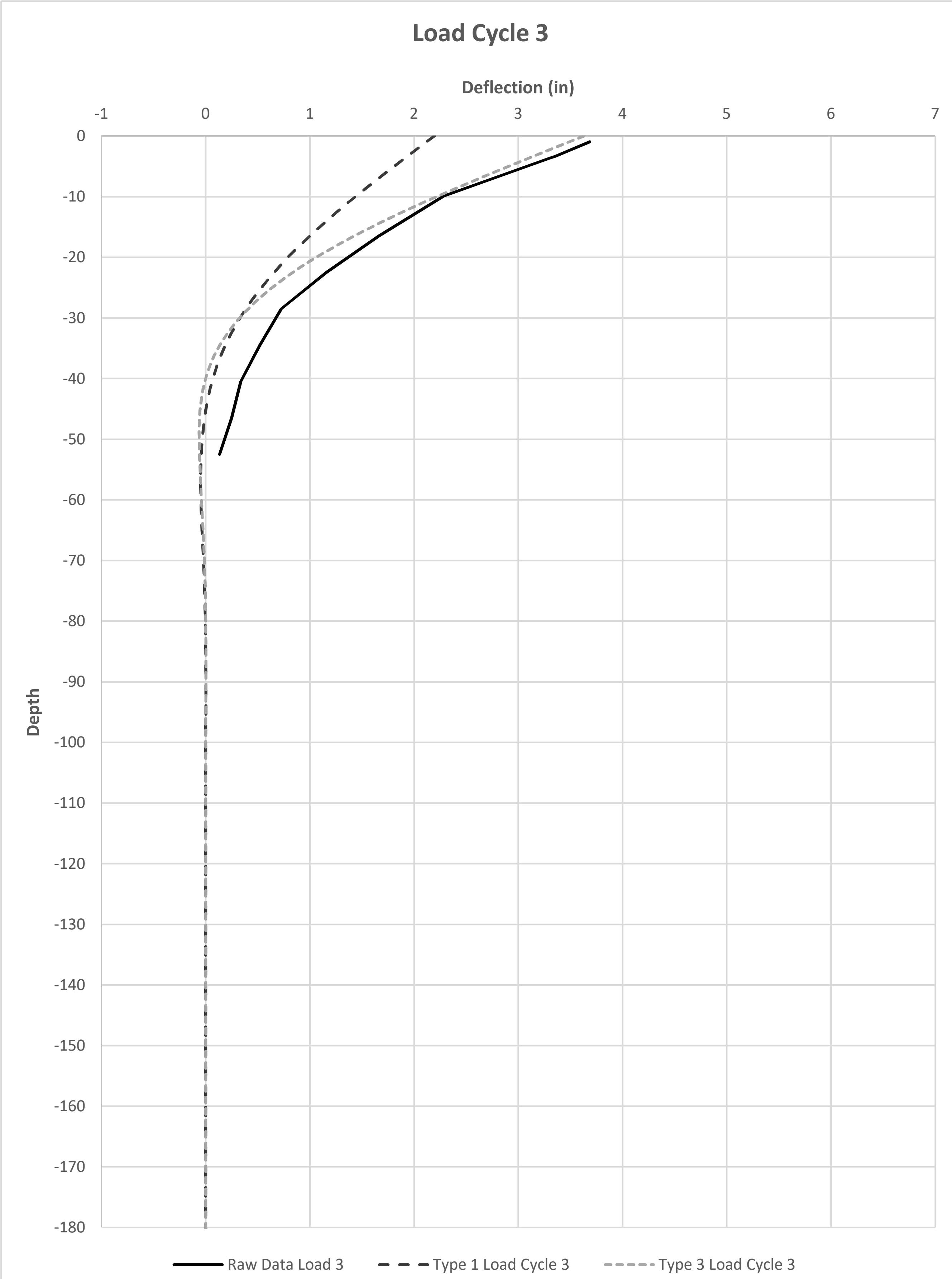


Figure 18 - Comparison of Raw Data, Type 1, and Type 3 for Load 3

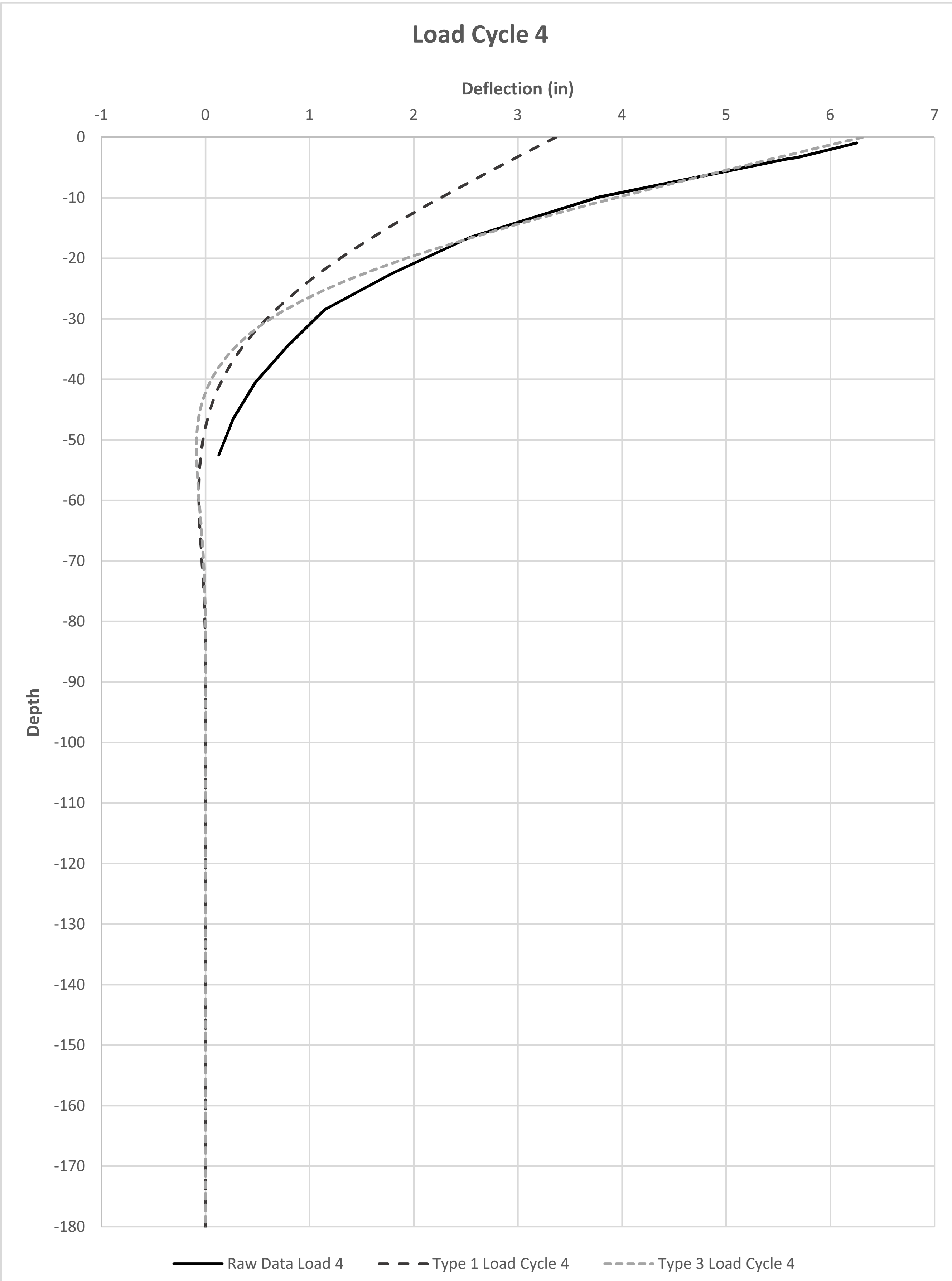


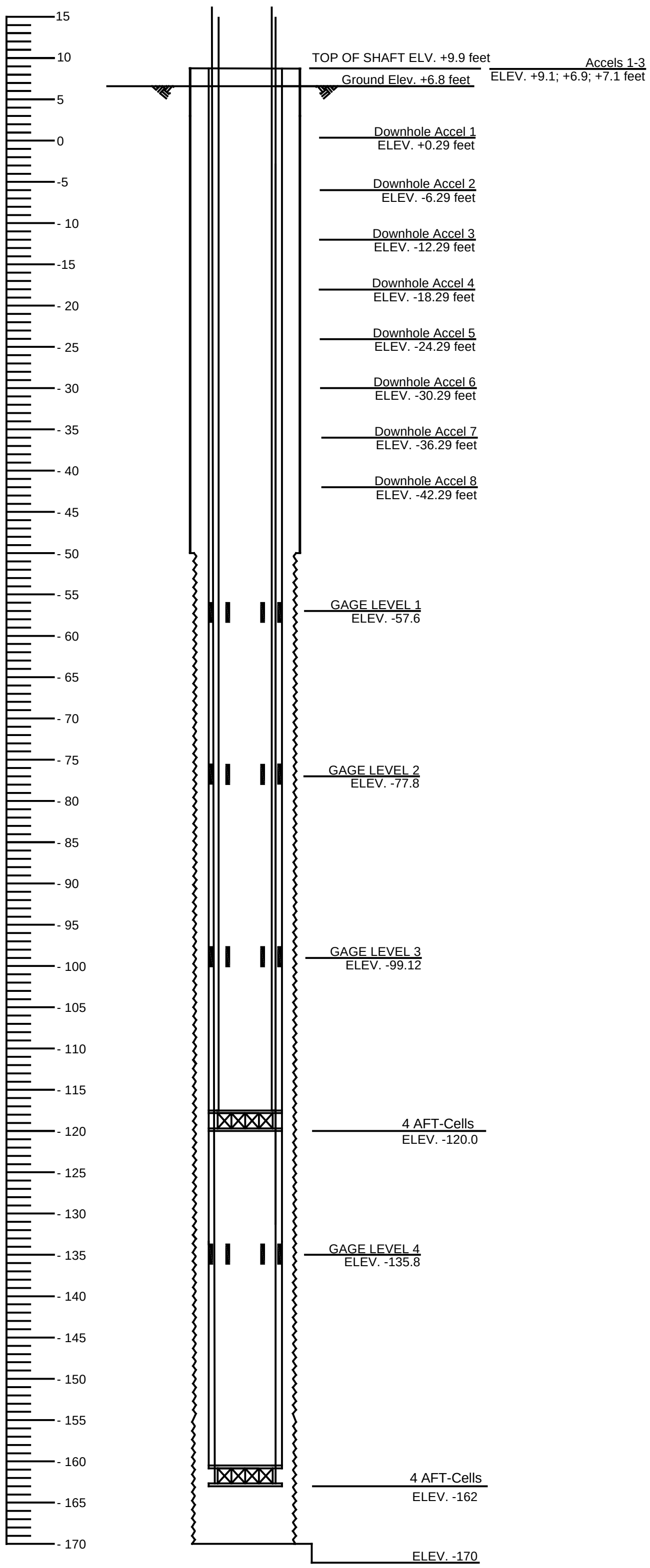
Figure 19 - Comparison of Raw Data, Type 1, and Type 3 for Load 4

Appendix B

As-Built Test Shaft Schematic
Concrete Pour Log
Concrete Strength Report
Soil Boring Report

Report of Lateral Statnamic Testing
I-10 Mobile River Bridge
AFT Project No. 518009
Mobile, Alabama

TEST SHAFT - As Built
72" Ø DRILLED SHAFT - AFT-Cell Load Test



APPLIED FOUNDATION TESTING 4035 J Louis St Green Cove Springs, Fl 32043	72-INCH DIAMETER DRILLED SHAFT		
	I-10 MOBILE RIVER BRIDGE		
	DWN BY: KS Rev.:	04/30/18	FIGURE 1

FORM C-35 **ALABAMA DEPARTMENT OF TRANSPORTATION**

Revised 07-15-94

DRILLED SHAFT POURING RECORD

Project Number IM-I010(341)		County Mobile	Area SW Region
Bridge Station Test Shaft	To Station	Bridge Identification Number	
Road Between		and	
Contractor Jordan Pile Driving / A.H. Beck		Inspector Jay Davison	
Date 3/23/2018	Bent No. & Lane	Shaft No. TP-WPB	Kind of Soil Silty Sand
Diameter of Shaft 72" / 77" in Casing (-46.8 EL)	Shaft Volume per Linear Foot (V_{LF}) 1.047 CY / 1.198 CY in Casing	Shaft Tip Elevation -170	

Load Number	Quantity (Cu. Yds.)	Slump (In.)	Pouring Time		Concrete Elevation	Tremie Tip Elevation	Cylinder Number
			Start	Finish			
1	8	7.5	2:22 PM	2:28 PM	-165.3	-165	
2	8		2:28 PM	2:32 PM	-157.1	-165	
3	8		2:32 PM	2:51 PM	-150.6	-165	
4	8	9.5	2:52 PM	3:03 PM	-143.5	-160	
5	8		3:03 PM	3:09 PM	-138.6	-155	
6	8		3:10 PM	3:16 PM	-131.0	-150	
7	8		3:19 PM	3:35 PM	-124.2	-140	
8	8		3:35 PM	3:40 PM	-117.8	-135	
9	8	9.25	3:40 PM	3:45 PM	-109.7	-130	
10	8		3:45 PM	3:50 PM	-102.8	-120	
11	8		3:50 PM	3:55 PM	-93.8	-115	
12	8		3:55 PM	4:00 PM	-86.5	-110	
13	8	9.5	4:09 PM	4:13 PM	-79.3	-105	
14	8		4:13 PM	4:19 PM	-71.8	-90	
15	8		4:19 PM	4:28 PM	-63.1	-80	
16	8		4:25 PM	4:35 PM	-56.8	-70	
17	8		4:35 PM	4:39 PM	-48.8	-60	
18	8		4:39 PM	4:52 PM	-42.1	-55	
19	8		4:52 PM	4:56 PM	-35.7	-45	

V_Q = ______

1. Top of concrete elevation at completion of pour prior to trimming any excess : ____________
2. Shaft length before trimming : **L** = ______________ Ft.
3. Corresponding theoretical volume : $V_T = V_{LF} \times L$ = ______________ Cu. Yds.
4. Volume of excess in last truck : V_E = ______________ Cu. Yds.
5. Volume of overflow (if any) : V_O = ______________ Cu. Yds.
6. Actual shaft volume before trimming : $V_A = V_Q - V_E - V_O$ = ______________ Cu. Yds.
7. Overpour : $\frac{V_A - V_T}{V_T} \times 100$ = ______________ %

REMARKS

1. Record any problems with the operation of the mixing plant, supply irregularities (concrete delays), or possible setbacks (loss of priming in the tremie, movement of reinforcing steel, difficulties with extraction of temporary casing, caving of shaft wall, etc.) on the back of this sheet in the space provided for observations.
2. A theoretical volume versus elevation line should be plotted on the graph on the back of this sheet prior to concrete placement.
3. The actual concrete placement curve should be plotted during construction of the shaft. An elevation check should be taken as each truck pours out and the data recorded above and plotted on graph.
4. Any large variations of the actual concrete placement curve from the theoretical placement line should be investigated.
5. Draw sketch on back of this sheet showing location of shaft.

Correct______________________ **Approved**______________________

Project Manager **Area Operations Engineer**

FORM C-35 **ALABAMA DEPARTMENT OF TRANSPORTATION**

Revised 07-15-94

DRILLED SHAFT POURING RECORD

Project Number	County	Area
IM-I010(341)	Mobile	SW Region

Bridge Station	To Station	Bridge Identification Number
Test Shaft		

Road Between	and

Contractor	Inspector
Jordan Pile Driving / A.H. Beck	Jay Davison

Date	Bent No. & Lane	Shaft No.	Kind of Soil
3/23/18		TP-WPB	Silty Sand

Diameter of Shaft	Shaft Volume per Linear Foot (V_{LF})	Shaft Tip Elevation
72" / 77" in Casing (-46.8 EL)	1.047 CY / 1.198 CY in Casing	-170

Load Number	Quantity (Cu. Yds.)	Slump (In.)	Pouring Time Start	Pouring Time Finish	Concrete Elevation	Tremie Tip Elevation	Cylinder Number
20	8		4:56 PM	5:01 PM	-28.8	-40	
21	8	9.5	5:01 PM	5:05 PM	-24.3	-35	
22	8		5:05 PM	5:10 PM	-15.8	-30	
23	8		5:10 PM	5:14 PM	-9.5	-20	
24	8		5:14 PM	5:20 PM	-3.6	-15	
25	8		5:20 PM	5:24 PM	3.2	-10	
26	8	9	5:24 PM	5:30 PM	9.0	-5	
27	4		5:40 PM	5:50 PM	10.2	-5	

V_Q = 212

1. Top of concrete elevation at completion of pour prior to trimming any excess : 10.2
2. Shaft length before trimming : **L** = 180.2 Ft.
3. Corresponding theoretical volume : $V_T = V_{LF} \times L$ = 197.3 Cu. Yds.
4. Volume of excess in last truck : V_E = 2 Cu. Yds.
5. Volume of overflow (if any) : V_O = 2 Cu. Yds.
6. Actual shaft volume before trimming : $V_A = V_Q - V_E - V_O$ = 208 Cu. Yds.
7. Overpour : $\frac{V_A - V_T}{V_T} \times 100$ = 5.4 %

REMARKS

1. Record any problems with the operation of the mixing plant, supply irregularities (concrete delays), or possible setbacks (loss of priming in the tremie, movement of reinforcing steel, difficulties with extraction of temporary casing, caving of shaft wall, etc.) on the back of this sheet in the space provided for observations.
2. A theoretical volume versus elevation line should be plotted on the graph on the back of this sheet prior to concrete placement.
3. The actual concrete placement curve should be plotted during construction of the shaft. An elevation check should be taken as each truck pours out and the data recorded above and plotted on graph.
4. Any large variations of the actual concrete placement curve from the theoretical placement line should be investigated.
5. Draw sketch on back of this sheet showing location of shaft.

Correct ______________________ **Approved** ______________________

Project Manager **Area Operations Engineer**

Kay Ivey
Governor

Alabama Department of Transportation
Concrete Placement and Testing Report
BMT-174 Pending Tests

Report ID: 56081 **Pour Date:** 03/23/2018

John R. Cooper
Transportation Director

Project No: IM-I010(341)
Project Manager: Davison, Jay
Class/Type Concrete: DS-2A
Mix ID: DS2A-001-18
Method of Curing in Structure: Other Method
Cylinder Field Curing Method: Cylinder Curing Box
Time Placing Started/Completed: 02:00 PM / 06:05 PM
Supplied/Placed This Date: 212 CuYd / 212 CuYd

Area: Mobile
County: MOBILE
Prime Contractor: 11462 JORDAN PILE DRIVING, INC.
Ready Mix Supplier: Bayou Concrete, LLC - 10037 - Mobile, AL Plant 2(Canal)
Weather: Clear
Ambient Placement Temp Begin/End: 75 F / 70 F
Cylinder Field Curing Temp Low/High: 60 F / 80 F

Test Records

Ticket No: 20138293 **Test Start:** 02:10 PM **Test End:** 02:20 PM **Slump (in):** 9.25 **Air %:** 1.5 **Temp (F):** 82 **Cast Date:** 03/23/2018 **Inspector:** Burdett, Chris

Sample ID	Cylinder No	Cylinder Received Date	Test Date	Age	Average Diameter	Length	X-Section Area (sqin)	Total Applied Load	Req'd Strength (psi)	Actual Strength (psi)	Fracture Type	Lab Technician	Lab Remarks
786223	DS-1	03/26/2018	03/27/2018	4	5.98	12.0	28.04	131040	Varies	4670	Type 5	11907 Holland, Travis	N/A
786224	DS-2	03/26/2018	03/28/2018	5	5.97	12.0	27.95	140410	Varies	5020	Type 3	11907 Holland, Travis	N/A
786225	DS-3	03/26/2018	03/30/2018	7	5.98	12.0	28.09	154430	Varies	5500	Type 5	11907 Holland, Travis	N/A
786227	DS-5												
786226	DS-4												

Ticket No: 20138300 **Test Start:** 03:20 PM **Test End:** 03:30 PM **Slump (in):** 9.25 **Air %:** 1.2 **Temp (F):** 80 **Cast Date:** 03/23/2018 **Inspector:** Burdett, Chris

Sample ID	Cylinder No	Cylinder Received Date	Test Date	Age	Average Diameter	Length	X-Section Area (sqin)	Total Applied Load	Req'd Strength (psi)	Actual Strength (psi)	Fracture Type	Lab Technician	Lab Remarks
786228	DS-6	03/26/2018	03/27/2018	4	6.00	12.0	28.27	113310	Varies	4010	Type 2	11907 Holland, Travis	N/A
786229	DS-7	03/26/2018	03/28/2018	5	5.98	12.0	28.09	123940	Varies	4410	Type 3	11907 Holland, Travis	N/A
786230	DS-8	03/26/2018	03/30/2018	7	5.97	12.0	27.99	152990	Varies	5470	Type 5	11907 Holland, Travis	N/A
786232	DS-10												
786231	DS-9												

Ticket No: 20138308 **Test Start:** 03:50 PM **Test End:** 04:00 PM **Slump (in):** 9.50 **Air %:** 2 **Temp (F):** 79 **Cast Date:** 03/23/2018 **Inspector:** Burdett, Chris

Sample ID	Cylinder No	Cylinder Received Date	Test Date	Age	Average Diameter	Length	X-Section Area (sqin)	Total Applied Load	Req'd Strength (psi)	Actual Strength (psi)	Fracture Type	Lab Technician	Lab Remarks
786234	DS-11	03/26/2018	03/27/2018	4	5.99	12.0	28.13	129340	Varies	4600	Type 2	11907 Holland, Travis	N/A
786235	DS-12	03/26/2018	03/28/2018	5	5.98	12.0	28.09	140800	Varies	5010	Type 3	11907 Holland, Travis	N/A
786236	DS-13	03/26/2018	03/30/2018	7	6.00	12.0	28.27	153630	Varies	5430	Type 5	11907 Holland, Travis	N/A
786237	DS-14												
786238	DS-15												

Alabama Department of Transportation
Concrete Placement and Testing Report
BMT-174 Pending Tests

Report ID: 56081 **Pour Date:** 03/23/2018

Ticket No: 20138314 **Test Start:** 04:45 PM **Test End:** 04:55 PM **Slump (in):** 9.50 **Air %:** 1.5 **Temp (F):** 80 **Cast Date:** 03/23/2018 **Inspector:** Burdett, Chris

Sample ID	Cylinder No	Cylinder Received Date	Test Date	Age	Average Diameter	Length	X-Section Area (sqin)	Total Applied Load	Req'd Strength (psi)	Actual Strength (psi)	Fracture Type	Lab Technician	Lab Remarks
786239	DS-16	03/26/2018	03/27/2018	4	5.98	12.0	28.09	109580	Varies	3900	Type 3	11907 Holland, Travis	N/A
786240	DS-17	03/26/2018	03/28/2018	5	5.97	12.0	27.95	126550	Varies	4530	Type 5	11907 Holland, Travis	N/A
786241	DS-18	03/26/2018	03/30/2018	7	5.99	12.0	28.18	164140	Varies	5830	Type 3	11907 Holland, Travis	N/A
786242	DS-19												
786243	DS-20												

Ticket No: 20138321 **Test Start:** 05:25 PM **Test End:** 05:35 PM **Slump (in):** 9.00 **Air %:** 1.5 **Temp (F):** 82 **Cast Date:** 03/23/2018 **Inspector:** Burdett, Chris

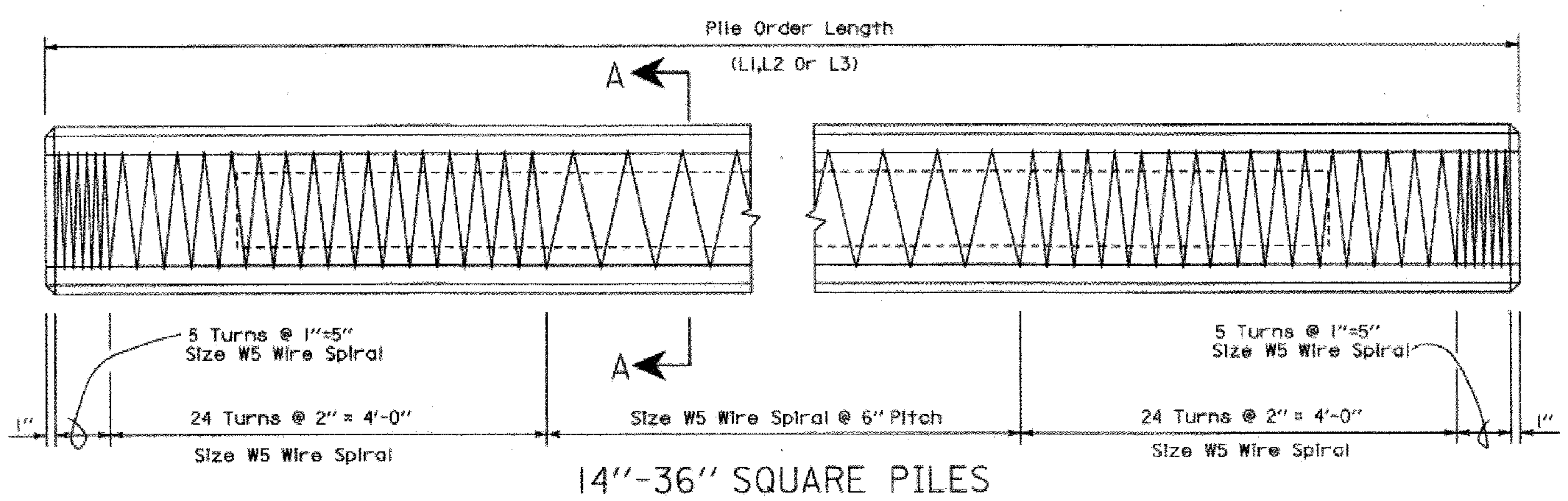
Sample ID	Cylinder No	Cylinder Received Date	Test Date	Age	Average Diameter	Length	X-Section Area (sqin)	Total Applied Load	Req'd Strength (psi)	Actual Strength (psi)	Fracture Type	Lab Technician	Lab Remarks
786244	DS-21	03/26/2018	03/27/2018	4	5.98	12.0	28.09	105880	Varies	3770	Type 3	11907 Holland, Travis	N/A
786245	DS-22	03/26/2018	03/28/2018	5	5.97	12.0	27.99	128670	Varies	4600	Type 5	11907 Holland, Travis	N/A
786246	DS-23	03/26/2018	03/30/2018	7	5.99	12.0	28.18	160430	Varies	5690	Type 5	11907 Holland, Travis	N/A
786247	DS-24												
786248	DS-25												

Pay Item(s): 0011 | 0190 | 506C087 | Drilled Shaft Construction, 6'-0" Diameter, Class DS2A Concrete

Reviewed by:

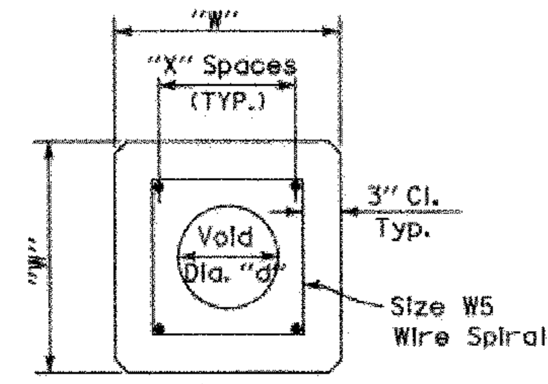
General Remarks: Rosalind Pettaway: Lab #99071-0001 Lab #99071-0002 Lab #99071-0003 Lab #99071-0004 Lab #99071-0005 Lab #99071-0006 Lab #99071-0007 Lab #99071-0008 Lab #99071-0009 Lab #99071-0010Lab #99071-0011 Lab #99071-0012 Lab #99071-0013 Lab #99071-0014 Lab #99071-0015

Disclaimer: All tests are in accordance with applicable AASHTO and ASTM specifications: C-31, C-39, C-143, C-172, C-231, C-1064, and C-1231.



14"-36" SQUARE PILES

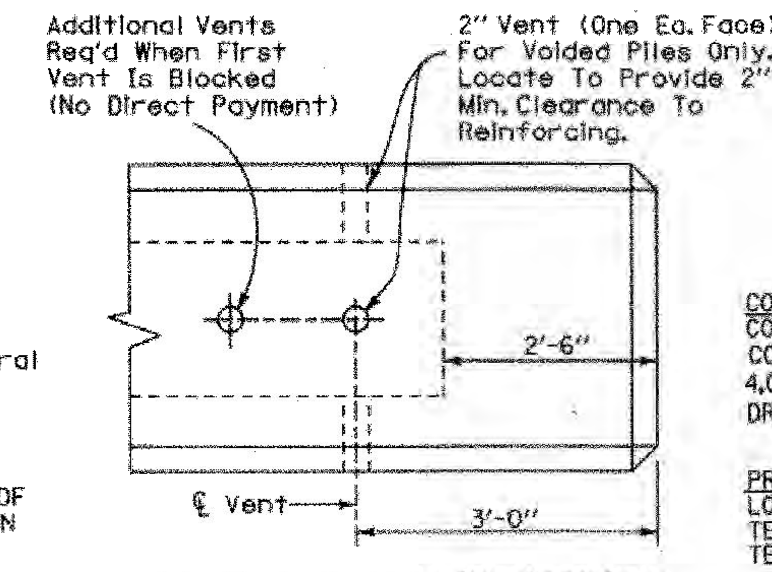
NO SCALE



NOTE:
STRAND PROTECTION: WHEN STRANDS ARE CUT FLUSH WITH END SURFACES OF PILE, THEY SHALL BE PAINTED WITH AN APPROVED EPOXY IMMEDIATELY AFTER CUTTING.

SECTION A-A

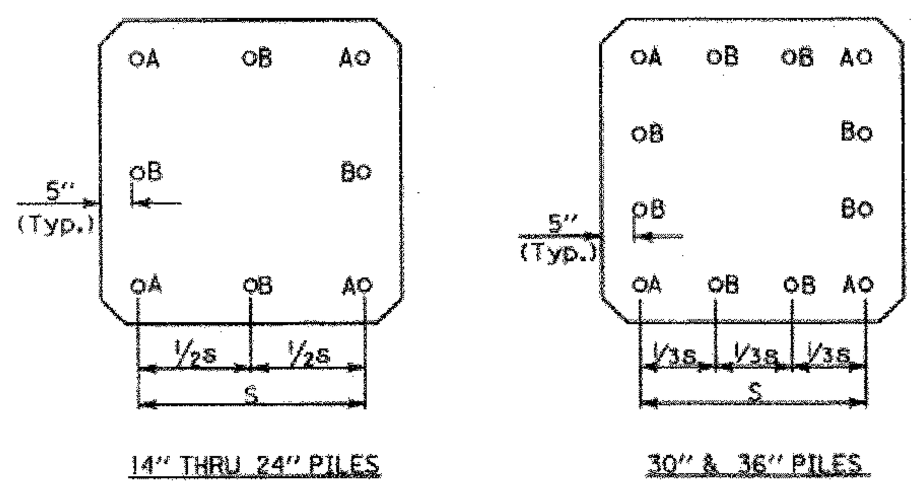
NO SCALE



Note: Vents Req'd At Pile Head Only.

PILE HEAD DETAIL

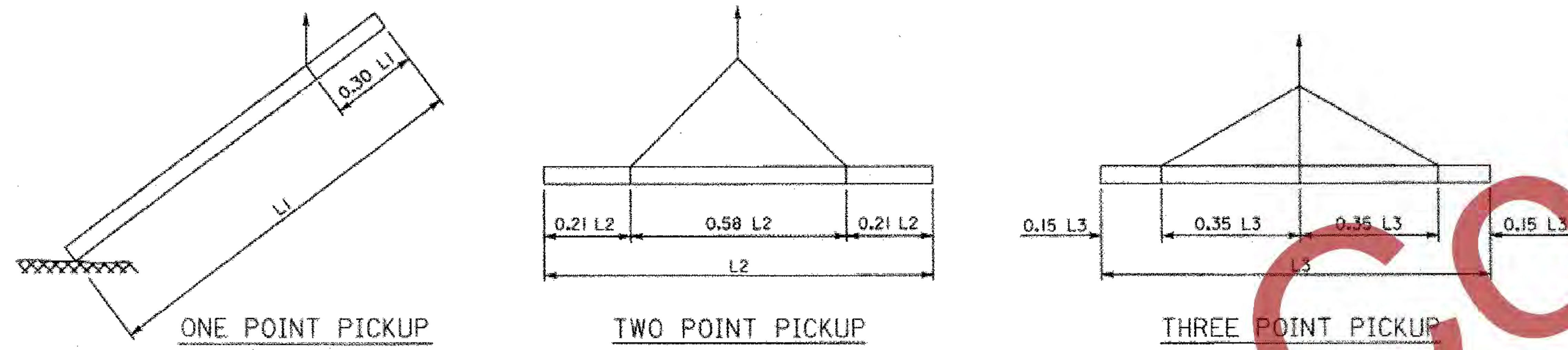
NO SCALE



DOWEL HOLE PATTERN

DOWEL SIZE	D
#4,#6	1"
#7,#8	1¼"

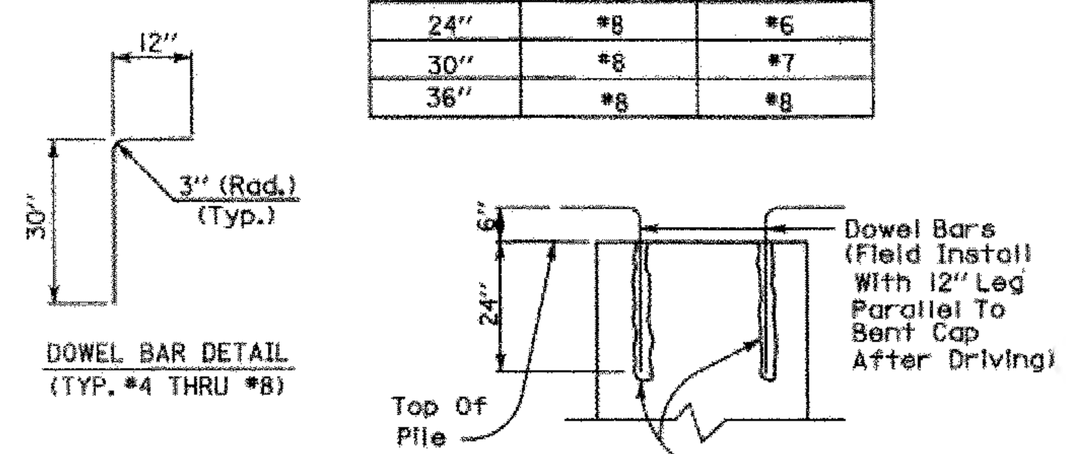
PILE SIZE	DOWEL BAR SIZE LOCATION A	DOWEL BAR SIZE LOCATION B
14"	#7	—
16"	#8	—
18"	#8	#4
20"	#8	#6
24"	#8	#6
30"	#8	#7
36"	#8	#8



NOTE: Pick-Up Points To Be Plainly Marked On Piles

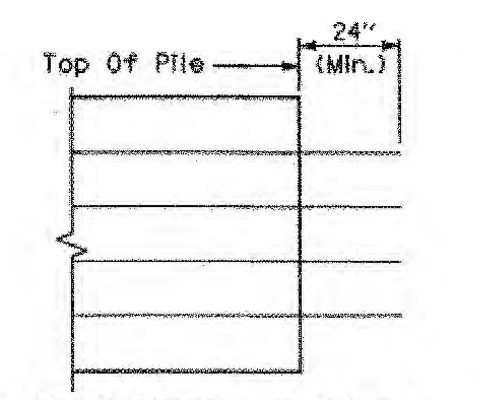
PICKUP DETAILS

NO SCALE



NOTE:
Dowel Holes Shall Be Drilled After Driving Is Complete. Holes Shall Be Cleaned Prior To Setting Dowel Bars And Shall Be Free Of Dust, Oil, Water And Other Contaminents. Dowel Bars Shall Be Set Using An Approved Epoxy.

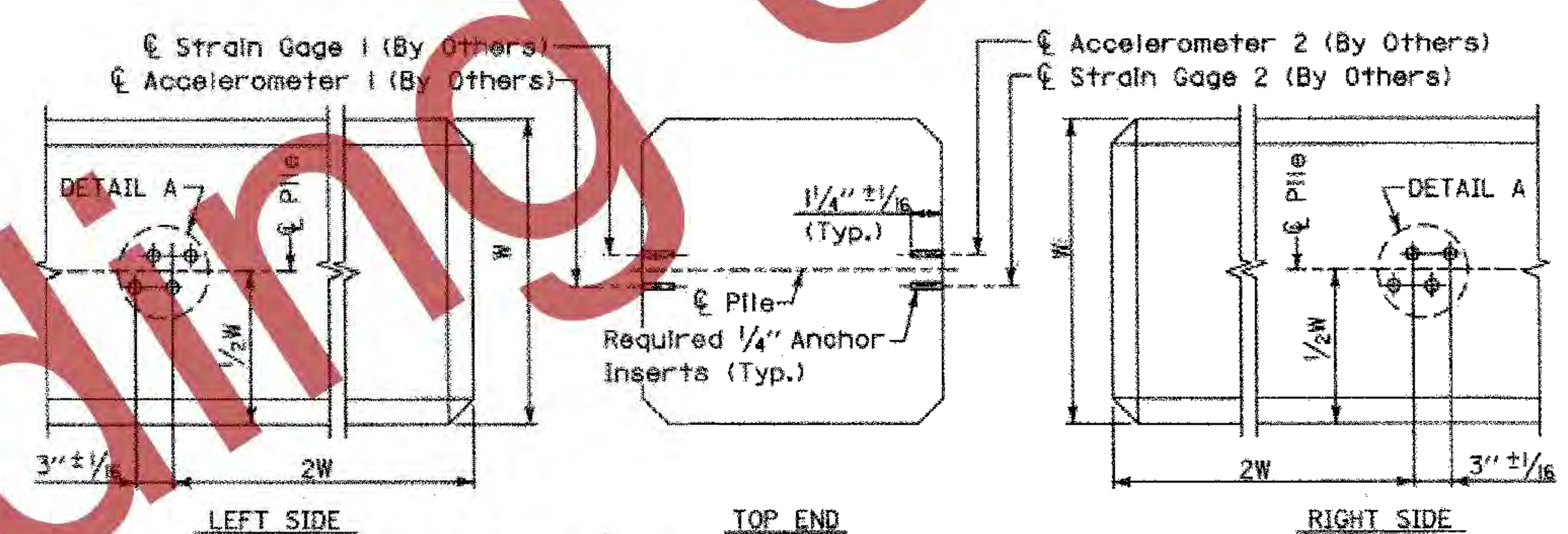
ALTERNATE 'B' (DOWEL BAR EXTENSION)



Prestressed Strands To Extend 24" Beyond Pile Cut-Off To Provide Attachment Of Pile To Bent And Abutment Caps (Typ. 14" Thru 36" Piles)

ALTERNATE 'A' (STRAND EXTENSION)

PILE HEAD ATTACHMENT



* LOCATION OF REQUIRED 1/4" INSERTS

NO SCALE

* 1/4" INSERTS: INSERTS FOR ALDOT MATERIALS & TEST BUREAU USE SHALL BE EITHER CAST INTO OR DRILLED INTO ALL PILING.

GENERAL NOTES

CONCRETE: THE CONTRACTOR SHALL DESIGN AND SUBMIT FOR APPROVAL A CONCRETE MIX WITH MINIMUM COMPRESSIVE CYLINDER STRENGTH OF 5,000 P.S.I. AT 28 DAYS UNLESS SHOWN OTHERWISE ON THE CONTRACT DRAWINGS. CONCRETE STRENGTH AT TIME OF TRANSFER OF PRESTRESSING FORCE SHALL BE 4,000 P.S.I. OR GREATER. CEMENT SHALL BE TYPE II EXCEPT WHEN OTHERWISE NOTED ON THE CONTRACT DRAWINGS, SPECIFICATIONS, OR SPECIAL PROVISIONS.

PRESTRESSING STEEL: STRESSING CABLE SHALL BE ½" DIA., SEVEN WIRE, UNCOATED, STRESS-RELIEVED OR LOW RELAXATION, GRADE 270, AND SHALL CONFORM TO THE REQUIREMENTS OF AASHTO M 203. AN INITIAL TENSION OF 28,910 LBS. SHALL BE APPLIED TO EACH STRESS-RELIEVED TYPE STRAND, AND AN INITIAL TENSION OF 30,975 LBS. SHALL BE APPLIED TO EACH LOW-RELAXATION TYPE STRAND.

REINFORCING BARS: REINFORCING STEEL SHALL BE DEFORMED BILLET STEEL BARS, GRADE 60 AND SHALL MEET THE REQUIREMENTS OF AASHTO-M31.

SPIRAL REINFORCING STEEL: SPIRAL REINFORCEMENT SHALL BE SIZE W5(MIN.) COLD-DRAWN STEEL WIRE AND SHALL CONFORM TO AASHTO M-32.

FABRICATION TOLERANCES: MANUFACTURE OF THE PILING AND FABRICATION TOLERANCES SHALL BE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS. THE DETENSIONING PROCEDURE SHALL BE SUBMITTED TO THE BRIDGE ENGINEER FOR APPROVAL.

CHAMFERS AND CORNERS: ON PILES 18" OR SMALLER, ALL EXPOSED CONCRETE CORNERS ARE TO HAVE ¾" CHAMFERS. ON PILES 20" OR LARGER, ALL EXPOSED CONCRETE CORNERS ARE TO HAVE 1½" CHAMFER. A 1" RAD. CURVE WILL BE PERMITTED IN LIEU OF CHAMFERS SHOWN ABOVE. HOWEVER, ALL BENT PILES FURNISHED SHALL BE OF SAME CONFIGURATION.

PICK-UP AND HANDLING: MAXIMUM LENGTHS FOR PICK-UP HAVE BEEN DETERMINED USING THE FOLLOWING STRESS ASSUMPTIONS:

LOADING: 1½ TIMES FULL DEAD LOAD. ALLOWABLE TENSILE STRESS EQUALS $5\sqrt{f'c}$ PSI. THIS STRESS AND LOADING CRITERIA ARE BASED ON CAREFUL HANDLING OF THE PILE. ROTATION OF PILE IN THE SLING IS TO BE PREVENTED UNTIL PILE IS IN VERTICAL POSITION. PICK-UP POINTS FOR ALL PILES TO BE CLEARLY MARKED ON PILE. PICK-UP POINTS SHOWN MAY BE MODIFIED FOR TRANSPORTATION PURPOSES PROVIDED THE TENSILE STRESS BASED ON ABOVE LOADING CRITERIA DOES NOT EXCEED $5\sqrt{f'c}$ PSI. THE MODIFIED PICK-UP POINTS SHALL BE SENT TO THE BRIDGE DESIGN ENGINEER FOR REVIEW.

PICK-UP DEVICES: CAST-IN-PLACE LOOPS MAY BE USED AS PICK-UP DEVICES FOR PRESTRESSED PILES. FOR PILE ABUTMENTS AND FOR PILE FOOTINGS THAT ARE TO BE CONSTRUCTED BELOW GROUNDLINE, THE FOLLOWING SHALL APPLY: THE LOOPS SHALL BE CUT OFF FLUSH WITH FACE OF THE PILE AND EXPOSED SURFACES OF THE LOOPS SHALL BE COATED WITH AN APPROVED EPOXY. FOR PILE BENTS AND FOR PILE FOOTINGS THAT ARE TO BE CONSTRUCTED ABOVE POOL (WATERLINE), THE FOLLOWING SHALL APPLY: A 3"x3" BY 1½" DEEP RECESS (BLOCKOUT) SHALL BE PROVIDED AT EACH LOOP PROTRUSION. THE LOOPS SHALL BE CUT OFF FLUSH WITH THE RECESSED FACE OF THE PILE AND THE RECESS SHALL BE FILLED WITH AN APPROVED EPOXY. THE EPOXY SHALL OBTAIN THE 28-DAY STRENGTH SPECIFIED FOR THE PILE PRIOR TO DRIVING THE PILE. THE TYPE OF PICK-UP DEVICE TO BE USED BY THE CONTRACTOR SHALL BE CLEARLY SHOWN ON THE PRESTRESSED CONCRETE PILE SHOP DRAWINGS.

SHIPPING: PILING SHALL BE HELD AT THE PLANT FOR A MINIMUM OF 21 DAYS PRIOR TO SHIPPING. PILING SHALL NOT BE TRANSPORTED UNTIL THE MINIMUM 28 DAY COMPRESSIVE CONCRETE STRENGTH IS OBTAINED AND VERIFIED BY TEST CYLINDERS.

DRIVING: PILES SHALL BE DRIVEN TO AT LEAST THE MINIMUM TIP ELEVATION AS SHOWN ON CONTRACT PLANS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

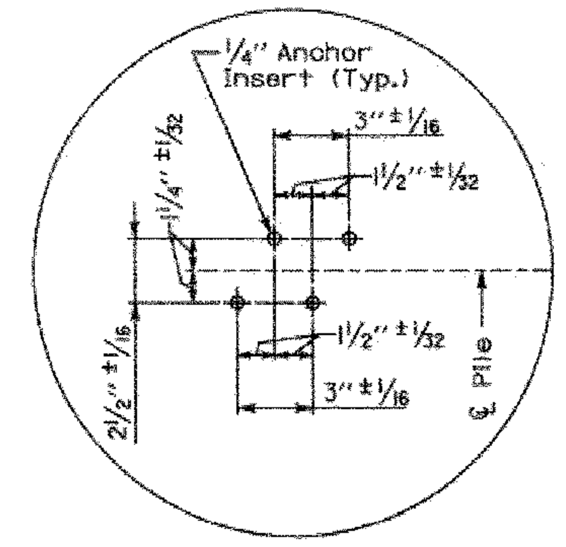
PILE HEAD ATTACHMENT: PROVISION SHALL BE MADE FOR PILE HEAD ATTACHMENT BY STRAND EXTENSION OR DOWEL BAR EXTENSION (SEE DETAIL, THIS SHEET) FOR BENT CAPS, ABUTMENT CAPS, AND FOR PILE FOOTINGS WHENEVER FOOTINGS ARE TO BE CONSTRUCTED ABOVE POOL (WATERLINE). THE CONTRACTOR'S PROPOSED METHOD OF PILE HEAD ATTACHMENT SHALL BE CLEARLY SHOWN ON THE PRESTRESSED CONCRETE PILE SHOP DRAWINGS. A PILE HEAD ATTACHMENT IS NOT REQUIRED FOR PILES IN FOOTINGS TO BE CONSTRUCTED BELOW GROUNDLINE.

BUILD-UP: THE USE OF A BUILD-UP (DRIVING OR NON-DRIVING) SHALL BE SUBJECT TO APPROVAL OF THE BRIDGE ENGINEER. SUBMIT DETAILS TO THE BRIDGE ENGINEER. CONCRETE SHALL BE THE SAME JOB MIX AS THE PRESTRESS CONCRETE.

JETTING OF PILES: JETTING OF PRESTRESSED CONCRETE PILES IS PERMISSIBLE SUBJECT TO SATISFYING THE CONDITIONS STATED IN ARTICLE 505.03(c)2 OF THE STANDARD SPECIFICATIONS. REFERENCE THIS ARTICLE OF THE SPECIFICATIONS FOR JET TUBE INSTALLATION REQUIREMENTS.

PILE PROPERTIES

PILE SIZE "W"	WEIGHT PER. LIN. FT. (Lbs./Ft.)	SECTION MODULUS OF CROSS SECTION ($in.^3$)	AREA OF NORMAL CROSS SECTION ($in.^2$)	VOID DIA. "d"	STRESS RELIEVED STRAND: NO. OF STRANDS	STRAND LAYOUT ("X" SPACES)	INITIAL PRESTRESS (PSI)	MAX. CASTING LENGTH: 1 POINT PICK-UP L1	2 POINT PICK-UP L2	3 POINT PICK-UP L3	LOW RELAXATION STRAND: NO. OF STRANDS	STRAND LAYOUT ("X" SPACES)	INITIAL PRESTRESS (PSI)	MAX. CASTING LENGTH: 1 POINT PICK-UP L1	2 POINT PICK-UP L2	3 POINT PICK-UP L3
14" Solid	204	457	196	0.00"	8	2	1180	60'-0"	85'-0"	121'-0"	8	2	1264	61'-0"	87'-0"	125'-0"
16" Solid	267	683	256	0.00"	8	2	903	58'-0"	83'-0"	118'-0"	8	2	968	60'-0"	84'-0"	121'-0"
18" Solid	338	972	324	0.00"	12	3	1071	66'-0"	93'-0"	133'-0"	12	3	1147	67'-0"	95'-0"	136'-0"
20" Solid	417	1,333	400	0.00"	16	4	1156	71'-0"	101'-0"	144'-0"	12	3	929	66'-0"	93'-0"	134'-0"
24" Voided	510	2,254	489	10.50"	16	4	946	78'-0"	110'-0"	158'-0"	16	4	1013	80'-0"	113'-0"	162-0"
30" Voided	715	4,257	686	16.50"	24	6	1011	93'-0"	131'-0"	188'-0"	20	5	903	89'-0"	126'-0"	181'-0"
36" Voided	936	7,077	898	22.50"	32	8	1030	105'-0"	149'-0"	213'-0"	28	7	966	103'-0"	145'-0"	208'-0"



DETAIL A

THESE DRAWINGS REPRESENT DESIGNS PREPARED FOR USE BY THE ALABAMA DEPARTMENT OF TRANSPORTATION AND ARE NOT TO BE COPIED, REPRODUCED, ALTERED, OR USED BY ANYONE, OR ANY ORGANIZATION, WITHOUT THE EXPRESSED WRITTEN CONSENT OF THE ALABAMA DEPARTMENT OF TRANSPORTATION REPRESENTATIVE AUTHORIZED TO APPROVE SUCH USE. ANYONE MAKING UNAUTHORIZED USE OF THESE DRAWINGS MAY BE PROSECUTED TO THE FULLEST EXTENT OF THE LAW.

ASSISTANT BRIDGE ENGINEER

BRIDGE ENGINEER

ALABAMA DEPARTMENT OF TRANSPORTATION

THIS SPECIAL PROJECT DRAWING TO BE USED WITH ANY OF THE FOLLOWING STANDARDS

REVISIONS

BRIDGE SPECIAL PROJECT DRAWING

PRECAST PRESTRESSED CONCRETE PILES 14-16-18-20-24-30 & 36 INCHES

ESTIMATED QUANTITIES	SPECIAL PROJ. DWG. NO.
COMPUTED BY:	PSCP-1
VERIFIED BY:	
DESIGNED BY:	
SCALE:	SHEET NO. 1 OF 1

CHECKED BY: | DRAWN BY: K.R.T. | DATE CHECKED: 10-19-04 | DATE DRAWN: 11-20-91

(THIS SPECIAL PROJECT DRAWING FOR USE ON PROJECT NO. IM-I010(341), Mobile & Baldwin COUNTY ONLY)

REFERENCE PROJECT NUMBER	FISCAL YEAR	SHEET NUMBER
IM-I010(341)	2018	16

thompson ENGINEERING

RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway					County:	Mobile
Boring No.:	TH-10	Boring Location:	470+55.32	Offset:	106.31' RT	Alignment:	I-10 Bayway
ALDOT PE No.:	DPI-0030(005)	TE Project No.:	15-1101-0228			Eng./Geo.:	C.Tisher
Elev.:	12.9 ft.	Northing:	245999.249	Easting:	1797615.33	Date Started:	9/7/2017
Total Depth:	180.0 ft.	Soil Depth:	180.0 ft.	Core Depth:	0.0 ft.	Date Completed:	9/8/2017
Bore Hole Diameter (in):	4-inch	AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207				
Drill Machine:	CME 45C	Drill Method:	MR	Hammer Type:	Automatic	Energy Ratio:	86%
Core Size:	N/A	Driller:	Thompson Eng	Groundwater:	TOB 1.8 ft.	24 HR	20.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
0.0		Loose, light blue and brown, fine grained, with trace gravel and wood, SILTY SAND (SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=17.8 %#200=18.3	0.0	SS-1	2	4	6	10
	10.0	Medium dense, reddish brown, fine grained, POORLY GRADED SAND with SILT (SP-SM)	1.5	SS-2	4	8	7	15
		Medium dense, pale brown, fine grained, POORLY GRADED SAND with SILT (SP-SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=21.1 %#200=10.9	3.0	SS-3	5	8	6	14
5.0		Medium dense, moist, gray	4.5	SS-4	5	6	6	12
		Loose	6.0	SS-5	3	4	3	7
	5.0	Very loose	8.5	SS-6	1	2	1	3
10.0	0.0							
15.0		Very soft, moist, dark gray, with trace gravel, SANDY FAT CLAY (CH, A-7-6(14)), LL=55 PL=23 PI=31 NMC=51.7 %#200=54.0	13.5	SS-7	0	0	1	1
20.0	-5.0	Undisturbed sample obtained from 18.0 to 20.0 feet. Approximately 24 inches of recovery. Moist, dark gray and reddish brown, LEAN CLAY with SAND (CL, A-6(15)), LL=39 PL=16 PI=22 NMC=48.7 %#200=73.8	18.0	ST-1				
25.0	-10.0	Medium dense, moist, white, fine to medium grained, POORLY GRADED SAND with SILT (SP-SM, A-3(0)), LL=NP PL=NP PI=NP NMC=26.4 %#200=5.6	23.5	SS-8	9	14	15	29
30.0	-15.0	Medium dense, moist, white and pale brown, fine grained, POORLY GRADED SAND with SILT	28.5	SS-9	8	10	13	23

● SPT N VALUE (blows/foot)
PL MC LL
▲ FINES CONTENT (%) ▲
10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	AC - Auger Cuttings	HSA - Hollow Stem Augers	MR - Mud Rotary Wash
ST - Shelby Tube	GB - Grab Bag	SSA - Solid Stem Augers	RC - Rock Coring
DCP - Dynamic Cone Penetrometer	NQ - Rock Core	HA - Hand Auger	

thompson ENGINEERING

RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway					County:	Mobile
Boring No.:	TH-10	Boring Location:	470+55.32	Offset:	106.31' RT	Alignment:	I-10 Bayway
ALDOT PE No.:	DPI-0030(005)	TE Project No.:	15-1101-0228			Eng./Geo.:	C.Tisher
Elev.:	12.9 ft.	Northing:	245999.249	Easting:	1797615.33	Date Started:	9/7/2017
Total Depth:	180.0 ft.	Soil Depth:	180.0 ft.	Core Depth:	0.0 ft.	Date Completed:	9/8/2017
Bore Hole Diameter (in):	4-inch	AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207				
Drill Machine:	CME 45C	Drill Method:	MR	Hammer Type:	Automatic	Energy Ratio:	86%
Core Size:	N/A	Driller:	Thompson Eng	Groundwater:	TOB 1.8 ft.	24 HR	20.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
30.0		(SP-SM, A-3(0)), LL=NP PL=NP PI=NP NMC=23.7 %#200=6.9						
35.0	-20.0	Dense, moist, reddish brown, fine grained, POORLY GRADED SILT WITH SAND (SP-SM)	33.5	SS-10	8	17	18	35
40.0	-25.0	Dense, reddish brown and pale brown	38.5	SS-11	9	15	18	33
45.0	-30.0	Dense, moist, red and pale brown, fine to medium grained, POORLY GRADED SAND with SILT (SP-SM, A-3(0)), LL=NP PL=NP PI=NP NMC=22.4 %#200=5.6	43.5	SS-12	9	16	15	31
50.0	-35.0	Medium dense	48.5	SS-13	7	13	16	29
55.0	-40.0	Medium dense, fine grained	53.5	SS-14	12	12	15	27
60.0	-45.0	Medium dense, moist, red and pale brown, fine to medium grained, POORLY GRADED SAND with SILT	58.5	SS-15	6	6	5	11

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	AC - Auger Cuttings	HSA - Hollow Stem Augers	MR - Mud Rotary Wash
ST - Shelby Tube	GB - Grab Bag	SSA - Solid Stem Augers	RC - Rock Coring
DCP - Dynamic Cone Penetrometer	NQ - Rock Core	HA - Hand Auger	

thompson ENGINEERING

RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway					County:	Mobile
Boring No.:	TH-10	Boring Location:	470+55.32	Offset:	106.31' RT	Alignment:	I-10 Bayway
ALDOT PE No.:	DPI-0030(005)	TE Project No.:	15-1101-0228			Eng./Geo.:	C.Tisher
Elev.:	12.9 ft.	Northing:	245999.249	Easting:	1797615.33	Date Started:	9/7/2017
Total Depth:	180.0 ft.	Soil Depth:	180.0 ft.	Core Depth:	0.0 ft.	Date Completed:	9/8/2017
Bore Hole Diameter (in):	4-inch	AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207				
Drill Machine:	CME 45C	Drill Method:	MR	Hammer Type:	Automatic	Energy Ratio:	86%
Core Size:	N/A	Driller:	Thompson Eng	Groundwater:	TOB 1.8 ft.	24 HR	20.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
60.0		(SP-SM, A-3(0)), LL=NP PL=NP PI=NP NMC=22.8 %#200=5.2						
65.0	-50.0	Dense, fine grained	63.5	SS-16	7	15	19	34
70.0	-55.0	Medium dense	68.5	SS-17	4	8	8	16
75.0	-60.0	Medium dense, moist, red and pale brown, fine to medium grained, POORLY GRADED SAND (SP, A-3(0)), LL=NP PL=NP PI=NP NMC=19.9 %#200=3.7	73.5	SS-18	10	10	14	24
80.0	-65.0	Dense	78.5	SS-19	12	14	17	31
85.0	-70.0	Medium dense, pale brown and reddish brown, with trace gravel	83.5	SS-20	6	7	10	17
90.0	-75.0	Medium dense, moist, pale brown and reddish brown, fine to medium grained, POORLY GRADED SAND	88.5	SS-21	6	6	7	13

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	AC - Auger Cuttings	HSA - Hollow Stem Augers	MR - Mud Rotary Wash
ST - Shelby Tube	GB - Grab Bag	SSA - Solid Stem Augers	RC - Rock Coring
DCP - Dynamic Cone Penetrometer	NQ - Rock Core	HA - Hand Auger	

STRATA SYMBOLS

- SAND (SP)
- SILT (MH)
- FAT CLAY (CH)
- SILTY SAND (SM)
- POORLY GRADED SAND with SILT (SP-SM)
- ORGANIC SOILS (OL)
- Paving
- GRAVEL (GP)
- SANDY SILT (ML)
- LEAN CLAY (CL)
- TOPSOIL
- CLAYEY SAND (SC)
- CLAYEY SILTY SAND (SC-SM)
- WELL GRADED SAND with SILT and GRAVEL (SW-SM)
- SANDSTONE
- DOLOMITE
- CLAYEY GRAVEL (GC)
- POORLY GRADED GRAVEL with SILT and SAND (GP-GM)
- SILTY CLAY (CL-ML)
- Ground Water, ATD
- 24 Hr./Delayed Ground Water

HSA - Hollow Stem Auger
SSA - Solid Stem Auger
MR - Mud Rotary

NO - Not Obtained
NE - Not Encountered
REC Recovery
RQD Rock Quality Designation
pp - Pocket Penetrometer
SS - Split Spoon
ST - Shelby Tube
DCP - Dynamic Cone Penetrometer
AC - Auger Cuttings
GB - Grab Bag
NQ - Rock Core

Alabama Department of Transportation

Bridge Sheet of

thompson ENGINEERING
2970 COTTAGE HILL RD.
MOBILE, AL 36606

PROJECT NO. 17-1101-0145
I-10 MOBILE RIVER BRIDGE
LOAD TEST PROGRAM
MOBILE COUNTY, ALABAMA

APPROVED : SAM STERNBERG III, P.E.
GEOTECHNICAL ENGINEER

DATE :

Preliminary Project No:

TEST BORING RECORD
Sheet 1 of 12

thompson ENGINEERING

RECORD OF TEST BORING

Site Description: I-10 Mobile River Bridge and Bayway		County: Mobile	
Boring No.: TH-10	Boring Location: 470+55.32	Offset: 106.31' RT	Alignment: I-10 Bayway
ALDOT PE No.: DPI-0030(005)	TE Project No.: 15-1101-0228	Eng./Geo.: C.Tisher	
Elev.: 12.9 ft.	Northing: 245999.249	Easting: 1797615.33	Date Started: 9/7/2017
Total Depth: 180.0 ft.	Soil Depth: 180.0 ft.	Core Depth: 0.0 ft.	Date Completed: 9/8/2017
Bore Hole Diameter (in): 4-inch	AASHTO / ASTM Sampling Methods: AASHTO T206 & T207		
Drill Machine: CME 45C	Drill Method: MR	Hammer Type: Automatic	Energy Ratio: 86%
Core Size: N/A	Driller: Thompson Eng	Groundwater: TOB 1.8 ft.	24 HR 20.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
90.0		(SP, A-3(0)), LL=NP PL=NP PI=NP NMC=24.0 %#200=4.7						
	-80.0							
95.0		Dense	93.5	SS-22	8	16	21	37
	-85.0							
100.0		Dense	98.5	SS-23	16	22	24	46
	-90.0							
105.0		Firm, moist, dark gray, FAT CLAY (CH)	103.5	SS-24	2	3	4	7
	-95.0							
110.0		Undisturbed sample obtained from 108.0 to 110.0 feet. Approximately 24 inches of recovery. Moist, greenish gray, with trace sand, FAT CLAY (CH, A-7-6(66)), LL=85 PL=23 PI=62 NMC=39.5 %#200=93.7	108.0	ST-2				
	-100.0							
115.0		Stiff, moist, greenish gray, LEAN CLAY with SAND (CL)	113.5	SS-25	2	5	8	13
	-105.0							
120.0		Undisturbed sample obtained from 118.0 to 120.0 feet. Approximately 24 inches of recovery. Moist, greenish gray, LEAN CLAY with SAND (CL,	118.0	ST-3				

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon, ST - Shelby Tube, DCP - Dynamic Cone Penetrometer, AC - Auger Cuttings, GB - Grab Bag, NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers, SSA - Solid Stem Augers, HA - Hand Auger, MR - Mud Rotary Wash, RC - Rock Coring

thompson ENGINEERING

RECORD OF TEST BORING

Site Description: I-10 Mobile River Bridge and Bayway		County: Mobile	
Boring No.: TH-10	Boring Location: 470+55.32	Offset: 106.31' RT	Alignment: I-10 Bayway
ALDOT PE No.: DPI-0030(005)	TE Project No.: 15-1101-0228	Eng./Geo.: C.Tisher	
Elev.: 12.9 ft.	Northing: 245999.249	Easting: 1797615.33	Date Started: 9/7/2017
Total Depth: 180.0 ft.	Soil Depth: 180.0 ft.	Core Depth: 0.0 ft.	Date Completed: 9/8/2017
Bore Hole Diameter (in): 4-inch	AASHTO / ASTM Sampling Methods: AASHTO T206 & T207		
Drill Machine: CME 45C	Drill Method: MR	Hammer Type: Automatic	Energy Ratio: 86%
Core Size: N/A	Driller: Thompson Eng	Groundwater: TOB 1.8 ft.	24 HR 20.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
120.0		A-6(12)), LL=33 PL=17 PI=16 NMC=30.4 %#200=83.4						
	-110.0							
125.0		Dense, moist, pale brown, fine to medium grained, SAND (SP), with gravel	123.5	SS-26	9	16	15	31
	-115.0							
130.0		Dense, pale brown, medium to coarse grained	128.5	SS-27	9	19	18	37
	-120.0							
135.0		Very dense, moist, pale brown, fine to medium grained, with trace gravel, SILTY SAND (SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=16.9 %#200=13.5	133.5	SS-28	16	37	39	76
	-125.0							
140.0		Dense	138.5	SS-29	13	20	22	42
	-130.0							
145.0		Very dense, with trace gravel	143.5	SS-30	16	28	31	59
	-135.0							
150.0		Very stiff, moist, bluish gray, SANDY LEAN CLAY (CL, A-6(8)), LL=32 PL=14 PI=17 NMC=22.8	148.5	SS-31	8	11	12	23

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon, ST - Shelby Tube, DCP - Dynamic Cone Penetrometer, AC - Auger Cuttings, GB - Grab Bag, NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers, SSA - Solid Stem Augers, HA - Hand Auger, MR - Mud Rotary Wash, RC - Rock Coring

thompson ENGINEERING

RECORD OF TEST BORING

Site Description: I-10 Mobile River Bridge and Bayway		County: Mobile	
Boring No.: TH-10	Boring Location: 470+55.32	Offset: 106.31' RT	Alignment: I-10 Bayway
ALDOT PE No.: DPI-0030(005)	TE Project No.: 15-1101-0228	Eng./Geo.: C.Tisher	
Elev.: 12.9 ft.	Northing: 245999.249	Easting: 1797615.33	Date Started: 9/7/2017
Total Depth: 180.0 ft.	Soil Depth: 180.0 ft.	Core Depth: 0.0 ft.	Date Completed: 9/8/2017
Bore Hole Diameter (in): 4-inch	AASHTO / ASTM Sampling Methods: AASHTO T206 & T207		
Drill Machine: CME 45C	Drill Method: MR	Hammer Type: Automatic	Energy Ratio: 86%
Core Size: N/A	Driller: Thompson Eng	Groundwater: TOB 1.8 ft.	24 HR 20.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
150.0		%#200=62.6						
	-140.0							
155.0								
	-145.0							
160.0		Hard, moist, bluish gray, FAT CLAY (CH, A-7-6(42)), LL=57 PL=14 PI=43 NMC=18.1 %#200=92.3	158.5	SS-32	9	17	22	39
	-150.0							
165.0								
	-155.0							
170.0		Dense, moist, grayish brown, fine to medium grained, with trace clay and trace gravel, SILTY SAND (SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=15.1 %#200=19.5	168.5	SS-33	6	18	27	45
	-160.0							
175.0								
	-165.0							
180.0		Very dense, wet, brownish gray, fine grained, POORLY GRADED SAND with SILT (SP-SM)	178.5	SS-34	30	50/6	X	50/6

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon, ST - Shelby Tube, DCP - Dynamic Cone Penetrometer, AC - Auger Cuttings, GB - Grab Bag, NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers, SSA - Solid Stem Augers, HA - Hand Auger, MR - Mud Rotary Wash, RC - Rock Coring

STRATA SYMBOLS

- SAND (SP)
- SILT (MH)
- FAT CLAY (CH)
- SILTY SAND (SM)
- POORLY GRADED SAND with SILT (SP-SM)
- ORGANIC SOILS (OL)
- Paving
- GRAVEL (GP)
- SANDY SILT (ML)
- LEAN CLAY (CL)
- TOPSOIL
- CLAYEY SAND (SC)
- CLAYEY SILTY SAND (SC-SM)
- WELL GRADED SAND with SILT and GRAVEL (SW-SM)
- SANDSTONE
- DOLOMITE
- CLAYEY GRAVEL (GC)
- POORLY GRADED GRAVEL with SILT and SAND (GP-GM)
- SILTY CLAY (CL-ML)
- Ground Water, ATD
- 24 Hr./Delayed Ground Water
- HSA - Hollow Stem Auger
- SSA - Solid Stem Auger
- MR - Mud Rotary

NO - Not Obtained
NE - Not Encountered
REC Recovery
RQD Rock Quality Designation
pp - Pocket Penetrometer
SS - Split Spoon
ST - Shelby Tube
DCP - Dynamic Cone Penetrometer
AC - Auger Cuttings
GB - Grab Bag
NQ - Rock Core

Alabama Department of Transportation

Bridge Sheet of

thompson ENGINEERING
2970 COTTAGE HILL RD.
MOBILE, AL 36606

PROJECT NO. 17-1101-0145
I-10 MOBILE RIVER BRIDGE
LOAD TEST PROGRAM
MOBILE COUNTY, ALABAMA

APPROVED : SAM STERNBERG III, P.E.
GEOTECHNICAL ENGINEER

DATE :

Preliminary Project No:

TEST BORING RECORD
Sheet 2 of 12

thompson ENGINEERING — RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway
County:	Mobile
Boring No.:	TH-10
Boring Location:	470+55.32
Offset:	106.31' RT
Alignment:	I-10 Bayway
ALDOT PE No.:	DPI-0030(005)
TE Project No.:	15-1101-0228
Eng./Geo.:	C.Tisher
Elev.:	12.9 ft.
Northing:	245999.249
Easting:	1797615.33
Date Started:	9/7/2017
Total Depth:	180.0 ft.
Soil Depth:	180.0 ft.
Core Depth:	0.0 ft.
Date Completed:	9/8/2017
Bore Hole Diameter (in):	4-inch
AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207
Drill Machine:	CME 45C
Drill Method:	MR
Hammer Type:	Automatic
Energy Ratio:	86%
Core Size:	N/A
Driller:	Thompson Eng
Groundwater: TOB	1.8 ft.
24 HR	20.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
		Boring Terminated at 180.0 feet.							
		*Groundwater depth TOB most likely influenced by drilling method.							

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) ▲ 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon; ST - Shelby Tube; DCP - Dynamic Cone Penetrometer; AC - Auger Cuttings; GB - Grab Bag; NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers; SSA - Solid Stem Augers; HA - Hand Auger; MR - Mud Rotary Wash; RC - Rock Coring

thompson ENGINEERING — RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway
County:	Mobile
Boring No.:	MB-1
Boring Location:	514+25.88
Offset:	18.84' LT
Alignment:	I-10 Main Span
ALDOT PE No.:	DPI-0030(005)
TE Project No.:	15-1101-0228
Eng./Geo.:	B.Ellis/C.Tisher
Elev.:	2.9 ft.
Northing:	249675.65
Easting:	1799417.497
Date Started:	4/20/2016
Total Depth:	300.0 ft.
Soil Depth:	300.0 ft.
Core Depth:	0.0 ft.
Date Completed:	4/27/2016
Bore Hole Diameter (in):	4-inch
AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207
Drill Machine:	CME 550X
Drill Method:	MR
Hammer Type:	Automatic
Energy Ratio:	88%
Core Size:	N/A
Driller:	Thompson Eng
Groundwater: TOB	0.0 ft.
24 HR	0.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
		Loose, moist, dark brown, fine to coarse grained, SILTY SAND with GRAVEL (SM)	0.0	SS-1	4	4	4	8
	0.0	Medium dense, wet, dark brown, fine to medium grained, with wood, SILTY SAND with GRAVEL (SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=57.0 %#200=17.6	1.5	SS-2	4	5	7	12
5.0		Very loose, wet, dark brown, fine to coarse grained, POORLY GRADED GRAVEL with SILT and SAND (GP-GM)	3.0	SS-3	4	2	2	4
		Loose, most likely fall in	4.5	SS-4	2	2	5	7
	-5.0	Loose, most likely fall in	6.0	SS-5	3	3	3	6
10.0		Very loose, most likely fall in	8.5	SS-6	2	1	1	2
15.0	-10.0	Very loose, wet, dark brown, fine to coarse grained, POORLY GRADED GRAVEL with SILT and SAND (GP-GM, A-1-a(0)), LL=NP PL=NP PI=NP NMC=18.9 %#200=10.9	13.5	SS-7	1	2	2	4
20.0	-15.0	Loose, wet, gray and brown, fine grained, POORLY GRADED SAND with GRAVEL (SP, A-1-b(0)), LL=NP PL=NP PI=NP NMC=16.9 %#200=4.7	18.5	SS-8	5	5	4	9
25.0	-20.0	Loose, dark brown and gray, fine to medium grained	23.5	SS-9	4	5	5	10
30.0	-25.0	Medium dense, gray and light gray	28.5	SS-10	8	12	11	23

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) ▲ 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon; ST - Shelby Tube; DCP - Dynamic Cone Penetrometer; AC - Auger Cuttings; GB - Grab Bag; NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers; SSA - Solid Stem Augers; HA - Hand Auger; MR - Mud Rotary Wash; RC - Rock Coring

thompson ENGINEERING — RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway
County:	Mobile
Boring No.:	MB-1
Boring Location:	514+25.88
Offset:	18.84' LT
Alignment:	I-10 Main Span
ALDOT PE No.:	DPI-0030(005)
TE Project No.:	15-1101-0228
Eng./Geo.:	B.Ellis/C.Tisher
Elev.:	2.9 ft.
Northing:	249675.65
Easting:	1799417.497
Date Started:	4/20/2016
Total Depth:	300.0 ft.
Soil Depth:	300.0 ft.
Core Depth:	0.0 ft.
Date Completed:	4/27/2016
Bore Hole Diameter (in):	4-inch
AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207
Drill Machine:	CME 550X
Drill Method:	MR
Hammer Type:	Automatic
Energy Ratio:	88%
Core Size:	N/A
Driller:	Thompson Eng
Groundwater: TOB	0.0 ft.
24 HR	0.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
30.0								
35.0	-30.0	Medium dense, wet, yellowish brown and brown, fine grained, POORLY GRADED SAND with GRAVEL (SP, A-3(0)), LL=NP PL=NP PI=NP NMC=28.7 %#200=3.4	33.5	SS-11	6	5	6	11
40.0	-35.0	Loose, with trace shells	38.5	SS-12	5	4	5	9
45.0	-40.0	Medium dense, wet, pale brown, fine to medium grained, with trace gravel, POORLY GRADED SAND (SP, A-1-b(0)), LL=NP PL=NP PI=NP NMC=22.2 %#200=2.1	43.5	SS-13	4	6	8	14
50.0	-45.0	Loose, wet, pale brown, fine to medium grained, POORLY GRADED GRAVEL with SAND (GP, A-1-a(0)), LL=NP PL=NP PI=NP NMC=11.7 %#200=3.1	48.5	SS-14	6	5	4	9
55.0	-50.0	Loose, light brown	53.5	SS-15	4	3	4	7
60.0	-55.0	Medium dense, wet, pale brown, fine to medium grained, POORLY GRADED SAND with SILT	58.5	SS-16	8	10	6	16

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) ▲ 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon; ST - Shelby Tube; DCP - Dynamic Cone Penetrometer; AC - Auger Cuttings; GB - Grab Bag; NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers; SSA - Solid Stem Augers; HA - Hand Auger; MR - Mud Rotary Wash; RC - Rock Coring

STRATA SYMBOLS

- SAND (SP)
- SILT (MH)
- FAT CLAY (CH)
- SILTY SAND (SM)
- POORLY GRADED SAND with SILT (SP-SM)
- ORGANIC SOILS (OL)
- Paving
- GRAVEL (GP)
- SANDY SILT (ML)
- LEAN CLAY (CL)
- TOPSOIL
- CLAYEY SAND (SC)
- CLAYEY SILTY SAND (SC-SM)
- WELL GRADED SAND with SILT and GRAVEL (SW-SM)
- SANDSTONE
- DOLOMITE
- CLAYEY GRAVEL (GC)
- POORLY GRADED GRAVEL with SILT and SAND (GP-GM)
- SILTY CLAY (CL-ML)
- Ground Water, ATD
- 24 Hr./Delayed Ground Water
- HSA - Hollow Stem Auger
- SSA - Solid Stem Auger
- MR - Mud Rotary

NO - Not Obtained
NE - Not Encountered
REC / RQD — Recovery / Rock Quality Designation
pp - Pocket Penetrometer
SS - Split Spoon
ST - Shelby Tube
DCP - Dynamic Cone Penetrometer
AC - Auger Cuttings
GB - Grab Bag
NQ - Rock Core

Alabama Department of Transportation

Bridge Sheet of

thompson ENGINEERING
2970 COTTAGE HILL RD.
MOBILE, AL 36606

PROJECT NO. 17-1101-0145
I-10 MOBILE RIVER BRIDGE
LOAD TEST PROGRAM
MOBILE COUNTY, ALABAMA

APPROVED : SAM STERNBERG III, P.E.
GEOTECHNICAL ENGINEER
DATE :

Preliminary Project No:

TEST BORING RECORD
Sheet 3 of 12

REFERENCE PROJECT NUMBER	FISCAL YEAR	SHEET NUMBER
IM-I010(341)	2018	19

RECORD OF TEST BORING

thompson ENGINEERING

Site Description:	I-10 Mobile River Bridge and Bayway
County:	Mobile
Boring No.:	MB-1
Boring Location:	514+25.88
Offset:	18.84' LT
Alignment:	I-10 Main Span
ALDOT PE No.:	DPI-0030(005)
TE Project No.:	15-1101-0228
Eng./Geo.:	B.Ellis/C.Tisher
Elev.:	2.9 ft.
Northing:	249675.65
Easting:	1799417.497
Date Started:	4/20/2016
Total Depth:	300.0 ft.
Soil Depth:	300.0 ft.
Core Depth:	0.0 ft.
Date Completed:	4/27/2016
Bore Hole Diameter (in):	4-inch
AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207
Drill Machine:	CME 550X
Drill Method:	MR
Hammer Type:	Automatic
Energy Ratio:	88%
Core Size:	N/A
Driller:	Thompson Eng
Groundwater: TOB	0.0 ft.
24 HR	0.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
60.0		(SP-SM)						
65.0	-60.0	Medium dense, wet, reddish brown and brown, fine to medium grained, POORLY GRADED SAND with SILT (SP-SM, A-3(0)), LL=NP PL=NP PI=NP NMC=19.3 %#200=8.6	63.5	SS-17	6	8	12	20
70.0	-65.0	Very dense, No Recovery	68.5	SS-18	35	50/5	X	50/5
75.0	-70.0	Very dense, light brown	73.5	SS-19	12	28	24	52
80.0	-75.0	Very dense	78.5	SS-20	50	X	X	100+
85.0	-80.0	Medium dense, wet, medium to fine grained, with trace gravel	83.5	SS-21	7	8	7	15
90.0	-85.0	Firm, moist, dark gray, FAT CLAY (CH) NOTE: Sample rods slipped through hoisting ring and	88.5	SS-22	0	0	5	5

SPT N VALUE (blows/foot); PL MC LL; FINES CONTENT (%); 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon; ST - Shelby Tube; DCP - Dynamic Cone Penetrometer; AC - Auger Cuttings; GB - Grab Bag; NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers; SSA - Solid Stem Augers; HA - Hand Auger; MR - Mud Rotary Wash; RC - Rock Coring

RECORD OF TEST BORING

thompson ENGINEERING

Site Description: I-10 Mobile River Bridge and Bayway; County: Mobile; Boring No.: MB-1; Boring Location: 514+25.88; Offset: 18.84' LT; Alignment: I-10 Main Span; ALDOT PE No.: DPI-0030(005); TE Project No.: 15-1101-0228; Eng./Geo.: B.Ellis/C.Tisher; Elev.: 2.9 ft.; Northing: 249675.65; Easting: 1799417.497; Date Started: 4/20/2016; Total Depth: 300.0 ft.; Soil Depth: 300.0 ft.; Core Depth: 0.0 ft.; Date Completed: 4/27/2016; Bore Hole Diameter (in): 4-inch; AASHTO / ASTM Sampling Methods: AASHTO T206 & T207; Drill Machine: CME 550X; Drill Method: MR; Hammer Type: Automatic; Energy Ratio: 88%; Core Size: N/A; Driller: Thompson Eng; Groundwater: TOB 0.0 ft.; 24 HR 0.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
90.0		penetrated the first 12 inches of the sample length. Undisturbed sample obtained from 90.5 to 92.5 feet. Approximately 24 inches of recovery.	90.5	ST-1				
95.0	-90.0	Very stiff, moist, dark grayish brown, with trace sand, FAT CLAY (CH, A-7-6(29)), LL=52 PL=22 PI=31 NMC=40.1 %#200=75.7 Firm	93.5	SS-23	2	4	4	8
100.0	-95.0	Undisturbed sample obtained from 98.5 to 100.5 feet. Approximately 24 inches of recovery. Very stiff, moist, dark brown and light gray, FAT CLAY (CH, A-7-6(71)), LL=89 PL=28 PI=61 NMC=44.0 %#200=99.4	98.5	ST-2				
105.0	-100.0	Very dense, wet, gray and light gray, fine grained, SILTY CLAYEY SAND (SC-SM, A-2-4(0)), LL=21 PL=17 PI=4 NMC=23.9 %#200=26.7	103.5	SS-24	3	20	32	52
110.0	-105.0	Dense, wet, light gray, fine grained, POORLY GRADED SAND (SP)	108.5	SS-25	14	20	28	48
115.0	-110.0	Very dense, wet, light gray, fine to coarse grained, POORLY GRADED SAND (SP, A-1-b(0)), LL=NP PL=NP PI=NP NMC=19.5 %#200=3.3	113.5	SS-26	19	32	33	65
120.0	-115.0	Dense, fine grained, with trace gravel	118.5	SS-27	9	15	23	38

SPT N VALUE (blows/foot); PL MC LL; FINES CONTENT (%); 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon; ST - Shelby Tube; DCP - Dynamic Cone Penetrometer; AC - Auger Cuttings; GB - Grab Bag; NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers; SSA - Solid Stem Augers; HA - Hand Auger; MR - Mud Rotary Wash; RC - Rock Coring

RECORD OF TEST BORING

thompson ENGINEERING

Site Description: I-10 Mobile River Bridge and Bayway; County: Mobile; Boring No.: MB-1; Boring Location: 514+25.88; Offset: 18.84' LT; Alignment: I-10 Main Span; ALDOT PE No.: DPI-0030(005); TE Project No.: 15-1101-0228; Eng./Geo.: B.Ellis/C.Tisher; Elev.: 2.9 ft.; Northing: 249675.65; Easting: 1799417.497; Date Started: 4/20/2016; Total Depth: 300.0 ft.; Soil Depth: 300.0 ft.; Core Depth: 0.0 ft.; Date Completed: 4/27/2016; Bore Hole Diameter (in): 4-inch; AASHTO / ASTM Sampling Methods: AASHTO T206 & T207; Drill Machine: CME 550X; Drill Method: MR; Hammer Type: Automatic; Energy Ratio: 88%; Core Size: N/A; Driller: Thompson Eng; Groundwater: TOB 0.0 ft.; 24 HR 0.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
120.0								
125.0	-120.0	Very dense	123.5	SS-28	15	29	28	57
130.0	-125.0	Stiff, moist, gray, with trace sand, FAT CLAY (CH, A-7-6(34)), LL=53 PL=21 PI=32 NMC=23.7 %#200=95.0	128.5	SS-29	4	5	4	9
135.0	-130.0	Medium dense, wet, gray, fine grained, POORLY GRADED SAND with SILT (SP-SM)	133.5	SS-30	3	7	19	26
140.0	-135.0	Medium dense	138.5	SS-31	15	14	15	29
145.0	-140.0	Medium dense	143.5	SS-32	7	8	10	18
150.0	-145.0	Very dense, wet, gray, fine grained, POORLY GRADED SAND with SILT (SP-SM, A-2-4(0)), LL=NP	148.5	SS-33	28	34	27	61

SPT N VALUE (blows/foot); PL MC LL; FINES CONTENT (%); 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE: SS - Split Spoon; ST - Shelby Tube; DCP - Dynamic Cone Penetrometer; AC - Auger Cuttings; GB - Grab Bag; NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers; SSA - Solid Stem Augers; HA - Hand Auger; MR - Mud Rotary Wash; RC - Rock Coring

STRATA SYMBOLS

- SAND (SP)
- SILT (MH)
- FAT CLAY (CH)
- SILTY SAND (SM)
- POORLY GRADED SAND with SILT (SP-SM)
- ORGANIC SOILS (OL)
- Paving
- GRAVEL (GP)
- SANDY SILT (ML)
- LEAN CLAY (CL)
- TOPSOIL
- CLAYEY SAND (SC)
- CLAYEY SILTY SAND (SC-SM)
- WELL GRADED SAND with SILT and GRAVEL (SW-SM)
- SANDSTONE
- DOLOMITE
- CLAYEY GRAVEL (GC)
- POORLY GRADED GRAVEL with SILT and SAND (GP-GM)
- SILTY CLAY (CL-ML)
- Ground Water, ATD
- 24 Hr./Delayed Ground Water
- HSA - Hollow Stem Auger
- SSA - Solid Stem Auger
- MR - Mud Rotary

NO - Not Obtained
NE - Not Encountered
$\frac{REC}{RQD}$ Recovery / Rock Quality Designation
pp - Pocket Penetrometer
SS - Split Spoon
ST - Shelby Tube
DCP - Dynamic Cone Penetrometer
AC - Auger Cuttings
GB - Grab Bag
NQ - Rock Core

Alabama Department of Transportation

Bridge Sheet of

thompson ENGINEERING
2970 COTTAGE HILL RD.
MOBILE, AL 36606

PROJECT NO. 17-1101-0145
I-10 MOBILE RIVER BRIDGE
LOAD TEST PROGRAM
MOBILE COUNTY, ALABAMA

APPROVED : SAM STERNBERG III, P.E.
GEOTECHNICAL ENGINEER
DATE :

Preliminary Project No:

TEST BORING RECORD
Sheet 4 of 12

REFERENCE PROJECT NUMBER	FISCAL YEAR	SHEET NUMBER
IM-I010(341)	2018	20

thompson ENGINEERING

RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway					County:	Mobile
Boring No.:	MB-1	Boring Location:	514+25.88	Offset:	18.84' LT	Alignment:	I-10 Main Span
ALDOT PE No.:	DPI-0030(005)	TE Project No.:	15-1101-0228			Eng./Geo.:	B.Ellis/C.Tisher
Elev.:	2.9 ft.	Northing:	249675.65	Easting:	1799417.497	Date Started:	4/20/2016
Total Depth:	300.0 ft.	Soil Depth:	300.0 ft.	Core Depth:	0.0 ft.	Date Completed:	4/27/2016
Bore Hole Diameter (in):	4-inch	AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207				
Drill Machine:	CME 550X	Drill Method:	MR	Hammer Type:	Automatic	Energy Ratio:	88%
Core Size:	N/A	Driller:	Thompson Eng	Groundwater:	TOB 0.0 ft.	24 HR	0.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
150.0		PL=NP PI=NP NMC=22.5 %#200=10.5						
	-150.0							
155.0		Undisturbed sample obtained from 153.5 to 155.5 feet. Approximately 24 inches of recovery. With trace clay	153.5	ST-3				
	-155.0							
160.0		Very dense	158.5	SS-34	26	24	32	56
	-160.0							
165.0		Very dense, wet, greenish gray, fine grained, with trace gravel, POORLY GRADED SAND with SILT (SP-SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=23.8 %#200=11.5	163.5	SS-35	23	47	50+	100
	-165.0							
170.0		Dense, wet, greenish gray, fine grained, CLAYEY SAND (SC, A-6(7)), LL=36 PL=13 PI=24 NMC=23.2 %#200=48.4	168.5	SS-36	11	19	18	37
	-170.0							
175.0		Dense, wet, gray, fine grained, POORLY GRADED SAND with SILT (SP-SM)	173.5	SS-37	11	18	25	43
	-175.0							
180.0		Dense	178.5	SS-38	16	19	20	39

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) 10 20 30 40 50 60 70 80 90

>>

LEGEND

SAMPLER TYPE
SS - Split Spoon AC - Auger Cuttings
ST - Shelby Tube GB - Grab Bag
DCP - Dynamic Cone Penetrometer NQ - Rock Core

DRILLING METHOD
HSA - Hollow Stem Augers MR - Mud Rotary Wash
SSA - Solid Stem Augers RC - Rock Coring
HA - Hand Auger

thompson ENGINEERING

RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway					County:	Mobile
Boring No.:	MB-1	Boring Location:	514+25.88	Offset:	18.84' LT	Alignment:	I-10 Main Span
ALDOT PE No.:	DPI-0030(005)	TE Project No.:	15-1101-0228			Eng./Geo.:	B.Ellis/C.Tisher
Elev.:	2.9 ft.	Northing:	249675.65	Easting:	1799417.497	Date Started:	4/20/2016
Total Depth:	300.0 ft.	Soil Depth:	300.0 ft.	Core Depth:	0.0 ft.	Date Completed:	4/27/2016
Bore Hole Diameter (in):	4-inch	AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207				
Drill Machine:	CME 550X	Drill Method:	MR	Hammer Type:	Automatic	Energy Ratio:	88%
Core Size:	N/A	Driller:	Thompson Eng	Groundwater:	TOB 0.0 ft.	24 HR	0.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
180.0								
	-180.0							
185.0		Very dense, wet, gray, fine grained, POORLY GRADED SAND with SILT (SP-SM, A-3(0)), LL=NP PL=NP PI=NP NMC=26.5 %#200=9.7	183.5	SS-39	43	41	29	70
	-185.0							
190.0		Undisturbed sample obtained from 188.5 to 190.5 feet. Approximately 24 inches of recovery. Hard, wet, bluish gray, SANDY LEAN CLAY (CL, A-6(6)), LL=28 PL=14 PI=14 NMC=17.8 %#200=62.9	188.5	ST-4				
	-190.0							
195.0		Hard, wet, bluish gray, with trace sand, LEAN CLAY (CL, A-7-6(29)), LL=46 PL=16 PI=30 NMC=21.0 %#200=91.7	193.5	SS-40	12	14	21	35
	-195.0							
200.0		Hard	198.5	SS-41	22	18	20	38
	-200.0							
205.0								
	-205.0							
210.0		Hard, wet, bluish gray, with trace sand, LEAN CLAY (CL, A-6(21)), LL=39 PL=15 PI=24 NMC=17.0	208.5	SS-42	12	15	17	32

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE
SS - Split Spoon AC - Auger Cuttings
ST - Shelby Tube GB - Grab Bag
DCP - Dynamic Cone Penetrometer NQ - Rock Core

DRILLING METHOD
HSA - Hollow Stem Augers MR - Mud Rotary Wash
SSA - Solid Stem Augers RC - Rock Coring
HA - Hand Auger

thompson ENGINEERING

RECORD OF TEST BORING

Site Description:	I-10 Mobile River Bridge and Bayway					County:	Mobile
Boring No.:	MB-1	Boring Location:	514+25.88	Offset:	18.84' LT	Alignment:	I-10 Main Span
ALDOT PE No.:	DPI-0030(005)	TE Project No.:	15-1101-0228			Eng./Geo.:	B.Ellis/C.Tisher
Elev.:	2.9 ft.	Northing:	249675.65	Easting:	1799417.497	Date Started:	4/20/2016
Total Depth:	300.0 ft.	Soil Depth:	300.0 ft.	Core Depth:	0.0 ft.	Date Completed:	4/27/2016
Bore Hole Diameter (in):	4-inch	AASHTO / ASTM Sampling Methods:	AASHTO T206 & T207				
Drill Machine:	CME 550X	Drill Method:	MR	Hammer Type:	Automatic	Energy Ratio:	88%
Core Size:	N/A	Driller:	Thompson Eng	Groundwater:	TOB 0.0 ft.	24 HR	0.0 ft.

Depth (ft)	Elevation (ft)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
210.0		%#200=88.7						
	-210.0							
215.0								
	-215.0							
220.0		Very dense, wet, bluish gray, fine grained, SILTY SAND (SM)	218.5	SS-43	23	33	48	81
	-220.0							
225.0								
	-225.0							
230.0		Dense, gray	228.5	SS-44	6	13	19	32
	-230.0							
235.0								
	-235.0							
240.0		Loose, wet, gray, fine grained, SILTY SAND (SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=25.3	238.5	SS-45	4	4	4	8

● SPT N VALUE (blows/foot) PL MC LL ▲ FINES CONTENT (%) 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE
SS - Split Spoon AC - Auger Cuttings
ST - Shelby Tube GB - Grab Bag
DCP - Dynamic Cone Penetrometer NQ - Rock Core

DRILLING METHOD
HSA - Hollow Stem Augers MR - Mud Rotary Wash
SSA - Solid Stem Augers RC - Rock Coring
HA - Hand Auger

STRATA SYMBOLS

SAND (SP)
SILT (MH)
FAT CLAY (CH)
SILTY SAND (SM)
POORLY GRADED SAND with SILT (SP-SM)
ORGANIC SOILS (OL)
Paving
GRAVEL (GP)
SANDY SILT (ML)
LEAN CLAY (CL)
TOPSOIL
CLAYEY SAND (SC)
CLAYEY SILTY SAND (SC-SM)
WELL GRADED SAND with SILT and GRAVEL (SW-SM)
SANDSTONE
DOLOMITE
CLAYEY GRAVEL (GC)
POORLY GRADED GRAVEL with SILT and SAND (GP-GM)
SILTY CLAY (CL-ML)
Ground Water, ATD
24 Hr./Delayed Ground Water
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
MR - Mud Rotary

NO - Not Obtained
NE - Not Encountered
REC Recovery
RQD Rock Quality Designation
pp - Pocket Penetrometer
SS - Split Spoon
ST - Shelby Tube
DCP - Dynamic Cone Penetrometer
AC - Auger Cuttings
GB - Grab Bag
NQ - Rock Core

Alabama Department of Transportation

Bridge Sheet of

thompson ENGINEERING
2970 COTTAGE HILL RD.
MOBILE, AL 36606

PROJECT NO. 17-1101-0145
I-10 MOBILE RIVER BRIDGE
LOAD TEST PROGRAM
MOBILE COUNTY, ALABAMA

APPROVED : SAM STERNBERG III, P.E.
GEOTECHNICAL ENGINEER
DATE :

Preliminary Project No:

TEST BORING RECORD
Sheet 5 of 12

thompson ENGINEERING — RECORD OF TEST BORING

Site Description: I-10 Mobile River Bridge and Bayway		County: Mobile	
Boring No.: MB-1	Boring Location: 514+25.88	Offset: 18.84' LT	Alignment: I-10 Main Span
ALDOT PE No.: DPI-0030(005)	TE Project No.: 15-1101-0228		Eng./Geo.: B.Ellis/C.Tisher
Elev.: 2.9 ft.	Northing: 249675.65	Easting: 1799417.497	Date Started: 4/20/2016
Total Depth: 300.0 ft.	Soil Depth: 300.0 ft.	Core Depth: 0.0 ft.	Date Completed: 4/27/2016
Bore Hole Diameter (in): 4-inch	AASHTO / ASTM Sampling Methods: AASHTO T206 & T207		
Drill Machine: CME 550X	Drill Method: MR	Hammer Type: Automatic	Energy Ratio: 88%
Core Size: N/A	Driller: Thompson Eng	Groundwater: TOB 0.0 ft.	24 HR 0.0 ft.

Depth (ft) 240.0 – 270.0; Elevation (ft) -240.0 – -265.0

Material Description	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
%#200=28.0						
Medium dense	248.5	SS-46	5	10	11	21
Very dense, wet, gray, fine grained, POORLY GRADED SAND with SILT (SP-SM)	258.5	SS-47	30	50/0	X	50/0
Very dense, with trace gravel	268.5	SS-48	43	50	X	50/6

SPT N VALUE (blows/foot) ● PL MC LL ▲ FINES CONTENT (%) ▲ 10 20 30 40 50 60 70 80 90

thompson ENGINEERING — RECORD OF TEST BORING

Site Description: I-10 Mobile River Bridge and Bayway		County: Mobile	
Boring No.: MB-1	Boring Location: 514+25.88	Offset: 18.84' LT	Alignment: I-10 Main Span
ALDOT PE No.: DPI-0030(005)	TE Project No.: 15-1101-0228		Eng./Geo.: B.Ellis/C.Tisher
Elev.: 2.9 ft.	Northing: 249675.65	Easting: 1799417.497	Date Started: 4/20/2016
Total Depth: 300.0 ft.	Soil Depth: 300.0 ft.	Core Depth: 0.0 ft.	Date Completed: 4/27/2016
Bore Hole Diameter (in): 4-inch	AASHTO / ASTM Sampling Methods: AASHTO T206 & T207		
Drill Machine: CME 550X	Drill Method: MR	Hammer Type: Automatic	Energy Ratio: 88%
Core Size: N/A	Driller: Thompson Eng	Groundwater: TOB 0.0 ft.	24 HR 0.0 ft.

Depth (ft) 270.0 – 300.0; Elevation (ft) -270.0 – -295.0

Material Description	Sample Depth (ft.)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
Very dense	278.5	SS-49	24	50/4	X	50/4
Very dense, wet, light gray, fine grained, with trace gravel, POORLY GRADED SAND with SILT (SP-SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=21.1 %#200=10.9	288.5	SS-50	43	41	49	90
Very dense, gray, with trace clay	298.5	SS-51	25	50	X	50/6

SPT N VALUE (blows/foot) ● PL MC LL ▲ FINES CONTENT (%) ▲ 10 20 30 40 50 60 70 80 90

thompson ENGINEERING — RECORD OF TEST BORING

Site Description: I-10 Mobile River Bridge and Bayway		County: Mobile	
Boring No.: MB-1	Boring Location: 514+25.88	Offset: 18.84' LT	Alignment: I-10 Main Span
ALDOT PE No.: DPI-0030(005)	TE Project No.: 15-1101-0228		Eng./Geo.: B.Ellis/C.Tisher
Elev.: 2.9 ft.	Northing: 249675.65	Easting: 1799417.497	Date Started: 4/20/2016
Total Depth: 300.0 ft.	Soil Depth: 300.0 ft.	Core Depth: 0.0 ft.	Date Completed: 4/27/2016
Bore Hole Diameter (in): 4-inch	AASHTO / ASTM Sampling Methods: AASHTO T206 & T207		
Drill Machine: CME 550X	Drill Method: MR	Hammer Type: Automatic	Energy Ratio: 88%
Core Size: N/A	Driller: Thompson Eng	Groundwater: TOB 0.0 ft.	24 HR 0.0 ft.

Boring Terminated at 300.0 feet.

LEGEND

SAMPLER TYPE: SS - Split Spoon; ST - Shelby Tube; DCP - Dynamic Cone Penetrometer; AC - Auger Cuttings; GB - Grab Bag; NQ - Rock Core

DRILLING METHOD: HSA - Hollow Stem Augers; SSA - Solid Stem Augers; HA - Hand Auger; MR - Mud Rotary Wash; RC - Rock Coring

STRATA SYMBOLS

SAND (SP)
SILT (MH)
FAT CLAY (CH)
SILTY SAND (SM)
POORLY GRADED SAND with SILT (SP-SM)
ORGANIC SOILS (OL)
Paving
GRAVEL (GP)
SANDY SILT (ML)
LEAN CLAY (CL)
TOPSOIL
CLAYEY SAND (SC)
CLAYEY SILTY SAND (SC-SM)
WELL GRADED SAND with SILT and GRAVEL (SW-SM)
SANDSTONE
DOLOMITE
CLAYEY GRAVEL (GC)
POORLY GRADED GRAVEL with SILT and SAND (GP-GM)
SILTY CLAY (CL-ML)
Ground Water, ATD
24 Hr./Delayed Ground Water
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
MR - Mud Rotary

NO - Not Obtained
NE - Not Encountered
REC Recovery
RQD Rock Quality Designation
pp - Pocket Penetrometer
SS - Split Spoon
ST - Shelby Tube
DCP - Dynamic Cone Penetrometer
AC - Auger Cuttings
GB - Grab Bag
NQ - Rock Core

Alabama Department of Transportation

Bridge Sheet of

thompson ENGINEERING
2970 COTTAGE HILL RD.
MOBILE, AL 36606

PROJECT NO. 17-1101-0145
I-10 MOBILE RIVER BRIDGE
LOAD TEST PROGRAM
MOBILE COUNTY, ALABAMA

APPROVED : SAM STERNBERG III, P.E.
GEOTECHNICAL ENGINEER
DATE :

Preliminary Project No:

TEST BORING RECORD
Sheet 6 of 12

Appendix C
Calibrations

Report of Lateral Statnamic Testing
I-10 Mobile River Bridge
AFT Project No. 518009
Mobile, Alabama

KELK LOAD CELL CALIBRATION CARD

MODEL No. C3929-1 SERIAL No. 13

RATED CAPACITY 22 MN / 1800 MT

FULL SCALE SENSITIVITY 1.7594 mV/V* / 1.4117 AT RATED CAPACITY

OUTPUT WITH 50,000 [Ω] SHUNT RESISTOR 1.2024 mV/V*
APPLIED ACROSS BLACK AND WHITE LEADS

FOR ROUTINE MILL **CALIBRATION** OF LOAD METERING SYSTEM ▶ SHUNT RESISTOR SIMULATES APPLICATION OF 68.34 / 85.18 % of RATED CAPACITY

INPUT RES. 261.2 [Ω] AT 23° C (77° F)
GREEN (+), BLACK(-)

OUTPUT RES. 252.2 [Ω] AT 23° C (77° F)
RED (+), WHITE(-)

* OPEN CIRCUIT MEASUREMENT (AMPLIFIER DISCONNECTED)

DATE 26-May-2016
BY: Stefan Georgiev
Work Order: JR10483

KELK Form# 887
Rev. 2014-05-13

VISHAY PRECISION GROUP CANADA ULC
48 LESMILL ROAD
TORONTO, ONTARIO, CANADA

KELK

CERTIFICATE OF TESTS

Load Cell:

Model No. **C3929-1**
Serial No. **13**

Work Order: **JR10483**
Tested By: **WP**
Approved By: **Stefan Georgiev**
Test Date: **26-May-2016**

The above identified load cell was calibrated in accordance with ASTM E74-13a.

Rated Capacity: (Full Scale) **22 / 1800 MN/MT**

Full scale sensitivity: **1.7594 / 1.4117 mV/V**

Combined Error:[1] ≤ 0.1 % of full scale
Zero offset:[2] 0.023 mV/V

Electrical connection: 4 FT Twisted, 4-conductor, shielded cable.

Excitation Positive: GREEN
Excitation Negative: BLACK
Signal Positive: RED
Signal Negative: WHITE

Input resistance: (Black & Green)[2] 261.2 Ω
Output resistance: (Red & White)[2] 252.2 Ω
Excitation Voltage: 10 VDC

Load Limits:

300 % of rated capacity without zero shift[3]
500 % of rated capacity without change in characteristics[4]

Output with shunt resistor connected between BLACK and WHITE leads:

Shunt Res. [Ω]	OUTPUT(shunt) [mV/V]	% of Rated Capacity	SIMULATED OUTPUT [MN]
50,000	1.2024	68.34 / 85.18	15.035
100,000	0.6021	34.22 / 42.65	7.529
150,000	0.4017	22.83 / 28.46	5.023

Reference Document: KELK Drawing No. 28852

Notes:
[1] The combined error is defined as the permitted error envelope which covers linearity, hysteresis and repeatability.
[2] Measured at room temperature, including cable.
[3] No change in load cell characteristics.
[4] Highest permissible single loading without damage:
[5] Compensation Range: 20 to 100 ℃

KELK Form #892
Rev. 2014-12-18

GEORGE KELK CORPORATION

LOAD CELL CALIBRATION REPORT

Model No.:	C3929		Work Order No:	JR10483
Serial No.:	13	Bridge 1 of 3	Test date:	05-19-2016
Capacity:	22000000	N	Test by:	WP
Calibration facility:	10000000	lb		

*************************** PRELOAD CYCLE ***************************

Preload	Load %	Load [N]	Load cell output [mV/V]
1	150.1	33017204.0	2.6321
2	150.2	33037238.0	2.6408
3	150.1	33030262.0	2.6409

************************* CALIBRATION CYCLE *************************

Test No.	Coefficients of optimized line fit: OUTPUT = A+B*LOAD		Theoretical output at full load B*CAPACITY [mV/V]	Maximum linearity error [%]	Maximum hysteresis error [%]	Number of test samples:
	A [mV/V]	B [mV/V/N]				
1	0.0041	7.9979E-08	1.7595	0.111	0.154	691
2	0.0047	7.9954E-08	1.7590	0.110	0.153	678
3	0.0047	7.9950E-08	1.7589	0.107	0.139	685

Load values were based on the output from master calibration load cells,
C1880_20, C1880_12, C1880_13, C1880_14, C1880_15, C1880_16, C1880_17, C1880_18, C1880_19, .
calibrated in accordance with ASTM specification E 74-91 against standard traceable to the National Institute of Standards and Technology in Washington D.C. USA. Based on the test data from 3 load cycles, the load cell output vs. applied load is represented by the straight line equation of the form: OUTPUT=A+B*LOAD, where the coefficients A and B are as follows:

A = 0.0045 mV/V
B = 7.99717E-08 mV/V/N

Optimized full load sensitivity=B*CAPACITY = <u>1.7594</u> mV/V

Standard deviation of least squares fit: s = 0.0010 mV/V
Uncertainty (ASTM E74-91) = 2.4*s = 0.0025 mV/V
or 31315.2 N
or 0.14 % of full scale output

Output with shunt resistor put across BLACK and WHITE leads:

	Shunt Res. [K-ohm]	**OUTPUT(shunt)** [mV/V]	SIMULATED OUTPUT %	[N]	[kg]	[lb]
=>	50	1.2024	68.34	15035811.0	1533192.2	3380184.0
->	100	0.6021	34.22	7529304.0	767758.4	1692654.5
->	150	0.4017	22.83	5022678.5	512159.4	1129142.8
	200	0.3013	17.13	3768161.4	384237.1	847116.2
	250	0.2412	13.71	3015516.1	307490.3	677914.8
	300	0.2010	11.42	2513066.6	256255.8	564959.7
	350	0.1723	9.79	2154439.1	219686.8	484337.1
	400	0.1508	8.57	1885289.7	192241.8	423829.9
	500	0.1206	6.86	1508373.9	153807.9	339095.9
	600	0.1005	5.71	1256989.6	128174.4	282582.4
	700	0.0862	4.90	1078131.8	109936.4	242373.6
	800	0.0754	4.28	942594.0	96115.7	211903.5

Maximum test linearity error 0.116 % of full scale output
Maximum test hysteresis error 0.154 % of full scale output
Maximum test repeatability error 0.037 % of full scale output
Combined error (+/-) 0.116 % of full scale output

Page 2. (Computed Load Table)

GEORGE KELK CORPORATION
LOAD CELL CALIBRATION REPORT

Model No.:	C3929		Work Order No:	JR10483
Serial No.:	13	Bridge 1 of 3	Test date:	05-19-2016
Capacity:	22000000	N	Test by:	WP
Calibration facility:	10000000	lb		

Test No.1			Test No.2			Test No.3		
Load Step %	Applied Load [N]	Load Cell Output [mV/V]	Load Step %	Applied Load [N]	Load Cell Output [mV/V]	Load Step %	Applied Load [N]	Load Cell Output [mV/V]
10.01	2202096.8	0.1814	10.02	2205295.3	0.1819	10.01	2202172.0	0.1815
14.98	3296566.3	0.2683	14.99	3297257.0	0.2685	15.13	3327960.3	0.2708
20.02	4403782.0	0.3567	20.04	4407787.0	0.3572	20.01	4401986.5	0.3566
24.94	5486938.0	0.4434	24.92	5482094.0	0.4432	24.87	5471070.5	0.4422
30.13	6628926.5	0.5350	29.87	6571482.0	0.5306	30.14	6630306.5	0.5352
35.01	7702057.0	0.6210	34.86	7668868.0	0.6185	34.95	7688134.5	0.6200
39.94	8785963.0	0.7078	40.09	8819159.0	0.7107	39.92	8782701.0	0.7077
44.88	9874659.0	0.7951	45.00	9899419.0	0.7972	44.95	9889994.0	0.7964
49.91	10979253.0	0.8834	50.07	11016187.0	0.8865	50.13	11028017.0	0.8874
54.87	12072069.0	0.9707	54.91	12079451.0	0.9714	55.10	12121057.0	0.9747
60.06	13212162.0	1.0618	59.95	13189496.0	1.0601	60.04	13209283.0	1.0616
65.09	14319261.0	1.1502	64.97	14293014.0	1.1481	65.04	14308382.0	1.1493
70.07	15414816.0	1.2375	70.05	15411891.0	1.2374	70.01	15401304.0	1.2364
75.09	16518949.0	1.3255	74.98	16495793.0	1.3238	75.01	16502157.0	1.3241
79.89	17574852.0	1.4097	79.89	17576384.0	1.4098	79.96	17590284.0	1.4109
84.89	18675880.0	1.4974	85.07	18714960.0	1.5005	84.93	18683942.0	1.4980
89.89	19774894.0	1.5848	89.98	19795984.0	1.5866	89.90	19777736.0	1.5850
95.12	20926174.0	1.6765	95.02	20903450.0	1.6748	95.10	20922352.0	1.6761
100.08	22017870.0	1.7633	99.97	21994266.0	1.7615	100.04	22007952.0	1.7625
95.11	20924842.0	1.6765	95.03	20907668.0	1.6753	95.01	20902336.0	1.6748
90.02	19803560.0	1.5875	89.90	19778764.0	1.5857	89.92	19783290.0	1.5859
85.00	18700908.0	1.4998	85.10	18721504.0	1.5016	85.08	18716554.0	1.5011
80.02	17604012.0	1.4126	80.10	17621440.0	1.4141	80.07	17616282.0	1.4135
75.04	16508084.0	1.3253	75.12	16525893.0	1.3269	75.01	16502226.0	1.3250
70.10	15422471.0	1.2389	69.88	15373893.0	1.2352	70.01	15401565.0	1.2373
64.88	14273865.0	1.1473	64.89	14274822.0	1.1475	65.06	14313005.0	1.1505
59.98	13196312.0	1.0613	59.91	13180754.0	1.0602	60.11	13223305.0	1.0637
55.06	12112237.0	0.9747	54.91	12079913.0	0.9724	55.11	12123936.0	0.9759
49.91	10980639.0	0.8842	49.99	10998709.0	0.8859	49.96	10990830.0	0.8853
44.95	9888036.0	0.7968	45.12	9926231.0	0.8000	44.91	9880452.0	0.7964
39.98	8795148.0	0.7092	40.00	8799391.0	0.7097	40.11	8823959.0	0.7117
35.03	7707375.5	0.6219	35.06	7713487.0	0.6226	35.11	7725251.0	0.6236
30.07	6614339.0	0.5341	30.11	6624381.5	0.5350	30.12	6625468.0	0.5351
24.89	5476621.5	0.4423	25.02	5503913.0	0.4448	24.93	5484179.0	0.4432
19.98	4396573.5	0.3551	19.91	4380765.5	0.3542	19.94	4386725.5	0.3547
15.09	3319595.0	0.2682	15.10	3322271.3	0.2687	14.91	3279873.3	0.2653
9.95	2189979.3	0.1777	10.08	2217168.3	0.1802	9.93	2184692.3	0.1776

Model No.: C3929

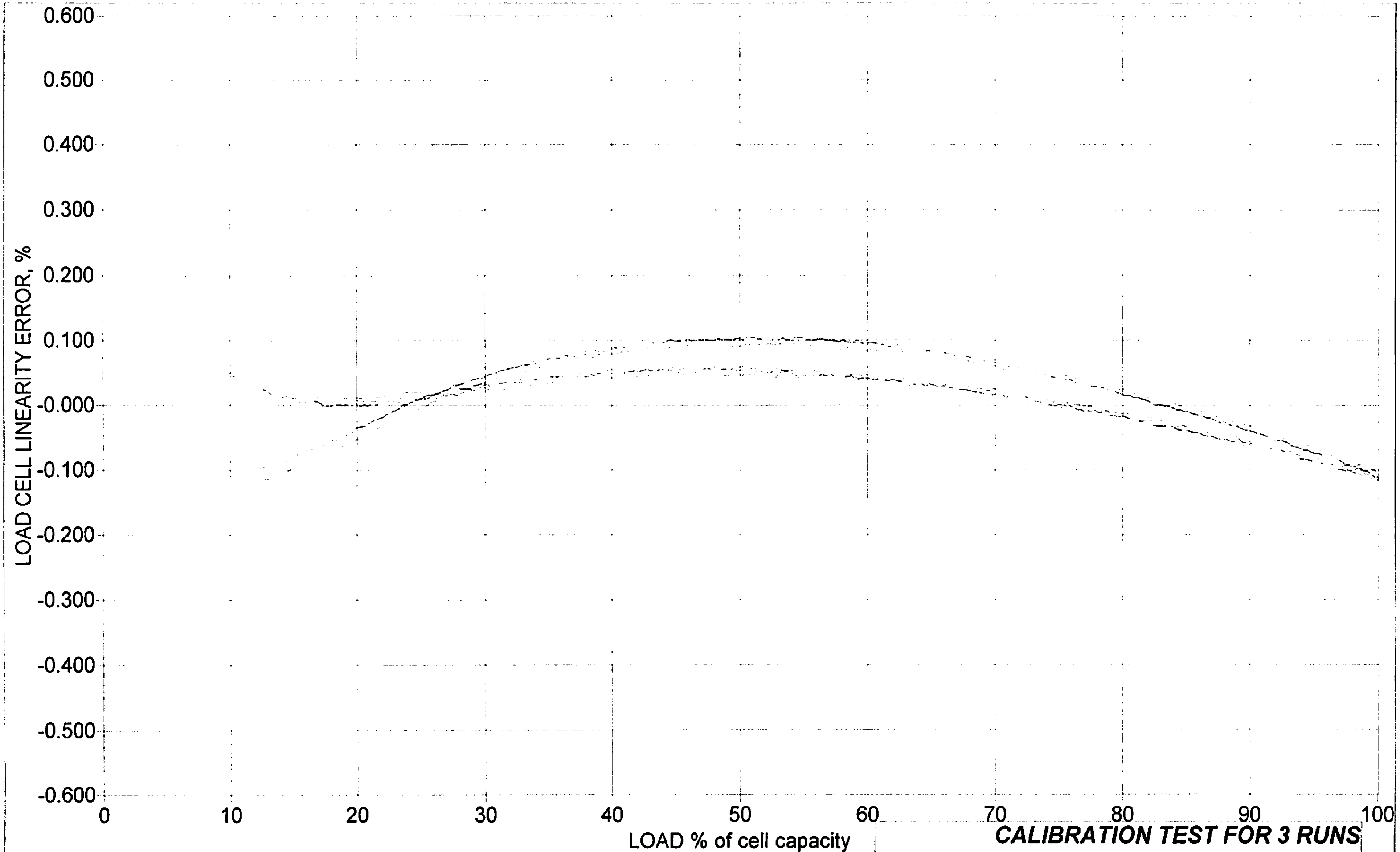
Capacity: 22000000 N

W.O. No.: JR10483

Serial No.: 13

Sensitivity = 1.7594 mV/V

Test Date: 05-19-2016



Linearity:	0.116	%
Hysteresis at 11%	0.154	%
Repeatability	0.037	%
Combined	0.116	%

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3711B1130G

Serial Number: LW11331

Description: DC Accelerometer

Manufacturer: PCB

Method: Back-to-Back Comparison AT401-3

Calibration Data

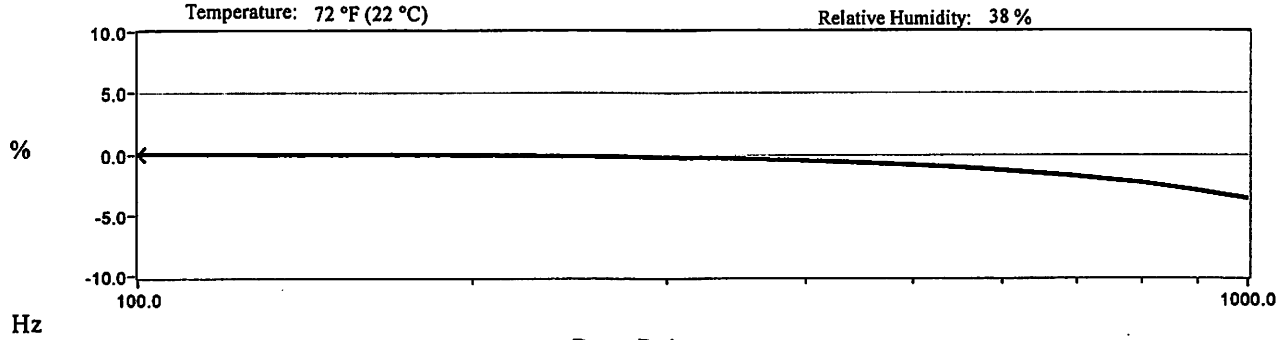
Sensitivity @ 100 Hz **65.9 mV/g** **(6.72 mV/m/s²)**

Offset Voltage (@ 0 g) -1.3 mVDC

Sensitivity Plot

Temperature: 72 °F (22 °C)

Relative Humidity: 38 %



Data Points

Frequency (Hz)	Dev. (%)
REF. FREQ.	0.0
300	-0.2
500	-0.9
1000	-3.6

Mounting Surface: Calibration Fixture w/Silicone Grease Fastener: Stud Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 10.0 g (98.1 m/s²)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.008 x (freq)². [2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.80665 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 683/287323 and PTB Traceable thru Project 17014.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540-1-1994 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: Jeffrey Mattison JM 3426 Date: 1/19/2018

ACCREDITED
CALIBRATION CERT #1862.01

PCB PIEZOTRONICS
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL14-3599243067.897+0

ACS-103

~ Calibration Certificate ~
Per ISO 16063-21

Model Number: 3711B1130G

Serial Number: LW11331

Description: DC Accelerometer

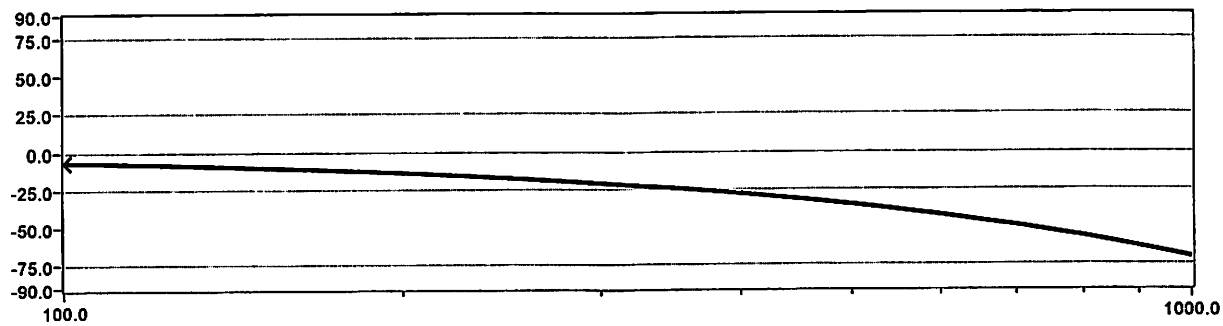
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-3

Calibration Data

Sensitivity @ 100 Hz **65.9 mV/g** **(6.72 mV/m/s²)**

Phase Plot



Data Points

Frequency (Hz)	Phase (°)
REF. FREQ.	-7.0
300	-21.3
500	-35.4
1000	-70.4

Notes

1. Calibration is NIST Traceable thru Project 683/287323 and PTB Traceable thru Project 17014.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540-1-1994 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: Jeffrey Mattison JM 3426 Date: 1/19/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL14-3599243067.897+0

ACS-103

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: **3711B1130G**

Serial Number: **LW11331**

Description: DC Accelerometer

Manufacturer: PCB

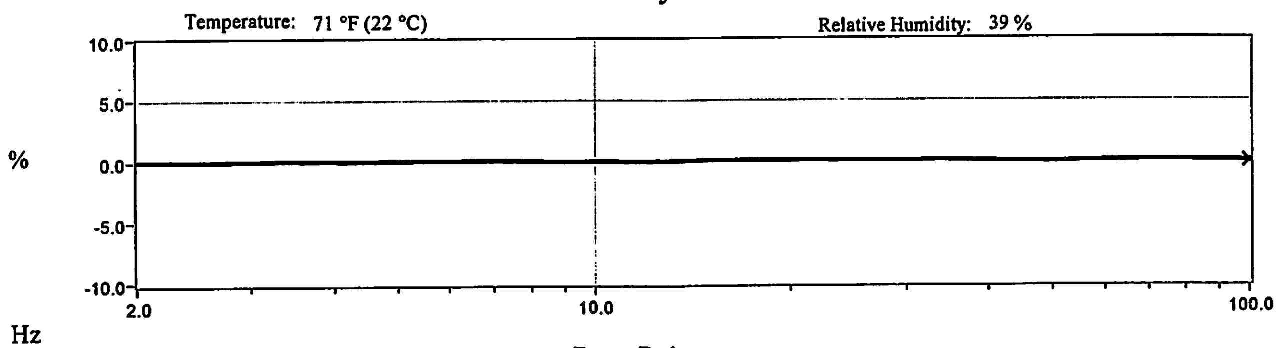
Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz **65.9 mV/g**

(6.72 mV/m/s²)

Sensitivity Plot



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
2	0.0	20	0.1
5	0.0	30	0.1
7	0.1	50	-0.0
10	0.0	70	0.1
15	0.1	REF. FREQ.	0.0

Mounting Surface: Calibration Fixture w/Silicone Grease Fastener: Stud Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 1.00 g (9.81 m/s²)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.207 x (freq)². [2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.80665 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Due to state of art limitations, the test uncertainty ratio is 3:1. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: Jeffrey Mattison JM 3426 Date: 1/19/2018

ACCREDITED
CALIBRATION CERT #1862.01

PCB PIEZOTRONICS
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL14-3599243312.761+0

ACS-103

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3711B1130G

Serial Number: LW11331

Description: DC Accelerometer

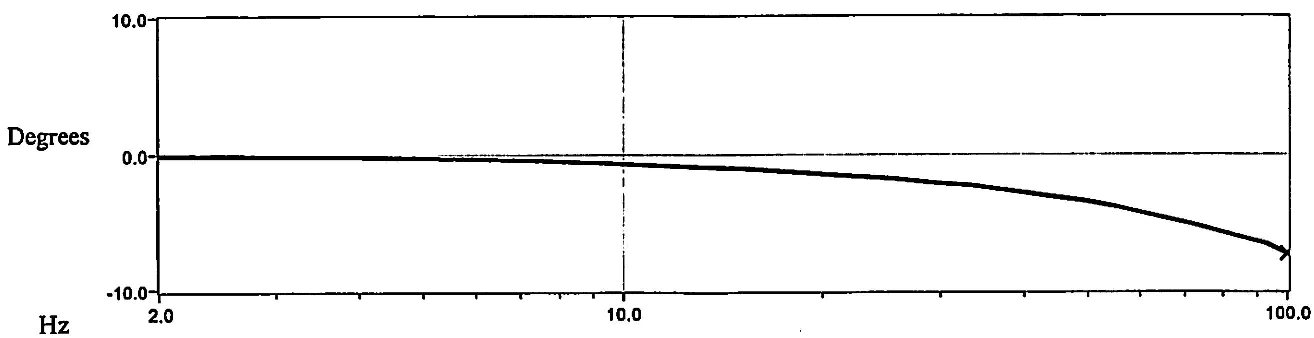
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz **65.9 mV/g** **(6.72 mV/m/s²)**

Phase Plot



Data Points

Frequency (Hz)	Phase (°)	Frequency (Hz)	Phase (°)
2	-0.2	70	-5.1
5	-0.3	REF. FREQ.	-7.4
7	-0.5		
10	-0.8		
15	-1.1		
20	-1.5		
30	-2.2		
50	-3.6		

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: Jeffrey Mattison JM 3426 Date: 1/19/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL14-3599243312.761+0

ACS-103

THE MODAL SHOP INC.
A PCB GROUP CO.

3149 East Kemper Rd.
Cincinnati, OH 45241
Ph : 513-351-9919
Fax: 513-458-2172
www.modalshop.com

~Calibration Certificate~

Sensor Information

Model Number: 3711B1130G
Serial Number: LW6495
Manufacturer: PCB
ID Number: 47836
Description: Capacitive Accelerometer

Calibration Data

Sensitivity @ 100 Hz:	65.88	mV/g
Phase @ 100 Hz:	-7.01	deg.
Test Level:	1.00	g

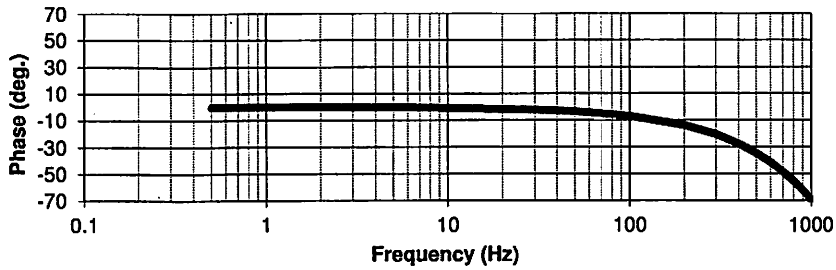
Transducer Specifications

Amp. Range:	± 30	g
Resolution:	0.0035	g
Resonant Freq:	≥ 4000	Hz
Temp. Range:	-54 to 121	°C
	-65 to 250	°F
Axis:	Uni-Axial	

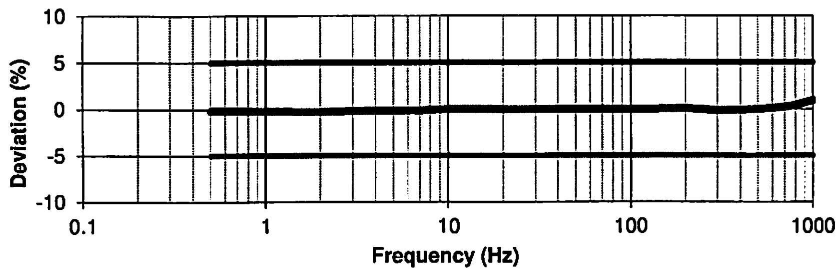
Data Table

Freq. (Hz)	Deviation (%)	Phase (deg)
0.5	-0.1626	-0.0534
1	-0.2460	-0.0969
2	-0.2637	-0.1342
3	-0.2144	-0.1869
4	-0.1751	-0.2778
5	-0.1535	-0.3346
7	-0.1482	-0.4506
8	-0.0487	-0.5282
10	0.0182	-0.6634
30	-0.0194	-2.2111
50	0.0240	-3.5229
100	0.0000	-7.0108
200	0.0861	-13.8882
300	-0.1506	-20.9373
400	-0.0791	-27.7213
500	0.0017	-34.6268
600	0.1314	-41.5239
700	0.2355	-48.4881
800	0.4064	-55.4263
900	0.6951	-62.3885
1000	0.9722	-69.4414

Phase Response



Amplitude Response



Customer

TMS Rental
3149 E. Kemper Rd
Cincinnati, OH 45241

User Notes

Notes

Results relate only to the items calibrated.
This certificate may not be reproduced except in full, without written permision.
Method: Back-to-Back Comparison Calibration per ISO 16063 Part 21
This calibration was performed with TMS 9155 Calibration Workstation 1 version 6.0.0
Calibration traceable to NIST (project number 822/271196).
Back-to-Back Comparison Calibration per ISO 16063-21
Procedures Used: PRD-P220, PRD-P214
Measurement uncertainty (95% confidence level with coverage factor 2) for frequency ranges tested during calibration are as follows: 0.5-1 Hz; 1.10%; >1-10 Hz; ± 0.80%, 11-99 Hz; ±1.20%, 100 Hz; ± 0.75%, 101-920 Hz; ± 1.00%, 921-5000 Hz; ± 1.40%, 5001-10,000 Hz; ± 1.90%, 10,001-15,000 Hz; ± 2.20%, 15,001-20,000 Hz; ± 2.8%.

Lab Conditions

Temperature: 74 (23) °F (°C)
Humidity: 39 %

Unit Condition

As Found: In Tolerance
As Left: In Tolerance

Equipment Used

Description	Manufacturer	Model	Serial	Due Date
Data Aquisition Card	NI	PCI-4461	19A1EE8	8/29/2018
Ref Std Conditioner	NI	PCI-6251	136F2A3	2/13/2018
Reference Std	PCB	080A200	110553	5/26/2018
Air Bearing Shaker	PCB	396C11	603	n/a
Ref Std Conditioner	PCB	442A102	305	5/26/2018
SUT Signal Conditioner	PCB	445B101	557	10/25/2018
Power Amplifier	TMS	2100E21-C	50002	n/a
Reference Std	TMS	2129E025	111	2/13/2018
Long Stroke Shaker	TMS	2129E025-779	111	n/a

Cal Date: 11-Jan-18
Due Date:

Approval Information

Technician: Ed Devlin
Approval: Edward A. Devlin

ACCREDITED
2649.01

Cal ID: 35041 Calibration Lab

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: **3711E1150G**

Serial Number: **8860**

Description: DC Accelerometer

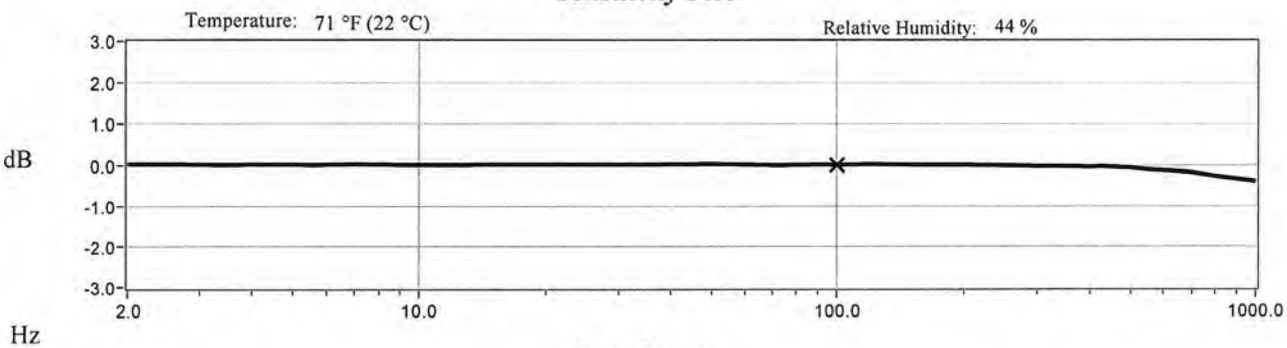
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz	**40.2 mV/g** **(4.10 mV/m/s²)**	Offset Voltage (@ 0 g)	9.3 mVDC

Sensitivity Plot



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
2	0.1	20	0.1	200	-0.0
5	0.1	30	0.1	500	-0.8
7	0.1	50	0.3	1000	-4.5
10	0.0	70	-0.0		
15	0.1	REF. FREQ.	0.0		

Mounting Surface: Calibration Fixture w/Silicone Grease Fastener: Stud Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 1.00 g (9.81 m/s^2)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.207 x $(freq)^2$. [2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.80665 m/s^2.

Condition of Unit

As Found: In Tolerance

As Left: In Tolerance

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Due to state of art limitations, the test uncertainty ratio is 3:1. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: Ronald Stevens RS 4270 Date: 1/25/2018

ACCREDITED
CALIBRATION CERT #1862.01

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3599778558.281+0

ACS-145

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: **3711E1150G**

Serial Number: **8860**

Description: DC Accelerometer

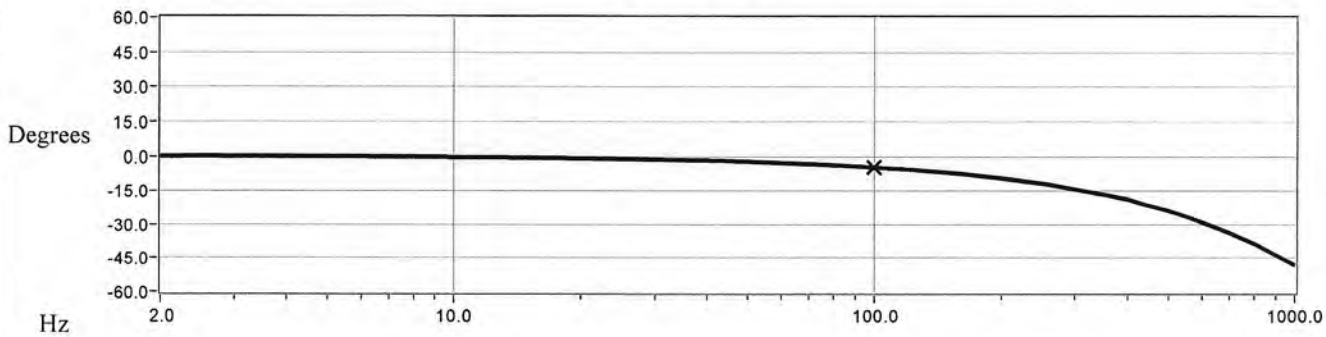
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz **40.2 mV/g** **(4.10 mV/m/s²)**

Phase Plot



Data Points

Frequency (Hz)	Phase (°)	Frequency (Hz)	Phase (°)
2	-0.2	70	-3.5
5	-0.3	REF. FREQ.	-4.9
7	-0.3	200	-9.5
10	-0.6	500	-23.9
15	-0.8	1000	-48.2
20	-1.0		
30	-1.5		
50	-2.4		

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: Ronald Stevens RS 4270 Date: 1/25/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3599778558.281+0

ACS-145

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3701G2FA50G

Serial Number: 3795

Description: DC Accelerometer

Manufacturer: PCB

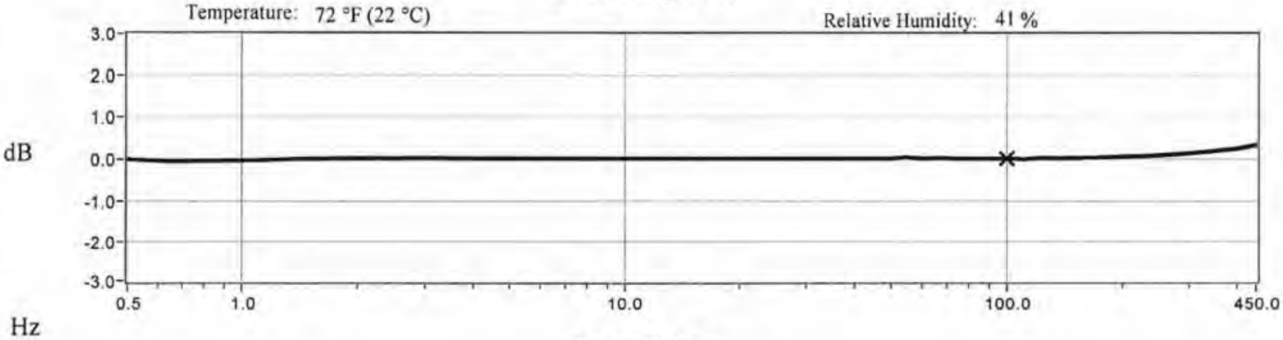
Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz	**59.9 mV/g**	Offset Voltage (@ 0 g)	9.6 mVDC
	(6.10 mV/m/s²)	Resonant Frequency	1.59 kHz

Sensitivity Plot

Temperature: 72 °F (22 °C) Relative Humidity: 41 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
0.5	-0.3	10	0.1	70	0.1
1	-0.6	15	0.1	REF. FREQ.	0.0
2	0.0	20	0.0	200	0.5
5	0.0	30	0.1	450	3.9
7	0.0	50	0.1		

Mounting Surface: Calibration Fixture w/Silicone Grease Fastener: Stud Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 1.00 g (9.81 m/s²)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude: Acceleration Level (g) = 0.207 x (freq)². [2]The gravitational constant used for calculations by the calibration system is: 1 g = 9.80665 m/s².

Condition of Unit

As Found: In Tolerance

As Left: In Tolerance

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Due to state of art limitations, the test uncertainty ratio is 3:1. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: Ronald Stevens RS 4270 Date: 1/25/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3599767065.696+1

ACS-11

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3701G2FA50G

Serial Number: 3795

Description: DC Accelerometer

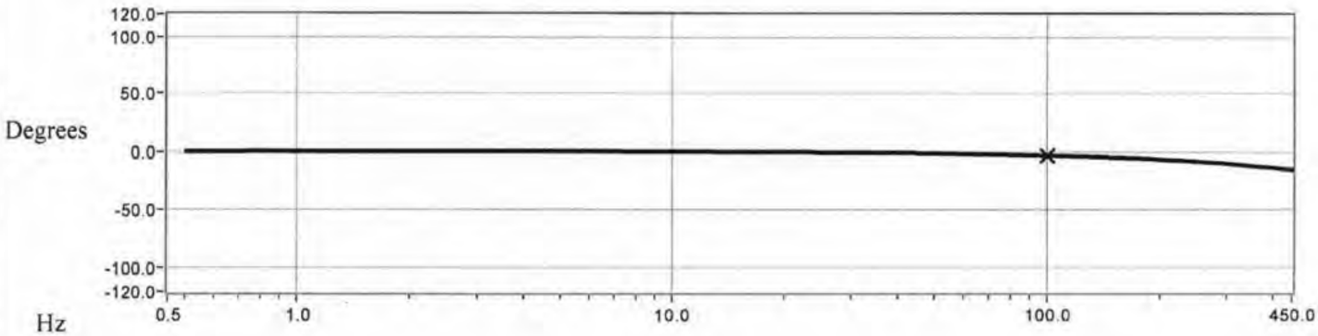
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz **59.9 mV/g** **(6.10 mV/m/s²)**

Phase Plot



Data Points

Frequency (Hz)	Phase (°)	Frequency (Hz)	Phase (°)
0.5	-0.6	30	-1.3
1	-0.2	50	-2.0
2	-0.2	70	-2.8
5	-0.3	REF. FREQ.	-4.0
7	-0.3	200	-7.3
10	-0.5	450	-16.4
15	-0.7		
20	-0.9		

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: Ronald Stevens RS 4270 Date: 1/25/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3599767065.696+1

ACS-11

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3701G2FA50G

Serial Number: 7497

Description: DC Accelerometer

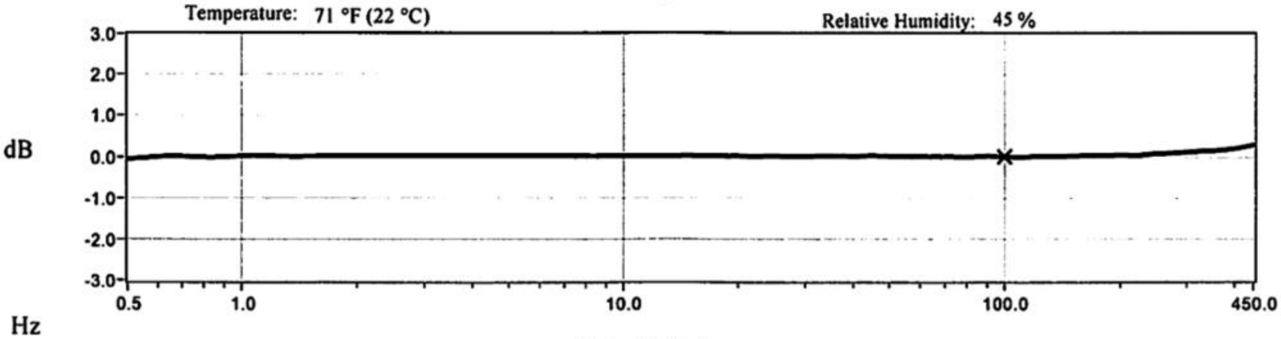
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz	**60.2 mV/g**	Offset Voltage (@ 0 g)	0.2 mVDC
	(6.14 mV/m/s²)	Resonant Frequency	1.70 kHz

Sensitivity Plot



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
0.5	-0.8	10	0.1	70	0.0
1	0.1	15	0.3	REF. FREQ.	0.0
2	0.2	20	0.2	200	0.5
5	0.3	30	0.1	450	3.3
7	0.2	50	0.2		

Mounting Surface: Calibration Fixture w/Silicone Grease Fastener: Stud Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 1.00 g (9.81 m/s²)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude: Acceleration Level (g) = 0.207 x (freq)². [2]The gravitational constant used for calculations by the calibration system is: 1 g = 9.80665 m/s².

Condition of Unit

As Found: In Tolerance

As Left: In Tolerance

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Due to state of art limitations, the test uncertainty ratio is 3:1. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: David Higgins DH

Date: 2/12/2018

PCB PIEZOTRONICS
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3601281202.825+2

ACS-11

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3701G2FA50G

Serial Number: 7497

Description: DC Accelerometer

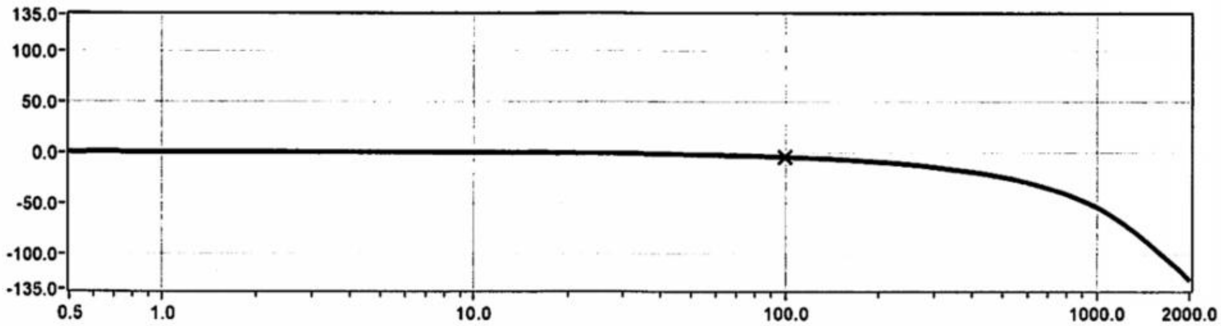
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz **60.2 mV/g** **(6.14 mV/m/s²)**

Phase Plot



Data Points

Frequency (Hz)	Phase (°)	Frequency (Hz)	Phase (°)
0.5	-0.2	30	-1.7
1	-0.1	50	-2.6
2	-0.1	70	-3.7
5	-0.3	REF. FREQ.	-5.1
7	-0.4	200	-9.9
10	-0.6	450	-22.2
15	-0.8		
20	-1.1		

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: David Higgins DH Date: 2/12/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3601281202.825+2

ACS-11

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: **3701G2FA50G**

Serial Number: **8445**

Description: DC Accelerometer

Manufacturer: PCB

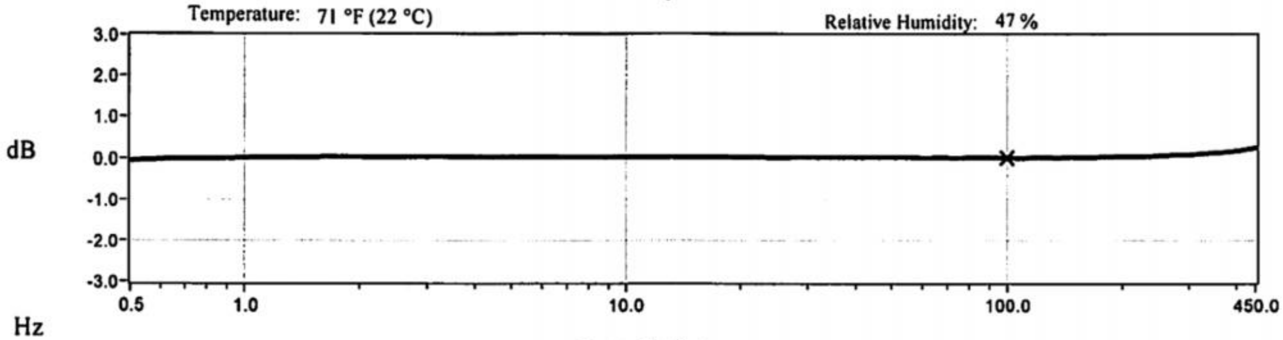
Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz	**59.6 mV/g**	Offset Voltage (@ 0 g)	0.2 mVDC
	(6.08 mV/m/s²)	Resonant Frequency	1.70 kHz

Sensitivity Plot

Temperature: 71 °F (22 °C) Relative Humidity: 47 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
0.5	-0.8	10	0.2	70	0.1
1	0.0	15	0.2	REF. FREQ.	0.0
2	0.2	20	0.2	200	0.4
5	0.2	30	0.2	450	2.8
7	0.2	50	0.2		

Mounting Surface: Calibration Fixture w/Silicone Grease Fastener: Stud Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 1.00 g (9.81 m/s²)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.207 x (freq)². [2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.80665 m/s².

Condition of Unit

As Found: In Tolerance

As Left: In Tolerance

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Due to state of art limitations, the test uncertainty ratio is 3:1. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: David Higgins DH Date: 2/12/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3601284164.540+1

ACS-11

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3701G2FA50G

Serial Number: 8445

Description: DC Accelerometer

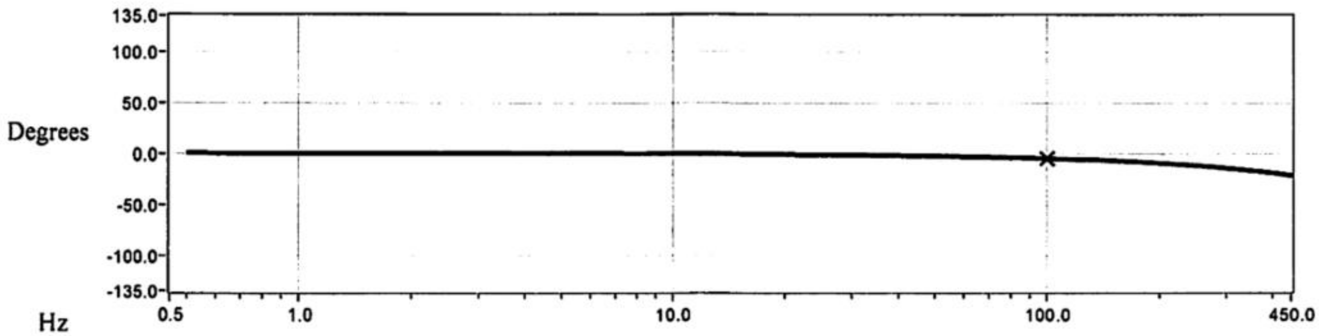
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz **59.6 mV/g** **(6.08 mV/m/s²)**

Phase Plot



Data Points

Frequency (Hz)	Phase (°)	Frequency (Hz)	Phase (°)
0.5	0.1	30	-1.6
1	-0.2	50	-2.6
2	-0.1	70	-3.7
5	-0.2	REF. FREQ.	-5.1
7	-0.3	200	-9.7
10	-0.6	450	-22.0
15	-0.8		
20	-1.1		

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: David Higgins DH Date: 2/12/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3601284164.540+1

ACS-11

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3701G2FA50G

Serial Number: 7152

Description: DC Accelerometer

Manufacturer: PCB

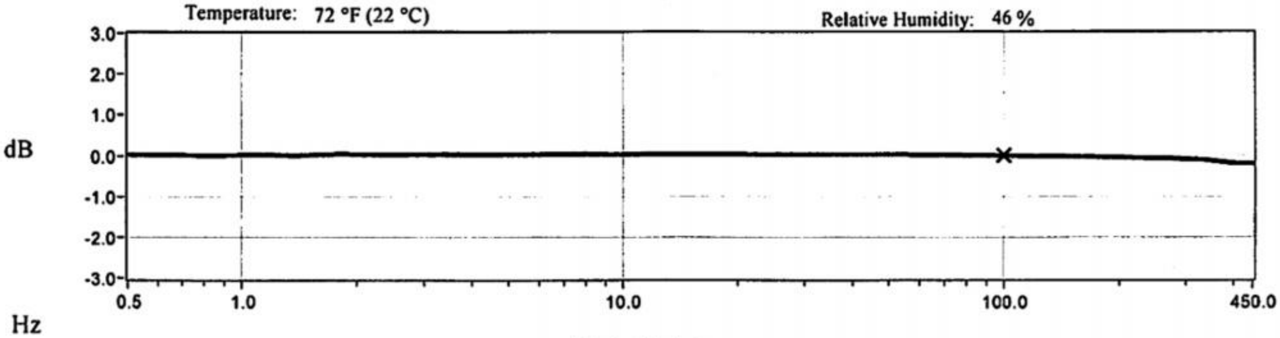
Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz	**58.9 mV/g**	Offset Voltage (@ 0 g)	0.3 mVDC
	(6.01 mV/m/s²)	Resonant Frequency	1.70 kHz

Sensitivity Plot

Temperature: 72 °F (22 °C) Relative Humidity: 46 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
0.5	0.3	10	0.3	70	0.1
1	0.2	15	0.4	REF. FREQ.	0.0
2	0.4	20	0.3	200	-0.5
5	0.4	30	0.3	450	-2.3
7	0.4	50	0.3		

Mounting Surface: Calibration Fixture w/Silicone Grease Fastener: Stud Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 1.00 g (9.81 m/s²)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude: Acceleration Level (g) = 0.207 x (freq)². [2]The gravitational constant used for calculations by the calibration system is: 1 g = 9.80665 m/s².

Condition of Unit

As Found: In Tolerance

As Left: In Tolerance

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Due to state of art limitations, the test uncertainty ratio is 3:1. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: David Higgins DH

Date: 2/12/2018

PCB PIEZOTRONICS INC
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3601280273.370+1

ACS-11

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: **3701G2FA50G**

Serial Number: **7152**

Description: DC Accelerometer

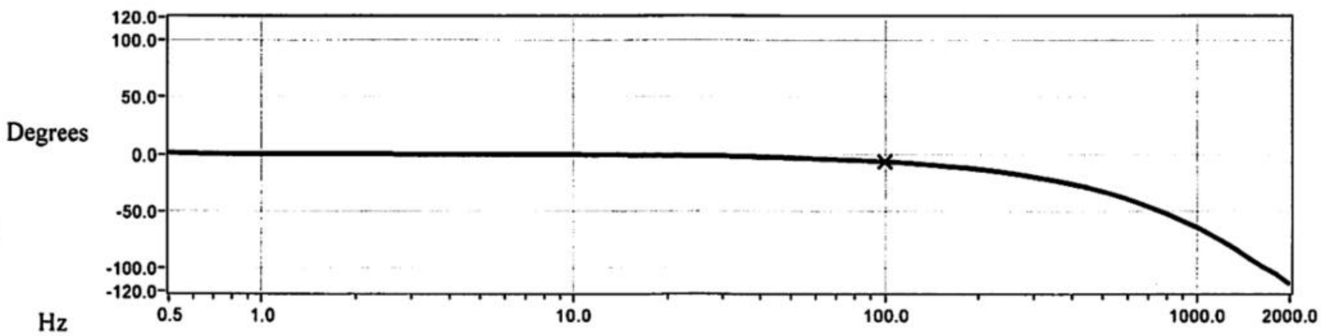
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz **58.9 mV/g** **(6.01 mV/m/s²)**

Phase Plot



Data Points

Frequency (Hz)	Phase (°)	Frequency (Hz)	Phase (°)
0.5	0.8	30	-2.2
1	-0.0	50	-3.5
2	-0.2	70	-5.0
5	-0.4	REF. FREQ.	-7.0
7	-0.5	200	-13.4
10	-0.8	450	-29.6
15	-1.1		
20	-1.5		

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: David Higgins DH

Date: 2/12/2018

PCB PIEZOTRONICS
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3601280273.370+1

ACS-11

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 3701G2FA50G

Serial Number: 7499

Description: DC Accelerometer

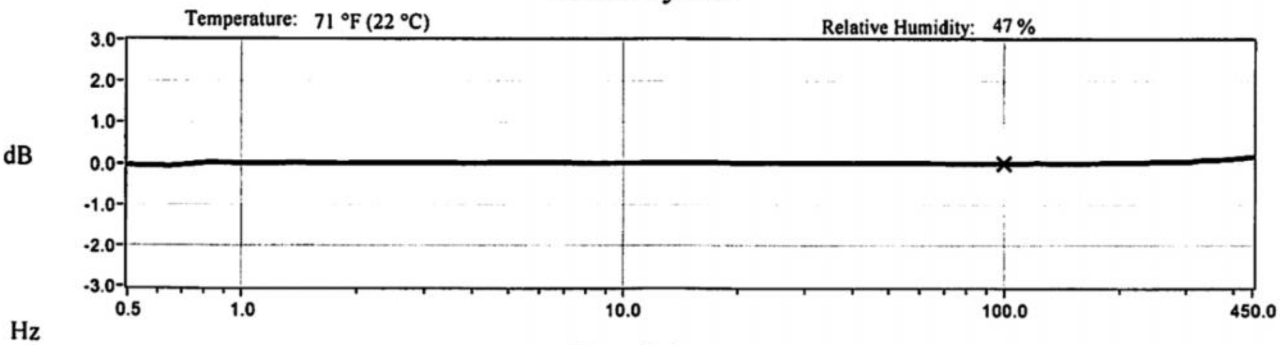
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz	**58.8 mV/g**	Offset Voltage (@ 0 g)	0.3 mVDC
	(5.99 mV/m/s²)	Resonant Frequency	1.70 kHz

Sensitivity Plot



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
0.5	-0.5	10	0.1	70	0.1
1	0.1	15	0.2	REF. FREQ.	0.0
2	0.1	20	0.1	200	0.2
5	0.2	30	0.1	450	1.9
7	0.2	50	0.1		

Mounting Surface: Calibration Fixture w/Silicone Grease Fastener: Stud Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 1.00 g (9.81 m/s²)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude: Acceleration Level (g) = 0.207 x (freq)². [2]The gravitational constant used for calculations by the calibration system is: 1 g = 9.80665 m/s².

Condition of Unit

As Found: In Tolerance

As Left: In Tolerance

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Due to state of art limitations, the test uncertainty ratio is 3:1. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: David Higgins DH Date: 2/12/2018

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3601283381.677+1

ACS-11

~ *Calibration Certificate* ~

Per ISO 16063-21

Model Number: **3701G2FA50G**

Serial Number: **7499**

Description: DC Accelerometer

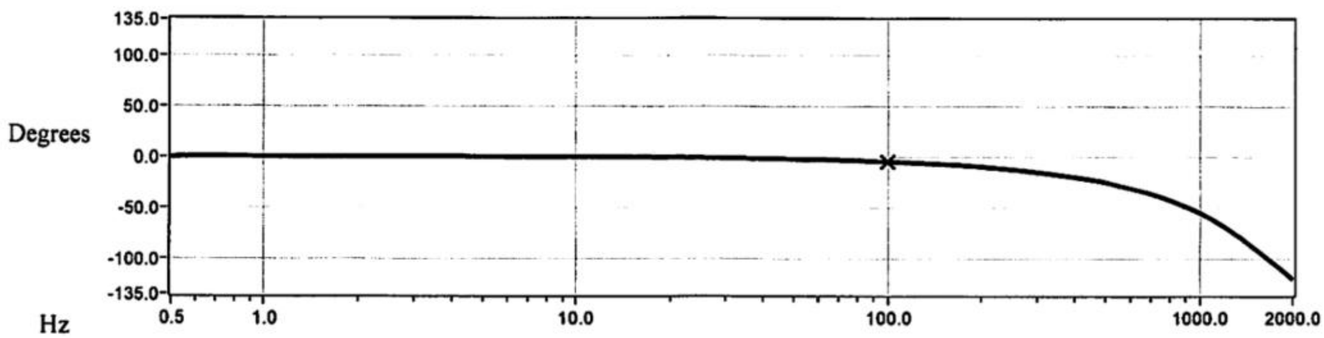
Manufacturer: PCB

Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz **58.8 mV/g** **(5.99 mV/m/s²)**

Phase Plot



Data Points

Frequency (Hz)	Phase (°)	Frequency (Hz)	Phase (°)
0.5	-0.7	30	-1.7
1	-0.1	50	-2.7
2	-0.0	70	-3.8
5	-0.4	REF. FREQ.	-5.4
7	-0.4	200	-10.4
10	-0.6	450	-23.1
15	-0.9		
20	-1.1		

Notes

1. Calibration is traceable to one or more of the following; PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz; +/- 1.8%, 1-30 Hz; +/- 1.0%, 30.01-199 Hz; +/- 1.5%, 200-1 kHz; +/- 3.0%.

Technician: David Higgins DH Date: 2/12/2018

PCB PIEZOTRONICS INC
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

CAL96-3601283381.677+1

ACS-11