Designation: D 5882 – 00

Standard Test Method for Low Strain Integrity Testing of Piles[1]

This standard is issued under the fixed designation D 5882; 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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method[2] covers the procedure for determining the integrity of individual vertical or inclined piles by measuring and analyzing the velocity (required) and force (optional) response of the pile induced by an (hand held hammer or other similar type) impact device applied axially to the pile normally at the pile head. This test method is applicable to long structural elements that function in a manner similar to foundation piles, regardless of their method of installation provided that they are receptive to low strain impact testing.

1.2 *This standard may involve hazardous materials, operations, and equipment. 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 and health practices and determine the applicability of regulatory limitations prior to use. Fig. 1*

2. Referenced Documents

2.1 *ASTM Standards:*

C 469 Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression[3]

D 198 Methods of Static Tests of Timbers in Structural Sizes[4]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[5]

D 1143 Method of Testing Piles Under Static Axial Compressive Load[5]

D 4945 Test Method for High Strain Dynamic Testing of Piles[5]

3. Terminology

3.1 Except as defined in 3.2, the terminology used in this test method conforms with Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

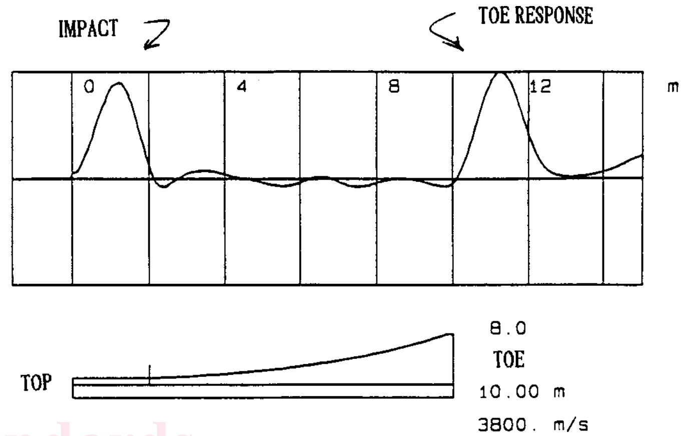

FIG. 1 Typical Velocity Traces Generated by the Apparatus for Obtaining Dynamic Measurements

3.2.1 *pile integrity*, *n*—the qualitative evaluation of the physical dimensions, continuity of a pile, and consistency of the pile material.

3.2.2 *pile impedance*, *n*—the dynamic Young's modulus of the pile material multiplied by the applicable cross sectional area of the pile and divided by the strain wave speed.

3.2.3 *pulse echo method*, *n*—test in which measurements of the pile head velocity and force (force measurement optional) are evaluated as a function of time.

3.2.4 *transient response method*, *n*—test in which the ratio of velocity transform to force transform (force measurement required) are evaluated as a function of frequency.

4. Significance and Use

4.1 Low strain integrity testing provides velocity and force (optional) data on structural elements (that is, structural columns, driven concrete piles, cast in place concrete piles, concrete filled steel pipe piles, timber piles, etc.). This data assists evaluation of pile integrity and pile physical dimensions (that is, cross-sectional area, length), continuity, and consistency of the pile material. This test method will not give information regarding the pile bearing capacity.

4.1.1 *Methods of Testing*

4.1.1.1 *Pulse Echo Method (PEM)*—The pile head motion is measured as a function of time. The time domain record is then evaluated for pile integrity.

4.1.1.2 *Transient Response Method (TRM)*—The pile head motion and force (measured with an instrumented hammer) are

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.11 on Deep Foundations.

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[2] Low-strain dynamic testing is a nondestructive method using lightweight equipment to assess only the integrity of the pile shaft.

[3] *Annual Book of ASTM Standards*, Vol 04.02.

[4] *Annual Book of ASTM Standards*, Vol 04.10.

[5] *Annual Book of ASTM Standards*, Vol 04.08.

measured as a function of time. The data are evaluated usually in the frequency domain.

5. Apparatus

5.1 *Apparatus for Applying Impact*

5.1.1 *Impact Force Application*—The impact may be delivered by any device (for example, a hand held hammer) that will produce an input force pulse of generally less than 1 ms duration and should not cause any local pile damage due to the impact. A hammer with a very hard plastic tip can induce a short input force pulse without causing local pile damage. The impact should be applied axially to the pile (normally on the pile head).

5.2 *Apparatus for Obtaining Measurements*

5.2.1 *Velocity Measurement*—Obtain velocity data with (one or more) accelerometers, provided the acceleration signal(s) can be integrated to velocity in the apparatus for reducing data. The accelerometer(s) should be placed at (or near) the pile head and shall have their sensitive axis parallel with the pile axis. Accelerometers shall be linear to at least 50 *g*. Either A/C or D/C accelerometers can be used. If A/C devices are used, the time constant shall be greater than 0.5 s and the resonant frequency shall be at least 30 000 Hz. If D/C devices are used, they shall have frequency response up to 5 000 Hz with less than −3 dB reduction of content. Alternatively, velocity or displacement transducers may be used to obtain velocity data, provided they are equivalent in performance to the specified accelerometers. Calibrate the transducer to an accuracy of 5 % throughout the applicable measurement range. If damage is suspected during use, recalibrate or replace the accelerometer.

5.2.2 *Force Measurement (optional)*—The impact device shall be capable of measuring the impact force as a function of time. The hammer may have a force load cell between the tip and hammer body. Alternatively, the hammer may have an accelerometer attached and the measured acceleration may be converted to force using the hammer mass. The force calibration shall be within 5 %. The hammer must be tuned such that the fourrier transform of the measured force shall have a smooth spectrum, without any local peaks.

5.2.3 *Placement of Transducers*—The motion sensor should be placed at or near the pile head using a suitable, or temporary, bonding material (that is, wax, vaseline, etc.) so that it is assured that it correctly measures the axial pile motion (transducer axis of sensitivity aligned with the pile axis). The motion sensor is placed generally near the center of the pile. Additional locations should be considered for piles with diameters greater than 500 mm. The low strain impact should be applied to the pile head within a distance of 300 mm from the motion sensor. If the pile head is not accessible, as when already integral with the structure, the sensor(s) may be attached to the side of the pile shaft.

5.3 *Signal Transmission*—The signals from the sensors shall be conveyed to the apparatus for recording, reducing, and displaying the data, see 5.4, by a low noise shielded cable or equivalent.

5.4 *Apparatus for Recording, Reducing and Displaying Data*:

5.4.1 *General*—The signals from the motion and force (optional) sensors, see 5.2, shall be conveyed to an apparatus for recording, reducing, and displaying data as a function of time. The apparatus shall include a graphic display of velocity and force (optional), and a data storage capability for retrieving records for further analysis. The apparatus should be capable of averaging data of several blows to reinforce the repetitive information from soil and pile effects while reducing random noise effects. The apparatus shall be able to apply increasing intensity amplification of the motion signal with time after the impact to enhance the interpretation of the measured motions that are reduced by soil and pile material damping. The apparatus must have filtering capability with variable frequency limits for eliminating high frequency, or low frequency signal components, or both. The apparatus shall be capable of transferring all data to a permanent storage medium. The

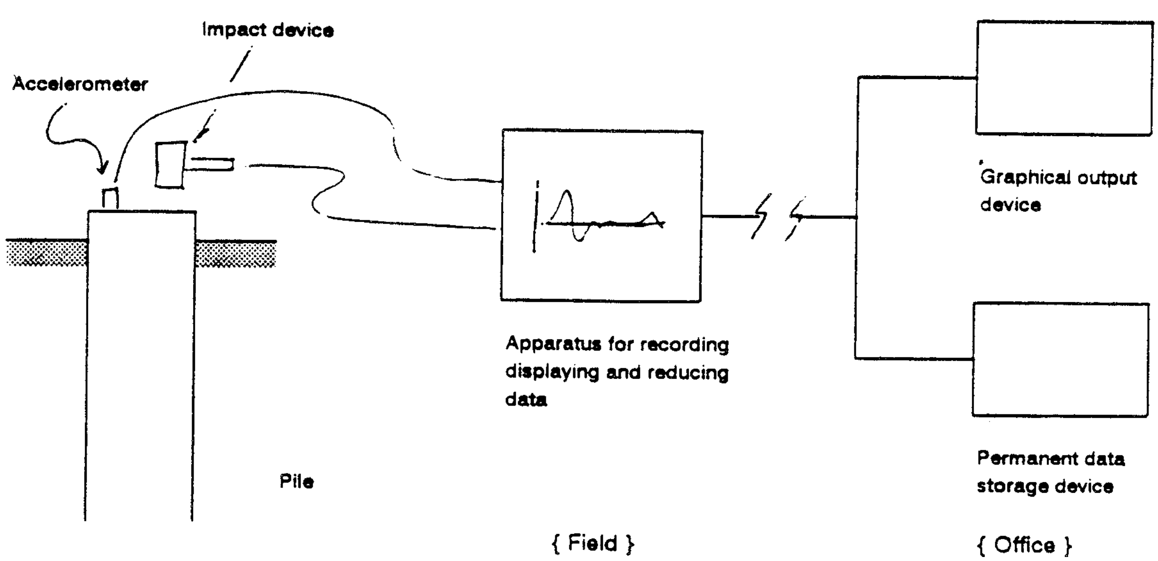

FIG. 2 Schematic Diagram of Apparatus for Integrity Testing