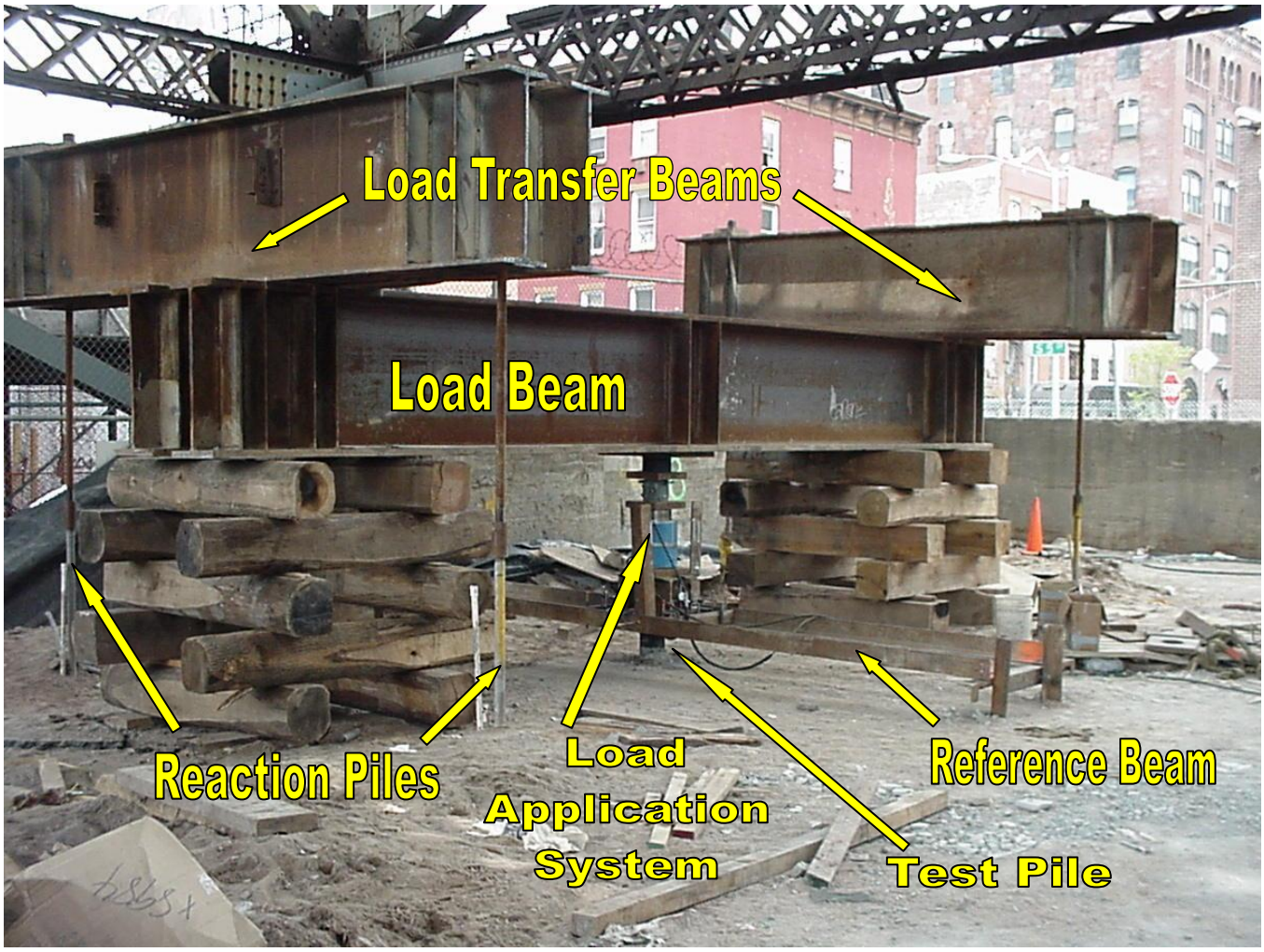
GCP-18

STATIC PILE LOAD TEST MANUAL



GEOTECHNICAL CONTROL PROCEDURE
GCP-18
Revision #4

AUGUST 2015

NEW YORK STATE OF OPPORTUNITY. Department of Transportation | Office of Technical Services | Geotechnical Engineering Bureau

GEOTECHNICAL CONTROL PROCEDURE:
STATIC PILE LOAD TEST MANUAL

GCP-18
Revision #4

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING BUREAU

AUGUST 2015

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INTRODUCTION

This manual presents uniform procedures for statewide conduct and reporting of results of static pile load tests, in conformance with NYSDOT specifications requirements. These tests have three primary objectives:

- To establish load-deflection relationships in the pile-soil system,
- To determine capacity of the pile-soil system, and
- To determine load distribution in the pile-soil system.

These tests will confirm design assumptions or provide information to allow those assumptions and the pile design to be modified. Three types of loading procedures for a static load test are:

1. ***The Quick Load Test***,
2. ***The Incremental Static Load Test, and***
3. ***The Constant Rate of Penetration Test.***

The Contractor must engage the services of a Professional Engineer licensed and registered in New York State, experienced in all aspects of pile load testing and acceptable to the Deputy Chief Engineer Structures (D.C.E.S) to perform the load tests and to prepare report of test results, as outlined in Chapter VIII. The Contractor's agreement with the Professional Engineer shall provide for additional technically qualified personnel to be at the test site at all times during testing to assure that loads are being maintained and to record data.

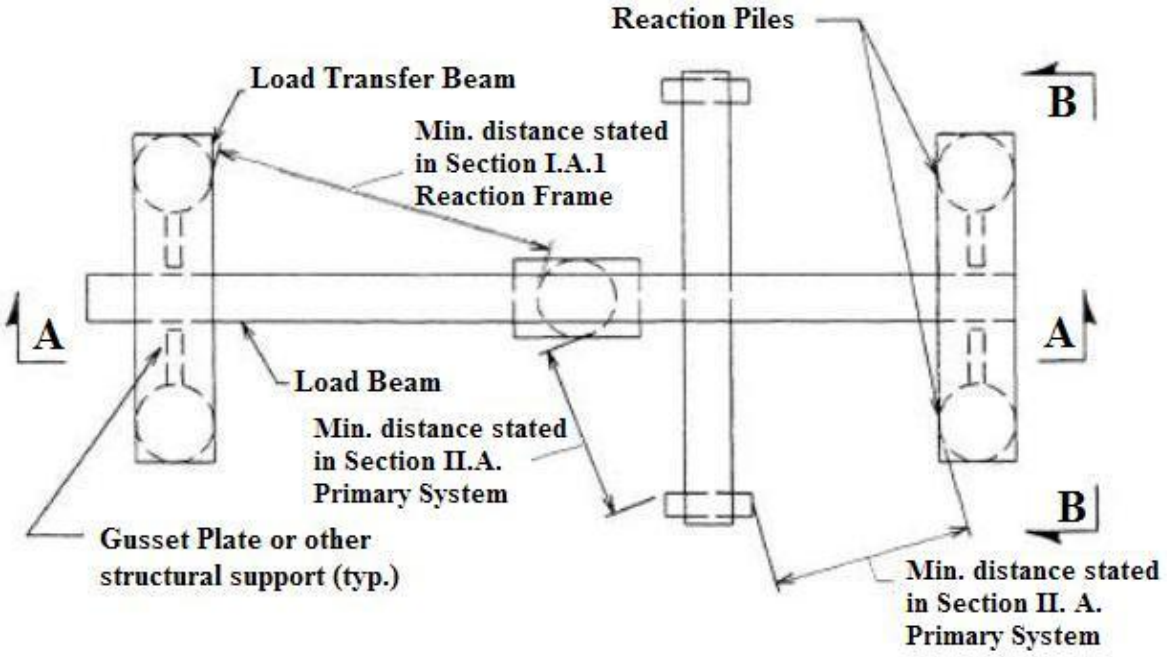
I. PILE TEST LOADS AND LOAD APPLICATION SYSTEMS

A. TYPES OF REACTION LOAD

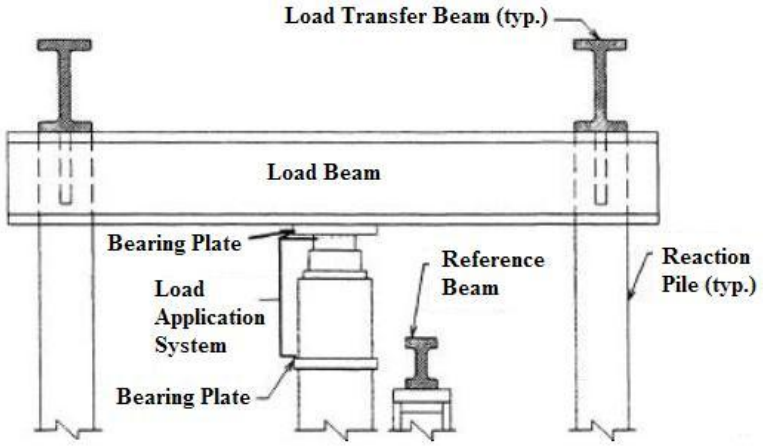
Apply the load to the pile by jacking against a reaction with one or more hydraulic jacks. The reaction is provided by one of the following methods:

1. **Reaction Frame.**
   Install two or more reaction piles, or anchors, for the reaction frame (Fig. 1) after the installation of the test pile. For driven piles, locate these reaction piles not less than 10 ft. (3 m) or the sum of 5 reaction pile diameters and 5 test pile diameters (whichever of the two criteria is the greater distance) from the test pile or reference beam supports. For drilled shafts or micropiles, locate these reaction piles not less than 10 ft. (3 m) or 5 reaction pile diameters (whichever of the two criteria is the greater distance) from the test pile or reference beam supports. These distances are measured between the faces of the test pile and reaction piles. Anchors, if used, must be designed with sufficient free length so as not to interfere with the load test pile or the reference system.

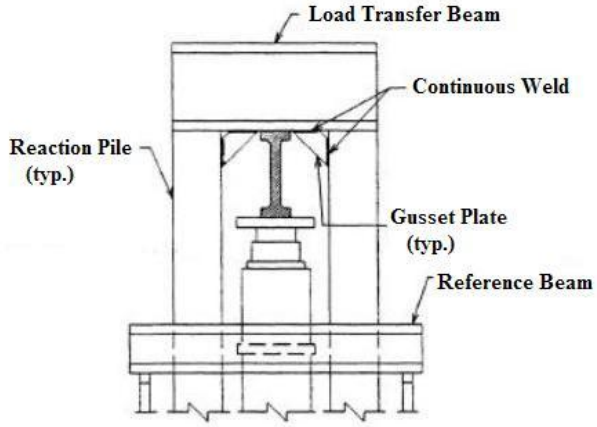
   Design the reaction frame and reaction piles to resist four times the pile design load indicated in the contract documents without undergoing a magnitude of deflection exceeding 75 percent of maximum travel of the jack.



Plan View



Section A-A



Section B-B

Figure 1 Typical Setup for a Reaction Frame

2. Weighted Box or Platform.

Construct a weighted box or platform (Fig. 2) over the test pile, supported on cribbing or on other piles installed after the test pile.

a. Cribbing Support:

For driven piles, drilled shafts or micropiles, locate the nearest face of the cribbing support not less than 10 ft. (3 m) or 5 test pile diameters (whichever of the two criteria is the greater distance) from the test pile or reference beam supports. Measure these distances between the test pile face and the nearest face of the cribbing supports. A greater spacing between the cribbing supports and test pile or reference system may be required to prevent foundation stresses caused by the cribbing from affecting the test.

b. Pile Support:

For driven piles, locate these support piles not less than 10 ft. (3 m) or the sum of 5 support pile diameters and 5 test pile diameters (whichever of the two criteria is the greater distance) from the test pile or reference beam supports. For drilled shafts or micropiles, locate these support piles not less than 10 ft. (3 m) or 5 reaction pile diameters (whichever of the two criteria is the greater distance) from the test pile or reference beam supports. Measure these distances between the test pile face and the nearest face of the pile supports.

Design the load beam and transfer beam to resist four times the pile design load indicated in the contract documents, without undergoing a magnitude of deflection exceeding 75 percent of maximum travel of the jack. Load the weighted box or platform with earth, sand, concrete, water, pig iron, or other suitable material to obtain a total weight of at least four times the pile design load indicated in the contract documents.

The load beam for a reaction frame may bear on the load transfer beam with no connections. The load beam may need stiffeners at the points of bearing. The beam may need truss work, not shown in the figure, to prevent excessive bending and resulting ram extension in excess of the seventy-five percent (75%) of the maximum travel of the jack.

The pressure intensity exerted on the ground surface from any cribbing must not exceed the bearing capacity of the soil or cause settlement of the test pile and/or measurement system.

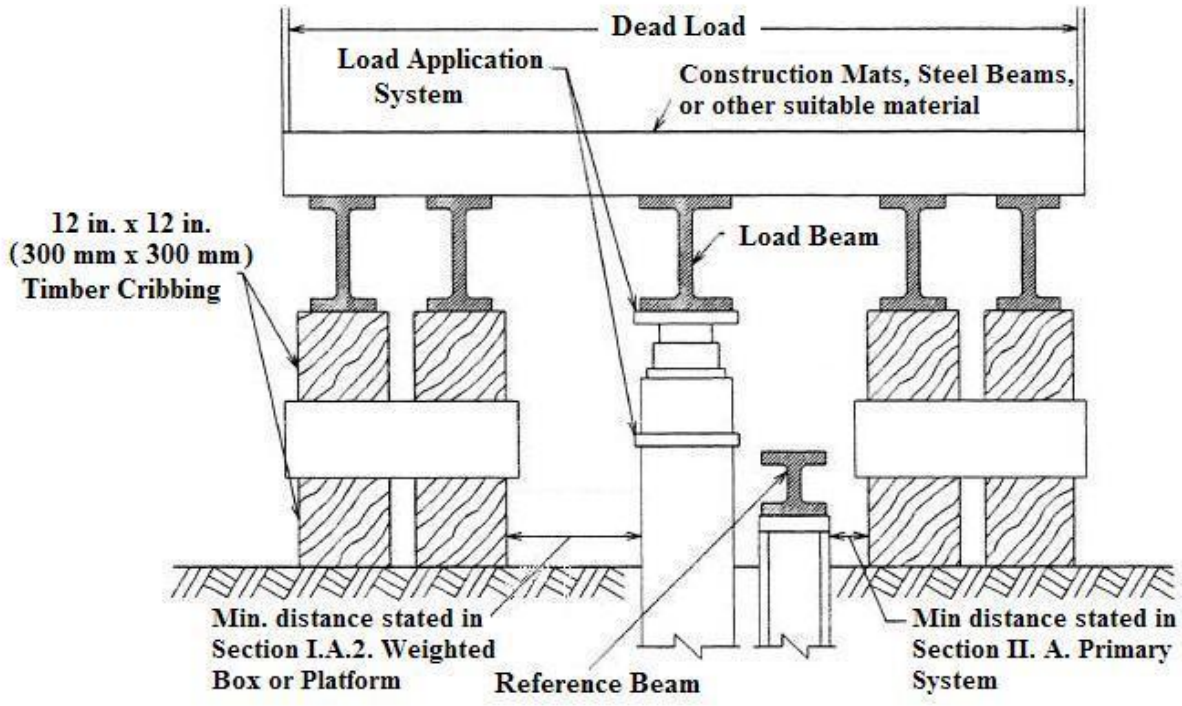


Figure 2 Typical Setup for a Weighted Box or Platform

3. **Alternative Methods.**
   The Contractor may request approval to apply the reaction load by another method. In that case, submit in writing a summary of the alternative loading system with appropriately detailed drawings for approval by the D.C.E.S.

B. LOAD APPLICATION SYSTEM

Apply load with one or more hydraulic jacks, having a capacity of at least four times the pile design load indicated in the contract documents. Use jacks with a minimum travel of 6 in. (150 mm), but not less than 25 percent of the test pile's maximum cross-section dimension. Equip the jack(s) with spherical bearing plates, to bear firmly and concentrically against the pile bearing plate and load-beam bearing plate. Use an automatic load-maintaining pump with manual supplement to control load application. Use a pressure gage for the jack so that the pressure reading corresponding to the pile design load indicated in the contract documents is between one-fourth and one-third of maximum gage pressure. Place a load cell (either electric or hydraulic, unless one or the other is specified in the contract documents) as shown in Figures 1 and 2 to measure strains for load monitoring during the load test. Arrange and construct the elements of the load-application system as follows:

1. Cut off the pile butt and cap it to provide a level bearing surface perpendicular to the pile axis. Use a steel plate for H-piles and empty cast-in-place piles, or a neat cement paste for concrete piles, timber piles, micropiles, drilled shafts or cast-in-place piles filled with concrete.
2. To distribute load over the pile's entire cross-section, place a solid steel billet of sufficient thickness (1 in. (25 mm) minimum) to prevent bending as a bearing plate between the capped pile and the jack base. The size of the solid steel billet shall be not less than the size of the pile butt or less than the area covered by the jack base.
3. Place the load application system (including hydraulic jack, spherical bearing and load cell) between the bearing plate on the pile and the center of the underside of the load beam.
4. To distribute load over the entire width of the load beam, place another solid steel billet of sufficient thickness (1 in. (25 mm) minimum) as a bearing plate between the load beam and the load application system.
5. Construct the system so that all components are centered along the pile's longitudinal axis, to ensure application of a concentric axial load.
6. Immediately before starting a load test, verify that at least 1 in. (25 mm) of clear space exists between the upper bearing plate and load beam, or the upper bearing plate and load application system.

II. MEASURING APPARATUS AND SITE PROTECTION

Provide apparatus for measuring deflection consisting of a primary system, at least one auxiliary system, and a network of settlement reference points. Establish two fixed independent benchmarks at least 50 ft. (15 m) from the test site to monitor the settlement reference points. If desired, the auxiliary system may also be referenced to these benchmarks. Clearly identify all measuring devices, scales, and reference points with numbers or letters to ensure accurate data recording.

A. PRIMARY SYSTEM

1. **Measuring Devices (Figures 3 & 4)**
   Provide one of these primary instrument packages to monitor movement of the pile top:

   a. Three linear variable differential transformers (LVDTs) and a readout unit. Use DC/DC-type displacement transducers having at least 6 in. (150 mm) of travel and a linearity of 0.5 percent or less. Supply a readout unit having a minimum display of 3-1/2 digits, capable of monitoring output from at least three DC/DC-type LVDTs.

   b. Three dial gages having at least 2 in. (50 mm) of travel, an adequate number of suitable gage blocks to increase the travel to at least an additional 4 in. (100 mm), and a precision of 30 μm.

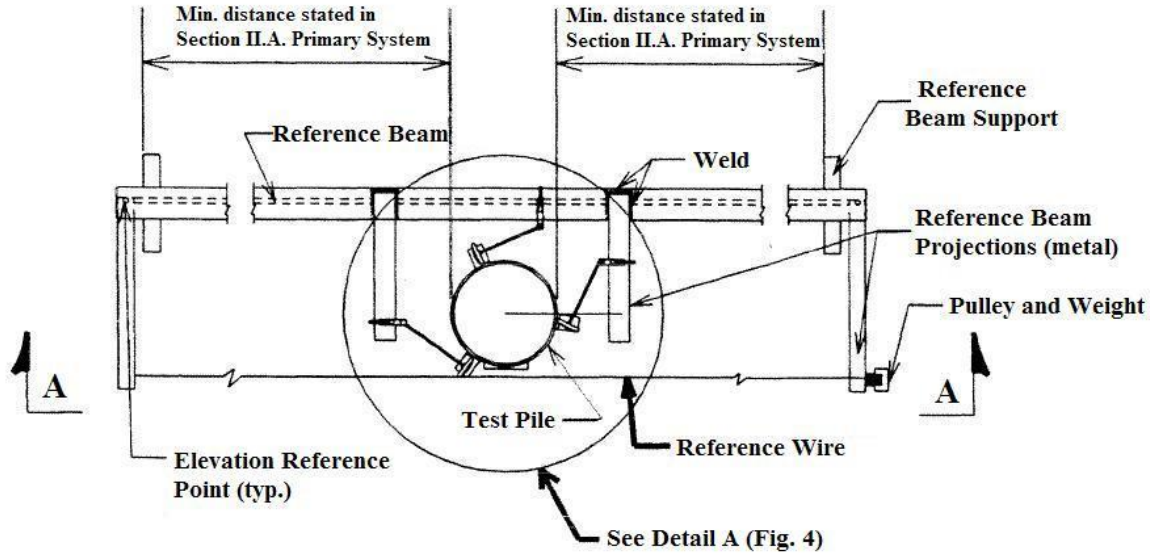
Align the measuring devices parallel to the longitudinal axis of the test pile and the axis of load application. Attach the devices to a simply supported reference beam, completely independent of the test pile and loading apparatus. Ensure the load application system will not interfere with any measuring devices during any part of the test. For driven piles, embed the reference beam supports at least 10 ft. (3 m) into the ground, at a horizontal distance of not less than 10 ft. (3 m), 5 reaction pile diameters, or 5 test pile diameters (whichever of theses is the greater distance) from the closest face of the test pile and from any reaction piles or supports for the weighted box or platform. For drilled shafts or micropiles, embed the reference beam supports at least 10 ft. (3 m) into the ground, at a horizontal distance of not less than 10 ft. (3 m) or 5 pile diameters (whichever of the two criteria is the greater distance) from the closest face of the test pile and from any reaction piles or supports for the weighted box or platform.

Maintain a clear distance of 6 in. to 12 in. (150 mm to 300 mm) from the test pile to the reference beam or any projection used to support a dial. The beam and projections should be at about the same elevation as the attachments to the pile on which the measuring devices will bear.

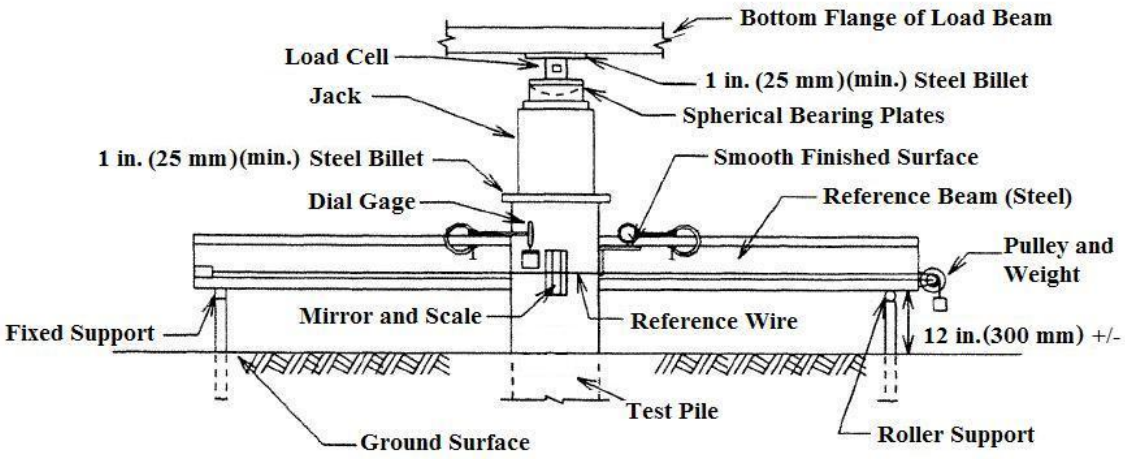
Attach the dial gage supports to the reference beam so as to allow the stem of each device to rest on an attachment to the pile sides. To mount hardware and pile attachments for LVDT

devices use materials, such as brass, aluminum, or 303 Series stainless steel, to avoid magnetic interference with the instruments. The pile attachments are angles, about 3 in. x 4 in. (75mm x 100 mm) with the 4 in. (100 mm) dimension projecting from the pile. For round piles, place these attachments on the perimeter of the pile at a 120E spacing and an equal radial distance. For piles of other cross-section, place the attachments at convenient locations as approved by the Engineer.

Surfaces on which the gage stems bear should have a smooth finish, such as glass or sheet acrylic, attached by an epoxy or other suitable material approved by the Engineer.

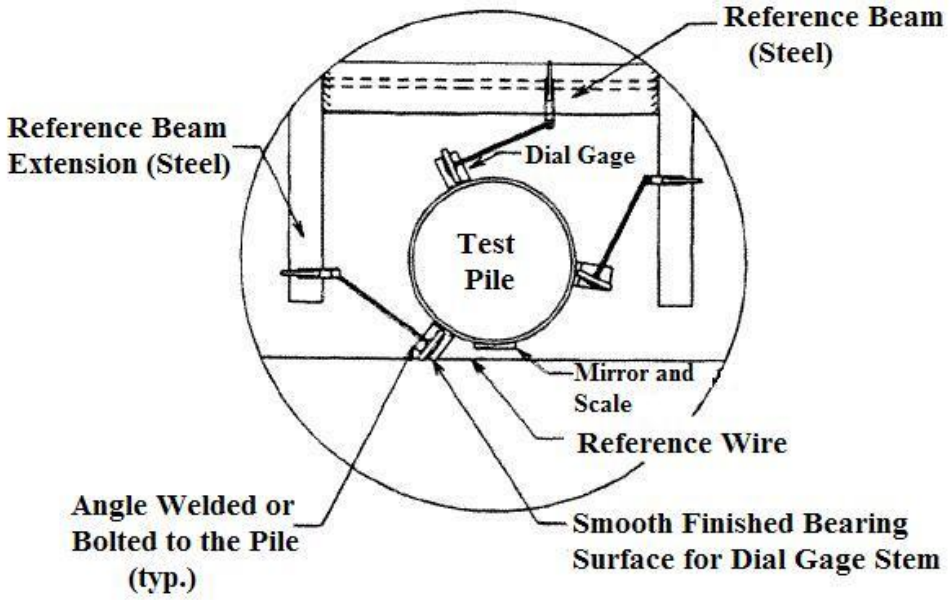


Plan View

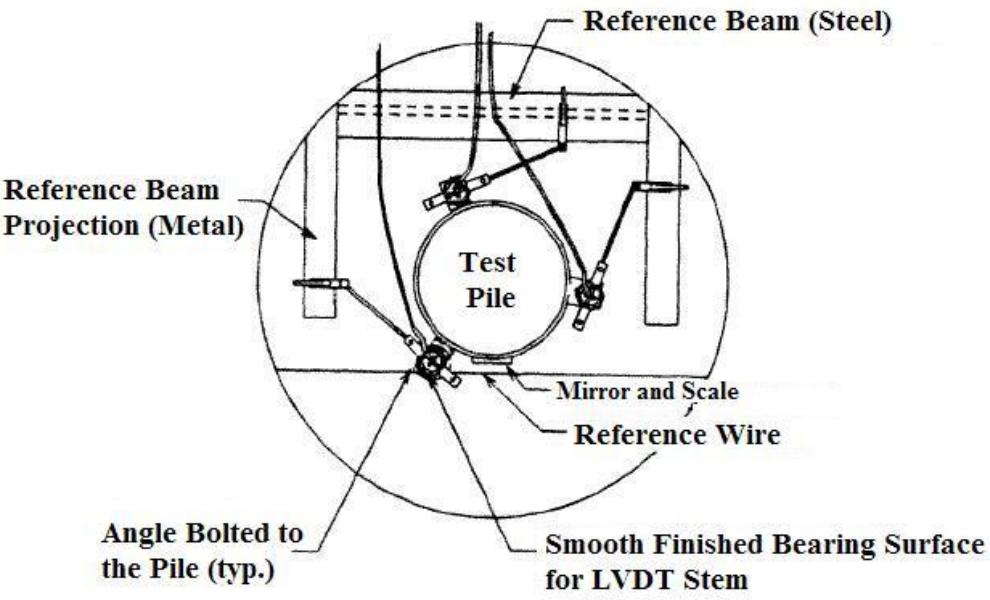


Section A-A

Figure 3 Typical Setup for Measuring System



Detail A for Dial Gages



Detail A for LVDTs

Figure 4 Measuring Devices

2. Telltale Strain Measurements (Figures 5 through 14)

Strain measurements on the pile to determine elastic shortening of the pile or validate that no load is transferred to the soil in the bond breaker length may be required by a special note in the contract documents. Telltales may be required at one or more points along the pile as indicated in the contract documents or designated by the D.C.E.S.

Attach the telltale measuring devices to the reference beam. The readings will be used to determine net deflection of the point(s) of investigation, from which elastic shortening will be calculated

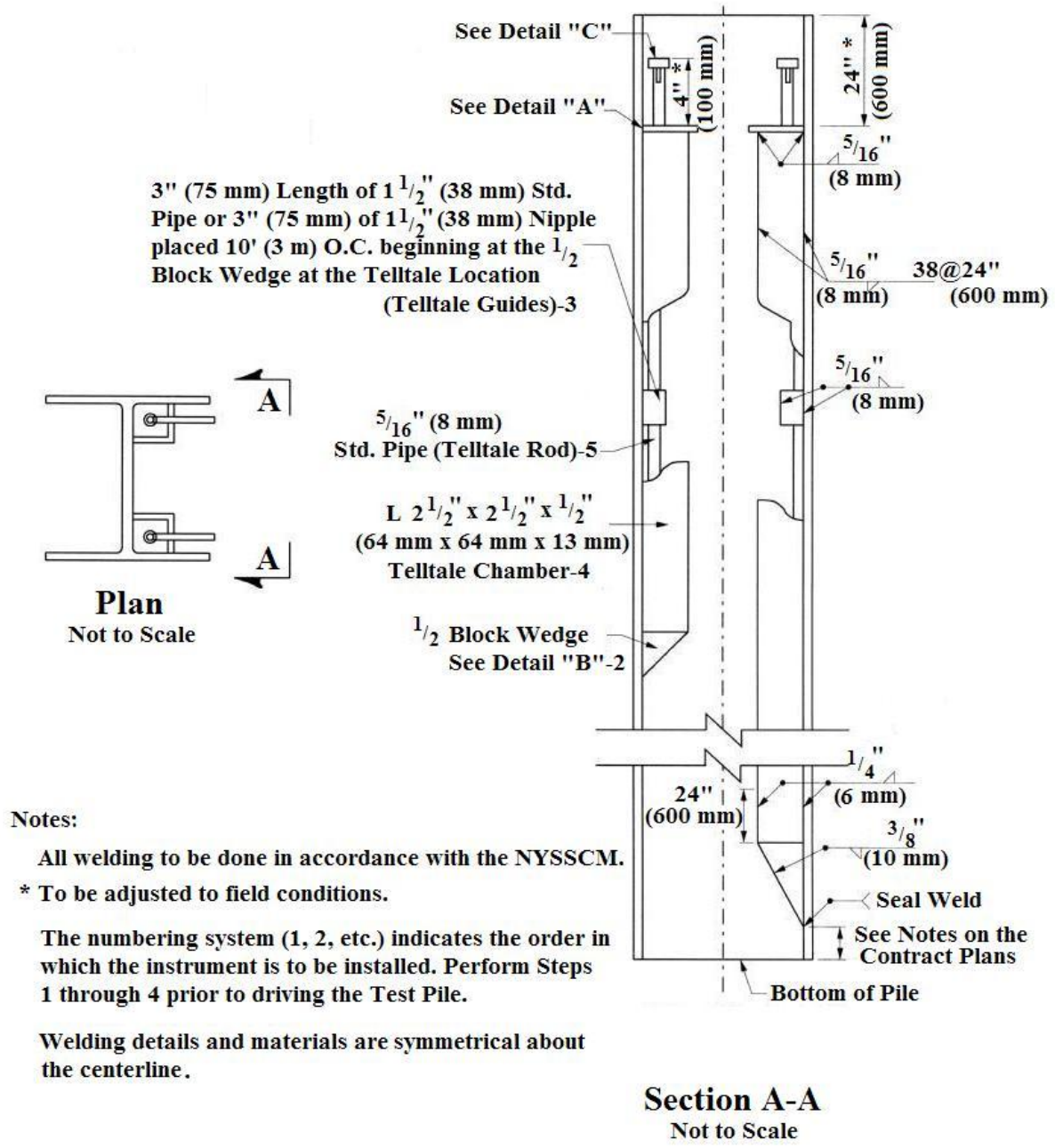
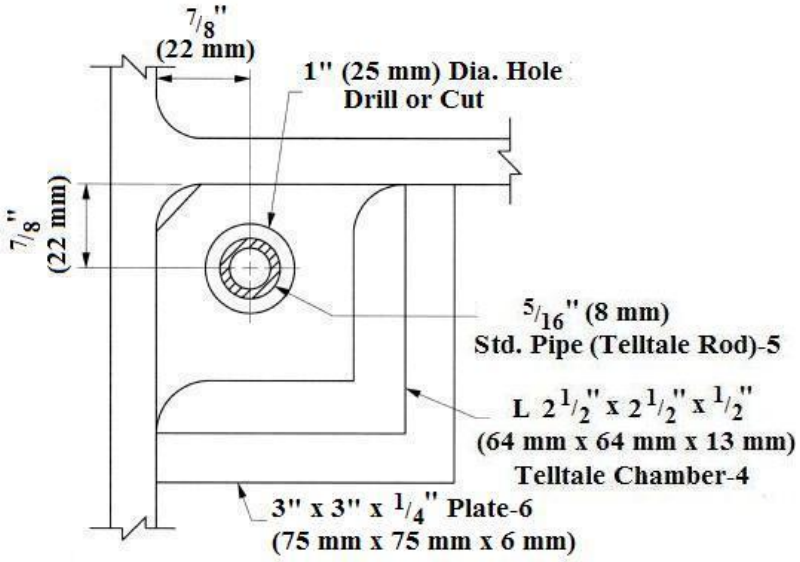
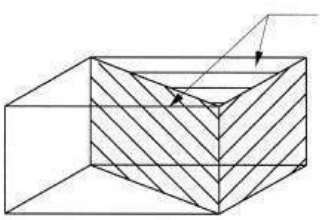


Figure 5 Telltale Installation Details for H-Piles



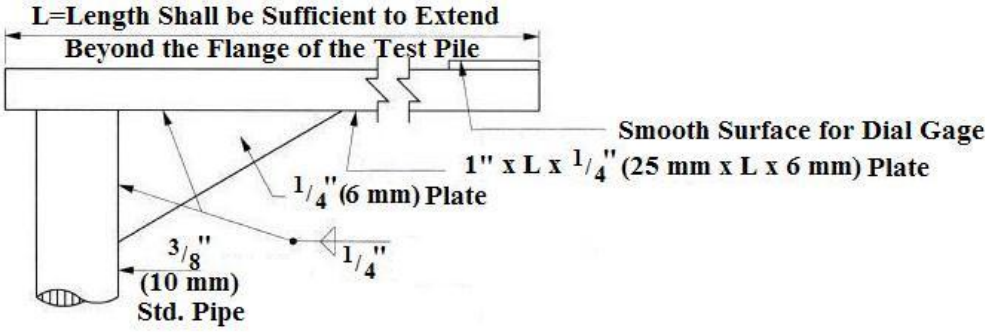
Top Restraint - Detail "A"

Not to Scale



1/2 Block Wedge - Detail "B"

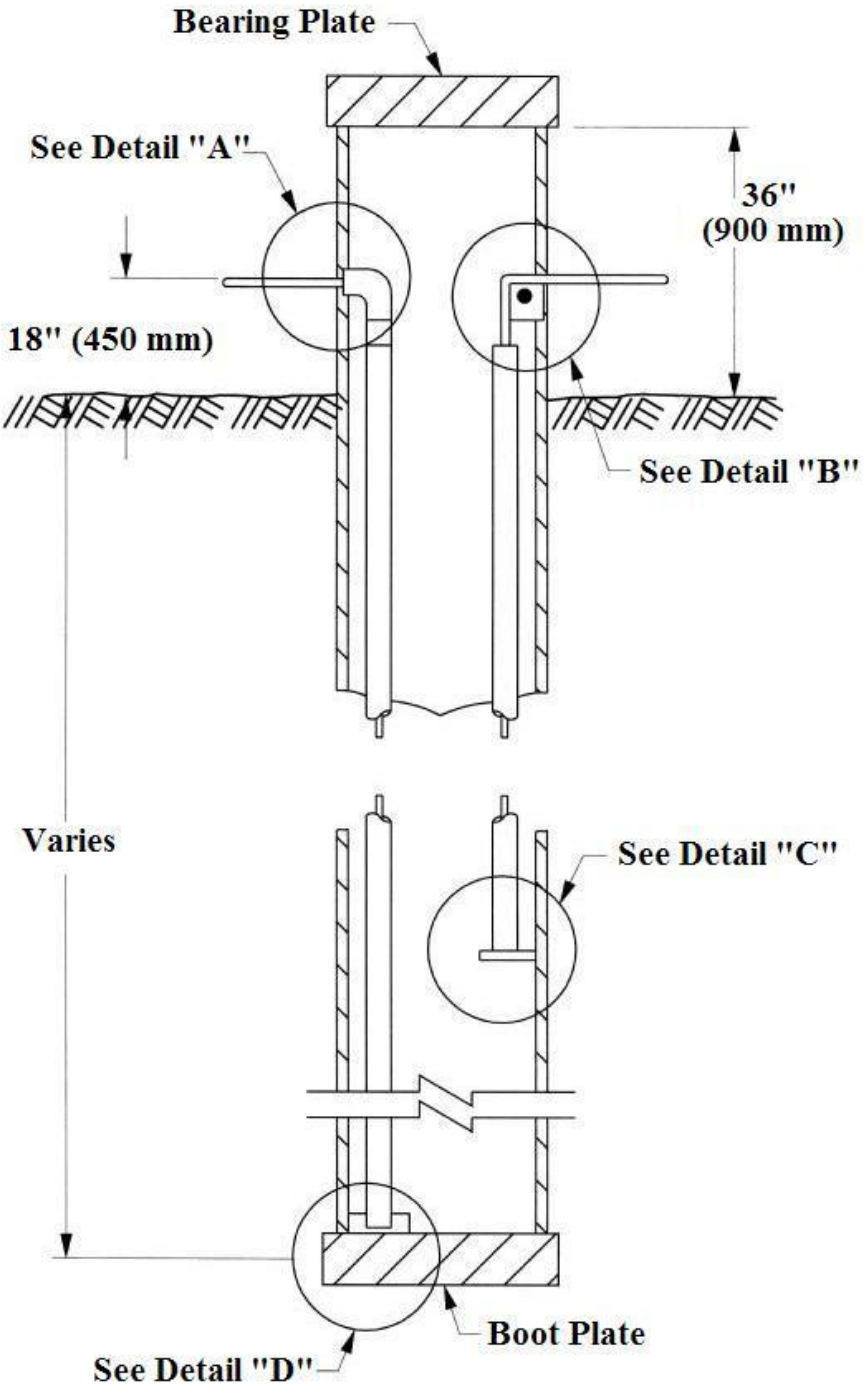
Not to Scale



Telltale Rod Dial Support Arm - Detail "C"

Not to Scale

Figure 6 Dial Support and Telltale Attachment Details for H-Piles



Typical Section
Not to Scale

Figure 7 Telltale Installation Details for Pipe Pile

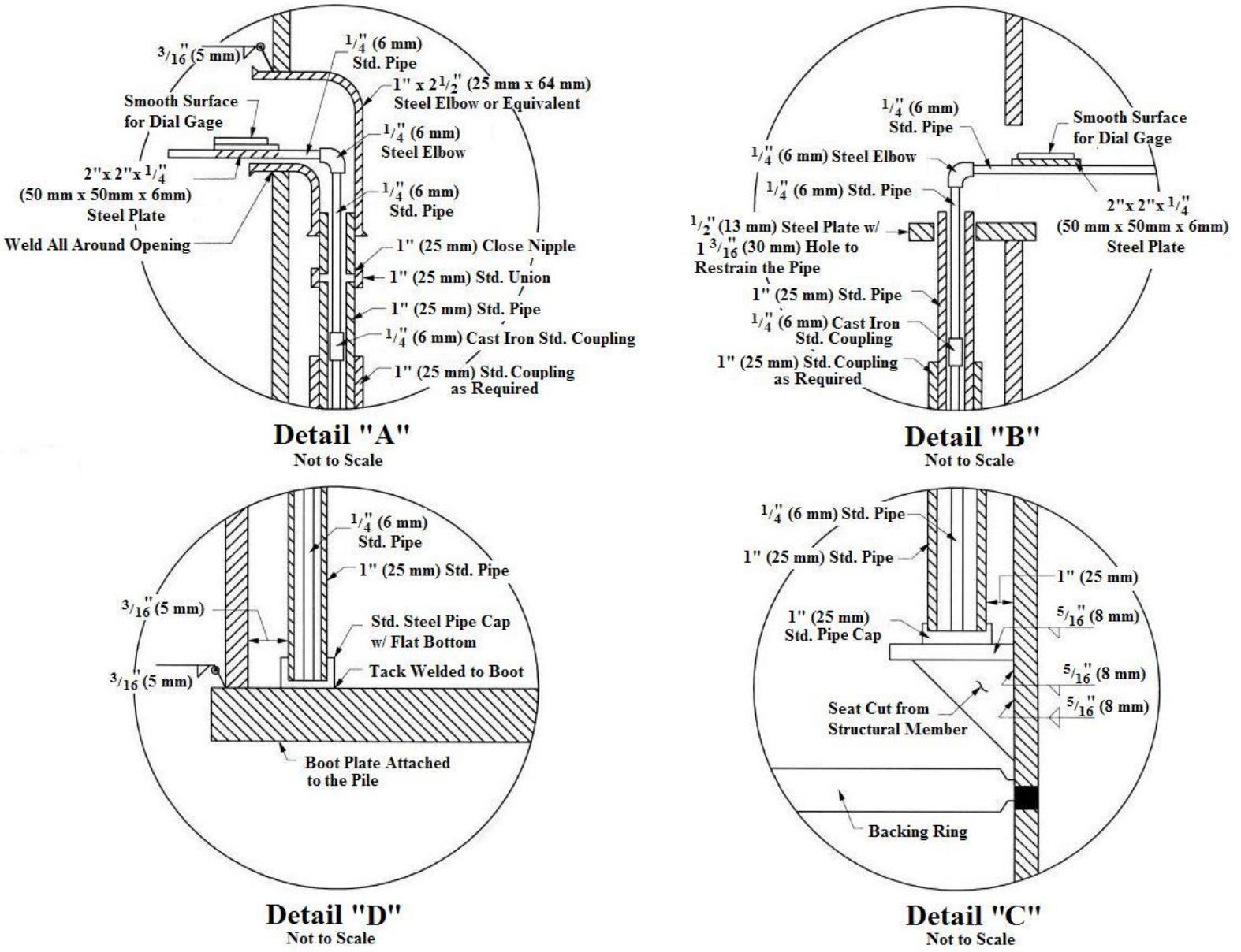


Figure 8 Dial Support and Telltale Attachment Details for Pipe Piles

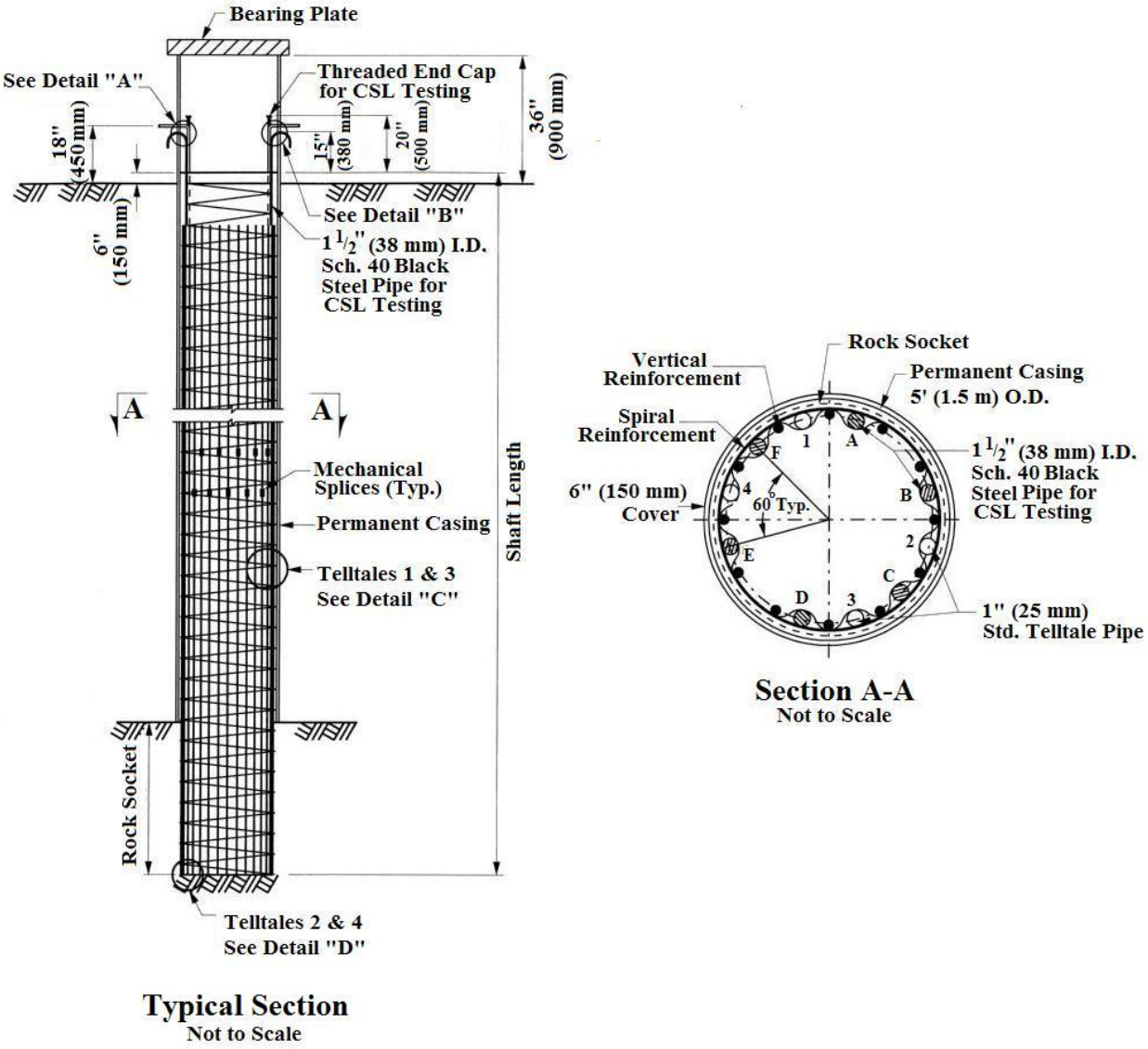


Figure 9 Telltale Installation Details for Drilled Shafts

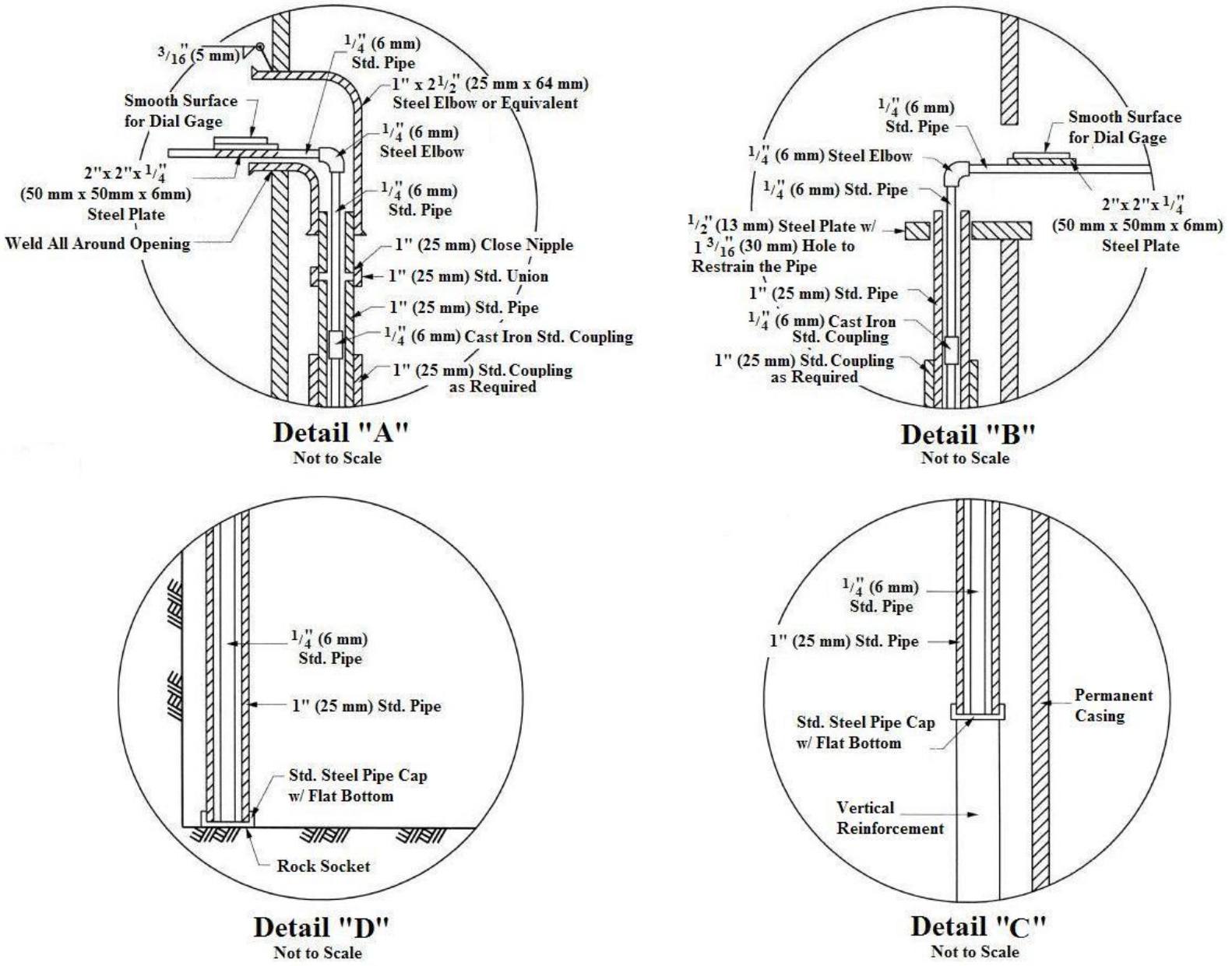


Figure 10 Dial Support and Telltale Attachment Details for Drilled Shafts

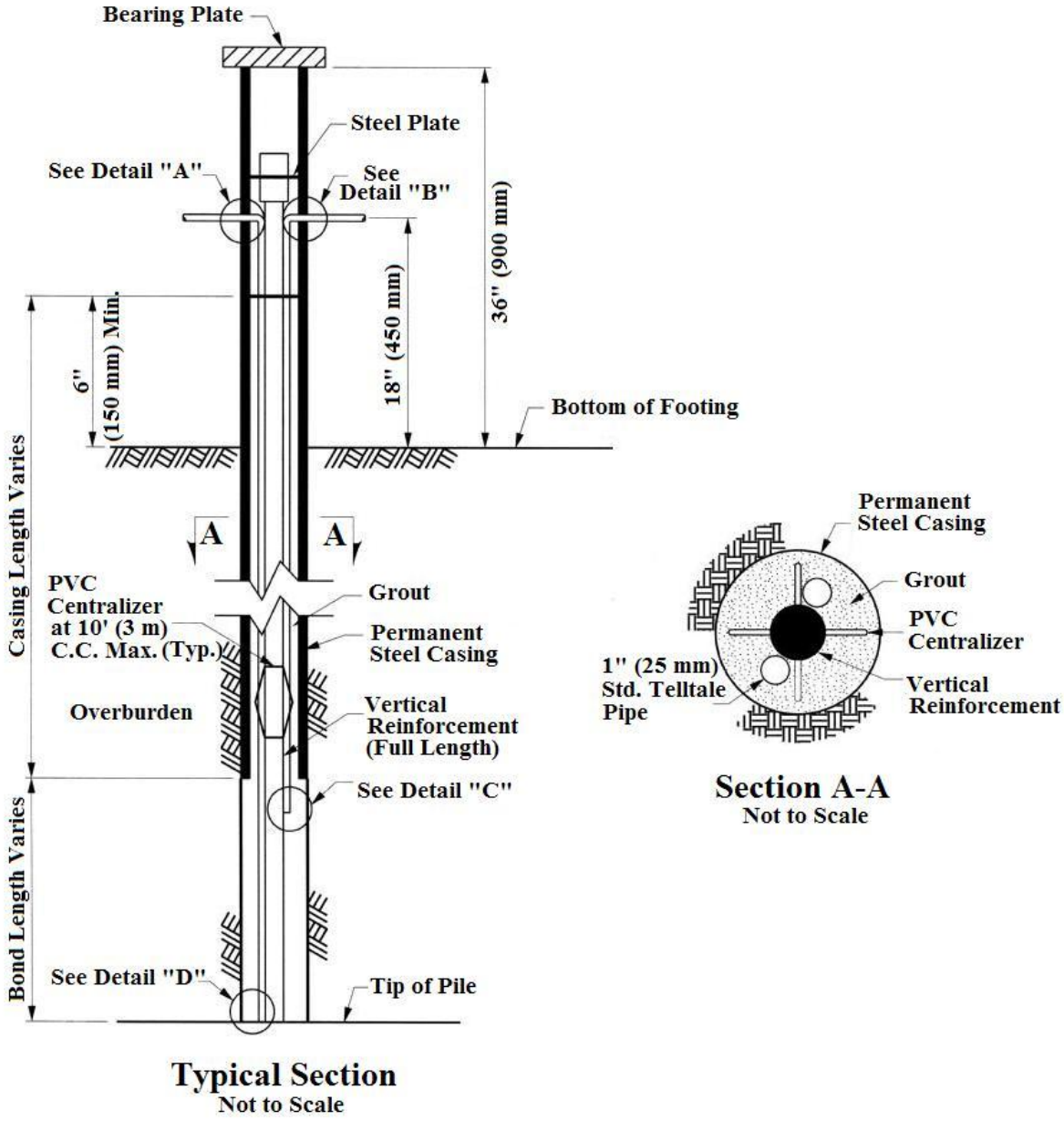


Figure 11 Telltale Installation Details for Micropiles

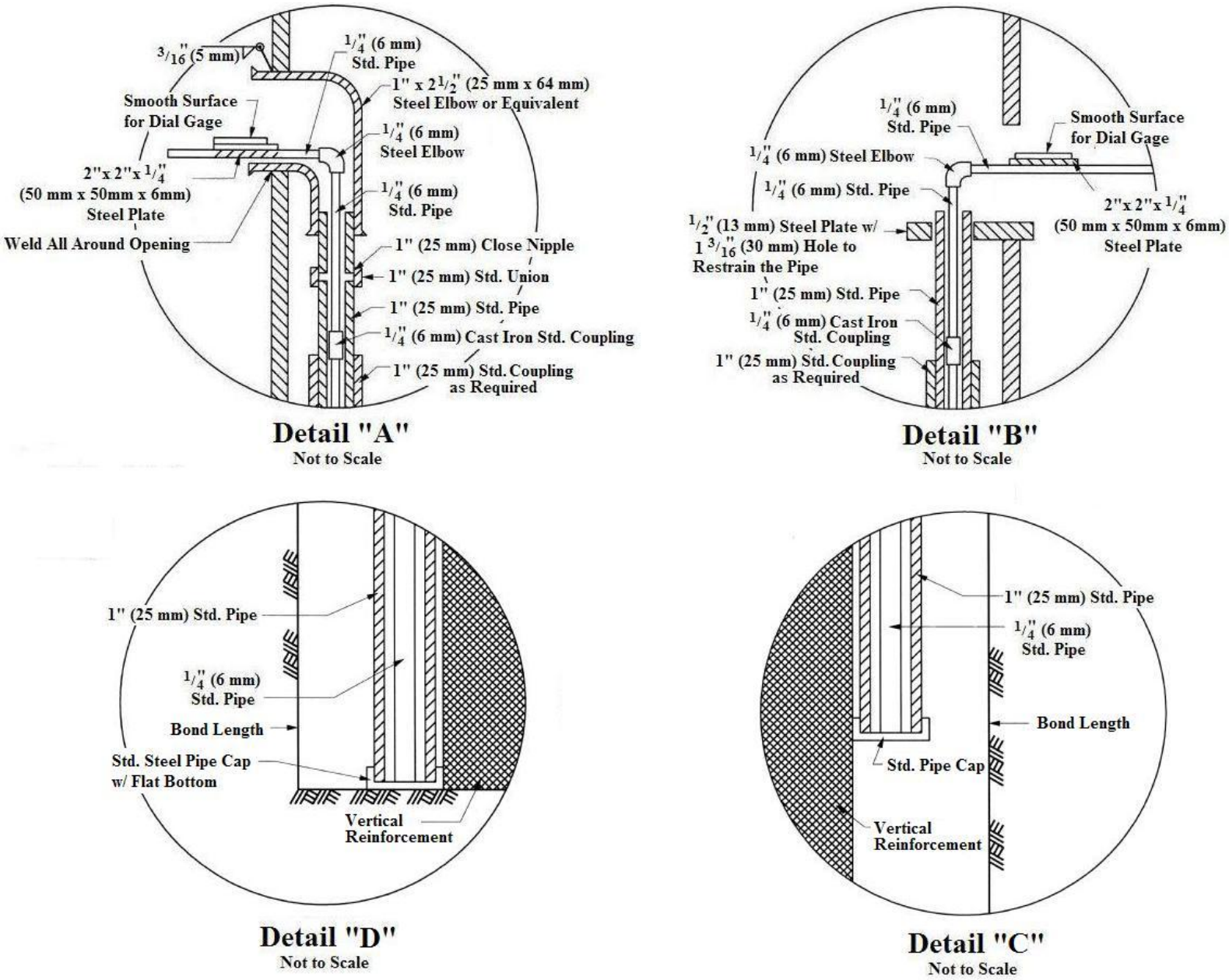


Figure 12 Dial Support and Telltale Attachment Details for Micropiles

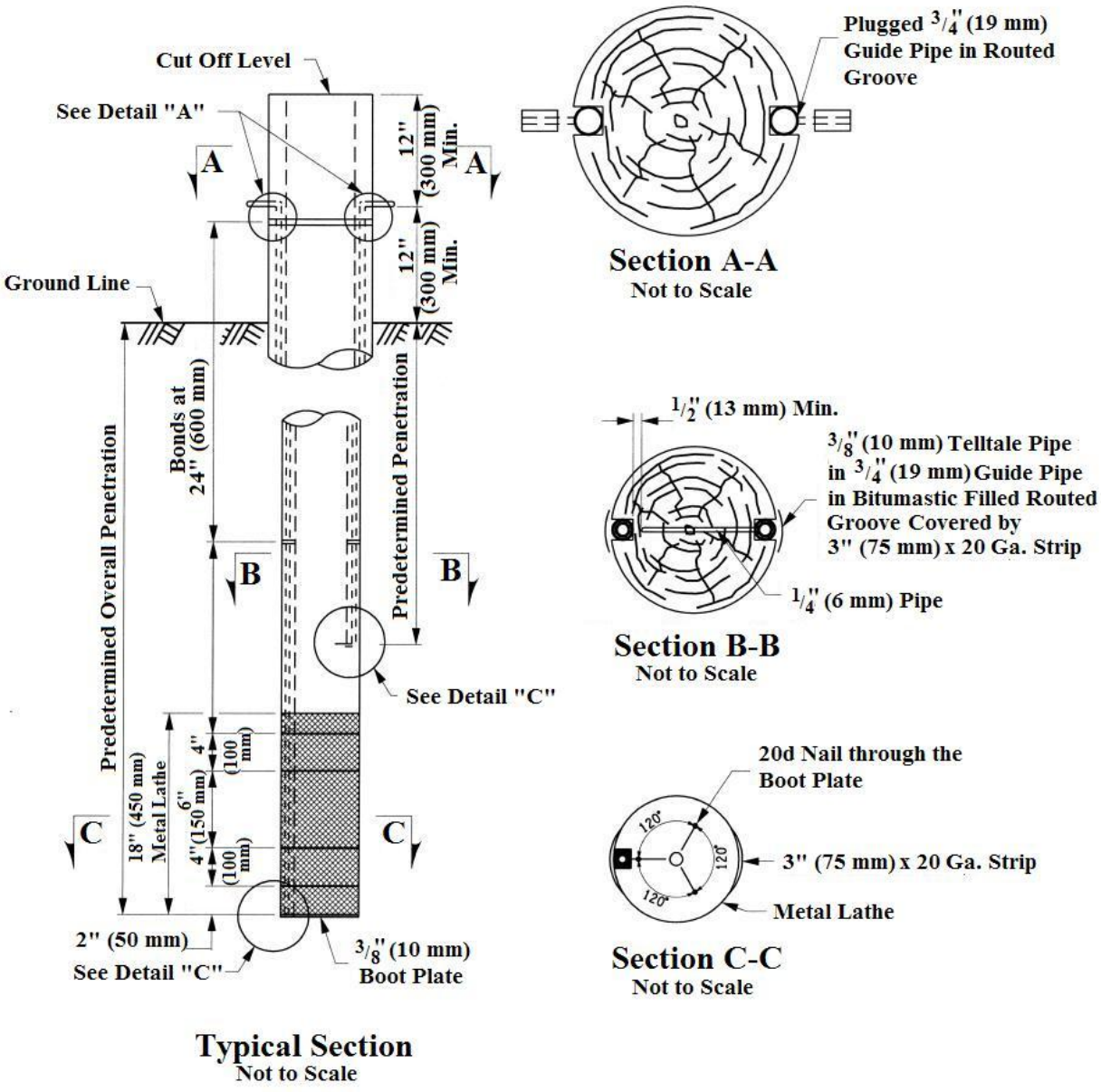


Figure 13 Telltale Installation Details for Timber Piles

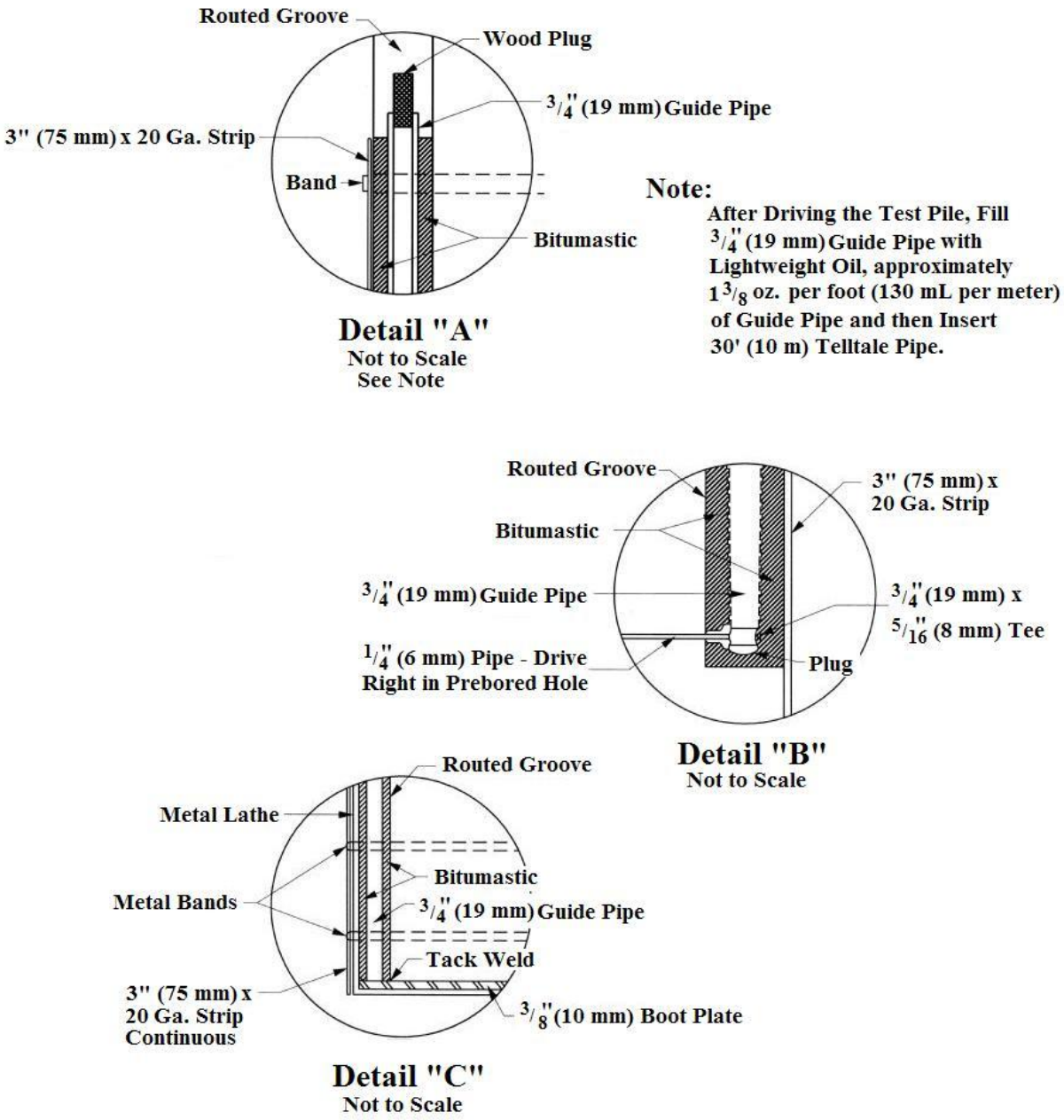


Figure 14 Dial Support and Telltale Attachment Details for Timber Piles

B. AUXILIARY SYSTEMS

These measuring systems consist of one or more of the following: wire, mirror, and scale; surveyor's level and target rod; or, as alternatives, electrical or optical levels.

1. **Wire, Mirror, and Scale (Figures 3 & 4 Details)**
   Determine pile movement by means of a single strand of wire drawn in front of a graduated scale mounted on a mirror. This scale, at least 6 in. (150 mm) long and machine-divided in graduations of 250 μm, is mounted on a 3 in. x 6 in. (75 mm x 150 mm) mirror with metal-and-glass bonding adhesive or electrical tape. Attach the mirror directly to the pile, oriented so that the mirror face is parallel to the reference beam. Mount the wire between the ends of the reference beam, with one end fixed and the other placed over a pulley with a weight to maintain tension. Locate the wire so that it is level and within ¾" (20 mm) of the mirror face.

2. **Surveyor's Level and Target Rod**
   Use a level and leveling rod with a vernier target that can be read to 1/50" (0.5 mm). Determine deflections by readings on the two fixed independent benchmarks, and on an established scale or fixed point on the pile top.

3. **Alternative Systems**
   Any other type of electrical or optical gage yielding a precision equivalent to the primary system is acceptable as an alternative, provided prior written approval is obtained from the D.C.E.S.

C. SETTLEMENT REFERENCE POINTS

Establish reference points on the test pile, at each end of the reference beam, and on each reaction pile (if used). Acceptable locations and materials are as follows:

1. **On the reference beam:** round-head bolt, or round bead of weld about 1/5" (5 mm) high
2. **On the test piles:** lug on the side about 1 in. (25 mm) from the top, or bead of weld on the steel billet
3. **On the reaction piles:** cut mark made by a hacksaw, or lug welded to the pile.

The Engineer will verify the elevation of these reference points with respect to the two fixed independent benchmarks.

D. SITE PROTECTION

Provide complete protection at all times for the pile supports and reference beam from wind, direct sunlight, frost action, and other disturbances. Also maintain a temperature of not less than 50° F (10° C) throughout the duration of the test and provide a thermometer to monitor temperature. To accomplish this, it may be necessary to provide heat and to construct a suitable test enclosure of fiber board, polyethylene, canvas, or other materials acceptable to the Engineer. Provide adequate lighting for the duration of the test.

III. REQUIREMENTS PRIOR TO TESTING

A. WAITING PERIOD

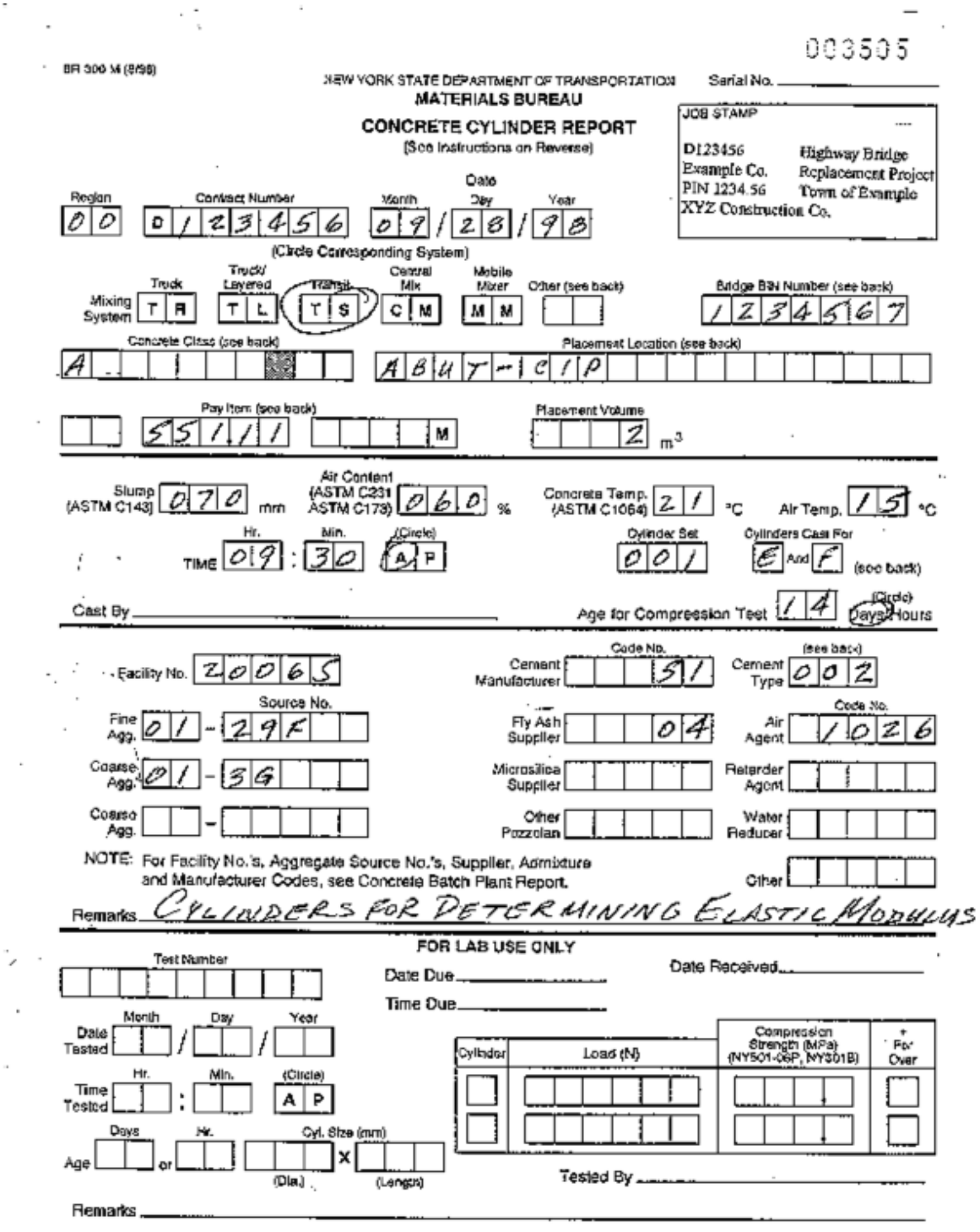
Observe a minimum waiting period of seven days (or as otherwise defined in the contract documents) between installing the last pile in the load test system and starting the test to account for both soil set-up and concrete curing. Completion of the set up of the load test system, using one of the reaction load methods described in Chapter I or an approved alternative, and set up of primary and auxiliary systems of measurement may be performed during this period.

B. CONTROL OF PILE HEAVE

Immediately after the test pile has been installed, establish the elevation of the pile top. Take all necessary precautions to prevent upward movement or rebound of the pile (pile heave) before the load test begins. Pile heave is caused by high pore pressures built up during driving, especially in fine-grained soils. To avoid heave, the pile may need to be weighted down until the excess pore pressure has dissipated sufficiently. When testing an empty cast-in-place pile, it may be advantageous to fill the pile with water to counteract the heave. The Contractor may wish to obtain pile top measurements during the waiting period to detect pile heave. In any case, a final pile top elevation must be determined before starting the load test. If this elevation differs by more than 1/5" (5 mm) from the pile-top elevation immediately after driving, suspend the load test and immediately notify the D.C.E.S. Corrective action may require the Contractor to re-drive the pile and provide an additional waiting period before the test, during which pile heave is restrained.

C. SPECIAL PROCEDURES FOR CAST-IN-PLACE PILES AND DRILLED SHAFTS

Fill cast-in-place piles (unless otherwise specified in the contract documents) or drilled shafts with concrete and observe a waiting period before load testing as described above in Chapter III A. Waiting Period. Three sets of concrete cylinders (1 set = 2 cylinders) must be cast in accordance with the Department's Materials Method 9.2 ("Field Inspection of Portland Cement Concrete"). Test in accordance with the "Early Open Sequence" designated on Form BR 300M (Fig. 15). Card 1 on this form should include the following statement under "Remarks": "Special Soils Requirement - Report Unit Weight." ("Early Open Sequence" and "Card 1" appear on the back of Form BR 300M.) These test results will be used to determine the modulus of elasticity of the concrete filling.



003505

BR 300 M (8/98)

NEW YORK STATE DEPARTMENT OF TRANSPORTATION Serial No. _____

MATERIALS BUREAU

CONCRETE CYLINDER REPORT

(See Instructions on Reverse)

JOB STAMP

D123456 Highway Bridge
Example Co. Replacement Project
PIN 1234.56 Town of Example
XYZ Construction Co.

Region: 00 | Contract Number: D123456 | Date: Month 09 / Day 28 / Year 98

(Circle Corresponding System)

Mixing System: Truck TR | Truck/Layered TL | Transit TS | Central Mix CM | Mobile Mixer MM | Other (see back)

Bridge BIN Number (see back): 1234567

Concrete Class (see back): A

Placement Location (see back): ABUT-1C1P

Pay Item (see back): 55111 M

Placement Volume: 2 m^3

Slump (ASTM C143): 070 mm

Air Content (ASTM C231 ASTM C173): 060 %

Concrete Temp. (ASTM C1064): 21 °C

Air Temp.: 15 °C

TIME: Hr. 09 : Min. 30 (Circle) A P

Cylinder Set: 001

Cylinders Cast For: E And F (see back)

Cast By _____

Age for Compression Test: 14 (Circle) Days Hours

Facility No.: 20065

Cement Manufacturer: Code No. 51

Cement Type: (see back) 002

Fine Agg.: 01 – Source No. 29F

Coarse Agg.: 01 – 36

Coarse Agg.: –

Fly Ash Supplier: 04

Air Agent: Code No. 1026

Microsilica Supplier:

Retarder Agent:

Other Pozzolan:

Water Reducer:

NOTE: For Facility No.'s, Aggregate Source No.'s, Supplier, Admixture and Manufacturer Codes, see Concrete Batch Plant Report.

Other:

Remarks: CYLINDERS FOR DETERMINING ELASTIC MODULUS

FOR LAB USE ONLY

Test Number:

Date Due: _____ Date Received: _____

Time Due: _____

Date Tested: Month / Day / Year

Time Tested: Hr. : Min. (Circle) A P

Age: Days or Hr.

Cyl. Size (mm): (Dia.) X (Length)

Cylinder	Load (N)	Compression Strength (MPa) (NY501-06P, NY301B)	+ For Over

Tested By _____

Remarks _____

Figure 15 - Typical Concrete Report

D. SPECIAL PROCEDURE FOR MICROPILES

Fill micropiles with grout and observe a waiting period before load testing as described above in Chapter III A. Waiting Period. Three compression cubes of grout must be cast in accordance with the Department's Materials Method 701-19E ("Grout Cube Molding Procedure"). Test in accordance with the sequence designated on Form BR 240a (Fig. 16) in Box 16 Additional Information.


BR 240a (11/74) SAMPLE AND ACCEPTANCE TRANSMITTAL NYSDOT MATERIALS BUREAU

SERIAL NO. 251077 | DATE REC'D 10/3/05 | TEST NO. 05 CU 90

To:

Material Represented by the Sample Described Below Was

On For

(Action Official Only When Validated Below By The Materials Bureau)

UPPER PORTION FOR MATERIALS BUREAU ONLY — INSPECTOR TO COMPLETE ALL APPLICABLE BOXES BELOW

16. ADDITIONAL INFO. (SEE INSTRUCTIONS ON REAR)
West Bound.
END Abutment.
Piles #14 thru #19
5000 PSI —
7 days & 28 Days.
RETAIN PINK COPY FOR YOUR RECORDS
FORWARD ALL OTHERS TO MATERIALS BUREAU

1. MATERIAL: No Shrink grout | 2. ITEM NO. | 3. DATE SAMPLED: 9/26/05 | 4. CONTRACT NO.: D259723

5. SUPPLIER AND LOCATION | 7. QUANTITY IN LOT: 2 Sets | 7. LOT NO.: Set #1

8. MANUFACTURER AND LOCATION (IF DIFFERENT THAN ABOVE) | 9. BATCH NO.: 1:30 PM. | 10. DATE OF MFGR.

11. SAMPLED AT: ☐ MILL ☐ PLANT ☐ JOB

12. TYPE: ☐ CONTROL SAMPLE ☐ INFO. SAMPLE ☐ BPR SAMPLE ☐ APPROVED LIST MAT. ☐ CERTIFIED MAT.

13. SAMPLED FROM: Grout Pump.

14. SAMPLED BY (INC. DIST. NO. OR AGENCY): TMLeonard-L#1

15. CONTRACTOR AND PROJECT LOCATION: Lancaster Development +90 Phase II

MATERIALS BUREAU VALIDATION

Figure 16 - Typical Grout Cube Report

IV. PILE AND STATIC PILE LOAD TEST CRITERION

A. PILE FAILURE CRITERIA

Pile failure is identified by a failure load. The failure load is defined as that load at which:

1. The load vs. gross deflection curve reaches a slope of 1/32" per kip of applied load (0.15 mm per kN of applied load), or
2. Criteria specified in the contract documents.

In addition, for driven piles only:

3. Top deflection equal to B/60 + PL/AE, where:
   B is the pile diameter or width (in. (mm)),
   P is load (kips (kN)),
   L is length (in. (mm)),
   A is cross-section (in^2 (mm^2)), and
   E is modulus of elasticity (ksi (GPa)).

B. STATIC PILE LOAD TEST ACCEPTANCE CRITERIA

The acceptance of a Static Pile Load Test will be based on the following:

1. The pile was installed in accordance with its respective specification,
2. The pile was tested in accordance with the test procedures contained in this manual,
3. Telltale readings validate that no load was transferred to the soil in the bond breaker length (when a bond breaker is specified),
4. The acceptable test pile meets any other criteria indicated in the contract documents, and
5. All reports and certifications have been submitted as outlined in Chapter VIII. Reports and Certifications.

For Contractor designed micropiles, acceptance of a Static Pile Load Test also requires that the micropile was loaded and unloaded successfully to a minimum of two times the micropile design load without attaining the failure criteria.

V. PROCEDURE FOR THE QUICK LOAD TEST

Perform one or more quick load tests, as specified in the contract documents, to determine the capacity of the pile-soil system. All provisions of Chapters I, II, and III, IV and VIII apply to this test method.

A. TEST PROCEDURE

Load the pile in increments until failure occurs, as defined in Chapter IV. A. Failure Criteria, or the capacity of the test equipment (minimum of four times design load) is reached.

Magnitude and sequence of load increments are as follows:

Cycle	Percent of Maximum Design Load
1	0, 20, 40, 60, 80, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200 (10-min hold), 175, 150, 125, 100, 75, 50, 25, 0 (1-hr final rebound)
2	0, 20, 40, 60, 80, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250…Up to Failure Criteria…, 250, 225, 200, 175, 150, 125, 100, 75, 50, 25, 0

Maintain each load increment for 5 minutes (Cycle 1). Maintain the 200 percent of the design load for 10 minutes. Maintain the rebound loads for 1 minute.

After removing the total applied load, reapply the load at the same initial increments and time intervals (Cycle 2). Continue loading the pile until failure occurs, as defined in Chapter IV. A. Failure Criteria, or capacity of the test equipment (minimum of four times design load) is reached. After completing this procedure, remove the load in decrements as stated above.

B. DATA COLLECTION

Before starting the test, record all initial readings and establish the elevations of the settlement reference points. Read and record information on the time-settlement data sheet (See Fig. 21 Example Time Settlement Data Sheet: Quick Test) supplied by the Engineer, as follows:

1. **Top Deflection Measurement**
   Read movement to the nearest 50 μm immediately before and after application of each load increment or decrement. Additionally, take readings at ½, 1, 2, and 5 minutes. While maintaining the 200 percent of the design load, take readings at ½, 1, 2, 5, and 10 minutes.

Measure the pile's final rebound after it has remained at zero load for 1 hour.

2. Telltale Strain Indicators

Read movement to the nearest 50 μm immediately before and after application of each load increment or decrement.

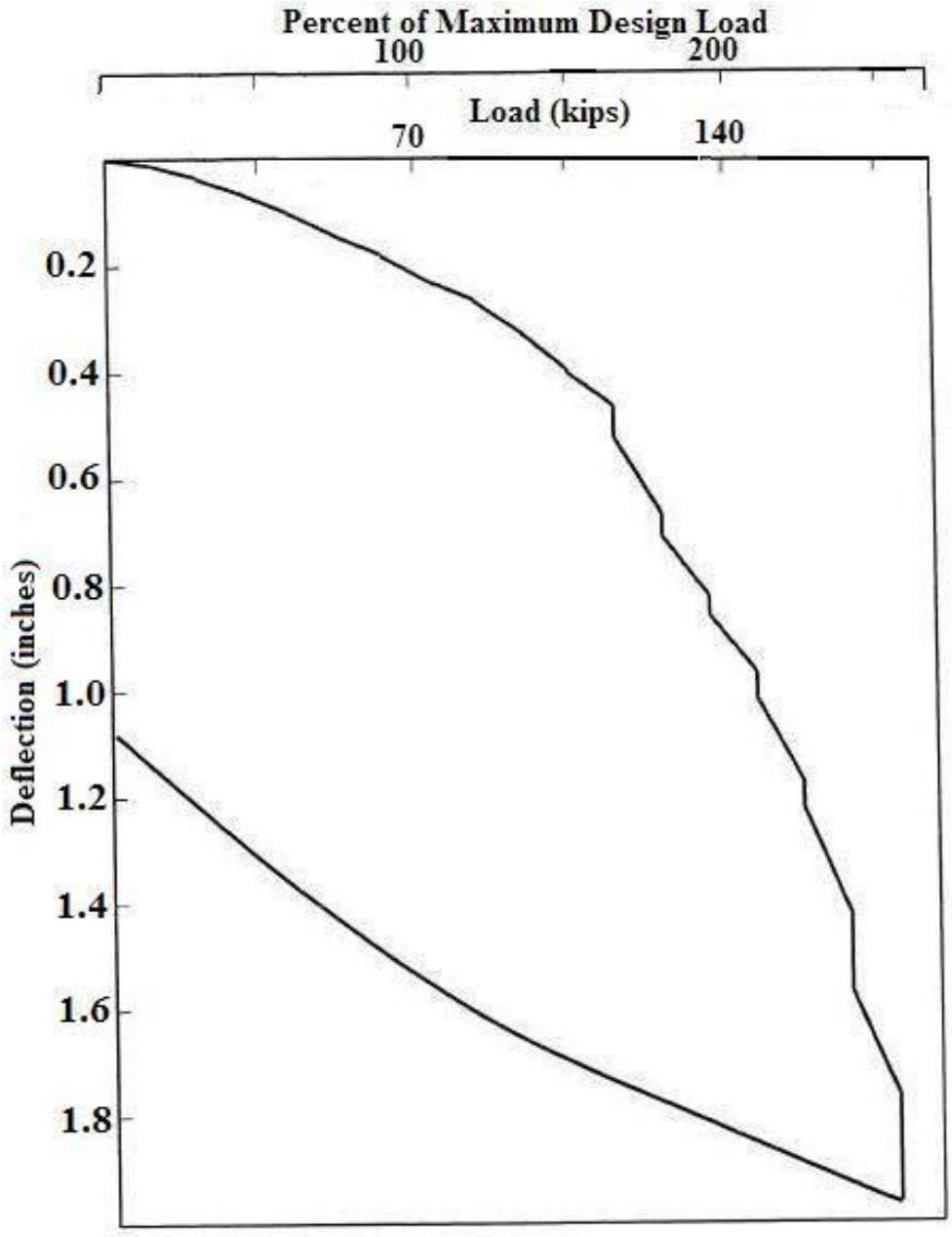


Figure 17(a) - Typical Load vs. Deflection Plot for Quick Test (*US Customary Units*)

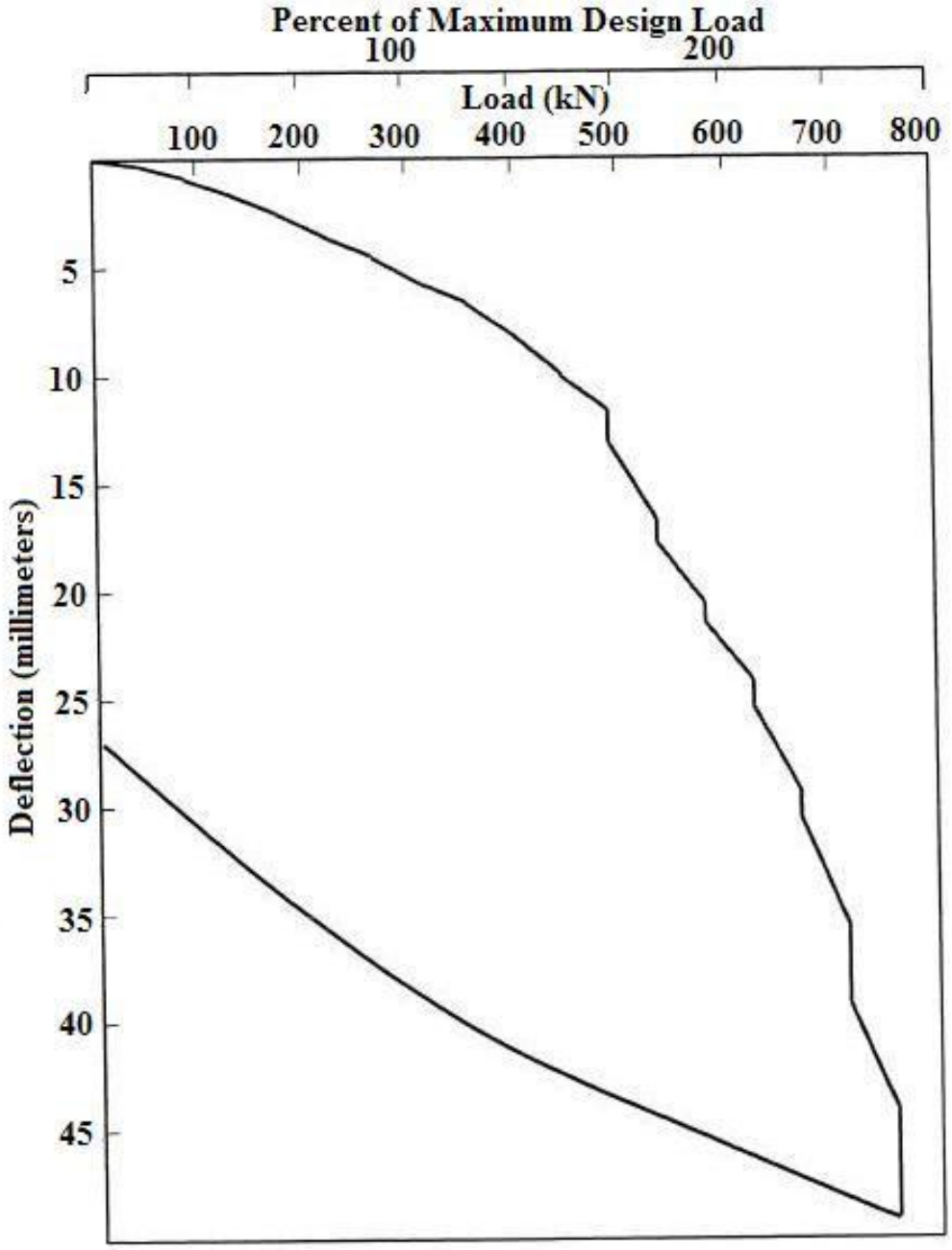


Figure 17 (b) Typical Load vs. Deflection Plot for Quick Test (*International System of Units*)

3. Auxiliary Systems

a. Wire, Mirror, and Scale

Read to the nearest 1/5" (0.5 mm) immediately before and after each fifth (5^{th}) load increment or decrement, by visually aligning the top of the wire with both its reflection in the mirror and the scale mounted on the mirror.

b. Rod and Level

Read to the nearest 1/5" (0.5 mm) immediately before, and as soon as possible after, each tenth (10^{th}) load increment or decrement.

C. SETTLEMENT REFERENCE POINTS

Check settlement to a precision of 1/5" (0.5 mm) on the reference points described in Chapter II, at a minimum as follows:

1. Immediately before the test,
2. Immediately before rebounding from 200 percent of the design load,
3. After the final rebound reading of Cycle 1, and
4. At the end of test.

If readings on the reference points vary by more than 1/12" (2 mm) from their initial values, or if a reading on the pile head varies by more than 1/12" (2 mm) from the settlement shown by the primary system, set up the level in another location and check the elevations. Continue this procedure until two sets of consistent level readings are obtained. If these two sets still differ by more than 1/12" (2 mm) from either initial readings on the reference beam, or primary system readings for the point on the test pile, halt the test until the discrepancy has been explained and adjusted.

If discrepancies occur as described in the preceding paragraph, the Engineer will halt the test and notify the D.C.E.S. The test may not resume until the system(s) are corrected to the satisfaction of the D.C.E.S. If, in the opinion of the D.C.E.S., these discrepancies have impaired the value of the test in progress, start the test again. No additional payment will be made for correcting the settlement-measuring system(s), or for portions of any load test unacceptable to the D.C.E.S.

VI. PROCEDURE FOR THE INCREMENTAL STATIC LOAD TEST

Perform one or more incremental static load tests, as specified in the contract documents, to determine load-deflection relationships and load distribution. All provisions of Chapters I, II, III, IV and VIII apply to this test method.

A. TEST PROCEDURE

Load and unload the test pile incrementally in three cycles, unless an alternative procedure is specified in the contract documents. Apply each load increment to the pile in as short a period as physically possible. The maximum load applied is twice the pile design load indicated in the contract documents unless failure, as defined in Chapter IV. A. Failure Criteria, occurs first. The required load increments are expressed as a percentage of the pile design load indicated in the contract documents. Magnitude and sequence of load increments for the three loading cycles are as follows:

Cycle	Percent of Maximum Design Load
1	0, 50, 100, 50, 0
2	0, 50, 100, 125, 150, 175, 200, 150, 100, 50, 0
3	0, 50, 100, 150, 200 (24-hr hold), 150, 100, 50, 0

Maintain each load increment until the deflection rate under the applied load, or rate of rebound from the previous load increment, is less than 50 μm in 15 minutes. The minimum period for maintaining a load increment, however, is 30 minutes and an increment may be removed after having been maintained for 2 hours, regardless of rate of deflection or rebound. When 200 percent of the design load has been applied during Cycle 3, provided the pile has not failed, leave this load in place for 24 hours. When the pile has rebounded to zero load at the end of Cycle 3, maintain zero load at least 1 hour. Maintain each load constant and note any adjustments to the jack in the "Remarks" column on the Time-Settlement Data Sheet.

If the pile fails before application of the 200-percent load, rebound it to zero load as specified in the table above. The Engineer will immediately notify the D.C.E.S. and give all pertinent details of the load test. The D.C.E.S. will notify the Engineer within one working day whether Cycle 3 is required, and to what maximum load the pile is to be reloaded for Cycle 3 of the loading sequence. The D.C.E.S. will notify the Engineer within two days as to the need for an additional load test if Cycle 3 of the loading procedure is canceled.

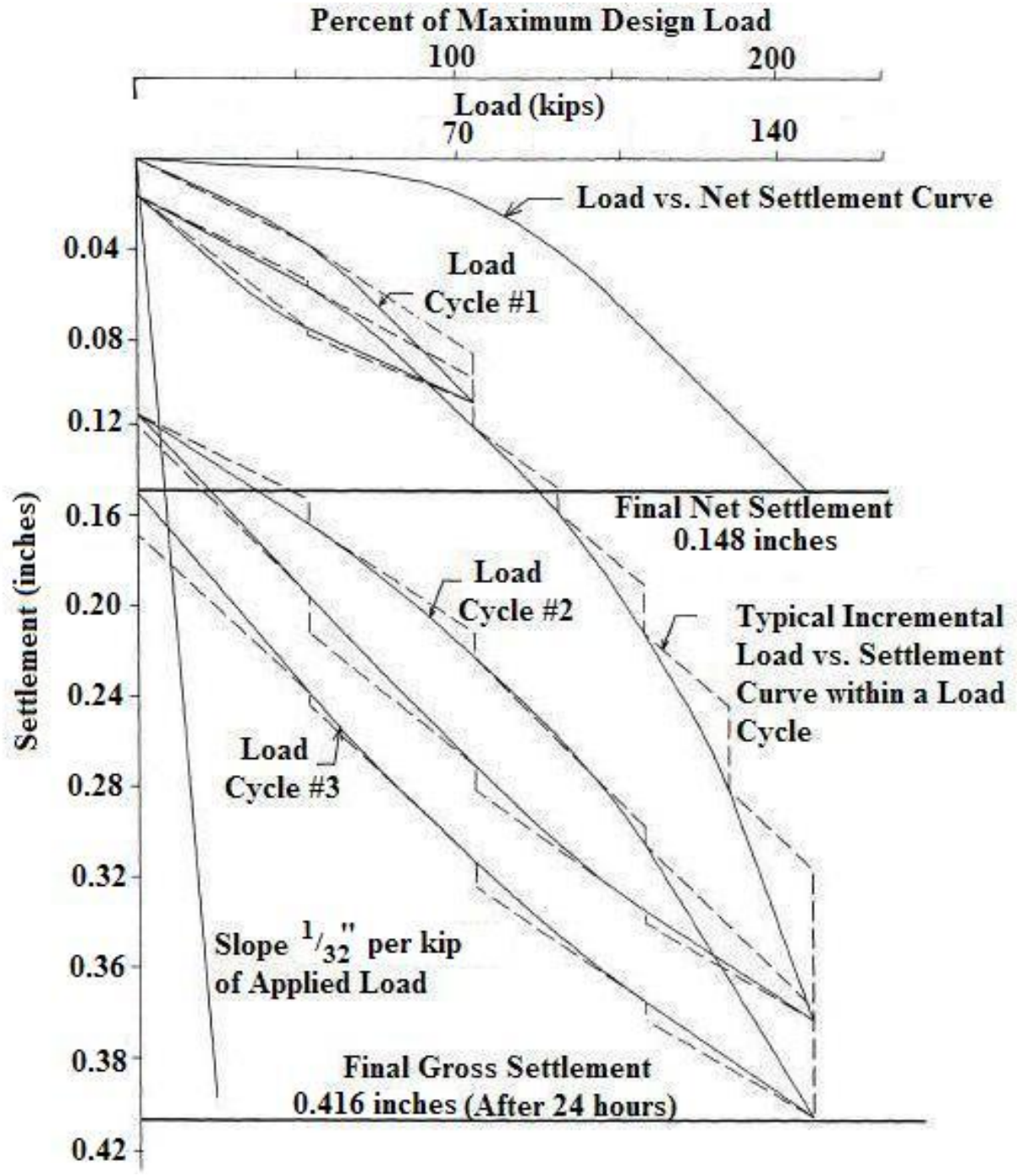


Figure 18 (a) Typical Load vs. Deflection Plot for Incremental Static Load Test (*US Customary Units*)

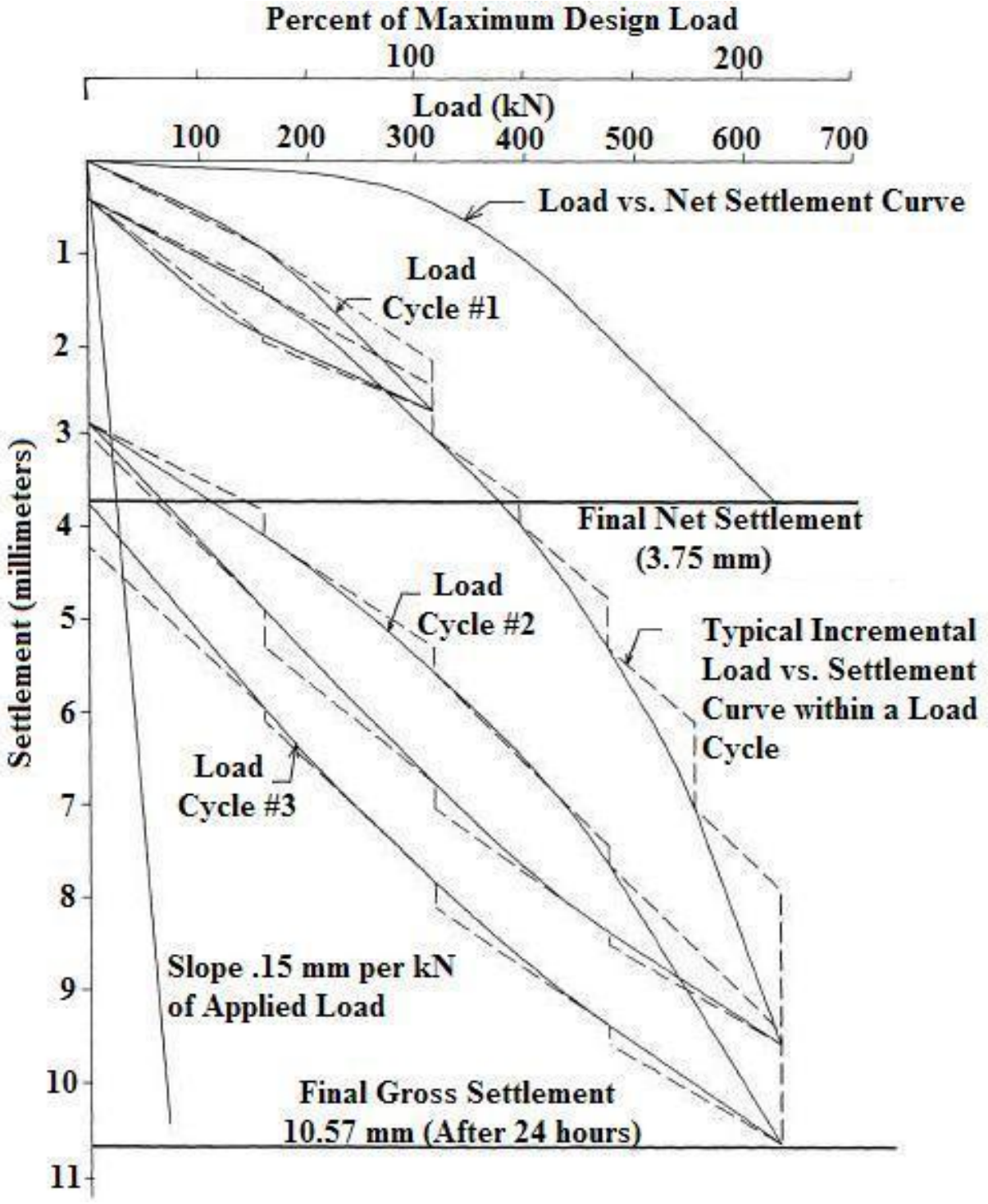


Figure 18 (b) Typical Load vs. Deflection Plot for Incremental Static Load Test (*International System of Units*)

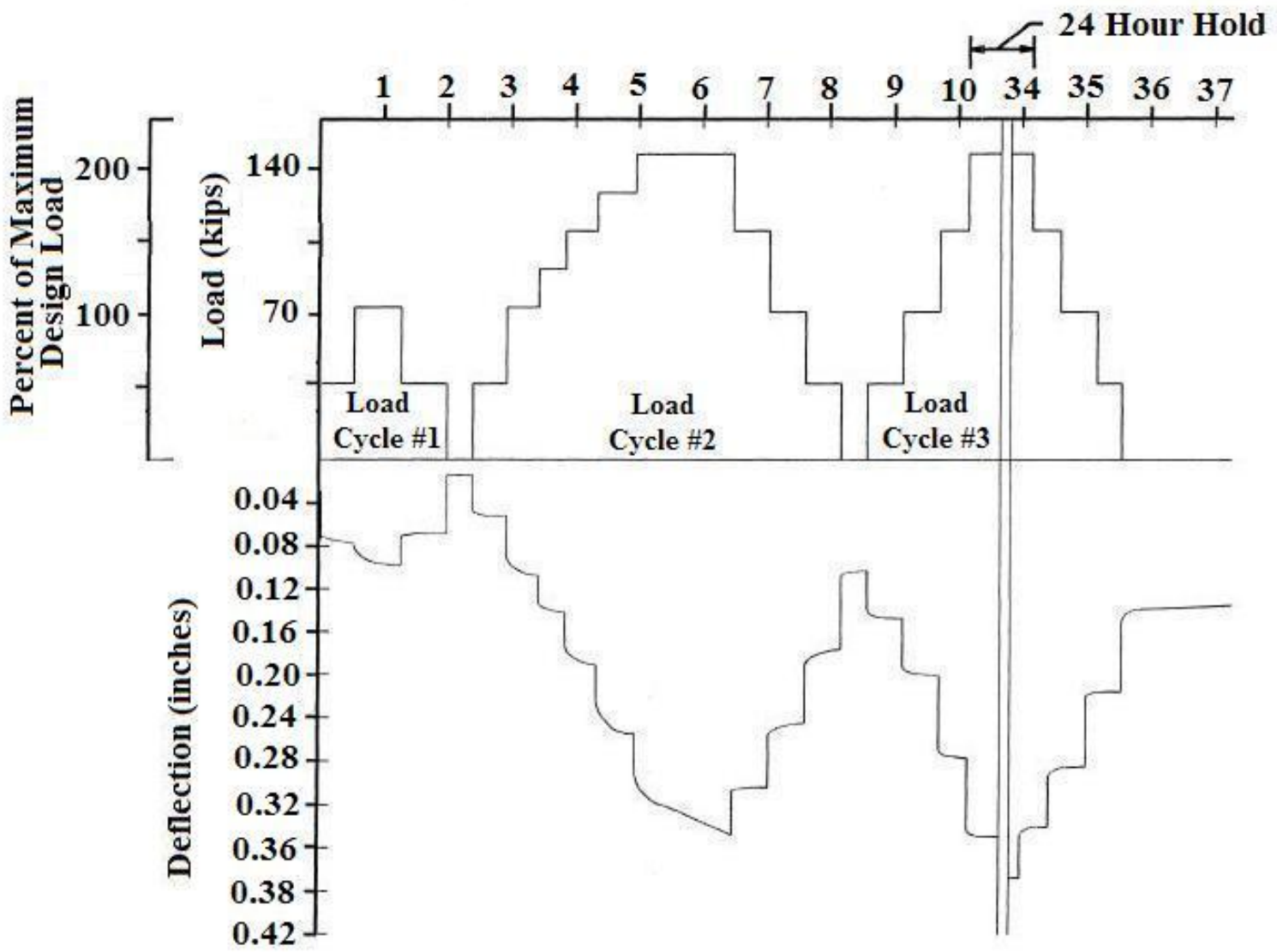


Figure 19 (a) Typical Load-Deflection vs. Time Plot for Incremental Static Load Test (*US Customary Units*)

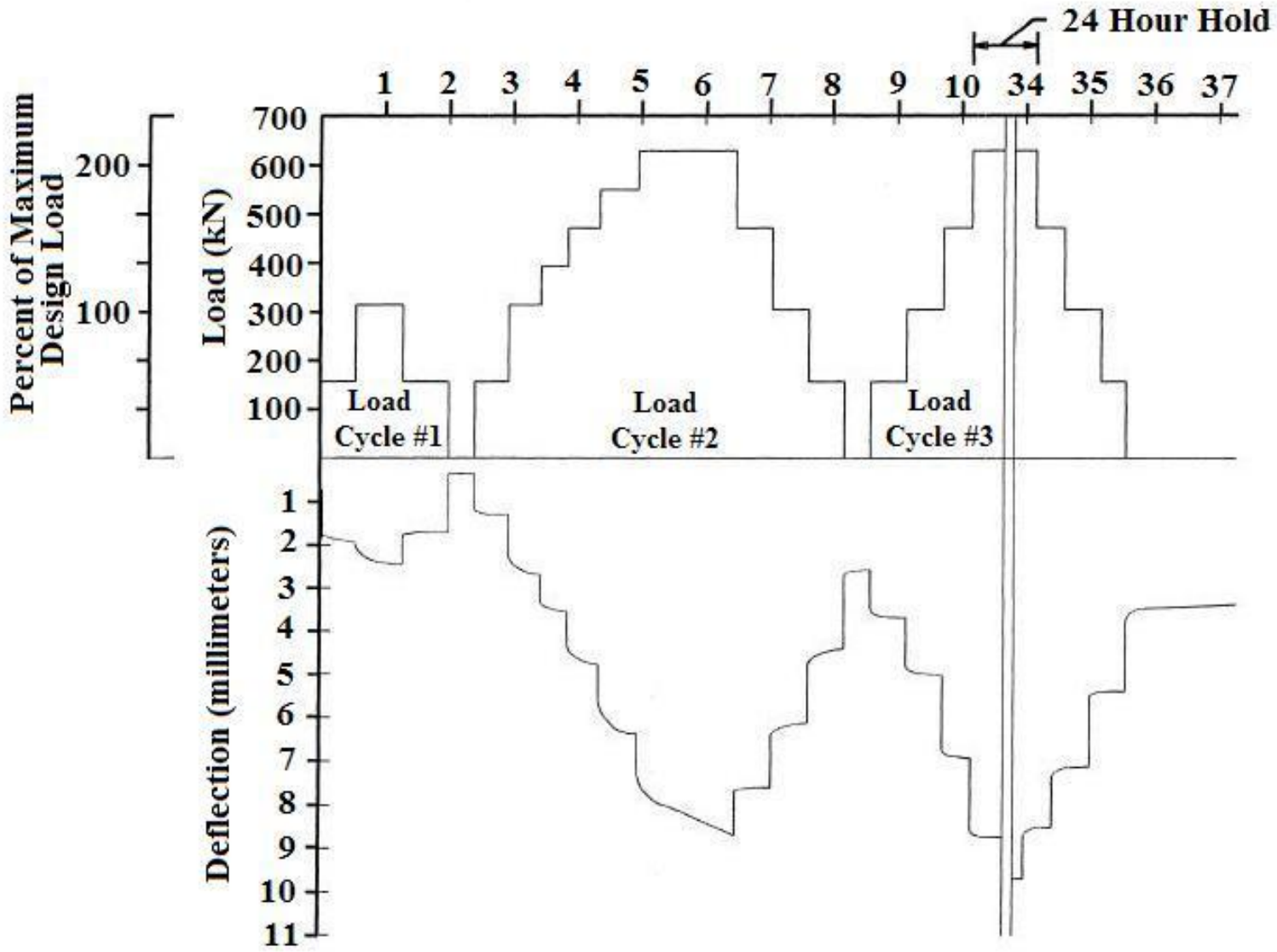


Figure 19 (b) Typical Load-Deflection vs. Time Plot for Incremental Static Load Test (*International System of Units*)

B. DATA COLLECTION

Before starting the test, record all initial readings and establish the elevations of the settlement reference points. Read and record information on the time-settlement data sheet (See Fig. 22 Example Time Settlement Data Sheet: Incremental Static Load Test) supplied by the Engineer, as follows:

1. **Top Deflection Measurement**
   Read movement to the nearest 50 μm before and after each new load increment or decrement. Take readings at ½, 1, 2, 4, 8, 15, and 30 minutes, and at 15-minute intervals thereafter for 2 hours or until the next increment is applied or removed. However, during the 24-hour hold of the 200-percent load, take readings every 3 hours after the first 2 hours of readings.

2. **Telltale Strain Indicators**
   Read movement to the nearest 50 μm before and after each load increment or decrement. During the 24-hour hold, read the telltale immediately after the load is applied, 2 hours later, and every 3 hours thereafter until the load is removed.

3. **Auxiliary Systems**

   a. Wire, Mirror, and Scale
   Read to the nearest 1/5" (0.5 mm) before and after each load increment or decrement, by visually aligning the top of the wire with both its reflection in the mirror and the scale mounted on the mirror.

   b. Rod and Level
   Read to the nearest 1/5" (0.5 mm) immediately before, and as soon as possible after, each load increment or decrement.

4. **Load Readings**
   Take load readings (in kips (kN)) from both the pressure gage on the jack and from the load cell, and record them in the appropriate columns on the Time-Settlement Data Sheet (See Fig. 22 Example Time Settlement Data Sheet: Incremental Static Load Test). Take readings before and after each load increment or decrement. During the 24-hour hold, take a reading after the load is applied, 2 hours later, and then every 3 hours until the load is removed. Any load adjustments should be noted in the "Remarks" column.

C. SETTLEMENT REFERENCE POINTS

Check settlement to a precision of 1/5" (0.5 mm) on the reference points described in Chapter II, at a minimum as follows:

1. Immediately before the test,
2. Immediately before rebounding from 100 percent of the design load (all cycles),
3. Immediately before rebounding from 200 percent of the design load (both cycles), and
4. At the end of test, after the final rebound reading.

If readings on the reference points vary by more than 1/12" (2 mm) from their initial values, or if a reading on the pile head varies by more than 1/12" (2 mm) from the settlement shown by the primary system, set up the level in another location and check the elevations. Continue this procedure until two sets of consistent level readings are obtained. If these two sets still differ by more than 1/12" (2 mm) from either initial readings on the reference beam, or primary system readings for the point on the test pile, halt the test until the discrepancy has been explained and adjusted.

If discrepancies occur as described in the preceding paragraph, the Engineer will halt the test and notify the D.C.E.S. The test may not resume until the system(s) are corrected to the satisfaction of the D.C.E.S. If, in the opinion of the D.C.E.S., these discrepancies have impaired the value of the test in progress, start the test again. No additional payment will be made for correcting the settlement-measuring system(s), or for portions of any load test unacceptable to the D.C.E.S.

VII. PROCEDURE FOR THE CONSTANT RATE OF PENETRATION TEST

Perform one or more constant rate of penetration tests, as specified in the contract documents, to determine the capacity of the pile-soil system. All provisions of Chapters I, II, III, IV and VIII also apply to this test method.

A. TEST PROCEDURE

Load the pile until failure occurs, as defined in Chapter IV. A. Failure Criteria, or the capacity of the test equipment (minimum of four times design load) is reached. Apply the load so that the pile top exhibits constant rate of deflection with time. Control the rate by monitoring one of the primary measuring systems at 15-second intervals. Rate of pile deflection η (in inches per minute (millimeters per minute)) is determined by the following relationship:

$$\eta = \lambda\ (PL/AE)$$

where λ = a soil constant (0.1 for cohesionless soils, 0.04 for cohesive soils, or as specified by the DCES) 1/minute,
P = pile design load, kips (kN) (as shown on the plans),
L = pile length, in. (mm)
A = pile area, (in^2 (mm^2)), and
E = pile modulus of elasticity, (ksi (GPa)).

B. DATA COLLECTION

Record readings on all dial gages, the load cell, and the pressure gage for the jack at 1-minute intervals, on the Time-Settlement Data Sheet (See Fig. 23 Example Time Settlement Data Sheet: Constant Rate of Penetration Test). At some point in the test, a minimal increase in load will stabilize the deflection rate; this point indicates approaching failure of the pile-soil system. Once this load is achieved, continue the test at the same rate η for 15 minutes, after which the rate is to be increased to 5η for another 5 minutes.

After completing this procedure, remove the load in decrements of 25 percent of the final load achieved. Maintain the rebound loads for 1 minute, and read and record all the primary measuring systems immediately before removing the next load decrement. Measure the pile's final rebound after it has remained at zero load for 1 hour.

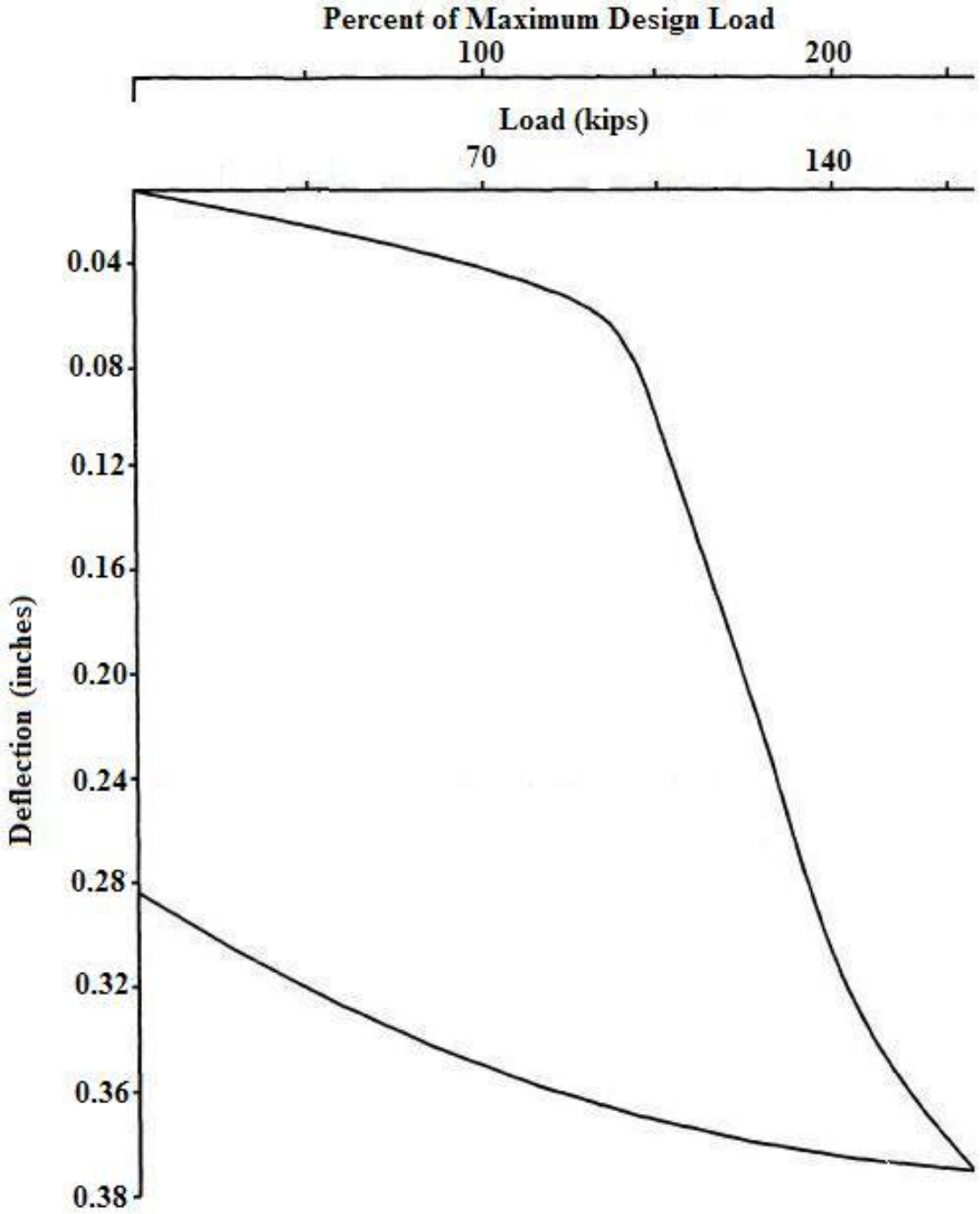


Figure 20 (a) Typical Load vs. Deflection Plot for Constant Rate of Penetration Test (*US Customary Units*)

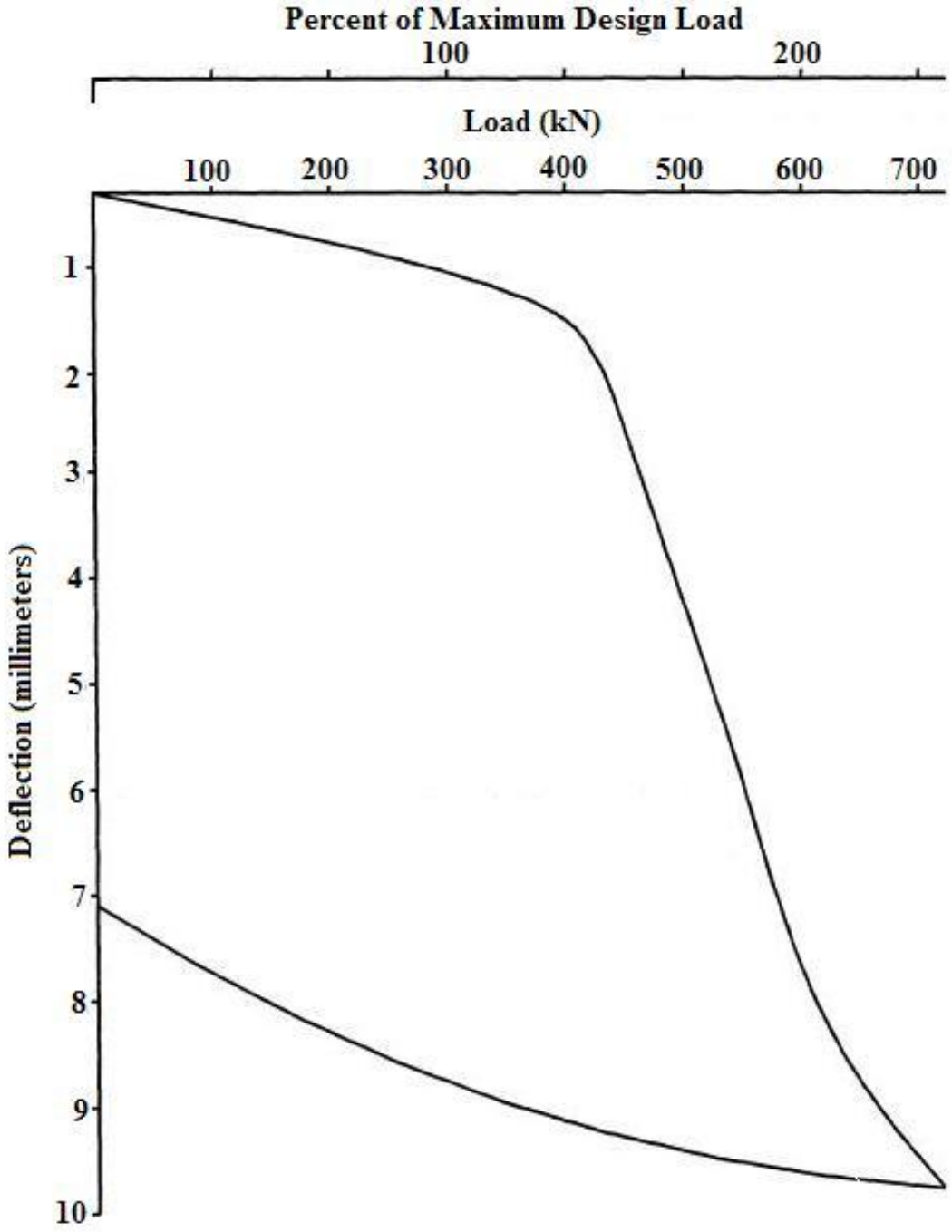


Figure 20 (b) Typical Load vs. Deflection Plot for Constant Rate of Penetration Test (*International System of Units*)

C. SETTLEMENT REFERENCE POINTS

Check settlement to a precision of 1/5" (0.5 mm) on the reference points described in Chapter II, at a minimum as follows:

1. Immediately before the test, and
2. At the end of test, after the final rebound reading.

If readings on the reference points vary by more than 1/12" (2 mm) from their initial values, or if a reading on the pile head varies by more than 1/12" (2 mm) from the settlement shown by the primary system, set up the level in another location and check the elevations. Continue this procedure until two sets of consistent level readings are obtained. If these two sets still differ by more than 1/12" (2 mm) from either initial readings on the reference beam, or primary system readings for the point on the test pile, halt the test until the discrepancy has been explained and adjusted.

If discrepancies occur as described in the preceding paragraph, the Engineer will halt the test and notify the D.C.E.S. The test may not resume until the system(s) are corrected to the satisfaction of the D.C.E.S. If, in the opinion of the D.C.E.S., these discrepancies have impaired the value of the test in progress, start the test again. No additional payment will be made for correcting the settlement-measuring system(s), or for portions of any load test unacceptable to the D.C.E.S.

VIII. REPORTS AND CERTIFICATION

Pile load tests require the following documentation:

A. Pre-installation report,
B. Post-installation report,
C. Certification of the loading system, and
D. Final report.

A. PRE-INSTALLATION REPORT

Submit this report to the Engineer for review and approval by the D.C.E.S. The D.C.E.S. requires 20 work days for review. After the D.C.E.S. has approved details of this report in writing, the test pile may be installed.

The pre-installation report shall include the following:

1. The names of three projects for which the Contractor's or subcontractor's Professional Engineer executing the test has successfully performed static pile load tests within the past five years,
2. Type and amount of dead-load reaction, or size and description of the reaction frame and location of reaction piles, including the Professional Engineer's stamp and signature on all design documents,
3. Method of supporting the reference beam and measuring devices, showing distances from the test pile and anchor piles or supports, or a reaction and its height above ground, and
4. Capacity of pressure gages and hydraulic jacks.

B. POST-INSTALLATION REPORT

This report includes items to be transmitted to the Engineer and included in the final report. The Engineer also transmits the following information to the D.C.E.S. before beginning the pile load test:

For all foundations:

1. Embedded length of pile
2. Length of pile tested

For driven foundations:

1. Test pile driving or re-driving records, including blows per foot (blows per decimeter) throughout the length driven and final driving resistance in blows per inch (blows per decimeter) for the last 2 ft. (0.6 m) of driving.
2. Actual rate of hammer operation during test pile driving.
3. Methods employed by the contractor to prevent pile rebound immediately after driving

For non-driven foundations

1. Actual or estimated cross-section of the column.
2. A copy of the inspector's report of the installation.

C. CERTIFICATION OF THE LOADING SYSTEM

Calibrate the hydraulic system, jack(s), pressure gage(s) and load cell within 14 days prior to starting the test. Calibration includes readings for loading and unloading. Loading system accuracy must be within 5 percent of the load applied. The Contractor submits calibration data to the D.C.E.S. before any load testing, including a copy of the jack certification and load calibration curve in the final report.

No re-calibration of these elements is required for more than one load test on the same project, provided that the following conditions are satisfied:

1. Equipment that has been calibrated and approved is not removed from the project for use elsewhere until all load tests are completed,
2. The calibrated equipment is carefully stored and properly maintained between tests in a manner approved by Engineer,
3. The calibrated equipment is secure and unaltered while awaiting use on a specific project,
4. The period between load tests using the approved calibrated equipment on the same project does not exceed one month, and
5. Readouts are determined to be within the required accuracy criteria.

Acceptance of the calibration data is necessary prior to performing the tests.

D. FINAL REPORT

Prepare a final report for each load test containing the following information:

1. Identification of the test pile,
2. A description of the test apparatus and the loading and deflection-measurement procedures used,
3. A copy of the time-settlement data collection sheet. See Fig.'s 21, 22 & 23 for typical completed forms,
4. A graphic representation of test results in the form of load-deflection curves (Fig.'s 17, 18 & 20), including gross and net settlement of top and telltales. Include curves for load-deflection vs. time (Fig. 19) so that elastic properties of the supporting soils may be determined,
5. Remarks concerning any unusual events or damage to the pile during driving or load testing,

6. Miscellaneous data, including;

- **a.** Structure for which piles are to be installed,
- **b.** Maximum pile design load shown on the plans,
- **c.** Date pile was installed,
- **d.** Copy of the pile-driving record,
- **e.** Dates of pile testing,
- **f.** Copy of Form BR 300M (Fig. 15) or BR 240a (Fig. 16), if required,
- **g.** Report on calibration of jack(s) and gage(s),
- **h.** Plot of jack calibration results,
- **i.** Elevation of ground water during test, if possible,
- **j.** Description of soil, based on the boring log of the nearest drill hole, and
- **k.** Records of level readings, taken as previously described in connection with settlement reference points.

Upon completion, forward three copies to the Engineer. Upon receipt by the D.C.E.S. for analysis, fifteen (15) work days will be allowed for review, after which the D.C.E.S. will forward findings to the Engineer. If the static pile load test results in a failure (as previously defined) at a load less than twice the design load, a final report is still required; in that event the D.C.E.S. may order an additional static pile load test.

GE 380 (7/03) **PILE LOAD TEST**

TIME SETTLEMENT DATA SHEET

JOB STAMP

D123456 Highway Bridge
Example Co. Replacement Project
PIN 1234.56 Town of Example
XYZ Construction Co.

BRIDGE DESIGNATION *BRIDGE NO. 12* DATE *4/30/98*

LOCATION *SOUTH ABUTMENT* PREPARED BY *S.W.C.*

PILE NO. *164* COMPUTED BY *J.W.P.*

PILE LOAD TEST NO. *1 QUICK TEST* CHECKED BY *R.W.G.*

PILE TIP ELEVATION *931.2 ft.*

ELAPSED TIME	READ TIME	JACK GAGE READ (psi)	JACK LOAD (kips)	LOAD CELL READ	LOAD CELL (kips)	DIAL READINGS -(in)			MEAN	DEFL.	TELL TALES-(in)				REMARKS
						A	B	C			READ	DEFL.	READ	DEFL	
10:46:00	*00:00.0*	*0*	*0*	*0*	*0*	*0.181*	*0.303*	*0.157*	*0.214*	*0.0*	*0.571*	*0.000*			
10:47:00	*00:00.0*	*928*	*46*	*51*	*45*	*0.268*	*0.390*	*0.240*	*0.299*	*0.087*	*0.575*	*0.004*			
10:47:30	*00:30.0*	*928*	*46*	*51*	*45*	*0.268*	*0.390*	*0.240*	*0.299*	*0.087*	*0.575*	*0.004*			
10:48:00	*01:00.0*	*928*	*46*	*51*	*45*	*0.268*	*0.390*	*0.240*	*0.299*	*0.087*	*0.575*	*0.004*			
10:49:00	*02:00.0*	*928*	*46*	*51*	*45*	*0.268*	*0.390*	*0.240*	*0.299*	*0.087*	*0.575*	*0.004*			
10:52:00	*05:00.0*	*928*	*46*	*51*	*45*	*0.268*	*0.390*	*0.240*	*0.299*	*0.087*	*0.575*	*0.004*			
															Load to 67 kips
10:53:00	*00:00.0*	*1441*	*71*	*76*	*67*	*0.295*	*0.413*	*0.264*	*0.324*	*0.110*	*0.579*	*0.008*			
10:53:30	*00:30.0*	*1441*	*71*	*76*	*67*	*0.295*	*0.413*	*0.264*	*0.324*	*0.110*	*0.579*	*0.008*			
10:54:00	*01:00.0*	*1441*	*71*	*76*	*67*	*0.295*	*0.413*	*0.264*	*0.324*	*0.110*	*0.579*	*0.008*			
10:55:00	*02:00.0*	*1441*	*71*	*76*	*67*	*0.295*	*0.413*	*0.264*	*0.324*	*0.110*	*0.579*	*0.008*			
10:58:00	*05:00.0*	*1441*	*71*	*76*	*67*	*0.295*	*0.413*	*0.264*	*0.324*	*0.110*	*0.579*	*0.008*			
															Load to 90 kips
10:59:00	*00:00.0*	*1813*	*99*	*102*	*90*	*0.350*	*0.469*	*0.319*	*0.379*	*0.165*	*0.587*	*0.016*			
10:59:30	*00:30.0*	*1813*	*99*	*102*	*90*	*0.350*	*0.469*	*0.319*	*0.379*	*0.165*	*0.587*	*0.016*			
11:00:00	*01:00.0*	*1813*	*99*	*102*	*90*	*0.350*	*0.469*	*0.319*	*0.379*	*0.165*	*0.587*	*0.016*			
11:01:00	*02:00.0*	*1813*	*99*	*102*	*90*	*0.350*	*0.469*	*0.319*	*0.379*	*0.165*	*0.587*	*0.016*			
11:04:00	*05:00.0*	*1813*	*99*	*102*	*90*	*0.350*	*0.469*	*0.319*	*0.379*	*0.165*	*0.587*	*0.016*			
															Load to 112 kips
11:05:00	*00:00.0*	*2277*	*113*	*127*	*112*	*0.386*	*0.504*	*0.354*	*0.415*	*0.201*	*0.594*	*0.024*			
11:05:30	*00:30.0*	*2277*	*113*	*127*	*112*	*0.386*	*0.504*	*0.354*	*0.415*	*0.201*	*0.594*	*0.024*			
11:06:00	*01:00.0*	*2277*	*113*	*127*	*112*	*0.386*	*0.504*	*0.354*	*0.415*	*0.201*	*0.594*	*0.024*			
11:07:00	*02:00.0*	*2277*	*113*	*127*	*112*	*0.386*	*0.504*	*0.354*	*0.415*	*0.201*	*0.594*	*0.024*			
11:10:00	*05:00.0*	*2277*	*113*	*127*	*112*	*0.386*	*0.504*	*0.354*	*0.415*	*0.201*	*0.594*	*0.024*			
															Past the design load increase by 12 kips
11:11:00	*00:00.0*	*2452*	*122*	*140*	*124*	*0.413*	*0.531*	*0.382*	*0.442*	*0.228*	*0.602*	*0.031*			*Load to 124 kips*

Figure 21a Portion of an Example Time Settlement Data Sheet: Quick Test (*US Customary Units*)

GE 380 (7/03) **PILE LOAD TEST**

TIME SETTLEMENT DATA SHEET

JOB STAMP

D123456 Highway Bridge
Example Co. Replacement Project
PIN 1234.56 Town of Example
XYZ Construction Co.

BRIDGE DESIGNATION *BRIDGE NO. 12* DATE *4/30/98*

LOCATION *SOUTH ABUTMENT* PREPARED BY *S.W.C.*

PILE NO. *164* COMPUTED BY *J.W.P.*

PILE LOAD TEST NO. *1 QUICK TEST* CHECKED BY *R.W.G.*

PILE TIP ELEVATION *283.9 m*

ELAPSED TIME	READ TIME	JACK GAGE READ (kPa)	JACK LOAD (kN)	LOAD CELL READ	LOAD CELL (kN)	DIAL READINGS -(mm)			MEAN	DEFL.	TELL TALES-(mm)				REMARKS
						A	B	C			READ	DEFL.	READ	DEFL	
10:46:00	*00:00.0*	*0*	*0*	*0*	*0*	*4.6*	*7.7*	*4.0*	*5.4*	*0.0*	*14.5*	*0.0*			
10:47:00	*00:00.0*	*6400*	*205*	*227*	*200*	*6.8*	*9.9*	*6.1*	*7.6*	*2.2*	*14.6*	*0.1*			
10:47:30	*00:30.0*	*6400*	*205*	*227*	*200*	*6.8*	*9.9*	*6.1*	*7.6*	*2.2*	*14.6*	*0.1*			
10:48:00	*01:00.0*	*6400*	*205*	*227*	*200*	*6.8*	*9.9*	*6.1*	*7.6*	*2.2*	*14.6*	*0.1*			
10:49:00	*02:00.0*	*6400*	*205*	*227*	*200*	*6.8*	*9.9*	*6.1*	*7.6*	*2.2*	*14.6*	*0.1*			
10:52:00	*05:00.0*	*6400*	*205*	*227*	*200*	*6.8*	*9.9*	*6.1*	*7.6*	*2.2*	*14.6*	*0.1*			
															Load to 300 kN
10:53:00	*00:00.0*	*9938*	*318*	*340*	*300*	*7.5*	*10.5*	*6.7*	*8.2*	*2.8*	*14.7*	*0.2*			
10:53:30	*00:30.0*	*9938*	*318*	*340*	*300*	*7.5*	*10.5*	*6.7*	*8.2*	*2.8*	*14.7*	*0.2*			
10:54:00	*01:00.0*	*9938*	*318*	*340*	*300*	*7.5*	*10.5*	*6.7*	*8.2*	*2.8*	*14.7*	*0.2*			
10:55:00	*02:00.0*	*9938*	*318*	*340*	*300*	*7.5*	*10.5*	*6.7*	*8.2*	*2.8*	*14.7*	*0.2*			
10:58:00	*05:00.0*	*9938*	*318*	*340*	*300*	*7.5*	*10.5*	*6.7*	*8.2*	*2.8*	*14.7*	*0.2*			
															Load to 400 kN
10:59:00	*00:00.0*	*12500*	*441*	*453*	*400*	*8.9*	*11.9*	*8.1*	*9.6*	*4.2*	*14.9*	*0.4*			
10:59:30	*00:30.0*	*12500*	*441*	*453*	*400*	*8.9*	*11.9*	*8.1*	*9.6*	*4.2*	*14.9*	*0.4*			
11:00:00	*01:00.0*	*12500*	*441*	*453*	*400*	*8.9*	*11.9*	*8.1*	*9.6*	*4.2*	*14.9*	*0.4*			
11:01:00	*02:00.0*	*12500*	*441*	*453*	*400*	*8.9*	*11.9*	*8.1*	*9.6*	*4.2*	*14.9*	*0.4*			
11:04:00	*05:00.0*	*12500*	*441*	*453*	*400*	*8.9*	*11.9*	*8.1*	*9.6*	*4.2*	*14.9*	*0.4*			
															Load to 500 kN
11:05:00	*00:00.0*	*15700*	*502*	*566*	*500*	*9.8*	*12.8*	*9.0*	*10.5*	*5.1*	*15.1*	*0.6*			
11:05:30	*00:30.0*	*15700*	*502*	*566*	*500*	*9.8*	*12.8*	*9.0*	*10.5*	*5.1*	*15.1*	*0.6*			
11:06:00	*01:00.0*	*15700*	*502*	*566*	*500*	*9.8*	*12.8*	*9.0*	*10.5*	*5.1*	*15.1*	*0.6*			
11:07:00	*02:00.0*	*15700*	*502*	*566*	*500*	*9.8*	*12.8*	*9.0*	*10.5*	*5.1*	*15.1*	*0.6*			
11:10:00	*05:00.0*	*15700*	*502*	*566*	*500*	*9.8*	*12.8*	*9.0*	*10.5*	*5.1*	*15.1*	*0.6*			
															Past the design load increase by 50 kN
11:11:00	*00:00.0*	*16905*	*541*	*623*	*550*	*10.5*	*13.5*	*9.7*	*11.2*	*5.8*	*15.3*	*0.8*			*Load to 550 kN*

Figure 21b Portion of an Example Time Settlement Data Sheet: Quick Test (*International System of Units*)

PILE LOAD TEST
TIME SETTLEMENT DATA SHEET

JOB STAMP

D123456 Highway Bridge
Example Co. Replacement Project
PIN 1234.56 Town of Example
XYZ Construction Co.

BRIDGE DESIGNATION *BRIDGE NO.12* DATE *4/27/98*

LOCATION *SOUTH ABUTMENT* PREPARED Y *S.W.C.*

PILE NO. *164* COMPUTED BY *J.W.P.*

PILE LOAD TEST NO. *1 (ISLT)* CHECKED BY *R.W.G.*

PILE TIP ELEVATION *931.2 ft.*

ELAPSED TIME	READ TIME	JACK GAGE READ (psi)	JACK LOAD (kips)	LOAD CELL READ	LOAD CELL (kips)	DIAL READINGS -(in)			MEAN	DEFL.	TELL TALES-(in)				REMARKS
						A	B	C			READ	DEFL.	READ	DEFL	
10:49:00	0	0	0	6770	0	0.095	0.321	0.063	0.160	0.000	0.040	0.000	0.112	0.000	Wire 409
															Load to 45 kips
10:50:00	0	709	44.3	6813	45	0.113	0.350	0.094	0.186	0.026	0.048	0.008	0.120	0.008	Wire 408 31/32
10:50:30	0.5					0.113	0.350	0.094	0.186	0.026	0.048	0.008	0.120	0.008	
10:51:00	1					0.115	0.350	0.094	0.186	0.026	0.048	0.008	0.120	0.008	
10:52:00	2					0.115	0.351	0.094	0.187	0.027	0.050	0.009	0.122	0.009	
10:54:00	4					0.115	0.352	0.094	0.187	0.027	0.050	0.009	0.122	0.009	
10:58:00	8					0.115	0.352	0.094	0.187	0.027	0.050	0.009	0.122	0.009	
11:05:00	15					0.115	0.352	0.094	0.187	0.027	0.050	0.009	0.123	0.011	
11:20:00	30					0.115	0.352	0.096	0.188	0.028	0.050	0.009	0.123	0.011	Wire 408 31/32
															Load to 90 kips
11:30:00	0	1276	89.5	6851	90	0.145	0.381	0.132	0.219	0.060	0.058	0.018	0.137	0.025	Wire 408 15/16
11:20:30	0.5					0.145	0.381	0.132	0.219	0.060	0.058	0.018	0.137	0.025	.
11:21:00	1					0.145	0.384	0.132	0.220	0.061	0.059	0.019	0.137	0.025	
11:22:00	2					0.146	0.384	0.133	0.221	0.061	0.059	0.019	0.137	0.025	
11:24:00	4					0.146	0.384	0.133	0.221	0.061	0.059	0.019	0.138	0.026	
11:28:00	8					0.146	0.384	0.133	0.221	0.061	0.059	0.019	0.138	0.026	
11:35:00	15					0.146	0.384	0.133	0.221	0.061	0.059	0.019	0.138	0.026	
11:50:00	30					0.146	0.384	0.133	0.221	0.061	0.059	0.019	0.139	0.027	Wire 408 15/16
															Load to 135 kips
12:00:00	0	1856	134	6893	135	0.192	0.420	0.176	0.263	0.103	0.067	0.027	0.156	0.044	Wire 408 57/64

Figure 22a Portion of an Example Time Settlement Data Sheet: Incremental Static Load Test (*US Customary Units*)

GE 380 (7/03)

PILE LOAD TEST
TIME SETTLEMENT DATA SHEET

JOB STAMP

D123456 Highway Bridge
Example Co. Replacement Project
PIN 1234.56 Town of Example
XYZ Construction Co.

BRIDGE DESIGNATION *BRIDGE NO.12*
LOCATION *SOUTH ABUTMENT*
PILE NO. *164*
PILE LOAD TEST NO. *1 (ISLT)*
PILE TIP ELEVATION *283.9 m*

DATE *4/27/98*
PREPARED Y *S.W.C.*
COMPUTED BY *J.W.P.*
CHECKED BY *R.W.G.*

ELAPSED TIME	READ TIME	JACK GAGE READ (kPa)	JACK LOAD (kN)	LOAD CELL READ	LOAD CELL (kN)	DIAL READINGS -(mm)			MEAN	DEFL.	TELL TALES-(mm)				REMARKS
						A	B	C			READ	DEFL.	READ	DEFL	
10:49:00	*0*	*0*	*0*	*30115*	*0*	*2.43*	*8.16*	*1.59*	*4.06*	*0.00*	*1.02*	*0*	*2.85*	*0*	*Wire 124.7*
															Load to 200 kN
10:50:00	*0*	*4890*	*197*	*30305*	*200*	*2.88*	*8.88*	*2.40*	*4.72*	*0.66*	*1.23*	*0.21*	*3.06*	*0.21*	*Wire 124.0*
10:50:30	*0.5*					*2.88*	*8.88*	*2.40*	*4.72*	*0.66*	*1.23*	*0.21*	*3.06*	*0.21*	
10:51:00	*1*					*2.91*	*8.88*	*2.40*	*4.73*	*0.67*	*1.23*	*0.21*	*3.06*	*0.21*	
10:52:00	*2*					*2.91*	*8.91*	*2.40*	*4.74*	*0.68*	*1.26*	*0.24*	*3.09*	*0.24*	
10:54:00	*4*					*2.91*	*8.94*	*2.40*	*4.75*	*0.69*	*1.26*	*0.24*	*3.09*	*0.24*	
10:58:00	*8*					*2.91*	*8.94*	*2.40*	*4.75*	*0.69*	*1.26*	*0.24*	*3.09*	*0.24*	
11:05:00	*15*					*2.91*	*8.94*	*2.40*	*4.75*	*0.69*	*1.26*	*0.24*	*3.12*	*0.27*	
11:20:00	*30*					*2.91*	*8.94*	*2.43*	*4.76*	*0.70*	*1.26*	*0.24*	*3.12*	*0.27*	*Wire 124.0*
															Load to 400 kN
11:30:00	*0*	*8800*	*398*	*30476*	*400*	*3.69*	*9.69*	*3.36*	*5.58*	*1.52*	*1.47*	*0.45*	*3.48*	*0.63*	*Wire 123.2*
11:20:30	*0.5*					*3.69*	*9.69*	*3.36*	*5.58*	*1.52*	*1.47*	*0.45*	*3.48*	*0.63*	
11:21:00	*1*					*3.69*	*9.75*	*3.36*	*5.60*	*1.54*	*1.50*	*0.48*	*3.48*	*0.63*	
11:22:00	*2*					*3.72*	*9.75*	*3.39*	*5.62*	*1.56*	*1.50*	*0.48*	*3.48*	*0.63*	
11:24:00	*4*					*3.72*	*9.75*	*3.39*	*5.62*	*1.56*	*1.50*	*0.48*	*3.51*	*0.66*	
11:28:00	*8*					*3.72*	*9.75*	*3.39*	*5.62*	*1.56*	*1.50*	*0.48*	*3.51*	*0.66*	
11:35:00	*15*					*3.72*	*9.75*	*3.39*	*5.62*	*1.56*	*1.50*	*0.48*	*3.51*	*0.66*	
11:50:00	*30*					*3.72*	*9.75*	*3.39*	*5.62*	*1.56*	*1.50*	*0.48*	*3.54*	*0.69*	*Wire 123.1*
															Load to 600 kN
12:00:00	*0*	*12800*	*596*	*30660*	*600*	*4.87*	*10.66*	*4.48*	*6.67*	*2.61*	*1.71*	*0.69*	*3.96*	*1.11*	*Wire 122.1*

Figure 22b Portion of an Example Time Settlement Data Sheet: Incremental Static Load Test (*International System of Units*)

PILE LOAD TEST
TIME SETTLEMENT DATA SHEET

JOB STAMP

D123456 Highway Bridge
Example Co. Replacement Project
PIN 1234.56 Town of Example
XYZ Construction Co.

BRIDGE DESIGNATION *BRIDGE NO. 12* DATE *4/27/98*

LOCATION *SOUTH ABUTMENT* PREPARED BY *S.W.C.*

PILE NO. *164* COMPUTED BY *J.W.P.*

PILE LOAD TEST NO. *1 (CRPT)* CHECKED BY *R.W.G.*

PILE TIP ELEVATION *931.2 ft.*

ELAPSED TIME	READ TIME	JACK GAGE READ (psi)	JACK LOAD (kips)	LOAD CELL READ	LOAD CELL (kips)	DIAL READINGS -(in)			MEAN	DEFL.	TELL TALES-(in)				REMARKS
						A	B	C			READ	DEFL.	READ	DEFL	
12:55:00	*0*	*0*	*0*	*6775*	*0*	*0.103*	*0.133*	*0.278*	*0.171*	*0.000*	*0.203*	*0.000*			*Wire 408*
	1	*450*	*33*	*6811*	*34*	*0.115*	*0.155*	*0.300*	*0.190*	*0.019*	*0.210*	*0.007*			
	2	*600*	*45*	*6823*	*45*	*0.128*	*0.170*	*0.312*	*0.203*	*0.032*	*0.216*	*0.013*			
	3	*900*	*67*	*6847*	*67*	*0.141*	*0.185*	*0.326*	*0.217*	*0.046*	*0.220*	*0.017*			
	4	*1050*	*78*	*6859*	*79*	*0.150*	*0.194*	*0.335*	*0.226*	*0.055*	*0.226*	*0.022*			
	5	*1200*	*89*	*6871*	*90*	*0.159*	*0.204*	*0.346*	*0.236*	*0.065*	*0.230*	*0.027*			
	6	*1500*	*112*	*6895*	*112*	*0.170*	*0.214*	*0.356*	*0.247*	*0.075*	*0.236*	*0.033*			
	7	*1650*	*123*	*6907*	*124*	*0.182*	*0.227*	*0.370*	*0.260*	*0.088*	*0.240*	*0.037*			
	8	*1800*	*134*	*6919*	*135*	*0.193*	*0.236*	*0.378*	*0.269*	*0.098*	*0.243*	*0.040*			
	9	*1950*	*145*	*6931*	*146*	*0.202*	*0.246*	*0.389*	*0.279*	*0.107*	*0.247*	*0.044*			
13:05:00	*10*	*2100*	*156*	*6943*	*157*	*0.210*	*0.253*	*0.396*	*0.286*	*0.115*	*0.250*	*0.047*			*Wire 407 7/8*
	11	*2250*	*167.5*	*6955*	*169*	*0.226*	*0.268*	*0.411*	*0.302*	*0.130*	*0.256*	*0.053*			
	12	*2400*	*178.5*	*6967*	*180*	*0.234*	*0.276*	*0.420*	*0.310*	*0.139*	*0.260*	*0.057*			
	13	*2550*	*190*	*6979*	*191*	*0.244*	*0.288*	*0.432*	*0.321*	*0.150*	*0.265*	*0.061*			
	14	*2700*	*201*	*6991*	*202*	*0.255*	*0.298*	*0.441*	*0.331*	*0.160*	*0.268*	*0.065*			
	15	*2850*	*212*	*7004*	*214*	*0.267*	*0.311*	*0.454*	*0.344*	*0.172*	*0.273*	*0.070*			
	16	*3000*	*223*	*7015*	*225*	*0.278*	*0.321*	*0.465*	*0.355*	*0.183*	*0.278*	*0.074*			
	17	*3150*	*234.5*	*7028*	*236*	*0.287*	*0.332*	*0.475*	*0.365*	*0.193*	*0.282*	*0.079*			
	18	*3300*	*245.5*	*7039*	*247*	*0.296*	*0.340*	*0.483*	*0.373*	*0.202*	*0.285*	*0.081*			
	19	*3450*	*257*	*7052*	*258*	*0.300*	*0.345*	*0.489*	*0.378*	*0.207*	*0.287*	*0.084*			
13:15:00	*20*	*3600*	*268*	*7064*	*270*	*0.309*	*0.355*	*0.498*	*0.387*	*0.216*	*0.291*	*0.088*			*Wire 407 25/32*

Figure 23a Portion of an Example Time Settlement Data Sheet: Constant Rate of Penetration Test (*US Customary Units*)

PILE LOAD TEST
TIME SETTLEMENT DATA SHEET

JOB STAMP

D123456 Highway Bridge
Example Co. Replacement Project
PIN 1234.56 Town of Example
XYZ Construction Co.

BRIDGE DESIGNATION *BRIDGE NO. 12* DATE *4/27/98*

LOCATION *SOUTH ABUTMENT* PREPARED BY *S.W.C.*

PILE NO. *164* COMPUTED BY *J.W.P.*

PILE LOAD TEST NO. *1 (CRPT)* CHECKED BY *R.W.G.*

PILE TIP ELEVATION *283.9 m*

ELAPSED TIME	READ TIME	JACK GAGE READ (kPa)	JACK LOAD (kN)	LOAD CELL READ	LOAD CELL (kN)	DIAL READINGS -(mm)			MEAN	DEFL.	TELL TALES-(mm)				REMARKS
						A	B	C			READ	DEFL.	READ	DEFL	
12:55:00	*0*	*0*	*0*	*30136*	*0*	*2.61*	*3.39*	*7.05*	*4.35*	*0.00*	*5.16*	*0.00*			*Wire 124.4*
	1	*3104*	*149*	*30297*	*150*	*2.91*	*3.93*	*7.62*	*4.82*	*0.47*	*5.34*	*0.18*			
	2	*4138*	*199*	*30350*	*200*	*3.24*	*4.32*	*7.92*	*5.16*	*0.81*	*5.49*	*0.33*			
	3	*6207*	*298*	*30457*	*300*	*3.57*	*4.71*	*8.28*	*5.52*	*1.17*	*5.58*	*0.42*			
	4	*7242*	*348*	*30511*	*350*	*3.81*	*4.92*	*8.52*	*5.75*	*1.40*	*5.73*	*0.57*			
	5	*8276*	*397*	*30564*	*400*	*4.05*	*5.19*	*8.79*	*6.01*	*1.66*	*5.85*	*0.69*			
	6	*10345*	*497*	*30671*	*500*	*4.32*	*5.43*	*9.03*	*6.26*	*1.91*	*6.00*	*0.84*			
	7	*11380*	*546*	*30725*	*550*	*4.62*	*5.76*	*9.39*	*6.59*	*2.24*	*6.09*	*0.93*			
	8	*12414*	*596*	*30778*	*600*	*4.89*	*6.00*	*9.60*	*6.83*	*2.48*	*6.18*	*1.02*			
	9	*13449*	*646*	*30832*	*650*	*5.13*	*6.24*	*9.87*	*7.08*	*2.73*	*6.27*	*1.11*			
13:05:00	*10*	*14483*	*695*	*30885*	*700*	*5.34*	*6.42*	*10.05*	*7.27*	*2.92*	*6.36*	*1.20*			*Wire 121.4*
	11	*15518*	*745*	*30939*	*750*	*5.73*	*6.81*	*10.44*	*7.66*	*3.31*	*6.51*	*1.35*			
	12	*16552*	*794*	*30992*	*800*	*5.94*	*7.02*	*10.68*	*7.88*	*3.53*	*6.60*	*1.44*			
	13	*17587*	*844*	*31046*	*850*	*6.21*	*7.32*	*10.98*	*8.17*	*3.82*	*6.72*	*1.56*			
	14	*18621*	*894*	*31099*	*900*	*6.48*	*7.56*	*11.19*	*8.41*	*4.06*	*6.81*	*1.65*			
	15	*19656*	*943*	*31153*	*950*	*6.78*	*7.89*	*11.52*	*8.73*	*4.38*	*6.93*	*1.77*			
	16	*20690*	*993*	*31206*	*1000*	*7.05*	*8.16*	*11.82*	*9.01*	*4.66*	*7.05*	*1.89*			
	17	*21725*	*1043*	*31260*	*1050*	*7.29*	*8.43*	*12.06*	*9.26*	*4.91*	*7.17*	*2.01*			
	18	*22759*	*1092*	*31313*	*1100*	*7.53*	*8.64*	*12.27*	*9.48*	*5.13*	*7.23*	*2.07*			
	19	*23794*	*1142*	*31367*	*1150*	*7.62*	*8.77*	*12.41*	*9.60*	*5.25*	*7.30*	*2.14*			
13:15:00	*20*	*24828*	*1192*	*31420*	*1200*	*7.85*	*9.02*	*12.65*	*9.84*	*5.49*	*7.39*	*2.23*			*Wire 118.9*

Figure 23b Portion of an Example Time Settlement Data Sheet: Constant Rate of Penetration Test (*International System of Units*)

BIBLIOGRAPHY

Readers interested in pursuing the subject of static pile-load testing may note seven bold-faced titles in the following list, recommended as having particular significance.

Butler, F.G., and Morton, K., "**Specification and Performance of Test Piles in Clay**", In Behaviour of Piles, London: Institution of Civil Engineers, 1971, pp. 17-26.

Chellis, R.D., **Pile Foundations**, New York: McGraw-Hill Book Company, 1971 (2nd ed.), pp. 455-74, 576-99.

Darragh, R.D., and Bell, R.A., "Load Tests on Long Bearing Piles", In Performance of Deep Foundations, Special Technical Publication 444, American Society for Testing and Materials, 1969, pp. 41-67.

Davission, M.T., "**Summary of Knowledge Gained from Tests on Instrumented Driven Piles**", Paper presented to the Foundations and Soil Mechanics Group, New York Metropolitan Section, American Society of Civil Engineers, April 1966.

Davisson, M.T., "Static Measurements of Pile Behavior", In Design and Installation of Pile Foundations and Cellular Structures (H-Y. Fang and T.D. Dismuke, eds.), Lehigh Valley, PA: Envo Publishing Co., 1970.

Fellenius, B.H., Negative Skin Friction on Long Piles Driven in Clay, Proceedings No. 25, Swedish Geotechnical Institute, 1971.

Flaate, K., "Effects of Pile Driving in Clays", Canadian Geotechnical Journal, Vol. 9, No. 1 (February 1972), pp. 81-88.

Fuller, F.M., and Hoy, H.E., "Pile Load Tests Including Quick Load Test Method, Conventional Methods, and Interpretations", Highway Research Record 333, Highway Research Board, 1970, pp. 74-86.

Geuze, E.C.W.A., Topics in Soil Mechanics & Foundation Engineering, Rensselaer Polytechnic Institute, 1970.

Goble, G.G., and Likins, G.E., Jr., **A Report on a Static and Dynamic Pile Test in Whitehalll, New York**, Department of Soil Mechanics, Structures, and Mechanical Design, Case Institute of Technology, August 1973.

Goble, G.G., and Rausche, F., A Report on a Static and Dynamic Pile test in Oneonta, New York, Division of Soil Mechanics, Structures, and Mechanical Design, Case Institute of Technology, April 1972.

Hirsch, T.J., and Edwards, T.C., Impact Load-Deformation Properties of Pile Cushioning Materials, Research Report 33-4, Texas Transportation Institute, Texas A&M University, May 1966.

Ireland, H.O., "**The Conduct and Interpretation of Pile Loading Tests**", Paper presented to the Foundations and Soil Mechanics Group, New York Metropolitan Section, American Society of Civil Engineers, May 1966.

Kyfor, Z.G, Schnore, A.R., Carlo, T.A., and Bailey, P.F., Static Pile Load Testing Manual. FHWA Publication SA 91 042, February 1992.

Lowery, L.L., Jr., et al., Pile Driving Analysis State of the Art, Research Report 33-13 (Final), Texas Transportation Institute, Texas A&M University, January 1969.

McClelland, B., "Design and Performance of Deep Foundations", Proceedings, American Society of Civil Engineers Specialty Conference on Performance of Earth and Earth-Supported Structures, Purdue University, Jan. 11-14, 1972, Vol. 2, pp. 111-44.

Terzaghi, K., Discussion of "Pile Driving Formulas: Progress Report of the Committee on the Bearing Value of Pile Foundations", Proceedings, American Society of Civil Engineers, Vol. 68 (February 1942), pp. 311-23.

Tomlinson, M.J., "Some Effects of Pile Driving on Skin Friction", In Behaviour of Piles, pp. 107-14. London: Institution of Civil Engineers, 1971.

Tomlinnson, M.J., "The Adhesion of Piles Driven in Clay Soils", Proceedings, 4th International Conference on Soil Mechanics and Foundation Engineering, London, August 12-24, 1957, Vol. 2, pp. 66-71. London: Butterworths Scientific Publications, 1957.

Van Weele, I.A.F., "**A Method of Separating the Bearing Capacity of A Test Pile Into Skin Friction and Point Resistance**", Proceedings, 4th International Conference on Soil Mechanics and Foundation Engineering, London, August 12-24, 1957, Vol. 2, pp. 76-80.

Vesic, A.S., "Load Transfer, Lateral Loads, and Group Action of Deep Foundations", In Performance of Deep Foundations, Special Technical Publication 444, American Society for Testing and Materials, 1969, pp. 5-14.

Whitaker, T. and Cooke, R.W., "**A New Approach to Pile Testing**", Proceedings, 5th International Conference on Soil Mechanics and Foundation Engineering. Paris, July 17-22, 1961, Vol. 2, pp. 171-76.

Woodward, R.J., Lundgren, R. and Boitano, J.D., Jr., "Pile Loading Tests in Stiff Clays", Proceedings, 5th International Conference on Soil Mechanics and Foundation Engineering, Paris, July 17-22, 1961, Vol. 2, pp. 177-84.

Zeevaert, L., Foundation Engineering in Difficult Subsoil Conditions, New York: Van Nostrand Reinhold Co., 1973, pp. 396-408.