Designation: D1883 – 07$^{\varepsilon 2}$

Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils[1]

This standard is issued under the fixed designation D1883; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε^1 NOTE—Editorially corrected units in Section 6.2 in May 2009.
ε^2 NOTE—Editorially corrected units in Section 10.3 in July 2009.

1. Scope*

1.1 This test method covers the determination of the CBR (California Bearing Ratio) of pavement subgrade, subbase, and base course materials from laboratory compacted specimens. The test method is primarily intended for (but not limited to) evaluating the strength of materials having maximum particle sizes less than ¾ in. (19 mm).

1.2 When materials having maximum particle sizes greater than ¾ in. (19 mm) are to be tested, this test method provides for modifying the gradation of the material so that the material used for tests all passes the ¾-in. sieve while the total gravel (+No. 4 to 3 in.) fraction remains the same. While traditionally this method of specimen preparation has been used to avoid the error inherent in testing materials containing large particles in the CBR test apparatus, the modified material may have significantly different strength properties than the original material. However, a large experience base has developed using this test method for materials for which the gradation has been modified, and satisfactory design methods are in use based on the results of tests using this procedure.

1.3 Past practice has shown that CBR results for those materials having substantial percentages of particles retained on the No. 4 sieve are more variable than for finer materials. Consequently, more trials may be required for these materials to establish a reliable CBR.

1.4 This test method provides for the determination of the CBR of a material at optimum water content or a range of water content from a specified compaction test and a specified dry unit weight. The dry unit weight is usually given as a percentage of maximum dry unit weight determined by Test Methods D698 or D1557.

1.5 The agency requesting the test shall specify the water content or range of water content and the dry unit weight for which the CBR is desired.

1.6 Unless specified otherwise by the requesting agency, or unless it has been shown to have no effect on test results for the material being tested, all specimens shall be soaked prior to penetration.

1.7 For the determination of CBR of field compacted materials, see Test Method D4429.

1.8 The values stated in inch-pound units are to be regarded as the standard. The SI equivalents shown in parentheses may be approximate.

1.9 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.9.1 The procedures used to specify how data are collected, recorded or calculated in this standard are regarded as the industry standard. In addition they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives, and it is common practice to increase or reduce significant digits or reported data to be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analytical methods for engineering design.

1.10 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.05 on Strength and Compressibility of Soils.

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***A Summary of Changes section appears at the end of this standard**

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D422 Test Method for Particle-Size Analysis of Soils

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3))

D1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

D2168 Practices for Calibration of Laboratory Mechanical-Rammer Soil Compactors

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

D4429 Test Method for CBR (California Bearing Ratio) of Soils in Place

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D6026 Practice for Using Significant Digits in Geotechnical Data

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 *Definitions*—All definitions are in accordance with Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *water content of the compaction specimen, w_i*—water content in percent of material used to compact the test specimen.

3.2.2 *water content top 1 in. (25.4-mm) after soaking w_s*—water content in percent of upper 1 in. (25.4 mm) of material removed after soaking and penetration.

3.2.3 *water content after testing, w_f*—water content in percent of material after soaking and final penetration; does not include material described in 3.2.2.

3.2.4 *dry density as compacted and before soaking, ρ_{di}*—dry density of the as-compacted test specimen using the measured wet mass and calculating the dry mass using the water content defined in 3.2.1.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4. Summary of Test Method

4.1 The California Bearing Ratio (CBR) test is a load test applied to the surface and used in soil investigations as an aid to the design of pavements. The laboratory test uses a circular piston to penetrate material compacted in a mold at a constant rate of penetration. The CBR is expressed as the ratio of the unit load on the piston required to penetrate 0.1 in. (2.5 mm) and 0.2 in (5 mm) of the test soil to the unit load required to penetrate a standard material of well-graded crusted stone.

4.2 This test method is used to determine the CBR of a material compacted in a specified mold. It is incumbent on the requesting agencies to specify the scope of testing to satisfy agency protocol or specific design requirements. Possible scope of testing includes:

4.2.1 CBR penetration tests are performed on each point of a compaction test performed in accordance with Method C of D698 or D1557. The CBR mold with the spacer disk specified in this standard has the same internal dimensions as a 6-in. (150-mm) diameter compaction mold.

4.2.2 Another alternative is for CBR test to be performed on material compacted to a specific water content and density. Alternatively, a water content range may be stated for one or more density values. This will often require a series of specimens prepared using two or three compactive efforts for the specified water content or over the range of water contents requested. The compactive efforts are achieved by following procedures of D698 or D1557 but varying the blows per layer to produce densities above and below the desired density.

5. Significance and Use

5.1 This test method is used to evaluate the potential strength of subgrade, subbase, and base course material, including recycled materials for use in road and airfield pavements. The CBR value obtained in this test forms an integral part of several flexible pavement design methods.

5.2 For applications where the effect of compaction water content on CBR is small, such as cohesionless, coarse-grained materials, or where an allowance is made for the effect of differing compaction water contents in the design procedure, the CBR may be determined at the optimum water content of a specified compaction effort. The dry unit weight specified is normally the minimum percent compaction allowed by the using agency's field compaction specification.

5.3 For applications where the effect of compaction water content on CBR is unknown or where it is desired to account for its effect, the CBR is determined for a range of water contents, usually the range of water content permitted for field compaction by using agency's field compaction specification.

5.4 The criteria for test specimen preparation of self cementing (and other) materials which gain strength with time must be based on a geotechnical engineering evaluation. As directed by the engineer, self-cementing materials shall be properly cured until bearing ratios representing long term service conditions can be measured.

NOTE 1—The agency performing this test can be evaluated in accordance with Practice D3740. Notwithstanding the statements on precision and bias contained in this test method, the precision of this test method is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D3740 does not in itself ensure reliable testing. Reliable testing depends on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Loading Machine*—The loading machine shall be equipped with a movable head or base that travels at a uniform (not pulsating) rate of 0.05 in. (1.27 mm)/min for use in forcing the penetration piston into the specimen. The load rate of 0.05 in. (1.27 mm)/min shall be maintained within ±20% over the range of loads developed during penetration. The minimum capacity of the loading machine shall be based on the requirements indicated in Table 1.

6.1.1 The machine shall be equipped with a load-indicating device matched to the anticipated maximum penetration load: 10 lbf (44 N) or less for a 10-kip (44.5-kN) capacity; 5 lbf (22 N) for 5-kip (22.3-kN) and 2 lbf (8.9 N) for 2.5-kip (11.2-kN).

6.1.2 Penetration measuring device (such as a mechanical dial indicator or electronic displacement transducer) that can be read to the nearest 0.001 in. (0.025 mm) and associated mounting hardware. A mounting assembly that connects the deformation measuring device to the penetrating piston and the edge of the mold will give accurate penetration measurements. However, mounting the deformation holder assembly to a stressed component of the load frame (such as tie rods) will introduce inaccuracies of penetration measurements.

6.2 *Mold*—The mold shall be a rigid metal cylinder with an inside diameter of 6 ± 0.026 in. (152.4 ± 0.66 mm) and a height of 7 ± 0.018 in. (177.8 ± 0.46 mm). It shall be provided with a metal extension collar at least 2.0 in. (50.8 mm) in height and a metal base plate having at least twenty eight 1⁄16-in. (1.59-mm) diameter holes uniformly spaced over the plate within the inside circumference of the mold. When assembled with spacer disc in place in the bottom of the mold, the mold shall have an internal volume (excluding extension collar) of 0.075 ± 0.0009 ft^3 (2124 ± 25 cm^3). Fig. 1 shows a satisfactory mold design. A calibration procedure should be used to confirm the actual volume of the mold with the spacer disk inserted. Suitable calibration procedures are contained in Test Methods D698 and D1557.

6.3 *Spacer Disk*—A circular metal spacer disc (see Fig. 1) having a minimum outside diameter of 5 15⁄16 in. (150.8 mm) but no greater than will allow the spacer disc to easily slip into the mold. The spacer disc shall be 2.416 ± 0.005 in. (61.37 ± 0.127 mm) in height.

6.4 *Rammer*—A rammer as specified in either Test Methods D698 or D1557 except that if a mechanical rammer is used it must be equipped with a circular foot, and when so equipped, must provide a means for distributing the rammer blows uniformly over the surface of the soil when compacting in a 6-in. (152.4-mm) diameter mold. The mechanical rammer must be calibrated and adjusted in accordance with Test Methods D2168.

6.5 *Expansion-Measuring Apparatus*— An adjustable metal stem and perforated metal plate, similar in configuration to that shown in Fig. 1. The perforated plate shall be 5 7⁄8 to 5 15⁄16 in. (149.23 to 150.81 mm) in diameter and have at least forty-two 1⁄16-in. (1.59-mm) diameter holes uniformly spaced over the plate. A metal tripod to support the dial gauge for measuring the amount of swell during soaking is also required. The expansion measuring apparatus shall not weigh more than 2.8 lbf (1.27 kg).

6.6 *Weights*—One or two annular metal weights having a total mass of 4.54 ± 0.02 kg and slotted metal weights each having masses of 2.27 ± 0.02 kg. The annular weight shall be 5 7⁄8 to 5 15⁄16 in. (149.23 to 150.81 mm) in diameter and shall have a center hole of approximately 2 1⁄8 in. (53.98 mm).

6.7 *Penetration Piston*—A metal piston 1.954 ± 0.005 in. (49.63 ± 0.13 mm) in diameter and not less than 4 in. (101.6 mm) long (see Fig. 1). If, from an operational standpoint, it is advantageous to use a piston of greater length, the longer piston may be used.

6.8 *Swell Measurement Device*—Generally mechanical dial indicators capable of reading to 0.001 in. (0.025 mm) with a range of 0.200-in. (5-mm) minimum.

6.9 *Balance*—A class GP5 balance meeting the requirements of Specifications D4753 for a balance of 1-g readability.

6.10 *Drying Oven*—Thermostatically controlled, preferably of a forced-draft type and capable of maintaining a uniform temperature of 230 ± 9°F (110 ± 5°C) throughout the drying chamber.

6.11 *Sieves*—3/4 in. (19 mm) and No. 4 (4.75 mm), conforming to the requirements of Specification E11.

6.12 *Filter Paper*—Fast filtering, high wet strength filter paper, 15-cm diameter.

6.13 *Straightedge*—A stiff metal straightedge of any convenient length but not less than 10 in. (254 mm). The total length of the straightedge shall be machined straight to a tolerance of ±0.005 in. (±0.1 mm). The scraping edge shall be beveled if it is thicker than 1/8 in. (3 mm).

6.14 *Soaking Tank or Pan*—A tank or pan of sufficient depth and breath to allow free water around and over the assembled mold. The tank or pan should have a bottom grating that allows free access of water to the perforations in the mold's base.

6.15 *Mixing Tools*—Miscellaneous tools such as mixing pan, spoon, trowel, spatula, etc., or a suitable mechanical device for thoroughly mixing the sample of soil with water.

TABLE 1 Minimum Load Capacity

Maximum Measurable CBR	Minimum Load Capacity (lbf)	(kN)
20	2500	11.2
50	5000	22.3
>50	10 000	44.5

7. Sample

7.1 The specimen(s) for compaction shall be prepared in accordance with the procedures given in Method C of Test

TABLE 2 Metric Equivalents

Inch-Pound Units, in.	Metric Equivalent, mm	Inch-Pound Units, in.	Metric Equivalent, mm	Inch-Pound Units, in.	Metric Equivalent, mm
0.003	0.076	19/32	15.08	3½	88.90
0.005	0.127	⅝	15.88	3¾	95.25
0.135	3.43	¾	19.10	4¼	108.0
0.201	5.11	15/16	23.81	4½	114.3
0.4375	11.11	1	25.40	4¾	120.7
0.4378	11.12	1⅛	28.58	5⅞	149.2
0.510	12.95	1¼	31.8	5 15/16	150.8
0.633	16.08	1⅜	34.9	6	152.0
1.370	34.60	1½	38.10	6 7/32	158.0
1.375	34.93	1¾	44.5	6½	165.1
1.954	49.63	1 13/16	46.04	7	177.8
2.416	61.37	1 15/16	49.21	7½	190.1
1/16	1.59	2	50.80	8⅜	212.7
7/32	5.56	2⅛	53.98	8½	215.9
¼	6.35	2⅕	55.9	9⅜	238.1
⅜	9.53	2¼	57.2	14¼	362.0
7/16	11.11	2½	63.50	18	457.2
15/32	11.91	2¾	69.85	32¼	719.2
½	12.70	2 31/32	75.41	36⅝	930.3
17/32	13.49	3	76.20	39	990.6

Inch-Pound Units, lb	Metric Equivalent, kg	Inch-Pound Units, psi	Metric Equivalent, MPa
0.04	0.02	200	1.4
0.05	0.02	400	2.8
0.12	0.05	600	4.1
0.59	0.27	800	5.5
0.71	0.32	1000	6.9
0.75	0.34	1200	8.3
3.20	1.45	1400	9.7
5.00	2.27		
10.00	4.54		

Methods D698 or D1557 for compaction in a 6-in. (152.4-mm) mold except as follows:

7.1.1 If all material passes a ¾-in. (19-mm) sieve, the entire gradation shall be used for preparing specimens for compaction without modification. If material is retained on the ¾-in. (19-mm) sieve, the material retained on the ¾-in. (19-mm) sieve shall be removed and replaced by an equal mass of material passing the ¾-in. (19-mm) sieve and retained on the No. 4 sieve obtained by separation from portions of the sample not used for testing.

8. Test Specimens

8.1 *Bearing Ratio at Optimum Water Content Only*—Using material prepared as described in 7.1, conduct a control compaction test with a sufficient number of test specimens to establish the optimum water content for the soil using the compaction method specified, either Test Methods D698 or D1557. A previously performed compaction test on the same material may be substituted for the compaction test just described, provided that if the sample contains material retained on the ¾-in. (19-mm) sieve, soil prepared as described in 7.1 is used (Note 2).

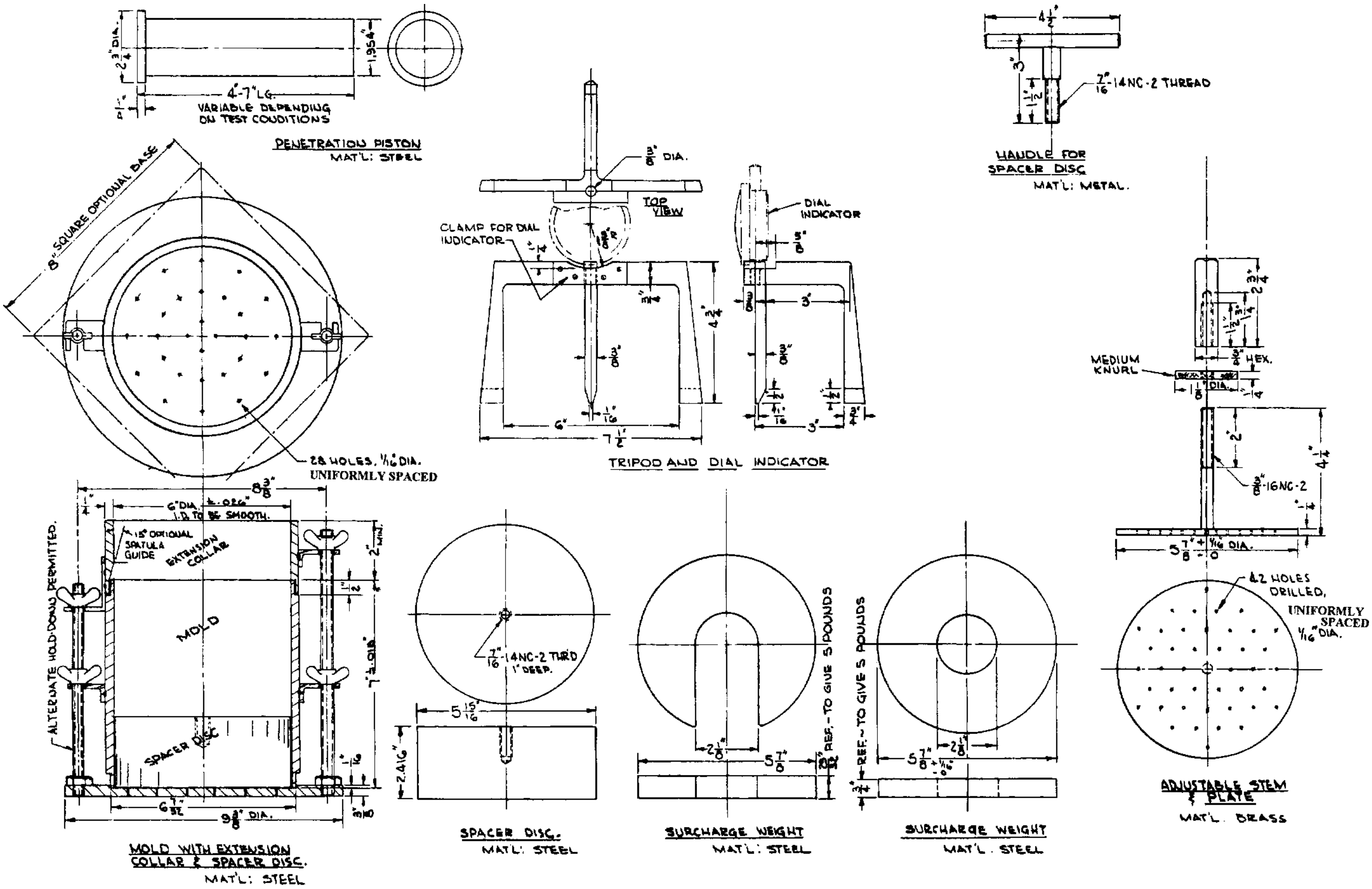
NOTE 2—Maximum dry unit weight obtained from a compaction test performed in a 4-in. (101.6-mm) diameter mold may be slightly greater than the maximum dry unit weight obtained from compaction in the 6-in. (152.4-mm) compaction mold or CBR mold.

8.1.1 For cases where the CBR is desired at 100 % maximum dry unit weight and optimum water content, compact a specimen using the specified compaction procedure, either Test Methods D698 or D1557, from soil prepared to within ±0.5 percentage point of optimum water content determined in accordance with Test Method D2216.

NOTE 3—Where the maximum dry unit weight was determined from compaction in the 4-in. (101.6-mm) mold, it may be necessary to compact specimens as described in 8.1.2, using 75 blows per layer or some other value sufficient to produce a specimen having a density equal to or greater than that required.

8.1.2 Where the CBR is desired at optimum water content and some percentage of maximum dry unit weight, compact three specimens from soil prepared to within ±0.5 percentage point of optimum water content and using the specified compaction but using a different number of blows per layer for each specimen. The number of blows per layer shall be varied as necessary to prepare specimens having unit weights above and below the desired value. Typically, if the CBR for soil at 95 % of maximum dry unit weight is desired, specimens compacted using 56, 25, and 10 blows per layer is satisfactory. Penetration shall be performed on each of these specimens.

8.2 *Bearing Ratio for a Range of Water Contents*—Prepare specimens in a manner similar to that described in 8.1 except that each specimen used to develop the compaction curve shall be penetrated. In addition, the complete water content-unit weight relationship for the 25-blow and 10-blow per layer compactions shall be developed and each test specimen compacted shall be penetrated. Perform all compaction in the CBR mold. In cases where the specified unit weight is at or near



NOTE 1—See Table 2 for metric equivalents.

FIG. 1 Bearing Ratio Test Apparatus

100 % maximum dry unit weight, it will be necessary to include a compactive effort greater than 56-blows per layer (Note 3).

NOTE 4—A semilog log plot of dry unit weight versus compactive effort usually gives a straight line relationship when compactive effort in ft-lb/ft^3 is plotted on the log scale. This type of plot is useful in establishing the compactive effort and number of blows per layer needed to bracket the specified dry unit weight and water content range.

8.2.1 If the CBR test specimen is to be soaked, take a representative sample of the material for the determination of water content in accordance with Test Method D2216. If the compaction process is conducted under reasonable controlled temperatures (65 to 75 F (18 to 24 C) and the processed soil is kept sealed during the compaction process, only one representative water content sample is required. However if the compaction process is being conducted in an uncontrolled environment take two water content samples one at the beginning of compaction and another sample of the remaining material after compaction. Use Test Method D2216 to determine the water contents and average the two values for reporting. The two samples should not differ more than 1.5 percentage points to assume reasonable uniformity of the compacted specimen's water content.

8.2.2 If the sample is not to be soaked, take a water content sample in accordance with Test Methods D698 or D1557 if the average water content is desired.

8.2.3 Clamp the mold (with extension collar attached) to the base plate with the hole for the extraction handle facing down. Insert the spacer disk over the base plate and place a disk of filter paper on top of the spacer disk. Compact the soil-water mixture into the mold in accordance with 8.1, 8.1.1, or 8.1.2.

8.2.4 Remove the extension collar and carefully trim the compacted soil even with the top of the mold by means of a straightedge. Patch with smaller size material any holes that may have developed in the surface by the removal of coarse material. Remove the perforated base plate and spacer disk, weigh, and record the mass of the mold plus compacted soil. Place a disk of coarse filter paper on the perforated base plate, invert the mold and compacted soil, and clamp the perforated base plate to the mold with compacted soil in contact with the filter paper.

8.2.5 Place the surcharge weights on the perforated plate and adjustable stem assembly and carefully lower onto the compacted soil specimen in the mold. Apply a surcharge equal to the weight of the base material and pavement within 5 lbf (2.27 kg), but in no case shall the total weight used be less than 10 lbf (4.54 kg). If no pavement weight is specified, use 10 lbf (4.54 kg) The mass of the Expansion Measuring Apparatus is ignored unless its mass is more than 2.8 lbf (1.27 kg). Immerse the mold and weights in water allowing free access of water to the top and bottom of the specimen. Take initial measurements for swell and allow the specimen to soak for 96 h. Maintain a constant water level during this period. A shorter immersion period is permissible for fine grained soils or granular soils that take up moisture readily, if tests show that the shorter period does not affect the results. At the end of 96 h, take final swell measurements and calculate the swell as a percentage of the initial height of the specimen.

8.2.6 Remove the free water and allow the specimen to drain downward for 15 min. Take care not to disturb the surface of the specimen during the removal of the water. It may be necessary to tilt the specimen in order to remove the surface water. Remove the weights, perforated plate, and filter paper, and determine and record the mass. The user may find it convenient to set the mold's base on the rim of a shallow pan to provide the tilt and carefully using a bulb syringe and adsorbent towels to remove free water.

9. Procedure for Bearing Test

9.1 Place a surcharge of weights on the specimen sufficient to produce an intensity of the loading specified; if no pavement weight is specified, use 10-lbf (4.54 kg) mass. If the specimen has been soaked previously, the surcharge shall be equal to that used during the soaking period. To prevent upheaval of soil into the hole of the surcharge weights, place the 5-lbf (2.27-kg) annular weight on the soil surface prior to seating the penetration piston, after which place the remainder of the surcharge weights.

9.2 Seat the penetration piston with the smallest possible load, but in no case in excess of 10 lbf (44 N). Either set both the load and penetration gauges to zero or make provisions to substract any initial values from all subsequently collected data. This initial load is required to ensure satisfactory seating of the piston and shall be considered as the zero load when determining the load penetration relation. Attach the penetrating measuring device in accordance with 6.1.2.

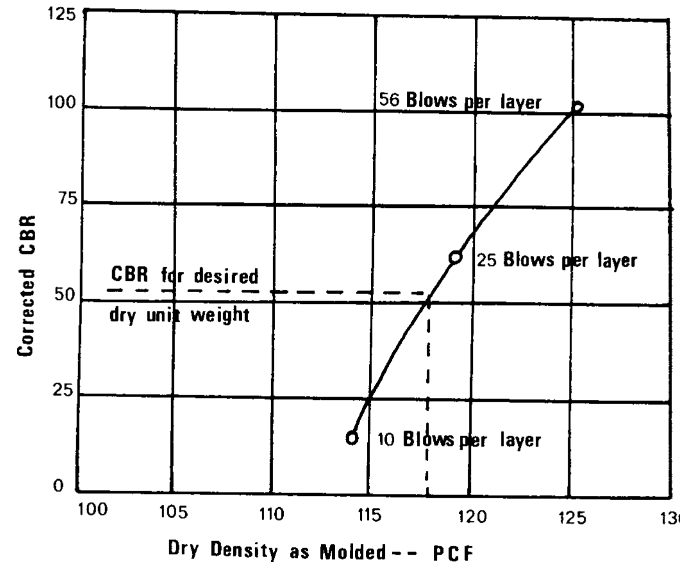
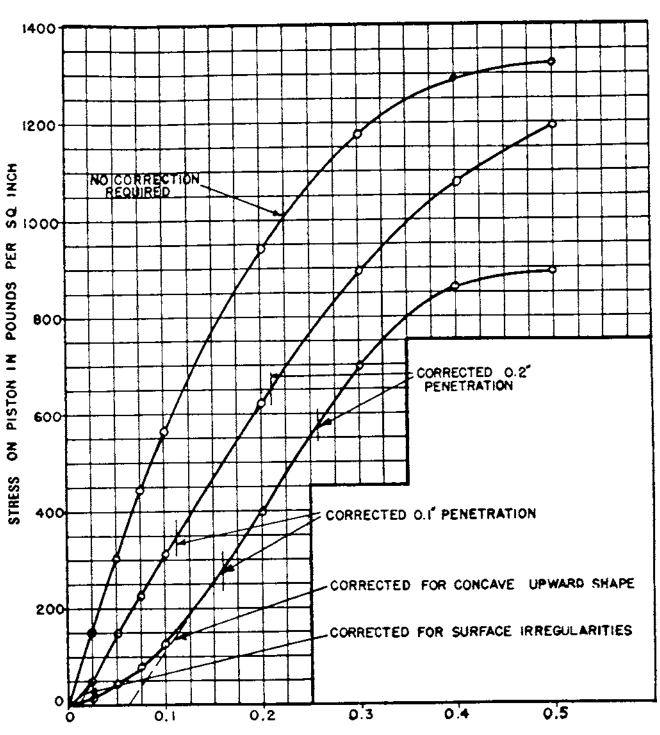


FIG. 3 Dry Density Versus CBR



NOTE 1—See Table 2 for metric equivalents.

FIG. 2 Correction of Load-Penetration Curves

NOTE 5—At high loads the supports may torque and affect the reading of the penetration gauge. Checking the depth of piston penetration is one means of checking for erroneous strain indications.

9.3 Apply the load on the penetration piston so that the rate of penetration is approximately 0.05 in. (1.27 mm)/min. Record the load readings at penetrations of 0.025 in. (0.64 mm), 0.050 in. (1.27 mm), 0.075 in. (1.91 mm), 0.100 in. (2.54 mm), 0.125 in. (3.18 mm), 0.150 in. (3.81 mm), 0.175 in. (4.45 mm), 0.200 in. (5.08 mm), 0.300 in. (7.62 mm), 0.400 in. (10.16 mm) and 0.500 in. (12.70 mm). Note the maximum load and penetration if it occurs for a penetration of less than 0.500 in. (12.70 mm). With manually operated loading devices, it may be necessary to take load readings at closer intervals to control the rate of penetration. Measure the depth of piston penetration into the soil by putting a ruler into the indentation and measuring the difference from the top of the soil to the bottom of the indentation. If the depth does not closely match the depth of penetration gauge, determine the cause and test a new sample.

9.4 If the test specimen was previously soaked, remove the soil from the mold and determine the water content of the top 1-in. (25.4-mm) layer. Take the water content sample in accordance with Test Methods D698 or D1557. Each water content sample shall weigh not less than 100 g for fine-grained soils nor less than 500 g for granular soils.

NOTE 6—The load readings at penetrations of over 0.300 in. (7.6 mm) may be omitted if the testing machine's capacity has been reached.

10. Calculation

10.1 *Load-Penetration Curve*—Calculate the penetration stress in pounds per square inch or megapascals and plot the stress penetration curve. In some instances, the stresspenetration curve may be concave upward initially, because of surface irregularities or other causes, and in such cases the zero point shall be adjusted as shown in Fig. 2.

NOTE 7—Fig. 2 should be used as an example of correction of load-penetration curves only. It is not meant to imply that the 0.2-in. penetration is always more than the 0.1-in. penetration.

10.2 *Bearing Ratio*—Using corrected stress values taken from the stress penetration curve for 0.100 in. (2.54 mm) and 0.200 in. (5.08 mm) penetrations, calculate the bearing ratios for each by dividing the corrected stresses by the standard stresses of 1000 psi (6.9 MPa) and 1500 psi (10.3 MPa) respectively, and multiplying by 100. Also, calculate the bearing ratios for the maximum stress, if the penetration is less than 0.200 in. (5.08 mm) by interpolating the standard stress. The bearing ratio reported for the soil is normally the one at 0.100 in. (2.54 mm) penetration. When the ratio at 0.200 in. (5.08 mm) penetration is greater, rerun the test. If the check test gives a similar result, use the bearing ratio at 0.200 in. (5.08 mm) penetration.

NOTE 8—On occasion the testing agency may be requested to determine the CBR value for a dry density not represented by the laboratory compaction curve. For example, the corrected CBR value for the dry density at 95 % of maximum dry density and at optimum water content might be requested. A recommended method to achieve this value is to compact two or three CBR test specimens at the same molded water content but compact each specimen to different compaction energies to achieve a density below and above the desired value. The corrected CBR values are plotted against the dry density and the desired CBR value interpreted as illustrated in Fig. 3. For consistency the corrected CBR values should be of identical origin, for example, all either soaked or un-soaked and all either at 0.1 or 0.2 corrected penetration values.

10.3 Calculate the dry density, ρ_d, of the compacted specimen (before soaking) as follows:

$$\rho_d = \frac{M_{sas}}{V_m}$$

where:

$$M_{sac} = \frac{M_{m+ws} - M_m}{(1 + w_{ac})}$$

M_{sac} = dry mass of soil as compacted, Mg or g,
M_{m+ws} = wet mass of soil as molded plus mold mass, Mg or g
M_m = mold mass, Mg or g,
w_{ac} = water content determination of representative scraps taken during the compaction process, and
V_m = volume of mold (area of mold × initial height), a calibrate value, m^3 or cm^3.

10.3.1 Conversion of dry density units:

$$\gamma_d = 9.8066 \times \rho_d, \ kN/m^3$$

or,

$$\gamma_d = 62.428 \times \rho_d, \ lbf/ft^3$$

where:

γ_d = dry unit weight, kN/m^3 or lbf/ft^3,
9.8066 = conversion factor, Mg/m^3 or g/cm^3 to kN/m^3, and
62.428 = conversion factor, Mg/m^3 or g/cm^3 to lbf/ft^3.

10.4 If the test specimen was soaked, calculate the percent swell as follows:

$$s = \left(\frac{S}{h_i}\right) \times 100$$

where:

s = swell that occurred during soaking, %,
S = vertical swell determined from the final minus initial swell measurement, in. (mm)
h_i = height of test specimen before swell, in. (mm).

11. Report

11.1 The report shall include, as a minimum, the following:

11.1.1 Method used for preparation and compaction of specimen: Test Methods D698 or D1557, or other, with description.

11.1.2 Condition of sample (unsoaked or soaked).

11.1.3 Dry density (unit weight) of sample as compacted (before soaking).

11.1.4 Water content of sample in percent:

11.1.4.1 As compacted.

11.1.4.2 Top 1-in (25.4-mm) layer after soaking.

11.1.5 Swell (percentage of initial height).

11.1.6 Bearing ratio of sample (unsoaked or soaked), percent.

11.1.7 Surcharge amount.

11.1.8 Any special sample preparation and testing procedures (for example, for self cementing materials).

11.1.9 Sample identification (location, boring number, etc.).

11.1.10 Any pertinent testing done to identify the sample such as: soil classifications per Test Method D2487, visual classification per Practice D2488, Atterberg Limits per Test Method D4318, gradation per Method D422, etc.

11.1.11 The percent material retained on the 19-mm sieve for those cases where scalping and replacement is used.

12. Precision and Bias

12.1 *Precision*—Test data on precision is not presented due to the nature of the materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program. Notwithstanding this statement the following is offer for guidance:

12.1.1 One user, based on seven repetitions, has developed a IS % of 9.2 % (compacted per Test Method D698) and 6.9 % (compacted per Test Method D1557). See Appendix X1 for the data used.

12.1.2 Subcommittee D18.05 is seeking any data from the users of this test method that might be used to make a more thorough statement on precision.

12.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

13. Keywords

13.1 This standard is indexed under the following terms:

California Bearing Ratio	Used For, Narrower Term
Pavement Subgrade	Used For, Narrower Term
Subgrade	Related Term, Broader Term
Pavement Subbase	Used For, Narrower Term
Subbase	Used For, Broader Term
Pavement Base Course	Used For, Narrower Term

Base Course	Used For, Broader Term	Earthfill	Related To
Strength of Soil	Used For	Cohesive Soils	Used For
Pavement Design	Used For, Narrower Term	Compressive Strength	Used For
Acceptance Tests	Used For	Flexible Pavements	Used For
Bearing Capacity	Used For	FoundationInvestigations	Used For
Materials Evaluations	Used For	Soil Tests	Used For
Bearing Ratio	Used For, Broader Term		
Load Penetration Curve	Used For		
Design	Used For, Broader Term		

APPENDIX

(Nonmandatory Information)

X1.

X1.1 See Fig. X1.1 for more information.

STANDARD (D698)
CBR

(x)	(x-x)	$(x-x)^2$
16.7	.5	.25
15.7	1.5	2.25
18.2	1.0	1
18.2	1.0	1
18.8	1.6	2.56
19.3	2.1	4.41
17.9	0.7	.49

x =124.8
x = 17.2
$(x-x)^2$ 11.96

S = 11.96 / 6

IS (one sigma) = 1.41

IS % = 1.41 X 100 / 17.2 = 8.2%

D2S % = 22.6%

MODIFIED (D1557)
CBR

(x)	(x-x)	$(x-x)^2$
77.0	3	9
70.2	3.8	14.44
80.8	6.8	46.24
68.2	5.8	33.64
76.7	2.7	7.29
71.7	2.3	5.29
73.3	0.7	.49

x =517.9
x = 74.0
$(x-x)^2$ 116.39

S = 116.39 / 6 = 19.39

IS = 4.4

IS % = 4.4 x 100 / 74 = 5.9%

D2S % = 16.7%

NOTES:
- All Material passed the #10 sieve
- Over 90% of all material passed the #40 sieve
- Method A of AASHTO T99 & T180 used
- Unit weights were 110 PCF ± (D698) and 122 PCF ± (D1557)
- 7 test repetitions
- The above data is from one user
- The (IS) and (D2S) limits represent the limits as described in ASTM Practice C670.

FIG. X1.1 Compactive Effort

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D1883 – 05) that may impact the use of this standard. (Approved November 15, 2007.)

(1) Revised Section 1 to include requirements of significant digits.
(2) Revised Section 1.1 to include Practice D6026.
(3) Added new Section 3, Terminology.
(4) Added note referencing Practice D3740 to Significance and Use section.
(5) Added details to Apparatus section
(6) Eliminated Note 8 that provided guidance for determining CBRs for penetrations other than 0.1 and 0.2 in.
(7) Eliminated old 9.4 and Figure 4 as these items pertain to engineering design.
(8) Added formulas to Calculation section.
(9) Modified the report section to include only essential information.
(10) Modified Precision and Bias section to conform to D18 Standards Preparation Manual.