

STANDARDS AUSTRALIA

RECONFIRMATION

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Methods of testing soils for engineering purposes

Method 6.5.1: Soil strength and consolidation tests—Determination of the static cone penetration resistance of a soil—Field test using a mechanical and electrical cone or friction-cone penetrometer

RECONFIRMATION NOTICE

Technical Committee CE-009 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 13 June 2013.

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NOTES

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Methods of testing soils for engineering purposes**Method 6.5.1: Soil strength and consolidation tests — Determination of the static cone penetration resistance of a soil — Field test using a mechanical and electrical cone or friction-cone penetrometer**

1 SCOPE This method applies to the determination of the static cone penetration resistance of a soil in the field, using a cone penetrometer, and additionally the sleeve skin friction and friction ratio of a soil in the field, using a friction-cone penetrometer (see Note 1).

2 APPARATUS The following apparatus shall be used:

- (a) *Penetrometer* A penetrometer, similar in general features to the type illustrated in Figures 1 or 2. The penetrometer point shall be a cone of 60 ± 2 degrees point angle, and a base diameter of 35.7, +0, -0.4 mm, resulting in a projected area of 1000 mm².

The cone shall be made from steel of a type and hardness to resist wear due to abrasion by soil, and shall have a surface finish equivalent to a ground-machined surface. Periodically check the dimensions of the cone and replace it when the dimensions no longer meet the specifications above.

As the method permits a variety of penetrometers to be used, the main features of each type are as follows:

- (i) *Simplified cone penetrometer — mechanical* Figure 1 shows the design of a typical simplified static cone penetrometer. The push rod is connected directly to the cone with the diameter of the push rod being about 8 mm less than that of the cone.
- (ii) *Cone penetrometer — mechanical* Figure 2 shows the design and action of a typical static cone penetrometer. A mantle of reduced diameter is attached above the cone, to minimize soil contamination of the sliding mechanism. This mechanism shall permit a downward movement of the cone, in relation to the outer sleeve, of at least 40 mm.
- (iii) *Friction-cone penetrometer — mechanical* Figure 3 shows the design and action of a typical mechanical friction-cone penetrometer.

The lower part of the tip, including a mantle attached to the cone point, advances first until the friction sleeve and then both advance. This mechanism shall permit a downward movement of the cone in relation to the outer sleeve of at least 40 mm in each phase.

The friction sleeve shall have the same outside diameter as the base diameter of the cone, viz 35.7 +0.5 –0 mm. No other part of the penetrometer shall project outside this diameter. The surface area of the sleeve shall be either 10,000 mm² or 15,000 mm² ±1 percent. The sleeve shall be made from steel with a smoothness equivalent to a ground machined surface. Periodically check the dimensions of the sleeve and replace it when it no longer meets specification.

- (iv) *Cone penetrometer—electrical* Figure 4 shows a typical design for an electrical cone penetrometer tip. The cone resistance is measured by a force transducer fitted to the cone.
- (v) *Friction-cone penetrometer—electrical* Figure 5 shows a typical design for an electrical friction-cone penetrometer tip. The friction force on the friction sleeve is measured separately from the cone resistance. An electric cable transmits the transducer signals to the surface data acquisition system.
- (b) *Rod assembly* The rods shall be of material and section adequate to sustain the maximum load from the thrust machine or to advance the cone, as applicable, without buckling in an unsupported length of 1.5 m. (see Note 2). The rod assembly for the penetrometers shall be as follows:
 - (i) *Simplified cone penetrometer—mechanical* Push rod(s) connected directly to the cone and of sufficient length to penetrate the depth required. The diameter of the rods shall be about 8 mm less than the diameter of the cone.
 - (ii) *Cone and friction-cone penetrometers—mechanical* The rod assembly consists of two parts as shown in Figures 2 and 3. The first part consists of a solid inner rod, which transmits the load from the thrust machine to the cone-plus-friction sleeve. The second part consists of a tubular outer rod with screwed flush joints, which transmits the thrust to advance the complete penetrometer tip. The outer rod, which also provides support for the inner rod, shall have a constant internal diameter and the rod assembly shall be free of any distortion, so that the clean lightly oiled inner rod is able to move freely inside the outer rod.

For a length of at least 1 m above the penetrometer, the external diameter of the outer rod shall not be greater than the diameter of the base of the cone.

The rods shall form a rigid-jointed string and shall have —

- (A) a smooth surface;
- (B) a constant external diameter;
- (C) screwed flush joints;
- (D) a continuous straight axis; and
- (E) a length the same as the outer rods ±0.1 mm.

The radial clearance between the inner and outer rods shall be between 0.5 and 1.0 mm.

- (iii) *Cone and friction-cone penetrometers—electrical* Electrical penetrometers require only tubular push rods with an internal diameter sufficient for passage of the electrical measuring cable, where this is used. The rods shall be of material and section adequate to sustain the maximum thrust of the machine, without buckling in an unsupported length of 1.5 m. The external diameter of the rods shall be no greater than the diameter of the base of the cone for a length of 1 m above the base. The rods shall have screwed flush joints and form a rigid-jointed string with a continuous straight axis (see Figures 4 and 5).

- (c) *Measuring equipment* The applied thrusts may be measured by any suitable device (e.g. a load ring, an hydraulic or electric load cell). The equipment shall measure the thrust to an accuracy of ± 2 percent of the mechanical thrust or 200 N, whichever is the greater.

The outputs from the electrical force transducers may be read and recorded by suitable devices. The equipment shall have an accuracy of $\pm 2\%$ of the maximum force or 200 N, whichever is the greater. It has been found convenient to obtain continuous penetration records on a strip chart recorder.

- (d) *Thrust machine* The thrust machine shall be capable of forcing the penetrometer and rod assembly into the soil at a constant rate and with a continuous stroke over a distance greater than one rod length. Deep penetrometer soundings usually require a thrust of at least 45 kN, and some machines have capacities in the range of 100 to 200 kN. A capacity of 100 kN should be adequate for all but exceptional circumstances.

The machine shall be fitted with a suitable rod guide at its base, to prevent significant bending of the rods between the machine and the ground surface (see Note 3).

The machine shall also be provided with some means of measuring depth of penetration, such as a graduated metre rule mounted adjacent to the rod assembly.

- (e) *Reaction equipment* Additional reaction in excess of that provided by the mass of the thrust machine is usually required (see Note 4).
- (f) *Friction reducer* (optional) The most common form of friction reducer is a rod with an enlarged diameter, fitted into the string of rods near the penetrometer tip (see Note 5).
- (g) *Spacers* If the test is carried out inside a cased borehole, suitable spacers shall be provided to prevent buckling of the rods (see Note 3).

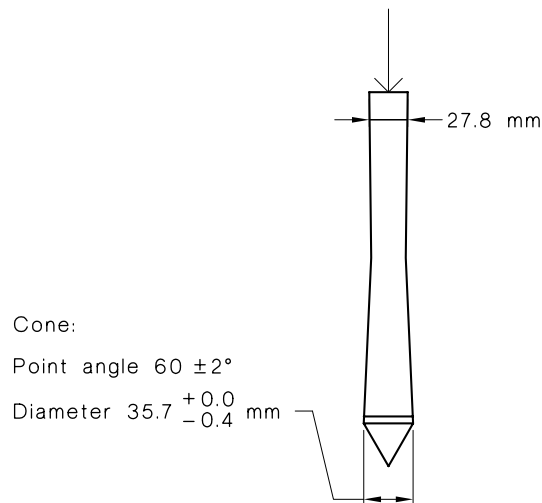


FIGURE 1 TYPICAL SIMPLIFIED CONE PENETROMETER