



Designation: D3966/D3966M – 22

Standard Test Methods for Deep Foundation Elements Under Static Lateral Load¹

This standard is issued under the fixed designation D3966/D3966M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 The test methods described in this standard measure the lateral deflection of an individual vertical or inclined deep foundation element or group of elements when subjected to static lateral loading. These methods apply to all deep foundations, or deep foundation systems as they are practical to test. The individual components of which are referred to herein as elements that function as, or in a manner similar to, drilled shafts, micropiles, cast-in-place piles (augered-cast-in-place piles, barrettes, and slurry walls), driven piles, such as pre-cast concrete piles, timber piles or steel sections (steel pipes or H-beams) or any number of other element types, regardless of their method of installation. Although the test methods may be used for testing single elements or element groups, the test results may not represent the long-term performance of the entire deep foundation system.

1.2 This standard provides minimum requirements for testing deep foundation elements under static lateral load. Project plans, specifications, provisions, or any combination thereof may provide additional requirements and procedures as needed to satisfy the objectives of a particular test program. The engineer in charge of the foundation design, referred to herein as the foundation engineer, shall approve any deviations, deletions, or additions to the requirements of this standard. (exception: the test load applied to the testing apparatus shall not exceed the rated capacity established by the engineer who designed the testing apparatus).

1.3 Apparatus and procedures herein designated “optional” may produce different test results and may be used only when approved by the foundation engineer. The word “shall” indicates a mandatory provision, and the word “should” indicates a recommended or advisory provision. Imperative sentences indicate mandatory provisions.

1.4 The foundation engineer should interpret the test results obtained from the procedures of this standard to predict the actual performance and adequacy of elements used in the constructed foundation.

¹ These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.11 on Deep Foundations.

Current edition approved Jan. 1, 2022. Published February 2022. Originally approved in 1981. Last previous edition approved in 2013 as D3966 – 07(2013)^{ε1}. DOI: 10.1520/D3966_D3966M-22.

1.5 An engineer (qualified to perform such work) shall design and approve all loading apparatus, loaded members and support frames. The foundation engineer shall design or specify the test procedures. The text of this standard references notes and footnotes, which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard. This standard also includes illustrations and appendices intended only for explanatory or advisory use.

1.6 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.7 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound [lbf] represents a unit of force [weight], while the unit for mass is slug. The rationalized slug unit is not given, unless dynamic [$F=ma$] calculations are involved.

1.8 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.8.1 The procedures used to specify how data are collected, recorded and calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that should generally be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user’s objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analysis methods for engineering data.

1.9 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.10 *This standard offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with*

professional judgment. Not all aspects of this standard may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.11 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.12 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

- A36/A36M Specification for Carbon Structural Steel
- A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- A572/A572M Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- D653 Terminology Relating to Soil, Rock, and Contained Fluids
- D1143/D1143M Test Methods for Deep Foundation Elements Under Static Axial Compressive Load
- D3689/D3689M Test Methods for Deep Foundations Under Static Axial Tensile Load
- D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D5882 Test Method for Low Strain Impact Integrity Testing of Deep Foundations
- D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data
- D6760 Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing
- D6230 Practices for Monitoring Earth or Structural Movement Using Inclinometers
- D7949 Test Methods for Thermal Integrity Profiling of Concrete Deep Foundations
- D8169/D8169M Test Methods for Deep Foundations Under Bi-Directional Static Axial Compressive Load
- 2.2 American Society of Mechanical Engineer Standards:³
 - ASME B30.1 Jacks
 - ASME B40.100 Pressure Gauges and Gauge Attachments

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

ASME B46.1 Surface Texture

ASME B89.1.10.M Dial Indicators (For Linear Measurements)

3. Terminology

3.1 *Definitions*—For definitions of common technical terms used in this standard, refer to Terminology D653.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *cast in-place element, n*—a deep foundation unit made of cement grout or concrete and constructed in its final location, for example, drilled shafts, bored elements, caissons, auger cast elements, pressure-injected footings, etc.

3.2.2 *deep foundation, n*—a relatively slender structural element that transmits some or all of the load it supports to soil or rock well below the ground surface, such as a steel pipe pile or concrete drilled shaft.

3.2.3 *driven element, n*—a deep foundation unit made of preformed material with a predetermined shape and size and typically installed by impact hammering, vibrating, or jacking.

3.2.4 *failure load, n*—the test load at which continuing, progressive movement occurs, or at which the total lateral movement exceeds the value specified by the foundation engineer.

3.2.5 *wireline, n*—a steel wire with a constant tension force between two supports and used as a reference line to read a scale indicating movement of the test element.

3.2.6 *gage or gauge, n*—an instrument used for measuring load, pressure, displacement, strain or such other physical properties associated with load testing as may be required.

4. Summary of Test Method

4.1 This standard provides minimum requirements for testing deep foundation elements under lateral load. The test is a specific type of test, most commonly referred to as a lateral load test. This standard is confined to test methods for loading deep foundation elements from the side. The loading requires constructing a reaction system that resists the applied lateral load. One or more deep foundation elements can be used as reaction. The principal measurements taken in addition to load are displacements.

4.2 This standard allows the following test procedures:

Procedure	Test	Section
A	Standard Loading	10.1.2
B	Excess Loading	10.1.3
C	Cyclic Loading	10.1.4
D	Surge Loading	10.1.5
E	Reverse Loading	10.1.6
F	Reciprocal Loading	10.1.7
G	Specified Lateral Movement	10.1.8
H	Combined Loading	10.1.9

5. Significance and Use

5.1 Field tests provide the most reliable relationship between the static lateral load applied to a deep foundation and the resulting lateral movement. Test results may also provide information used to assess the distribution of lateral resistance along the element and the long-term load-deflection behavior. The foundation engineer may evaluate the test results to