INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS

FIELD DETERMINATION OF STRENGTH USING DYNAMIC CONE PENETROMETER ITM No. 509-25

1.0 SCOPE.

1.1 This method covers the procedure for determination of the strength of materials using a Dynamic Cone Penetrometer (DCP).

1.2 The DCP may be used for clay, silty, or sandy soils, granular soils, chemical modified soils, or as directed by the Department. Structure backfill sizes 1 in., 1/2 in., No. 4 and No. 30 shall be tested with the DCP.

1.3 This ITM may involve hazardous materials, operations, and equipment and may not address all of the safety problems associated with the use of the test method. The user of the ITM is responsible for establishing appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2.0 REFERENCES.

2.1 AASHTO Standards.

T 99 Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

2.2 ASTM Standards.

D6951 Use of the Dynamic Cone Penetrometer in Shallow Pavement Applications

2.3 ITM Standards.

ITM 512 Field Determination of Maximum Dry Density and Optimum Moisture Content of Soil

3.0

TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101 and the following:

3.1 **Soil.** Cohesive material with more than 35% passing the No. 200 sieve. Clay, silty, and sandy soils are determined by the maximum dry density in accordance with AASHTO T 99 or ITM 512 using the Department Family of Curves and are defined as follows:

3.1.1 **Clay Soil.** Soil with a maximum dry density of 114 lb/ft^3 or less

3.1.2 Silty Soil. Soil with a maximum dry density greater than 114 lb/ft^3 and less than or equal to120 lb/ft^3

3.1.3 Sandy Soil. Soil with a maximum dry density greater than 120 lb/ft^3

3.2 Granular Soil with aggregate. Soil that is non-cohesive with 35 % or less material passing the No. 200 sieve.

3.3 Chemical Modified Soil. Soil that has been modified with portland cement, fly ash, lime, or a combination of these materials.

4.0 SIGNIFICANCE AND USE.

4.1 This test method is used to assess in situ strength of undisturbed soil, compacted soil and granular material. The penetration rate of the DCP may be used to estimate and identify strata thickness, shear strength of strata, and other material characteristics.

5.0 APPARATUS.

5.1 Dynamic Cone Penetrometer (Appendix A), with a 17.6 lbm steel drop hammer located between the handle and coupler assembly on a 0.625 in. diameter steel rod. The steel rod is required to be a minimum of 24 in. in length and be threaded on both ends to allow the attachment of a cone on one end and an anvil on the other end. The distance from the bottom of the hammer to the coupler assembly is 22.6 in. On the bottom of the rod is a replaceable hard sharp conical tip with an included angle of 60° and a diameter at the base of 0.79 in. (Note 1) The rod shall have 0.5 in. graduations. A ruler may be used to indicate the required penetration of the DCP on the steel rod.

The following table shows the important characteristics of the Dynamic Cone Penetrometer.

Mass of the Drop Hammer	Rod Size	Rod Length	Hammer Drop Height	Cone Angle
17.6 lbm	0.625 in. diameter	24 in. min	22.6 in	60°

Note 1 – A disposable cone may be used in chemically modified or other hard soils to avoid damage to the equipment, which may be caused by driving the hammer upward to extract the cone from the soil.

6.0 PROCEDURE

6.1 Check the DCP components for deficiencies, replace any damaged part, and assemble the equipment as shown in Appendix A. All joints are required to be securely tightened.

6.2 While testing on the granular soils, b borrow, or structural backfill, DCP sinks by its own weight. The steel rod should be marked and then the blow count should be recorded from the marking.

6.3 Verify that the graduated rod (Note 2) and cone, or cone adapter when using a disposable cone, are free of materials from the previous use.

Note 2 – The length of the graduated rod ranges from 24 in. to 40 in. The Department may select the length used based on a safe operating condition.

6.4 Scrape any loose material away from the site to be tested.

6.5 Hold the DCP in a vertical or plumb position by the handle, and seat the cone such that the cone base is flush with the surface of the material to be tested. The DCP is held by the anvil. The initial reading is taken from the cone base. Do not record the number of blows required to seat the cone to the cone base. When performing the test do not keep hand beneath the hammer.

6.6 Raise the hammer to the handle at the top of the upper rod without impacting the handle. Let the hammer drop freely on the anvil to drive the cone into the material. (Note 3)

Note 3 – Large aggregates or rock strata may stop or deviate the DCP penetration. If after several blows relatively little penetration is achieved, the DCP is required to be moved 1 ft away from the initial test site and a new test conducted.

6.7 Count the number of blows for the required penetration of the DCP into the material. The penetration of the DCP depends on the material variability and resistance of the material. If the DCP does not penetrate the required depth of material after 25 blows, the test is discontinued, and the material is considered to be in compliance with the strength requirements. (Note 4)

Note 4 – A DCP blow count verification test should be performed by excavating the soils to the depth of 2 ft when soils are not chemically modified or stabilized.

6.8 Remove the DCP rod from the material by carefully raising the hammer to strike the bottom until the DCP is free from the material. (Note 5)

Note 5 – Care is required to be taken to keep the DCP vertical or plumb during the extraction process to prevent bending of the rod. Do not rock the rod back and forth or in a circle to free the device from the material. The extraction of the rod in chemically

modified is easier with a disposable cone.

6.9 When transporting the DCP, do not allow a horizontally-laying rod to support the weight of the hammer. The DCP should be disassembled, placed in the case, or placed horizontally with the hammer resting next to the anvil. Both the upper and lower rod will bend if they are required to support the weight of the hammer.

6.10 The DCP case should be securely stored for transportation.

7.0 ACCEPTANCE CRITERIA.

7.1 Clay Soil. For clay soil, the strength of the soil is measured after completion of the compaction of each 6 in. of the soil. The number of blows of the DCP is measured for a penetration of 6 in. into the soil.

7.2 Silty Soil. For silty soil, the strength of the soil is measured after completion of compaction for each 12 in. of the soil. The number of blows of the DCP is measured for a penetration of 12 in. into the soil.

7.3 Sandy Soil. For sandy soil, the strength of the soil is measured after completion of compaction for each 12 in. of the soil. The number of blows of the DCP is measured for a penetration of 12 in. into the soil.

7.4 Chemically Modified Soils. For chemically modified soils, the strength of the soil is measured after completion of the compaction of each type of chemical modification.

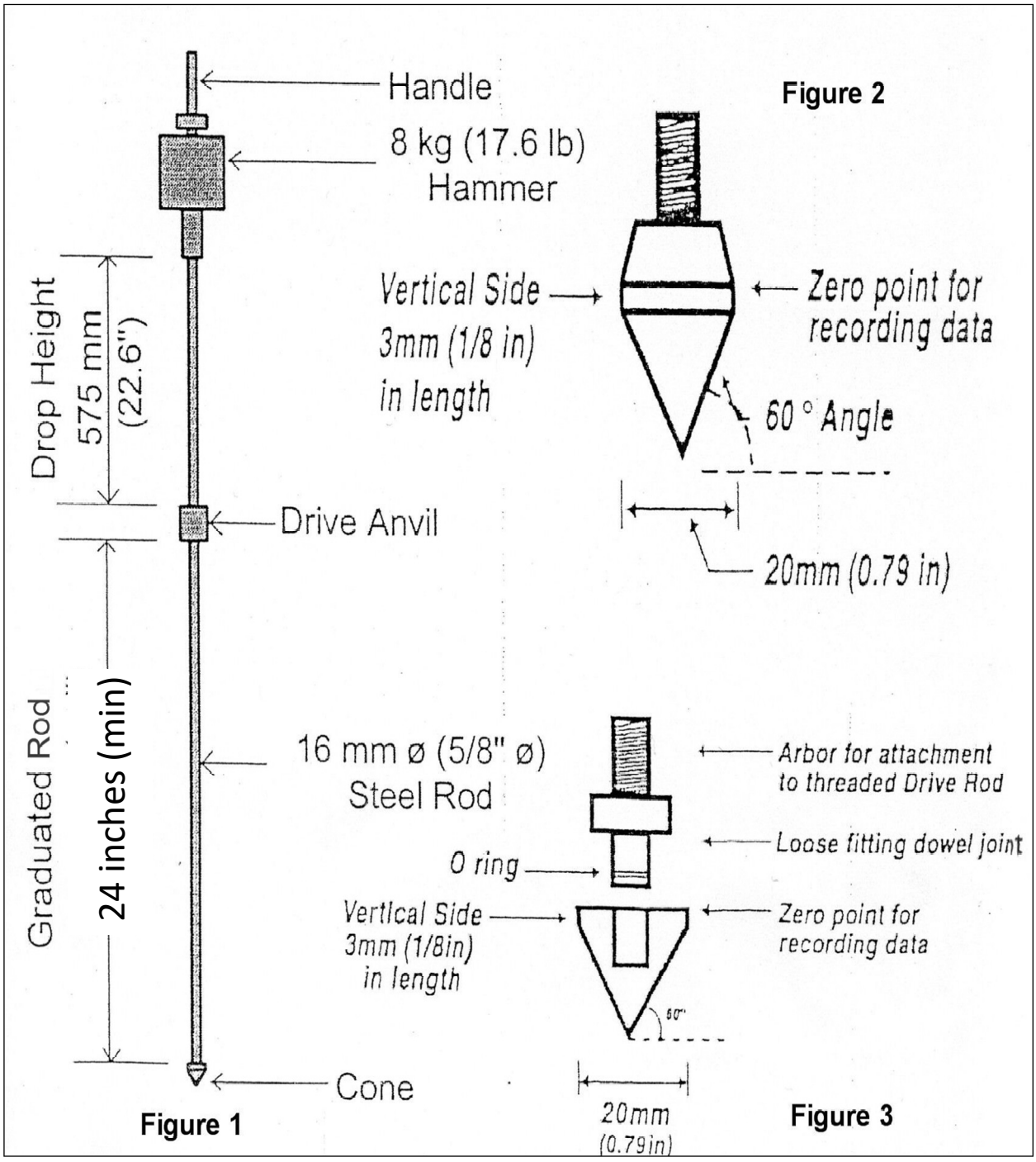
7.4.1 For a 14 in. lift, the number of blows of the DCP is measured initially for a penetration of the top 6 in. of the lift. A separate number of blows of the DCP is measured for a penetration into the bottom 8 in. of the lift.

When the DCP does not penetrate the required depth of chemically modified soils after 25 blows, the test is discontinued, and the chemically modified soils is considered to be in compliance with the strength requirements.

7.5 Granular Materials. For granular materials, the strength of the material is measured after completion of compaction for each 12 in. of the material. The number of blows of the DCP is measured for a penetration of 12 in. into the granular material.

8.0 REPORT.

Report the number of blows to obtain the required penetration of the DCP.


Handle
8 kg (17.6 lb)
Hammer
Drop Height
575 mm
(22.6")
Drive Anvil
Graduated Rod
24 inches (min)
16 mm ø (5/8" ø)
Steel Rod
Cone
Figure 1
Figure 2
Vertical Side
3mm (1/8 in)
in length
Zero point for
recording data
60 ° Angle
20mm (0.79 in)
Arbor for attachment
to threaded Drive Rod
Loose fitting dowel joint
O ring
Vertical Side
3mm (1/8in)
in length
Zero point for
recording data
60°
20mm
(0.79in)
Figure 3