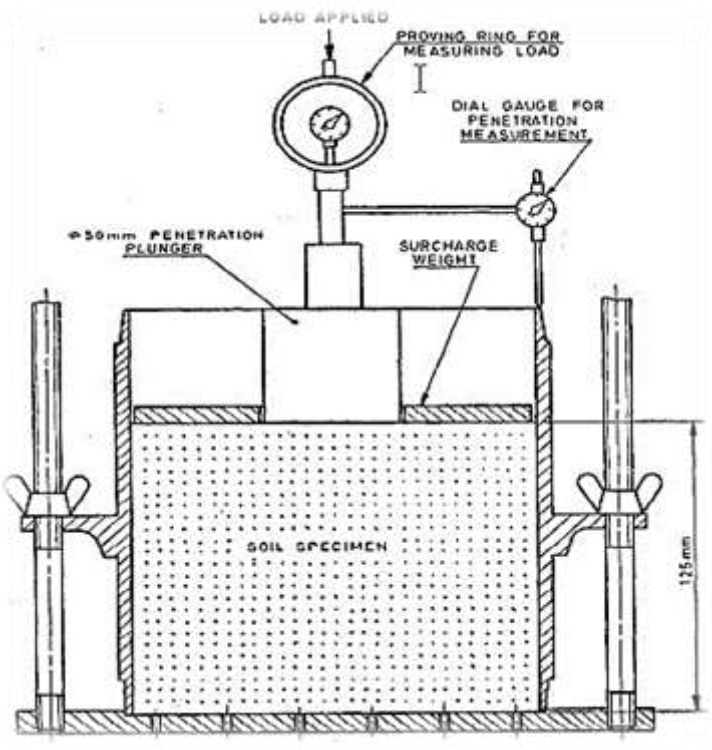
LABORATORY DETERMINATION OF CALIFORNIA BEARING RATIO (CBR)
IS : 2720 (Part 16) – 1987 (Re-affirmed 2002)

THEORY:

California Bearing Ratio (CBR) is defined as the ratio expressed in percentage of force per unit area required penetrating a soil mass with a circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material. Tests are performed out on natural or compacted soils in water soaked or un-soaked conditions and the results so obtained are compared with the curves of standard test.

APPARATUS REQUIRED:



1. CBR mould with detachable perforated base plate
2. Spacer disc with a removable handle (to be placed inside the mould)
3. Collar of 50mm high
4. Penetration plunger of 50 mm diameter
5. One annular and a few slotted surcharge masses 2.5 kg each
6. Rammer (2.6 kg with 310mm drop for standard proctor results) and (4.89 kg with 450mm drop for modified proctor results)
7. Straight cutting edge
8. Loading machine of 50 kN capacity fitted with a calibrated proving ring to which plunger has to be attached
9. Penetration measuring dial gauge of 0.01mm accuracy
10. Soaking tank
11. Swelling gauge consisting of perforated plate with adjustable extension stem

Mould Specification:

Diameter of the mould = 150mm

Height of the mould = 175mm

Height of the CBR soil specimen = 125mm

Soil specification:

Particle size = should pass through 19mm sieve

Soil particles of size greater than 19mm should be replaced by particles of size between 4.75mm and 19mm

PROCEDURE:

1. Take the weight of empty mould
2. Keep the spacer disc on the base plate and a filter paper on the disc and fix the mould to the base plate with the disc inside the mould and the attach the collar over the mould.
3. Add water to the specimen and compact it in accordance to Standard proctor test or modified proctor test .
4. After compaction, remove the collar and level the surface using cutting edge.
5. Detach the base pate and remove the spacer disc.
6. Take the weight of mould + compacted specimen and determine the bulk density of the specimen
7. Take sample for moisture content determination and hence find the dry density
8. Place filter paper on the perforated base plate.
9. Fix the mould upside down to the base plate so that surface of the specimen which was downwards in contact with spacer disc during compaction is now turned upwards on which the penetration test is to be performed (for unsoaked condition).
10. For soaked condition, Fix adjustable stem and perforated plate on the compacted soil specimen in the mould along with 2.5kg surcharge load
11. Place the above set up in the soaking tank for four days (ignore this step in case of unsoaked CBR).
12. After four days, measure the swell reading and find % swell with the help of dial gauge reading
13. Remove the mould from the tank and allow water to drain.
14. Then place the specimen under the penetration piston and place total surcharge load of 4kg (2.5kg during soaking + 1.5 kg during testing)
15. The load and deformation gauges shall then be set to zero
16. Load shall be applied to the plunger into the soil at the rate of 1.25 mm per minute.
17. Reading of the load shall be taken at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 4.0, 5.0, 7.5, 10.0 and 12.5 mm
18. Remove the plunger and determine the water content of the soil.
19. Plot **load versus deformation curve.**

CALCULATIONS:

Expansion ratio:

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

Where,

d_f=final dial gauge reading in mm(after 96 hrs),

d_s=initial dial gauge reading in mm, and

h=initial height of the specimen in mm

California bearing Ratio (CBR):

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

Where,

P_T = corrected unit (or total) test load corresponding to the chosen penetration from the load penetration curve

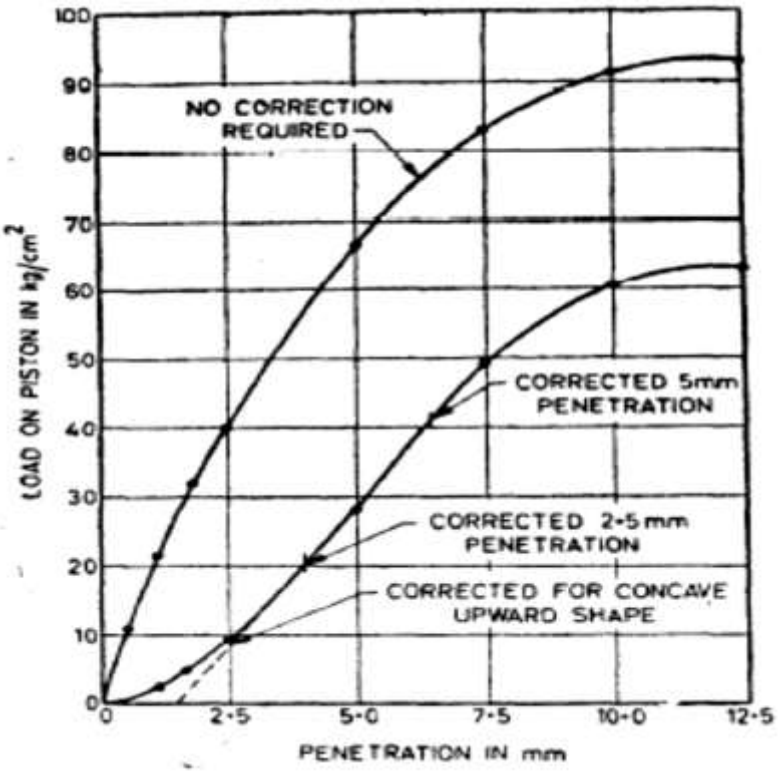
P_S = unit (or total) standard load for the same depth of penetration as for P_T taken from the table given below.

Penetration Depth	*Unit Standard Load*	*Total Standard Load*
(1)	(2)	(3)
mm	kg/cm²	kgf
2·5	70	1 370
5·0	105	2 055

Generally, the CBR value at 2.5 mm penetration will be greater than that at 5 mm penetration and in such a case, the former shall be taken as the CBR value for design purposes. If the CBR value corresponding to a penetration of 5 mm exceeds that for 2.5 mm, the test shall be repeated. If identical results follow, the CBR corresponding to 5 mm penetration shall be taken for design.

Corrections in load vs. deformation curve:

The curve plotted may be convex upwards although the initial portion of the curve may be concave upwards due to surface irregularities. A correction shall then be applied by joining the tangent to the curve at the point of maximum slope. The corrected curve shall be taken to be this tangent, together with the convex portion of the original curve, with the origin of strains shifted to the point where the tangent cuts the horizontal axis for penetration.



IRC-37 SPECIFICATIONS:

SUBGRADE:

The CBR values for subgrade should range from 2% to 10%. Preferably it should be greater than 2%. If the CBR value is less than 2%, a soil capping layer of 150mm thickness, having CBR value greater than or equal to 10% should be provided between subgrade and sub-base. The subgrade should be compacted to 97% of maximum dry density achieved with heavy (modified proctor) compaction as well as the dry density obtained should not be less than 1.75gm/cc for Expressways, National Highways, State Highways, Major District Roads and other heavily trafficked roads. In other cases the subgrade should be compacted to at least 97% of the standard proctor density.

SUB-BASE:

The sub base soil should have liquid limit less than 25% and plasticity index less than 6%. For cumulative traffic up to 2 msa (million standard axles), the CBR value should not be less than 20%. For cumulative traffic greater than 2 msa (million standard axles), the CBR value should not be less than 30%.

Note:

CBR test is performed for both soaked and unsoaked soil specimen. Usually, the unsoaked CBR value will be greater than the CBR value for soaked condition. The CBR values for unsoaked specimen are suitable for (i) arid regions, (ii) where comparatively thick bituminous surfacing of an impermeable nature is provided in top and where the water table is very deep. For other cases, soaked CBR results are preferred.

OBSERVATIONS:

Maximum dry density of the specimen to be prepared		g/cc
Optimum moisture content to be taken		%
Weight of the empty mould		g
Weight of the soil specimen and mould before soaking		g
Volume of the soil specimen		cm^3
Bulk density of the specimen		g/cc
Water content of the specimen		%
Dry density of the specimen		g/cc
Diameter of plunger		cm
Area of plunger		sq.cm
Deformation rate		mm/minute
Proving ring constant		kN/division
Standard pressure for 2.5mm penetration		kg/cm^2
Standard pressure for 5mm penetration		kg/cm^2

Unsoaked condition:

Dial gauge reading in divisions	**Penetration in mm**	**Load in division**	**Load in kN**	**Pressure in kg/cm^2**	**CBR (after correction)**
0					
50					
100					
150					
200					
250					
400					
500					
750					
1000					
1250					

Soaked condition:

Maximum dry density of the specimen to be prepared		g/cc
Optimum moisture content to be taken		%
Weight of the empty mould		g
Weight of the soil specimen and mould before soaking		g
Volume of the soil specimen		cm^3
Bulk density of the specimen		g/cc
Water content of the specimen		%
Dry density of the specimen		g/cc
Weight of the soil specimen and mould after soaking for 96 hours		g
Weight gain due to absorption of water		g
Diameter of plunger		cm
Area of plunger		sq.cm
Deformation rate		mm/minute
Proving ring constant		kN/division
Standard pressure for 2.5mm penetration		kg/cm^2
Standard pressure for 5mm penetration		kg/cm^2

Dial gauge reading in divisions	**Penetration in mm**	**Load in division**	**Load in kN**	**Pressure in kg/cm^2**	**CBR (after correction)**
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