5.2 Dynamic Cone Penetrometer (DCP) Test

5.2.1 General. The dynamic cone penetrometer (DCP) test was developed by Transport and Road Research Laboratory (TRRL), England. The DCP is an instrument designed for the rapid in-situ measurement of the structural properties of existing road pavements constructed with unbound materials. It is also used for determining the in-situ CBR value of compacted soil sub-grade beneath the existing road pavement. Continuous measurements can be made down to a depth of 800 mm or, when an extension rod is fitted, to a depth of 1200 mm. Where pavement layers have different strengths the boundaries can be identified and the thickness of the layers determined.

Correlations have been established between measurements with DCP and California Bearing Ratio (CBR) so that results can be interpreted and compared with CBR specifications for pavement design. Agreement is generally good over most of the range but differences are apparent at low values of CBR, especially for fine-grained materials. A typical test takes only a few minutes and therefore the instrument provides a very efficient method of obtaining information which would normally require the digging of test pits.

5.2.2 Apparatus. The DCP uses an 8kg weight dropping through a height of 575 mm and a 60° cone having a diameter of 20mm. The apparatus is assembled as shown in Figure 5.2.1. It has the following parts:

a) Handle
b) Top Rod
c) Hammer (8kg)
d) Anvil
e) Handguard Cursor
f) Bottom Rod
g) 1 Meter rule
h) 60° Cone
i) Spanners and tommy bar are used to ensure that the screwed joints are kept tight at all times.

The following joints should be secured with loctite or similar non-hardening thread locking compound prior to use:

(i) Handle/top rod
(ii) Anvil/bottom rod
(iii) Bottom rod/cone

5.2.3 Procedure

a) After assembly, the zero reading of the apparatus is recorded. This is done by standing the DCP on a hard surface, such as concrete, checking that it is vertical and then entering the zero reading in the appropriate place on the proforma (Form 5.2.1).
Figure 5.2.1 Dynamic cone penetrometer assembly
b) The instrument is held vertical as shown in Figure 5.2.2 and the weight carefully raised to the handle. Care should be taken to ensure that the weight is touching the handle, but not lifting the instrument, before it is allowed to drop and that the operator lets it fall freely and does not lower it with his hands.

*Note.* If during the test the DCP leaves the vertical no attempt should be made to correct this as contact between the bottom rod and the sides of the hole will give rise to erroneous results.

c) It is recommended that a reading should be taken at increments of penetration of about 10mm. However, it is usually easier to take a scale reading after a set number of blows. It is therefore necessary to change the number of blows between readings according to the strength of the layer being penetrated. For good quality granular bases readings every 5 or 10 blows are normally satisfactory but for weaker sub-base layers and sub-grades readings every 1 or 2 blows may be appropriate.

*Note.* There is no disadvantage in taking too many readings, however if readings are taken too infrequently, weak spots may be missed and it will be more difficult to identify layer boundaries accurately, hence important information will be lost.

d) After completing the test the DCP is removed by gently tapping the weight upwards against the handle. Care should be taken when doing this as if it is done too vigorously the life of the instrument will be reduced.

*Note 1.* Penetration rates as low as 0.5 mm/blow are acceptable but if there is no measurable penetration after 20 consecutive blows it can be assumed that the DCP will not penetrate the material. Under these circumstances a hole can be drilled through the layer using an electric or pneumatic drill or by coring. The lower layer can then be tested in the normal way. If only occasional difficulties are experienced in penetrating granular materials it is worthwhile repeating any failed tests a short distance away from the original test point.

2) Cone should be replaced when its diameter is reduced by 10 percent.

### 5.2.4 Calculation and expression of results

The results of the DCP test are usually recorded on a field data sheet similar to that shown in Form 5.2.1. The results can then either be plotted by hand Figure 5.2.3 or processed by computer. The boundaries between layers are easily identified by the change in the rate of penetration. The thickness of the layers can usually be obtained to within 10 mm except where it is necessary to core (or drill holes) through strong materials to obtain access to the lower layers. In these circumstances the top few millimeters of the underlying layer is often disturbed slightly and appears weaker than normal. Relationship between the DCP readings and CBR can be obtained by the following equation:

\[
\text{DCP - CBR percent} = \frac{3700}{(\text{Pen}_5)^{1.3}}
\]

The Pen$_5$ = Penetration in mm, every 5 blow interval. Relationship between the DCP reading and the CBR can also be found from Kley and Van Hearden graph as shown in Figure 5.2.4.
Figure 5.2.2 Dynamic Cone Penetrometer in Action
5.2.5 Report. The test report shall contain the following information:

a) The method of test used
b) Data sheet shall be included (Form 5.2.1)
c) Blows - Penetration depth curve (Figure 5.2.3) and CBR (%) value.

All other necessary information, needed by the client, should be added.
### DCP - TEST

**SITE/ROAD:** KENANA, SUDAN  
**DATE:**  
**TEST NO.:** 6  
**SECTION NO./CHAINAGE:** 2/48  
**ZERO READING OF DCP:** 60 mm  
**DIRECTION:** SOUTH  
**STARTED TEST AT:** TOP OF BITUMINOUS SURFACING  
**WHEEL PATH:** VERGE SIDE

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DCP Test Field Sheet

MAY 2001
Figure 5.2.3: DCP Test Result
Figure 5.2.4: DCP - CBR Relationship