Method ST6

MEASUREMENT OF THE *IN SITU* STRENGTH OF SOILS BY THE DYNAMIC CONE PENETROMETER (DCP)

1. SCOPE

This method describes the determination of the rate of penetration of the Dynamic Cone Penetrometer (DCP) into a natural or compacted material by virtue of the built-in sliding hammer. The penetration rate is inversely proportional to the resistance of the ground to the penetration of the cone of the DCP and may be related, *inter alia*, to the *in situ* CBR or soil density (see 5.1).

2. APPARATUS

1. Dynamic Cone Penetrometer as illustrated in Figure ST6/1 with the appropriate spanners, spare cones, rods, etc. (See 5.2).
2. A pick or hand auger.
3. A spade.
4. A measuring tape, 2m long.
5. Traffic cones, warning signs and flags as required.

3. METHOD

Assemble the DCP as shown in Figure ST6/1 ensuring that the parts are fitting properly and that the hammer can slide freely. Place the tip of the cone on the site to be tested (see 5.2). Hold the DCP vertically and by means of a hammer knock the cone into the surface up to the zero mark, which is the parallel-sided shoulder portion (=3mm wide) just above the cone-shaped tip.

Attach the measuring rod to the DCP and zero the sliding scale.

While holding the DCP vertically, lift the hammer as far as it can go and allow it to fall freely and strike the anvil, driving the cone into the ground surface.

The penetration can be read off after each blow of the hammer or after as many blows as are practical or required for the purpose of the test (see 5.3). Record the penetration (to the nearest 1mm) and the number of blows on form ST6/1 or a similar form (see 5.4).

On completion of the test, the DCP is extracted by ramming the hammer against the upper stop - usually after the measuring scale has been detached to prevent damage (see 5.5).

The strength of layers deeper than the reach of the DCP can be measured by removing some or all of the overlying material with a pick and spade or using a hand auger. At the start of the test the depth below the original datum level of the material to be tested is measured, using a trace measure and recorded.

4. CALCULATIONS

4.1 The DCP penetration depths in mm are plotted against the number of blows on Form ST6/1 and a penetration curve is drawn, the angle of which is the penetration rate, known as the "DCP number" (DN) in mm/blow. A consistent slope angle thus indicates a consistent DN for that particular zone.

4.2 ***In situ* shear strength (CBR)**

From the curve, the DN (in mm/blow) at different zones or the mean over a chosen depth may be calculated to obtain the *in situ* shear strength of the particular zone. The DN of a specific zone is obtained by dividing the zone thickness by the number of hammer blows to penetrate that zone.

From Table 1 the equivalent *in situ* CBR value of that zone can be obtained.

TABLE 1

DCP number (mm/BLOW)	*IN SITU* CBR	DCP number (mm/BLOW)	*IN SITU* CBR
3	110	17	12
4	75	18	11
5	55	19	10
6	45	20	9
7	35	22	8
8	30	25	7
9	25	28	6
10	22	32	5
11	20	38	4
12	18	48	3
13	16	60-70	2
14	15	+80	1
15	14		
16	13		

5. NOTES

5.1 The DCP may be used to assess the density of a fairly uniform material by relating density to penetration rate (DN) on the same material. In this way under-compacted or "soft spots" can be identified even though the DCP does not measure density directly.

A field DCP measurement results in a field or *in situ* CBR and will normally not correlate with the laboratory or soaked CBR of the same material. The test is thus intended to evaluate the *in situ* strength of a material under prevailing conditions.

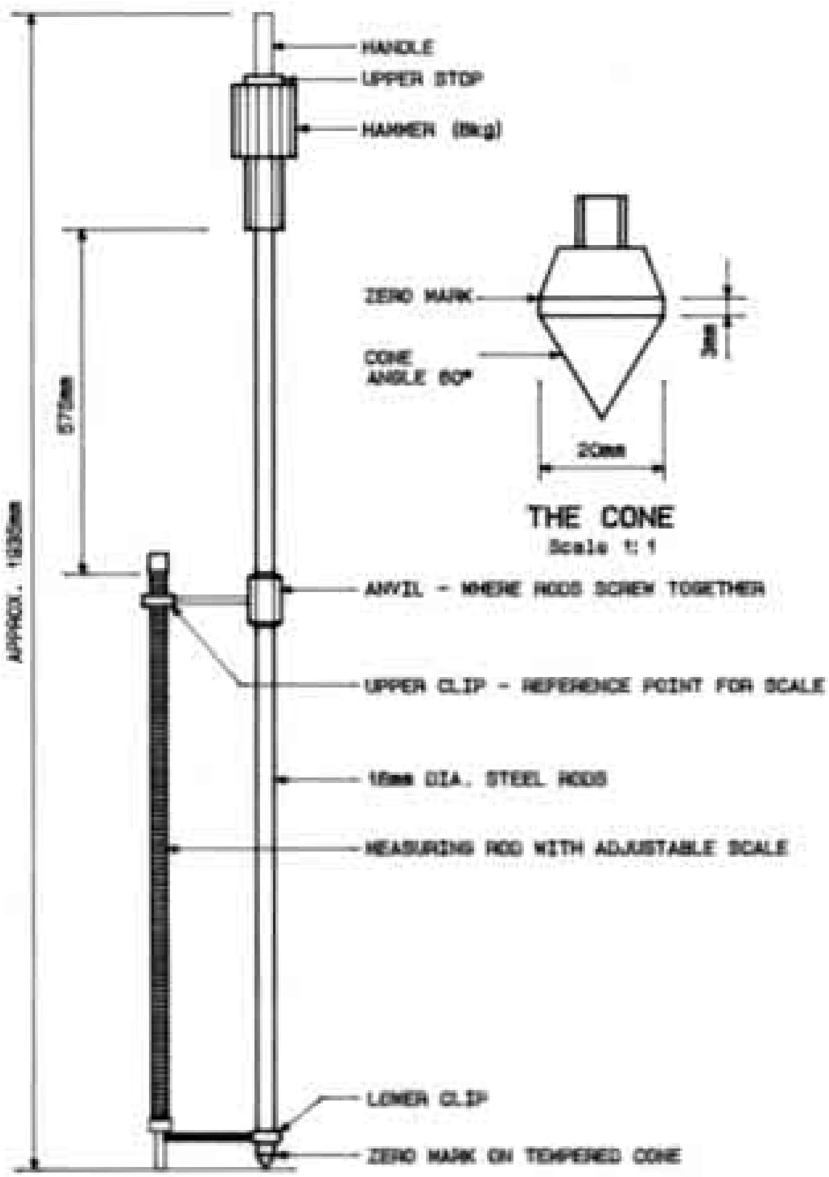
If a number of DCP penetrations have to be compared with one another (or with target values), or when the mean values for a section of road have to be estimated, the DN values may be recorded on the DCP layer-strength diagram as illustrated in Form ST6/2.

5.2 The cone must be replaced when its diameter has been reduced by 5 per cent or it has been visibly damaged.

5.3 Reading after each blow are recommended for thin layers, say up to 150mm thick, but readings after every fifth blow are usually sufficient. The regularity of readings also depends on the rate of penetration. Readings should be taken more often with very soft material than with resistant material.

5.4 The results may be plotted on the work sheet as the readings are taken, to get an immediate indication of the penetration rate for each layer.

5.5 If necessary, samples of the material can be taken after the DCP test using a hand auger, or a pick and shovel for harder material.



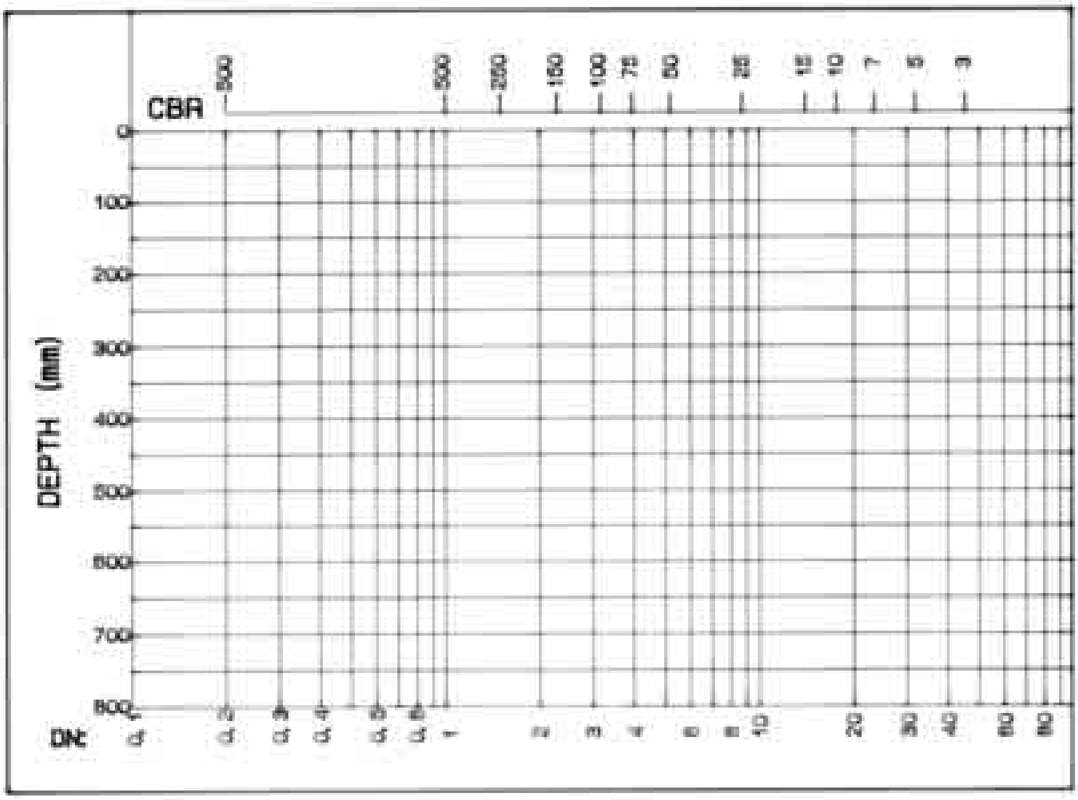
THE DYNAMIC CONE PENETROMETER

NOT TO SCALE

FIGURE ST6/1

ROAD ____________________

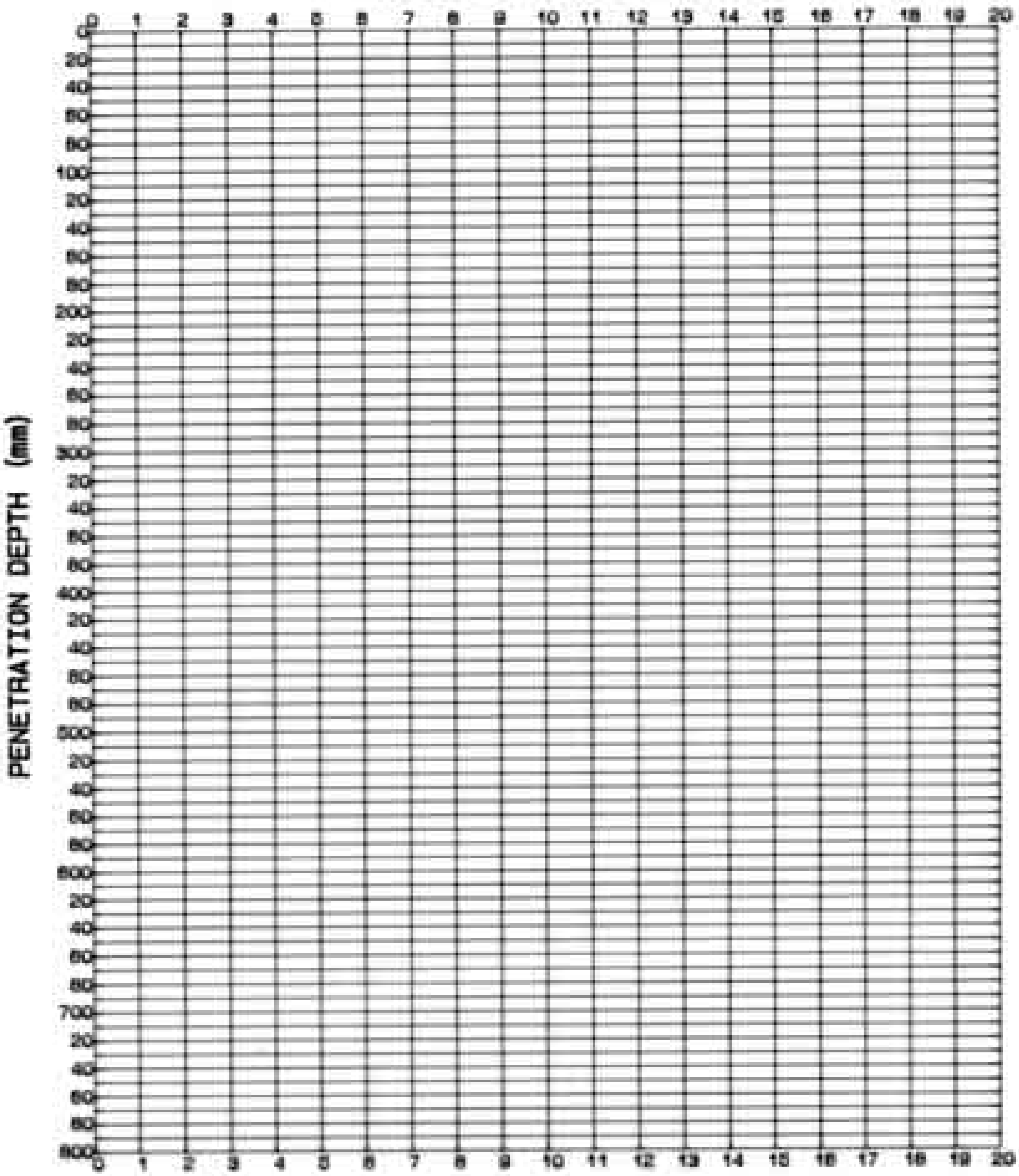
DISTANCE km ____________________ DATE ____________________



DCP LAYER - STRENGTH DIAGRAM

FORM ST6/2

ROAD ________ km ________ L | | X | | C/L | | | | R



DCP PENETRATION DEPTHS VERSUS NUMBER OF BLOWS

FORM ST6/1

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