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( Reaffirmed 1987 )

*Indian Standard*

METHOD FOR  
SUBSURFACE SOUNDING FOR SOILS

PART II DYNAMIC METHOD USING CONE AND  
BENTONITE SLURRY

( *First Revision* )

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**BUREAU OF INDIAN STANDARDS**  
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NEW DELHI 110002

# Indian Standard

## METHOD FOR SUBSURFACE SOUNDING FOR SOILS

### PART II DYNAMIC METHOD USING CONE AND BENTONITE SLURRY

( *First Revision* )

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*Indian Standard*METHOD FOR  
SUBSURFACE SOUNDING FOR SOILSPART II DYNAMIC METHOD USING CONE AND  
BENTONITE SLURRY*( First Revision )*

## 0. FOREWORD

**0.1** This Indian Standard ( Part II ) ( First Revision ) was adopted by the Indian Standards Institution on 22 December 1976, after the draft finalized by the Soil Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

**0.2** Dynamic cone penetration test is a simple device for probing the soil strata and it has an advantage over the standard penetration test that making of a bore hole is avoided. Moreover, the data obtained by cone test provides a continuous record of soil resistance. The resistance  $N_{cbr}$  ( see Note ) to penetration in terms of blows per 30 cm of penetration of the cone specified in this standard and developed by the Central Building Research Institute, Roorkee, has been co-related quantitatively to the standard penetration value  $N$  obtained in accordance with IS:2131-1963\*. Studies with a view to establish a definite co-relation between  $N_{cbr}$  and  $N$  values for different regions of the country are in progress. The Sectional Committee responsible for the preparation of this standard decided to publish this standard in the meantime so that it could serve as a basis of test to various investigators and others engaged in subsurface exploration for foundations and thus make the results of investigations comparable.

NOTE — The resistance to penetration in the standard penetration test ( IS : 2131-1963\* ) shall be designated as  $N$ , that to a 50 mm cone [ see IS : 4968 ( Part I ) - 1976† ] as  $N_{cd}$  and that to a 62.5 mm cone using bentonite slurry as  $N_{cbr}$ .

**0.3** This standard was first published in 1968. In this revision several changes have been made taking into consideration the experience gained in conducting the test and in the manufacture of the equipment. The major changes made relate to the material of the cone and the hammer,

\*Method for standard penetration test for soils.

†Method for subsurface sounding for soils. Part I Dynamic method using 50 mm cone without bentonite slurry. ( *first revision* ).

and the criteria for stopping of the driving of the cone. The diameter of the cone has been changed to 62.5 mm and the provision permitting the use of cones of other diameters has been withdrawn. Additional information has been given on the bentonite slurry used in the test. Correlations between  $N_{cbr}$  and  $N$  values have also been included.

**0.4** Correlation between cone penetration values obtained using 62.5 mm cone ( $N_{cbr}$ ), and penetration values obtained by other methods may be developed for a given site by conducting the latter tests adjacent (about 3 to 5 m) to the location of the cone test. However, for medium to fine sands the following relationships between the standard penetration value ( $N$ ) obtained in accordance with IS:2131-1963\* and the cone penetration value ( $N_{cbr}$ ) in accordance with method specified in this standard [IS:4968 (Part II)] have been developed by the Central Building Research Institute, Roorkee. These relationships when utilized shall be used with caution.

- a) When the 62.5 mm cone is driven dry up to 9 m (without bentonite slurry):

$$N_{cbr} = 1.5 N \text{ .....up to a depth of 4 m}$$

$$N_{cbr} = 1.75 N \text{ .....for depths of 4 to 9 m}$$

- b) When the 62.5 mm cone is penetrated by circulating slurry:

$$N_{cbr} = N$$

**0.5** In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practice in the field in this country.

**0.6** In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS:2-1960†.

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## **1. SCOPE**

**1.1** This standard (Part II) covers the procedure of dynamic driving of a 62.5 mm cone and thereby obtaining a record of resistance of the soil. The cone is directly driven into the ground and for eliminating the friction on the driving rods bentonite slurry is used. The use of bentonite slurry may not be necessary when the investigation required is up to a depth of 6 m only.

\*Method for standard penetration test for soils.

†Rules for rounding off numerical values (revised).

2. EQUIPMENT

2.1 Cone — The cone shall be of suitable steel with the tip hardened. The dimensions and the shape of the cone shall be as given in Fig. 1. The cone should be suitably threaded to enable it to be attached to A rods used for driving.

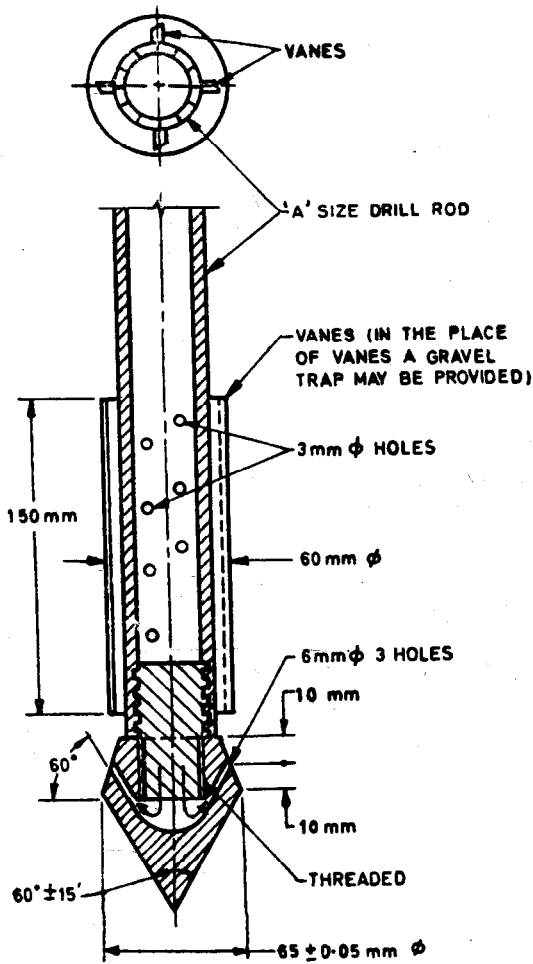


FIG. 1 CONE ASSEMBLY

**2.2 Driving Rods** — The rods used for the test should be *A* rods of suitable lengths with threads for joining *A* rod coupling at either end. The rods should be marked at every 100 mm.

NOTE — The outer and internal diameter of *A* rods are 41.27 and 28.57 mm respectively.

**2.2.1** Four mild steel vanes as shown in Fig. 1 (*see also 2.6*) shall be welded to the driving rod immediately above the cone. As an alternative, a gravel trap about 150 mm high of wire gauze of 5 mm mesh may be provided on the rod immediately above the cone.

**2.3 Driving Head** — The driving head shall be of mild steel with threads at either end for *A* rods coupling (*see Note under 2.2*). It shall have a diameter of 100 mm and a length of 100 to 150 mm.

**2.4 Hoisting Equipment** — Any suitable hoisting equipment, like a tripod may be used. The equipment shall be designed to be stable under conditions of impact of the hammer over the driving head when the cone is driven during the test. Provision shall be made to enable the operator to climb up the equipment for fixing the pulley, ropes, etc. A typical set up using a tripod is shown in Fig. 2. Suitable guides shall be provided for keeping the driving rods vertical and in position.

**2.5 Hammer** — The hammer used for driving the cone shall be of mild steel or cast iron with a base of mild steel. It shall be 250 mm high and of suitable diameter. The weight of the hammer together with the chain shall be 65 kg. It shall have a hole at the centre running throughout its length and of suitable diameter for the *A* rod (*see Note under 2.2*) and/or guide to pass freely through it. The clearance between the rod and/or guide and the hole in the hammer shall be about 5 mm.

NOTE — An automatic arrangement for controlling the drop of the hammer may be preferred if available.

**2.6 Pumping Unit for Bentonite Slurry** — It consists of slurry pump of capacity 35 to 45 l/min at a pressure of 700 to 850 kN/m<sup>2</sup> (7 to 8.5 kgf/cm<sup>2</sup>) with a suction hose assembly and a swivel assembly. For better circulation of slurry at greater depths a vane borer consisting of four vanes and a number of drill holes for the escape of slurry may be provided in between the driving rod and the cone (*see Fig. 1 and Fig. 2*).

### 3. PROCEDURE

**3.1** The vane shall be connected to the driving rods, with the vane borer/gravel trap in position. The driving head with the guide rod shall be fixed on the driving rods. This assembly shall be kept in position with the cone resting vertically on the ground at the point to be tested. For the circulation of slurry the guide rod shall be connected to a water

swivel preferably through a flexible tube connection and then through another flexible tube to the pumping unit for bentonite slurry. The swivel assembly shall be held in position by a rope passing over the pulley provided for that purpose. The slurry tank shall be filled with bentonite slurry of suitable consistency ( *see* Note ). The slurry should generally be prepared separately and stored in drums. The tank end of the inlet tube to the pump shall be provided with suitable protection against entry of debris and it shall be kept immersed in the slurry tank. The hammer, to which a rope has been attached for operation, shall be slid over the guide rod, to rest on the driving head. A typical assembly of the equipment for test using a tripod is shown in Fig. 2.

NOTE — In the case of medium to fine sand, 5 percent bentonite slurry has been found useful. In the case of coarse sand, slurry of thicker consistency subject to circulation requirements may be needed. In the case of hard water, addition of 1 percent soap solution has been found useful to get a better suspension of the bentonite.

**3.2** The cone shall be driven by allowing the 65 kg hammer to drop freely through a height of 750 mm on the driving head. A drum type winch fixed to central leg of the tripod may be used for lifting the drop weight provided the free fall of the hammer is not affected. The driving of the cone and the pumping in of the slurry shall be started simultaneously. Driving shall not be done for more than 30 cm at a time after which it shall be stopped for a minute or two. Pumping shall, however, be continued. This helps in keeping the hole lined and also avoids the choking of the holes provided in the cone. The driving rods shall be given a few turns ( about 4 or 5 turns ) every now and then so that the hole above the cone is maintained. Efficient circulation of slurry is necessary for eliminating friction on the rods. The number of blows for every 100 mm penetration of the cone shall be recorded. The process shall be repeated till the cone is driven to the required depth ( *see* Note ).

NOTE — In order to avoid damage to the equipment, driving may be stopped when the number of blows exceeds 35 for 100 mm penetration when the cone is driven dry and 20 for 100 mm penetration when the cone is penetrated by circulating slurry.

#### 4. REPORT

**4.1** The number of blows ( $N_{cbr}$ ) should be reported as a continuous record for every 300 mm penetration either in a tabular form or as a graph between  $N_{cbr}$  and depth. Records of the test shall also include the following:

- a) Date of probing;
- b) Location;
- c) Elevation of ground surface;



- d) Depth of water table and its likely variation, from available information;
- e) Total resistance at the required levels;
- f) Any interruptions in probing with reasons;
- g) Any other information available, for example, type of soil; and
- h) Diameter of the cone used in the test.

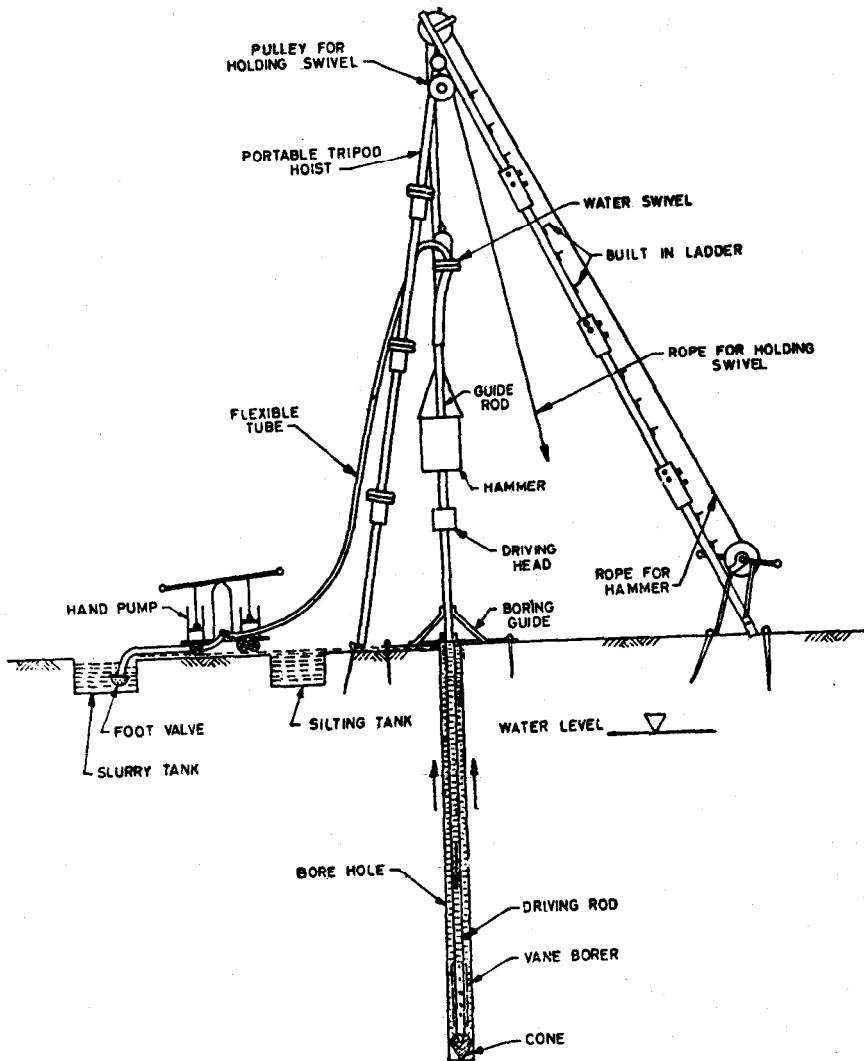


FIG. 2 A TYPICAL SET UP FOR DYNAMIC CONE PENETRATION TEST

( Continued from page 2 )

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