LABORATORY DETERMINATION OF
CALIFORNIA BEARING RATIO

STANDARD

- IS: 2720 (Part 16) 1979.

DEFINITION

- California bearing ratio is the ratio of force per unit area required to penetrate in to a soil mass with a circular plunger of 50mm diameter at the rate of 1.25mm / min.

APPARTUS

- Moulds 2250cc capacity with base plate, stay rod and wing nut confirming to 4.1, 4.3 and 4.4 of
  IS: 9669-1980.

- Collar confirming to 4.2 of IS: 9669-1980.

- Spacer Disc confirming to 4.4 of IS: 9669-1980.

- Metal rammer confirming to IS: 9189-1979.

- Expansion measuring apparatus with the adjustable stem, perforated plates, tripod confirming and to weights confirming to 4.4 of IS: 9669-1980.

- Loading machine having a capacity of at least 5000kg and equipped with a movable head or base that travels at a uniform rate of 1.25mm / min for use in forcing the penetration plunger in to the specimen.

- Penetration plunger confirming to 4.4 of IS: 9669-1980.

- Dial gauge two numbers reading to 0.01mm.

- IS sieves 37.50 or 22.50 or 19mm and 4.75mm.

- Miscellaneous apparatus such as mixing bowl, straight edge, scales, soaking tank, drying oven, filter paper, dishes and calibrated measuring jar.

PROCEDURE

- There are two types of methods in compacting soil specimen in the CBR moulds
  i.   Static Compaction method.
  ii.   Dynamic Compaction method.

- The material used in the above two methods shall pass 19mm sieve for fine grained soils and 37.50mm sieve for coarse materials up to 37.50mm.

- Replace the material retained on 19mm sieve by an equal amount of material passing 19mm sieve and retained on 4.75mm sieve

- Replace the material retained on 37.50mm sieve by an equal amount of material passing 37.50mm sieve and retained on 4.75mm sieve.

Static Compaction

- In this method calculate the mass of wet soil at required moisture content to give a desired density when compacted in a standard test mould as given below

  Volume of mould   = 2250cc.

  Weight of dry soil (W)   = 2250 x MDD.

  Weight of wet soil $= 1 + \dfrac{m}{100} \times W$

  Weight of water = Weight of wet soil - Weight of dry soil.

  m = Optimum moisture content obtained from the laboratory compaction test.

- Take oven dried soil sample of calculated weight and thoroughly mix with water (OMC) as obtained from the above equation.

- Record the empty weight of the mould with base plate, with extension collar removed (m_1).

- Place the correct mass of the wet soil in to the mould in five layers.

- Gently compact each layer with the spacer disc.

- Place a filter paper on top of the soil followed by a 5cms displacer disc.

- Compact the mould by pressing it in between the platens of the compression testing machine until the top of the spacer disc comes flush with the top of the mould.

- Held the load for about 30 seconds and then release.

- In some soil types where a certain amount of rebound occurs, it may be necessary to reapply load to force the displacer disc slightly below the top of the mould so that on rebound the right volume is obtained.
- Remove the mould from the compression testing machine.
- Remove the spacer disc and weigh the mould with compacted soil (m_2).
- Replace the extension collar of the mould.
- Prepare two more specimens in the same procedure as described above.

Dynamic Compaction

- Take representative sample of soil weighing approximately 6kg and mix thoroughly at OMC.
- Record the empty weight of the mould with base plate, with extension collar removed (m_1).
- Replace the extension collar of the mould.

- Insert a spacer disc over the base plate and place a coarse filter paper on the top of the spacer disc.
- Place the mould on a solid base such as a concrete floor or plinth and compact the wet soil in to the mould in five layers of approximately equal mass each layer being given 56 blows with 4.90kg hammer equally distributed and dropped from a height of 450 mm above the soil.
- The amount of soil used shall be sufficient to fill the mould, leaving not more than about 6mm to be struck off when the extension collar is removed.
- Remove the extension collar and carefully level the compacted soil to the top of the mould by means of a straight edge.
- Remove the spacer disc by inverting the mould and weigh the mould with compacted soil (m_2).
- Place a filter paper between the base plate and the inverted mould.
- Replace the extension collar of the mould.
- Prepare two more specimens in the same procedure as described above.

- In both the cases of compaction, if the sample is to be soaked, take representative samples of the material at the beginning of compaction and another sample of remaining material after compaction for the determination of moisture content.

- Each sample shall weigh not less than 100g for fine-grained soils and not less than 500 for granular soils.

- Place the adjustable stem and perforated plate on the compacted soil specimen in the mould.

- Place the weights to produce a surcharge equal to the weight of base material and pavement to the nearest 2.5kg on the perforated plate.

- Immerse the whole mould and weights in a tank of water allowing free access of water to the top and bottom of specimen for 96 hours.

Test for Swelling

- This test is optional and may be omitted if not necessary.

- Determine the initial height of specimen (h) in mm.

- Mount the expansion-measuring device along with the tripod on the edge of the mould and record the initial dial gauge reading (d_s).

- Keep this set up as such undisturbed for 96 hours noting down the readings every day against the time of reading.

- Maintain a constant water level through out the period of soaking.

- Note the final reading of the dial gauge at the end of soaking period (d_h).

Calculations for Swelling

- Expansion ratio = $\dfrac{d_f - d_s}{h} \times 100$

  d_s = Initial dial gauge reading in mm

  d_f = final dial gauge reading in mm

  h = initial height of specimen in mm

Penetration Test

- After 96 hours of soaking take out the specimen from the water and remove the extension collar, perforated disc, surcharge weights and filter paper.

- Drain off the excess water by placing the mould inclined for about 15 minutes and weigh the mould.

Testing of CBR specimen

- Place the mould on the lower plate of the testing machine with top face exposed

- To prevent upheaval of soil in to the hole of surcharge weights, place 2.5kg annular weights on the soil surface prior to seating the penetration plunger after which place the reminder of the surcharge weights.

- Set the plunger under a load of 4 kg so that full contact is established between the surface of the specimen and the plunger.

- Set the stress and strain gauges to zero.

- Consider the initial load applied to the plunger as the zero load.

- Apply the load at the rate of 1.25 mm / min.

- Take the readings of the load at penetration of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4, 5, 7.5, 10 and 12.5.

- Raise the plunger and detach the mould from the loading equipment.

- Collect the sample of about 20 to 50gms of soil from the top 30mm layer of specimen and determine the water content in accordance with IS: 2720 (Part 4) 1973.

- Examine the specimen carefully after the test is completed for the presence of any over size soil particles, which are likely to affect the results if they happen to be located directly below the penetration plunger.

CALCULATION OF CBR FROM LOAD PENETRATION CURVE

- Plot the load penetration curve in natural scale, load on Y - axis and penetration on X – axis as shown in Fig: 2.9.2.

- If the curve is uniformly convex upwards although the initial portion of the curve may be concave upwards due to surface irregularities make correction by drawing a tangent to the upper curve at the point of contra flexure as below
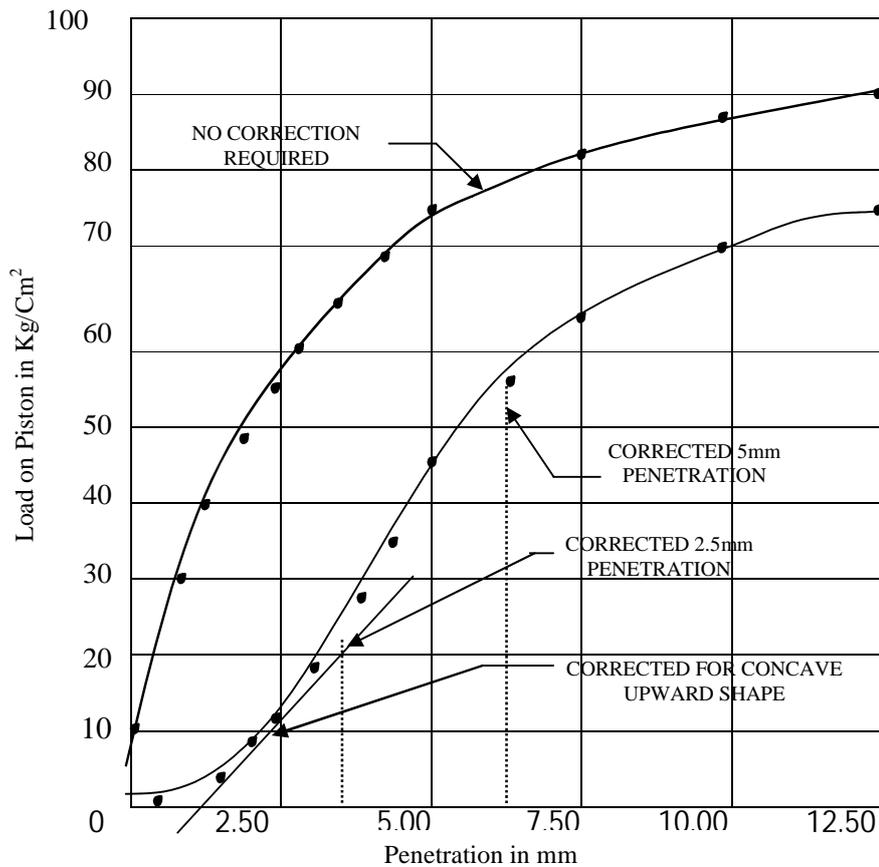
Load vs. Penetration curve

- Take the intersection point of the tangent and the X – axis as the origin.
  Calculate the CBR values for penetration of 2.50mm and 5.00mm.

- Corresponding to the penetration value at which CBR is to be desired, take the corrected load values from the load penetration curve and calculate the CBR from the equation

$$\text{California Bearing Ratio} = \frac{P_T \times C_f}{P_S} \times 100.$$

P_T = Corrected unit test load corresponding to the chosen penetration from load penetration curve

P_S = Total standard load for the same depth of penetration, which can be taken from the Table below

C_f = Proving ring correction factor.

Standard loads at specified penetrations

Penetration depth (mm)	Unit Standard load Kgf/ cm^2	Total Standard load (Kgf)
2.50	70	1370
5.00	105	2055
7.50	134	2630
10.00	162	3180
12.50	183	3600

REPORT

- Report the CBR value to the nearest second decimal.
- Take the average of three test specimens as the CBR value of the test.
- Generally, the CBR value at 2.50mm penetration will be greater than that at 5.00mm penetration and in such case take the value at 2.50mm as the CBR value.
- If the CBR value corresponding to a penetration of 5.00mm exceeds that of 2.50mm,repeat the test.
- If the identical results follow, take the value corresponding to 5.00mm as the CBR value.

PRECAUTIONS

- Clean the holes of the base plate and that of perforated disc thoroughly.
- Align the surcharge weight with the plunger so that the plunger penetrates freely in to the soil.

Format on next page

Punjab State Road Sector Project
Consultancy Services for Project Preparatory Studies for Package 3 (Phase I)
Part B, Construction Supervision

Construction Supervision Manual

FORM D6

Punjab State Road Sector Project
PWD B&R Branch, Govt. of Punjab
Punjab Roads & Bridges Development Board

CALIFORNIA BEARING RATIO TEST DATA SHEET
(IS 2720 Part 16)

Molding Date:	Penetration Date:
Sample No.:	Tested by:

Density Data

A. Condition of Specimen	Before Soaking	After Soaking
B. Wt. of Compacted Sample, Mold and Base Plate, g		
C. Wt. of Mold and Base Plate, g		
D. Wt. of Sample, g		
E. Height of Specimen, cm		
F. Vol. of Specimen, cm3		
G. Wet Density, g/cm3		
H. Moisture Content, %		
I. Dry Density, g/cm3		

Expansion Ratio Determination

J. Surcharge Weight, kg		O. Expansion Ratio:
K. Initial Height of Specimen, mm		$O = (N / K) (100)$
L. Initial Dial Gauge Reading, mm		
M. Final Dial Gauge Reading, mm		
N. Difference, mm		

Water Content Data

	Before Compaction	After Compaction	After Soaking Top 30mm	After Soaking Bulk
Wt. of Can + Wet Soil, g				
Wt. of Can + Dry Soil, g				
Wt. of Water, g				
Wt. of Can, g				
Wt. of Dry Soil, g				
Water Content, %				
Average Water Content, %				

Penetration Data

Penetration	Load Dial Reading	Total Load (kgf)	Corr. (kgf)	CBR		Penetration	Unit Std. Load (kgf/cm2)	Total Std. Load (kgf)
0.5 mm						2.5 mm	70	1370
1.0 mm						5.0 mm	105	2055
1.5 mm						7.5 mm	134	2630
2.0 mm						10.0 mm	162	3180
2.5 mm						12.5 mm	183	3600
4.0 mm								
5.0 mm								
7.5 mm								
10.0 mm								
12.5 mm								

Remarks : _____

Approved /Not Approved

_____ _____ _____
Contractor's Representative   Materials Engineer   Resident Engineer
                                              Consultant   Consultant