OPERATING INSTRUCTIONS

Dynamic Cone Penetrometer

29-3720

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INTRODUCTION

The TRRL DCP (Dynamic Cone Penetrometer A2465) is an instrument designed for the rapid in-situ measurement of the structural properties of existing road pavements constructed with unbound materials. Continuous measurements can be made down to a depth of approximately 850mm or, when extension shafts are used (Figure 2) to a recommended maximum depth of 2 metres. Where pavement layers have different strengths the boundaries can be identified and the thickness of the layers determined.

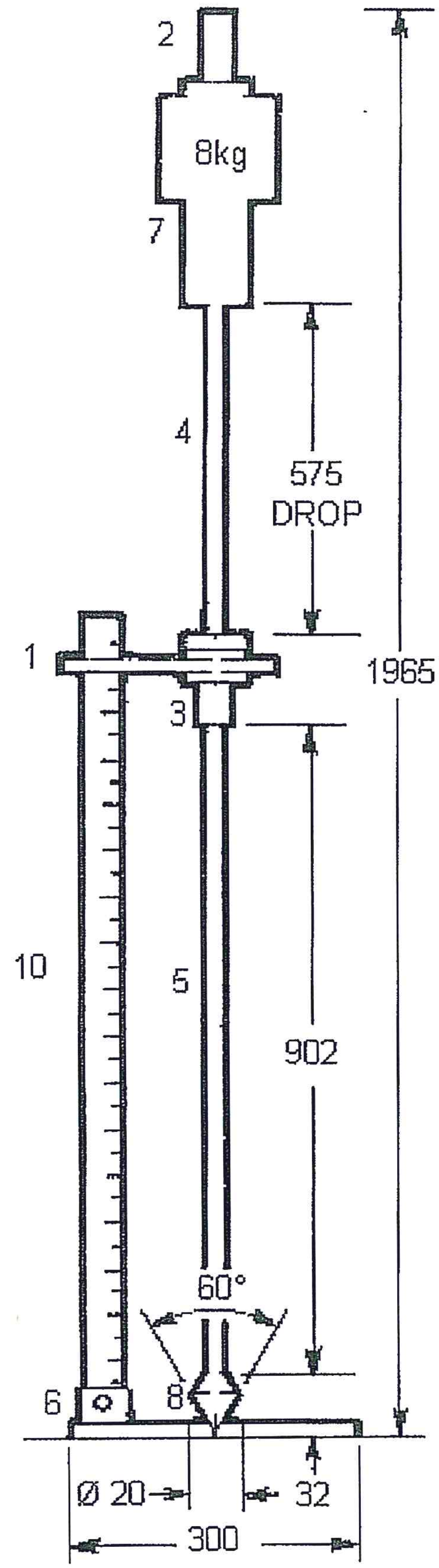
Correlations have been established in the earlier work (Van Vuuren 1969, Kleyn and Van Heerden 1983, Smith and Pratt 1983) between measurements with the DCP and CBR (California Bearing Ratio) so that results can be interpreted and compared with CBR specifications for pavement design. A typical test takes 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.

ASSEMBLY

The design of the DCP is similar to that described by Kleyn, Maree and Savage (1982) in that it uses an 8kg weight dropping through a height of 575mm and a 60° cone having a diameter of 20mm.

The instrument is assembled as shown in Figure 1. It is supplied with two 13—17mm AF Spanners, Tommy Bar, 3mm AF Hex Wrench and a bottle of 'Loctite 242' used for securing handle/top rod and bottom rod/cone joints (see parts list Figure 6).

Early instruments were usually split at the top rod/anvil joint for carriage and storage. Later models are split at the lower rod/anvil joint to facilitate the use of extension shaft sets. It is important that joints are checked regularly during use as operating the DCP with any loose joints will reduce the life of the instrument considerably.



A2465 ASSEMBLED DCP
Figure 1

OPERATION

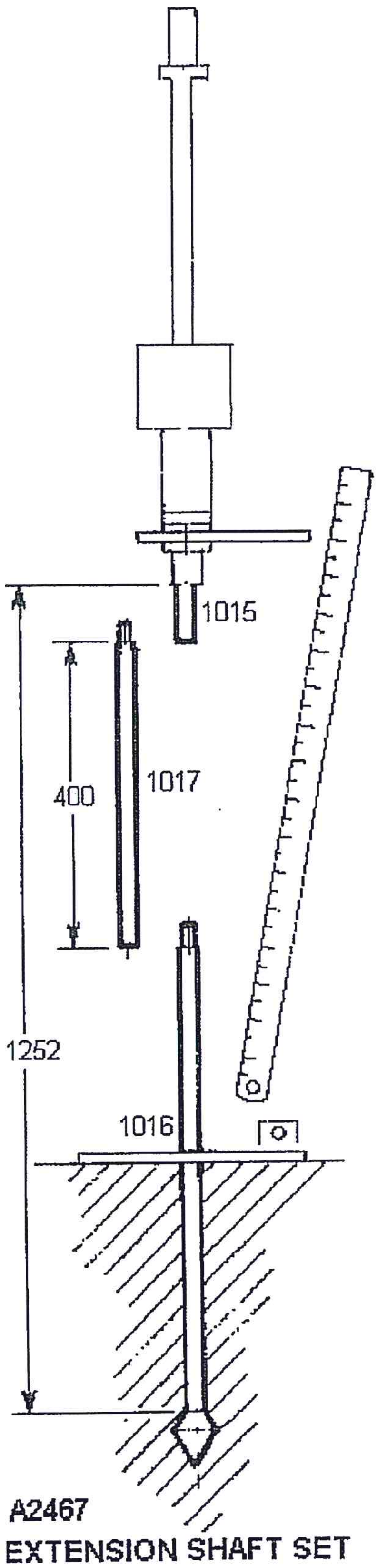
After assembly, the first task is to record the zero reading of the instrument. This is done by standing the DCP on a hard surface, such as concrete, checking that it is vertical and then entering the zero reading in the appropriate place on the test sheet (Figure 4).

The DCP needs three operators, one to hold the instrument, one to raise and drop the weight and one to record the results. The instrument is held vertical and the weight carefully raised to the handle ensuring that the weight is touching the handle, but not lifting the instrument. The operator then lets it fall freely (without lowering it by hand). If during the test the DCP leaves the vertical, no attempt should be made to correct this as contact between the bottom shaft and the sides of the hole will give rise to erroneous results.

It is recommended that a scale reading should be taken at increments of penetration of about 10mm. However it is usually easier to take a 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 the weaker sub-base layers and subgrade readings every 1 or 2 blows may be appropriate. There is no disadvantage in taking too many readings, but if too few are taken, weak spots may be missed and it will be more difficult to identify layer boundaries accurately hence important information will be lost.

When the extended version of the DCP is used (Figure 2) the instrument must be driven into the pavement to a depth of 500-600mm before the extension rod is added. To do this the metre rule has to be detached from its base plate and the bottom shaft split to accept the extension. After re-assembly a penetration reading should be taken before the test is continued.

After completing the test, the DCP is removed by gently tapping the weight upwards against the handle. <u>Care should be taken as if this is done too vigorously damage may result.</u>



A2467
EXTENSION SHAFT SET

Figure 2

Little difficulty is normally experienced with the penetration of most types of granular or lightly stabilised materials. It is more difficult to penetrate strongly stabilised layers, granular materials with large particles and very dense, high quality crushed stone. The instrument has been designed for strong materials and therefore the operator should persevere with the test. Penetration rates as low as 0.5mm/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 materials. Under these circumstances a hole can be drilled through the layer using an electric or pneumatic drill or by coring. The lower layers of pavement 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.

The DCP can be driven through both single and double surface dressings but it is recommended that thick bituminous surfacing should be cored prior to testing.

If the DCP is used extensively for hard materials, wear on the cone itself will be accelerated. The cone is a replaceable item and it is recommended by many authorities that replacement be made when the diameter has reduced by 10 per cent. However other causes of wear can also occur hence the cone should be inspected before every test. Typically the cone will need replacing after about 10 holes in hard material and in the absence of damage other than shoulder wear this is the recommended practice.

INTERPRETATION OF RESULTS

The results of the DCP test are usually recorded on a field test sheet similar to that shown in Figure 3. The results can then either be plotted by hand, as shown in Figure 4 or processed by computer. Alternative systems using field data loggers have also been developed.

Figure 3 and 4 illustrate a typical result. 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 10mm 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 millimetres of the underlying layer is often disturbed slightly and appears weaker than normal.

Relationships between the DCP readings and CBR have been obtained by several authors (Figure 5). The relationship derived by Kleyn and Van Heerden is based on the largest data set and is the one currently used by the TRRL Overseas Unit.

Agreement is generally good over most of the range but differences are apparent at low values of CBR, especially for fine grained materials. It is expected that for such materials the relationship between DCP and CBR will depend on material state, therefore the precise values are needed. It is advisable to calibrate the DCP for the materials in question. The user should consult the references for advice.

REFERENCES

KLEYN E.G., MAREE J.H. and SAVAGE D.F. (1982). The application of the pavement DCP determine the bearing properties and performance of road pavements. Proceedings of the International Symposium on bearing capacity of roads and airfields. Vol. 1, Trondheim, Norway (The Norwegian Institute of Technology).

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SMITH R.B. and PRATT D.N. (1983). A field study of in-situ California Bearing Ratio Dynamic Cone Penetrometer testing for road subgrade investigations. Australian Road Research 13(4) December 1983 pp 285-294. (Australian Road Research Board).

VAN VUUREN (1969). Rapid determination of CBR with the portable Dynamic Cone Penetrometer. Reprint from 'The Rhodesian Engineer'. September 1969.

Figure 3: EXAMPLE OF TYPICAL COMPLETED DCP FIELD TEST SHEET

SITE / ROAD *KENANA, SUDAN*	DATE *29-8-90*
	TEST NO. *6*
SECTION NO./CHAINAGE *2/48*	DCP ZERO READING *60* mm
DIRECTION *SOUTH*	TEST STARTED AT *TOP OF BITUMINOUS SURFACE*
WHEEL PATH *VERGE SIDE*	

NO. OF BLOWS	TOTAL BLOWS	READING MM	NO. OF BLOWS	TOTAL BLOWS	READING MM	NO. OF BLOWS	TOTAL BLOWS	READING MM
0	0	63	5	165	434			
10	10	75	3	168	457			
10	20	89	1	169	466			
10	30	99	1	170	477			
10	40	118	1	171	491			
10	50	130	1	172	513			
10	60	149	1	173	539			
10	70	166	1	174	565			
10	80	181	1	175	592			
10	90	204	1	176	620			
10	100	215	1	177	647			
10	110	230	1	178	664			
10	120	253	1	179	686			
5	125	269	1	180	705			
5	130	289	1	181	724			
5	135	307	1	182	744			
5	140	326	1	183	764			
5	145	347	1	184	784			
5	150	364	1	185	804			
5	155	385	1	186	824			
5	160	408						

Figure 4: EXAMPLE DCP TEST RESULT SUDAN

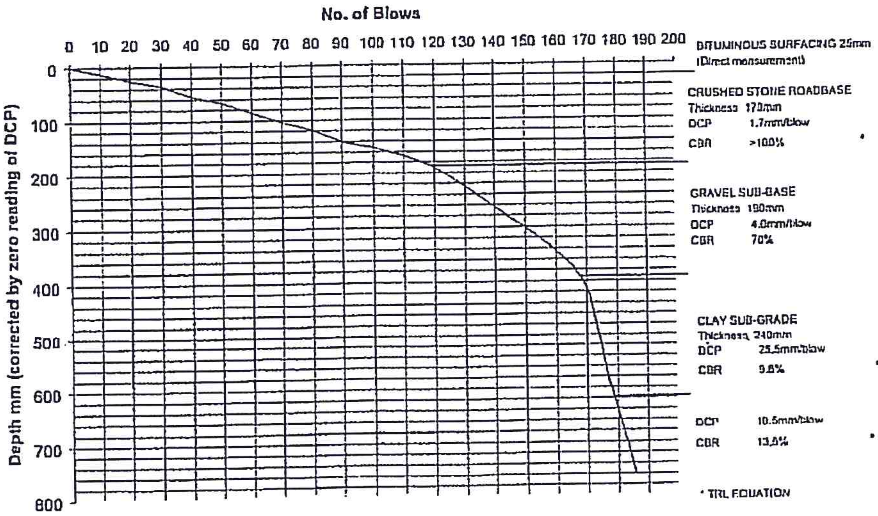
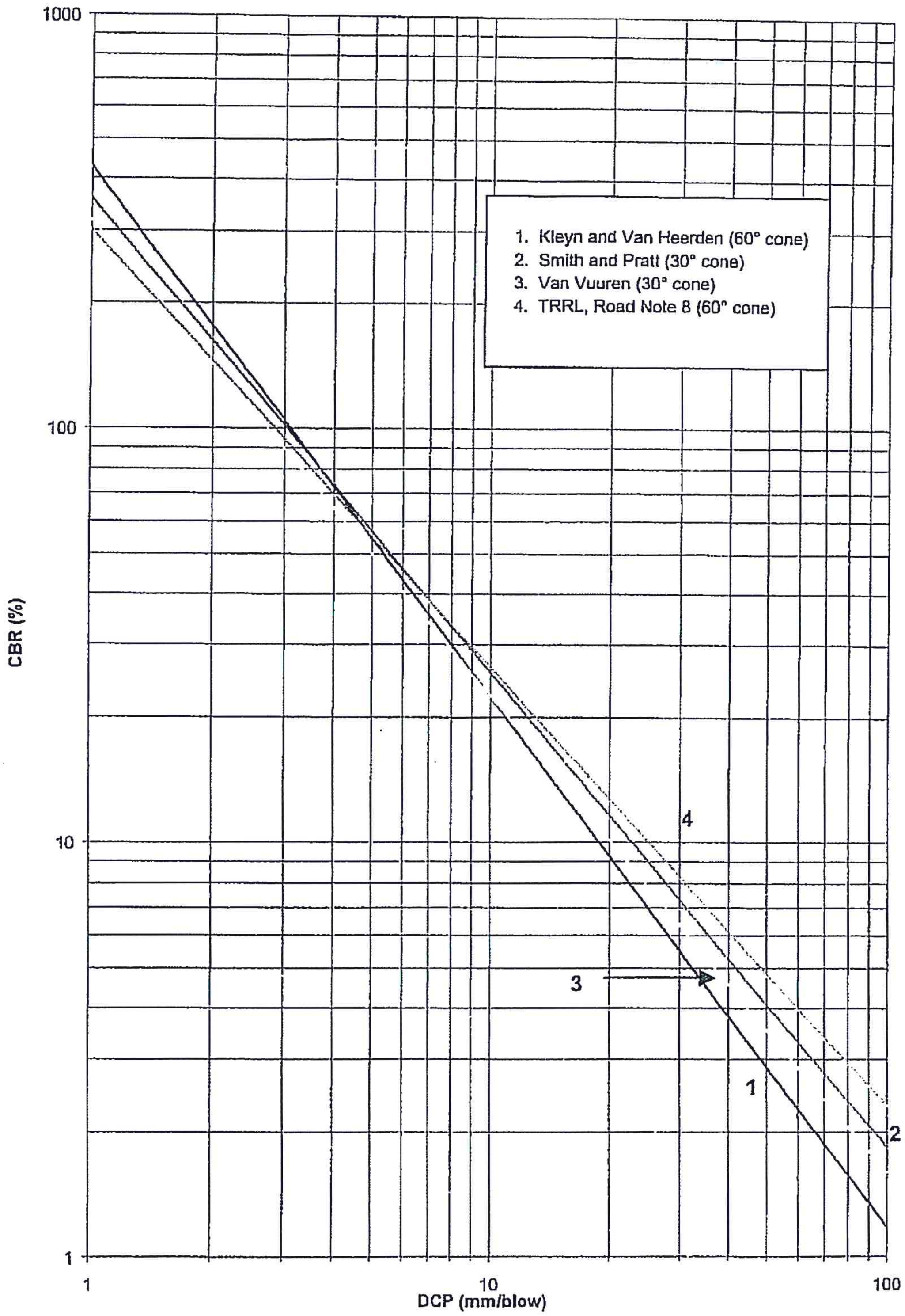


Figure 5: DCP - CBR RELATIONSHIPS



1. $\log_{10}(CBR) = 2.632 - 1.28 \log_{10}(\text{mm/blow})$
2. $\log_{10}(CBR) = 2.555 - 1.145 \log_{10}(\text{mm/blow})$
3. $\log_{10}(CBR) = 2.503 - 1.15 \log_{10}(\text{mm/blow})$
4. $\log_{10}(CBR) = 2.48 - 1.057 \log_{10}(\text{mm/blow})$

EXAMPLE FOR PHOTOCOPYING

SITE / ROAD	DATE
	TEST NO.
SECTION NO./CHAINAGE	DCP ZERO READING mm
DIRECTION	TEST STARTED AT
WHEEL PATH	

NO. OF BLOWS	TOTAL BLOWS	READING MM	NO. OF BLOWS	TOTAL BLOWS	READING MM	NO. OF BLOWS	TOTAL BLOWS	READING MM