

ITEM 551.54XX--25 - HIGH-STRAIN DYNAMIC TESTING OF NON-DRIVEN FOUNDATIONS

1. DESCRIPTION:

1.01 This work shall consist of furnishing all materials, equipment and labor necessary for conducting high-strain dynamic tests on a non-driven test pile or shaft. The test involves imparting a sufficient impact force, from a drop weight or ram, to the test pile or shaft in accordance with the Contract Documents and as directed by the Engineer. The test pile or shaft is instrumented to obtain records of force and velocity for determination of load carrying capacity and other parameters. The pile or shaft used for the test will be instrumented and tested by a qualified Testing Engineer hired by the Contractor. The Contractor will be required to supply material and labor as needed by the Testing Engineer and apply the impact force. Testing procedures shall conform to [REDACTED] unless otherwise noted.

1.02 Definitions:

- A. **Pile or Shaft:** May be a Micropile, Drilled Shaft or a Cast-In-Place pile previously driven and concreted and no longer capable of being driven with conventional equipment on the project.
- B. **Test Area:** Is the top of the shaft or pile measured two diameters from the top where the instruments will be attached.
- C. **Permanent Set:** Is the permanent displacement of the pile or shaft after each impact. It is used as an integration constant in the analysis of the data.
- D. **Pedestal:** Is a beam or pipe used to transfer the impact force from the drop weight to the top of the pile when reinforcing is protruding.

2. MATERIALS:

- 2.01 A thin-walled casing or equivalent (optional, see Construction Details).
- 2.02 A drop weight in the range of one to two percent [REDACTED] of the anticipated pile capacity. The cross section of the weight will be symmetrical. The area of the weight or the impact protrusion will be consistent with the striker plate (see below).
- 2.03 A guide allowing variable drop heights typically between [REDACTED] and [REDACTED] and maintaining drop weight alignment with the pile or shaft. The guide will be equipped with a release mechanism, such as hydraulic shears, hydraulic or mechanically actuated pin, or a pair of tongs, such that the weight will drop in free fall. The maximum height of the fall will not exceed 10 feet.
- 2.04 A cushion consisting of new sheets of plywood with a total thickness between [REDACTED] and [REDACTED] to be placed on the pile or shaft top.
- 2.05 A steel striker plate shall have a thickness of at least [REDACTED] and a cross section area between [REDACTED] [REDACTED] of pile or shaft top area, but not less than the area of the impacting surface of the drop weight.
- 2.06 One (1) kW of 115 Volt AC power.
- 2.07 Surveyor's transit, laser light level, or equivalent for measurements of pile set under each impact.

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3. CONSTRUCTION DETAILS:

- 3.01 Construct the test shaft using the approved techniques, creating a flat, level (perpendicular to the longitudinal axis of the pile or shaft), and solid concrete pile or shaft top.
- 3.02 The pile or shaft shall extend a minimum of two pile or shaft diameters above the adjacent grade, to create a "test area". This may be accomplished by either excavating the required distance below grade or extending the pile or shaft above grade. If a permanent casing is not required and the extension method is chosen, then the "test area" shall be cased in a thin-wall casing, tube, or equivalent. Casing of this test area shall be made as a continuation of the construction of the shaft. There should be no soil contamination or non-uniformities in the concrete located within or below the test area. The pile or shaft top shall be made level to the casing and smoothed.
- 3.03 The testing instruments will be located approximately one and one-half diameter from the top of the pile or shaft. Prior to the testing of cased piles or shafts, four (4) "windows" (approximate size of [REDACTED]) diametrically opposite of each other shall be located and removed from the casing. On a pile or shaft where casing is not present, the Contractor shall smooth the concrete surface by grinding similar areas around the pile circumference such that proper gage attachment can be accomplished.
- 3.04 Establish reference point(s) on the pile or shaft for determining the elevation and permanent set.
- 3.05 Provide the Testing Engineer access to attach the gages to the exposed concrete and/or steel casing and examine the pile or shaft top to insure the concrete or grout is flush with or above the casing.
- 3.06 Apply plywood cushion and then striker plate to the pile or shaft top. If reinforcing protrudes from the pile or shaft top, then a pedestal shall be secured in such a manner as not to move under impact. The impedance of the pedestal defined as the cross-sectional area times the modulus of elasticity divided by the wave speed of the respective material shall be at least 80% of the impedance of the pile or shaft being tested.
- 3.07 Position the guide and drop weight assembly and apply a minimum of two (2) drop weight impacts to the pile top. The first drop height should be minimal to allow the testing Engineer to assess the testing equipment, the driving system, and pile stresses. Subsequent impacts may then be applied by utilizing higher drop heights, not to exceed a maximum of ten impacts.
- 3.08 Before and after each of the impacts, the Contractor shall determine the elevation of the reference point(s) in order to calculate the set or net displacement of the pile or shaft from each impact.
- 3.09 Upon completion of the test, return the pile to acceptable production condition, as determined by the engineer, if the pile or shaft is to be used in the finished work.
- 3.10 **Requirements of the Testing Engineer:**
 - A. The Contractor shall employ and compensate a specialized dynamic testing firm. Dynamic testing is to be performed by an independent specialist from a firm with a minimum of five (5) years experience in dynamic testing. The actual dynamic test shall be conducted and/or supervised by a Licensed Professional Engineer with at least two (2) years of dynamic testing experience or who has achieved Basic Level or better on the Foundation QC High Strain Dynamic Pile Testing Examination. Selection of the firm must be approved by the Engineer.

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3. CONSTRUCTION DETAILS: (cont'd)

3.10 Requirements of the Testing Engineer: (cont'd)

- B. The independent dynamic testing firm shall supply the following testing instrumentation in addition to that outlined in ASTM Specification D4945-00 Section 5:
 - 1. Pile Driving Analyzer® (PDA) manufactured by Pile Dynamics, Inc., Model PAK, PAX or PAL or equivalent.
 - 2. Four (4) calibrated strain transducers.
 - 3. Four (4) calibrated accelerometers.
- C. Prior to performing the dynamic test, the Testing Engineer shall be provided with soil borings, shaft installation records, concrete properties (strength, etc.) and details regarding the anticipated dynamic loading equipment. The test Engineer is required to perform wave equation analyses (using GRLWEAP software by Pile Dynamics, Inc., or equivalent) to determine the suitability of the proposed dynamic load testing equipment and acceptable range of ram drop heights so as not to cause damage in the test shaft during the test.
- D. The Testing Engineer or representative shall drill the holes, set the attaching apparatus and attach the instruments for the test. This procedure will require a maximum of one (1) hour.
- E. After each impact, the Testing Engineer shall evaluate the data and determine if the capacity has been mobilized. If the capacity has not been achieved, then a new drop height and/or a change in the cushion thickness will be ordered. This procedure will take 30 minutes.

3.11 Reporting of Results:

- A. It is the Testing Engineers' responsibility to submit a timely report of the testing results. In addition to the field results, results from at least one (1) CAPWAP® analysis or equivalent shall be submitted. CAPWAP analyses shall be performed by an Engineer that has achieved Advanced Level or better on the Foundation QC High Strain Dynamic Pile Testing Examination. The report must also provide the following:
 - 1. Wave Equation analysis results obtained prior to testing.
 - 2. CAPWAP (or equivalent) analysis results.
 - 3. For each impact the maximum measured force, maximum calculated tension force, transferred energy to the sensor location, corresponding stresses, and the Case Method bearing capacity.
 - 4. Assessment of the test results both with respect to pile capacity and integrity.

4. METHOD OF MEASUREMENT:

- 4.01 This work will be measured as the number of High-Strain Dynamic Tests for Non-Driven Piles completed to the satisfaction of the Engineer.

5. BASIS OF PAYMENT:

- 5.01 The unit price bid shall include the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the test and provide the required test report. The pile or shaft is to be paid under the item for that work.

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5. BASIS OF PAYMENT: (cont'd)

NOTE: The “XX” in the Pay Item Number denotes the required ram weight.

Item 551.54XX 25 (XX) =	Common Ram Weights (Tons)