

Determination of Equivalent Californian Bearing Ratio by Plate Bearing Test

Lab Test Reference 610

Test Procedure Reference

D Croney

1.1 Principle Apparatus

The plate bearing test was first developed in the United States as a design aid to the determination of pavement thickness for given wheel loading. Design charts were produced with curves relating to Modulus of Sub Grade Reaction to pavement thickness for differing traffic conditions. In the United Kingdom the pavement design procedure makes use of the laboratory CBR test which because of its limitations is unsuitable for in situ testing granular soils and clays containing gravel or aggregates such as boulder clay. A larger diameter plate typically 300mm or 450mm provides a method of assessing bearing capacity by measurement of penetration of a different load increments. Equivalent CBR values can be derived from the Modulus of sub grade reaction by use of mathematically devised relationship.

1.2

1.2.1 Hydraulic jack and pump capable of exerting a force of up to 10 tonnes.

1.2.2 Hydraulic, oil filled, load gauge to measure readings of force with scaled increments between 0-70KN.

1.2.3 Circular steel plates with handles, 20 to 25mm thick, 300 + 5mm and 450mm + 5mm diameter.

1.2.4 A complete datum bar assembly.

1.2.5 Three dial gauges and dial gauge supporting bars at least 450mm long. Dial gauges to be accurate to 0.01mm, with a travel of 50mm.

1.2.6 A quantity of fine sand on which to seat the plate.

1.2.7 Mobile Kentledge of 10 tonnes of suitable dimension and construction to allow hydraulic jack to be conveniently positioned under a chassis member.

1.2.8 Stop Watch.

1.3 Standard Test Method

1.3.1 The site to be tested must be in a reasonably prepared condition capable of allowing the mobile kentledge access without causing it to become bogged down.

1.3.2 The chosen position is prepared by first applying a layer of sand a few millimetres thick over an area slightly larger than the diameter of the plate. (In cases where the existing ground is already fairly smooth and level a thin sheet of plastic may be laid down on the surface before the sand is spread thereby enabling some sand to be recovered).

1.3.3 Assemble all the dial gauges and rods and attach them to the datum bars at the outermost extremities.

- 1.3.4 Fit the legs to the datum bars at the outermost extremities.
- 1.3.5 The 450mm or 300mm plate is placed on top of the sand layer with the centre of the plate directly beneath a suitable jacking point on the mobile kentledge.
- 1.3.6 The plate should be thoroughly bedded by using a slight downward pressure and twisting action.
- 1.3.7 The assembled datum is placed on the ground with the legs as far as possible away from the influence of the kentledge reaction whilst manoeuvring the rods and dial gauges such that the dial gauge spindle tips are positioned on the circular plate at third points around the circumference. The gauges are adjusted to allow up to 10mm penetration of the plate.
- 1.3.8 The hydraulic jack is positioned in the centre of the plate together with sufficient spacing pieces for the top of the jack to be close the underside of the kentledge vehicle.
- 1.3.9 Using the hydraulic pump, the jack is pressurised to give a pre-load of 10kN for one minute in order to seat the plate. This load is released and the plate allowed to recover for a further two minutes.
- 1.3.10 The dial gauges are now re-set to zero and the first cycle of loading is ready to commence.

NOTE: As the intention of the test is to record the force necessary to produce a penetration of 1.25mm under the plate, five load readings are taken spread over the penetration range of between 0 to 1.5mm at approximately 0.25mm intervals. If a load is applied that produces an average of about 0.5mm of penetration and is recorded as the first load value then about half that load should produce an average incremental increase in penetration of 0.25mm.

- 1.3.11 A load is now applied by use of the hydraulic jack and immediately after the load has been attained, a reading is taken from each of the dial gauges. The time of this set of readings is noted and after one minute further sets of readings are taken and these continued until the rate of increase of plate movement is less than 0.0025mm/min. Care should be taken that the load is kept constant by observing the pressure gauge and applying slight increase in pressure if required by use of the hydraulic pump. When minimal further movement is detected then a final set of dial gauge readings is taken.
- 1.3.12 This procedure is repeated at five cycles of increasing ensuring that 1.25mm deflection of the plate has been achieved.

1.4 Calculations

- 1.4.1 The mean of the three final readings is taken at each load application and this value is plotted as shown in Figure 1 with mean plate deflection on the x-axis and corresponding load on the y-axis.
- 1.4.2 The resultant graph is generally slightly curved and a straight line is now drawn from the origin to intersect the graph to a deflection value of 1.25mm. The load is then read off the y-axis and recorded in the box in the Figure 1.
- 1.4.3 The modulus of sub grade reaction is calculated from the following relationship.

K = Module of Sub Grade Reaction

$$K = (1/018 \times L) / (D^2 \times P) \text{ MN/m}^2/\text{m}$$

L = Load in KN at Deflection of 1.25mm

D = Diameter of Plate (m)

P = Correction factor for plate size (see Fig 2)

- 1.4.4 The approximate equivalent CBR is given by the relationship derived by D Croney in the publication, "The Design and Performance of Road Pavements fig"

Note: The following Formula has been deduced from this relationship:

$$\text{CBR} = ((K)^{1.71512} / 14.304)$$