AMRL #:_____ SOIL WORKSHEET INDEX REPORT #: _____

❖ - Indicates the line has been modified since the version of the worksheets dated 2014-04-10.

** NP for Not Presented or use a vertical line

DRY PREPARATION OF DISTURBED SOIL AND SOIL AGGREGATE SAMPLES FOR TEST (R58) **____** **(D421) ____**

APPARATUS Date: _____

1. Sieves: 4.75-mm (No.4), 2.00-mm (No.10), 425-µm (No.40) [*AASHTO only: and 19.0-mm (3/4-in.)*]?..... _____
2. Pulverizing apparatus (one of the following):
   (a) Mortar and rubber-covered pestle? ..... _____
   or (b) *AASHTO only: Mechanical device consisting of power-driven, rubber-covered muller?*..... _____
   or (c) *AASHTO only: Other device that breaks up aggregations of particles without reducing grain size?*.... _____
3. Sample splitter: sample splitter, riffle sampler, or quartering equipment [*AASHTO only: or canvas cloth*]?..... _____
4. Balance: readable to 0.1% of sample mass that meets M231 (G1 or G2) **[*ASTM: sensitive to 0.1 g (GP2)*]**?..... _____

PROCEDURE

Initial Preparation

1. *AASHTO: Sample thoroughly dried in air or drying apparatus, not exceeding 60 ℃ (140 ℉)?* ..... _____
   ASTM: Sample dried in air at room temperature (no drying device)?**.....** _____
2. Sample selected by splitting or quartering and then pulverized (without reducing natural grain size)? ..... _____
3. Portion of dried sample selected for particle size analysis weighed and mass recorded as mass of total sample uncorrected for hygroscopic moisture? ..... _____

A AASHTO & ASTM Procedure **A** using a 2.00-mm (No.10) sieve

1. Sample separated on the 2.00-mm (No.10) sieve?..... _____
2. Fraction retained on 2.00-mm (No.10) sieve pulverized and resieved on the 2.00-mm sieve?..... _____
3. Both portions passing 2.00-mm sieve thoroughly mixed together? ..... _____
4. ***ASTM only: Fraction retained on No. 10 sieve after second sieving washed of all fine material, dried, weighed, and recorded as the mass of coarse material?*****.....** _____
5. Coarse material retained on sieve set aside for sieve analysis **[*ASTM: and record mass retained on No.10*]**?.. _____

B *AASHTO only Procedure **B** using a 4.75-mm (No.4) and 2.00-mm (No.10) sieve*

1. *Sample separated on the 4.75-mm (No.4) sieve?*..... _____
2. *Fraction retained on 4.75-mm sieve pulverized and resieved on the 4.75-mm sieve?*..... _____
3. *Sample passing 4.75-mm sieve mixed thoroughly and then split or quartered to obtain a representative portion adequate for desired tests?*..... _____
4. *That portion weighed and then separated on the 2.00-mm (No.10) sieve?*..... _____
5. *Fraction retained on 2.00-mm sieve pulverized and resieved on the 2.00-mm sieve?*..... _____
6. *Both portions passing the 2.00-mm sieve thoroughly mixed together, larger material save for sieve analysis?*.. _____

Material passing the 2.00-mm (No.10) sieve – Particle Size Analysis (T88 / D422) and Specific Gravity (T100)

1. Fraction passing the 2.00-mm (No.10) sieve split or quartered to obtain representative samples?..... _____
2. *AASHTO, for T88: approx. 110 g (sandy) or 60 g (silt or clay) [AMRL: at least]?*..... _____
   ASTM, for D422: approx. 115 g (sandy) or 65 g (silt or clay) [AMRL: at least]?**.....** _____
   Note: *These masses include both the hygroscopic moisture specimen and the test specimen.*
3. *AASHTO only, for T100: at least 10 g (bottle) or 25 g (flask)?*..... _____

Material passing the 425-µm (No.40) sieve – Liquid and Plastic Limit (T89 & T90 / D4318)

1. Remained minus 2.00-mm (No.10) material separated on the 425-µm (No.40) sieve? ..... _____
2. ***ASTM only: Fraction retained on No.40 sieve discarded, fraction passing No.40 sieve used for D4318?*****.....** _____
3. *AASHTO only: Fraction retained on No.40 sieve carefully pulverized and resieved on No.40 sieve?*..... _____
4. *AASHTO only: When repeated pulverizing produces only a small quantity of soil passing the 425-µm (No.40) sieve, material retained on 425-µm sieve discarded?* ..... _____
5. *AASHTO only: Fraction(s) passing 425-µm sieve thoroughly mixed together for physical tests?* ..... _____

COMMENTS (T87 / D421): (R58 / D421)

PARTICLE SIZE ANALYSIS OF SOILS (T88) _____
(HYDROMETER TEST) **(D422) _____**

APPARATUS Date: _____

1. Stirring apparatus (One of the following):
   (a) Mechanical stirrer, rotation at least 10,000 rpm:
      (1) Stir ring paddle similar to those in Fig. 1 and dispersion cup similar to those in Fig. 2? ..... _____
      (2) Cup has 6 long rods and 6 short rods opposed, in good condition? ..... _____
   (b) Air-jet dispersion device (Fig 3)? ..... _____
   (c) Iowa State Device? ..... _____
2. Hydrometer (conforming to ASTM E100):

Type 151H			**Type 152H**		
Scale graduations from 0.995 to 1.038?			Scale graduations from -5 to 60 g/L?		
Scale length from 1.000 to 1.031 is 8.2 – 8.4 cm?			Scale length from 0 to 50 g/L is 8.2 – 8.4 cm?		
Bulb diameter 3.00 – 3.20 cm?			Bulb diameter 3.05 – 3.20 cm?		
Length from 1.000 to bulb tip 24.5 ± 0.1 cm?			Length from 0 g/L to bulb tip 24.5 ± 0.1 cm?		

3. Sedimentation cylinders:
   (a) 1000-mL capacity, made of glass, 1000-mL mark at 360±20 mm (14±1.0 in.) from bottom on inside? _____
   (b) Approximately 460 mm (18 in.) in height and 60 mm (2.5 in.) in diameter [AMRL: ± 1/4 in.]? ..... _____

4. Thermometer, Readable **[*ASTM: accurate*]** to 0.5°C (1°F)? ..... _____
   [*AASHTO only: and calibrated SN:* _____] (*write any calibration notes in R18*)
   Note to assessors: *please see guidance regarding thermometer Groups in the General worksheets.*
5. Sieves, one of the two sets listed below
   (a) *Set 1 AASHTO: (3 in.), 2 in., 1 in., 3/8 in., Nos. 4, 10, 40, and 200?* ..... _____
   Set 1 ASTM: (3 in.), 2 in., 1 1/2 in., 1 in., 3/4 in., 3/8 in., Nos. 4, 10, 20, 40, 60, 140, and 200? ... _____
   (b) Set 2 *AASHTO* & ***ASTM***: (3 in.), 1 1/2 in., 3/4 in., 3/8 in., Nos. 4, 8, 16, 30, 50, 100, and 200? ..... _____
6. Water bath or constant temperature room? ..... _____
7. Beaker: 250-mL capacity [*AASHTO only: 250 to 500-mL capacity, made of glass*]? ..... _____
8. Timing device, readable to nearest second? ..... _____
9. Dispersing agent:
   (a) Solution of sodium hexametaphosphate in distilled or demineralized water, 40 g/L? ..... _____
   (b) Solution less than a month old or adjusted to pH of 8 or 9 with sodium carbonate? ..... _____
   (c) Date of preparation marked on bottle containing solution? ..... _____
10. Distilled or demineralized water? ..... _____
11. Stirring device, any non-porous device suitable for stirring the sample without loss of material? ..... _____
12. *Containers (AASHTO only): Resistant to corrosion, disintegration, and weight change with close-fitting lids?* _____
13. Oven, maintains 110±5°C (230±9°F)? ..... _____
14. Balance, readable to 0.1% of sample mass **[*ASTM only: for minus No. 10 material, sensitive to 0.01 g*]**? ..... _____

COMMENTS (T88 / D422): (T88 / D422)

PARTICLE SIZE ANALYSIS OF SOILS (T88) ____
(HYDROMETER TEST) **(D422) _____**

PROCEDURE Date: _____

Sample Preparation

1. *AASHTO: Samples prepared by R58 or T146 (allows drying apparatus, not exceeding 60°C (140°F))?* ..... _____
   ASTM: Samples prepared by D421 (drying apparatus not permitted)? ..... _____
2. Coarse material separated on 4.75-mm (No.4) and/or 2.00-mm (No.10), or 425-µm (No.40) **[*ASTM only: or 75-µm (No.200)*]** sieve? ..... _____
3. Hygroscopic and hydrometer samples weighed to 0.01 g, coarse sieve analysis material to 0.1%? ..... _____
4. Hygroscopic moisture sample weighs at least 10 g **[*ASTM: 10 to 15 g*]**, dried to constant mass at 110±5°C (230±9°F) and weighed? ..... _____

Coarse Sieve Analysis

1. Sieve analysis performed on material retained on 2.00-mm (No. 10) sieve (or other separation sieve)? ..... _____
2. Sieving continued until no more than 1% of material on sieve passes during 60 seconds of continuous sieving? _____

Hydrometer Analysis

1. Composite correction for hydrometer reading determined [*AASHTO: for each hydrometer used for testing*]? ... _____
2. Test sample weighs approximately 100 g [AMRL: ± 10 g] (sandy) or 50 g [AMRL ± 5 g] (clay or silt)? ..... _____
   Note: *This sample sometimes includes the hygroscopic moisture sample so it may be up to 15 g more than stated tolerance.*
3. Sample placed in beaker, 125 mL of dispersing agent added, and stirred [*AASHTO only: stirred with glass rod*]?
   Note, ASTM only: *If Iowa State device used, sample can be soaked in sedimentation cylinder.* ..... _____
4. Sample soaked at least 12 hours **[*ASTM: at least 16 hours*]** in dispersing agent? ..... _____
5. Sample washed into dispersion cup with distilled or demineralized water until cup is more than half full? ..... _____
6. Mechanical dispersion: Dispersed for 60 seconds? ..... _____

   or Air dispersion: 7 kPa (1 psi) before filling, volume of mixture no more than 250 mL, Dispersed @ 140 kPa (20 psi) for 1, 5, 10, or 15 minutes, based on plasticity index of soil? ..... _____

7. Mixture transferred to cylinder, suspension made up to 1000 mL with distilled or demineralized water, [*AASHTO only: and allowed to obtain uniform temperature*]? ..... _____
8. Cylinder and contents turned upside down and back for approximately 60 turns in 60 seconds [AMRL: 55 to 70 turns, ± 5 seconds] (counting turn upside down and back as two turns)? ..... _____
9. Hydrometer readings taken at 2, 5, 15, 30, 60, 250, and 1440 minutes (24 hours)? ***Note:*** *Additional readings OK.*. _____
   Note, AASHTO only: *Material clinging to the inside walls of the cylinder may be rinsed in with a small amount of water.*
10. ***ASTM only: If water bath is used, cylinder placed in bath between 2- and 5-minute readings?*** ..... _____
11. Hydrometer slowly placed in suspension about 25 or 30 seconds **[*ASTM: about 20 to 25 seconds*]** prior to a reading [AMRL: AASHTO 20-35 ASTM: 15 to 30]? ..... _____
12. *AASHTO only: Hydrometer floats freely and does not touch wall of cylinder?* ..... _____
13. Hydrometer read at top of meniscus [*AASHTO only: to nearest 0.5 g/L or to nearest 0.0005 spec. grav.*]? ..... _____
14. Hydrometer removed from suspension between readings and placed in graduate of clean water with spinning motion (or otherwise cleaned between readings ***Note:*** *NOT in composite correction!*)? ..... _____
15. Thermometer placed in suspension and temperature recorded after each hydrometer reading? ..... _____

Fine Sieve Analysis

1. After final hydrometer reading, specimen washed over 75-µm (No. 200) sieve? ..... _____
2. *AASHTO only: Excess water decanted from washed sample only through the 75-µm sieve?* ..... _____
3. Material retained on 75-µm sieve oven-dried at 110±5°C (230±9°F)? ..... _____
4. Sieve analysis performed on plus 75-µm material [*AASHTO only: using at least the No.40 & No.200 sieves*]? . _____

Calculations

1. Calculations performed in accordance with test method? ..... _____

COMMENTS (T88 / D422): (T88 / D422)

DETERMINING THE LIQUID LIMIT OF SOILS (T89) _____
(D4318) _____

APPARATUS Date: _____

1. Grooving tools:

AASHTO Curved Grooving Tools:

Gauge end (square) 9.80 – 10.20 mm?				
Cutting edge width 1.9 – 2.1 mm*?				
Curved end thickness 9.9 – 10.1 mm?				
Radius of curve 22.2 mm (7/8 in.)?				
Curve length approximately 90°?				

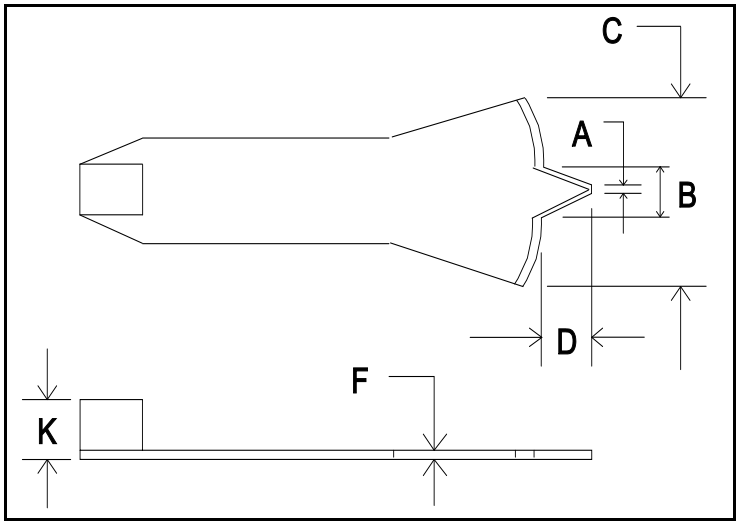
Note: Separate gauge block may be used (dimension K).
* Additional tolerance of 0.1 mm allowed for cutting edge of used grooving tools.

AASHTO or ***ASTM*** Flat Grooving Tool Dimensions (see diagram below):

A = 1.9 – 2.1 mm?				
B = 10.8 – 11.2 mm?				
C = 39.5 – 40.5 mm?				
D = 7.9 – 8.1 mm?				
F = 1.9 – 2.1 mm?				
K = 9.95 – 10.05 mm?				

Note: Separate gauge block may be used (dimension K).

Flat Grooving Tool Diagram:



COMMENTS (T89 / D4318): (T89 / D4318)

DETERMINING THE LIQUID LIMIT OF SOILS (T89) _____
(D4318) _____

APPARATUS (Continued) Date: _____

2. Liquid Limit Devices: Maker:_____

Hand operated or Electric that runs at 1.9 – 2.1 drops / second?			
Base dimensions (mm): *AASHTO: 125 ±5 x 150 ±5 x 50 ±5*?*			
ASTM: 125 ±2 x 150 ±2 x 50 ±2*?			
Base has four feet made of resilient material?			
Brass cup thickness 1.9 – 2.1 mm?			
Cup depth 26 – 28 mm and little or no groove in cup?			
Rim not worn to less than ½ original thickness?			
Cam and followers not worn excessively?			
AASHTO: Point of contact on cup or base less than 13 mm diameter?			
AASHTO: Base of hard rubber?			
ASTM: Point of contact on base less than 10 mm (3/8 in.) diameter?			
ASTM only: Maximum 3 mm (1/8in.) side-to-side cup movement?			
ASTM only: Cup weight 185 – 215 g (including the attached follower)?			
ASTM only: Base resilience – Average rebound is 77 – 90%?			

***** **Note**: Worn bases may be refinished to a thickness not less than 42.5 mm **[*ASTM: 48.00 mm*]**.

3. Porcelain dish, or similar **[*ASTM: glass or plastic*]** mixing dish, about 115 mm in diameter? ..... _____
4. Spatula or pill knife, about 75 to 100 mm **[*ASTM: 10 to 13 cm*]** long and 20 mm wide? ..... _____
5. Water content containers, resistant to corrosion, disintegration, and weight change, with close-fitting lids? ..... _____
6. Balance, Class G1/GP1 [readable to 0.01 g]? ..... _____
7. Oven, maintains 110±5°C (230±9°F)? ..... _____
8. Distilled or demineralized water, unless comparative tests show no difference compared to tap water? ..... _____
9. ***Miscellaneous ASTM equipment:***
   (a) ***Ground glass plate, of appropriate size?*** ..... _____
   (b) ***8 in. diameter sieves, 2.00 mm (No. 10) and 425-µm (No. 40)?*** ..... _____
   (c) ***Washing pan, round, flat-bottomed, at least 7.6 cm (3 in.) deep and slightly larger than 20.3 cm (8 in.) in diameter at bottom?*** ..... _____
   (d) ***Storage container, does not contaminate specimen or allow moisture loss?*** ..... _____

PROCEDURE

Sample Preparation, AASHTO only:

1. Sample obtained by T87 or T146? ..... ____
2. Sample consists of about 100 g of soil passing 425-µm (No. 40) sieve? ..... ____
3. Soil mixed with 15 to 20 mL of distilled or demineralized water in mixing dish (other than brass cup)? ..... ____
Note: *Tap water may be used for routine testing if comparative tests indicate no differences in results.*
4. Mixing done by stirring, kneading and chopping with spatula? ..... ____
5. Additional increments of water added (1 to 3 mL) until mass is uniform and has stiff consistency? ..... ____
6. No additional dry soil added to wet sample once testing has begun? ..... ____
7. If too wet, sample either discarded or mixed to evaporate water? ..... ____

COMMENTS (T89 / D4318): (T89 / D4318)

DETERMINING THE LIQUID LIMIT OF SOILS **(D4318)**

ASTM only PROCEDURE (continued) Date: _____

Sample preparation, ASTM only (one of the following):

A. Samples Passing 425-µm (No. 40) Sieve (Wet Preparation)

1. Specimen consists of 150 to 200 g of material passing the 425-µm (No. 40) sieve? ..... _____
2. Water content adjusted by mixing sample with spatula on glass plate or in mixing dish while adding distilled or demineralized water (sample may be soaked in a dish before mixing)? ..... _____
   ***Note*:** *Tap water may be used for routine testing if comparative tests indicate no differences in results.*
3. If using Method A (Multipoint), water content adjusted to 25-35 blow consistency? ..... _____
4. If using Method B (One-Point), water content adjusted to 20-30 blow consistency? ..... _____
5. If plus 425-µm material is encountered, particles removed by hand or by pressing through a 425-µm sieve with a rubber implement (or other convenient device that does not damage the sieve or sample)? ..... _____
6. If concretions, shells, or other fragile particles are found, these items removed by hand or by washing? ..... _____
7. Sample placed in covered storage dish for at least 16 hours and remixed immediately before test? ..... _____

B. Samples Containing Material Retained on 425-µm (No. 40) Sieve (Wet Preparation)

1. Specimen consists of enough material to provide 150 to 200 g of material passing the 425-µm sieve? ..... _____
2. Sample placed in pan or dish and distilled or demineralized water added to cover soil? ..... _____
   ***Note*:** *Tap water may be used for routine testing if comparative tests indicate no differences in results.*
3. Sample soaked until all lumps softened? ..... _____
4. If large amount of material is retained on 425-µm (No. 40) sieve:
   (a) No more than 500 g of soil (mixed in water) poured on a 425-µm (No. 40) sieve (or 2.00-mm and 425-µm sieve nest) in a clean pan and washed through sieve? ..... _____
   (b) Water added to 13 mm (0.5 in.) above sieve wire surface and material retained on 425-µm sieve agitated and rubbed until only coarse particles remain? ..... _____
   (c) Material retained on 425-µm sieve discarded? ..... _____
5. Water content reduced to approaching liquid limit by one or more of the following:
   (a) Drying at room temp. or warm air currents (required method for samples containing soluble salts)? ... _____
   (b) Decanting clear water from the surface of the suspension? ..... _____
   (c) Filtering in a Buchner funnel, by using filter candles, or draining in a colander or Paris dish? ..... _____
6. Water content adjusted by mixing sample with spatula on glass plate or in mixing dish while adding distilled or demineralized water (sample may be soaked in a dish before mixing)? ..... _____
7. If using Method A (Multipoint), water content adjusted to 25-35 blow consistency? ..... _____
8. If using Method B (One-Point), water content adjusted to 20-30 blow consistency? ..... _____
9. Sample placed in covered storage container for at least 16 hours and remixed immediately before test? ..... _____

C. "Dry" Preparation, should only be used when dry prep. method is specified, otherwise use a wet prep. method

1. Specimen sufficient to provide 150 to 200 g of material passing 425-µm (No. 40) sieve? ..... _____
2. Sample dried at no more than 60°C (140°F)? ..... _____
3. Soil pulverized with rubber covered pestle or by other means that does not cause sample particle breakdown? . _____
4. If concretions, shells, or other fragile particles are found, these items removed by hand or by washing? ..... _____
5. Sample separated on a 425-µm (No. 40) sieve and repulverized until all fine material passes through the sieve? _____
6. Material retained on 425-µm (No. 40) sieve soaked in a small amount of water and poured over a 425-µm sieve, catching the wash water and suspended fines? ..... _____
7. Plus 425-µm material discarded and wash water with suspended fines added to minus 425-µm dry material? ... _____
8. Water content adjusted by mixing sample with spatula on glass plate or in mixing dish while adding distilled or demineralized water (sample may be soaked in a dish before mixing)? ..... _____
   ***Note*:** *Tap water may be used for routine testing if comparative tests indicate no differences in results.*
9. If using Method A (Multipoint), water content adjusted to 25-35 blow consistency? ..... _____
10. If using Method B (One-Point), water content adjusted to 20-30 blow consistency? ..... _____
11. Sample placed in covered storage container for at least 16 hours and remixed immediately before test? ..... _____

COMMENTS (D4318): (D4318)

DETERMINING THE LIQUID LIMIT OF SOILS (T89) _____
(D4318) _____

MULTIPOINT METHOD (A) PROCEDURE Date: _____

Multipoint Procedure:

1. Liquid limit device previously inspected for wear and height of cup drop checked [*AASHTO only: prior to each day's testing*]? _____
2. Part of mixture put in cup and spread with spatula until 10 mm deep at maximum thickness? _____
3. As few strokes of spatula as possible used? _____
4. Care taken to avoid entrapment of air bubbles? _____
5. *AASHTO only: Excess soil returned to mixing dish?* _____
6. Unused wet soil in storage dish covered with wet towel (or other means) during test? _____

7. Flat grooving tool: Groove formed in soil by drawing tool, beveled edge forward, through soil on a line joining highest point through lowest point on the rim of the cup? _____
   Note: *Several strokes may be used, or precut groove with spatula and use tool to bring cut to final dimension.*
   or *Curved grooving tool (AASHTO only): Soil in dish divided through centerline of follower with no more than six strokes of curved tool and only last stroke of grooving tool scrapes bottom of cup?* _____

8. Tearing along groove and slippage of cake avoided? _____
9. Cup lifted & dropped twice per second until bottom of groove closes about 13 mm (0.5 in.) in 25 to 35 blows? _____
10. Base of device not held with hand while turning crank? _____
11. ***ASTM only: If air bubble caused premature groove closure, soil reformed in cup, adding soil to fill in groove, and above procedure repeated?*** _____
12. Number of shocks required to close groove recorded? _____
13. Slice of soil, width of spatula, extending across cake at right angles to groove and including portion that flowed together removed from dish and placed in container? _____
14. Container covered and then weighed to 0.01 g? _____
15. Water content determined according to (T265 / D2216)? _____
    Note: *per T265/D2216, remove lids while drying in the oven and replaced when the sample is removed from the oven.*
16. Soil remaining in cup returned to mixing dish? _____
17. Cup and grooving tool washed and dried? _____
18. Additional water added to unused material? _____
19. Steps 2 through 18 repeated for closure in 20 to 30 shocks? _____
20. Steps 2 through 18 repeated for closure in 15 to 25 shocks? _____
21. *AASHTO only: Range of three determinations at least 10 shocks?* _____
22. Lids removed before specimens are placed in oven to dry? _____
23. Water content calculated [*AASHTO only: to nearest whole percent*] by following equation? _____

$$\% \text{ moisture} = \frac{\text{mass of water}}{\text{mass of oven dry soil}} \times 100$$

24. Flow curve plotted and drawn as straight line on semi-logarithmic paper? _____
25. Moisture on linear scale and shocks on log scale? _____
26. Liquid limit equals moisture content at 25 shocks from curve? _____
27. Liquid limit value reported to nearest whole number? _____
28. *AASHTO only: For referee testing, time schedule of Section 14 used?* _____

COMMENTS (T89 / D4318, Multipoint): (T89 / D4318, Multipoint)

DETERMINING THE LIQUID LIMIT OF SOILS (T89) _____
(D4318) _____

ONE-POINT METHOD (B) PROCEDURE Date: _____

One-Point Procedure:

1. Liquid limit device previously inspected for wear and height of cup drop checked [*AASHTO only: prior to each day's testing*]? ..... _____
2. Once testing has begun, no additional dry soil added to sample? ..... _____
3. Part of mixture put in cup and spread with spatula until 10 mm deep at maximum thickness? ..... _____
4. Care taken to avoid entrapment of air bubbles and as few strokes of spatula as possible used? ..... _____
5. Excess soil returned to mixing dish? ..... _____
6. Unused wet soil in storage dish covered **[*ASTM: with wet towel or by other means*]** during test? ..... _____

7. Flat grooving tool: Groove formed in soil by drawing tool, beveled edge forward, through soil on a line joining highest point through lowest point on the rim of the cup? ..... _____
   Note: *Several strokes may be used, or precut groove with spatula and use tool to bring cut to final dimension.*
   or *Curved grooving tool, AASHTO only: Soil in dish divided through centerline of follower with no more than six strokes of curved tool and only last stroke of grooving tool scrapes bottom of cup?* ..... _____

8. Tearing along groove and slippage of cake avoided **[*ASTM only: and no crumbs of soil on bottom of cup*]**? . _____
9. Cup lifted and dropped twice per second until bottom of groove closes about 13 mm (0.5 in.) in 22 to 28 blows **[*ASTM only: 20 to 30 blows*]**? ..... _____
   Note, AASHTO only: *Closures between 15 and 40 blows acceptable if variations of ±5% of the true liquid limit are tolerable to the lab. Note if lab accepts anything other than 22 to 28 blows.*

10. Base of device not held with hand while turning crank? ..... _____
11. If target number of blows is not met, water content adjusted and steps 2 through 10 repeated? ..... _____
12. If the groove closes inside the target blow range, number of blows recorded? ..... _____
13. ***ASTM only: After groove closes inside target blow count range, first moisture content taken - slice of soil, the width of spatula, extending across cake at right angles to groove and including the portion that flowed together removed from dish, placed in weighed container and covered?*** ..... _____
14. Sample immediately returned to mixing dish and combined with unused soil, with no additional water added? _____
    or ***ASTM only: Soil reformed in cup adding soil to replace that removed?*** ..... _____
15. Steps 2 through 10 repeated? ..... _____

16. Is the test restarted (and closure data / moisture sample discarded):
    (a) If the second closure obtained is not within ± 2 blows of the first closure? ..... _____
    (b) *AASHTO: If the second closure obtained is not within the 22 to 28 blow range?* ..... _____
    (c) ***ASTM: If the second closure obtained is not within the 20 to 30 blow range?*** ..... _____

17. If second closure is acceptable (see Step 16), number of blows recorded for second closure? ..... _____
18. Slice of soil, width of spatula, extending across cake at right angles to groove and including portion that flowed together removed from dish and placed in container **[*ASTM: recorded as second moisture sample*]**? .. _____
19. Container covered and then weighed to 0.01 g? ..... _____
20. Lids removed before specimens are placed in oven to dry? ..... _____
21. Water content determined according to (T265 / D2216)? ..... _____
    Note: *per T265/D2216, remove lids while drying in the oven and replaced when the sample is removed from the oven.*
22. Water content calculated [*AASHTO only: to nearest whole percent*] by following equation? ..... _____

$$\% \text{ moisture} = \frac{\text{mass of water}}{\text{mass of oven dry soil}} \times 100$$

23. Liquid limit calculated by one of the methods listed [AASHTO: nomograph, multicurve, slide rule, etc.]? ..... _____
24. ***ASTM only: Liquid limit calculated by using equations in book and averaging the two results?*** ..... _____
25. ***ASTM only: If difference between the two liquid limit values is greater than one percentage point, is test repeated?*** ..... _____

COMMENTS (T89 / D4318, One-Point): (T89 / D4318 One-Point)

DETERMINING THE PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (T90) ____
(D4318) ____

APPARATUS Date: _____

1. Porcelain dish , or similar mixing dish, about 115 mm [AMRL: 75 to 125 mm] in diameter?..... ____

2. Spatula or pill knife, about 75 to 100 mm **[*ASTM: 10 to 13 cm*]** long and 20 mm wide?..... ____

3. Rolling surface:
   AASHTO: Ground glass plate or smooth unglazed paper? ..... ____
   ASTM: Ground glass plate at least 30 cm (12 in.) square by 1 cm (3/8 in.) thick? ..... ____

4. **OPTIONAL:** Plastic limit rolling device:..... ____
   (a) Made of acrylic.
   (b) Top plate and bottom fixed plate of suitable dimensions for properly rolling specimens.
   (c) Designed so top plate slides freely on side rails without wobbling.
   (d) Height of side rails:
   AASHTO: 3.20±0.25 mm + thickness of unglazed paper attached to bottom plate.
   ASTM: 3.2 mm (1/8 in.) + total thickness of unglazed paper that is not in contact with top or bottom surface of side rails. Tolerance on height is ± 1/4 mm (± 1/100 in.).
   (e) Unglazed paper that does not add foreign matter (fibers, paper fragments) to soil during test attached to top and bottom plates [*AASHTO only: attached by spray-on adhesive or self-adhesive backing*].

5. Water content containers: resistant to corrosion, disintegration, and weight change, with close-fitting lids? ..... ____

6. Balance, Class G1/GP1 [readable to 0.01 g]? ..... ____

7. Oven, maintains 110±5°C (230±9°F)?..... ____

COMMENTS (T90 / D4318): (T90 / D4318)

DETERMINING THE PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (T90) ____
(D4318) ____

PROCEDURE Date: _____

1. *AASHTO: Sample is either at least 20 g of minus 425-µm (No. 40) material obtained by T87 or T146, or about 8 g [AMRL: 7 to 10 g] of liquid limit material?* ____
   ASTM: Sample is 20 g or more of liquid limit material? ____
2. *AASHTO only: If 20-g sample of dry material:*
   (a) Mixed with distilled or demineralized water in mixing dish? ____
   (b) Approximately 8-g [AMRL: 7 to 10-g] ball formed? ____
3. A 1.5 to 2-g portion of the 8-g ball **[*ASTM: 20-g*]** selected and formed into ellipsoidal mass? ____

4. **ALTERNATE** procedure (using plastic limit rolling device):
   (a) Ellipsoidal mass placed on bottom plate and top plate placed in contact with mass? ____
   Note: *More than one soil mass can be rolled simultaneously in the device.*
   (b) Simultaneous downward force and back and forth motion applied to top plate so plate comes in contact with side rails within 2 minutes? ____
   (c) Soil thread not allowed to contact side rails during rolling? ____
   Note, ASTM only: If soil thread contacts rails, smaller masses of soil may be used.

5. Mass rolled between fingers or palm and plate/paper (or between top and bottom plate of rolling device) to form 3-mm **[*ASTM: 3.2-mm*]** diameter thread? ____
6. Rate of rolling between 80 to 90 strokes per minute (counting stroke as one complete motion of hand forward and back to the starting position) [AMRL: approximately]? ____
7. Mass rolled for no more than two minutes to obtain correct thread diameter? ____
8. When thread diameter is 3 mm **[*ASTM: 3.2 mm*]**, thread broken into several pieces? ____
9. Pieces squeezed together between thumbs and fingers into ellipsoidal mass? ____
10. Steps 4 through 9 repeated until thread crumbles and soil can no longer be rolled into a thread? ____
    Note: *Crumbling may occur when thread diameter is greater than the correct diameter.*
11. Operator does not attempt to produce failure at exactly 3 mm **[*ASTM: 3.2 mm*]** diameter? ____
12. Crumbled pieces placed in tared container and container immediately covered? ____
13. *AASHTO: Steps 3 through 12 repeated until the 8-g specimen is completely tested?* ____
    ASTM: Steps 3 through 12 repeated until two containers each contain at least 6 g of crumbled soil? ____
14. Mass of specimen and container determined to 0.01 g? ____
15. Specimen dried and water content determined according to (T265 / D2216)? ____
16. Plastic limit calculated by following equation? ____

$$\% \text{ moisture} = \frac{\text{mass of water}}{\text{mass of oven dry soil}} \times 100$$

17. ASTM only: Plastic limit calculated by averaging results of two specimens? ____
18. Plastic limit reported to at least the nearest whole number? ____
19. Plasticity index calculated from: PI = Liquid limit - Plastic limit? ____

COMMENTS (T90 / D4318): (T90 / D4318)

MOISTURE-DENSITY RELATIONS OF SOILS (T99 & T180) ____
(D698 & D1557) ____

APPARATUS Date: _____

1. **2.5-kg (5.5-lb) Rammers (T99 / D698)**

MANUAL rammers – Circular Face - 2.5-kg (5.5-lb.), with 4 vent holes approximately 19 mm from each end?

Ram mass	AASHTO	2.486 – 2.504 kg (5.48 – 5.52 lb)?				
	ASTM	***5.48 – 5.52 lb (2.472 – 2.518 kg)?***				
Face diameter	AASHTO	50.42 – 51.05 mm (1.985 – 2.010 in.)?				
	ASTM	***1.990 – 2.010 in. (50.55 – 51.05 mm)?***				
Drop height	AASHTO	303 – 307 mm (11.94 – 12.06 in.)? (for findings please record in metric)				
	ASTM	***11.95 – 12.05 in. (303.8 – 305.8 mm)?***				

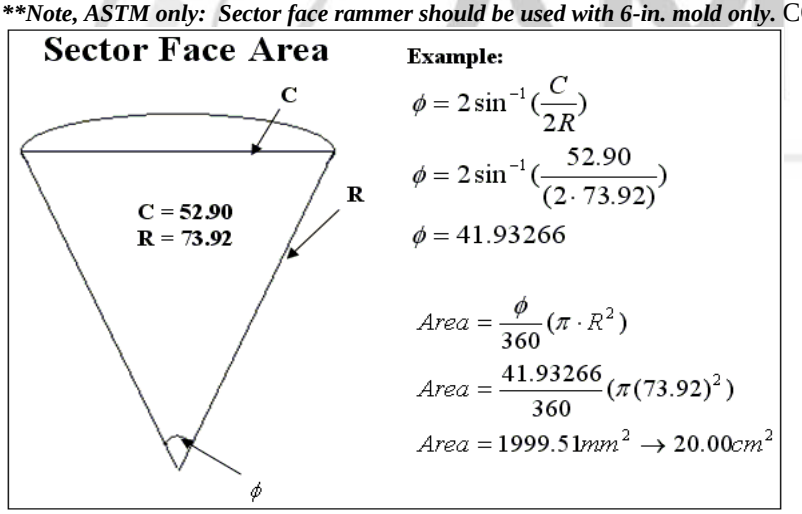
MECHANICAL rammers – Circular Face - 2.5-kg (5.5-lb), 305 mm (12 in.) drop height
Note: ***ASTM D2168 permits an increase in mechanical rammer mass of up to 10%. Decreasing the drop height is also permitted.***

Face diameter	AASHTO	50.42 – 51.05 mm (1.985 – 2.010 in.)?				
	ASTM	***1.990 – 2.010 in. (50.55 – 51.05 mm)?***				
Calibration	Both	Calibrated according to ***ASTM D2168*?***				

SECTOR Face** - Mechanical rammer - 2.5-kg (5.5-lb), 305 mm (12 in.) drop height
Note: ***ASTM D2168 permits an increase in mechanical rammer mass of up to 10%. Decreasing the drop height is also permitted.***

Face dimensions	AASHTO	Area 1997 – 2047 mm^2 (3.095 – 3.173 $in.^2$)?				
	ASTM	***Radius 2.88 – 2.92 in. (73.2 – 74.2 mm)?***				
Calibration	Both	Calibrated according to ***ASTM D2168*?***				

**Note:* ASTM D2168 has two methods - two curves are plotted using material at the optimum water content or the lead plug method.
***Note, ASTM only: Sector face rammer should be used with 6-in. mold only.* COMMENTS (T99 & T180 / D698 & D1557):



MOISTURE-DENSITY RELATIONS OF SOILS (T99 & T180) ____
(D698 & D1557) ____

APPARATUS (Continued) Date: _____

2. **4.54-kg (10-lb) Rammers (T180 / D1557)**

MANUAL rammers – Circular Face - 4.54-kg (10-lb), with 4 vent holes approximately 19 mm from each end?

Ram mass	AASHTO	4.527 – 4.545 kg (9.98 – 10.02 lb)?				
	ASTM	***9.98 – 10.02 lb (4.527 – 4.545 kg)?***				
Face diameter	AASHTO	50.42 – 51.05 mm (1.985 – 2.010 in.)?				
	ASTM	***1.990 – 2.010 in. (50.55 – 51.05 mm)?***				
Drop height	AASHTO	455 – 459 mm (17.94 – 18.06 in.)? (for findings please record in metric)				
	ASTM	***17.95 – 18.05 in. (455.9 – 458.5 mm)?***				

MECHANICAL rammers – Circular Face - 4.54-kg (10-lb), 457 mm (18 in.) drop height
Note: ***ASTM D2168 permits an increase in mechanical rammer mass of up to 10%. Decreasing the drop height is also permitted.***

Face diameter	AASHTO	50.42 – 51.05 mm (1.985 – 2.010 in.)?				
	ASTM	***1.990 – 2.010 in. (50.55 – 51.05 mm)?***				
Calibration	Both	Calibrated according to ***ASTM D2168?***				

SECTOR Face** - Mechanical rammer - 4.54-kg (10-lb), 457 mm (18 in.) drop height
Note: ***ASTM D2168 permits an increase in mechanical rammer mass of up to 10%. Decreasing the drop height is also permitted.***

Face dimensions	AASHTO	Area 1997 – 2047 mm^2 (3.095 – 3.173 $in.^2$)?				
	ASTM	***Radius 2.88 – 2.92 in. (73.2 – 74.2 mm)?***				
Calibration	Both	Calibrated according to ***ASTM D2168*?***				

**Note:* ASTM D2168 has two methods - two curves are plotted using material at the optimum water content or the lead plug method.
Note (ASTM only): Sector face rammer should be used with 6-in. mold only.

3. Metal straightedges (T99 & T180 / D698 & D1557)

Beveled Edge	AASHTO	One beveled edge?				
	ASTM	***Scraping edge beveled if thicker than 1/8 in. (3 mm)?***				
Planar	AASHTO	One edge plane to 0.250 mm (0.01 in.)?				
	ASTM	***Total length plane to ± 0.005 in. (± 0.1 mm)?***				
Length	Both	At least 250 mm (10 in.) long?				

4. Sieves: 19 mm (3/4 in.) and 4.75 mm (No. 4) **[*ASTM only: and 3/8 in. (9.5 mm)*]**? ..... _____
5. Sample extruder [*AASHTO: for solid-walled molds only*] **[*ASTM: optional*]**? ..... _____
   Note, AASHTO only: *Lab doesn't need a sample extruder for use with 6-in. molds if 6-in. molds not used for testing.*
6. Compaction base: concrete block (at least 90 kg or 200 lb) or concrete floor? ..... _____
7. Mixing tools, mixing pan, spoon, trowel, spatula, etc. or mechanical device? ..... _____
8. *AASHTO only: Containers: resistant to corrosion, disintegration, and weight change with close-fitting lids?*... _____
9. Balances: readable to 1 g, *AASHTO Class G2 and G20*, ***ASTM Class GP5***?..... _____
10. Drying oven at 110 ± 5°C (230 ± 9°F)?..... _____
11. ***ASTM only: All equipment standardized at least annually or every 1,000 test specimens, whichever is first?*** _____

COMMENTS (T99 & T180 / D698 & D1557):

MOISTURE-DENSITY RELATIONS OF SOILS (T99 & T180) ____
(D698 & D1557) ____

APPARATUS (Continued) Date: _____

11. **4-in.** MOLDS (101.6 mm)

Detachable collar	Both	Detachable collar fits mold?						
Internal diameter	Both	101.19 – 102.01 mm (3.984 – 4.016 in.)?*						
Height of mold	AASHTO	116.30 – 116.56 mm (4.579 – 4.589 in.)?*						
	ASTM	***4.566 – 4.602 in. (115.9 – 116.9 mm)?***						
Base plate	Both	Detachable, planar [*AASHTO: to 0.005 in.*]?						

12. **6-in.** MOLDS (152.4 mm) - *AASHTO only: 6-in. molds are not required. Only check 6-in. molds if used for testing.*

Detachable collar	Both	Detachable collar fits mold?						
Internal diameter	Both	151.74 – 153.06 mm (5.974 – 6.026 in)?*						
Height of mold	AASHTO	116.30 – 116.56 mm (4.579 – 4.589 in.)?*						
	ASTM	***4.566 – 4.602 in. (115.9 – 116.9 mm)?***						
Base plate	Both	Detachable, planar [*AASHTO: to 0.005 in.*]?						

** (AASHTO only): If molds are calibrated according to T19 (water-filled method), tolerances may be exceeded by up to 50%. Alternative type molds, volumes of 1/30 or 1/13.33 ft^3 are acceptable if comparative tests are made against conforming cylindrical molds.*

4-in. mold	*Diameter*	*100.99 - 102.21 mm (3.976 - 4.024 in.)*	*Height*	*116.23 - 116.64 mm (4.576 - 4.592 in.)*
6-in. mold	*Diameter*	*151.41 - 153.39 mm (5.961 - 6.039 in.)*	*Height*	*116.23 - 116.64 mm (4.576 - 4.592 in.)*

Note (AASHTO only): Split molds may be used provided the test results are correlated with those of the solid-wall mold on several soil types and the same moisture-density results are obtained. Records of this correlation must be available for inspection.

Note (ASTM only): Split molds and tapered molds are acceptable. Split molds must meet specs when locked. Tapered molds, internal diameter no more than 0.200 in./linear foot of mold height.

SAMPLE PREPARATION

AASHTO Sample Preparation:

1. *If damp, sample dried in air or drying apparatus, not exceeding 60 °C (140 °F)?* ..... _____
2. *A/B: Sample pulverized and sieved over 4.75-mm (No. 4) sieve and material retained discarded?*..... _____
   C/D: Sample pulverized and sieved over 19.0-mm (3/4 in.) sieve and material retained discarded? ..... _____
   Note to assessors: *the replacement of coarse material procedure previously specified is not considered appropriate to compute the maximum density.*
3. *Minimum dry sample mass: (A) 3 kg (7 lb), (B) 7 kg (16 lb), (C) 5 kg (11 lb), (D) 11 kg (25 lb)?* ..... _____
4. *If oversize material is >5% by mass of specimen (or other minimum percentage specified by requesting agency) and the specimen is used for field density compaction control, are test results corrected by T224?*..... _____

ASTM Sample Preparation:

1. ***Dry - If damp, sample dried in air or drying apparatus, not exceeding 60 °C (140 °F), then pulverized and sieved over No. 4 (A), 3/8 in. (B), or 3/4 in. (C) sieve?***..... _____
   or ***Moist - Without previous drying, sample sieved over No. 4 (A), 3/8 in. (B), or 3/4 in. (C) sieve and moisture content of processed soil determined?***..... _____
2. ***Percentage retained determined by a simplified gradation using sieve(s) of interest (as in D6913 or C136)?***. _____
   or ***Retained material (washed if necessary) oven dried and the dry mass of oversized material recorded?*** ..... _____
3. ***At least 4 (preferably 5) specimens prepared, varying by about 2% (not exceeding 4%) moisture, bracketing estimated optimum water content, and let stand in separate containers (according to Table 2, standing time not required for sands and gravels without silt, most soils 16 hours minimum)?*** ..... _____
4. ***Mass of each compaction point specimen about 2.3 kg (5 lbm) (A/B), or 5.9 kg (13 lbm) (C)?***..... _____
5. ***For specimens containing >5% by mass of oversize particles, corrections made according to D4718?*** ..... _____

COMMENTS (T99 & T180 / D698 & D1557):

MOISTURE-DENSITY RELATIONS OF SOILS (T99 & T180) ____
(D698 & D1557) ____

PROCEDURE Date: _____

1. *AASHTO: Dry sample mixed with water to approximately 4% below optimum moisture?* ..... _____
   ASTM: First sample removed from sample container after appropriate standing time (see Table 2)? ..... _____
2. Appropriate equipment selected for testing method:
   (a) T99 / D698 5.5 lb rammer, 12 in. drop, 3 layers - mold size and particle size as in table? ..... _____
   (b) T180 / D1557 10 lb rammer, 18 in. drop, 5 layers - mold size and particle size as in table? ..... _____

Demonstration: AASHTO (T99 / T180) Method: _____ ASTM (D698 / D1557) Method: _____

AASHTO Method	Mold Size	Particle Size	# of Blows	ASTM Method	Mold Size	Particle Size	# of Blows
A	4 in.	- No. 4	25	***A***	***4 in.***	***- No. 4***	25
B	6 in.	- No. 4	56	***B***	***4 in.***	***- 3/8 in.***	25
C	4 in.	- ¾ in.	25	***C***	***6 in.***	***- 3/4 in.***	56
D	6 in.	- ¾ in.	56	----	----	----	----

3. ***ASTM only: Mass of mold (and baseplate, if not trimming bottom) recorded?*** ..... _____
4. Layer of soil placed in mold and soil lightly tamped with manual rammer or 2-in. diameter similar device until it is not in a fluffy or loose state (prior to compaction)? ..... _____
5. Mold rests on rigid and stable foundation during compaction? ..... _____
6. ***ASTM only: Circular face mechanical rammer NOT used with 6-in. mold unless the mechanical compactor is designed to distribute the blows uniformly over the surface of the specimen?*** ..... _____
7. Soil compacted with appropriate number layers and blows for method selected (see table and Step 2)? ..... _____
8. Following compaction of each of first two (T99/D698) or four (T180/D1557) layers, any excess soil on mold walls trimmed **[*ASTM only: trimmed soil must be discarded*]**? ..... _____
9. ***ASTM only: If top of soil after compaction is more than 1/4 in. above rim of mold, is sample discarded?*** .... _____
10. ***ASTM only: If top of soil after compaction is below rim of mold, is sample discarded?*** ..... _____
11. Collar **[*ASTM only: and base plate if applicable*]** removed and soil trimmed to top of mold with straightedge? _____
    Note: *The base plate should only be removed if the mold is calibrated without the base plate attached.*
12. Any holes in top surface filled in with unused or trimmed soil [*AASHTO only: only allowed in T99 for C/D*]? . _____
13. ***ASTM only: Bottom of specimen trimmed (if mold volume was determined without base plate)?*** ..... _____
14. Mold and contents weighed to nearest 5 g (0.01 lb) and wet density calculated? ..... _____
15. *AASHTO: Soil removed from mold (using the sample extruder for solid molds), sample sliced vertically through center, moisture sample removed from one cut face (as shown in Figure 3), and weighed immediately – minimum mass 100 g **(A/B)** or 500 g **(C/D)**?* ..... _____
    ASTM: Soil removed from mold, water content determined according to Table 1, Method B from D2216, whole sample is preferable* [*Min sample mass:* (A): –No. 4 (100 g), (B): –3/8 in. (500 g), (C): –3/4 in. (2.5 kg)], *samples less than 200 g must be weighed to within 0.01 g? ..... _____
    Note to assessors: *A representative sample must include material from all 3 or 5 layers of the sample.*
16. *AASHTO: Material broken up to passing 4.75-mm size, recombined, and water content increased by 2%?* ..... _____
    or *If soil is fragile in character or soil is a heavy-textured clayey material, new sample used for each point:*
    (a) Samples mixed with water varying by approx 2% moisture, bracketing optimum moisture content? .... _____
    (b) Samples placed in covered containers and allowed to stand for at least 12 hours? ..... _____
    ASTM: Next prepared sample at 2% higher water content removed from container and used for testing? .... _____
17. ***ASTM only: Previously compacted soil <u>not</u> re-used for testing (may give an artificially higher unit weight)?*** _____
18. Steps 4 through 16 repeated for each increment of water until wet unit mass either decreases or stabilizes? ..... _____
19. Water content and oven-dry unit mass calculated for each sample? ..... _____
20. Unit weight **[*ASTM: to nearest 0.1 lb/ft^3 or 0.2 kN/m^3*]** plotted on ordinate, water content **[*ASTM: to nearest 0.1%*]** plotted on abscissa, and points connected with curve? ..... _____
21. Water content at peak of curve taken as optimum water content? ..... _____
22. *AASHTO: Dry unit mass at optimum reported as maximum density, to nearest 10 kg/m^3 (or 1 lb/ft^3)?* ..... _____
    ASTM: Dry unit mass at optimum reported as maximum density, to nearest 0.1 lb/ft^3 (0.02 kN/m^3)? ..... _____
23. ***ASTM only: 100% saturation curve plotted?*** ..... _____
24. ***ASTM only: Water-filled volume of mold, linear volume, or average of the two used in calculations?*** ..... _____

COMMENTS (T99 & T180 / D698 & D1557):

SPECIFIC GRAVITY OF SOILS (T100)

AASHTO APPARATUS Date: _____

1. Pycnometer, calibrated for series of temperatures likely to prevail during testing? ..... _____
   (a) Volumetric flask, capacity at least 100 mL? ..... _____
   or (b) Stoppered bottle, capacity at least 50 mL, stopper of same material as bottle and permits emission of air and surplus water? ..... _____
   ***Note*:** *A 500-mL flask is required for clay samples containing natural moisture.*

2. Balance (One of the following):
   (a) Class G1 (readable to 0.01 g) for use with volumetric flask? ..... _____
   or (b) Class B (readable to 0.001 g) for use with stoppered bottle? ..... _____

3. Oven, maintains 110±5°C (230±9°F)? ..... _____

4. Distilled or demineralized water? ..... _____

5. Thermometer, range within which test is being performed, graduated in 0.5°C (1.0°F) scale? ..... _____

6. Method of removing entrapped air (One of the following):
   (a) Vacuum, absolute pressure less than 13.33 kPa (100 mm Hg or 4 inches Hg)? ..... _____
   ***Note*:** *About 660 mm Hg (26 in. Hg) on a relative pressure gauge at sea level. (A relative pressure gauge reads 0 when the vacuum system is off.)*
   or (b) Boiling (hot plate or Bunsen burner)? ..... _____

COMMENTS (T100): (T100)

SPECIFIC GRAVITY OF SOILS **(D854)**

ASTM APPARATUS Date: _____

1. Pycnometer:
   - (a) Volumetric flask, capacity at least 250 mL? ..... _____
   - or (b) Stoppered flask? ..... _____
   - or (c) Stoppered iodine flask? ..... _____

   ***Note*:** *The volume of pycnometer must be 2 or 3 times greater than the volume of the soil-water mixture used during the de-airing potion of the test.*

2. Balance:
   - (a) Class GP1 (readable to 0.01 g)? ..... _____
   - (b) Capacity at least 500 g when using a 250-mL pycnometer OR at least 1000 g when using a 500-mL pycnometer? ..... _____

3. Oven, maintains 110±5°C (230±9°F)? ..... _____

4. Thermometric Device:
   - (a) Readable to the nearest 0.1°C (0.2°F) with a maximum permissible error of 0.5°C (1°F)? ..... _____
     Note to assessors: *please see guidance regarding thermometer Groups in the General worksheets.*
   - (b) Can be read at an immersion depth ranging between 25 and 80 mm? ..... _____
   - (c) Standardized every 12 months and NIST traceable? ..... _____
   - (d) At least one standardization temperature in range of testing? ..... _____

5. Soil drying apparatus:
   - (a) Desiccator, of suitable size and contains silica gel or anhydrous calcium sulfate (Drierite)? ..... _____
   - or (b) Tare pan that can be tightly sealed, for drying back the sample? ..... _____

6. Method of removing entrapped air (One of the following):
   - (a) Vacuum, absolute pressure less than 13.33 kPa (100 mm Hg or 4 inches Hg)? ..... _____
     Note*:* *About 660 mm Hg (26 in. Hg) on a relative pressure gauge at sea level. (A relative pressure gauge reads 0 when the vacuum system is off.)*
   - or (b) Boiling (hot plate or Bunsen burner)? ..... _____

7. Insulated container, styrofoam cooler with cover or equivalent container, large enough to hold between 3 and 6 pycnometers plus a beaker, a water bottle, and a thermometer? ..... _____

8. Funnel:
   - (a) Non-corrosive smooth surface funnel? ..... _____
   - (b) Stem extends past the calibration mark on the volumetric flask or stoppered seal on the stoppered flasks? ..... _____
   - (c) Diameter of stem large enough that soil solids will easily pass through? ..... _____

9. Sieve, No. 4 (4.75-mm)? ..... _____

10. Distilled water? ..... _____

11. OPTIONAL: Pycnometer filling tube with lateral vents, assists in adding deaired water to pycnometer without disturbing the soil-water mixture? ..... _____
12. OPTIONAL: Blender, with mixing blades built into the base of the mixing container? ..... _____

COMMENTS (D854): (D854)

SPECIFIC GRAVITY OF SOILS (T100)

AASHTO PROCEDURE Date: _____

Sample Preparation, AASHTO

1. Sample passes 2.00-mm (No. 10) sieve if specific gravity value is used for T88, otherwise sample passes 4.75-mm (No. 4) sieve? ..... _____
2. Sample mass (oven-dry basis): At least 25 g (flask) or at least 10 g (bottle)? ..... _____

A. Oven-Dried Samples

1. Sample dried to constant mass or at least 12 hours in oven at 110±5°C (230±9°F)? ..... _____
   ***Note*:** *Certain soils may be dried in reduced air pressure and at lower temperatures.*
2. Sample cooled to room temperature? ..... _____
3. Sample weighed and transferred to pycnometer, or transferred to pycnometer and then weighed? ..... _____
4. All masses determined to the nearest 0.01 g (flask) or 0.001 g (bottle)? ..... _____
5. Distilled water added to pycnometer to completely cover sample? ..... _____
6. Sample soaked in distilled water for at least 12 hours? ..... _____
   ***Note*:** *Kerosene may be used in place of distilled water for oven-dried samples.*

B. Samples Containing Natural Moisture (Clay soils only!)

1. Dispersed in distilled water using T88 dispersing equipment before placing in 500-mL flask? ..... _____

Procedure, AASHTO

1. Distilled water added to cover soaked specimen in pycnometer to a maximum of about 3/4 full (flask) or 1/2 full (bottle)? ..... _____
2. Entrapped air removed by:
   (a) Vacuum (at < 100 mm Hg absolute pressure), while occasionally agitating the sample? ..... _____
   ***Note**: If vacuum method is used, the distilled water may be added in layers, & each layer subjected to vacuum.*
   or (b) Boiling for at least 10 minutes while occasionally rolling the pycnometer? ..... _____
3. Boiled samples cooled to room temperature? ..... _____
4. Pycnometer filled with distilled water to calibrated capacity? ..... _____
5. Outside of pycnometer cleaned and dried, and pycnometer and contents weighed? ..... _____
6. Temperature of contents measured? ..... _____
7. If tested as sample with natural moisture, contents dried at 110±5°C (230±9°F)? ..... _____

Calculation, AASHTO

1. Specific gravity calculated as in book to at least nearest 0.01 or 0.001 for bottle)? ..... _____
2. Specific gravity value calculated based on water at 20°C (multiply by "K"), unless otherwise specified? ..... _____
3. If plus 4.75-mm (No. 4) material, specific gravity taken as weighted average of T85 (for plus 4.75-mm material) and T100 (for minus 4.75-mm material) values? ..... _____

COMMENTS (T100): (T100)

SPECIFIC GRAVITY OF SOILS **(D854)**

ASTM PROCEDURE Date: _____

Calibration of Pycnometer, ASTM

1. Mass of clean and dry pycnometer determined to the nearest 0.01 g? ..... _____
2. Determination repeated 5 times? ..... _____
3. Average and standard deviation recorded? ..... _____
4. Standard deviation less than or equal to 0.02 g? ..... _____
5. Water deaired to ensure that there are no air bubbles in the water using either boiling, vacuum, combination of vacuum and heat, or a deairing device, and water not used until it is room temperature? ..... _____
6. Deaired water added to above or below calibration mark? ..... _____
7. Pycnometer(s) placed in covered insulated container, along with thermometer, stopper (if stoppered pycnometer is used), and deaired water in a bottle or beaker along with eyedropper or pipette? ..... _____
8. Pycnometer(s) allowed to come to thermal equilibrium for at least 3 hours? ..... _____

   ***Note*:** *The equilibrium temperature should be within 4 ℃ of room temperature and between 15 and 30 ℃.*
9. Steps 8 through 14 in Procedure followed? ..... _____
10. Pycnometer(s) placed back in insulated container and water level adjusted in each pycnometer? ..... _____
11. Pycnometer(s) allowed to thermally equilibrate for at least 3 hours? ..... _____
12. Procedure repeated to obtain 5 measurements for each pycnometer? ..... _____
13. Volume determined by calculation below? ..... _____

$$V_p = ((M_{pw,c} - M_p)/p_{w,c})$$

where: $M_{pw,c}$ = mass of the pycnometer and water at the calibration temperature, g
M_p = average mass of the dry pycnometer at calibration, g
$p_{w,c}$ = mass density of water at the calibration temperature, g/mL (Table 2)

14. Average and standard deviation of the five volume determinations calculated? ..... _____
15. Standard deviation (rounded to 2 decimal places) less than or equal to 0.05 mL? ..... _____
16. If standard deviation is larger than 0.05 mL, procedure revised until standard deviation is less than or equal to 0.05 mL? ..... _____

COMMENTS (D854): (D854)

SPECIFIC GRAVITY OF SOILS **(D854)**

ASTM PROCEDURE (Continued) Date: _____

Sample Preparation, ASTM

1. Sample passes No. 4 (4.75 mm) sieve? ..... _____
2. Sample mass at least 35 g (No. 4) for 250-mL flask or at least 50 g for a 500-mL flask (depending on soil type and pycnometer size, see Table 1)? ..... _____

Method A - Moist Specimens, ASTM

1. Mass of pycnometer verified that it is within 0.06 g of the average calibrated mass, using same balance that was used for calibration? ..... _____
2. If not, pycnometer re-calibrated? ..... _____
3. Water content determined according to D2216? ..... _____
4. Using this water content, range of wet masses calculated that will yield enough dry material for the specific gravity specimen according to Section 7.1? ..... _____
5. Specimen obtained within this range and not sampled to obtain exact predetermined mass? ..... _____
6. 100 mL of water added to soil? ..... _____
7. Soil dispersed using blender or equivalent device? ..... _____
   Note: *The min. volume of slurry that can be prepared by this equipment may require using a 500-mL pycnometer.*
8. Prepared slurry poured into pycnometer, using funnel? ..... _____
9. Material remaining on the funnel rinsed into pycnometer? ..... _____

Method B - Oven-Dried Specimens, ASTM

1. Mass of pycnometer verified that it is within 0.06 g of the average calibrated mass, using same balance that was used for calibration? ..... _____
2. Sample dried to constant mass in oven at 110±5°C (230±9°F)? ..... _____
   Note**:** *Clods of soil can be broken down using a mortar and pestle.*
3. Soil solids spooned into pycnometer using funnel? ..... _____
   Note**:** *Any remaining soil particles on the funnel should be rinsed into the pycnometer using a squirt bottle.*

COMMENTS (D854): (D854)

SPECIFIC GRAVITY OF SOILS **(D854)**

ASTM PROCEDURE (Continued) Date: _____

Procedure, ASTM

1. Distilled water added until the water level is between 1/3 and 1/2 of the depth of the main body of the pycnometer? ..... _____
   ***Note*:** *Kerosene may be used in place of distilled water for oven-dried samples. If kerosene used, aspirator should be used to remove entrapped air.*
2. Water agitated until slurry is formed? ..... _____
   ***Note*:** *If a viscous paste is formed, a larger pycnometer should be used.*
3. Entrapped air removed by one of the following:
   (a) Boiling for at least 2 hours while occasionally agitating the pycnometer? ..... _____
   (b) Vacuum for at least 2 hours (at < 100 mm Hg absolute) while continually agitating the pycnometer? . _____
   (c) Boil and vacuum at least 1 hour after initiation of boiling while occasionally rolling pycnometer? ..... _____
      (1) Placed in warm water bath (not more than 40°C) while applying vacuum? ..... _____
      (2) Water level in bath slightly below the water level in the pycnometer? ..... _____
4. If heat was used, specimen allowed to cool to room temperature? ..... _____
5. Distilled water that has been deaired (see calibration) added to above or below calibration mark using small diameter tubing or pycnometer filling tube so that clear water layer develops over top of slurry? ..... _____
   ***Note*:** *If using stoppered iodine flask, flask filled so that base of stopper will be submerged in water. Also, if water becomes cloudy, water not added above calibration mark or stoppered seal area; then, remaining water added the next day.*
6. If the added water becomes cloudy, water kept below the calibration mark and adjust the next day? ..... _____
7. Pycnometer, thermometer, deaired water (in a bottle or beaker), and an eyedropper or pipette placed in the insulated container? ..... _____
8. Allowed to achieve thermal equilibrium overnight? ..... _____
9. Pycnometer removed by only touching the rim? ..... _____
10. Pycnometer placed on an insulated block (or work performed in container)? ..... _____
11. Pycnometer: water level adjusted to calibration mark using water from insulated container? ..... _____
    or Stoppered flask: stopper placed in bottle while removing excess water with eyedropper, and rim dried using paper towel? ..... _____
12. Outside of pycnometer (and inside of stem, if volumetric flask is used) cleaned and dried, and pycnometer and contents weighed to nearest 0.01 g? ..... _____
    ***Note*:** *Use same balance for pycnometer calibration and testing.*
13. Temperature of contents measured to nearest 0.1°C using the thermally equilibrated thermometer and inserting to appropriate depth of immersion? ..... _____
14. Soil slurry transferred to pan, contents dried at 110±5°C (230±9°F), and cooled in desiccator? ..... _____
    ***Note*:** *Desiccator not required if sample tare can be tightly sealed.*
15. Pan and contents weighed to nearest 0.01g? ..... _____

Calculations, ASTM

1. Specific gravity calculated as in book to at least nearest 0.01? ..... _____
2. Specific gravity value calculated based on water at 20°C (multiply by "K"), unless otherwise specified? ..... _____

COMMENTS (D854): (D854)

MOISTURE-DENSITY RELATIONS OF SOIL-CEMENT MIXTURES (T134) ____
(D558) ____

WETTING-AND-DRYING TEST OF COMPACTED SOIL-CEMENT MIXTURES (T135) ____
(D559) ____

FREEZING-AND-THAWING TESTS OF COMPACTED SOIL-CEMENT MIXTURES (T136) ____
(D560) ____

APPARATUS Date: _____

FOR (T134 / D558), (T135 / D559), and (T136 / D560):

1. Rammers, molds (4-in. diameter), straightedges, mixing tools, moisture containers, and oven conform to requirements of (T99 / D698)? ..... ____

Notes:

(a) Base of mold does not have planeness requirements.

(b) ASTM only: Rammer must have diameter of 1.995 - 2.005 in. (50.55 – 51.05 mm), mass of 5.48 - 5.52 lb (2.48 - 2.50 kg), and drop height of 12.0± 0.05 in. (303.5 - 306.1 mm).

(c) (T134 / D558, T135, T136) Radius of sector-face rammer must be 2.000±0.008 in. (50.80± 0.21 mm). ***D558: radius of sector face rammer 2.0± 0.2-in. (73.7± 0.5-mm)*** (T134, T135 and T136 area as listed in T99 worksheets.) ***D559 and D560 only: Sector face rammer should not be used unless previous tests on similar materials show similar results using circular face rammer.***

(d) ASTM only: Straightedge must be 12 in. (305 mm) long and must have one beveled edge, regardless of thickness.

2. Sieves: 75 mm (3 in.), 19 mm (3/4 in.) and 4.75 mm (No. 4)? ..... ____
3. Sample extruder (not required for split-type molds)? ..... ____
4. Balances:
   (a) (T134/D558, D559, D560) Class G2/GP2 for moisture determination? ..... ____
   (b) (T134) A balance or scale conforming to the requirements of M 231, Class G 20 ..... ____
   (c) (D558, D559, D560) ***Class GP 5 with a readability of 1 g?*** ..... ____
   (d) (T135, T136) Capacity 11.5 kg, sensitive to 0.005 kg? ..... ____
5. Container, flat round pan about 12 in. (305 mm) in diameter and 2 in. (50 mm) deep? ..... ____
6. Butcher knife, approximately 10 in. (250 mm) long, for trimming top of specimens? ..... ____
   [AMRL: the cutting plane of the knife is larger than the diameter of the mold.]

For (T135 / D559) and (T136 / D560) ONLY:

1. Moist room, or covered container:
   (a) Maintains 21±1.7°C (70±3°F)? ..... ____
   (b) 100% relative humidity? ..... ____
   (c) If covered container, how is temperature maintained constant? _____
   (d) Evidence of high humidity in covered container? ..... ____
2. Wire scratch brush, mounted on 7 1/2 in. x 2 1/2 in. (191 x 64 mm) hardwood block? ..... ____
3. Scarifier, six-pronged ice pick or similar apparatus? ..... ____
4. Measuring device, readable to 0.01 in. (0.25 mm) **[*ASTM: 0.2 mm*]**? ..... ____
5. Graduate, 250 mL capacity? ..... ____
6. Pans and carriers, for handling materials and test specimens? ..... ____

For (T135 / D559) ONLY:

1. Water bath, suitable tank for submerging compacted specimens? ..... ____
2. Oven, maintains 71±3°C (160±5°F)? ..... ____

For (T136 / D560) ONLY:

1. Freezing cabinet, maintains -23°C (-10°F) or lower? ..... ____
2. Absorptive pads, 6.4 mm (1/4 in.) thick felt pads, blotters, etc.? ..... ____

COMMENTS (T134 & T135 & T136 / D558 & D559 & D560):

MOISTURE-DENSITY RELATIONS OF SOIL-CEMENT MIXTURES (T134) ____
(D558) ____

PROCEDURE Date: _____

Method A - Sample Preparation (Material Passing No. 4 Sieve):

1. If damp, sample dried in air or drying apparatus, not exceeding 140°F (60°C)? ____
2. Sample pulverized and sieved over No. 4 (4.75-mm) sieve? ____
3. Sample passing No. 4 sieve weighs approximately 6 lb (2.7 kg) or more? ____

Method B - Sample Preparation (Material Passing 3/4 in. Sieve):

1. If damp, sample dried in air or drying apparatus, not exceeding 140°F (60°C)? ____
2. Sample pulverized and sieved over No. 4 (4.75-mm) sieve? ____
3. Material retained on No. 4 sieve (aggregate separated out) pulverized? ____
4. Sample sieved over 3-in. (75-mm), 3/4-in. (19.0-mm), and No. 4 sieves? ____
5. Material retained on 3-in. sieve discarded? ____
6. Percentage, by oven-dry mass, retained on 3/4-in. and No. 4 sieves determined? ____
7. Minus 3/4 in. plus No. 4 material saturated in water and saturated surface dry condition obtained? ____
8. Separate samples of minus No. 4 and saturated surface dry (minus 3/4 in. plus No. 4) material selected so that total sample will weigh approximately 11 lb (4.99 kg) or more? ____
9. Percentage, by oven-dry mass, of minus 3/4 in. plus No. 4 material is same as percentage of minus 3 in. plus No. 4 material in original sample? ____

Procedure

1. Required amount of cement conforming to (M85 / C150) or (M240 / C595) added to soil (added to minus No. 4 soil for Method B)? ____
2. Soil and cement mixed thoroughly to uniform color? ____
3. When needed, water added for 4 to 6% less than estimated optimum moisture? ____
4. If soil is heavy clay material:
   (a) Mixture compacted in required container to depth of about 2 in. (50 mm)? ____
   (b) Compacted mixture covered and allowed to stand 5 to 10 minutes? ____
   (c) Mixture pulverized to passing No. 4 size and remixed? ____
5. Method B only: Saturated surface dry material added to soil-cement mixture and mixed thoroughly? ____
6. Layer of mixture placed in mold (with collar attached)? ____
7. Mold on rigid and stable foundation? ____
8. Sample compacted in three equal layers, with 25 blows per layer? ____
9. Collar removed and soil trimmed to top of mold with knife and straightedge? ____
10. Method B only: During trimming, particles extending above top of mold removed and holes replaced with finer material? ____
11. Mold and contents weighed? ____
12. Mass of specimen and mold minus mass of mold multiplied by 30 (or divided by 942.95)? ____
13. Soil removed from mold and sliced vertically through center? ____
14. Moisture sample removed from full height of one cut face and weighed immediately? ____
15. Sample weighs at least 100 g (Method A) or at least 500 g (Method B)? ____
16. Moisture samples dried in oven at 230±9°F (110±5°C) for at least 12 hours or to constant mass? ____
17. Remainder of material from mold broken up to about passing No. 4 (Method A) or 3/4 in. (Method B) size and added to remainder of original test sample? ____

    or Separate and new sample used for each point? ____

    Note: *A separate sample shall be used for each point when the soil material is fragile and will reduce in grain size from repeated compaction.*
18. Water added to increase water content by 1 or 2%? ____
19. Steps 6 through 18 repeated for each increment of water added? ____
20. Process continued until wet unit mass either decreases or stabilizes? ____
21. Moisture content and oven-dry unit mass determined for each sample? ____
22. Unit mass plotted on ordinate, moisture content plotted on abscissa and points connected with curve? ____
23. Moisture content at peak of curve taken as optimum moisture content? ____
24. Dry unit mass at optimum moisture content reported as maximum density? ____

COMMENTS (T134 / D558): (T134 / D558)

WETTING-AND-DRYING TEST OF COMPACTED SOIL-CEMENT MIXTURES (T135) ____
(D559) ____

PROCEDURE (Continued) Date: _____

Method A - Sample Preparation (Material Passing No. 4 Sieve):

1. If damp, sample dried in air or drying apparatus, not exceeding 140°F (60°C)? ____
2. Sample pulverized and sieved over No. 4 (4.75-mm) sieve? ____
3. Sufficient quantity of soil selected to provide two (optional) compacted specimens and required moisture samples? ____
   Note: *One specimen (No. 2 - Standard) is required for routine testing. Other specimen (No. 1 - Optional) is made for research work and for testing unusual soils.*
4. Required amount of cement conforming to M85 or M240 **[*ASTM C150 or C595*]** added to soil? ____
5. Soil and cement mixed thoroughly to uniform color? ____
6. Water added to optimum water content at time of compaction and mixed thoroughly? ____
7. If soil is heavy clay material:
   (a) Mixture compacted in required container to depth of about 2 in. (50 mm)? ____
   (b) Compacted mixture covered and allowed to stand 5 to 10 minutes? ____
   (c) Mixture pulverized to about passing No. 4 size and remixed? ____
8. Layer of mixture placed in mold (with collar attached)? ____
9. Mold on rigid and stable foundation? ____
10. Sample compacted in three equal layers, with 25 blows per layer? ____
11. Tops of first and second layers scarified before placing and compacting next layers? ____
12. Scarification forms grooves at right angles to each other, approximately 3 mm (1/8 in.) wide, 6.4 mm (1/4 in.) **[*ASTM: 1/8 in. (3.2 mm)*]** deep, and 6.4 mm (1/4 in.) apart? ____
13. During compaction, representative sample weighing at least 100 g taken from uncompacted material? ____
14. Moisture content sample weighed and dried according to T265 **[*ASTM: dried in oven at 230 ± 9°F (110 ± 5°C) for at least 12 hours or to constant weight*]**? ____
15. Collar removed and soil trimmed to top of mold with knife and straightedge? ____
16. Mold and contents weighed? ____
17. Specimen removed from mold and oven-dry density calculated in kg/m^3 (lb/ft^3) **[*ASTM: g/cm^3*]**? ____
18. This specimen identified as No. 1 and used for data on moisture and volume changes? ____
19. Second specimen formed immediately as above, and % moisture and oven-dry density determined? ____
20. This specimen identified as No. 2 and used for data on soil-cement losses during test? ____
21. Average diameter determined to 0.01 in. (0.25 mm) by taking 3 height measurements 120° apart, & average height determined to 0.01 in. (0.25 mm) by taking 3 diameter measurements at quarter points of height? ____
    Note: *All height and diameter measurements should be taken at same points on specimen at all times.*
22. Specimens placed on carriers in moist room and protected from free water for 7 days? ____
23. Specimen No. 1 weighed and measured after 7-day storage period? ____
24. Specimens submerged in water at room temperature for 5 hours? ____
25. Specimen No. 1 [*AASHTO only: blotted*], weighed, and measured? ____
26. Both specimens placed in oven at 71±3°C (160±5°F) for 42 hours and removed? ____
27. Specimen No. 1 weighed and measured? ____
28. Specimen No. 2 given 2 firm strokes on all areas with wire brush? ____
29. Strokes applied to full height and width of specimens with force of approximately 13.3 N (3 lb)? ____
30. 18 - 20 strokes cover sides of specimen twice, and 4 strokes applied on each end? ____
31. Steps 24 through 30 repeated for 12 cycles? ____
    Note*: Specimen No. 1 may be discontinued prior to 12 cycles if measurements become inaccurate due to soil-cement loss.*
32. *AASHTO: Specimens dried according to T265 and weighed?* ____
    ASTM: Specimens dried to constant weight at 230°F (110°C) and weighed? ____

COMMENTS (T135 / D559): (T135 / D559)

WETTING-AND-DRYING TEST OF COMPACTED SOIL-CEMENT MIXTURES (T135) ____
(D559) ____

PROCEDURE (Continued) Date: _____

Method B - Sample Preparation (Material Passing 3/4 in. Sieve):

1. If damp, sample dried in air or drying apparatus, not exceeding 140°F (60°C)? ..... ____
2. Sample pulverized and sieved over No. 4 (4.75-mm) sieve? ..... ____
3. Material retained on No. 4 sieve (aggregate separated out) pulverized? ..... ____
4. Sample sieved over 3-in. (75-mm), 3/4 in. (19.0-mm), and No. 4 sieves? ..... ____
5. Material retained on 3-in. sieve discarded? ..... ____
6. Percentage, by oven-dry mass, retained on 3/4-in. and No. 4 sieves determined? ..... ____
7. Minus 3/4 in. plus No. 4 material saturated in water and saturated surface-dry condition obtained? ..... ____
8. Separate samples of minus No. 4 and saturated surface-dry (minus 3/4 in. plus No. 4) material selected so that total sample will be enough to provide two (See first **Note** on previous page) compacted specimens and required moisture samples? ..... ____
9. Percentage, by oven-dry mass, of minus 3/4 in. plus No. 4 material is same as percentage of minus 3 in. plus No. 4 material in original sample? ..... ____
10. Steps 4 though 7 of Method A followed (water added to -No. 4 material)? ..... ____
11. Saturated surface-dry aggregate added to mixture and mixed thoroughly? ..... ____
12. Sample compacted and trimmed according to Steps 8 through 15 of Method A, except moisture sample weighs at least 500 g? ..... ____
13. Before compacting each layer, inside of mold spaded with butcher knife? ..... ____
14. During trimming, particles extending above top of mold removed and holes replaced with finer material? ..... ____
15. Steps 16 through 32 of Method A followed? ..... ____

Calculations

1. Calculations performed using book equations? ..... ____

COMMENTS (T135 / D559): (T136 / D559)

FREEZING-AND-THAWING TESTS OF COMPACTED SOIL-CEMENT MIXTURES (T136) ____
(D560) ____

PROCEDURE Date: _____

Method A - Sample Preparation (Material Passing No. 4 Sieve):

1. If damp, sample dried in air or drying apparatus, not exceeding 140°F (60°C)? ____
2. Sample pulverized and sieved over No. 4 (4.75-mm) sieve? ____
3. Sufficient quantity of soil selected to provide two (optional) compacted specimens and required moisture samples? ____
   Note: *One specimen (No. 2 - Standard) is required for routine testing. Other specimen (No. 1 - Optional) is made for research work and for testing unusual soils.*
4. Required amount of cement conforming to M85 or M240 ***(ASTM C150 or C595)*** added to soil? ____
5. Soil and cement mixed thoroughly to uniform color? ____
6. Water added to optimum water content at time of compaction and mixed thoroughly? ____
7. If soil is heavy clay material:
   (a) Mixture compacted in required container to depth of about 2 in. (50 mm)? ____
   (b) Compacted mixture covered and allowed to stand 5 to 10 minutes? ____
   (c) Mixture pulverized to about passing No. 4 size and remixed? ____
8. Layer of mixture placed in mold (with collar attached)? ____
9. Mold on rigid and stable foundation? ____
10. Sample compacted in three equal layers, with 25 blows per layer? ____
11. Tops of first and second layers scarified before placing and compacting next layers? ____
12. Scarification forms grooves at right angles to each other, approximately 3 mm (1/8 in.) wide, 3 mm (1/8 in.) deep, and 6 mm (1/4 in.) apart? ____
13. During compaction, representative sample weighing at least 100 g taken from uncompacted material? ____
14. Moisture content sample weighed and dried according to (T265)? ____
15. Collar removed and soil trimmed to top of mold with knife and straightedge? ____
16. Mold and contents weighed? ____
17. Specimen removed from mold and oven-dry density calculated in kg/m^3 (lb/ft^3) **[*ASTM: g/cm^3*]**? ____
18. This specimen identified as No. 1 and used for data on moisture and volume changes? ____
19. Second specimen formed immediately as above, and % moisture and oven-dry density determined? ____
20. This specimen identified as No. 2 and used for data on soil-cement losses during test? ____
21. Average diameter determined to 0.01 in. (0.25 mm) by taking 3 height measurements 120° apart, & average height determined to 0.01 in. (0.25 mm) by taking 3 diameter measurements at quarter points of height? ____
    Note: *All height and diameter measurements should be taken at same points on specimen at all times.*
22. Specimens placed on carriers in moist room and protected from free water for 7 days? ____
23. Specimen No. 1 weighed and measured after 7-day storage period? ____

Method B - Sample Preparation (Material Passing 3/4 in. Sieve):

1. If damp, sample dried in air or drying apparatus, not exceeding 140°F (60°C)? ____
2. Sample pulverized and sieved over No. 4 (4.75-mm) sieve? ____
3. Material retained on No. 4 sieve (aggregate separated out) pulverized? ____
4. Sample sieved over 3-in. (75-mm), 3/4-in. (19.0-mm), and No. 4 (4.75-mm) sieves? ____
5. Material retained on 3-in. sieve discarded? ____
6. Percentage, by oven-dry mass, retained on 3/4 in. and No. 4 sieves determined? ____
7. Minus 3/4 in. plus No. 4 material saturated in water and saturated surface dry condition obtained? ____
8. Separate samples of minus No. 4 and saturated surface-dry (minus 3/4 in. plus No. 4) material selected so that total sample will be enough to provide two (See first **Note** on this page) compacted specimens and required moisture samples? ____
9. Percentage, by oven-dry mass, of minus 3/4 in. plus No. 4 material is same as percentage of minus 3 in. plus No. 4 material in original sample? ____
10. Steps 4 though 7 of Method A followed (water added to -No. 4 material)? ____

COMMENTS (T136 / D560): (T136 / D560)

FREEZING-AND-THAWING TESTS OF COMPACTED SOIL-CEMENT MIXTURES (T136) ____
(D560) ____

PROCEDURE (Continued) Date: _____

Method B - Sample Preparation (Material Passing 3/4 in. Sieve) (**continued**):

11. Saturated surface-dry aggregate added to mixture and mixed thoroughly? ..... ____
12. Sample compacted and trimmed according to Steps 8 through 15 of Method A, except moisture sample weighs at least 500 g? ..... ____
13. Before compacting each layer, is inside of mold spaded with butcher knife? ..... ____
14. During trimming, particles extending above top of mold removed and holes replaced with finer material?..... ____
15. Steps 16 through 23 of Method A followed? ..... ____

Procedure

1. After storage in moist room, water-saturated absorptive pads placed between specimens and carriers?..... ____
2. Assembly placed in freezing cabinet at no warmer than -23°C (-10°F) for 24 hours and removed?..... ____
3. Specimen No. 1 weighed and measured?..... ____
4. Assembly placed in moist room or covered container for 23 hours and removed?..... ____
5. Free water made available to absorptive pads under specimens during thawing? ..... ____
6. Specimen No. 1 weighed and measured?..... ____
7. Specimen No. 2 given 2 firm strokes on all areas with wire brush? ..... ____
8. Strokes applied to full height and width of specimens with force of approximately 13.3 N (3 lb)?..... ____
9. 18 - 20 strokes cover sides of specimen twice, and 4 strokes applied on each end? ..... ____
10. After brushing, specimens turned over end for end before they are replaced on water-saturated pads?..... ____
11. Steps 1 through 10 repeated for 12 cycles?..... ____
    Note: *Specimen No. 1 may be discontinued prior to 12 cycles if measurements become inaccurate due to soil-cement loss.*
12. *AASHTO: Specimens dried according to T265 and weighed?*..... ____
    ***ASTM: Specimens dried to constant weight at 230°F (110°C) and weighed?*..... ____**

Calculations

1. Calculations performed using book equations?..... ____

COMMENTS (T136 / D560): (T136 / D560)

WET PREPARATION OF DISTURBED SOIL SAMPLES FOR TEST (T146) ____

APPARATUS Date: _____

1. Sieves:
   19.0 mm (3/4 in.)? ____ 2.00 mm (No. 10)? ____
   4.75 mm (No. 4)? ____ 425-µm (No. 40)? ____

2. Pulverizing apparatus (One of the following):
   (a) Mortar and rubber-covered pestle? ..... ____
   or (b) Mechanical device consisting of power-driven, rubber-covered muller? ..... ____
   or (c) Other device that breaks up aggregations of particles without reducing grain size? ..... ____

3. Sample splitter (One of the following):
   (a) Sample splitter? ..... ____
   or (b) Riffle sampler? ..... ____
   or (c) Quartering equipment? ..... ____
   or (d) Canvas quartering cloth? ..... ____

4. Balance:
   Meets M231? ..... ____

5. Oven, maintains 110±5°C (230±9°F)? ..... ____

6. Filter funnels or candles (Optional):
   (a) Buchner funnels 254 mm (10 in.) in diameter and filter paper? ..... ____
   or (b) Filter candles? ..... ____

7. Pans, 300 mm (12 in.) in diameter by 75 mm (3 in.) deep? ..... ____

8. Suitable containers, prevent moisture loss during storage of moist samples? ..... ____

PROCEDURE

Method **A**

1. Field sample dried in air or drying apparatus, not exceeding 60°C (140°F)? ..... ____
2. Sample pulverized and representative sample selected by splitting, quartering or use of a sampler? ..... ____
3. If applicable, test sample for Particle Size Analysis weighed and recorded as total sample mass uncorrected for hygroscopic moisture? ..... ____
4. Sample separated on 425-µm (No. 40) sieve? ..... ____
5. Material passing No. 40 set aside? ..... ____
6. Material retained on No. 40 placed in pan, covered with water, and allowed to soak for 2 to 24 hours until aggregations have become soft and broken down? ..... ____
7. Empty No. 40 sieve placed in bottom of a clean pan and liquid from soaked sample poured onto it? ..... ____
8. Additional water added to bring water level in pan approximately 13 mm (1/2 in.) above sieve mesh? ..... ____
9. Portion of soaked sample, not exceeding 0.45 kg (1 lb), placed in water on No. 40 sieve and stirred by hand while sieve is agitated up and down? ..... ____
10. Any lumps retained on sieve broken between thumb and fingers? ..... ____
11. Sieve held above water in pan and material retained on sieve washed with small amount of clean water? ..... ____
12. Washed material retained on sieve transferred to clean pan before placing another increment of soaked material on the sieve? ..... ____

COMMENTS (T146): (T146)

WET PREPARATION OF DISTURBED SOIL SAMPLES FOR TEST (T146) ____

PROCEDURE (Continued) Date: _____

Method **A** (**Continued**)

13. Steps 9 through 12 repeated [using portions not exceeding 0.45 kg (1 lb)] until entire soaked sample has been washed? ____
14. Material retained on No. 40 sieve (after all washings) dried and then sieved over No. 40? ____
15. Any material passing No. 40 after this sieving added to the -No. 40 material set aside in Step 5? ____
16. Material retained on No. 40 set aside for mechanical analysis of coarse material? ____
17. Pan containing wash water set aside for several hours until water above soil is clear, then clear water decanted or siphoned off? ____

or Wash water and soil filtered on Buchner funnels fitted with filter paper and vacuum applied to speed filtering, and soil on filter paper removed and combined with sediment remaining in pan? ____

18. Soil remaining in pan dried at temperature not exceeding 60°C (140°F)? ____
19. Dried soil pulverized and combined with -No. 40 material obtained in Step 5 and Step 15? ____
20. All -No. 40 material thoroughly mixed and sample selected for required tests? ____

Method **B**

1. Samples shipped from field to lab in sealed containers and contain natural moisture? ____
2. For rapid mechanical analysis results based on dry mass of original material, representative portion selected and dried at 110±5°C (230±9°F) for moisture content determination? ____
3. Representative portion of moist sample selected, estimated to contain sufficient particles passing the 425-µm (No. 40) sieve to make tests for determination of soil constants? ____
4. This portion soaked in water until aggregations become soft? ____

***Note**: Samples obviously containing only particles passing the No. 40 sieve may be used without first washing on the No. 40 sieve.*

5. Steps 7 through 13 of Method A followed with soaked material transferred to sieve in workable increments? ____
6. Pan containing washings set aside for several hours or until water above particles is clear? ____
7. Clear water decanted, pipetted, or siphoned off? ____

or Most water removed by filtering on Buchner funnels fitted with filter paper or by using filter candles and moist soil removed from filter paper or filter candles and combined with sediment remaining in pan? ____

8. Moisture content of -No. 40 material reduced until material reaches a putty-like consistency, but not below natural moisture content? ____
9. Moisture reduced by one of the following: air-drying, oven drying at temperature not exceeding 110°C (230°F), boiling, filtering on Buchner funnel, or by use of filter candles? ____
10. Sample stirred often during evaporation and cooling? ____
11. Heated samples cooled to room temperature before testing? ____
12. Prepared sample protected in moisture-tight container from further drying until all required tests are performed? ____

COMMENTS (T146): (T146)

PLASTIC FINES IN GRADED AGGREGATES AND SOILS BY USE OF THE SAND EQUIVALENT TEST (T176) _____ **(D2419) _____**

APPARATUS Date: _____

1. Graduated plastic cylinders (at least three recommended)? ..... _____
   (a) Outside diameter 38.1 mm (1.5 in.).
   (b) Inside diameter 31.0 – 32.0 mm (1.25 in.).
   (c) Inside height 430 mm (17 in.).
   (d) Graduations at 2.54 mm (0.1 in.), marked up to at least 15 in.
   (e) Rubber stopper that fits cylinder.

2. Satisfactory siphon assembly? ..... _____
   (a) Irrigator tube with an outside diameter 6.4 mm (1/4 in.) and length approximately 510 mm (20 in.).
   (b) Pinched end with No. 60 holes (1.0 mm diameter) drilled in two places on end.

3. Weighted foot assembly, weighs 1000 ± 5 g with a guide fixed to the shaft? ..... _____
   Note: Older (1969) model of weighted foot assembly with guide cap that fits over upper end of graduated cylinder is acceptable.

4. Tin measure, diameter approximately 57 mm (2 1/4 in.) and capacity of 85±5 mL? ..... _____

5. Wide-mouth funnel [*AASHTO only: Diameter approx. 100 mm (4 in.)* [*AMRL: 3 to 5 in.*] *at the mouth*]? ..... _____

6. Clock or watch, readable in minutes and seconds? ..... _____

7. Shaker (One of the following):
   ***Note**, AASHTO only: Mechanical shaker required for referee testing. Informational note if mechanical shaker NP.*
   (a) Mechanical
      (1) Operates at 175 ± 2 cycles per **minute** (127 to 135 cycles during testing period)?..... _____
      (2) Securely fastened to firm and level mount? ..... _____
   (b) Manually operated
      (1) Securely fastened to firm and level mount? ..... _____
   (c) Hand method
      (1) Effective method of determining 9 ± 1 in. throw length?..... _____

COMMENTS (T176 / D2419): (T176 / D2419)

PLASTIC FINES IN GRADED AGGREGATES AND SOILS BY USE OF THE SAND EQUIVALENT TEST (T176) _____ **(D2419) _____**

APPARATUS (Continued) Date: _____

8. Stock calcium chloride solution (One of the following):
   (a) 454 g (1 lb) technical grade anhydrous calcium chloride, 2050 g (4.515 lb) USP glycerin, and 47 g (0.10 lb) formaldehyde (40% by volume solution); diluted to 3.78 L (1 gallon) with distilled or demineralized water? ..... _____
   or (b) 577 g (1.27 lb) A.C.S. grade calcium chloride dihydrate, 2050 g (4.515 lb) USP glycerin, and 59 g (0.13 lb) 1,5-pentanedial (glutaraldehyde) (50% solution in water); diluted to 3.78 (1 gallon) with distilled or demineralized water? ..... _____
   or (c) 577 g (1.27 lb) A.C.S. grade calcium chloride dihydrate, 2050 g (4.515 lb) USP glycerin, and 63 g (0.14 lb) kathon CG/ICP; diluted to 3.78 L (1 gallon) with distilled or demineralized water? ..... _____

   Note*: *Stock solution may be made without using any biocide (formaldehyde, glutaraldehyde, or kathon), provided the storage time of the stock solution is not sufficient to promote fungi growth.

9. Working calcium chloride solution:
   (a) One measuring tin full (85±5 mL) of stock calcium chloride solution diluted to 3.78 L (1 gallon) with water? ..... _____
   (b) Stored in 4 L (1 gallon) bottle on shelf 915 ± 25 mm (36 ± 1 in.) **[*ASTM: 90 ±5 cm (36 ±2 in.)*]** above work surface? ..... _____
   Note: *Solution may be stored in larger glass or plastic vat, provided the liquid level is maintained between 915 to 1170 mm (36 and 46 in.)* ***[ASTM: 36 and 45 in. (91 to 114 cm)]*** *above work surface.*

   (c) Temperature of solution is 22 ± 3°C (72 ± 5°F)? ..... _____
   (d) Solution is free of biological growth **[*ASTM: fungus*]**? ..... _____
   (e) *AASHTO only: Solution discarded if it is not clear and transparent?* ..... _____
   AASHTO only: Solution discarded if more than 30 days old? ..... _____
   ASTM only: Solution discarded if more than 2 weeks old, and fresh solution not added to old solution (Sections 6.6 to 6.8)? ..... _____

10. Oven, maintains 110±5°C (230 ± 9°F)? ..... _____

11. Work surface free of vibration and not exposed to direct sunlight? ..... _____

12. 4.75-mm (No. 4) sieve? ..... _____

13. *AASHTO only: Straightedge or spatula?* ..... _____

14. *AASHTO only: Quartering or splitting cloth?* ..... _____

15. ***ASTM only: Flat pan, for mixing?*** ..... _____

COMMENTS (T176 / D2419): (T176 / D2419)

PLASTIC FINES IN GRADED AGGREGATES AND SOILS BY USE OF THE SAND EQUIVALENT TEST (T176) _____ **(D2419) _____**

PROCEDURE Date: _____

Sample Preparation

AASHTO only:

1. Sample obtained by T2, pulverized and passed through 4.75-mm (No. 4) sieve? _____
2. All fines cleaned from +No. 4 particles and included with -No. 4 material? _____
3. Sample split or quartered to yield 500 to 750 g (1.1 to 1.6 lb) of -No. 4 material? _____
***Note**: If necessary, material may be dampened before splitting or quartering to avoid segregation or loss of fines.*

ASTM only:

1. Sample mixed and reduced according to C702 (splitting or quartering)? _____
2. Sample sieved on No. 4 (4.75-mm) sieve until not more than one weight percent of residue passes the sieve during one minute? _____
3. Any +No. 4 lumps pulverized to pass No. 4 sieve? _____
4. All fines cleaned from +No. 4 particles and included with -No. 4 material? _____
5. Sample is at least 1500 g of -No. 4 material? _____

Method 1 - Air Dry

***Note**: If necessary, material may be dampened before splitting or quartering to avoid segregation or loss of fines.*

AASHTO only:

1. *Enough -No. 4 material split or quartered to fill the 85-mL (3-oz) tin slightly rounded above brim?* _____
2. *While filling, bottom edge of tin tapped on hard surface to consolidate material?* _____
3. *Tin struck off level full with spatula or straightedge?* _____

ASTM only (Procedure A):

1. ***Measuring tin filled four times by dipping from sample?*** _____
2. ***When a measure full is dipped, bottom edge tapped on hard surface at least 4 times to consolidate material?*** _____
3. ***Measure level full or slightly rounded above the brim?*** _____
4. ***Amount of material in four measures determined by weight or by volume, using plastic cylinder?*** _____
5. ***This material returned to sample?*** _____
6. ***Sample quartered or split according to C702 to obtain the predetermined weight or volume?*** _____
7. ***Sample split or quartered two more times to obtain specimens?*** _____
8. ***Each specimen dried at 230 ± 9°F (110 ± 5°C) and cooled to room temperature before testing?*** _____

Method 2 - Pre-Wet (*AASHTO* and ***ASTM** Procedure **B)***

1. ***ASTM only: Material dampened sufficiently to prevent segregation or loss of fines?*** _____
2. ***ASTM only: 1000 to 1500 g of material split or quartered out?*** _____
3. ***ASTM only: Material mixed thoroughly with hand trowel in circular pan by scooping toward middle of pan while rotating it horizontally?*** _____
4. ***ASTM only: Mixing continued for at least one minute?*** _____
5. Moisture condition checked by tightly squeezing small portion in palm of hand, forming a cast? _____
6. Sample at proper water content (cast permits careful handling without breaking)? _____
   (a) If too dry (cast crumbles easily), water added and remixed? _____
   (b) If too wet (shows free water), sample drained and air dried, mixing frequently? _____
7. If either (a) or (b) above occurred, sample placed in pan, covered with lid or damp cloth (not touching sample), and allowed to stand for at least 15 minutes? _____

COMMENTS (T176 / D2419): (T176 / D2419)

PLASTIC FINES IN GRADED AGGREGATES AND SOILS BY USE OF THE SAND EQUIVALENT TEST (T176) _____ **(D2419) _____**

PROCEDURE (Continued) Date: _____

Method 2 - Pre-Wet (AASHTO and ***ASTM Procedure B)*** (Continued)

1. *AASHTO: Sample placed on splitting cloth and mixed by alternately lifting each corner of cloth and pulling it over sample toward diagonally opposite corner, causing material to be rolled?* ..... _____
   ASTM: Sample remixed for 1 minute after minimum curing time, without water, and formed into a cone with a trowel? ..... _____
2. *AASHTO only: When material appears to be homogeneous, mixing finished with sample in a pile near center of cloth?* ..... _____
3. Tin measure pushed through base of pile with free hand against pile opposite the measure? ..... _____
4. Material fills tin to overflowing? ..... _____
5. Material compacted into tin with palm of hand? ..... _____
6. Tin struck off level full with spatula or straightedge **[*ASTM: or with trowel using a sawing motion*]**? ..... _____

Method 3 – AASHTO only Reference / Referee Method

1. *AASHTO only: If using referee method (mechanical shaker), sample obtained by either Method 1 or 2, then dried to constant mass at 110±5 ℃ (230 ± 9 ℉), and cooled to room temperature before testing?* ..... _____

Procedure

1. 101.6 ± 2.5 mm (4 ± 0.1 in.) of working calcium chloride solution siphoned into plastic cylinder? ..... _____
2. Prepared sample poured from measuring tin into cylinder, using funnel to avoid spillage? ..... _____
3. Bottom of cylinder tapped sharply on heel of hand several times to release air bubbles? ..... _____
4. Wetted sample allowed to stand undisturbed for 10 ± 1 minutes? ..... _____
5. Stopper placed in cylinder and material loosened from bottom by shaking? ..... _____
6. Mechanical Shaker Method (Referee Method):
   (a) Stoppered cylinder placed in mechanical shaker and timer set? ..... _____
   (b) Cylinder and contents shaken for 45 ± 1 seconds (127 to 135 cycles during testing period)? ..... _____

   Manual Shaker Method
   (a) Stoppered cylinder secured in hand shaker and stroke counter reset to zero? ..... _____
   (b) Fingertips pushed against right hand spring steel strap, and smooth oscillating motion maintained? ..... _____
   (c) Tip of pointer reverses direction within marker limits? ..... _____
   (d) Shaking action continued for 100 strokes in 45 ± 5 seconds? ..... _____

   Hand Method
   (a) Cylinder held horizontally and shaken vigorously in horizontal linear motion from end to end? ..... _____
   (b) Cylinder shaken 90 cycles (one cycle is a complete back and forth motion) in approx. 30 seconds [AMRL: ± 3 s.], using throw of 229 ± 25 mm (9 ± 1 in.)? ..... _____
7. Following shaking, cylinder set upright on work table and stopper removed? ..... _____
8. Irrigator tube inserted in cylinder and material rinsed from cylinder walls as irrigator is lowered? ..... _____
9. Irrigator forced through material to bottom of cylinder by gentle stabbing and twisting action while solution flows from tip? ..... _____
10. Stabbing and twisting motion applied until cylinder filled to 381-mm (15-in.) **[*ASTM: 38.0-cm*]** mark? ..... _____
11. Irrigator raised slowly without shutting off flow so liquid level is maintained at about 15 in.? ..... _____
12. Final level adjusted to 15 in. before irrigator is removed from cylinder [*AASHTO only: between top 2 graduations, but not above the 381-mm level*]? ..... _____
13. Cylinder and contents allowed to stand undisturbed for 20 minutes±15 seconds? ..... _____
14. Timing started immediately after withdrawal of irrigator? ..... _____

COMMENTS (T176 / D2419): (T176 / D2419)

PLASTIC FINES IN GRADED AGGREGATES AND SOILS BY USE OF THE SAND EQUIVALENT TEST (T176) _____ **(D2419) _____**

PROCEDURE (Continued) Date: _____

Procedure (continued)

15. After sedimentation, level at top of clay suspension (clay reading) recorded? ..... _____
16. If no clear line of demarcation, sample allowed to stand undisturbed until clay reading can be obtained, and total sedimentation time recorded?..... _____
17. If sedimentation time exceeds 30 minutes, test rerun using 3 individual samples of same material, and clay reading requiring shortest sedimentation time recorded? ..... _____
18. Weighted foot assembly gently lowered into cylinder, without hitting mouth of cylinder? ..... _____
19. When foot rests on sand, assembly tipped toward cylinder graduations until indicator touches cylinder?..... _____
20. 254 mm (10 in.) subtracted from level indicated by extreme top edge of indicator, and this value recorded as sand reading?..... _____
21. If clay/sand readings fall between 2.5-mm (0.1-in.) graduations, is level of higher graduation recorded? ..... _____

Calculations

1. Sand equivalent calculated to 0.1 using following equation? ..... _____

$$\frac{\text{Sand Reading}}{\text{Clay Reading}} \times 100$$

2. If sand equivalent is not a whole number, reported as next higher whole number?..... _____
3. If desired to average sand equivalent values, and average is not a whole number, reported as next higher whole number?..... _____

COMMENTS (T176 / D2419): (T176 / D2419)

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (T190) ____
(D2844) ____

APPARATUS Date: _____

1. Kneading compactor (as follows): ..... _____
   (a) Capable of average pressure of 2413 **[*ASTM: 2410*]** ±110 kPa (350±16 psi) to tamper foot.
   (b) Equipped with counter or timer for measuring number of tamps.
   (c) Mold holder, rotates equally between tamps and firmly restrains mold during compaction.
   (d) Holder base is metal plate 100.8 mm (3 31/32 in.) in diameter and 12.7 mm (0.5 in.) high.
   (e) Rubber disk 100.0 mm (3 15/16 in.) in diameter and 3.2 mm (1/8 in.) high cemented to holder base.
   (f) Equipped with trough for feeding sample to mold in 20 increments.
2. Rubber disks, diameter 100 mm (3 15/16 in.), and 3.2 mm (1/8 in.) thick? ..... _____
3. Tamping rod, metal rod, 38 to 51 mm (1.5 to 2.5 in.) **[*ASTM: 38 mm (1.5 in.)*]** in diameter? ..... _____

4. Compression testing machine, minimum capacity of 45 kN (10,000 lbf)? ..... _____
5. Molds:

Inside diameter: 101.55 – 101.65 mm (3.998 – 4.002 in.)?								
Height: 126.80 – 127.20 mm (4.992 – 5.008 in.)?								
Inside surface roughened?								

6. Exudation-indicator device, equipped with 6 lights [*AASHTO: or similar to Figure 5 equipped with mirror*]? . _____
7. Phospher bronze disk, diameter 100.8 mm (3.97 in.), outer edge has forty-two 4.0-mm (5/32 in.) holes? ..... _____
8. Filter paper: **Note to assessors:** *It is acceptable for the laboratory to cut the filter paper to the specified size.*
   (a) Smooth surface, 100 mm in diameter, .15 mm (0.006 in.) thick? ..... _____
   (b) Creped surface, 110 mm in diameter, .15 mm (0.006 in.) thick? ..... _____

9. Expansion-pressure devices (at least 3), with calibrated spring steel bars, specimen height measuring device, perforated disc and stem design? ..... _____
10. *AASHTO only: Expansion pressure calibration equipment, suitable hanger and weight for steel spring bar calibration and a calibrated proving ring?* ..... _____
11. Deflection gauge, with 0.002 mm (0.0001 in.) divisions, an Allen wrench, and proving level assembly? ..... _____

12. Solid-walled metal follower, height 127 mm (5 in.) [*AASHTO: minimum*] [AMRL: 5-7 in.], and diameter of 100.20 to 100.46 mm (3.945 - 3.955 in.)? ..... _____

13. Standard metal specimen, outside diameter 101.60 mm (4 in.), and height 152.4 mm **[*ASTM: 152.2 mm*]** (6 in.) [AMRL 5 to 7 in.]? ..... _____
14. Stabilometer, with accessories? ..... _____

15. Balance, *Class G5 or better, having sufficient capacity* **[*ASTM: 5000-g capacity, accurate to 1 g*]**? ..... _____
16. Sieves, 25.0 mm (1 in.), 19.0 mm (3/4 in.), and 4.75 mm (No. 4)? ..... _____
17. Miscellaneous equipment, mixing pans, spoons, and spatulas, gallon cans with close-fitting lids? ..... _____

COMMENTS (T190 / D2844): (T190 / D2844)

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (T190) ____
(D2844) ____

PROCEDURE Date: _____

Soil Preparation

1. Any coatings removed from coarse aggregate and clay lumps broken to pass 4.75-mm (No. 4) sieve? ..... _____
2. When material is retained on 19.0-mm (3/4-in.) sieve:
   (a) When 75% or more passes 19.0-mm sieve, that part of sample passing 19.0-mm sieve used? ..... _____
   (b) If less than 75% passes 19.0-mm sieve, that part of sample passing 25.0-mm (1-in.) sieve used? ..... _____

Specimen Preparation

1. Four approximately 1200 g samples mixed with amount of water estimated to equal 1/2 to 2/3 of water required to produce saturation? ..... _____
2. Samples placed in covered containers and allowed to stand overnight? ..... _____
3. Just prior to compaction, samples mixed with final amount of water to produce saturation? ..... _____
4. First sample is pilot specimen to assist in determining final amount of water required? ..... _____
5. Material selected to fabricate compacted sample 101.6 mm (4 in.) in diameter by 63.5 mm (2.5 in.) high? ..... _____
   Note: *Compacted specimen heights of 58.4 to 68.6 mm (2.3 to 2.7 in.)* **[*ASTM: 2.45 to 2.55 in. (62 to 65 mm)*]** *are ok.*
6. Mold placed in mold holder approximately 3 mm (1/8 in.) from base of holder [*AASHTO: by placing shim under mold edge or tightening set screw, if available, on mold holder*]? ..... _____
7. Compactor foot pressure set at 1724±172 kPa **[*ASTM: 1720±170 kPa*]** [250±25 psi]? ..... _____
8. 76.2 mm (3 in.) of soil in trough fed into mold? ..... _____
9. Balance of soil fed into mold in 20 equal increments, with one application of ram after each increment? ..... _____
10. Soil leveled with 10 additional tamps? ..... _____
11. Rubber disk placed on top of specimen [*AASHTO: set screw, if available, loosened and shim removed*]? ..... _____
12. 100 additional tamps applied with foot pressure of 2413 kPa **[*ASTM: 2410 kPa*]** [350 psi]? ..... _____
    Note: *Use lower compaction pressures <u>when necessary</u> to limit penetration of ram into soil to ≤ 6.35 mm (1/4 in.).*
13. Compaction stopped at any time before 100 tamps if water appears around bottom of mold? ..... _____
14. Mold removed and tamped surface leveled by hand tamping with tamping rod? ..... _____
15. Phosphor-bronze disk placed on tamped surface, and filter paper placed on disk? ..... _____
16. Mold inverted and placed on exudation-indicator device, so that filter paper is on bottom? ..... _____
17. Uniformly increasing pressure applied to soil with compression machine at rate of 8896 N **[*ASTM: 8900 N*]** [2000 lbf]/minute? ..... _____
18. Water exuded from soil at 2068 kPa **[*ASTM: 2070 kPa*]** [300 psi] [~3750 lbf], as evidence that enough moisture is present to produce saturation? ..... _____
19. Loading stopped and exudation pressure recorded when either 5 of 6 indicator lights on device are lighted or when 3 indicator lights are lighted and free water is visible around bottom of mold? ..... _____
20. Loading does not exceed 5516 kPa **[*ASTM: 5520 kPa*]** [800 psi] [~10,000 lbf]? ..... _____
21. At least two more specimens molded with different amounts of water so range of exudation pressures from 689 to 5516 kPa **[*ASTM: 690 to 5520 kPa*]** [100 to 800 psi] is obtained, which brackets the 2068 kPa **[*ASTM: 2070 kPa*]** [300 psi] value? ..... _____

COMMENTS (T190 / D2844): (T190 / D2844)

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (T190) ____
(D2844) ____

PROCEDURE (Continued) Date: _____

Expansion-Pressure Testing

1. Specimen allowed to rebound in covered mold at least 30 minutes after determining exudation pressure and the height to the nearest 2.5 mm (0.1 in.)? ____
2. Deflection gauge positioned on expansion-pressure device and adjusted, using Allen wrench, until gauge reads 0.229 mm (0.0090 in.)? ____
3. Creped surface filter paper placed on turntable? ____
4. Perforated disk with stem placed on compacted specimen and mold placed in expansion-pressure device? ____
5. Perforated disk seated firmly on specimen with pressure applied by fingers? ____
6. Turntable raised until deflection gauge reads zero? ____
7. Approximately 200 mL water placed in mold and expansion pressure allowed to develop for 16 - 24 hours? ____
8. Deflection read to 0.002 mm (0.0001 in.) after expansion time? ____
9. If deflection is greater than 0.254 mm (0.0100 in.), expansion-pressure device recalibrated? ____
10. Expansion pressure calculated by P = k (spring constant) x d (deflection)? ____

Adjustment of Stabilometer

1. Bronze nut on stabilometer stage base adjusted so top of stage is 89 mm (3 1/2 in.) below bottom of upper tapered ring of stabilometer? ____
2. With standard metal specimen in chamber, air amount in stabilometer cell adjusted so that 2±0.05 turns of pump handle increase liquid pressure from 34.4 to 689 kPa **[*ASTM: 34 to 690 kPa*]** [5 to 100 psi]? ____

Resistance-Value Testing

1. Water poured off top of specimen, and mold with specimen placed on top of stabilometer? ____
   Note: *If all water had drained through specimen, water should be added to top and allowed to stand for 15 minutes. Any excess water should then be poured off and test continued.*
2. Follower placed on top of specimen and specimen forced from mold into stabilometer? ____
3. Testing machine head lowered until it just engages follower? ____
4. Horizontal pressure of 34.5 kPa **[*ASTM: 34 kPa*]** [5 psi] applied to specimen with displacement pump? ____
5. Uniform vertical load applied at rate of 1.3 mm/minute (0.05 in./minute)? ____
6. Vertical load stopped at 8896 N **[*ASTM: 8900 N*]** [2000 lbf] and horizontal pressure recorded? ____
7. Vertical load reduced to 4448 N **[*ASTM: 4450 N*]** [1000 lbf]? ____
8. Horizontal pressure adjusted to 34.5 kPa (5 psi) **[*ASTM: reduced to 4 psi (27 kPa) then brought to 5 psi (34 kPa)*]** with displacement pump? ____
   Note: *This will result in further reduction in applied load and should be ignored.*
9. Stabilometer pump handle turned approximately 2 turns/second and number of turns (using turns-displacement indicator on stabilometer) required to raise horizontal pressure from 34.5 to 689 kPa **[*ASTM: 34 to 690 kPa*]** [5 to 100 psi] recorded? ____
10. R-value calculated using book equation? ____

COMMENTS (T190 / D2844): (T190 / D2844)

DENSITY OF SOIL IN-PLACE BY THE SAND-CONE METHOD (T191) _____
(D1556) _____

APPARATUS Date: _____

1. Density Apparatus (Figure 1, as follows): ..... _____
   (a) 4 L (1 gal.) jar **[*ASTM: jar or sand container of suitable volume*]**.
   (b) Detachable double funnel top connected by cylindrical valve with opening 12.7 mm (½ in.) diameter.
   (c) Valve has stops preventing rotation past open or closed.
   (d) ***ASTM: Walls of cone form angle of approx. 60º with base.***
   Note: *Other apparatus of similar proportions may be used if the basic principles of sand cone determination are observed.*

2. Base plate, has flanged center hole cast to receive large funnel?..... _____
   (a) ***ASTM only: Base plate is a minimum of 3 inches larger than funnel and***]? ..... _____

3. Calibration Container
   (a) *AASHTO: Inside diameter equal to or slightly less than diameter of opening of the base plate?* ..... _____
   (b) ***ASTM: Approximately same size and allows sand to fall approx. same distance as test hole? ..... _____***
   Note, ASTM only: *Molds from D698 (Proctor) are recommended containers*.
   (c) Of a known volume, calibrated according to T19 or D4253? (volume of container is V_C)..... _____

4. *Sand – AASHTO*..... _____
   (a) Clean, dry, free-flowing, and uncemented, having few particles passing the 0.075-mm (No. 200) or retained on the 2.00 mm (No. 10) sieves.
   (b) Several bulk density determinations made and variation in bulk densities is less than 1 percent.

5. ***Sand – ASTM*** ..... _____
   (a) Clean, dry, uniform in density and grading, uncemented, durable, and free-flowing.
   (b) Gradation has a uniformity coefficient ($C_u = D_{60}/D_{10}$) < 2.0, max particle size < 2 mm (No.10), and <3% by weight passing the 250-µm (No. 60) sieve.
   (c) Bulk density determined on each container or bag of sand, with not more than 1% variation between any determination and the average value, in air-dried state before use.
   (d) Sand not re-used without removing any contaminating soil, checking the gradation, drying and re-determining the bulk density. ***Note:*** *reclaiming sand after testing is not desirable.*
   (e) Bulk density test of sand made at interval not exceeding 14 days (not required if using cone correction Method B), always after significant changes in atmospheric humidity, before reusing, and before use of a new batch.
   Note: *A small amount of absorbed moisture can make a substantial change in bulk density. The bulk density may need to be determined more often than the 14 day maximum interval.*

6. Balances, class G20 readable to 5 g or better [*AASHTO only: Class G2 readable to 0.1 g*]?..... _____

7. Drying equipment for moisture content: stove, oven, or other suitable equipment?..... _____

8. Moisture content containers? ..... _____

COMMENTS (T191 / D1556): (T191 / D1556)

DENSITY OF SOIL IN-PLACE BY THE SAND-CONE METHOD (T191) _____
(D1556) _____

CONE CORRECTION Date: _____

AASHTO – use method A **ASTM – use method A or A&B**

Cone Correction Factor **[*ASTM: Method A By Mass*]**:

1. Empty apparatus placed upright on firm level surface with valve closed? ..... _____
2. *AASHTO: apparatus filled with sand that is dried and conditioned to the same state anticipated during testing (can be filled with or without the funnel attached)?* ..... _____
3. ***ASTM: Apparatus filled with sand? ..... _____***
4. Mass of apparatus with sand determined? (m_1) ..... _____
5. Base plate placed on clean, level, plane surface? ..... _____
6. Sand cone inverted and the funnel seated in the recess of the base plate? ..... _____
7. ***ASTM: Apparatus and base plate marked so that they can be reseated in the same position during testing? .*** _____
8. Valve opened fully until sand stops flowing **[*ASTM: ensure apparatus is not jarred or vibrated*]**? ..... _____
9. Valve closed sharply and mass of apparatus and remaining sand determined? (m_2) ..... _____
10. Mass of sand required to fill cone and base plate (Cone Correction) calculated by subtracting the final mass of apparatus and sand from the initial mass of apparatus and sand? (Cone correction $C_C = m_1 - m_2$) ..... _____
    AASHTO only Note: *For each container / bag of sand there will be a unique cone correction and sand calibration factor. Each sand cone and matched base plate will also have a set of unique cone corrections and bulk sand densities.*
11. ***ASTM only: Procedure repeated a minimum of three times and results averaged, maximum variation between any one determination and average does not exceed 1%, average value used in calculations? ..... _____***

OPTIONAL ***ASTM only: Calibration of Sand Cone Apparatus, Method B*** *by volume**:***

ASTM Note: *When large numbers of tests and batches of sand are anticipated, it may be advantageous to determine the volume of each apparatus and base plate. Unless the apparatus is damaged, this volume will remain constant and eliminated the need to repeat Method A when the sand bulk density changes. If used, the calculations in the field test must be altered.*

1. ***Mass of sand required to fill apparatus determined according to Method A for each batch of sand? ..... _____***
2. ***Volume of the funnel and base plate determined (volume equals bulk density of sand divided by cone correction determined in Method A)?..... _____***
3. ***Minimum of three determinations performed and average value calculated, maximum volume variation between any one determination and average does not exceed 1%, average value used in test calculations?... _____***

COMMENTS (T191 / D1556): (T191 / D1556)

DENSITY OF SOIL IN-PLACE BY THE SAND-CONE METHOD (T191) _____
(D1556) _____

SAND BULK DENSITY DETERMINATION Date: _____

Bulk Density Factor **[*ASTM: Bulk Density Determination, Method A (Preferred)*]**

1. Sand removed during the Cone Correction determination replaced and valve closed? ..... _____
2. Mass of apparatus with sand determined? (m_3)..... _____
3. Calibration container placed on clean, level plane surface?..... _____
4. Base plate placed on calibration container, apparatus inverted and seated in the recess of base plate?..... _____
5. Valve opened fully until sand stops flowing? ..... _____
6. Valve closed sharply and mass of apparatus and remaining sand determined? (m_4) ..... _____
7. Bulk Density calculated as follows:..... _____

$$D_B = (m_3 - m_4 - C_C) / V_C$$

Where:

D_B = bulk density of the sand
m_3 = initial mass of apparatus and sand
m_4 = final mass of apparatus and sand
C_c = Cone Correction
V_c = volume of calibration container

8. *AASHTO: At least three determinations made and results averaged?* ..... _____
9. *AASHTO: Each container/bag of sand has unique cone correction and sand calibration factor, each sand-cone and matched base plate has unique cone correction and bulk sand densities?* ..... _____
10. ***ASTM only: Procedure repeated a minimum of three times and results averaged, maximum variation between any one determination and average does not exceed 1%, average value used in calculations? ..... _____***

ASTM Bulk Density Determination, Method B (Alternative):

1. Metal Straightedge, about 2 in. (50 cm) wide, at least 1/8 in (3 mm) thick, with a length of approx. 1.5 times the diameter of calibration container? ..... _____
2. Apparatus filled with sand? ..... _____
3. Mass of empty calibration container determined? ..... _____
4. Apparatus inverted and supported over the calibration container so that sand falls approximately same distance and location as in field? ..... _____
5. Valve opened and container filled until just overflowing and valve closed?..... _____
6. Minimum number of strokes used to strike off excess material with care taken not to vibrate container? ..... _____
7. Any excess sand cleaned off outside of container? ..... _____
8. Mass of container and sand determined?..... _____
9. Net mass of sand calculated by subtracting mass of empty container from mass of container and sand?..... _____
10. Bulk density calculated as in Method A? ..... _____
11. Procedure repeated a minimum of three times and results averaged, maximum variation between any one determination and average does not exceed 1%, average value used in calculations? ..... _____

COMMENTS (T191 / D1556): (T191 / D1556)

DENSITY OF SOIL IN-PLACE BY THE SAND-CONE METHOD (T191) _____
(D1556) _____

SAND BULK DENSITY DETERMINATION Date: _____

Preparation:

1. ***ASTM: Apparatus inspected for damage, free rotation of valve and matching base plate?*** ..... _____
2. *AASHTO: apparatus filled with sand that is dried and conditioned ot the same state anticipated during testing (can be filled with or without the funnel attached)?* ..... _____
3. ***ASTM: Container filled with sand (bulk density of sand previously determined)?*** ..... _____
4. Mass of the filled sand cone apparatus determined? (m_5) ..... _____

Testing:

1. Test location prepared so that it is a level plane and base plate seated on prepared surface? ..... _____
2. ***ASTM: Base plate makes contact with the ground around flanged hole, base plate outlined to check for movement during the test, and if needed baseplate secured using nails or other means?*** ..... _____
3. Test hole dug inside the opening of the base plate without disturbing the soil that will bound the hole? ..... _____
4. ***ASTM: Test hole volume as large as practical (to minimize errors), hold depth selected to be representative of soil, should approximate the thickness of or more compacted lifts?*** ..... _____
5. ***ASTM: Sides of hole slope slightly inward, bottom reasonably flat and concave, granular soils may require digging a conical-shaped hole?*** ..... _____
6. ***ASTM: Hole kept as free as possible of pockets, overhangs, and sharp obtrusions?*** ..... _____
7. All loosened soil placed in container, loss of material and moisture avoided? ..... _____
8. ***ASTM: Base plate flange cleaned?*** ..... _____
9. Apparatus placed on base plate **[*ASTM: at the same position as marked during calibration*]**? ..... _____
10. ***ASTM: Vibrations from nearby personnel or equipment eliminated or minimized during testing?*** ..... _____
11. Valve opened, sand allowed to fill hole, base plate, and funnel until sand stops flowing? ..... _____
12. Valve closed and mass of apparatus and remaining sand determined? (m_6) ..... _____
13. Mass of moist material removed from test hole determined? (M_{WS}) ..... _____
14. Material mixed thoroughly and a representative sample removed for moisture determination **[*ASTM: or use entire sample*]**? ..... _____
15. ***ASTM: When required, mass of oversized material determined and appropriate corrections made according to D4718?*** ..... _____
16. Moisture content determined according to (T265 / D2216) or rapid methods (T217, D4959, D4944, D4643)? .. _____
17. Results from rapid methods corrected to the values obtained in accordance with (T265 / D2216)? ..... _____
18. Moisture content reported to nearest 0.1 percent? (w) ..... _____
19. Test hole volumes and moisture content samples conform to the following table [*AASHTO: suggested*]? ..... _____

Maximum Particle Size		**Minimum Test Hole, Volume**		***AASHTO only: Min. Moisture Content Sample, g***
Sieves		cm^3	cu ft	
AASHTO:	*4.75-mm (No. 4)*	*710*	*0.025*	*100*
	12.5-mm (0.5 in.)	1415	0.050	*250*
	25.0-mm (1 in.)	2125	0.075	*500*
AASHTO: ***ASTM:***	*50.0-mm (2 in.)* ***38.0-mm (1.5 in.)***	2830	0.100	*1000*

Note to Assessors: *No.4 sieve line is AASHTO only. Minimum moisture content mass is AASHTO only.*

20. Calculations performed according to the test method (AASHTO formulas listed, ASTM are equivalent)? ..... _____
    (a) Volume of the test hole, $V_H = (m_5 - m_6 - C_C) / D_B$
    (b) Dry mass of the material removed, $M_{DS} = (M_{WS} / (1 + (w/100))$
    (c) In-place dry density of the material removed from the hole, $D_D = M_{DS} / V_H$

COMMENTS (T191 / D1556): (T191 / D1556)

THE CALIFORNIA BEARING RATIO (T193) ____
(D1883) ____

APPARATUS Date: _____

1. METAL CYLINDRICAL MOLDS:

Inside diameter: 151.74 – 153.06 mm (5.974 – 6.026 in)?						
Height: 177.34 – 178.26 mm (6.982 – 7.018 in)?						
Extension collar approx. 50 mm [AMRL: at least] **[*ASTM: at least 50.8 mm*]** (2.0 in) high?						
Perforated base plate with **[*ASTM: at least 28*]** 1.6-mm (1/16-in) holes?						

2. **Surcharge weights**

ANNULAR surcharge weights

Center hole	Both	Approx. 54 mm [AMRL: 52 to 56] in diameter?						
Diameter	AASHTO	147.6 – 150.8 mm (5 7/8 ± 1/16 in)?						
	ASTM	***5 7/8 – 5 15/16 in (149.23 – 150.81 mm)?***						
Mass	AASHTO	2.23 – 2.31 kg (4.90 – 5.10 lb)?						
	ASTM	***4.52 – 4.56 kg (total mass of 1 or 2 weights)?***						

SLOTTED surcharge weights [*AASHTO only: or SPLIT weights*]

Diameter	AASHTO	147.6 – 150.8 mm (5 7/8 ± 1/16 in)?						
Mass	AASHTO	2.23 – 2.31 kg (4.90 – 5.10 lb) each?*						
	ASTM	***2.25 – 2.29 kg each?***						

***Note*:** Lab should have at least one annular weight and several slotted [*AASHTO only: or split*] weights.
* ***Note, AASHTO only:*** *If split weights, this is the mass of the pair.*

3. Metal spacer disk:
   (a) Diameter: 150.0 - 151.6 mm (5 15/16 ± 1/32 in.) **[*ASTM: 150.0 - 151.6 mm (5 15/16 ± 1/32 in.)*]**? .... _____
   (b) Height: 61.12 - 61.62 mm (2.406 - 2.426 in.) **[*ASTM: 2.411 - 2.421 in. (61.24 - 61.50 mm)*]**? ..... _____
4. Rammer, as specified in (T99 / D698) or (T180 / D1557), calibrated according to D2168? ..... _____
   Note, ASTM only: If mechanical rammer is used, it must be fitted with circular foot.
5. Expansion measuring apparatus:
   (a) Metal swell plate, fitted with adjustable stem, perforated with 1.6 mm (1/16 in.) diameter holes, diameter 147.6 - 150.8 mm (5 7/8 ± 1/16 in. **[*ASTM: 5 7/8 - 5 15/16 in. (149.23 - 150.81 mm*]**? ..... _____
   (b) Tripod to support dial indicator [*AASHTO only: arranged to fit mold extension collar*]? ..... _____
6. Dial indicators:
   (a) At least two available? ..... _____
   (b) Readable to 0.02 mm [ASTM: 0.025 mm] (0.001 in.)? ..... _____
   (c) AASHTO only: throw distance of at least 25 mm (1 in.)? ..... _____
7. ***ASTM only: Balance, class G5, meeting the requirements of D 4753 for a balance of 1-g readability?*** ..... _____

COMMENTS (T193 / D1883): (T193 / D1883)

THE CALIFORNIA BEARING RATIO (T193) ____
(D1883) ____

APPARATUS (Continued) Date: _____

8. Metal penetration piston, at least 102 mm (4 in.) long, diameter 49.50 - 49.76 mm (1.949 - 1.959 in.)?..... _____
9. Loading device: Manufacturer (if known): _____
   (a) Can load at rate of 1.27 mm (0.05 in.) per minute **[*ASTM only: within ±20%*]**?..... _____
   Note to assessors, ASTM only: ±20% is equivalent to 1.016 to 1.524 mm (0.04 to 0.06 in.) per minute.
   (b) *AASHTO: Capable of applying uniformly increasing load up to a capacity sufficient for the material being tested?*..... _____
   ASTM: Uniform rate (not pulsating) and minimum capacity based on following requirements? .... _____
   (c) ***ASTM only: Equipped with load-indicating device readable to 10 lbf (44 N) or less?*****.....** _____

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

10. Soaking tank covers specimen and allows free access of water to mold base?..... _____
    (a) *AASHTO only: Capable of maintaining water level 25 mm (1 in.) above top of specimens?*..... _____
11. Oven, maintains 110±5°C (230±9°F)?..... _____
12. *AASHTO only: Moisture containers, resistant to corrosion and weight change with close-fitting lids?*..... _____
13. Miscellaneous: Mixing pans, spoons, straightedge, filter paper, balances, etc.? ..... _____
14. ***ASTM only: Sieves, 2 in., 3/4 in., and No. 4?***..... _____

COMMENTS (T193 / D1883): (T193 / D1883)

THE CALIFORNIA BEARING RATIO (T193) ____
(D1883) ____

PROCEDURE Date: _____

Sample Preparation

1. Sample prepared for compaction according to (T99 / D698) or (T180 /D1557), using 152.4-mm (6-in.) mold?... ____
2. If all material passes 19.0-mm (3/4-in.) sieve, entire sample used?..... ____
3. If some +19.0 mm material, that material removed and replaced by equal amount of -19.0 mm, +4.75 mm (No. 4) material from unused sample?..... ____

Note to Assessors: *Use either Optimum Water Content (A) below* ***or*** *Range of Water Content (B) on next page.*

Sample Preparation – Optimum Water Content

A. For Bearing Ratio at Optimum Water Content, AASHTO only:

1. Representative portion of initial sample, weighing approximately 11 kg (25 lb), selected for moisture-density test?..... ____

2. Remainder of sample divided to obtain 3 representative portions weighing approx. 6.8 kg (15 lb) each? ..... ____

3. Using 11 kg (25 lb) portion, optimum water content and maximum dry density determined according to T99 or T180?..... ____

Note: A previously performed compaction test on same material may be substituted for this compaction test, provided if that sample contained +19.0 mm (3/4 in.) material, the +19.0 mm material was replaced with an equal amount of -19.0 mm, +4.75 mm (No. 4) material.

4. Three specimens compacted (generally at 10, 30, and 65 blows per layer for specimens 1, 2, and 3 respectively) with densities ranging from 95% (or lower) to 100% (or higher) of maximum dry density? ..... ____

or *One specimen compacted to maximum dry density at optimum water content determined by T99? ..... ____*

A. For Bearing Ratio at Optimum Water Content, ASTM only:

1. Control compaction test conducted with sufficient number of test specimens to establish optimum water content, according to D698 or D1557 (or, see above Note)? ..... ____

2. If CBR is desired at 100% maximum dry unit weight and optimum water content, specimen compacted according to D698 or D1557, from soil prepared to within ±0.5% of optimum water content? ..... ____

or

3. If CBR is desired at optimum water content and some percentage of maximum dry unit weight, three specimens compacted from soil to within ±0.5% of optimum moisture content using different number of blows per layer for each specimen (number of blows per layer varied to bracket unit weights above and below desired value)? ..... ____

Note: Typically, if CBR at 95% maximum dry unit weight is desired, specimens compacted using 56, 25, and 10 blows per layer is satisfactory.

4. Penetration performed on each compacted specimen?..... ____

COMMENTS (T193 / D1883): (T193 / D1883)

THE CALIFORNIA BEARING RATIO (T193) ____
(D1883) ____

PROCEDURE (Continued) Date: _____

Sample Preparation – Range of Water Content

B. *For Bearing Ratio for Range of Water Content, AASHTO only:*

1. *At least 5 representative portions weighing approximately 6.8 kg (15 lb) each selected for developing each compaction curve?* ..... ____
2. *Using 6.8 kg (15 lb) specimens, optimum water content and maximum dry density determined according to T99 (Method D) or T180 (Method D), except that CBR molds are used and each specimen is penetrated for CBR determination?* ..... ____
3. *Complete moisture-density relationship developed for 10 and 25 blow per layer compactions, and each compacted specimen is penetrated (all compactions performed in CBR molds)?* ..... ____
4. *If specified unit weight is at or near 100% maximum dry unit weight, is compactive effort greater than 56 blows per layer included?* ..... ____

B. ***For Bearing Ratio for Range of Water Content, ASTM only:***

1. ***Procedure same as that for Bearing Ratio at Optimum Water content, except each specimen used to develop compaction curve is penetrated?*** ..... ____
2. ***Complete water content - unit weight relation for 25 and 10 blow per layer compactions developed and each compacted specimen is penetrated (all compactions performed in CBR molds)?*** ..... ____
3. ***If specified unit weight is at or near 100% maximum dry unit weight, is compactive effort greater than 56 blows per layer included?*** ..... ____

Sample Compaction Procedure:

1. Mold clamped to base plate and extension collar attached? ..... _____
2. *AASHTO only: Mold and collar weighed to nearest 5 g (0.01 lb)?* ..... _____
3. Spacer disk placed in mold and filter paper placed on disk? ..... _____
4. Each sample mixed with water and compacted in mold according to desired method? ..... _____
5. Moisture content taken according to one of the following:
   (a) Both, Unsoaked CBR – moisture sample taken according to (T99 / D698) or (T180 / D1557) if average water content is desired? ..... _____
   Note, minimum sample mass: *fine grained samples (all –No. 4 material) = 100 g, coarse grained = 500 g.*
   (b) *AASHTO, Soaked CBR - moisture sample taken at beginning of compaction of each sample and at the end of the compaction procedure, and water content determined by (T265)?* ..... _____
   (c) ***ASTM, Soaked CBR, Controlled Environment – if the compaction process is conducted under controlled temperatures (65 to 75°F, 18 to 24°C) and processed soil is kept sealed during compaction, only one representative water content sample by (D2216) required (extras are ok)?*** ..... _____
   (d) ***ASTM, Soaked CBR, Uncontrolled Environment – sample taken at beginning and end of compaction, moisture determined according to (D2216), and average value used (values should not differ by more than 1.5%)?*** ..... _____
6. Extension collar removed and compacted soil trimmed even with top of mold using straightedge? ..... _____
7. Surface irregularities patched with small-sized material? ..... _____
8. *AASHTO: Spacer disk removed?* ..... _____
   ASTM: Spacer disk and base plate removed, and mass of mold and compacted soil determined? ..... _____
9. Filter paper placed on perforated base plate? ..... _____
10. Mold inverted and placed on filter paper (compacted soil contacts paper)? ..... _____
11. Base plate clamped to mold? ..... _____
12. *AASHTO only: Collar attached to mold and assembly weighed to nearest 5 g (0.01 lb)?* ..... _____

COMMENTS (T193 / D1883): (T193 / D1883)

THE CALIFORNIA BEARING RATIO (T193) ____
(D1883) ____

PROCEDURE (Continued) Date: _____

Soaking

1. Swell plate placed on sample in mold? ..... ____
2. Sufficient weights, at least 4.54 kg (10 lb), placed on swell plate for desired load? ..... ____
3. *AASHTO: Tripod and dial indicator placed on top of mold and initial reading taken?* ..... ____
4. Mold immersed in water, allowing free access of water to the top and bottom of the specimen? ..... ____
5. ***ASTM: Tripod and dial indicator placed on top of mold and initial reading taken?*** ..... ____
6. Water level in mold and tank maintained [AASHTO only: approx. 1 in.] above top of specimen during soaking? ____
7. Specimen soaked for 96 hours (4 days)? ..... ____
   Note: *A shorter immersion period [AASHTO only: not less than 24 hours] may be used for materials that drain readily, if tests show that shorter period doesn't affect test results. AASHTO only: Soaking period greater than 4 days may be required for some clays.*
8. Final dial reading taken and percent swell calculated? ..... ____
9. Specimen removed from tank, water poured off top, and allowed to drain downward for 15 minutes? ..... ____
10. Surcharge weights, perforated plate and filter paper removed after draining? ..... ____
11. Mass of specimen determined [AASHTO only: optional]? ..... ____

Penetration Test

1. Penetration piston seated after one surcharge weight **[*ASTM: 2.27-kg annular weight*]** has been placed on specimen? ..... ____
2. Piston seated with load of no more than 44 N (10 lb)? ..... ____
3. Remainder of surcharge weights, equal to that used during soaking, placed on specimen? ..... ____
4. Penetration dial indicator and load indicators set to zero? ..... ____
5. ***ASTM only: Strain gauge (penetration gauge) <u>not</u> attached to testing machine's support bars (legs)?*** ..... ____
6. Loads applied to piston so penetration rate is uniform at 1.3 mm (0.05 in.) per minute **[*ASTM only: ±20%*]**? .... ____
7. *AASHTO: Loads recorded at penetrations of 0.64, 1.27, 1.91, 2.54, 5.08 and 7.62 mm (0.025, 0.050, 0.075, 0.100, 0.150, 0.200, and 0.300 in.) (additional readings are optional)?* ..... ____

   ASTM: Loads recorded at penetrations of 0.025, 0.050, 0.075, 0.100, 0.125, 0.150, 0.175, 0.200, 0.300, 0.400 and 0.500 in. (0.64, 1.27, 1.91, 2.54, 3.18, 3.81, 4.45, 5.08, 7.62, 10.16 and 12.70 mm)? ..... ____
   Note, ASTM only: ***Load readings at penetrations over 0.300 in. (7.6 mm) may be omitted if testing machine's capacity has been reached.***
8. ***ASTM only: Max load and depth noted if it occurs for penetration of less than 0.500 in. (12.70 mm)?*** ..... ____
9. ***ASTM only: Depth of piston penetration into soil measured with ruler?*** ..... ____
10. ***ASTM only: If measured depth does not closely match depth of penetration gauge, cause determined and new sample tested?*** ..... ____
11. If using a soaked CBR, water content of upper 25 mm (1 in.) of sample determined, according to D698 / D1557 (weighs at least 100 g for fine-grained soils or 500 g for coarse-grained soils) [*AASHTO: this step is* ***optional***]? ____
12. Stress-strain curve prepared? ..... ____
13. CBR values obtained in percent by dividing corrected load values at 2.54 and 5.08 mm (0.10 and 0.20 in.) by the standard loads of 1000 and 1500 psi (6.9 and 10.3 MPa), respectively, and multiplying those ratios by 100? ____
14. If CBR is greater at 5.08 mm (0.20 in.) than at 2.54 mm (0.10 in.) penetration, is test rerun? ..... ____
15. If check test gives similar results, ratio at 5.08 mm (0.20 in.) penetration used? ..... ____

COMMENTS (T193 / D1883): (T193 / D1883)

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL (T208) _____
(D2166) _____

APPARATUS Date: _____

1. Compression device, Manufacturer: _____ SN: _____
   (a) Has sufficient capacity and control to provide specified loading rate (can be a platform weighing scale equipped with a screw-jack-activated load yoke, hydraulic loading device, or other type)? ..... _____

2. Compression measurement device, proving ring load cell SN: _____
   (a) Capable of measuring the compressive stress to within the minimum specified readability:
   (1) AASHTO: required readability varies with cross-sectional area of specimen, see table? ..... _____
   Note to assessor: *Check the calibration records for proving rings to determine the readability.*

AASHTO Soil strength range	**Required readability**	**Example: a ~2-in. diameter sample**	**Example: a ~3-in. diameter sample**
Soil strength < 100 kPa (1.0 ton/ft^2)	measure to nearest 1 kPa (0.01 ton/ft^2) (20 lb/ft^2)	measure to nearest 0.5 lbs soil max load < 44 lbs	measure to nearest 1 lbs soil max load < 100 lbs
Soil strength ≥ 100 kPa (1.0 ton/ft^2)	measure to nearest 5 kPa (0.05 ton/ft^2) (100 lb/ft^2)	measure to nearest 2 lbs soil max load ≥ 44 lbs	measure to nearest 5 lbs soil max load ≥ 100 lbs

   (2) ASTM: readable to three significant digits at the maximum stress or within 1 kPa, whichever is larger? ..... _____

3. Deformation indicator, LVDT dial indicator other SN: _____
   (a) Graduated to 0.02 mm **[*ASTM 0.03 mm*]** (0.001 in.) or better? ..... _____
   (b) Range of travel at least 20% of specimen length? ..... _____

4. Sample extruder (**Note to assessor:** *write finding if a sample extruder is not available during testing*)? ..... _____
   (a) Hand-operated, mechanical, or hydraulic extruder capable of extruding the soil core from the sampling tube in the same direction of travel in which the sample entered the tube? ..... _____
   (b) Has a length of travel at least equal to the required untrimmed test length of the sample and permits the extrusion to occur in one operation without resetting the piston or extrusion mechanism? ..... _____
   (c) Can be operated at a relatively uniform rate and causes negligible disturbance of the sample? ..... _____

5. Dial comparator, or other suitable device, for measuring specimens to nearest 0.1% of measured dimension .... _____
   Note**:** *Vernier calipers are not recommended for soft specimens, which will deform as the calipers are set.*
6. Timer, indicates elapsed time to nearest second? ..... _____
7. Balance, readable to 0.1% of specimen mass **[*ASTM only: readable to 0.01 g for specimens of 200 g or less*]**? _____
8. Drying equipment as specified in (T265 / D2216), for drying water content samples:
   (a) Water content containers [*AASHTO only: Resistant to corrosion, disintegration, and weight change, with close-fitting lids*]? ..... _____
   (b) Oven, maintains 110 ± 5°C (230 ± 9°F)? ..... _____
9. Specimen preparation tools, trimming / carving tools and remolding apparatus? ..... _____

PROCEDURE

Undisturbed Specimens

1. Specimens handled carefully to prevent disturbance, changes in cross section, or loss of water content? ..... _____
2. Carved specimens prepared, whenever possible, in humidity-controlled room? ..... _____
3. Any small pebbles or shells removed when carving or trimming? ..... _____
4. Voids on specimen surface filled in with remolded soil obtained from trimmings? ..... _____
5. When pebbles or crumbling result in excessive irregularity at ends, specimen capped with minimum thickness of plaster of Paris, hydrostone, or similar material? ..... _____
   Notes: *Specimens may be sealed with rubber membrane, thin plastic coatings, or coating of grease or sprayed plastic immediately after preparation and during entire test. Also, if specimen is capped, mass and dimensions should be determined before capping.*
6. If entire specimen not used for water content, representative cuttings taken and placed in covered container? ... _____
7. Water content of cuttings determined according to (T265 / D2216)? ..... _____
8. ***ASTM: Initial dry density determined according to D7263 (Method A wax-coated method, Method B direct measurement or can calculate sample volume from height and inner dimensions of sample tube)?*** ..... _____

COMMENTS (T208 / D2166): (T208 / D2166)

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL (T208) _____
(D2166) _____

PROCEDURE (continued) Date: _____

Remolded Specimens

1. Prepared from either failed undisturbed sample or from disturbed sample? ..... _____
2. If failed undisturbed sample, wrapped in thin rubber membrane and material worked thoroughly with fingers to assure complete remolding? ..... _____
3. If remolding, care taken to avoid entrapped air, obtain uniform density, remold to same void ratio as undisturbed specimen and preserve natural water content? ..... _____

Compacted Specimens

1. Prepared to predetermined water content and density required? ..... _____
2. After forming specimen, ends trimmed perpendicular to longitudinal axis? ..... _____

Specimen Size

1. Specimen diameter at least 30 mm (1.3 in.)? ..... _____
2. Largest particle in test specimen smaller than 1/10th specimen diameter, or for specimens having diameter 72 mm (2.8 in.) or larger, largest particle size smaller than 1/6th specimen diameter? ..... _____
3. Height-to-diameter ratio between 2 and 2.5? ..... _____
4. Average height and diameter of specimen determined to 0.1%? ..... _____
5. Minimum of 3 height measurements taken 120° apart **[*ASTM: approximately 120° apart*]**? ..... _____
6. At least 3 diameter measurements taken at quarter points of height? ..... _____
7. Mass of specimen determined to 0.1%? ..... _____

Procedure

1. Specimen centered on bottom platen of loading device? ..... _____
2. Loading device adjusted so upper platen just makes contact with specimen? ..... _____
3. Deformation indicator zeroed **[*ASTM: or initial reading recorded from electronic deformation device*]**? ..... _____
4. Load applied to produce axial strain rate of 0.5 to 2% per minute, at a constant rate? ..... _____

Specimen height	0.5% of height	2% of height

Note to assessor: *Take several readings during the test to determine if the compression device is operating at a constant rate.*

Distance traveled	Elapsed time	Rate (distance / time)

5. Load, deformation, and time values recorded at sufficient intervals to define stress-strain curve (usually 10 to 15 points are sufficient)? ..... _____
6. Loading continued until load values decrease with increasing strain, or until 15% strain is reached? ..... _____
7. Rate of strain chosen so that time of failure does not exceed about 15 minutes? ..... _____
   Note, *AASHTO only: Strain rate for testing sealed specimens may be decreased, if desired. Also, higher or lower strain rates may be used if materials are either soft or brittle.*
8. Water content determined using entire specimen, unless cuttings were taken? ..... _____
9. Photo or sketch made of specimen at failure, showing slope angle of failure surface if angle is measurable? ..... _____
10. Calculations and graph (if desired) made according to book? ..... _____

COMMENTS (T208 / D2166): (T208 / D2166)

PERMEABILITY OF GRANULAR SOILS (CONSTANT HEAD) (T215) _____
(D2434) _____

APPARATUS Date: _____

Permeameter, similar to Fig.1 and minimum cylinder diameter 8 or 12 times max. particle size? ..... _____

1. One of the following:
   - (a) Large material (maximum particle size 3/8 in. to 3/4 in.)
     - (1) <35% soil retained on 9.5-mm (3/8-in.) sieve: 152-mm (6-in.) diameter cylinder.
     - (2) >35% soil retained on 9.5-mm (3/8-in.) sieve: 229-mm (9-in.) diameter cylinder.
   - (b) Small material (maximum particle size No.10 to 3/8 in.)
     - (1) <35% soil retained on 2.00-mm (No.10) sieve: 76-mm (3-in.) diameter cylinder.
     - (2) >35% soil retained on 2.00-mm (No.10) sieve: 114-mm (4.5-in.) diameter cylinder.

2. Permeameter fitted with porous disks or reinforced screens at top and bottom of chamber? ..... _____
   - (a) Screen or disk permeability greater than specimen permeability? ..... _____
   - (b) Bottom screen openings small enough to prevent movement of particles? ..... _____
   - (c) Top screen applies a pressure of 22 to 45-N (5 to 10-lbf) total load when top plate is in place? ..... _____
3. Manometer outlets, to measure loss of head (h) over a length (L) that is ≥ the diameter of the cylinder? ..... _____
   - (a) Equipped with manometer valves? ..... _____
   - (b) Protected with screens to prevent sample material from leaving the permeameter? ..... _____
4. Duplicate top plate, with four symmetrically placed openings through which the height measurements can be made to determine the volume of the sample? ..... _____

❖ (Picture has been removed because it was causing worksheet programs to crash.

Other Equipment:

1. Constant head filter tank, similar to Fig.1? ..... _____
   - (a) Supplies water and removes most air from tap water or uses deaired water? ..... _____
   - (b) Suitable control valves to maintain flow with soil voids saturated with water and no air bubbles? ..... _____
   - (c) Height of tank can be adjusted finely enough to change head by 0.5 cm increments? ..... _____
2. Large funnels, with spout length > height of the permeability chamber (spout length at least 150 mm (6 in.))? . _____
   - (a) For large material (3/8 to 3/4 in.) – cylindrical spouts 25 mm (1 in.) in diameter? ..... _____
   - (b) For small material (No.10 to 3/8 in.) – cylindrical spouts 13 mm (1/2 in.) in diameter? ..... _____
3. Specimen Compaction Equipment, as desired (proctor hammer, vibrating tamper, rod for sliding weights, etc)? _____
4. Vacuum Pump or Water-Faucet Aspirator, for evacuating and saturating specimens under full vacuum? ..... _____
5. Manometer tubes, with metric scales for measuring head of water? ..... _____
6. Balance, sensitive to 1 g (0.002 lb), with 2-kg (4.4-lb) capacity? ..... _____
7. Scoop, with approximately 100 g (0.25 lb) capacity? ..... _____
8. 250-mL graduated cylinder, for measuring quantity of flow? ..... _____
9. Thermometer, no specific requirements listed, but should be of suitable range and sensitivity to correct test measurements for the viscosity of water? ..... _____
10. Clock with sweep second hand (***Note to assessors:*** *digital clock or stop watch also acceptable*)? ..... _____
11. Miscellaneous Apparatus: quart jar, mixing pan, and quartering equipment? ..... _____

COMMENTS (T215 / D2434): (T215 / D2434)

PERMEABILITY OF GRANULAR SOILS (CONSTANT HEAD) (T215) _____
(D2434) _____

PROCEDURE Date: _____

Sample Selection

1. Sieve analysis (T88 / D422) performed prior to permeability test on sample of the complete soil? ..... _____
2. Any particles larger than 19 mm (3/4 in.) separated out by sieving? ..... _____
3. All plus 19 mm (3/4 in.) material not used for permeability test, but percentage recorded? ..... _____
4. Selected sample is air-dried granular soil that contains <10% of material passing 75-µm (No. 200) sieve? ..... _____
5. Sample, selected by quartering, is approx. twice the amount required to fill permeameter chamber? ..... _____

Preparation of Specimens

1. Following measurements made in cm or cm^2 and recorded on the test data sheet:
   (a) Inside diameter (D) of permeameter? ..... _____
   (b) Length (L) between manometer outlets (L must be $\geq D$)? ..... _____
2. Cross-sectional area (A) calculated? $\{(1/2 * D)^2 * \text{pi}\}$ ..... _____
3. To determine depth (H_1):
   (a) Lower and upper porous stone temporarily placed inside the permeameter? ..... _____
   (b) Duplicate top plate with 4 symmetrically spaced openings placed on top of permeameter? ..... _____
   (c) Depth (H_1), average of 4 measurements from upper surface of top plate to top of upper porous stone? _____
   (d) Upper porous stone removed from permeameter? ..... _____
4. Small portion of sample selected for water content determination? ..... _____
5. Remaining air-dried sample weighed (W_1) for unit weight determinations? ..... _____
6. Prepared sample placed in uniform thin layers, approximately equal in thickness after compaction to maximum size of particle, but not less than approx. 15 mm (0.6 in.) (use one of the following)? ..... _____

   (a) Large material (maximum particle size 3/8 in. to 3/4 in.)
      (1) Scoop used to spread soil, by starting at the perimeter of the permeameter and drawing the scoop toward the center in one smooth motion? ..... _____
      (2) Cylinder turned for successive scoops until uniform layer formed of thickness equal to maximum particle size? ..... _____
   (b) Small material (maximum particle size No.10 to 3/8 in.)
      (1) Funnel placed in permeameter with spout touching lower plate or previous layer? ..... _____
      (2) Funnel filled with enough soil, taken from different areas in pan, to form layer? ..... _____
      (3) Funnel lifted by 15 mm (0.6 in.) or approximately the unconsolidated layer thickness to be formed, and soil spread in slow spiral motion from perimeter to center? ..... _____
      (4) Layer is uniform and soil remixed in pan for each layer? ..... _____

7. Successive layers of soil compacted to desired relative density to approximately 2 cm (0.8 in.) [AMRL: 1 to 3 cm] above upper manometer outlet? ..... _____

Compaction Procedure (one of the following):

1. Minimum Density (0% Relative Density) – no compaction necessary? ..... _____
2. Maximum Density (100% Relative Density) – use one of the following:
   (a) Vibrating Tamper – light tamping action uniformly over surface, should not cause soil to escape from beneath the edges of the tamping foot [*suggested equipment – tamping foot diameter 51 mm (2 in.)*]? . _____
   (b) Sliding Weight – tamping blows uniformly distributed and sufficient to produce maximum density [*suggested equipment – tamping foot diam. 51 mm (2 in.); rod for sliding weights of 100 g (for sands) to 1 kg (for soils with a large gravel content), with an adjustable drop height 4 in. (for sands) to 8 in. (for gravels)*]? ..... _____
   (c) Other Methods – should not cause segregation of particle sizes? ..... _____
3. Relative Density Intermediate Between 0 and 100% - procedure for reproducible density determined by trial in a separate container and then used to compact the soil in the permeability cylinder? ..... _____

COMMENTS (T215 / D2434): (T215 / D2434)

PERMEABILITY OF GRANULAR SOILS (CONSTANT HEAD) (T215) _____
(D2434) _____

PROCEDURE (Continued) Date: _____

Preparation of Specimen for Permeability Test

1. To determine depth (H_2):
   - (a) Upper porous disk placed on specimen? ..... _____
   - (b) Soil surface leveled by rotating upper porous disk gently back and forth? ..... _____
   - (c) Spring placed on top of porous stone? ..... _____
   - (d) Duplicate top plate with 4 symmetrically spaced openings placed on top of permeameter and spring compressed lightly to seat the porous plate? ..... _____
   - (e) Depth (H_2), average of 4 measurements from upper surface of top plate to top of upper porous stone? _____
2. Measure and record:
   - (a) Final height of specimen (H)?{$H = H_1 - H_2$}? ..... _____
   - (b) Final mass of air-dried soil ($W_1 - W_2$), found by weighing soil (W_2) remaining in pan? ..... _____
     Note to assessor: *Care must be taken to ensure that all sample particles that were weighed initially (W_1) are either transferred to the permeameter or remain in the pan (W_2). Loss of particles on compaction equipment, funnels, scoops, and laboratory surfaces can give an inaccurate measurement of the final mass of the sample.*
   - (c) Unit weight, void ratio, and relative density of specimen computed? ..... _____
3. With gasket in place, top plate pressed down against spring and attached securely to top of cylinder, making air-tight seal? ..... _____
4. Air removed so that the pressure inside the permeameter is ≤ 50 cm (20 in.) Hg absolute for 15 minutes? ..... _____
5. any remaining air removed by subjecting specimen to full vacuum and specimen slowly saturated with water from bottom upward (constant head tank connected to bottom of permeameter)? ..... _____
6. Continued saturation maintained with either de-aired water or water maintained at in-flow temperature high enough to cause decreasing temperature gradient in specimen? ..... _____
7. Type of water (native, low mineral, deaired, tap, etc) used noted on data sheet? ..... _____
8. After permeameter full of water, inlet and outlet valves closed and vacuum disconnected? ..... _____
9. Care taken to ensure permeability flow system and manometer system free of air and working satisfactorily? .. _____
10. Inlet tube filled with water from constant-head tank by slightly opening filter tank valve? ..... _____
11. Inlet tube connected to top of permeameter? ..... _____
12. Inlet valve and manometer outlet cocks opened slightly to allow water to flow and release air bubbles? ..... _____
13. Water manometer tubes connected to manometer outlets and filled with water to remove air? ..... _____
14. Water in manometer tubes to allowed reach their stable water level under zero head? ..... _____

Permeability Procedure (constant head tank should start at the lowest setting that will be used during testing)

1. Inlet valve from filter tank opened slightly for first run, allowing water to pass through the sample? ..... _____
2. Measurements of flow and head delayed until stable head condition attained (manometer levels are stable)? .... _____
3. Time (t), head (h)-the difference in level in the manometers, quantity of flow (Q), and water temperature (T) recorded on data sheet? ..... _____
4. Test runs repeated at heads increasing by 0.5 cm? ..... _____
   Note: *If turbulent flow is indicated, 1-cm head intervals may be used.*
5. Specimen drained and inspected at completion of test, checking for segregation of fines? ..... _____

Calculation

1. Coefficient of permeability calculated as (k) = QL/Ath? ..... _____
   Where k = coefficient of permeability
   Q = quantity of flow (amount of water that exited the permeameter during a trial run)
   L = length between two manometer outlets
   A = cross-sectional area of testing chamber
   t = time (elapsed time of trial run)
   h = head, the difference in the manometer levels
2. Permeability corrected to that for 20°C (68°F) by multiplying k by the ratio of the viscosity of water at test temperature to the viscosity of water at 20°C (68°F)? ..... _____

COMMENTS (T215 / D2434): (T215 / D2434)

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (T216) _____
(D2435) _____

APPARATUS Date: _____

1. Specimen ring, made of non-corrosive material? _____
   (a) Rigid such that ring diameter does not change under greatest applied load (changes < 0.04%).
   (b) Inner surface highly polished or coated with low-friction material.
2. Porous disks, made of silicon carbide, aluminum oxide, or similar non-corrosive material: _____
   (a) Grade of disks fine enough to prevent intrusion of soil into the pores (unless filter paper is used).
   (b) Diameter of top disk 0.2 to 0.5 mm (0.01 to 0.02 in.) less than inside diameter of the ring.
   ***Note*:** *If floating ring is used, bottom disk shall have same diameter as top disk.*
   (c) Thick enough to prevent breakage.
   (d) Top disk loaded through corrosion-resistant plate of sufficient rigidity to prevent disk breakage.
   (e) Disks clean and free from cracks, chips, and non-uniformities.
   (f) Disks cleaned after each use with nonabrasive brush and boiled to remove clay particles.
3. Optional: Filter screen, low ash filter paper **[*ASTM: or monofilament-nylon screen*]**? _____
   Note to assessors: *If a filter screen is used it must be accounted for in the calculations.*
4. Trimming equipment, turntable or trimming lathe? _____
   or Cutter, with sharp edge, highly polished surface and coated with low-friction material, inside diameter = ring? _____
5. Deformation indicator, to measure change in specimen height, readable to 0.0025 mm (0.0001 in.)? _____
6. Oven, maintains 110±5°C (230±9°F)? _____
7. Water content containers, resistant to corrosion, disintegration, and weight change, with close-fitting lids? _____
   Note, ASTM only: *Lids are not required for samples greater than 200 g.*
8. Balance: *AASHTO: Readable to 0.1% of sample mass or better?* _____
   ASTM: Capable of determining specimen mass to 4 sig figs. and reads to nearest 0.01 g? _____
9. Testing environment:
   (a) Temperature fluctuates less than ±4°C (7°F) **[*ASTM: Test conducted in the range of 22 ± 5°C (72 ± 9°F) with a fluctuation of no more than ±2°C (±4°F)*]**? _____
   (b) No direct exposure to sunlight? _____
10. Timing device, readable to 1 second? _____
11. Distilled or demineralized water? _____
12. Spatulas, knives, and wire saws as needed? _____

13. Load device? _____
    (a) Accurate to ±0.5% of applied load.
    (b) Permits quick application of a given load increment without significant impact.
    Note: *Load application time should be less than $0.01*t_{100}$ (ex: if primary consolidation takes 3 minutes, load application should take less than 2 seconds).*
14. Consolidometer? _____
    (a) *AASHTO: Inside diameter of ring determined to 0.075 mm (0.003 in.).*
    ASTM: Inside diameter of ring fabricated to a tolerance of at least 0.1% of the diameter.
    (b) Has means of submerging specimen, applying vertical load, and measuring change in height of specimen.
15. Calibration disk, made of copper, hard steel, or aluminum: _____
    (a) Approximately **[AMRL: within ¼ in.]** the same height as test specimen.
    (b) Diameter between 1 mm (0.04 in.) and 5 mm (0.20 in.) smaller than ring diameter.
16. Consolidometer apparatus deformation correction:
    (a) Correction must be applied for apparatus flexibility/ compressibility:
        (1) Whenever paper filter screens are used? _____
        (2) *AASHTO: whenever the correction exceeds 5% of the measured deformation?* _____
        ASTM: if the equipment deformation exceeds 0.1% of the initial specimen height (if correction is required for any load, correction shall be applied to all measurements)?... _____
    (b) Consolidometer assembled with calibration disk, moistened porous disks, and filter paper (if used)? _____
    (c) Consolidometer loaded and unloaded according to exact schedule used in the test and deformation recorded (exact loading schedule is critical especially when using filter paper)? _____
    (d) Plot/table of corrections to measured deformation of specimen made for each load applied? _____
    (e) Correction after replacement and reassembly of apparatus components, and annually? _____

COMMENTS (T216 / D2435): (T216 / D2435)

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (T216) _____
(D2435) _____

PROCEDURE Date: _____

Specimen Preparation:

1. Height at least 12 mm (0.5 in.), but not less than 10 times maximum particle diameter? _____
2. Sample at least 50 mm (2.00 in.) in diameter and diameter-to-height ratio at least 2.5? _____
3. Prepared with minimum soil disturbance or change in moisture and density? _____
4. Vibration, distortion, and compression avoided? _____
5. Specimen trimmed, placed in consolidation ring, and trimmed flush with ring? _____
   ***Note*:** *Specimen may be recessed slightly below top of ring to facilitate centering of top stone.*
6. If small particles found during surface trimming, particles removed and void filled with soil from trimmings? _____
7. Specimen weighed in ring? _____
8. Initial height of specimen determined to nearest 0.025 mm (0.001 in.) **[*ASTM: 0.01 mm (0.001 in.)*]** by averaging at least 4 evenly spaced measurements over top and bottom surfaces **[*ASTM: and subtracting the thickness of the filter screens when appropriate*]**? _____
9. Initial specimen volume determined to nearest 0.25 cm^3 (0.015 $in.^3$) from ring diameter and initial height? _____
10. If enough material available, two or three water content determinations made from trimmed material in accordance with (T265 / D2216)? _____

Procedure

1. Ring assembled with specimen, porous disks, filter disks (when needed), and consolidometer? _____
   ***Note*:** *Porous disks may be damp or dry, depending on soil type. Dry porous disks and filters must be used with dry, highly expansive soils.*
2. Consolidometer enclosed in loose-fitting plastic or rubber membrane to prevent evaporation, unless specimen is inundated after applying seating load? _____
3. Consolidometer placed in loading device and seating pressure of 5 kPa (100 lbf/ft^2) applied (or about 2 - 3 kPa (50 lbf/ft^2) or less for very soft soils)? _____
   ***Note*:** *Additional load may be added to prevent specimen from swelling, if necessary.*
4. Deformation indicator adjusted and initial zero reading recorded immed. after application of seating load? _____
5. If testing a specimen that was saturated under field conditions or obtained below water table:
   (a) Specimen inundated shortly after application of seating load? _____
   (b) Load increased as required to prevent swelling during inundation? _____
   (c) Load required to prevent swelling and resulting deformation reading recorded? _____
6. Specimen subjected to increments of constant total stress, with specific loading schedule dependent on purpose of test? _____
   ***Note*:** *Standard loading schedule is 12, 25, 50, 100, 200, etc. kPa (250, 500, 1000, 2000, 4000, etc. lbf/ft^2).*
7. Height or change in height of specimen recorded before applying each pressure increment? _____
8. Method A:
   (a) Standard load increment duration of 24 hours? _____
   (b) Height or change in height recorded at set time intervals for at least 2 load increments? _____
   (c) Sufficient readings taken near end of pressure increment period to verify completion of primary consolidation? _____

   Method B:
   (a) Height or change in height recorded at set time intervals for each load increment? _____
   (b) Standard load increment duration exceeds time required for completion of primary consolidation? _____
9. Readings taken at approximately 0.1, 0.25, 0.5, 1, 2, 4, 8, 15 and 30 minutes, 1, 2, 4, 8 and 24 etc. hours, measured from time of each incremental pressure application? _____
   ***Note*:** *Other time intervals and loading schedules are acceptable.*
10. When rebound or unloading characteristics are required, soil unloaded in reverse order and readings taken as before? _____
11. At completion of test, free water wiped from specimen and ring, and specimen weighed in ring? _____
12. ***ASTM only: Final height of the specimen measured to 0.01 mm (0.001 in.)?*** _____
13. Water content determined according to (T265 / D2216)? _____
14. Calculations and graphs made according to book? _____
15. Correction for apparatus flexibility applied to all tests when filter paper is used and all tests when the correction exceeds 5% of the measured deformation **[*ASTM: exceeds 0.1% of initial specimen height*]**? ★ _____

COMMENTS (T216 / D2435): (T216 / D2435)

DETERMINATION OF MOISTURE IN SOILS BY MEANS OF A CALCIUM CARBIDE GAS PRESSURE MOISTURE TESTER (T217) _____ **(D4944)** _____

APPARATUS

Date: _____

1. Calcium Carbide Pressure Moisture Tester, chamber with attached pressure gauge for water content of specimens having mass of at least 20 g? ..... _____
2. Balance, Class G2 [readable to 0.1g]? ***Note:*** *Beam balance provided by manufacturer is also acceptable.* ..... _____
3. Two 31.75-mm (1.25-in) Steel Balls? ..... _____
4. Calcium Carbide Reagent, finely pulverized and of a grade capable of producing acetylene gas in the amount of at least 0.14 m^3/kg (2.25 ft^3/lb) of carbide? ..... _____
5. ***ASTM: No. 4 (4.75-mm) Sieve?*** ..... _____

PROCEDURE

Calibration:

1. *AASHTO: Accuracy of gauge checked by using calibration kit with standard gauge?* ..... _____
2. *AASHTO: Accuracy of correction curve (provided by manufacturer) checked by comparing curve-corrected moisture contents to moisture contents of locally prepared soils determined using (T265)?* ..... _____

   or *AASHTO: Calibration curve developed for range of soil material at wide range of water content?* ..... _____
3. ***ASTM: Calibration curve developed for range of soil material at wide range of water content?*** ..... _____

Testing

Note, AASHTO only: *The procedure for placing the soil specimen and calcium carbide reagent into the tester should be as follows or in accordance with the manufacturer's instructions. Manufacturer's instructions shall be followed for use of steel balls when testing sand.*

1. For 20-g or 26-g tester, three scoops (approx. 24 g) **[*ASTM: two scoops (approx 22 g)*]** of calcium carbide placed in body of moisture tester ***OR*** for 200D tester, six scoops (approx. 48 g) of calcium carbide used? ..... _____
2. Care taken to prevent calcium carbide from coming into contact with water? ..... _____
3. Sample weighed to exact mass specified by the manufacturer of the instrument in the balance provided? ..... _____
4. ***ASTM only: Sample contains particles smaller than the No. 4 (4.75-mm) sieve?*** ..... _____
5. Sample placed in cap of tester and steel balls placed in body of tester with calcium carbide? ..... _____
6. If moisture content exceeds limit of pressure gauge [AASHTO: 12% for aggregate or 20% for soil] ½ size sample used and dial reading multiplied by 2? ..... _____
7. Pressure vessel horizontal, cap inserted, and unit sealed by tightening clamp? ..... _____
8. Care taken that no carbide comes in contact with soil until seal is complete? ..... _____
9. Moisture tester raised to vertical position so that soil in cap falls into pressure vessel? ..... _____
10. ***ASTM only: Side of apparatus struck with open hand to assure all material falls out of cap?*** ..... _____
11. Instrument shaken vigorously **[*ASTM: with a rotating motion*]** to break up all lumps? ..... _____
12. Shaking continues for at least 60 seconds (granular soils) and up to 180 seconds (other soils)? ..... _____
13. Time permitted to allow dissipation of heat from chemical reaction? ..... _____
14. Dial read once needle stops moving while holding the instrument at eye level, in a horizontal position? ..... _____
15. Sample mass and dial reading recorded? ..... _____
16. Gas pressure slowly released, pressure vessel emptied, and material examined for lumps? ..... _____
17. If sample not completely pulverized, test repeated with new sample? ..... _____
18. Cap cleaned thoroughly of all carbide and soil before test is rerun? ..... _____
19. ***ASTM only: Apparatus allowed to cool to same temperature as it was during calibration?*** ..... _____

Calculations

1. Wet mass dial reading converted to dry mass (unless using 200D tester)? ..... _____
2. *AASHTO: % moisture by dry mass of soil determined from correction curve provided by the manufacturer?* .. _____

   ASTM: ***% moisture by dry mass of soil determined from the calibration curve (developed internally)?*** ..... _____
3. Percent moisture determined to nearest whole percent? ..... _____

   Note to Assessors: *the AASHTO and ASTM calculations provide the same results.*

COMMENTS (T217 / D4944): (T217 / D4944)

CORRECTION FOR COARSE PARTICLES IN THE SOIL COMPACTION TEST (OVERSIZE CORRECTION)

(T224)

Note to assessors: *The preparation sections of T224 and D4718 differ, but the equations are functionally equivalent. When assessing for both, please assess both versions of the preparation and one version of the calculations.*
Note to assessors: *If the lab uses both methods 1 and 2, then check both procedures. If the lab only uses one, dash the other.*

Abbreviations: Date: _____

Subscripts denote the following information: C = Coarse, f = Fine, T = Total, D = dry material, M = moist material

M = mass of material (example: M_D = mass of dry material, M_{DF} = mass of dry fine material)
P_f = percent of fine particles of sieve used, by weight
P_C = percent of the oversize particles of sieve used, by weight
MC = moisture content of group of particles, expressed as a decimal
D = total field wet density, kg/m^3 (pcf)
D_f = dry density of the fine particles, kg/m^3 (pcf) result for Field → Proctor
D_d = total dry density (combined fine and oversized), kg/m^3 (pcf) result for Proctor → Field

k = 1000 x Bulk Specific Gravity (G_m) (oven-dry basis) of coarse particles, kg/m^3;
OR 62.4 x Bulk Specific Gravity (G_m) (oven-dry basis) of coarse particles, pcf

Method 1 - Compacted Laboratory Dry Density Corrected to Field Dry Density (result is corrected D_d) (Proctor → Field)

1. Laboratory accredited for T99 or T180? (Required for accreditation) ..... _____
2. Drying oven and Proctor equipment available (or results of these tests available)? ..... _____
3. Proctor A & B: This method only used for samples with <40% retained on the 4.75-mm (No.4) sieve? ..... _____
4. Proctor C & D: This method only used for samples with <30% retained on the 19.0-mm (3/4-in.) sieve? ..... _____
5. Bulk specific gravity (G_M) of coarse particles determined according to T85 / C127 (Sp.G of Coarse Aggregate) [*AASHTO only: or can be assumed as 2.60 for most construction applications*]? ..... _____
6. Moisture content of fine particles and oversize particles determined (by T265, T217, or T255)? ..... _____
   (a) Moisture content of oversize material can be assumed to be 2% for most construction applications.
   (b) If the moisture content of the oversize material is generally known, use it in the calculations.
   (c) If drying equipment is available, recommended that actual moisture content be determined.
7. Dry mass of the coarse particles calculated, and dry mass of fine particles calculated? ..... _____
   $\mathbf{M_D = M_M / (1 + MC)}$ (***Note:*** *this calculation is performed twice, once for coarse and once for fine.*)
8. Percentage of fine particles and oversized particles by dry weight of the total sample calculated? ..... _____
   $\mathbf{P_f = 100\ M_{DF} / (M_{DF} + M_{DC})}$ $\mathbf{P_C = 100\ M_{DC} / (M_{DF} + M_{DC})}$
9. Corrected moisture content of the total sample (combined fine and oversized) calculated? ..... _____
   $\mathbf{MC_T = (MC_f\ P_f + MC_C\ P_C) / 100}$
10. Corrected dry density of the total sample (combined fine and oversized) calculated? ..... _____
    $\mathbf{D_d = 100\ D_f\ k / (D_f\ P_C + k\ P_f)}$

Method 2- Field-Wet Density Corrected to Compacted-Laboratory Density (result is corrected D_f) (Field → Proctor)

1. Laboratory accredited for an appropriate field density method? (Required for accreditation) ..... _____
   Note: *AMRL offers nuke gauge and sand cone as appropriate field density methods.*
2. Moisture content of fine particles and oversize particles determined (by T265, T217, or T255)? ..... _____
   (a) If using the nuclear moisture / density gauge, read the moisture content directly from the gauge.
   (b) Moisture content of oversize material can be assumed to be 2% for most construction applications.
   (c) If the moisture content of the oversize material is generally known, use it in the calculations.
   (d) If drying equipment is available, recommended that actual moisture content be determined.
3. Moisture content of the fine particles of the field sample calculated? ..... _____
   $\mathbf{MC_f = (100\ MC_T - MC_C\ P_C) / P_f}$
4. Dry field density of the sample calculated? ..... _____
   $\mathbf{D_d = D / (1 + MC_T)}$
5. Dry field density of the fine particles of the field sample calculated? ..... _____
   $\mathbf{D_f = D_d\ P_f / (100 - ((D_d\ P_C) / (k)))}$

COMMENTS (T224 / D4718): (T224 / D4718)

CORRECTION FOR COARSE PARTICLES IN THE SOIL COMPACTION TEST (OVERSIZE CORRECTION) (D4718)

Note to assessors: *If the lab uses both methods 1 and 2, then check both procedures. If the lab only uses one, dash the other.*

Abbreviations: Date: _____

Subscripts denote the following information: C = Coarse, F = Fine, D = dry material, M = moist material

M = mass of material (example: M_D = mass of dry material, M_{DF} = mass of dry finer fraction)
P_f = percent of finer fraction, by weight
P_C = percent of the oversize fraction, by weight
w = water content, expressed as a decimal
δ_D = dry unit weight of the total sample (from field test)
δ_W = unit weight of water (62.42 lbf/ft^3 OR 9.802 kN/m^3)
C_w = corrected water content of combined finer and oversize fractions

δ_F = dry unit weight of the finer fraction result for Field → Proctor
$C\delta_D$ = corrected unit dry weight of the total material (combined finer and oversize) result for Proctor → Field

Method 1 - Correction of Unit Weight and Water Content for Total Sample (result is corrected $C\delta_D$) (Proctor → Field)

1. Laboratory accredited for D698 or D1557? (Required for accreditation) ..... _____
2. Drying oven and Proctor equipment available (or results of these tests available)? ..... _____
3. Sample prepared according to D698 (Proctor), D1557 (Modified Proctor), or D4253 (Vibratory Table)? ..... _____
4. Mass of the moist fine fraction and mass of the moist oversize fraction of the sample determined? ..... _____
   Note: *Oversize fraction is plus No. 4 material, plus 3/4-in. material, or other appropriate size.*
5. Water content of each fraction determined by D2216 (Moisture Content of Soils)? ..... _____
6. Mass of the dry finer fraction calculated, and mass of the dry oversize fraction calculated? ..... _____
   $\mathbf{M_D = M_M / (1 + w)}$ (***Note:*** *this calculation is performed twice, once for coarse and once for fine.*)
7. Percentage of fine particles and oversize particles by dry weight of the total sample calculated? ..... _____
   $\mathbf{P_F = 100\ M_{DF} / (M_{DF} + M_{DC})}$ $\mathbf{P_C = 100\ M_{DC} / (M_{DF} + M_{DC})}$
8. Bulk specific gravity (G_M) of the oversize fraction calculated by C127 (Sp.G of Coarse Aggregate)? ..... _____
9. Corrected water content of the total material (combined finer and oversize fraction) calculated? ..... _____
   $\mathbf{C_w = (w_F\ P_F + w_C\ P_C)}$
10. Corrected dry unit weight of the total material (combined finer and oversize fraction) calculated? ..... _____
    $\mathbf{C\delta_D = 100\ \delta_F\ G_M\ \delta_W / (\delta_F\ P_C + G_M\ \delta_W\ P_F)}$

Method 2 - Correction of Unit Weight & Water Content for Finer Faction of Soil (result is corrected δ_F) (Field → Proctor)

1. Laboratory accredited for D6938 (Nuke Gauge) or D1556 (Sand Cone)? (Required for accreditation) ..... _____
2. Sample of total material obtained in the field in conjunction with a unit dry weight (δ_D) and a water content (w) by methods such as D1556 (Sand Cone), D2167 (Rubber Balloon), or D6938 (Nuke Gauge)? ..... _____
   Note: *Since this practice is usually used for materials containing coarse gravel and cobbles, special care should be taken to assure that the volume of the material sampled is adequate to accurately represent the material in the field.*
3. Oversize particles removed from the field sample and percentage of oversize material determined? ..... _____
   Note: *Oversize fraction is plus No. 4 material, plus 3/4-in. material, or other appropriate size.*
4. Bulk specific gravity of oversize material calculated by C127 (Sp.G Coarse Aggregate) or known value used? _____
5. Water content of the finer fraction of the field sample calculated? ..... _____
   $\mathbf{w_F = (100\ w - w_C\ P_C) / P_F}$
6. Dry unit weight of the finer fraction of the field sample calculated? ..... _____
   $\mathbf{\delta_F = \delta_D\ G_M\ \delta_w\ P_F / (100\ G_M\ \delta_w - \delta_D\ P_C)}$

Report

1. Report contains the following information: ..... _____
   (a) The identification of the sample, method used to compact the sample.
   (b) The method use to obtain the field sample, value of bulk specific gravity, G_M, used in the calculations.
   (c) The sieve size used to separate the oversize particles and the percentage of oversize particles.
   (d) Lab samples: dry unit weight, water content of the finer fraction, corrected value for the total sample.
   (e) Field samples: dry unit weight, water content of the total sample, corrected value for the finer fraction.

COMMENTS (T224 / D4718): (T224 / D4718)

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (T236) _____ **(D3080) _____**

APPARATUS Date: _____

1. Direct shear device, made of non-corrosive material (as follows): _____
   (a) Capable of holding specimens in a way that torque is not applied to specimen.
   (b) Has means of applying normal stress and shearing force, measuring change in thickness of specimen, permitting drainage of water through porous stones, and submerging specimen in water.
   (c) Capable of applying a shear force to the specimen along the plane parallel to the face of the specimen.
   (d) Sample frames sufficiently rigid to prevent distortion during shearing.

2. Loading devices:
   (a) Normal Force
      (1) Capable of applying force quickly without exceeding it? _____
      (2) Accurate to ±1% of applied load? _____
      (3) ***ASTM: Proving ring or load cell accurate to 0.5 lbf (2.5 N) or 1% of normal force during shearing, whichever is greater, unless dead weights are used?*** _____

   (b) Shear Force (*AASHTO: use either controlled displacement or controlled stress*)
      (1) AASHTO, for controlled displacement: capable of shearing specimen at uniform rate of displacement with less than ±5% deviation, and permits adjustment of displacement rate? _____
      (2) AASHTO, for controlled stress: Capable of applying force quickly and accurate to ±1% of applied load? _____
      (3) ASTM: Capable of shearing specimen at uniform rate of displacement with < ±5% deviation, adjusts displacement rate from 0.0001 to 0.04 in. /min. (.0025 to 1.0 mm/min.)? _____

3. ASTM only, Shear box bowl and force measurement device: _____
(a) Metallic box that supports shear box, serving as a container for test water to submerge specimen.
(b) Provides either reaction against which one half of shear box is restrained, or solid base with provisions for aligning one half of shear box, which is free to move coincident with applied shear force in horizontal plane.
(c) Proving ring or load cell accurate to 0.5 lbf (2.5 N) or 1% of shear force at failure, whichever is greater.

4. Metal calibration disk, approximately same thickness as test specimen:
   (a) *AASHTO only: about 5 mm smaller in diameter than the specimen, made of copper or hard steel?* _____
   (b) ***ASTM only: with a diameter slightly less than the direct shear box specimen holder?*** _____
5. Porous stones **[*ASTM: porous inserts*]** _____
   (a) Made of non-corrosive material.
   (b) ***ASTM only: Diameter of top stone 0.01 to 0.02 in. (0.2 to 0.5 mm) less than inside of ring.***
   (c) Hydraulic conductivity greater than soil, but fine enough to prevent excess clogging into pores.
6. Balance, *AASHTO: Sensitive to 0.1 g or to 0.1% of specimen mass* **[*ASTM: Readable to 0.1% or better*]?** _____
7. Moisture room (if required): to minimize moisture change [*AASHTO: moisture loss does not exceed 0.5%*]? _____
8. Trimmer or cutting ring? _____
9. Displacement / deformation indicators, **[*ASTM only: dial gauges or displacement transformers*]** _____
   (a) One sensitive to 0.002 mm **[*ASTM: 0.0001 in. (0.0025 mm)*]** for thickness change.
   (b) One sensitive to 0.02 mm **[*ASTM: 0.001 in. (0.025 mm)*]** for displacement.
10. Oven, maintains 110±5°C (230±9°F)? _____
11. Moisture sample containers, resistant to corrosion, disintegration, and weight change with close-fitting lids? _____
12. Test water, similar to the composition of the specimen pore fluid or as required by the requesting agency (potable tap water if no water was specified)? _____
13. Miscellaneous: equipment for remolding or compacting specimens, timing device that displays seconds, distilled or demineralized water, spatulas, knives, straight edge, wire saws? _____

COMMENTS (T236 / D3080):

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (T236) _____ **(D3080) _____**

ASTM APPARATUS (Continued) Date: _____

14. ASTM only, Shear box (evaluate for all shear boxes)? ..... _____

(a) Circular or square, and made of stainless steel, bronze, or aluminum.

(b) Provisions for drainage through top and bottom.

(c) Divided vertically by horizontal plane into two halves of equal thickness that are fitted together with alignment screws.

(d) Fitted with gap screws to control space (gap) between top and bottom halves.

Shear box mass (Evaluate for all shear boxes when demonstrating ASTM):

(e) Weight of top box less than 1% of applied normal force (Section 6.4.3)? ..... _____

Note: *Evaluate the shear box using the smallest normal force (vertical load) used during the shear portion of the test. Do not evaluate at other consolidation loads. Evaluate for all shear boxes.*

OR (f) Shear box supported by a suitable counter force (counterbalance arrangement)?..... _____

Square box			**Circular box**		
Length (in.)			Diameter (in.)		
Width (in.)			Radius (in.)		= 1/2 * Diameter
Square area (in.^{2})		= Length * Width	Circular area (in.^{2})		= π * (Radius^2)

Note: *Convert mm to in.: (# in mm*0.0394 = # in inches) Convert g to lb: (# in g*0.002205 = # in pounds) 2 kips = 1 ton = 2000 lb*

ASTM: Evaluate for all shear boxes (including counterbalanced boxes)

A = Weight of top box (lb) _____ B = Area of specimen (in.^{2}) _____ C = load of box lb / in.^{2} (A/B) _____

D = Normal force used during shear (lb / ft.^{2}) _____ E = convert normal force to lb / in.^{2} (D/144) _____

F = 1% of normal force (E x 0.01) _____ Shear box percent of applied normal force (C / E x 100) _____

PROCEDURE

Calibration (Other methods that have been proven to be equally accurate may be used.)

1. Calibration performed when device is first placed in service and whenever any components are changed?..... _____
2. *AASHTO only: Calibration performed annually thereafter?*..... _____
3. Calibration performed with the calibration disk used in place of a test specimen?..... _____
4. ***ASTM only: Normal force of ~1 lbf/in^2 (~5 kPa) applied and displacement recorded as the zero reading?*** ... _____
5. Increments of normal force applied and the normal displacement recorded for each increment? ..... _____
6. Applied normal force removed in reverse order and the normal displacement again recorded?..... _____
7. Average of the two recorded deformation values corresponding to load used calculated? ..... _____
8. ***ASTM only: Correction must be applied to every test measurement if apparatus deformation correction exceeds 0.1% of the initial specimen thickness at any load level?***..... _____
9. Average deformation of the device as a function of applied load plotted? ..... _____

Sample Preparation

1. ***ASTM only: Sample large enough for at least three specimens of similar material?*** ..... _____
2. Specimen at least 50 mm (2.00 in.) in diameter (or width, for square specimens) **[*ASTM only: or not less than 10 times maximum particle size diameter, whichever is larger*]**?..... _____
3. Thickness at least 13 mm (0.5 in.) **[*ASTM: 0.5 in (12 mm)*]**, but not less than 6 times max particle diameter?.. _____
4. Diameter-to-thickness ratio (or width-to-thickness ratio) at least 2:1? ..... _____

COMMENTS (T236 / D3080): (T236 / D3080)

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (T236) _____ **(D3080) _____**

PROCEDURE (Continued) Date: _____

Sample preparation continued, one of the following (5, 6, or 7):

5. Undisturbed **[*ASTM: Intact*]** Samples:
   - (a) Prepared with minimum moisture loss **[*ASTM: and minimum change in cross-section*]**?..... _____
   - (b) *AASHTO: Specimen trimmed to inside diameter of direct shear device?*..... _____
     ***Note**, AASHTO only: Diameter of undisturbed test specimens cut from tube samples should be at least 6 mm (0.25 in.) less than the diameter of the sampling tube to minimize disturbance caused by sampling.*
     ASTM: Specimen trimmed to fit shear box, top and bottom surfaces trimmed flat and parallel? ..... _____
   - (c) Care taken to prevent disturbing sensitive soils and initial specimen mass recorded? ..... _____

6. *Compacted Samples (AASHTO), compacted to desired moisture density conditions directly in shear device, or in a mold of equal dimensions and extruded into the shear device, or in a larger mold and trimmed?*..... _____
   Compacted Samples (ASTM), compacted according to D698 or D1557 and then trimmed as if it were an intact sample, shear plane should not be aligned with any of the compaction lift interfaces? ..... _____

7. ***Reconstituted Samples - Laboratory Fabricated Samples (ASTM)***
   - (a) ***Material blended to uniform batch and stand for appropriate times depending on soil type?*****.....** _____
   - (b) ***Specimens prepared using compaction method, water content, and unit weight requested?*****.....** _____
   - (c) ***Moist porous stone insert placed in bottom of shear box?*** **.....** _____
   - (d) ***Specimen molded by:***
     - (1) ***Kneading / tamping each layer until compacted to a known volume?*** **.....** _____
     - ***or*** (2) ***Adjusting the number of layers, number of tamps per layer, and force per tamp?*****.....** _____
   - (e) ***Layer boundaries should not be in the same plane as the shear plane (unless testing this)?*****.....** _____
   - (f) ***Top of each layer scarified prior to adding additional material?*****.....** _____
   - (g) ***Compaction tamper has area in contact with soil equal to or less than 1/2 area of mold?*****.....** _____
   - (h) ***Soil compacted until desired unit weight obtained?*** **.....** _____

Consolidation

1. Shear box assembled with frames aligned and locked in place?..... _____
   Note**:** *A light coating of grease between frames and/or Teflon spacers or Teflon-coated surfaces may be used to ensure water-tightness and reduce friction during shear.*
2. Specimen inserted and loading devices connected?..... _____
3. Displacement indicators positioned and initial thickness determined **[*ASTM: or indicator zeroed*]**? ..... _____
4. Porous stone placed on specimen (***Note*****:** *Porous stones may be dampened prior to insertion*)?..... _____
5. ***ASTM only: Small normal force (approximately 1 lbf/in^2 (7 kPa)) applied and alignment verified?*** **.....** _____
6. Initial normal force applied? ..... _____
7. ***ASTM only: Applied vertical and horizontal loads and initial vertical and horizontal displacement readings recorded?*****.....** _____
8. Water reservoir filled above top of specimen **[*ASTM: if required*]**, and that water level maintained during consolidation and shear? ..... _____
9. ***ASTM only: Normal force required to achieve desired normal stress or increment thereof calculated and recorded?*****.....** _____
10. Specimen allowed to drain and reach primary consolidation under desired normal force (or increments of force) prior to shearing? ..... _____
11. ***ASTM only: If consolidation to a specific stress and then rebounding to a lower stress is required, maximum stress maintained for at least one cycle of secondary compression?***..... _____
12. Normal displacement readings recorded before each increment of normal force is applied? ..... _____
13. Normal displacement readings plotted against elapsed time **[*ASTM: against either log or time of square root of time (in minutes)*]**? ..... _____
14. *AASHTO only: Final increment = previous normal force developed and produces specified normal stress?*..... _____
15. After consolidation, frames unlocked and separated approx. 0.025 in. (0.64 mm) using the gap screws? ..... _____

COMMENTS (T236 / D3080): (T236 / D3080)

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (T236) _____ **(D3080) _____**

PROCEDURE (Continued) Date: _____

Shear, AASHTO, Controlled-Displacement

1. *Specimen sheared at relatively slow rate, preferably determined by total elapsed time to failure (t_f, time to failure = 50*t_{50}, where t_{50} is the time required to achieve 50% consolidation)?* _____
2. *Shearing force applied and displacement rate determined by dividing estimated shear deformation (at maximum shear stress) by computed time to failure?* _____
3. *Test continued until shear stress becomes essentially constant or until shear deformation of 10% of original diameter has been reached?* _____
4. *Applied shear force, shear, and normal deformations recorded at sufficient intervals?* _____
5. *At completion, specimen removed, oven-dried according to T265, and weighed to determine mass of solids?* _____

or

Shear, AASHTO, Controlled-Stress

1. *Specimen sheared at relatively slow rate, preferably determined by total elapsed time to failure (t_f, time to failure = 50*t_{50}, where t_{50} is time required to achieve 50% consolidation)?* _____
2. *Shearing force applied in increments equal to about 10% of the estimated maximum?* _____
3. *At least 95% consolidation permitted before applying next increment?* _____
4. *When 50 to 70% of estimated failure force has been applied, increments reduced to 1/2 initial size or 5% of estimated maximum shear stress?* _____
5. *As failure is approached, series of increments equal to 1/4 initial increment used?* _____
6. *Applied shear force, shear, and normal deformations recorded at sufficient intervals?* _____
7. *At completion, specimen removed, oven-dried according to T265, and weighed to determine mass of solids?* _____

Shear, ASTM

1. ***Specimen sheared at relatively slow rate, preferably determined by total elapsed time to failure (t_f, time to failure = 50*t_{50}, where t_{50} is time required to achieve 50% consolidation)?*** _____
   ***Note*:** *If normal displacement vs. square root of time used, t_{50} can be calculated from time to complete 90% consolidation by: $t_{50} = t_{90} / 4.28$.*
2. ***Time, vertical and horizontal displacements, and normal and shear forces recorded (initially and during shearing)?*** _____
3. ***Readings taken at about 0.1, 0.2, 0.3, 0.4, 0.5, 1, 1.5, 2, 2.5, and 3% of relative lateral displacement?*** _____
4. ***Readings thereafter taken at intervals equal to 2% relative lateral displacement until test is complete?*** _____
   ***Note*:** *Test may be stopped to re-gap shear box halves during shear.*
5. ***Shearing continued until at least 10% relative lateral displacement (unless otherwise specified)?*** _____
6. ***After failure is reached, shear box halves separated with sliding motion along failure plane of cohesive soils (not by pulling apart perpendicularly to failure surface)?*** _____
7. ***Failure surface photographed, sketched, or described (unless sample is cohesionless)?*** _____
8. ***Specimen removed and water content determined according to D2216?*** _____

COMMENTS (T236 / D3080): (T236 / D3080)

LABORATORY DETERMINATION OF MOISTURE CONTENT OF SOILS (T265) ____
(D2216) ____

APPARATUS Date: _____

1. Oven, maintains 110 ± 5°C (230 ± 9°F) **[*ASTM only: vented*]**? ..... ____

2. *AASHTO:* *Balance, Readable to 0.1% of sample mass, or better?*..... ____
   ASTM: ***Balance, For samples 200 g or less readable to ± 0.01 g, for > 200 g readable to ± 0.1 g? ..... ____***

3. Water content containers:
   AASHTO: Resistant to corrosion, disintegration, and change in mass with close-fitting lids? ..... ____
   ASTM: Resistant to corrosion or change in mass, uniquely identified, and matched with a lid, if lid is used? . ____

4. **Optional,** ***ASTM only: Desiccator, Contains silica gel or anhydrous calcium sulfate (Drierite)? ..... ____***
   Note, ASTM only: Desiccators are required when containers with close-fitting lids are not used for samples under 200 g.

5. ***ASTM only: Knives, spatulas, scoops, quartering cloth, wire saws, etc., as required?..... ____***

Note to Assessors: *The demonstration of this procedure can be combined with another test that requires a moisture content calculation, such as the Plastic Limit test.*

PROCEDURE

Sample Selection

1. Representative sample of moist soil selected? ..... ____
   (a) Disturbed samples – scooping or miniature stockpile method? ..... ____
   (b) Intact samples, not layered – whole sample, half sample, or representative slice? ..... ____
   (c) Intact sample, layered – average specimen or multiple individual specimen and average results? ..... ____
2. Maximum particle size (100% passing) vs. minimum sample mass is one of the following?
   AASHTO: No.40 – 10 g, No.4 – 100 g, ½ in – 300 g, 1 in. – 500 g, 2 in. – 1 kg? ..... ____
   ASTM method A: No.4 – 20 g, 3/8 in. – 50g, ¾ in. – 250 g, 1.5 in – 1 kg, 3 in – 5 kg? ..... ____
   ASTM method B: No.10 – 20 g, No.4 – 100 g, 3/8 in. – 500 g, ¾ in. – 2.5 kg, 1.5 in – 10 kg, 3 in – 50 kg?. ____

3. *AASHTO: Mass of clean, dry container plus lid determined?* ..... ____
   ASTM: Mass of clean, dry container plus lid (if used) determined and container ID # recorded? ..... ____
   Note*: Containers without lids may be used if moist sample* **[*ASTM only: if sample > 200 g*]** *is weighed immediately, and dried sample is weighed immediately after being removed from oven / cooling in a desiccator. In this case, ignore any reference to using lids.*

4. Sample placed in container, immediately covered with lid, and weighed? ..... ____
5. ***ASTM only: If water content data is to be used to calculate other relationships, such as moist or dry mass, then specimen mass up to 200 g determined using a balance accurate to 0.01 g?*** ..... ____
6. Lid removed, container placed in oven, and sample dried to constant mass? ..... ____

7. For samples containing gypsum or highly organic samples (which would be chemically altered at 110°C)
   (a) Dried at 60°C (140°F) or less? ..... ____
   or (b) Dried by vacuum desiccation at approx. 10 mm Hg and temp. not lower than 23°C (73°F)? ..... ____

8. ASTM only: Dry samples removed from oven before additional wet samples are added when containers without lids are in use (unless all samples are being dried at least overnight)? ..... ____

9. Lid replaced immediately and sample cooled to room temperature **[*Optional, ASTM only: in desiccator*]**? ..... ____
10. Container, including lid and dried sample, weighed? ..... ____
11. Water content calculated to nearest 0.1 % **[*ASTM Method A only: to nearest 1%*]** by the following formula?.... ____

$$\% \text{ moisture} = \frac{\text{mass of water}}{\text{mass of oven dry soil}} \times 100$$

COMMENTS (T265 / D2216): (T265 / D2216)

DETERMINATION OF ORGANIC CONTENT IN SOILS BY LOSS ON IGNITION

(T267) ____
(D2974) ____

APPARATUS

Date: _____

1. Muffle Furnace **[*ASTM Method C*]**
   (a) Can maintain 455 ± 10°C (833 ± 18°F) **[*ASTM: Method C - 440 ± 22°C*]**?..... _____
   AASHTO only: Dimensions adequate to accommodate the container and sample?..... _____
   (b) *AASHTO only: indicates temperature while in use?*..... _____
2. Crucibles or evaporating dishes
   (a) High silica, alundum (aluminum oxide), porcelain, or nickel crucibles of 30- to 50-mL capacity **[*ASTM: Not less than 100-mL capacity with heavy-duty aluminum foil cover*]**?..... _____
   or (b) *AASHTO only: Porcelain evaporating dishes with approximately 100-mm top diameter?*..... _____

3. Desiccator, of sufficient size and containing effective desiccant? ..... _____
4. Oven, capable of maintaining 110 ± 5°C (230 ± 9°F)?..... _____
5. Balance, Class G1, readable to 0.01 g **[*ASTM: minimum capacity 500 g and readable to 0.01 g*]**?..... _____
6. Containers: suitable rustproof metal, porcelain, glass, or plastic coated containers?..... _____
7. Miscellaneous supplies: asbestos gloves, tongs, spoons, spatulas, etc.? ..... _____
8. ***ASTM only: Rubber sheet, oil cloth, or other non-absorbent material?*****.....** _____

PROCEDURE

AASHTO Sample Preparation (oven dry)

1. Sample of material passing the 2.00-mm (No. 10) sieve prepared in accordance with T87? ..... _____
2. Representative sample with mass at least 100 g?..... _____
3. Sample dried in oven at 110 ± 5°C (230 ± 9°F), then cooled in desiccator?..... _____

ASTM Sample Preparation (moisture as received)

1. Representative field sample placed on a rubber sheet, oil cloth, or equivalent and mixed thoroughly?..... _____
2. Reduced by quartering and placed in waterproof container?..... _____
3. Work done rapidly or in high humidity room to prevent evaporation?..... _____

ASTM only PROCEDURES

ASTM Method A: Moisture Content Determination

1. Mass of evaporating dish and heavy-duty aluminum cover determined to 0.01 g and recorded?..... _____
2. At least 50 g placed in dish?..... _____
3. Soft lumps crushed with spoon or spatula?..... _____
4. Thickness of peat does not exceed 3 cm? ..... _____
5. Dish covered immediately and weighed to 0.01 g?..... _____
6. Specimen dried uncovered at 110±5°C at least 16 hours or until there is less than 0.1% change per hour?... _____
7. Specimen removed from oven, covered tightly, and cooled in a desiccator?..... _____
8. Dry mass determined to 0.01 g, keeping exposure to the room atmosphere to a minimum?..... _____
9. Moisture content calculated as [(wet – dry)/dry]×100?..... _____

COMMENTS (T267 / D2974): (T267 / D2974)

DETERMINATION OF ORGANIC CONTENT (T267) ____
IN SOILS BY LOSS ON IGNITION **(D2974) ____**

ASTM only PROCEDURE (Continued) Date: _____

***ASTM Method B*: Moisture Content Determination**
Note: This method should be used when peat is to be used as fuel. AMRL does not offer accreditation for Method B.

***ASTM Method D*: Ash Content Determination**
Note: This method should be used when peat is to be used as fuel. AMRL does not offer accreditation for Method D.

AASHTO / ASTM PROCEDURE

***AASHTO Method* and *ASTM Method C*:**

1. Mass of evaporating dish **[*ASTM: and cover*]** determined to 0.01 g and recorded? (*C*) ..... _____
2. Approx. 10 to 40 g **[*ASTM: part or all of an oven-dried sample*]** sample placed in dish? ..... _____
   ***Note, AASHTO only**: Masses for lightweight materials such as peat may be less than 10 g but should fill the crucible to at least 3/4 depth. A cover for the crucible may be required during the initial phase of ignition to prevent the sample from being "blown out" of the container.*
3. Sample mass determined to 0.01 g **[*ASTM only: while covered, then cover removed*]**? (*A*) ..... _____

4. *AASHTO: Sample dried uncovered in furnace at 455 ± 10°C (833 ± 18°F) for at least 6 hours?* ..... _____
   ASTM: Furnace gradually brought to 440 ± 40°C (Method C) and held? ..... _____

5. ***ASTM only: Specimen burned until no change of mass occurs after at least 1 hour period?*** ..... _____
6. Sample removed and cooled in desiccator? ..... _____
7. Final mass determined to 0.01 g **[*ASTM: keeping exposure to the room atmosphere to a minimum*]**? (*B*) ..... _____
8. *AASHTO: Organic content determined to nearest 0.1 percent by the following equation?* ..... _____

   $$\% \text{ organic} = (A - B) / (A - C)$$

   where: A = mass of crucible or dish and oven-dried soil, before ignition;
   B = mass of crucible or dish and oven-dried soil, after ignition;
   C = mass of crucible or dish, to nearest 0.01 g.

   ASTM: Ash content percent calculated as (mass of ash × 100) / (oven-dried mass)? ..... _____
9. ***ASTM only: Organic matter calculated to 0.1% as (100.0 – ash content percent)?*** ..... _____

COMMENTS (T267 / D2974): (T267 / D2974)

DETERMINING MINIMUM LABORATORY SOIL RESISTIVITY (T288) ____

APPARATUS Date: _____

1. Balance, readable to 0.1% of sample mass, or better, that meets M231? ..... _____
2. Drying apparatus, suitable device capable of drying samples at a temperature not exceeding 60°C (140°F)? ..... _____
3. Sieves: 6.3-mm (1/4-in.), 4.75-mm (No.4), and 2.00-mm (No.10)? ..... _____
4. Pulverizing apparatus (one of the following):
   (a) Mortar and rubber-covered pestle? ..... _____
   (b) Other device that breaks up aggregations of particles without reducing grain size? ..... _____
5. Sample splitter: sample splitter, riffle splitter, quartering equipment, or canvas cloth? ..... _____
6. Resistivity meter, an alternating current (AC) meter or a 12-volt direct current (DC) meter utilizing a Wien Bridge (AC bridge) with a phase sensitive detector and a square wave inverter that produces a nominal alternating signal at 97 Hz? ..... _____
7. 100, 200, 500, and 900-ohm resistors with a 1% tolerance? ..... _____
8. Soil box, fitted with two stainless steel electrodes (one of the following):
   (a) Box with dimensions 177.8 x 127 mm (7 x 5 in.) and electrodes 152.4 x 44.45 mm (6 x 1.75 in.)? ..... _____
   (b) Box with dimensions 165.1 x 114.3 mm (6.5 x 4.5 in.) and electrodes 152.4 x 44.45 mm (6 x 1.75 in.)? ..... _____
   (c) Alternate box of similar design (allowed per Note 8 of T288) with correct multiplier determined for the calculations for the alternate box and sufficient sample prepared to fill the soil box? ..... _____
   Note: Some "alternative design" boxes include two pins in addition to the rectangular electrodes so that the box can also be used for other test methods. These boxes are acceptable if they are used in the two electrode mode.
9. Graduated cylinder, 100 mL capacity? ..... _____
10. Distilled or deionized water? ..... _____
11. Straightedge, 305-mm (12-in.) in length? ..... _____
12. Mixing pans, non-corrosive (stainless steel, plastic, etc.)? ..... _____

PROCEDURE

Initial Preparation

1. Sample dried in air or drying apparatus not exceeding 60°C (140°F)? ..... _____
2. Approximately 1500 g of soil passing 2.00-mm (No. 10) sieve obtained by splitting or quartering and then pulverized (without reducing natural grain size)? ..... _____
3. Portion of dried sample selected for testing separated into fractions by one of the following:
   (a) Alternate method using 2.0-mm (No. 10) sieve
      (1) Dried sample separated into two fractions using a 2.0-mm (No. 10) sieve? ..... _____
      (2) Fraction retained on the sieve pulverized until aggregations broken into separate grains? ..... _____
      (3) Ground soil separated into two fractions using the 2.0-mm (No. 10) sieve? ..... _____

   (b) Alternate method using 4.75-mm (No.4) and 2.0-mm (No. 10) sieves? ..... _____
      (1) Dried sample separated into two fractions using a 4.75-mm (No.4) sieve.
      (2) Fraction retained on the sieve pulverized until aggregations broken into separate grains and sample separated again on the No. 4 sieve.
      (3) Fraction passing the No. 4 sieve mixed thoroughly, representative portion for testing obtained by splitting or quartering.
      (4) Split portion separated on the 2.0-mm (No. 10) sieve and procedure followed for processing over a 2.0-mm (No. 10 sieve) (see Alternative method using a (No. 10) above).

   (c) Alternate method using 6.3-mm (1/4-in.) and 2.0-mm (No. 10) sieves? ..... _____
      (1) Dried sample separated into two fractions using a 6.3-mm (1/4-in.) sieve.
      (2) Fraction retained on the sieve pulverized until aggregations broken into separate grains and sample separated again on the ¼-in. sieve.
      (3) Fraction passing the ¼-in. sieve mixed thoroughly, representative portion for testing obtained by splitting or quartering.
      (4) Split portion separated on the 2.0-mm (No. 10) sieve and procedure followed for processing over a 2.0-mm (No. 10 sieve) (see Alternative method using a (No. 10) above).

COMMENTS (T288): (T288)

DETERMINING MINIMUM LABORATORY SOIL RESISTIVITY (T288) ____

PROCEDURE (continued) Date: _____

Calibration of Resistivity Meter (follow manufacturer's instructions or the following procedure):

1. Resistivity meter zeroed by clamping the two leads together and adjusting the meter? ..... _____
2. Leads of the meter connected to the 100-ohm resistor and meter read, and then process repeated with the 200, 500, and 900-ohm resistors? ..... _____
3. Meter functioning satisfactorily if the readings are within 10% of the resistance of the resistor? ..... _____

Soil resistivity determination,

1. Material selected in accordance with T248 consists of approximately 1500 g of soil passing the 2.0-mm (No. 10) sieve? ..... _____
2. Sample mixed thoroughly with 150 mL of distilled water? ..... _____
3. Test sample covered with damp cloth and allowed to stabilize until equilibrium is reached or allowed to cure for a minimum of 12 hours? ..... _____
4. Meter zeroed per manufacturer's instructions? ..... _____
5. Soil box cleaned thoroughly with distilled water? ..... _____
6. Soil thoroughly mixed and sample placed in soil box in layers and compacted (compaction with fingers is sufficient)? ..... _____
7. Excess material trimmed with straightedge? ..... _____
8. Resistance measured, resistivity of the soil calculated in accordance with the instructions furnished with the meter and test value recorded? ..... _____
9. Soil removed from the box, 100 mL of distilled water added to the sample and mixed thoroughly? ..... _____
10. Soil box cleaned with distilled water prior to performing next trial? ..... _____
11. Steps after zeroing the gauge (Steps 5-10) repeated until a minimum value is determined? ..... _____
12. Minimum value used for calculating the minimum soil resistivity and reporting? ..... _____
13. Minimum Soil Resistivity calculated by the following equation using the correct multiplier? ..... _____

Minimum Soil Resistivity =[minimum reading (ohms)] x [multiplier for box size used]

Note: The multiplier typically used is 6.67 cm (for the 7 x 5 in. box). The correct multiplier can be calculated for other sizes of boxes using the following formula:

Multiplier = [Surface area of one electrode (cm^2)] / [Measured average distance between electrodes (cm)]

COMMENTS (T288): (T288)

DETERMINING pH OF SOIL FOR USE IN CORROSION TESTING (T289) _____

APPARATUS Date: _____

1. Sieves: 6.3-mm (1/4-in.), 4.75-mm (No. 4), and 2.00-mm (No. 10)? ..... _____
2. Balance, readable to 0.1% of sample mass, or better, that meets M231? ..... _____
3. Drying apparatus, suitable device capable of drying samples at a temp. not exceeding 60°C (140°F)? ..... _____
4. Pulverizing apparatus (one of the following):
   (a) Mortar and rubber-covered pestle? ..... _____
   (b) Other device that breaks up aggregations of particles without reducing grain size? ..... _____
5. Sample splitter: sample splitter, riffle splitter, quartering equipment, or canvas cloth? ..... _____
6. pH meter, suitable for laboratory or field analysis, with either one or two electrodes? ..... _____
7. Wide-mouth glass beaker, 50 mL capacity, OR other suitable container (if light-weight material is tested beaker size may need to be increased up to 250 mL)? ..... _____
8. Watch glass, of suitable size to cover the container? ..... _____
9. Standard buffer solutions of known pH values: standards used are pH of 4.0, 7.0, and 10.0? ..... _____
10. Distilled water? ..... _____
11. Teaspoon or small scoop? ..... _____
12. Thermometer, range at least 15 to 35°C, readable to the nearest 0.1°C? ..... _____
13. Glass stirring rod (a glass thermometer should not be used as a stirring rod)? ..... _____

PROCEDURE

Initial Preparation

1. Sample as received in moist condition for pH testing purposes? ..... _____
2. If sample is too wet, sample dried to a moist condition in air or drying apparatus not exceeding 60°C (140°F) prior to sample selection? ..... _____
3. Representative test sample to perform pH test (approximately 100 g of material passing the 2.0-mm (No. 10) sieve) obtained by splitting or quartering according to T248? ..... _____

4. Portion of the sample selected for testing separated into fractions by one of the following:
   (a) Alternate method using 2.0-mm (No. 10) sieve
      (1) Sample separated into two fractions using a 2.0-mm (No. 10) sieve? ..... _____
      (2) Fraction retained on the sieve pulverized until aggregations broken into separate grains? ..... _____
      (3) Ground soil separated into two fractions using the 2.0-mm (No. 10) sieve? ..... _____

   (b) Alternate method using 4.75-mm (No. 4) and 2.0-mm (No. 10) sieves? ..... _____
      (5) Sample separated into two fractions using a 4.75-mm (No. 4) sieve.
      (6) Fraction retained on the sieve pulverized until aggregations broken into separate grains and sample separated again on the No. 4 sieve.
      (7) Fraction passing the No. 4 sieve mixed thoroughly, representative portion for testing obtained by splitting or quartering.
      (8) Split portion separated on the 2.0-mm (No. 10) sieve and processed according to method (a).

   (c) Alternate method using 6.3-mm (1/4-in.) and 2.0-mm (No. 10) sieves? ..... _____
      (5) Sample separated into two fractions using a 6.3-mm (1/4-in.) sieve.
      (6) Fraction retained on the sieve pulverized until aggregations broken into separate grains and sample separated again on the ¼-in. sieve.
      (7) Fraction passing the ¼-in. sieve mixed thoroughly, representative portion for testing obtained by splitting or quartering.
      (8) Spit portion separated on the 2.0-mm (No. 10) sieve and processed according to method (a).

COMMENTS (T289): (T289)

DETERMINING pH OF SOIL FOR USE IN CORROSION TESTING (T289) ____

PROCEDURE (continued) Date: _____

Determination of soil pH:

1. 30.0 ± 0.1 g of soil from the material selected for testing placed in the testing container? ..... _____
2. Distilled water, mass 30.0 ± 0.1 g, added to soil sample? ..... _____
3. Stirred to obtain soil slurry and covered with watch glass? ..... _____
4. Sample let stand for a minimum of 1 hour, stirring every 10 to 15 minutes? ..... _____
5. Temperature of sample measured, pH meter temperature controller adjusted to the same temperature as the sample (for meters with automatic temperature control, follow manufacturer's instructions)? ..... _____
6. pH meter standardized with the standard solutions and temperature adjusted to that of sample? ..... _____
7. Sample stirred with glass rod and then electrode(s) immediately placed in soil slurry? ..... _____
8. Beaker or container gently turned to make good contact between solution and electrode(s)? ..... _____
9. Electrode(s) not placed directly into the soil, only placed in the soil slurry solution? ..... _____
10. Electrode(s) immersed for 30 seconds or longer before reading meter? ..... _____
11. pH value read and recorded to the nearest 0.1 (round to nearest 0.1 if the meter reads further)? ..... _____
12. Electrode(s) rinsed well with distilled water and dabbed lightly with tissues to remove any film formed? ..... _____

Note: *Electrodes should not be wiped because this can cause polarization and slow response time.*

COMMENTS (T289): (T289)

UNCONSOLIDATED, UNDRAINED COMPRESSIVE (T296) _____
STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION **(D2850) _____**

APPARATUS Date: _____

1. **Triaxial testing setup** (chamber, compression machine, etc as follows): ..... _____
***Note*:** *No ripples should be visible in a glass of water on loading platen while the operating at test speed.*
   (a) Axial loading device (compression machine):
      (1) Has capacity and control to provide loading rate to within ±1% **[*ASTM: ±5%*]** of selected rate and operates with minimal vibration.
   (b) Axial load-measuring device, such as a proving ring, electronic load cell, or hydraulic load cell.
      (1) Accurate to 1% of axial load at failure.
      (2) *AASHTO only: If located inside chamber, insensitive to horizontal forces and chamber pressure.*
   (c) Triaxial compression chamber:
      (1) Top plate has vent valve for air to be forced out of chamber as it is filled.
      (2) Base plate has inlet valve through which pressure liquid is supplied to chamber.
   (d) Axial load piston:
      (1) Negligible lateral bending of piston during loading.
      (2) Variation in axial load due to friction does not exceed 0.1 percent of axial load at failure.
   (e) Chamber pressure control and measurement devices:
      (1) Chamber pressure < 200 kPa (28 psi) – must control and measure to within ±2 kPa (0.25 psi).
      (2) Chamber pressure > 200 kPa (28 psi) – must control and measure to within ±1%.

2. Deformation indicator:
   (a) Measures vertical deformation to within ±0.02% **[*ASTM: 0.03%*]** of specimen height? ..... _____
   (b) Travel range at least 20% of initial specimen height? ..... _____

3. Specimen cap and base (as follows):..... _____
   (a) Made of rigid, non-corrosive, impermeable material that prevents drainage of specimen.
   (b) Circular cross-section and circular plane surface of contact with specimen (or porous disks).
   (c) Diameter of cap and base equal to initial diameter of specimen.
   (d) Designed to prevent lateral motion or tilting [*AASHTO only: no more than 5° tilt during shear*].
   (e) Surfaces of cap and base that contact membrane to form a seal are smooth and free of scratches.
   (f) Weight of cap produces axial stress on specimen less than 1 kN/m^2 (0.145 psi)?..... _____

   Mass of cap: _____ Area of specimen: _____

   Mass / area (should be < 1 kN/m^2 (0.145 lb per inch^2): _____

4. Rubber membranes (as follows): ..... _____
   (a) Checked for leakage.
   (b) Unstretched diameter between 90-95% of specimen diameter.
   (c) Membrane thickness less than 1% of specimen diameter.

5. Extruder, for preparing intact samples, capable of extruding sample with minimum disturbance?..... _____
Note to assessor: *write finding if a sample extruder is not available during testing*

6. Optional: Rubber O-rings, unstressed inside diameter between 75 and 85% of cap and base diameter? ..... _____

COMMENTS (T296 / D2850): (T296 / D2850)

UNCONSOLIDATED, UNDRAINED COMPRESSIVE (T296) _____
STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION **(D2850)** _____

APPARATUS (Continued) Date: _____

7. Specimen size measurement devices, measure diameter and height to within ±0.1% of total dimension **[*ASTM: to four significant digits*]**, without sample disturbance? ..... _____

8. *AASHTO only, Electronic recorders (optional), used to record specimen behavior, calibrated through electronic recorders using known input standards?* ..... _____

9. Sample extruder, capable of extruding soil from sampling tube at a uniform rate, in same direction of travel in which sample entered tube, with minimum sample disturbance? ..... _____
   (a) *AASHTO only: sample extruder can be operated at a relatively uniform rate, has a length of travel at least equal to the required untrimmed test length of the sample, and permits the extrusion to occur in one operation without resetting the piston or extrusion mechanism?* ..... _____

10. Balance, accurate to within ±0.05% **[*ASTM: to four significant digits*]** of total specimen mass? ..... _____

11. *AASHTO only, Testing environment for shear, out of direct sunlight and temperature fluctuations less than ±4°C (±7.2°F)?* ..... _____

12. Miscellaneous apparatus:
   (a) Specimen trimming and carving tools? ..... _____
   (b) Steel straightedge for final trimming of specimens? ..... _____
   (c) Compaction apparatus and water content containers? ..... _____
   (d) *AASHTO only: membrane and O-ring expanders?* ..... _____

13. ***ASTM only, Timer, indicates elapsed testing time to nearest 1 second?*** ..... _____

COMMENTS (T296 / D2850): (T296 / D2850)

UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION

(T296) _____
(D2850) _____

PROCEDURE Date: _____

Specimen Size

1. Cylindrical, minimum diameter of 3.3 cm (1.3 in.)? _____
2. Height to diameter ratio between 2 and 2.5? _____
3. Largest particle size less than 1/6 of specimen diameter, or noted on report? _____

Undisturbed / Intact Specimens

1. Specimens handled to minimize disturbance, compression, and changes in cross-section or moisture content? _____
2. Trimmed specimens prepared in controlled environment where water content change is minimized? _____
3. Voids from pebbles or crumbling filled with remolded soil from trimmings? _____
4. Final trimming of end surfaces done with steel straightedge? _____
5. One or more water content determinations of trimmings determined according to (T265 / D2216)? _____
6. Specimen dimensions determined to within ±0.1% of total dimension? _____
7. *AASHTO: Minimum of 3 height measurements taken 120° apart and average determined?* _____
8. *AASHTO: Minimum of 3 diameter measurements taken at quarter points of height and average determined?* _____
9. Specimen mass determined to within ±0.05% **[*ASTM: four significant digits*]**? _____

Remolded Specimens

1. Previously undisturbed specimen (still encased in rubber membrane) thoroughly worked with fingers? _____
2. Specimen reformed in mold having dimensions so that remolded specimen dimensions will be equal to undisturbed specimen dimensions? _____
3. Care taken to avoid entrapped air? _____
4. ***ASTM: Minimum of 3 height measurements taken 120° apart and average determined?*** _____
5. ***ASTM: Minimum of 3 diameter measurements taken at quarter points of height and average determined?*** _____

Compacted Specimens

1. Prepared using predetermined water content required? _____
2. *AASHTO only: Sample prepared using compaction method and unit weight required?* _____
3. Soil thoroughly mixed with water to desired water content and stored in covered container for at least 16 hours prior to compaction? _____
4. Split mold of circular cross-section that meets specimen size requirements used? _____
5. Tamper area in contact with soil less than or equal to 1/2 area of mold? _____
6. Specimen compacted in at least six layers? _____
7. Specimens molded to desired density by:
   (a) Kneading or tamping each layer until accumulative soil weight placed in mold is compacted to known volume? _____
   or (b) Adjusting number of layers, number of tamps per layer, and force per tamp? _____
8. Top of each layer scarified before adding material for next layer? _____
9. After forming with specimen ends perpendicular to longitudinal axis, mold removed? _____
10. One or more water content determinations on excess material determined according to (T265 / D2216)? _____
11. Specimen dimensions determined to within ±0.1% of total dimension? _____
12. Specimen mass determined to within ±0.05% **[*ASTM: four significant digits*]**? _____

Mounting Specimen

1. Membrane placed on membrane expander or membrane rolled on cap or base? _____
2. *AASHTO only: Pressure-control device attached to chamber base?* _____
3. Rubber membrane placed around specimen and sealed at cap and base with O-rings or other positive seal at each end (***Note**: Silicon grease may be used on vertical surfaces of cap and base to aid sealing)?* _____

COMMENTS (T296 / D2850): (T296 / D2850)

UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (T296) _____ **(D2850) _____**

PROCEDURE (Continued) Date: _____

Loading Procedure

1. Triaxial chamber assembled? ..... _____
2. Axial load piston brought in contact with specimen cap several times to permit proper seating and alignment without exceeding load of 0.5% of estimated compressive strength? ..... _____
   ***Note*:** *If piston weight exceeds 0.5% of estimated compressive strength, piston shall be locked in place above specimen cap after seating and alignment are checked, and kept locked until chamber pressure application.*
3. Deformation indicator read to three significant digits when piston brought into contact the final time? ..... _____
4. Pressure-maintaining and measurement device attached and chamber filled with confining fluid? ..... _____
   Note, AASHTO Only: *Although the confining "fluid" is typically a liquid, compressed air or other gasses may be used.*
5. Desired chamber pressure applied? ..... _____
6. Approximately 10 minutes elapses before continuing test [*AASHTO only: optional*]? ..... _____
   Note, ASTM only: *Waiting period may need to be increased for soft or partially saturated soils.*
   Note to Assessor: *This allows the specimen to stabilize under the chamber pressure prior to application of the load.*
7. If axial load-measuring device is located outside chamber:
   (a) Test started with piston slightly above specimen cap to record piston friction to three significant digits and upward thrust due to chamber pressure? ..... _____
   or (b) Axial load measuring device adjusted to compensate for friction and thrust? ..... _____
8. Initial reading on deformation indicator recorded to three significant digits when piston contacts cap? ..... _____
9. Axial load applied to produce axial strain of approximately 1% per minute for plastic soils or 0.3% per minute for brittle soils? ..... _____
10. Loading continued until 15% axial strain achieved? ..... _____
    ***Note*:** *Loading may be stopped when deviator stress has peaked then dropped 20%, or when axial strain has reached 5% beyond strain at peak deviator stress.*
11. Load and deformation values recorded to three significant digits at the following points (minimum):
    (a) Values recorded at 0.1, 0.2, 0.3, 0.4 and 0.5% strain? ..... _____
    (b) Values recorded in increments of 0.5% strain until 3% strain is reached? ..... _____
    (c) Values recorded in increments of 1% strain until 15% axial strain is achieved? ..... _____
    ***Note*:** *Alternate intervals for readings may be used if sufficient points are obtained to define the stress-strain curve. The values listed should be considered minimums.*
12. Sufficient readings taken to define stress-strain curve? ..... _____

Removing Specimen

AASHTO only:

1. Axial load removed, and chamber and back pressures reduced to zero? ..... _____
2. Specimen quickly removed with drainage valves remaining closed? ..... _____
3. Rubber membrane removed, free water on specimen blotted away? ..... _____
Note: *If specimen is to be used for index tests, specimen should be weighed prior to removing material for index property tests and a representative portion of the specimen should be used to determine final water content.*

ASTM only:

1. Specimen removed from chamber? ..... _____

Calculations

1. Sketch or photograph of specimen made, showing mode of failure, prior to placing specimen in oven? ..... _____
2. Water content of entire specimen (if possible) determined according to (T265 / D2216)? ..... _____
3. Calculations performed to three significant digits and graphs made according to book? ..... _____

COMMENTS (T296 / D2850): (T296 / D2850)

CONSOLIDATED, UNDRAINED TRIAXIAL (T297) _____
COMPRESSION TEST ON COHESIVE SOILS **(D4767) _____**

APPARATUS Date: _____

1. Axial loading device (compression machine)? ..... _____
   (a) Has capacity and control to provide loading rate to within ±1% of selected rate.
   (b) Operates with minimal vibration.
   ***Note*:** *No ripples should be visible in a glass of water on loading platen while the operating at test speed.*

2. Axial load-measuring device?..... _____
   (a) Type (circle one): Load ring Electronic load cell Hydraulic load cell Other _____
   (b) Accurate to 1% of axial load at failure.
   (c) If located inside chamber, insensitive to horizontal forces and chamber pressure.

3. Triaxial compression chamber? ..... _____
   (a) Top plate has vent valve for air to be forced out of chamber as it is filled.
   (b) Base plate has inlet valve through which pressure liquid is supplied to chamber.
   (c) Base plate has inlets leading to specimen base and provide for connection to cap to allow saturation and drainage of specimen when required.

4. Axial load piston? ..... _____
   (a) Negligible lateral bending of piston during loading.
   (b) Variation in axial load due to friction does not exceed 0.1 percent of axial load at failure.

5. Pressure and vacuum control and measurement devices?..... _____
   (a) Chamber pressure < 200 kPa (28 psi) – must control and measure to within ±2 kPa (0.25 psi).
   (b) Chamber pressure > 200 kPa (28 psi) – must control and measure to within ±1%.
   (c) Vacuums controlled and measured to within ±0.25 psi (2 kPa).
   (d) If separate devices are used to measure chamber pressure and back pressure, are devices calibrated simultaneously against the same pressure source.

6. Pore-water pressure measurement device? ..... _____
   (a) Chamber pressure < 200 kPa (28 psi) – must measure to within ±2 kPa (0.25 psi).
   (b) Chamber pressure > 200 kPa (28 psi) – must measure to within ±1%.
   (c) During undrained shear, pore water pressure measured in a way that allows as little water as possible into or out of specimen.

7. Volume change measurement device (usually a burette)? ..... _____
   (a) Accurate to ±0.05% of total volume of specimen. {Volume= $(1/2 * d)^2 * h$}
   (b) Able to withstand maximum chamber pressure.

8. Deformation indicator? ..... _____
   (a) Measures vertical deformation to within ±0.25% of specimen height.
   (b) Travel range at least 15% of initial specimen height.

COMMENTS (T297 / D4767): (T297 / D4767)

CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

(T297) _____
(D4767) _____

APPARATUS (Continued) Date: _____

9. Specimen cap and base?..... _____
   (a) Provides drainage from both ends of specimen.
   (b) Made of rigid, non-corrosive, impermeable material.
   (c) Circular cross-section and circular plane surface of contact with porous disks.
   (d) Weight of cap and top porous disc less than 0.5% of applied axial load at failure.
   (e) Diameter of cap and base equal to initial diameter of specimen.
   (f) Designed to prevent lateral motion or tilting during testing.
   (g) Surfaces of cap and base that contact membrane to form a seal are smooth and free of scratches.
   (h) If weight is greater than 0.5% of the axial load at failure and >50 g, is the axial load corrected?..... _____

10. Porous discs?..... _____
   (a) Two, to separate top and bottom of specimen from cap and base, diameter equal to specimen.
   (b) Checked regularly to determine whether they have become clogged.

11. Optional: Filter paper strips or discs? ..... _____
   (a) Type that do not dissolve in water.
   (b) Strips cover no more than 50% of specimen surface.

12. Rubber membranes?..... _____
   (a) Checked for leakage.
   (b) Unstretched diameter between 90-95% of specimen diameter.
   (c) Membrane thickness less than 1% of specimen diameter.

13. Optional: Rubber O-rings, unstressed inside diameter between 75 and 85% of cap and base diameter? ..... _____

14. Valves, capable of withstanding applied pressures without leakage and produce minimum volume change due to their operation (creates pressure change less than ±0.1 psi)?..... _____

15. Specimen-size measurement device:
   (a) Measure diameter and height to 4 significant digits without specimen disturbance or deformation? .... _____

16. Optional, Electronic recorders, for recording specimen behavior:
   (a) Measuring devices calibrated through electronic recorders using known input standards?..... _____

17. Sample Extruder, capable of extruding soil from sampling tube at a uniform rate, in same direction of travel in which sample entered tube, with minimum sample disturbance? ..... _____

18. Timer, indicates elapsed testing time to nearest 1 second? ..... _____

19. Weighing device, accurate to within ±0.05% of total specimen mass and readable to 4 significant digits?..... _____

20. Water de-aeration device or de-aired water supply? ..... _____

21. Testing environment (for consolidation and shear):
   (a) Temperature fluctuations less than ±7.2°F (±4°C), out of direct sunlight? ..... _____

22. Extruder, for preparing intact samples, capable of extruding sample with minimum disturbance?..... _____
   Note to assessor: *write finding if a sample extruder is not available during testing.*

23. Trimming and carving tools, compaction apparatus, membrane and O-ring expander, and water content cans?. _____

COMMENTS (T297 / D4767): (T297 / D4767)

CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

(T297) _____
(D4767) _____

PROCEDURE Date: _____

Specimen Size

1. Cylindrical, minimum diameter of 3.3 cm (1.3 in.)? ..... _____
2. Height to diameter ratio between 2 and 2.5? ..... _____
3. Largest particle size less than 1/6 of specimen diameter, or noted on report? ..... _____

Intact Specimens

1. Specimens handled to minimize disturbance, compression, and changes in cross-section or moisture content? . _____
2. Trimmed specimens prepared in controlled environment where water content change is minimized? ..... _____
3. Voids from pebbles or crumbling filled with remolded soil from trimmings? ..... _____
4. Final trimming of end surfaces done with steel straightedge? ..... _____
5. One or more water content determinations of trimmings determined according to (T265 / D2216)? ..... _____
6. Specimen dimensions determined to 4 significant digits? ..... _____
7. Specimen mass determined to 4 significant digits? ..... _____

Reconstituted Specimens

1. Soil thoroughly mixed with water to desired water and stored in covered container for at least 16 hours? ..... _____
2. Split mold of circular cross-section that meets specimen size requirements used? ..... _____
3. Tamper area in contact with soil less than or equal to 1/2 area of mold? ..... _____
4. Specimens molded to desired density by:
   (a) Kneading or tamping each layer until accumulative soil weight placed in mold is compacted to known volume? ..... _____

   or (b) Adjusting number of layers, number of tamps per layer, and force per tamp? ..... _____

5. Top of each layer scarified before adding material for next layer? ..... _____
6. Specimen reconstituted (compacted) in at least six layers? ..... _____
7. After forming with specimen ends perpendicular to longitudinal axis, mold removed? ..... _____
8. One or more water content determinations on excess material determined according to (T265 / D2216)? ..... _____
9. Specimen dimensions and mass determined to 4 significant digits? ..... _____
10. Minimum of 3 height measurements taken 120° apart and average determined? ..... _____
11. Minimum of 3 diameter measurements taken at quarter points of height and average determined? ..... _____
12. Height and diameter measurements do not vary by more than 5% from the average measurement? ..... _____

Mounting Specimen

1. Membrane placed on membrane expander or membrane rolled on cap or base? ..... _____
2. Porous discs and drainage tubes checked for obstructions by passing liquid through the lines? ..... _____
3. Pressure, volume and pore-pressure measurement / control devices attached to chamber base? ..... _____

Wet Mounting Method

1. Drainage lines and pore water pressure measuring device filled with deaired water? ..... _____
2. Porous discs saturated by boiling in water at least 10 minutes, cooled to room temperature? ..... _____
3. Saturated porous disc placed on specimen base and free water wiped from disc? ..... _____
4. Specimen placed on disc, followed by second porous disc and specimen cap? ..... _____
5. If using filter-paper strips or cage, paper saturated with water prior to placing on specimen, and not more than 50% of specimen periphery covered with vertical strips of paper? ..... _____
6. Specimen cap, specimen and porous discs checked that they are centered on specimen base? ..... _____

COMMENTS (T297 / D4767): (T297 / D4767)

CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

(T297) _____
(D4767) _____

PROCEDURE (Continued) Date: _____

Dry Mounting Method

1. Specimen drainage system dried? ..... _____
2. Porous discs dried overnight in oven and cooled in desiccator to room temperature? ..... _____
3. Dry disc placed on base, followed by specimen, another disc and cap? ..... _____
   Note: *Dry filter-paper discs may be placed between porous discs and specimen. Also, filter paper strips or cage may be held in place by small pieces of tape.*
4. Specimen cap, discs, and specimen checked that they are centered on base? ..... _____

After Specimen Has Been Mounted

1. Rubber membrane placed around specimen and sealed at cap and base with positive seal at each end? ..... _____
2. Top drainage line attached and alignment of specimen and cap checked:
   Dry Mounting Method:
   (a) Partial vacuum of approximately 5 psi (35 kPa) (not to exceed consolidation stress) applied through top drainage line prior to checking alignment? ..... _____
   (b) If eccentricity appears, vacuum released, specimen and cap realigned, and vacuum reapplied? ..... _____
   Wet Mounting Method: alignment of specimen and cap checked without use of a partial vacuum? ..... _____

Saturation

1. Triaxial chamber assembled? ..... _____
2. Axial load piston brought in contact with specimen cap several times to permit proper seating and alignment without exceeding load of 0.5% of estimated load at failure? ..... _____
3. Deformation indicator read to three significant digits when piston brought into contact the final time? ..... _____
4. Chamber carefully filled to avoid trapping air in the chamber? ..... _____
5. Saturation accomplished without undesirable pre-stressing or swelling of specimen (Test method only suggests ways of doing this step)? ..... _____
6. Specimen considered adequately saturated if "B" value > 0.95 or if a plot of "B" versus back pressure indicates no further increase in "B" with increasing back pressure? ..... _____
7. "B" calculated as change in pore pressure divided by change in chamber pressure? ..... _____

Consolidation

1. Axial load piston brought into contact with specimen cap and deformation read to 3 significant digits? ..... _____
2. Care taken not to exceed axial load of 0.5% of estimated axial load at failure? ..... _____
3. Piston raised a small distance above the cap and locked in place? ..... _____
4. With drainage valves closed, maximum back pressure held constant while chamber pressure increased until difference between chamber and back pressure equals desired effective consolidation pressure? ..... _____
   Note: *Increasing chamber pressure allowed over a period of up to 10 minutes with drainage valves open. Volume change readings then begin immediately after total pressure is reached.*
5. Consolidation accomplished in stages if effective consolidation stress is greater than 40 kPa (5.8 lb/in^2) and filter strips used, with a load increment ratio not exceeding 2 (stress not more than doubled each increment)? .. _____
6. Initial volume change reading obtained, drainage valves opened to allow specimen to drain from both ends? ... _____
   Note: *volume change readings are typically obtained from a burette, but other systems are allowable.*
7. Volume change readings recorded at increasing intervals of elapsed time, such as 0.1, 0.2, 0.5, 1, 2, 4, 8, 15 and 30 minutes, 1, 2, 4 and 8 hours, etc? ..... _____
   Note**:** *Times with easy square roots, or other intervals, may be used.*
8. After the 15 minute volume change reading, piston coupled with specimen cap and deformation readings obtained to three significant digits? ..... _____

COMMENTS (T297 / D4767): (T297 / D4767)

CONSOLIDATED, UNDRAINED TRIAXIAL (T297) _____
COMPRESSION TEST ON COHESIVE SOILS **(D4767) _____**

PROCEDURE (Continued) Date: _____

Consolidation (continued)

9. Volume change and deformation readings plotted versus logarithm or square root of elapsed time? ..... _____
10. Consolidation continued for at least one log cycle of time or one overnight period after 100% primary consolidation has been reached, as determined by one of the procedures of (T216 / D2435)? ..... _____
Note*: *A marked deviation between slopes of volume change readings and deformation curves toward end of consolidation (based on deformation readings) indicates fluid leakage from chamber into specimen, and test should be terminated.
11. Time for 50% primary consolidation, (t_{50}), determined by one of the procedures in (T216 / D2435)? ..... _____
***Note:** If the specimen swells or does not consolidate, check for equipment malfunction. If a similar specimen is being tested at a higher effective consolidation stress, the t_{50} from that test can be used instead. If there is no other data available use a strain rate of 1% / hr.*

Prior to Axial Loading

1. Specimen isolated by opening or closing appropriate valves so pore-water pressure will be measured by pore-pressure measurement device and no drainage will occur during shear? ..... _____
2. Axial load piston brought into contact with specimen cap without exceeding load of 0.5% of estimated axial load at failure? ..... _____
3. If axial load-measuring device located outside chamber, test started with piston slightly above specimen cap to record piston friction and upward thrust due to chamber pressure **or** axial load measuring device adjusted to compensate for friction and thrust? ..... _____
4. When piston moves downward prior to cap contact, the reading of axial load-measuring device does not vary by more than 0.1% of estimated failure load? ..... _____
5. Initial pore-pressure recorded to the nearest 0.7 kPa (0.1 psi) immediately prior to piston contact on cap? ..... _____

Axial Loading

1. Axial load applied at a rate to produce equalization of pore pressures throughout specimen at failure? ..... _____
Note*: *Strain rate is preferably determined by dividing expected strain at failure % (such as 4%) by 10x the value of t_{50}.
2. Load, deformation and pore-water pressure values recorded at increments of 0.1% to 1% strain? ..... _____
Note*: *The increments listed here should be considered minimums. Additional readings are acceptable.
3. Load and deformation recorded to three significant digits and pore-water pressure values recorded to the nearest 0.7 kPa (0.1 psi)? ..... _____
4. Values then recorded at every 1% and sufficient readings taken to define stress-strain curve? ..... _____
5. Loading continued until 15% strain? ..... _____
Note*: *Loading may be stopped when principal stress difference (deviator stress) has dropped 20%, or when 5% additional axial strain occurs after peak in principal stress difference (deviator stress).

Removing Specimen

1. Axial load removed, and chamber and back pressure reduced to zero? ..... _____
2. Specimen quickly removed with drainage valves remaining closed? ..... _____
3. Rubber membrane (and filter-paper strips or cage, if used) removed, free water on specimen blotted away, and water content of total specimen determined according to (T265 / D2216)? ..... _____
Note*: *If specimen is to be used for index tests, specimen should be weighed prior to removing material for index property tests and a representative portion of the specimen should be used to determine final water content.
4. Sketch or photograph of specimen made, showing mode of failure, prior to placing specimen in oven? ..... _____
5. Calculations and graphs made according to book? ..... _____

COMMENTS (T297 / D4767): (T297 / D4767)

IN-PLACE DENSITY AND MOISTURE CONTENT OF SOIL AND SOIL-AGGREGATE BY NUCLEAR METHODS (SHALLOW DEPTH) (T310) _____ **(D6938) _____**

APPARATUS Date: _____

1. Nuclear density/moisture gauge? ..... _____
   (a) Sealed source of high energy gamma radiation (such as cesium or radium).
   (b) Gamma detector (any type, such as Geiger-Mueller tube).
   (c) Fast neutron source, sealed mixture of radioactive material (such as americium, radium, or californium-252) and a target material (such as beryllium).
   (d) Slow neutron detector, any type (such as boron trifluoride or helium-3 proportional counter.

2. Reference standard, block of material used for checking instrument operation, correction of source decay, and to establish conditions for a reproducible reference count rate? ..... _____
3. Site preparation device, such as a plate, straightedge, or other suitable leveling tool for planning test site, and in Direct Transmission Method, guiding drive pin to prepare perpendicular hole? ..... _____
4. Drive pin, slight larger diameter than Direct Transmission instrument [*AASHTO only: does not exceed diameter of Direct Transmission instrument by more than 6 mm (1/4 in.)*]? ..... _____
5. Drive pin extractor, tool used to remove drive pin in vertical direction so pin will not distort hole? ..... _____
   Note: *A slide hammer, with drive pin attached, may also be used to prepare hold and to extract pin.*
6. Acceptable Calibration Method (check records) [*AASHTO only: must be calibrated on multiple blocks*]?..... _____
   Note to assessors: *Please review the records for the gauge presented for demonstration and spot check several additional records if available. Record the type of calibration used for each record reviewed. Please add an informational note and / or Alert on the report.*
   (a) *AASHTO only: Interval 24 months, unless using a verification procedure?*..... _____
   (b) ***ASTM only: Interval 12 months, unless using a verification procedure?*** ..... _____

Gauge make:_____ **Serial #:**_____ **Type (circle one):** one-block three-block five-block

Gauge make:_____ **Serial #:**_____ **Type (circle one):** one-block three-block five-block

Gauge make:_____ **Serial #:**_____ **Type (circle one):** one-block three-block five-block

Gauge make:_____ **Serial #:**_____ **Type (circle one):** one-block three-block five-block

Gauge make:_____ **Serial #:**_____ **Type (circle one):** one-block three-block five-block

COMMENTS (T310 / D6938): (T310 / D6938)

(X1) – ASTM only Observation

IN-PLACE DENSITY AND MOISTURE CONTENT OF SOIL AND SOIL-AGGREGATE BY NUCLEAR METHODS (SHALLOW DEPTH)

(T310) _____
(D6938) _____

PROCEDURE Date: _____

Calibration ***Note to assessors:*** *calibration records from the manufacturer are usually fine.*

1. New gages initially calibrated? ..... _____
2. Existing gages calibrated to re-establish calibration curves, tables, or equivalent coefficients at least once every 24 months **[*ASTM 12 mo.*]** in accordance with Appendix A1 and A2? (unless owner has established a verification procedure, see Verification section below)? ..... _____
3. Calibration produces calibration response within ±16 kg/m^3 (±1.0 lb/ft^3) on standard block(s) of materials of established and constant densities (can be done by manufacturer, user, or independent vendor)? ..... _____
4. Blocks used for wet density calibration capable of generating a general and reliable curve covering entire density range of materials to be tested in the field? ..... _____
5. Standard deviation of measurement results do not exceed 0.2% of measured block density? ..... _____
6. *AASHTO: Blocks used for water content calibration made of materials of established and constant moisture densities (multiple blocks are required)?* ..... _____
7. Density of block(s) used verified at least every 5 years (metals, plastics, etc) or every year for blocks made of materials that can change density or water content, such as soil, rock, or concrete? ..... _____

   Note, AASHTO only: *Unless calibration blocks are damaged during transportation from one facility to another, they do not need to be re-verified for density. However, changes in the size and set up of the calibration bays, or environmental conditions such as temperature changes and different background radiation levels may affect the blocks and the gauge response on the calibration blocks.*
8. ***ASTM only: Water content of materials used to establish calibration varies through range to include water content of materials to be tested, and in density range of 1600 to 2240 kg/m^3 (100 to 140 lbf/ft^3))? ..... _____***

Verification (optional)

1. Verification procedure documented and results formally recorded (check records)? ..... _____
2. Existing gages verified at least once every 12 months? ..... _____
3. Verification performed by taking a sufficient number of counts on one or more blocks of established density to ensure the accuracy of the existing calibration as follows (check records):
   (a) For density: to within ±32 kg/m^3 (±2.0 lb/ft^3) at each measurement depth? ..... _____
   (b) For moisture: to within ±16 kg/m^3 (±1.0 lb/ft^3)? ..... _____
4. If variance exceeds specified limits above, is gage re-calibrated? ..... _____
5. Assigned block density (for each calibration depth) and assigned water content of the block(s) stated as part of verification data? ..... _____

Standardization

1. Performed at start of each day's use? ..... _____
2. *AASHTO: Permanent records of data retained?* ..... _____
   ASTM: Records retained for a sufficient amount of time (at least the last 4 standardization count)? ..... _____
3. Performed with equipment at least 10 m (30 ft) **[*ASTM: 9 m (30 ft)*]** from other radioactive sources, and clear of large masses of water or other items which may affect reference count? ..... _____
4. If recommended by manufacturer, gauge turned on and allowed to stabilize prior to use and power left on during the use of the gauge for that day? ..... _____
5. Using reference standard, at least four repetitive readings taken at normal measurement period, and mean obtained? ..... _____

   Note: *One measurement of four or more times the normal period is acceptable.*
6. Equation 1 **[*ASTM: and Equation 2*]** used to determined standardization? ..... _____

   or Procedure recommended by gauge manufacturer used to determine compliance with gauge calibration curves? ..... _____

   Note to assessors: *Gauges that calculate compliance automatically are an example of a manufacturer's procedure.*

COMMENTS (T310 / D6938): (T310 / D6938)

IN-PLACE DENSITY AND MOISTURE CONTENT OF SOIL AND SOIL-AGGREGATE BY NUCLEAR METHODS (SHALLOW DEPTH)

(T310) _____
(D6938) _____

PROCEDURE (Continued) Date: _____

Procedure

1. Test location selected where gauge will be at least 6 in. **[*ASTM: 24 in.*]** away from any vertical mass? ..... _____
2. If test location is closer than 600 mm (24 in.) from any vertical mass, such as a trench, gauge manufacturer correction procedures followed? ..... _____
3. All loose, disturbed and additional material removed as necessary to expose top of material to be tested? ..... _____
4. Horizontal area sufficient in size to accommodate the gauge prepared by scraping the area smooth to obtain maximum contact between gauge and material tested? ..... _____
5. ***ASTM only: If gauge base is to be placed below surrounding surface, is horizontal area at least twice the area of the gauge base? If depression is greater than 25 mm (1 in.), is larger area cleared?*** ..... _____
6. Native fines or fine sand used to fill voids as necessary **[*ASTM: not to exceed 10% of bottom area of gauge*]**? _____
7. Surface smoothed with rigid plate or other suitable tool? ..... _____
8. Maximum void beneath gauge without filling does not exceed 3 mm (1/8 in.)? ..... _____
9. Gauge turned on and allowed to stabilize (warm up) according to manufacturer's recommendations? ..... _____

Backscatter or Backscatter/Air-Gap Ratio Method

1. Gauge seated firmly on prepared test site? ..... _____
2. All other radioactive sources kept at least 10m (30 ft) away from gauge? ..... _____
3. Gauge set to Backscatter (BS) position? ..... _____
4. One or more 1-minute readings secured and recorded? ..... _____
5. For Backscatter/Air-Gap Ratio method, same number of readings for the normal measurement period taken for normal measurement period in air-gap position as in standard backscatter position? ..... _____
6. Air-gap ratio determined by dividing counts per minute obtained in air-gap position by counts per minute obtained in standard backscatter position? ..... _____
   Note: *Many gauges have built-in provisions for automatically calculating the air-gap ratio and wet density.*
7. ***ASTM only: Ratio of reading to the standard count or to the air gap count determined?*** ..... _____
8. In-place wet density determined by use of calibration curve previously established, or gauge read directly if so equipped? ..... _____

COMMENTS (T310 / D6938): (T310 / D6938)

IN-PLACE DENSITY AND MOISTURE CONTENT OF SOIL AND SOIL-AGGREGATE BY NUCLEAR METHODS (SHALLOW DEPTH)

(T310) _____
(D6938) _____

PROCEDURE (Continued) Date: _____

Direct Transmission Method (Density Determination)

1. Test location selected where gauge will be at least 6 in. away from any vertical mass? ..... _____
2. Hole made perpendicularly to prepared surface using guide and hole-forming device?..... _____
3. Hole is at least 50 mm (2 in.) deeper than desired measurement depth?..... _____
4. Hole aligned so that insertion of the probe will not cause the gauge to tilt from plane of prepared area?..... _____
5. Test area marked to allow placement of instrument over test site and to allow alignment of source rod to the hole *(Follow manufacturer's recommendations if applicable)?* ..... _____
6. Hole forming device removed carefully to prevent the distortion of the hole, damage to surface, and loose material from falling into the hole? ..... _____
7. Gauge placed on material to be testing, ensuring maximum surface contact? ..... _____
8. Source rod **[*ASTM: probe*]** lowered into hole to desired test depth?..... _____
   ***Note**, **AASHTO only [ASTM: recommended when possible]:** A rod containing radioactive sources shall not be extended out of its shielded position prior to placing it in the test hole.*
9. Gauge pulled gently in direction that will bring side of probe to face center of gauge so that probe is in intimate contact with the side of the hole in the gamma measurement path?..... _____
10. All other radioactive sources kept at least 10 m (30 ft) away from gauge? ..... _____
11. If gauge is so equipped, depth selector set to same depth as probe before recording the automated values (gauge computed densities, moisture contents, and weights)? ..... _____
12. One or more 1-minute readings secured and recorded? ..... _____
13. In-place wet density determined by calibration curve previously established, or gauge read directly? ..... _____
    ***Note:** The gauge may be rotated about the axis of the probe to obtain additional readings (when oversize material is present this can be used as a check).*
14. ***ASTM only: In-place wet density determined from count ratio, calibration, and adjustment data? .....*** _____
15. ***ASTM only: If volume tested has excess oversize material with respect to D698, D1557 or D4253, correction for wet density (unit weight) and water content determined in accordance with D4718 and applied?.....*** _____

Calculations

1. If dry density required, in-place water content determined by using nuclear methods, gravimetric samples and laboratory determination, or other approved instrumentation? ..... _____
2. If water content determined by nuclear methods, moisture subtracted from wet density [both in kg/m^3 (lbm/ft^3)] and dry density obtained or gauge readings used directly? ..... _____
3. If water content determined by other methods, Equation 2 used?..... _____

COMMENTS (T310 / D6938): (T310 / D6938)

GRAIN-SIZE ANALYSIS OF GRANULAR SOIL MATERIALS (T311)

APPARATUS Date: _____

1. Platform Scale: Conforms to requirement of M231 for class of general purpose scale required for principal sample weight being tested (AMRL: Readable to 0.1% of sample mass or better)? ..... ____

2. Balance: Conforms to requirement of M231 for class of general purpose balance required for principal sample weight being tested (AMRL: Readable to 0.1% of sample mass or better)? ..... ____

3. Sieves: Conform to M92? ..... ____
   Note: Sieves larger than 203-mm (8-in.) diameter recommended for testing coarse aggregate ..... ____
   Note: Heavy duty screen with larger wire diameter may be desirable ..... ____

4. Optional: Mechanical Sieve Shaker: ..... ____
   (a) Impacts a vertical or lateral and vertical motion to the sieve? ..... ____
   Note: Mechanical shaker recommended for sample sizes of 20 kg or greater ..... ____
   Note: Time of sieving limited (not more than 5 min.) to avoid sample degradation? ..... ____
   Note: Appropriate mechanical shaker used for nominal aggregate size tested? ..... ____
   (Large sieving surfaces could result in loss of material if used for smaller samples of coarse granular or fine granular material.)

5. Oven: Capable of being maintained at 110±5°C (230±9°F)? ..... ____

6. Non-corrosive containers that are not subject to weight change? ..... ____

COMMENTS (T311): (T311)

GRAIN-SIZE ANALYSIS OF GRANULAR SOIL MATERIALS (T311)

PROCEDURE Date: _____

1. Representative sample obtained according to following table (not a requirement)? ____

Nominal Maximum Size	Sample Mass
50 mm (2 in.)	20 kg
19 mm (3/4 in.)	7 kg
6.3 mm (1/4 in.)	1 kg

2. **Note**: 6.3-mm sieve used for separation? ____
3. **Note**: Alternative sieve sizes (i.e., 4.75 mm, 2.00 mm, etc.) may be used for separation, depending on sample type, size, and/or tester's preference ____
4. **Note**: If alternative sieve size used, that size must replace the 6.3-mm size as outlined in the method ____
5. **Note**: If alternative sieve size used, new Sieve Analysis Data Sheet developed for alternative sieve utilized? ____
6. Sample screened on a 6.3-mm sieve? ____
7. Plus 6.3-mm material dried and screened again if excessive amount of silt or clay adheres to particles? ____
8. **Note**: Care taken to prevent sieve overloading throughout the test? ____
   (Overloading occurs when there is an insufficient amount of sieve openings for material to pass through)
9. **Note**: Sample may be divided into smaller portions and sieved to prevent overloading ____
10. **Note**: Wood mallet may be used if significant amount of particles adhere together to form silt and/or clay balls . ____
11. **Note**: Care taken not to pulverize particles or damage the sieve? ____

Plus 6.3-mm Material

1. Plus 6.3-mm material fully dried (no visible signs of moisture)? ____
2. **Note**: Particles larger than 100 mm removed, weighed, and noted on data sheet? ____
3. **Note**: Plus 100-mm material **not** included in test? ____
4. Plus 6.3-mm material weighed to the nearest 5 g and recorded? ____
5. Plus 6.3-mm material sieved over specified sieves? ____
6. Last sieve shall be the 6.3 mm followed by a pan ____
7. Material in pan weighed to the nearest 5 g and recorded? ____
8. Material in pan combined with minus 6.3-mm material obtained in the initial separation (steps 6 & 7 above) ____
9. Material retained on each sieve weighed to the nearest 5 g and recorded? ____
10. Values added up and recorded at the bottom of the column? ____
11. Total mass of plus 6.3-mm material computed [(Plus 6.3-mm Material) – (Material in Pan)]? ____
12. **Note**: If mechanical shaker used, sieves shaken at least 3 min. and no longer than 5 min.? ____
13. **Note**: If shaken manually, sieves shaken at least 5 min.? ____
14. **Note**: Particles stuck in sieve openings removed, weighed, and included in mass retained on that sieve? ____
15. **Note**: Particles not forced through sieve openings ____
16. Minus 6.3-mm material weighed to the nearest 5 g and recorded? ____
17. Minus 6.3-mm material immediately mixed thoroughly? ____

Moisture Content Sample

1. 500-g moisture specimen obtained by splitting or quartering? ____
2 Weight of container and weight of soil and container recorded to nearest 0.1 g ____
3. Sample placed in container of known weight? ____
4. Sample dried to a constant mass? ____
5. Sample cooled, re-weighed, and recorded to nearest 0.1 g? ____
6. **Note**: If sample is recycled material, or contains bituminous material, it shall be dried to a constant weight by air drying or in an oven not exceeding 60°C? ____
7. **Note**: If dried on a hot plate or stove, container holding the sample placed on a pan containing a thin layer of sand to prevent spattering and/or fracturing of soil particles? ____
8. **Note**: If dried in an oven, sample temperature maintained at 110 ± 5°C for at least 12 hours or until it maintains a constant weight? ____
9. **Note**: If minus 6.3-mm material less than 500 g, moisture content and gradation may be performed on the smaller amount only if the sample is considered to be representative ____

COMMENTS (T311): (T311)

GRAIN-SIZE ANALYSIS OF GRANULAR SOIL MATERIALS (T311)

PROCEDURE (Continued) Date: _____

Wash Sample

1. 300 ± 5 g portion obtained from moisture sample and mass recorded to nearest 0.1 g? ____
2. Sample washed on a 75-µm sieve? ____
3. It is suggested that the wash be performed over a white basin to see when the wash water is clean ____
4. Sample thoroughly washed? ____
5. Sample carefully transferred from the sieve to a container for drying? ____
6. Sample dried in accordance with steps 35 through 37 above? ____
7. Dried sample weighed to the nearest 0.1 g and recorded? ____
8. **Note**: 75-µm sieve examined prior to each washing to determine its condition? ____
9. **Note**: 75-µm sieve replaced if any holes or cracks noticed in solder or if mesh stretched excessively? ____
10. **Note**: New 75-µm sieves washed with soap and water prior to initial use? ____
11. **Note**: Fingertips may be used to agitate sample without applying pressure to mesh itself ____
12. **Note**: Water does not overflow or splash out of sieve ____
13. **Note**: Tapping side of sieve is allowed ____

Minus 6.3-mm (1/4 in.) Material

1. Dried sample sieved over specified sieves ____
2. Last sieve should be the 75-µm sieve followed by a pan ____
3. Material retained on each sieve and in pan weighed to nearest 0.1 g and recorded? ____
4. Values added up and recorded at the bottom of the column? ____

Mass of Minus 6.3-mm (1/4 in.) Material for Moisture Content

1. Percent moisture content determined and recorded to nearest 0.1 percent? ____
2. Dry mass of minus 6.3-mm material computed [Moist Mass / (1 + (Moisture Content / 100))]? ____

Total Dry Mass Calculation

1. (Dry Mass of Plus 6.3-mm Material + Dry Mass of Minus 6.3-mm Material) ____

Particle Size Distribution of Plus 6.3-mm Material

1. Percent retained on each sieve computed (Mass Retained / Total Dry Mass) and recorded to nearest 0.1 percent? ____
2. Values added up and recorded at the bottom of the column? ____
3. Percent passing each sieve computed (% Passing Previous Sieve – % Retained on Sieve Being Checked) and recorded to nearest 0.1 percent? ____
4. Percent passing each sieve also reported to nearest one percent for checking specification criteria? ____

Particle Size Distribution of Minus 6.3-mm (1/4 in.) Material

1. Percent retained on each sieve computed (Mass Retained / Mass of Minus 6.3-mm Sample Prior to Washing) and recorded to nearest 0.1 percent? ____
2. Values added up and recorded at the bottom of the column? ____
3. Percent passing each sieve computed (based on minus 6.3-mm material) (% Passing Previous Sieve – % Retained on Sieve Being Checked) and recorded to nearest 0.1 percent? ____
4. Percent of total sample passing each sieve computed (based on total mass) [(% Passing Determined in Previous Step) x (% Total Passing the 6.3-mm Sieve)] / 100 and recorded to nearest 0.1 percent? ____
5. Percent passing each sieve (based on total mass) also reported to nearest one percent for checking specification criteria? ____

COMMENTS (T311): (T311)

AMOUNT OF MATERIAL IN SOILS FINER THAN THE NO. 200 SIEVE (D1140)

APPARATUS Date: _____

1. Balance, meets D4753, readable to 0.1% of test mass, or better (GP1 or GP2)? ..... _____
2. Sieve: 75 µm (No.200), **Optional:** Recommended upper sieve 425 µm (No.40) or larger?..... _____
3. Oven, maintains 110±5°C (230±9° F)?..... _____
4. Deflocculating agent (Method B only), suitable solution of sodium hexametaphosphate (example: 40 g/L)?..... _____

PROCEDURE

1. Sample thoroughly mixed and reduced to appropriate sample size (reduction to exact mass not permitted)? ..... _____
2. Max particle size / Min dry sample mass: (No.10) – 20g, (No.4) – 100g, 3/8 in – 500g, 3/4 in – 2.5 kg, etc?.... _____
   ***Note*:** *Sample size should be the same as D422 if used in conjunction with D422 (either 50 g clayey/silty or 100 g sandy).*
3. Specimen dried to constant mass at 110±5°C (230±9°F) and weighed to the nearest 0.1 g?..... _____

   or Water content determined from auxiliary specimen according to (D2216)?..... _____

4. Method A
   (a) Specimen placed on upper sieve? ..... _____

   or

5. Method B
   (a) Specimen placed in container and covered with water containing deflocculating agent? ..... _____
   (b) Specimen soaked for a minimum of 2 hours (preferably overnight)?..... _____
   (c) Specimen agitated periodically while soaking? ..... _____
   (d) At end of soaking period, sample vigorously agitated and immediately poured onto the sieve nest? .... _____
   (e) Any remaining residue in container rinsed onto sieve nest?..... _____

6. Specimen washed through the sieve (or sieve stack) by stream of water from a faucet?..... _____
   ***Note*:** *Spray nozzle or piece of rubber tubing may be attached to faucet.*
7. Force of water does not cause sample to splash over sides of sieve?..... _____
8. Care taken not to lose any soil if material is manipulated by hand? ..... _____
9. Downward pressure on the sample or sieve not used?..... _____
10. Care taken to not let water accumulate on the 75-µm sieve due to clogging of the screen? ..... _____
11. Washing continued until wash water coming through sieve is clear?..... _____
12. Material retained on 75-µm sieve dried on sieve, or transferred to sample container?..... _____
13. **Optional:** If transferred, excess water carefully decanted or suctioned from washed sample?..... _____
14. Specimen dried to constant mass at 110±5°C (230±9°F) and weighed to 0.1%? ..... _____
15. Calculation: % less than 75 µm = $\frac{\text{original dry mass - final dry mass}}{\text{original dry mass}} \times 100$?..... _____
16. Result reported to the nearest 0.1%?..... _____

COMMENTS (D1140): (D1140)

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES (D2487)
(UNIFIED SOIL CLASSIFICATION SYSTEM)

APPARATUS Date: _____

1. Equipment for obtaining and preparing samples? ..... _____
2. Apparatus for performing the following tests:
   (a) Particle size distribution (T88 / D422)? ..... _____
   (b) Liquid limit and plasticity index (T89 & T90 / D4318)? ..... _____
3. Plasticity chart, similar to Fig.4? ..... _____
4. Cumulative particle-size distribution curve, similar to Fig.5? ..... _____

PROCEDURE

1. Soil prep and required testing performed in accordance with accepted standard procedures? ..... _____
2. Preliminary soil classification (as in Table 1) using the following:
   (a) Fine-grained soil (50% or more passes No.200 sieve) – use Table 1 or Fig.2, follow Section 11? ..... _____
   (b) Coarse-grained soil (less than 50% passes No.200 sieve) – use Table 1 or Fig.3, follow Section 12? ... _____
   (c) Peat (highly organic, decomposing vegetable tissue) – labeled PT, no further classification? ..... _____
3. For fine-grained soils, classified as organic if (use Fig.2, follow Section 11):
   (a) Liquid Limit after oven drying is less than 75% of Liquid Limit before drying & PI < 4? ..... _____

Note to Assessors: *Pick example numbers for Liquid Limit and Plasticity of a hypothetical fine-grained sample. Using Fig.4 (see below), ask the technician to determine the symbol group. Have the technician follow the flow chart or table to determine the group name (see table).*

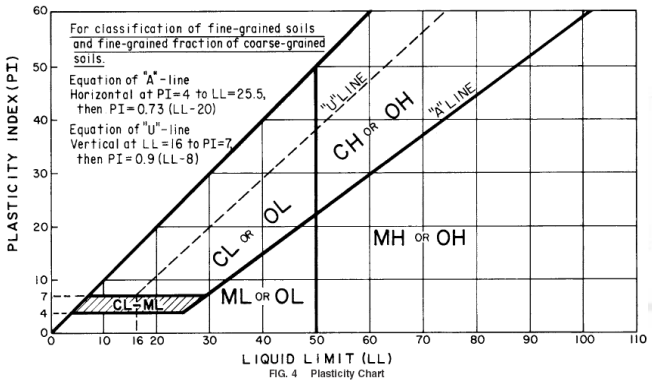


FIG. 4 Plasticity Chart

Classification of Fine-Grained Soils – Group Name Chart

Clays	Name	Inorganic clay If…	And…
CL	(Lean Clay)	PI is on or above "A" line –and– PI > 4	LL < 50
CH	(Fat Clay)	PI is on or above "A" line –and– PI > 4	LL > 50
CL-ML	(Silty Clay)	PI is on or above "A" line –and– PI > 4	4 < PI < 7
Silts	Name	Inorganic silt If…	And…
ML	(Silt)	PI is below "A" line –or– PI < 4	LL < 50
MH	(Elastic Silt)	PI is below "A" line –or– PI < 4	LL > 50
Organics	Name	Organic clay or silt If…	And…
OL	(Organic Silt)	PI is below "A" line –or– PI < 4	Organic (see 3. above) –and– LL < 50
OH	(Organic Clay)	PI is on or above "A" line –and– PI > 4	Organic (see 3. above) –and– LL > 50
…with	Name	Add remark If…	
	----- (no additions)	Amount retained on #200 < 15%	Choose:
	(with sand or gravel)	15% < amount retained on #200 < 30%	Sand – most between No. 4 and No. 40
	(sandy or gravelly)	Amount retained on #200 > 30%	Gravel – most between 3-in. and No. 4

Report:
1. Percentage (by dry weight) of any plus 3-in. (75-mm) material and maximum particle size reported? ..... _____
2. Report indicates group symbol, group name, and results of D422 & D4318? ..... _____

COMMENTS (D2487): (D2487)

DESCRIPTION AND IDENTIFICATION OF SOILS (D2488)
(VISUAL-MANUAL PROCEDURE)

APPARATUS Date: _____

1. Pocket knife or spatula, and **optional** hand lens? ..... _____
2. Purity of water - city water supply or natural source, including non-potable water? ..... _____
3. **Optional:** Dilute hydrochloric acid, 1 part HCl : 3 parts H_2O and test tube and stopper or jar with lid? ..... _____

PROCEDURE

Sampling

1. Representative sample obtained by an appropriate, accepted, or standard procedure? ..... _____
2. Sample carefully identified as to origin and of sufficient mass (Section 9.3)? ..... _____
3. Group name and symbol determined according to Fig.1 or Fig.2? ..... _____
4. Considered fine-grained if more than 50% fines (Section 14), otherwise coarse-grained (Section 15)? ..... _____

Descriptive Information

Note to Assessors: *Have the technician describe how information in each category is determined – what table they use or what properties they are observing. Use an intact soil sample when possible (such as a Shelby tube section).*

1. Angularity – angular, subangular, subrounded, rounded, or range (ex. subrounded to rounded) (Fig.3)? ..... _____
2. Shape – flat, elongated, flat & elongated, or not mentioned? Include approx. fractions of shapes (Fig.4)? ..... _____
3. Color – color of moist samples noted, including any layers or patches with varying colors? ..... _____
4. Odor – if unusual or distinctive, is it described? ..... _____
5. Moisture Condition – dry, moist, or wet (Table 3)? ..... _____
6. Optional HCL Reaction – none, weak, or strong (Table 4) (tests for calcium carbonate, a cementing agent)? .... _____
7. Consistency of intact fine-grained soils – very soft, soft, firm, hard, or very hard (Table 5)? ..... _____
8. Cementation of intact coarse-grained soils – weak, moderate, or strong (Table 6)? ..... _____
9. Structure of intact soils – stratified, laminated, fissured, slickensided, blocky, lensed, homogenous (Table 7)?.. _____
10. Range of Particle Sizes – describe range of particle sizes for each component (ex. 20% fine gravel)? ..... _____
11. Maximum Particle Size – sieve size for +No.4 material and fine, medium, or coarse description for sands? ..... _____
12. Hardness of coarse particles – describe fracture under hammer or lack of fracture? ..... _____
13. Additional comments – note any roots, root holes, difficulty drilling, caving of trench, or presence of mica? .... _____
14. Peat – if peat is found, not subjected to further testing? ..... _____

Preparation for Identification

1. Identification based on the portion of soil passing the 3-in. (75-mm) sieve? ..... _____
2. Percentage (by volume) of cobbles (between 12- & 3-in sieves) and boulders (+12-in.) estimated and noted? ... _____
3. Percentages (by dry mass) of gravels, sands, and fines estimated and noted (<5% components "trace")? ..... _____
4. Total percentages (excluding trace amounts) add up to 100%? ..... _____

Identification of Fine-Grained Soils *(Particles larger than the No. 40 sieve removed from a representative sample)*

1. Dry Strength – molded into wet putty-like ball (1 in. diam.), dried in air, and then crushed between fingers? .... _____
   Dry strength noted as none, low, medium, high, or very high (Table 8).
2. Dilatancy – shake a wet ball and note reaction of water appearing, squeeze, and note water disappearing? ..... _____
   Dilatancy noted as none, slow, or rapid (Table 9).
3. Toughness – roll to plastic limit and note pressure required to roll as low, medium, or high (Table 10)? ..... _____
4. Plasticity – describe plasticity as non-plastic, low, medium, or high (Table 11)? ..... _____

5. Characteristics used to determine group name and symbol (see table below)? ..... _____

Soils	Name	Dry Strength	Dilatancy	Toughness	Plasticity
CL	(Lean Clay)	Medium – High	None to Slow	Medium	Medium
CH	(Fat Clay)	High – Very High	None	High	High
ML	(Silt)	None – Low	Slow to Rapid	Low	Low or Non-plastic
MH	(Elastic Silt)	Low – Medium	None to Slow	Low to Medium	Low to Medium

Identification of Coarse-Grained Soils

1. Soil identified by particle size in accordance with the criteria specified in Section 15? ..... _____

COMMENTS (D2488): (D2488)

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD (D2937)

APPARATUS Date: _____

1. Drive cylinders, metal cylinder with one rim sharpened into a beveled edge.
   (a) Of suitable design for use at or near the surface? ..... _____
   (b) Cylinders are approximately 102 to 152 mm (4.00 to 6.00 in.) diameter OR drive cylinders of other diameter with proportional changes in the drive-cylinder tube and head? ..... _____
   Note to assessors: Typical dimensions are shown in Figure 1 but these are not requirements. Drive cylinders of other sizes must meet the clearance ratio, wall thickness, and area ratio shown in the standard.
   Approximate dimension for a 102 mm (4-in.) diameter drive cylinder (from Figure 1)

Outside Diameter 101 mm (4.0 in.)	Wall thickness 2 mm (5/64 in.)	Height 127 mm (5.0 in.)
Inside diameter 97 mm (3 7/8 in.)	Volume 0.94 L (0.033 ft^3, 940 cm^3)	Edge bevel 15°

   (c) If used as a basis for acceptance of compacted filled, cylinders at least 850 cm^3 (0.030 ft^3)? ..... _____

2. Drive head, with a sliding weight of suitable design for use with the drive cylinders? ..... _____
3. Straightedge, made of steel, with an edge beveled at approximately 45°? ..... _____
   (a) Approximately 3 mm (1/8 in.) by 38 mm (1 ½ inc.) by 305 mm (12.0 in.).
4. Shovel, suitable for digging the cylinder out after it is driven into the soil? ..... _____
5. Balances, GP5, readability 1 g (0.002 lbs) with a minimum capacity of 10 kg (22 lbs)? ..... _____
6. Drying equipment, equipment to determine the water content by D2216 (oven), D4643 (microwave), D4944 (speedy moisture), or D4959 (stove, hot plate, heat lamp, hair dryer, etc. - no open flames applied to sample)? _____

PROCEDURE

1. Fairly level ground surface obtained and all loose particles brushed from surface? ..... _____
2. Sampling performed at surface or not more than 1 m (3 ft) below surface, such as through a hole bored with an auger or dug by shovel? ..... _____
3. Depending on type of soil, the testing area can be prepared by bulldozer or other heavy equipment but testing area not deformed, compressed, torn, or otherwise disturbed? ..... _____
4. Cylinder and drive apparatus assembled with the sharpened edge on the surface to be sampled? ..... _____
5. Cylinder driven into the surface by raising the drop hammer and allowing it to fall, or alternatively by applying a uniform force via a jack or similar device? ..... _____
6. Drive rod kept steady and in the vertical position during the driving process? ..... _____
7. Cylinder driven approximately 13 mm (1/2 in.) below original surface? ..... _____
8. Care taken to prevent overdriving and if overdriving occurs or is suspected, is sample discarded? ..... _____
9. Drive head removed and shovel used to dig the cylinder from the ground, undercutting several inches below the bottom of the cylinder before lifting the cylinder out? ..... _____
10. Excess soil removed from sides of cylinder and ends trimmed flush using straightedge? ..... _____
11. Sample discarded and procedure repeated if any of the following occur:
    (a) If sample contains large rocks, roots, or other foreign material? ..... _____
    (b) If cylinder is not full or does not represent the in-situ soil? ..... _____
    (c) If the cylinder is deformed or otherwise damaged during the procedure? ..... _____
12. Mass and water content of the sample determined immediately or cylinder placed in a container to prevent lost of soil or moisture until mass and water determinations can be made? ..... _____
13. Mass of the drive cylinder and soil sample recorded to nearest 1 g (0.002 lbm)? ..... _____
14. Soil removed from drive cylinder and representative sample taken for water content sample, with the sample as large as practical but not less than 100 g (0.200 lbs) and selected to represent all material in the cylinder? ..... _____
15. Water content determined according to D2216 (oven), D4643 (microwave), D4944 (speedy moisture), or D4959 (moisture by direct heating)? ..... _____
16. Wet density, in-place dry density, and dry unit weight calculated? ..... _____

COMMENTS (D2937): (D2937)

ONE-DIMENSIONAL SWELL OR COLLAPSE OF COHESIVE SOILS (D4546)

APPARATUS Date: _____

1. Consolidometer:
   - (a) Inside diameter of ring determined to 0.025 mm (0.001 in.)? ..... _____
   - (b) Capable of exerting a pressure of either 200% of the maximum design pressure or the swell pressure, whichever is greater? ..... _____
   - (c) Consolidometer apparatus rigid? ..... _____
   - (d) Has a means of submerging the specimen, applying a vertical load, and measuring the change in height of the specimen? ..... _____

2. Calibration disk:
   - (a) Made of copper, brass, or hard steel? ..... _____
   - (b) Approximately the same height as the test specimen? ..... _____
   - (c) Diameter 1 mm (0.04 in.) [AMRL: 1 mm to 5 mm (0.04 to 0.20 in.)] smaller than the ring diameter? _____

3. Porous disks:
   - (a) Smooth ground and fine enough to prevent intrusion of soil into the pores (unless using filter paper)? _____
     Note to assessors: *it is recommended not to use filter paper due to its high compressibility.*
   - (b) Porous stones fit into ring without punching or allowing extrusion of specimen at high pressures? ..... _____
   - (c) Diameter of top disk is 0.2 to 0.5 mm (0.01 to 0.02 in.) less than the inside diameter of the ring? ..... _____
     Note to assessors: *If a floating ring is used, the bottom disk shall have the same diameter as the top disk.*
   - (d) Thick enough to prevent breakage? ..... _____
   - (e) Top disk loaded through corrosion-resistant plate of sufficient rigidity to prevent disk breakage? ..... _____
   - (f) Clean and free from cracks, chips, and non-uniformities? ..... _____

4. Trimming Equipment, trimmer or cutter with a sharp, clean edge? ..... _____

5. Deformation indicator, to measure change in specimen height, readable to 0.01 mm (0.0001 in.)? ..... _____

6. Water, as close in composition as possible to the water expected to encounter under field conditions? ..... _____

7. Oven, maintains 110 ± 5°C (230 ± 9°F)? ..... _____

8. Water content containers:
   - (a) Resistant to corrosion, disintegration, and weight change? ..... _____
   - (b) Close-fitting lids (not required for samples greater than 200 g)? ..... _____

9. Balance, capable of weighing the sample to nearest 0.1%? ..... _____

COMMENTS (D4546): (D4546)

ONE-DIMENSIONAL SWELL OR COLLAPSE OF COHESIVE SOILS (D4546)

PROCEDURE Date: _____

Method demonstrated:

1. Method A (**wetting-after-loading on multiple specimens**) – at least 4 identical specimens tested under a range of different loads, with inundation occurring after loading? ..... _____
2. Method B (**single-point wetting-after-loading on a single specimen**) – one specimen loaded to expected overburden, structural stress, or a seating load with inundation occurring after loading? ..... _____
3. Method C (**loading-after-wetting**) – Method A or B performed and following completion of the swell or collapse phase, the sample is consolidated and rebounded as in D2435 (One-Dimensional Consolidation)..... _____

Storage of samples:

1. Storage tubes made of brass, stainless steel, or are galvanized or lacquered to prevent corrosion? ..... _____
2. Stored samples thoroughly sealed to minimize stress relief and moisture loss? ..... _____
3. Samples extruded from the tube in the same direction as sampled? ..... _____

Specimen Preparation:

1. Specimens used for testing either laboratory-compacted or "intact"? ..... _____
2. Diameter at least 50 mm (2.0 in.) and height at least 20 mm (0.8 in)? ..... _____
3. Initial height recorded and is at least 6 times greater than the largest particle size in the specimen? (*h*)..... _____
4. Height and diameter do not vary by more than 5%? ..... _____
5. Specimen height and mold diameter measured to 0.025 mm (0.001 in.) using dial gauge block or similar? ..... _____
6. Initial specimen volume calculated to the nearest 0.001 cm^3 or 0.001 in^3? ..... _____
7. Laboratory compacted specimens prepared using the following procedure?..... _____
   (a) Compacted using kneading, moist-tamping, or static loads?..... _____
   (b) If the soil is compacted in multiple layers, is the surface lightly scarified in between layers?..... _____
   (c) Samples compacted to desired dry density and moisture content? ..... _____
8. If oversize particles are present in the specimen, is that information recorded on the data sheet and the report? _____
9. If the sample is remolded due to oversized particles, are the percentages and sizes of the scalped off fractions recorded and reported?..... _____

Procedure (ALL METHODS):

1. Consolidometer assembled with four or more specimens (Method A) or single specimens (Methods B and C) . _____
2. Are porous stones air-dry (and filter paper air dry, if used)? ..... _____
3. Space around specimen loosely enclosed to minimize change in specimen water content? ..... _____
   Note to assessors: *If moist paper is used around the ring, it should not contact the porous stones.*
4. Seating pressure of 1 kPa (20 psf) applied, including the weight of the top porous stone and load plate? ..... _____
5. Deformation indicator zeroed and initial reading taken? ..... _____

COMMENTS (D4546): (D4546)

ONE-DIMENSIONAL SWELL OR COLLAPSE OF COHESIVE SOILS (D4546)

PROCEDURE (Continued) Date: _____

Procedure (METHOD A or B) (**wetting-after-loading**):

1. (Method A Only) Different loads applied to each of the specimens (one may stay at the seating load)? ..... _____
2. (Method A Only) Loads selected as to encompass the range of expected loading in the field? ..... _____
3. (Method A Only) Stress built up over 5 to 10 minute intervals, with total loading time not to exceed 1 h? ..... _____
4. (Method B Only) Single specimen loaded to the desired stress? ..... _____
5. (Method B Only) If the sample is possibly disturbed, load removed and reapplied, to determine the degree of sample disturbance? ..... _____
6. Amount of compression prior to inundation recorded to 0.01 mm (0.001 in.)? (Δh_1) ..... _____
7. Specimens inundated with water? ..... _____
8. Deformation readings taken at intervals of 0.5, 1, 2, 4, 8, 15, and 30 minutes, 1, 2, 4, 8, and 24 hours until primary swell or collapse is complete and the change of height for secondary swell or collapse is small? ..... _____
   Note to assessors: *the data sheet should include time of each reading.*
9. Final amount of wetting induced swell or collapse recorded to 0.01 mm (0.001 in.)? (Δh_2) ..... _____
10. Prior to the loads being removed, is excess water removed by suction from the consolidometer? ..... _____
11. Any water clinging to the ring, top plate, and bottom of the chamber wiped off with filter paper? ..... _____
12. Specimen unloaded rapidly and any free moisture wiped off of the surfaces of the sample using filter paper? ... _____
13. Sample weighed and oven dried to determine final moisture content? ..... _____
14. Calculations performed according to the test method and results plotted? ..... _____

Procedure (METHOD C) (**loading-after-wetting**):

1. Sample loaded (as in Method A or B) to a sustained stress equal to the overburden pressure? ..... _____
2. Specimen then inundated with water? ..... _____
3. Amount of swell or collapse determined after inundation? ..... _____
4. Additional loads applied in time increments according to Methods D2435? ..... _____
5. Calculations performed according to the test method and results plotted? ..... _____

COMMENTS (D4546): (D4546)

DETERMINATION OF MOISTURE CONTENT OF SOIL BY MICROWAVE OVEN (D4643)

APPARATUS Date: _____

1. Microwave Oven, preferably with a vented chamber? _____
2. Balance, capacity of at least 2000 g and meets requirements of D4753 for a balance readable to 0.1 g? _____
3. Specimen Containers, suitable nonmetallic, nonabsorbent material resistant to thermal shock? _____
4. Container handling apparatus, glove or holder suitable for removing hot containers from oven? _____
5. (Optional) Desiccator, contains silica gel or anhydrous calcium phosphate or equivalent? _____
6. Heat Sink, suitable material/liquid placed in oven with sample (such as beaker of water or moistened brick)? _____
7. Stirring tools, spatulas, putty knives, glass rods, etc - suitable for cutting and stirring samples? _____

PROCEDURE

Specimen Selection

1. Representative sample of moist soil selected? _____
2. If moisture content determined as part of another test method:
   - (a) Specimen selection process, mass requirement, and techniques used from required test method? _____
   - (b) If minimum sample mass not specified, does the sample conform to mass requirements in Table 1? _____
   - (c) For bulk samples - sample mixed and then specimen selected according to mass req. in Table 1? _____
3. For small (jar) samples, representative sample taken according to the following:
   - (a) For cohesion-less soil, mixed thoroughly and sample mass conforms to Table 1? _____
   - (b) For cohesive soils:
     - (1) About 3 mm of material removed from the periphery and remainder sliced in half? _____
     - (2) If soil is layered, use procedure from line 1and mass conforms to Table 1? _____
     - (3) Sample broken or sliced into approximately 6 mm particles before drying? _____
4. If also performing other moisture content methods for comparison, other sample taken at the same time? _____

Specimen Conditioning

1. Specimen prepared as quickly as possible to avoid unrecorded moisture loss? _____
2. Sample broken up or cut into small size aggregations to aid in uniform drying? _____
3. Specimen stored in airtight container if not tested immediately? _____

Procedure

1. Mass of clean, dry container or dish determined? _____
2. Specimen placed in container and mass immediately recorded? _____
3. Soil and container placed in the microwave with the heat sink and oven turned on for 3 minutes? _____
   Note: *Experience with a particular soil type may necessitate longer or shorter initial drying times or adjustment of microwave power setting. This is acceptable as long as care is taken to ensure the sample is not subjected to overheating.*
4. Sample removed from oven (either of the following):
   - (a) Sample immediately weighed? _____
   - (b) Sample immediately placed in desiccator to cool before weighing? _____
5. Soil mixed and stirred with spatula, knife, or glass rod; with care taken not to lose any sample? _____
6. Soil and container placed back in microwave oven and power turned on for an additional 1 minute? _____
7. Steps 4 through 6 repeated until change in mass is less than 0.1 %? _____
8. Moisture content calculated using appropriate formula? _____
9. Final mass observed used for determining moisture content? _____
10. Sample that was dried in microwave NOT used for further testing? _____

COMMENTS (D4643): (D4643)

SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS (SDI) (D4644)

APPARATUS Date: _____

1. Slake Durability Device:
   - (a) Drum is 2.00 mm (No. 10) square-mesh? ..... _____
     - (1) Diameter of 140 mm (5.5 in) and 100 mm (3.9 in) long? ..... _____
     - (2) Ends are rigid plates, with one end removable? ..... _____
   - (b) Trough supports drum horizontally, and allows drum to rotate freely? ..... _____
   - (c) Motor capable of 20 rpm, constant to ± 5% for 10 min.? ..... _____
2. Oven, maintains 110 ± 5°C (230 ± 9°F)? ..... _____
3. Balance, sensitive to 1 g (G5/GP5), minimum 2000 g capacity? ..... _____
4. Miscellaneous: brush and hammer? ..... _____
5. Distilled water, for filling the trough? ..... _____

PROCEDURE

Sample Preparation:

1. Sample collected and stored so that natural moisture content is retained? ..... _____
2. 10 representative samples, each 40 to 60 g? ..... _____
   - (a) Each sample consists of intact, roughly equidimensional shale fragments? ..... _____
     ***Note*:** *Fragments can be naturally occurring or produced by breaking with a hammer; and can be from rock cores or test pits.*
   - (b) Sharp corners broken off and dust removed with a brush? ..... _____
3. Total test specimen is 450 to 550 g? ..... _____

Procedure:

5. Specimen photographed before placing in drum? ..... _____
6. Water content of each sample determined according to D2216, while in the drum to be used for testing? ..... _____
7. Drum mounted in the trough and coupled to the motor? ..... _____
8. Trough filled with distilled water at room temperature to 20 mm (0.8 in) below drum axis? ..... _____
9. Water temperature recorded at the beginning of the run? ..... _____
10. Drum rotated at 20 rpm for 10 minutes [AMRL Guidance: ± 30 seconds]? ..... _____

RPM Check:

Time Observed (seconds):_____ No. Revolutions:_____ Average RPM:_____ (60 x rev/time in seconds) ..... _____

11. Drum removed from the trough immediately after rotation is complete? ..... _____
12. Specimen and drum dried to constant mass at 110 ± 5°C (230 ± 9°F), using same oven as step 2? ..... _____
13. Water temperature recorded at the end of each run? ..... _____
14. Steps 3 through 9 repeated for a second cycle? ..... _____
15. Specimen photographed, or standard description (Type I, II, or III) recorded? ..... _____
    ***Note*:** *Type I – specimen unchanged, Type II – large and small fragments, Type III – specimen is only small fragments.*

16. Calculation: Slake durability index = $\frac{\text{mass of drum \& final dry sample – mass of the drum}}{\text{mass of drum \& initial dry sample – mass of the drum}} \times 100$ ..... _____

17. Slake durability index reported to the nearest 0.1%? ..... _____
18. Report includes the following: specimen description, where the sample was obtained, range and average value of the water temperature, natural water content, and a description of the fragments retained in the drum? ..... _____

COMMENTS (D4644): (D4644)

EXPANSION INDEX OF SOILS **(D4829)**

APPARATUS Date: _____

1. Molds:

	1	2	3	4
Cylindrical in shape and made of metal with detachable collar?				
Inscribed with a mark 50.8 mm (2.00 in.) above the base?				
Designed to retain a removable stainless steel ring?				
Internal diameter of 101.9 ± 0.1 mm (4.010 ± 0.005 in.)?				

2. Stainless Steel Ring:

	1	2	3	4
Height of 25.4 mm (1 in.)?				
Internal diameter of 101.9 mm (4.01 in.) **[AMRL: 101.9 ± 0.1 mm (4.01 in ± 0.005 in.)]** and ring fits inside mold?				
Wall thickness not less than 3.10 mm (0.120 in.)?				

3. Rammer
   (a) Diameter of 50.8 mm (2.00 in.) **[AMRL: 50.8 ± 0.13 mm (2.00 ± 0.005 in.)]**? ..... _____
   (b) Mass of 2.5 kg (5.5 lbm) **[AMRL: 2.495 ± 0.023 kg (5.50 ± 0.02 lbm)]**? ..... _____
   (c) Drop height of 304.8 ± 1.3 mm (12 ± 0.05 in.)? ..... _____
4. Balance, Class GP2, capacity at least 1000 g? ..... _____
5. Oven, maintains 110 ± 5°C (230 ± 9°F)? ..... _____
6. Straightedge, at least 150 mm (6 in.) in length with one beveled edge? ..... _____
7. Sieve: 4.75 mm (No. 4)? ..... _____
8. Mixing tools, pans, spoons, trowels, etc.? ..... _____
9. Loading device, consolidometer or equivalent (similar to D2435), for supporting and submerging specimen, applying a vertical load, and measuring the change in height? ..... _____
10. Porous disks? ..... _____
    (a) Disks are air dry? ..... _____
    (b) 12.7 ± 0.13 mm (0.50 ± 0.005 in.) in height? ..... _____
    (c) 101.5 ± 0.13 mm (3.995 ± 0.005 in.) in diameter? ..... _____
11. Compaction Foundation, such as a cube of concrete, mass not less than 90 kg (200 lbs)? ..... _____
12. Dial indicator, resolution of 0.03 mm (0.001 in.)? ..... _____

PROCEDURE

Sample Preparation

1. Sample is air dried below 60°C (140°F) until friable? ..... _____
2. Aggregations broken up without reducing natural particle size? ..... _____
3. Sieved on the 4.75-mm (No. 4) sieve? ..... _____
4. Percent retained on the sieve recorded and coarser material discarded? ..... _____
5. 1-kg representative sample selected? ..... _____
6. Sample mixed with distilled water to bring to a water content that has a degree of saturation of 50 ± 2 % in the compacted condition (see calculation in #11, Specimen Compaction)? ..... _____
7. Sample of at least 100-g selected for determination of water content? ..... _____
   (a) Sample weighed and immediately dried in an oven at 110 ± 5°C (230 ± 9°F)? ..... _____
   (b) Sample dried at least 12 hours or to constant mass as per ASTM D2216? ..... _____
   (c) Water content determined to 0.1% or better? ..... _____
8. Remainder of sample sealed in an airtight container for 16 hours? ..... _____

COMMENTS (D4829): (D4829)

EXPANSION INDEX OF SOILS **(D4829)**

PROCEDURE (Continued) Date: _____

Specimen Compaction

1. Steel ring placed inside compaction mold? ..... _____
2. Sample compacted in mold in two equal layers to give a total compacted depth of 50.8 mm (2 in.)? ..... _____
3. Mold is resting on a uniform, rigid foundation such as a cube of concrete at least 90 kg (200 lb) in mass? ..... _____
4. Each layer compacted by 15 uniformly distributed blows of the rammer? ..... _____
5. First compacted layer scarified with a knife or other suitable object? ..... _____
6. Upper and lower portions of the mold removed from the inner ring? ..... _____
7. Specimen trimmed flush with top and bottom of the ring using straightedge? ..... _____
8. Initial height determined to 0.03 mm (0.001 in.) or assumed equal to height of the ring (H_1)? ..... _____
9. Dry unit weight determined to 0.1 kN/m^3 (0.1 lbf/ft^3) or better (γ_d)? ..... _____
10. Specific gravity of 2.7 used unless it is known to be less than 2.6 or more than 2.8 (G_S)? ..... _____
11. Degree of saturation, *S*, calculated to be within 50 ± 2% by the following? ..... _____

$$S = \frac{wG_S\gamma_d}{G_S\gamma_w - \gamma_d}$$

S = degree of saturation, %
w = moisture content, %
G_s = specific gravity, 2.7 used unless specific gravity is known to be <2.6 or >2.8
γ_w = unit weight of water at 20°C (68°F), 9.97 kN/m^3 (62.3 lbf/ft^3).
γ_d = dry unit weight of compacted soil specimen, kN/m^3 (62.3 lbf/ft^3)

12. If degree of saturation is not 50 ± 2%, water content of soil adjusted and another specimen compacted? ..... _____

Testing

1. Compacted specimen placed in consolidometer ring (or equivalent)? ..... _____
2. Air-dried porous disks placed at top and bottom ends? ..... _____
3. Specimen subjected to total pressure of 6.9 kPa (1 psi), including the weight of the upper disk? ..... _____

A = Mass of loading weight, g _____ B = Mass of top porous disk, air dry, g _____

C = Total mass on specimen, g (A +B) _____ D = Total mass in lbs (C/454) _____

E = Specimen diameter, in. _____ F = Specimen Area, in^2 (π[0.5E]^2) _____

G = Total pressure on specimen, psi (D/F) _____

4. Specimen compressed with this pressure for 10 min.? ..... _____
5. After 10 min, initial reading (D_1) on dial indicator determined to 0.03 mm (0.001 in.) or better? ..... _____
6. Specimen inundated with distilled water? ..... _____
7. Dial indicator readings taken in accordance with ASTM D2435 for 24 h or until rate of expansion becomes less than 0.005 mm/h (0.0002 in./h) (readings should be taken for at least 3 h)? ..... _____
8. Specimen removed and final dial reading (D_2) determined? ..... _____
9. Mass determined to nearest 0.1 g? ..... _____
10. Expansion index, *EI*, calculated and reported to nearest whole number (H_1= height of sample before test)? ..... _____

$$EI = \frac{D_2 - D_1}{H_1} \times 1000$$

11. If initial height is greater than final height, *EI* reported as zero? ..... _____

COMMENTS (D4829): (D4829)

SHRINKAGE FACTORS OF SOILS BY THE WAX METHOD (D4943)

APPARATUS Date: _____

1. Sample Preparation Equipment:
- (a) Mortar and pestle, iron or porcelain mortar with rubber tipped pestle? _____
- (b) Spatula or pill knife, blade approximately 100 mm long and 20 mm wide? _____
- (c) No. 40 sieve, conforming to the requirements of ASTM E11? _____
- (d) Distilled water? _____
- (e) Liquid limit device and grooving tool, conforming to the requirements of D4318? _____

2. Calibration and Wax Density measurement equipment:
- (a) Glass or clear plastic plate, sufficient in size to calibrate the shrinkage dish (approx. 80 by 80 mm)? _____
- (b) Thin plastic tube, approximately 5 cm in diam., 4 cm long, with a removable cap or plug to block one end of the tube? _____
- (c) Calipers, readable to 0.01 mm? _____

3. Optional Equipment:
- (a) Suspension apparatus (optional), suitable for suspending the specimen in water? _____
- (b) Humidity enclosure (optional), capable of holding the sample and a small container of water? _____
- (c) Thermometer (optional), readable to 0.5°C? _____

4. Class GP1 balance, minimum capacity of 500 g? _____

5. Shrinkage dish, porcelain or monel metal (milk dish), approx. 40 to 45 mm diameter and 12 to 15 mm deep? _____

6. Oven, maintains 110 ± 5°C, preferably forced-draft type? _____

7. Straightedge, with beveled edge if thicker than 3 mm? _____

8. Wax (***Note to assessors:*** *Pure paraffin wax is not acceptable due to shrinkage on solidification.*):
- (a) Microcrystalline or other suitable wax that does not become brittle or shrink during solidification? _____
- **or** (b) A 50/50 mixture of petroleum jelly and paraffin wax? _____

9. Fine thread, capable of holding the specimen during wax dipping? _____

10. Water bath, sufficient size to submerge the soil pat during mass determination? _____

11. Wax warmer, temperature sufficiently controlled to prevent overheating? _____
Note to assessors: *Open flames are not recommended due to the potential for overheating.*

12. Petroleum based lubricant or grease? _____

CALIBRATION PROCEDURE

Calibration of Shrinkage Dish:
1. Each shrinkage dish in use permanently identified? _____
2. Dish, glass plate, lubricant, and water at room temperature? _____
3. Inside of the shrinkage dish and surface of the glass plate lightly greased and mass determined? (m_2) _____
4. Greased dish filled to overflowing with water and excess water removed by pressing the greased plate on top? _____
5. No air bubbles trapped under the glass plate and mass of filled dish and glass plate determined? (m_1) _____
6. Apparatus cleaned and steps 3 through 5 repeated? _____
7. If the difference of the trials is not less than 0.03 cm^3, is the procedure repeated until two trials show a difference of less than 0.03 cm^3? _____
8. Average of these two trials taken as the volume of the dish? {*Volume = ($m_1 - m_2$) / density of water at temp.*} _____

COMMENTS (D4943): (D4943)

SHRINKAGE FACTORS OF SOILS BY THE WAX METHOD (D4943)

CALIBRATION PROCEDURE (Continued) Date: _____

Measurement of Wax Density:

1. Specific gravity of the wax checked initially to two significant figures by either:
   - (a) Being provided by the manufacturer? ..... _____
   - **or** (b) Determined according to Step 2 procedure below? ..... _____
2. Specific gravity checked periodically thereafter [*AMRL: approx. 1 / year*] using the following procedure? ..... _____
   - (a) Inside of the plastic tube lightly greased? ..... _____
   - (b) Liquid wax poured into the tube and allowed to cool until solid? ..... _____
   - (c) Wax cylinder extruded from the tube and straight edge used to square both ends of the cylinder? ..... _____
   - (d) Mass of the wax cylinder determined? ..... _____
   - (e) Height (*h*) and diameter (*d*) of the cylinder determined in at least four locations each and averaged? .. _____
   - (f) Volume of the wax cylinder calculated? {*Volume of wax cylinder* $= \pi * d_{average}^{2} * h_{average} / 4$} ..... _____
   - (g) Density of the wax cylinder calculated? {*Density of wax = mass of cylinder / volume of cylinder*} ..... _____

   Note to Assessors: *Other methods of determining the wax density may be satisfactory.*

PROCEDURE

Specimen Preparation:

1. Apparatus, environment, and water bath maintained at approximately the same temperature (± 5°C) throughout calibration and testing? ..... _____
2. Sample prepared to a 10-blow consistency according to D4318 (150-200 g, passing the No. 40 sieve)? ..... _____
3. Volume of shrinkage dish known? (*V*) ..... _____
4. Inside of the shrinkage dish lightly greased and mass determined? (*M*) ..... _____
5. Enough wetted material placed in the dish to fill approximately one-thirds full? ..... _____
6. Soil compacted in dish by tapping against a firm, cushioned surface? ..... _____
7. Steps 5 and 6 repeated twice more, tapping until all included air is removed from the soil pat? ..... _____
8. Excess soil present above the rim of the dish and then struck off using a straightedge? ..... _____
9. Outside of the dish wiped of any excess soil and mass of dish determined immediately? (*Mw*) ..... _____
10. Soil pat allowed to dry in air until the color of the pat turns from dark to light? ..... _____
11. If cracking occurs, is the rate of moisture loss slowed by drying the pat in a humidity controlled enclosure? ..... _____

Testing:

1. Soil pat oven dried to constant mass at 110 ± 5°C and mass (including dish) determined? (*Md*) ..... _____
2. Soil pat securely tied using fine thread? ..... _____
3. Pat dipped in molten wax with the thread, using a continuous motion, taking no more than a few seconds? ..... _____
4. Soil pat completely coated and not allowed to stay immersed for more than a few seconds? ..... _____
5. If air bubbles are present, are they cut out and refilled? ..... _____
6. Dipping process repeated two or three times to create a smooth coating? ..... _____
7. Coated pat allowed to cool to room temperature and mass of coated pat in air recorded? (*Msxa*) ..... _____
8. Mass of water displaced by soil and wax determined by either:
   - (a) Hanging the soil pat from a balance into a water bath to determine immersed weight? (*Msxw*) ..... _____
   - **or** (b) Hanging the soil pat into a water bath placed on a balance while suspended separately to determine the mass of displaced water? (*Mwsx*) ..... _____

   Note to Assessors: *Other methods of determining the mass of water displaced may be acceptable.*
9. Apparatus, environment, and water bath maintained at approximately the same temperature (± 5°C) throughout calibration and testing? ..... _____
10. Calculations performed according to the method? ..... _____

COMMENTS (D4943): (D4943)

pH OF SOILS **(D4972)**

APPARATUS Date: _____

All Methods:

1. No. 10 (2 mm) sieve? ..... _____
2. Distilled water (prepared by distillation, ion exchange, reverse osmosis, or a combination thereof)? ..... _____

3. Calcium chloride stock solution (1.0 M)? ..... _____
   Note: *Stock solution may be purchased pre-mixed, or can be made from powder using the following method.*
   (a) 147 g of $CaCl_2*2H_2O$ dissolved in a small amount of distilled water in a 1 L volumetric flask? ..... _____
   (b) Solution allowed to cool and diluted to 1 L volume with distilled water? ..... _____
4. Calcium chloride solution (0.01 M):
   (a) 20.0 mL of $CaCl_2$ (1.0 M) stock solution from above diluted to 2 L with water, pH 5 to 7? ..... _____

5. One of the following sets of solutions:
   (a) Pre-mixed buffer solutions, as specified by the manufacturer for calibrating the pH testing device? .... _____
   Note: *Preferably three buffered solutions at pH 4, 7, and 10, respectively. The solutions shall meet the chemical requirements listed in the method (see below) and shall not be expired. Write a note if the laboratory cannot verify the pH testing device in accordance with the manufacturer's instructions.*

   or (b) Chemicals for mixing buffer solutions, as follows (all chemicals shall be reagent grade):
   Note to assessors: *If the laboratory-made solutions are pre-mixed, verify the mixing procedure and verify the concentration of the solutions. For purchased solutions, check the concentrations listed on the label.*
   (1) Acid potassium phthalate buffer solution (0.05 M)? ..... _____
      1. Potassium phthalate powder dried 1 hour at 105 ± 5°C? ..... _____
      2. 10.21 g of potassium phthalate dissolved is distilled water and then diluted to 1 L?. _____
      3. Shall maintain a pH of 4.0 from to 5 to 37°C? ..... _____
      4. Solution protected from evaporation and contamination from mold? ..... _____
      5. Solution discarded when mold is present? ..... _____
   (2) Phosphate buffer solution (0.025 M)? ..... _____
      1. KH_2PO_4 and KH_2HPO_4 salts dried in an oven for 2 hours at 130°C? ..... _____
      2. 3.40 g of KH_2PO_4 and 3.55 g of KH_2HPO_4 dissolved in water and diluted to 1 L? ... _____
      3. pH of solution 6.9 at 20°C? ..... _____
   (3) Carbonate Buffer Solution (0.025 M)? ..... ★_____
      1. 2.10 g of $NaHCO_3$ and 2.65 g of Na_2CO_3 dissolved in water and diluted to 1 L, salts dried 2 hours at 130°C before use, pH is 10.1 at 20°C? ..... ★_____

6. One of the following:
   Note: *The pH paper is less accurate and shall only be used for a rough estimate of the soil pH.*
   (a) Method A (Method A shall be used unless the pH paper method is specifically requested):
      (1) pH meter, potentiometer equipped with an electrode system? ..... ★_____
      or (2) pH meter, a silver/silver chloride electrode system? ..... _____
   (b) Method B
      (1) pH paper, sensitive to a pH range from 1 to 12, resolution 0.2 pH units? ..... _____

CALIBRATION OF pH METER (METHOD A)

1. pH meter calibrated using the buffer solutions listed above or using other NIST-traceable purchased solutions with values that bracket the expect pH value of the sample (one-point calibration NOT acceptable)? ..... ★_____
   pH meter properly adjusted (based on these readings) according to manufacturer's instructions? ..... _____

COMMENTS (D4972): (D4972)

pH OF SOILS **(D4972)**

PROCEDURE Date: _____

Preparation:

1. Soil air dried [AMRL: at less than 140°F]? ..... _____
2. Soil sieve through a No. 10 (2 mm) sieve to remove coarse fraction? ..... _____

pH in Distilled Water:

1. Approximately 10 g of air dried soil weighed out? ..... _____
2. Soil placed in a glass container and approximately 10 mL of distilled water added? ..... _____
   Note: *If 10 g of soil and 10 mL of water is insufficient to fully submerge the pH electrode, a larger sample such as 40 g of soil and 40 mL of water is permitted.* ★
   Note to assessors: *Many state methods specify a larger sample size. This is acceptable if the proportion of soil to water is maintained at approximately 1 to 1.*
3. Mixed thoroughly and allowed to stand for 1 hour? ..... _____
4. pH read using pH meter (or pH paper if Method B is specified)? ..... _____

and

pH in Calcium Chloride Solution (0.01M):

1. Approximately 10 g of air dried soil weight out? ..... _____
2. Soil placed in a glass container and approximately 10 mL of $CaCl_2$ (0.01 M) added? ..... _____
3. Mixed thoroughly and allowed to stand for 1 hour? ..... _____
4. Mixture at approximately room temperature (15 to 25°C) prior to determining pH? ..... _____
5. pH read using pH meter (or pH paper if Method B is specified)? ..... _____

Note to Assessors: *Both methods (pH in Distilled Water and pH in Calcium Chloride) must be presented. Both methods are necessary in order to fully define a soil's pH.*

Report:

1. pH reported to the first decimal place? ..... _____
2. Are measurements made in distilled water versus calcium chloride solution noted on report? ..... _____
3. When Method B is used to determine pH, is it noted on the report? ..... _____
4. If size fractions greater than the No. 10 (2 mm) sieve are used, are they listed on the report? ..... _____

COMMENTS (D4972): (D4972)

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS (D5084)
USING A FLEXIBLE WALL PERMEAMETER

APPARATUS Date: _____

1. Hydraulic system, designed to facilitate rapid and complete removal of free air bubbles from flow lines, conforms to one of the following designs (see table)? ..... _____

Method	Requirements (one of the following):
A	**Constant Head**
(a)	Capable of maintaining and measuring constant hydraulic pressures to ±5% or better? ..... _____
(b)	Head loss across permeameter held constant and measured to ±5% or better? ..... _____
(c)	Pressures measured to a minimum of three significant digits (last digit may be estimated)? ..... _____
B & C	**Falling Head**
(a)	Allows for measurement of applied head loss (hydraulic gradient) to ±5% or better? ..... _____
(b)	Head loss measured to a minimum of three significant digits (last digit may be estimated)? ..... _____
D	**Constant Rate of Flow**
(a)	Capable of maintaining and measuring (by syringe, pipette, etc.) constant rate of flow through specimen to ±5% or better? ..... _____
(b)	Head loss across permeameter measured to ±5% or better and to a minimum of three significant digits (last digit may be estimated)? ..... _____
E	**Constant Volume - Constant Head by Mercury**
(a)	Capable of maintaining constant head loss across permeameter to ±5% or better? ..... _____
(b)	Allows for measurement of applied head loss to ±5% or better at any time? ..... _____
(c)	Head loss measured to a minimum of three significant digits (last digit may be estimated)? ..... _____
F	**Constant Volume - Falling Head by Mercury**
(a)	Allows for measurement of applied head loss (hydraulic gradient) to ±5% or better? ..... _____
(b)	Head loss measured to a minimum of three significant digits (last digit may be estimated)? ..... _____

2. Back pressure system (to facilitate specimen saturation), capable of maintaining applied back pressure throughout duration of test and controlling and measuring back pressure to ±5% or better of applied pressure? ..... _____

3. Flow measurement system, rigid tubing or glass used throughout system, quantity of flow measured over interval of time to ±5% or better? (***Note:*** *Flow measurement system not necessary if lack of leakage, continuity of flow, and cessation of consolidation or swelling can be verified by other means.)* ..... _____

4. Permeameter cell pressure system:
   (a) Capable of applying and controlling cell pressure to ±5% or better of applied pressure? ..... _____
   (b) Effective stress on specimen (difference between cell pressure and pore water pressure) maintained to desired value with accuracy of ±10% or better? ..... _____

5. Permeameter cell:
   (a) If deformations are measured, deformation indicator graduated to 0.5 mm (0.01 in.) or better? ..... _____
   (b) Four drainage lines leading to specimen (two each to base and top cap) used to facilitate gas removal (recommended), controlled by no-volume-change valves? ..... _____

6. Top cap and base, impermeable and rigid:
   (a) Diameter or width of cap and base equal to specimen diameter or width to ±5% or better? ..... _____
   (b) Base prevents leakage, lateral motion, and tilting? ..... _____
   (c) Cap designed to receive piston or extensometer (if used) so piston-to-top cap contact area is concentric with cap? ..... _____
   (d) Surfaces of cap and base that contact membrane to form a seal are smooth and free of scratches? ..... _____

COMMENTS (D5084): (D5084)

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS (D5084)
USING A FLEXIBLE WALL PERMEAMETER

APPARATUS (Continued) Date: _____

7. Porous end pieces:
   (a) Made of silicon carbide, aluminum oxide or other material not attacked by specimen/permeant liquid?_____
   (b) Plane and smooth surfaces, free of cracks, chips, and discontinuities? ..... _____
   (c) Checked regularly to determine whether they have become clogged? ..... _____
   (d) Same diameter or width (±5% or better) as specimen, and sufficiently thick to prevent breaking? ..... _____
   (e) Hydraulic conductivity significantly greater than specimen? ..... _____

8. Filter paper (optional), to be placed between top and bottom porous end pieces and specimen? ..... _____
9. Sample extruder (usually required for testing cores), extrudes the sample in the same direction of travel in which the sample entered the tube with minimum disturbance of the sample? ..... _____
   Note to assessor: *write finding if a sample extruder is not available during testing.*
10. Flexible membranes, checked for flaws or pinholes prior to use, with an unstretched diameter between 90-95% of specimen diameter?..... _____
11. Rubber O-rings (optional), unstressed inside diameter or width less than 90% of cap and base diameter? ..... _____
12. Specimen mounting equipment, such as membrane stretcher and (optional) ring for expanding O-rings? ..... _____
13. Specimen compaction equipment and trimming equipment, suitable for compaction method specified?..... _____
14. Sample extruder (for intact samples), capable of extruding soil from sampling tube at a uniform rate, in same direction of travel in which sample entered tube, with minimum sample disturbance?..... _____
15. Specimen dimension measuring device, can measure to 0.5 mm (0.01 in.) or better, without disturbing sample?_____
16. Vacuum pump, for de-airing permeant liquid (water) and specimen saturation? ..... _____

17. Balances:
   (a) For specimens less than 100 g, readable to 0.01 g? ..... _____
   (b) For specimens 100 to 999 g, readable to 0.1 g?..... _____
   (c) For specimens 1000 g or over, readable to 1.0 g?..... _____

18. Temperature maintaining device
   (a) Maintains temperature within ±3°C (±6°F) or better? ..... _____
   (b) Test performed in temperature range between 15 and 30°C (59 and 86°F) or calculations adjusted for temperature and change in specific gravity of mercury & R_s?..... _____
   (c) Constant temp. room? ____ Water bath? ____ Insulated chamber? ____ Other?_____

19. Drying oven and water content containers, in accordance with D2216? ..... _____
20. Time measuring device, clock with a second hand or a stopwatch (or equivalent)?..... _____
21. Temperature measuring device, capable of measuring the test temperature to the nearest 0.1°C (or, if the number of significant digits in the calculation of hydraulic conductivity can be one, such as a final result of 10^{-8}, the test temperature can be measured to the nearest 1°C) (Section 9.5.2.2 D5084-10)? ..... _____

PROCEDURE

Undisturbed Specimens
1. Voids from pebble removal or crumbling that result in height or diameter variation of more than ±5% filled with remolded material from trimmings? ..... _____
2. Specimen trimmed in environment where water content change is minimized, and ends cut (not troweled)? ..... _____

Laboratory-Compacted Specimens
1. Prepared and compacted in mold as specified and compaction method noted in report? ..... _____
2. If placed and compacted in layers, surface of each layer scarified (unless requestor states otherwise)? ..... _____
3. Large clods of material not broken down prior to compaction, unless they will be broken in field construction? _____
4. Hard clods and individual particles do not exceed 1/6 of either specimen height or diameter?..... _____
5. After compaction, specimen removed from mold and ends scarified? ..... _____
   Note: *Other preparation methods are permitted if requested, but preparation method must be identified in report.*

COMMENTS (D5084): (D5084)

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS (D5084)
USING A FLEXIBLE WALL PERMEAMETER

PROCEDURE (Continued) Date: _____

Method demonstrated for assessment: ____

Method A - Constant Head
Method B - Falling-Head with Constant Tailwater Level
Method C - Falling-Head with Increasing Tailwater Level
Method D - Constant Rate of Flow
Method E - Constant Volume-Constant Head (by mercury)
Method F - Constant Volume-Falling Head (by mercury)

Specimen Size and Preparation

1. Minimum height and diameter of 25 mm (1.0 in.), measured to three significant digits or better? ..... _____
2. Height and diameter do not vary by more than ±5% (or for soil-cements no more than ±10%)? ..... _____
3. For uneven specimens, surface indentations not so deep that height and diameter vary by more than ±5%? ..... _____
4. Height and diameter at least 6 times greater than largest particle size in specimen? ..... _____
5. Specimen mass recorded to required tolerance based on specimen mass (see balances)? ..... _____
6. Water content of trimmings determined according to D2216, to nearest 0.1% or better? ..... _____
7. Specimen mounted immediately in permeameter? ..... _____
8. Dry unit weight calculated and initial degree of saturation estimated? ..... _____

Specimen Setup

1. Porous end pieces and filter paper (if used) soaked in permeant water? ..... _____
2. Membrane expanded and thin coat of silicon high-vacuum grease applied to sides of end cap? ..... _____
3. Porous end piece placed on base and one filter paper (if used) placed on end piece, followed by specimen? ..... _____
4. Second filter paper (if used) placed on specimen followed by second end piece and top cap? ..... _____
5. Membrane placed around specimen? ..... _____
6. Using membrane expander (or other O-ring expander), O-rings placed to seal membrane to base and top cap? _____
7. Flow tubing attached to top cap (if not already attached), permeameter cell assembled and filled with de-aired water or other cell fluid? ..... _____
8. Cell pressure reservoir attached to perm. cell line and hydraulic system attached to influent / effluent lines? ..... _____
9. Reservoir filled with de-aired water (or other liquid) and hydraulic system filled with deaired permeant water? _____
10. Small confining pressure of 7 to 35 kPa (1 to 5 psi) applied to cell, and pressure less than confining pressure applied to influent and effluent systems? ..... _____
11. Permeant water flushed through flow system? ..... _____
12. Control valves closed after all visible air removed from flow lines? ..... _____
13. During saturation of system and specimen or hydraulic conductivity measurements, maximum applied effective stress does not exceed that to which specimen is to be consolidated? ..... _____

Specimen Soaking (optional)

1. To aid in saturation, specimen soaked under partial vacuum applied to top of specimen? ..... _____
2. Water under atmospheric pressure applied to specimen base through influent lines? ..... _____
3. Magnitude of vacuum set to generate hydraulic gradient across sample less than what will be used during hydraulic conductivity measurements? ..... _____

COMMENTS (D5084): (D5084)

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS (D5084)
USING A FLEXIBLE WALL PERMEAMETER

PROCEDURE (Continued) Date: _____

Back Pressure Saturation (usually necessary)

1. Change in specimen volume minimized during saturation? _____
2. If monitored, initial specimen height recorded? _____
3. Flow line valves opened and any free air bubbles flushed out of system? _____
4. If electronic pressure transducer or other measuring device is used to measure pore pressures or applied hydraulic gradient, device bled of any trapped air? _____
5. Applied confining pressure adjusted to value to be used during sample saturation? _____
6. Back pressure applied by simultaneously increasing cell pressure and influent and effluent pressures in increments? _____
7. Effective confining stress is not < 7kPa (1 psi) at any time while head is applied? _____
8. Each pressure increment maintained for a few minutes to a few hours, depending on specimen characteristics? _____
   Note: *To assist in removal of entrapped air, a small hydraulic gradient may be applied across specimen to induce flow.*

9. Saturation verified by one of the following techniques:
   (a) "B" coefficient measured as in D4767, specimen considered adequately saturated if "B" value ≥ 0.95 or, for relatively incompressible materials, "B" value remains unchanged with application of larger values of back pressure ("B" value measured prior to or after completion of consolidation phase)? _____
   (b) Final degree of saturation calculated at completion of test, shall be 100±5%? _____
   (c) Other means, such as observing flow of water into specimen when back pressure is increased, provided data are available for similar materials to establish that the procedure used confirms saturation as required in (a) or (b) above? _____

Consolidation

1. Consolidation accomplished in stages, with increase in cell pressure minus back pressure (effective stress) in each new stage equal to or less than effective stress in previous stage (i.e., consolidation increment ratio of one or less)? _____
2. Specimen height recorded, if monitored, prior to application of consolidation pressure and periodically during consolidation? _____
3. Cell pressure increased to level necessary to develop desired effective stress, and consolidation begun? _____
   Note: *Drainage may be allowed from base or top of specimen, or simultaneously from both ends.*
4. (Optional) Outflow volumes recorded, or change in specimen height measured, to confirm primary consolidation was completed prior to starting hydraulic conductivity test? _____

Permeation

1. When possible, hydraulic gradient used for hydraulic conductivity measurements similar to that expected to occur in field (from < 1 to 5 cover most field conditions)? _____
2. Influent pressure increased to start permeation? _____
3. Effluent (tailwater) pressure NOT decreased (air bubbles may come out of solution if pressure is decreased)? _____
4. Back pressure maintained throughout permeation phase? _____
5. Maximum increase in headwater does not exceed 95% of the effective consolidation stress? _____
6. Test temperature read and recorded to nearest 0.1°C at start and end of each permeation trial? _____
   Note: *If number of significant digits in calculation of hydraulic conductivity at 20 ℃ can be one, test temperature can be measured to nearest 1 ℃.*
7. Time measured and recorded at the start and end of each permeation trial to 2 significant digits? _____

COMMENTS (D5084): (D5084)

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS (D5084)
USING A FLEXIBLE WALL PERMEAMETER

PROCEDURE (Continued) Date: _____

Permeation (continued)

Methods A and E (Constant Head)

1. Required head loss across specimen measured and recorded to required tolerances? ..... _____
2. Head loss across specimen kept constant to ±5% or better? ..... _____
3. Quantity of inflow (influent) and outflow (effluent) measured and recorded periodically to a minimum of three significant digits (last digit may be estimated)? ..... _____

Methods B, C, and F (Falling Head)

1. Required head loss across specimen measured and recorded to required tolerances at start and end of each permeation trial (as a minimum)? ..... _____
2. Applied head loss across specimen is at no time less than 75% of initial (maximum) head loss during each individual hydraulic conductivity determination? ..... _____
3. Methods B and C only - Volumes of outflow and inflow measured and recorded to three significant digits (last digit may be estimated) at start and end of each permeation trial (as a minimum)? ..... _____

Method D (Constant Rate of Flow)

1. Constant flow rate used to start specimen permeation? ..... _____
2. Flow rate chosen so hydraulic gradient does not exceed specified value? ..... _____
3. Rate of inflow, rate of outflow and head loss across specimen periodically measured to required tolerances? ... _____

Methods A, B, C, and D:

1. Any changes in specimen height, if monitored, recorded? ..... _____
2. Permeation continued until at least four values of conductivity are obtained over a time interval in which:
   (a) Ratio of outflow to inflow rate* is between 0.75 and 1.25? ..... _____
   (b) Hydraulic conductivity is steady (four or more consecutive hydraulic conductivity determinations fall with ±25% or better of mean value for $k \geq 1 \times 10^{-10}$ m/s or within ±50% for $k < 1 \times 10^{-10}$ m/s, and a plot of hydraulic conductivity vs. time shows no significant upward or downward trend)? ..... _____

* Method D only - Ratio of INflow to OUTflow rate

Methods E and F:

1. Any changes in specimen height, if monitored, recorded? ..... _____
2. Permeation continued until at least two or more values of hydraulic conductivity determinations fall within ±15% or better of mean value for $k \geq 1 \times 10^{-10}$ m/s or within ±50% or better for $k < 1 \times 10^{-10}$ m/s? ..... _____

Final Specimen Dimensions

1. Applied confining, influent and effluent pressures reduced so that significant specimen volume change is not generated? ..... _____
2. Permeameter cell carefully disassembled and specimen removed? ..... _____
3. Final height, diameter and total mass of specimen recorded according to required tolerances? ..... _____
4. Final specimen water content determined according to D2216? ..... _____
5. Calculations performed according to book equations specific to method used? ..... _____
6. Hydraulic conductivity based on water at 20°C (multiply by "k")? ..... _____

COMMENTS (D5084): (D5084)

POINT LOAD STRENGTH INDEX OF ROCK (D5731)

APPARATUS Date: _____

1. Point Load Tester (Fig. 1):
   - (a) Loading System:
     - (1) Loading frame has suitable platen-to-platen clearance to allow specimen of required size range (typically between 30 to 100 mm)? ..... _____
     - (2) Adjustable distance to accommodate both small and large specimens? ..... _____
     - (3) Capacity sufficient to break largest and strongest specimens? ..... _____
     - (4) Load frame does not permanently distort during repeated applications of max. test load? ..... _____
     - (5) No non-rigid component or spherical seat in the loading system? ..... _____
     - (6) Truncated, conical platens (Fig. 2) of hard material (Rockwell 58 HRC)? ..... _____
   - (b) Load Measuring System:
     - (1) Either a load cell or a hydraulic pressure gauge and includes a peak load indicator? ..... _____
     - (2) Measurements precise to ±5% or better of the full scale of the device? ..... _____
     - (3) (Optional) System may have interchangeable gauges and load measuring devices for use with different rock strengths and to achieve different degrees of accuracy? ..... _____
   - (c) Means for measuring distance between platen contact points:
     - (1) Either an electronic or Vernier direct reading scale that includes a zero adjustment? ..... _____
     - (2) Accurate to ±2% or better of the total distance between contact points? ..... _____
     - (3) Allows a check of the "zero displacement" value when platens are in contact? ..... _____
     - (4) Capable of recording or measuring any penetration of the specimen by the point load platens during testing? ..... _____
   - (d) Caliper or steel rule, for width measurement (accurate to ± 5% of the specimen size)? ..... _____
   - (e) System is resistant to shock and vibration? ..... _____

2. Miscellaneous items (as necessary): diamond saw, chisels, towels, marking pens, plotting paper? ..... _____

PROCEDURE

Test Samples and Specimens (Sample Preparation):

1. Sample size:
   - (a) At least 10 specimens for core (preferred) or block samples? ..... _____
   - (b) At least 20 specimens for irregular-shaped specimens obtained by other means? ..... _____
2. Specimen external diameter is between 30 mm and 85 mm (50 mm is preferred)? ..... _____
3. Sides are free from abrupt irregularities? ..... _____
4. Specimens are marked according to Fig. 4, indicating desired test orientation? ..... _____
5. Specimen dimensions are measured in three different places, and the average is calculated? ..... _____

Diametral Test (procedure repeated for each test specimen):

1. Core specimen has a length/diameter ratio greater than 1:1? ..... _____
2. Specimen is inserted in the test device and platens are closed, making contact with the core diameter? ..... _____
3. Distance (L) between the contact points and the nearest free end is at least 0.5 times the core diameter? ..... _____
4. Distance (L) recorded? ..... _____
5. The distance between platen contact points (D) is recorded? ..... _____
6. Load steadily increased so that failure occurs within 10 to 60 seconds? ..... _____
7. Failure load (P) is recorded, test rejected if the fracture surface passes through only one platen loading point? . _____

COMMENTS (D5731): (D5731)

POINT LOAD STRENGTH INDEX OF ROCK **(D5731)**

PROCEDURE (Continued) Date: _____

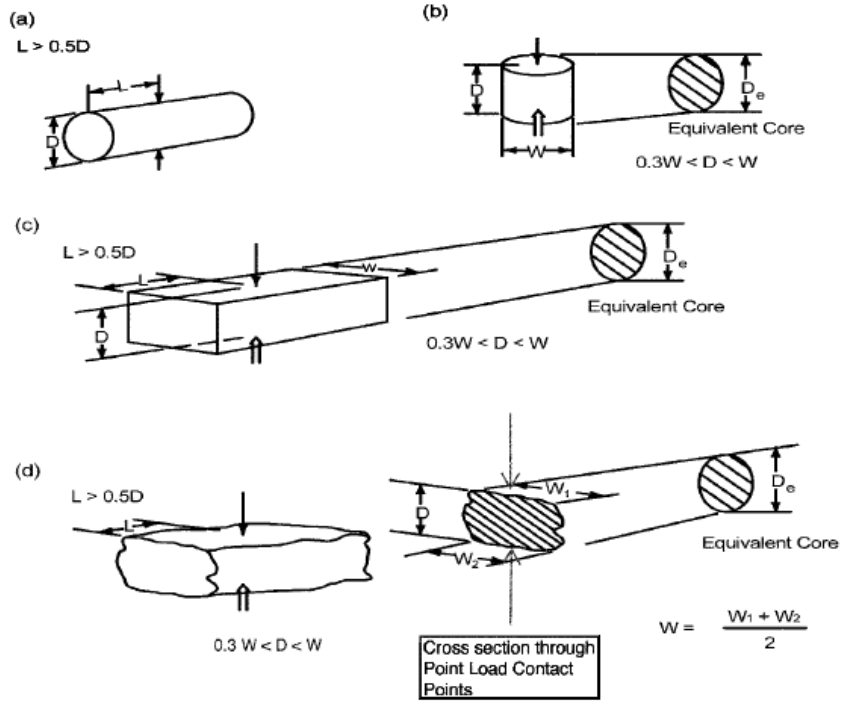
Axial Test (procedure repeated for each test specimen):

1. Core specimen has a length/diameter ratio between 1:3 and 1:1? ..... _____
2. Specimen inserted into the test device and platens closed, making contact along a line perpendicular to the core end faces (follow additional procedures for Anisotropic rock if applicable)? ..... _____
   Note to assessors: *Anisotropic rock is rock that exhibits differences in strength when tested in different orientations.*
3. Distance between platen contact points (D) recorded? ..... _____
4. Specimen width (W) measured perpendicular to the loading direction with an accuracy of ±5% and recorded? _____
5. Load steadily increased so that failure occurs within 10 to 60 seconds? ..... _____
6. Failure load (P) recorded, test rejected if the fracture surface passes through only one loading point? ..... _____

Block and Irregular Lump Tests (procedure repeated for each test specimen):

1. Rock blocks or lumps are 30 to 85 mm, and shape as shown in Fig. 3(c) and (d)? ..... _____
2. Ratio of diameter to width between 1:3 and 1:1 (preferably close to 1)? ..... _____
3. Distance between contact points and the nearest free end (L) is 0.5*width (W)? ..... _____
4. Specimen inserted in the test device and platens closed, making contact with the smallest dimension of the specimen, away from edges and corners? ..... _____
5. The distance between platen contact points (D) recorded? ..... _____
6. Specimen width (W) measured perpendicular to loading? ..... _____
7. If the sides are not parallel, W calculated as $(W_1 + W_2)/2$? ..... _____
8. Load steadily increased so that failure occurs within 10 to 60 seconds? ..... _____
9. Failure load (P) recorded, test rejected if the fracture surface passes through only one loading point? ..... _____

FIG. 2 Truncated, Conical Platen Dimensions for Point Load Apparatus



1—Legend: L = distance between contact points and nearest free face, and D_e = equivalent core diameter (see 10.1).

igurations and Specimen Shape Requirement for (a) the Diametral Test, (b) the Axial Test, (c) the Block Test, and (d) the Irregular Lump Test[3]

COMMENTS (D5731): (D5731)

POINT LOAD STRENGTH INDEX OF ROCK **(D5731)**

PROCEDURE (Continued) Date: _____

Anisotropic Rock Testing:

1. Rock sample is shale, bedded, schistose, or otherwise observably anisotropic? ..... _____
2. Sample tested in directions that will give the greatest and least strength values (generally parallel to the planes of anisotropy)? ..... _____
   Optional: *If the sample is a core drilled through weakness planes, a set of diametral tests may be completed first, at intervals that will yield pieces that can then be tested axially.*
3. When possible, is the core drilled so the core axis is parallel to the planes of weakness? ..... _____
4. Load applied along a single weakness plane for measurement of the point load strength index (I_s) in the direction of *least* strength? ..... _____
5. Load applied parallel to the direction of least strength for measurement of the point load strength index (I_s) in the direction of *greatest* strength? ..... _____
6. If sample consists of blocks or irregular lumps, is it tested in two subsamples (first load applied perpendicular to and then along observable planes of weakness)? ..... _____
7. If significant platen penetration occurs, is the dimension D used in calculations the value D′ measured at the instant of failure? ..... _____
   ***Note**: Dimension at failure may always be used as an alternative to the initial value and is preferred.*

Calculations:

1. Water content determined for each specimen according to (D2216) OR recorded as air-dried, as received, etc.? _____
2. Calculations performed according to the test method? ..... _____
3. Report includes the following:
   (a) Description of sample and direction of loading (parallel or normal)? ..... _____
   (b) Maximum applied load "P"? ..... _____
   (c) Calculated uncorrected (I_s) and corrected (D=50mm) ($I_{s(50)}$) point load strength index values? ..... _____
   (d) Estimated value of uniaxial compressive strength (σ_c) and strength classification? ..... _____
   (e) Value of strength anisotropy index ($I_{a(50)}$)? ..... _____
   (f) Type and location of failure, including any photographs of the specimens? ..... _____

COMMENTS (D5731): (D5731)

PARTICLE SIZE DISTRIBUTION (GRADATION) OF SOILS USING SIEVE ANALYSIS (D6913)

APPARATUS Date: _____

1. Sieves:
   - (a) Standard sieve set: 3 in, 2 in, 1 ½ in, 1 in, ¾ in, 3/8 in, Nos. 4, 10, 20, 40, 60, 100, 140, and 200?..... _____
     Note: *starting with a sieve smaller than 3 in. is permitted as long as 100% of the sample passes the largest sieve used.*
   - (b) Washing sieve: No. 200 (75-µm) with a minimum height above screen of 50 mm (2 in.)? ..... _____
   - (c) Designated separating sieves (as necessary, used if performing composite sieving):
     - (1) 1st designated separating sieve (typically a coarse sieve that is rectangular)? ..... _____
     - (2) 2nd designated separating sieve (typically a smaller sieve that is 8 in. diameter)? ..... _____
2. Mechanical sieve shaker (optional, required for referee testing): ❖
   - (a) Shake time between 10 and 20 minutes (write Informational note if shaker not presented)?..... ❖_____
     Note: *particles retained on the 1 ½ in. and larger sieve may be sieved individually by hand if needed.*
3. Balance:
   - (a) Method A: Able to determine mass to a minimum of three significant digits? ..... _____
   - (b) Method B: Able to determine mass to a minimum of four significant digits? ..... _____
4. Oven, maintains 110 ± 5°C (230 ± 9°F) throughout the drying chamber?..... _____
5. Sample containers and brushes, size and condition ok, wire brushes not used on sieves finer than the No. 20?.. _____
6. Washing sink, with satisfactory spray nozzle and a controllable rate of flow? ..... _____
7. Dispersant (either of the following):
   - (a) Dry addition: 4 g of sodium hexametaphosphate for each 100 mL of water used to soak the sample? .. _____
   - (b) Solution:
     - (1) Sodium hexametaphosphate mixed in distilled, deionized, or demineralized water, 40 g/L? .. _____
     - (2) Solution less than one week old with date of preparation indicated on the bottle or in a log? . _____
8. Optional equipment:
   - (a) Splitter or Riffle box (may be required for composite sieving or specific preparation methods)? ..... _____
     - (1) Minimum of 8 chutes?..... _____
     - (2) Even splits?..... _____
     - (3) Chute width at least 1.5 times the largest particle, not smaller than 1/2 in. for +3/8 in. material, not smaller than 1/8 in. for -3/8 in. material? ..... _____
     - (4) Method for controlling the feed rate of the material (feeder, hopper, etc.)? ..... _____
   - (b) Quartering accessories? ..... _____
   - (c) Mortar and rubber-covered pestle? ..... _____
   - (d) Low temperature drying oven, thermostatically controlled capable of maintaining a uniform temperature not to exceed 60°C? ..... _____
   - (e) Ultrasonic water bath (used to help disperse the sample)? ..... _____
   - (f) Dispersion shaker (helps assist in the dispersion process)? ..... _____

COMMENTS (D6913): (D6913)

PARTICLE SIZE DISTRIBUTION (GRADATION) OF SOILS USING SIEVE ANALYSIS (D6913)

VERIFICATION OF APPARATUS Date: _____

1. Sieves:
   (a) Verified and documented when put into service and every 6 months (may be extended to 12 months if less than 1000 analyses are made in 6 months)? ..... _____
   (b) Thoroughly cleaned if 10% or more of the openings are blocked?..... _____
2. Mechanical sieve shaker (optional, required for referee testing) ❖:
   (a) Verified and documented when put into service and every 12 months with each sieve set used (may be extended to 24 months if less than 1000 analyses are made in 12 months)? ..... _____
   Note: *subsequent verifications of any sieve shaker only need to be performed on the finest sieve set used on that shaker unless the time needed to meet sieving sufficiency changes.*
   (b) Enough material run so that most of the sieves retain material without being overloaded? ..... _____
   (c) Run according to the single-set method? ..... _____
   (d) Shake times tested starting at 10 minutes, no more than 20 minutes is permissible? ..... _____
   (e) Each mass determined to the nearest 0.01 g or 0.1%, whichever is greater? ..... _____
   (f) Verification based on the percent passing during 1 minute of continuous hand shaking (no single sieve should exceed 0.5% of the total specimen mass passing)? ..... _____
   (g) Hand shaking performed with the sieve and pan slightly inclined, struck with the heel of the hand using an upward motion at a rate of approx. 150 blows per minute, turned 1/6th of a rotation every 25 blows?_____

Note to Assessors: *The ASTM standardization requirements are included here because they are listed in the test method. If the laboratory is seeking accreditation, these issues will be covered in the R18 evaluation and the notes should be written under the quality system section. Only if they are not seeking R18 accreditation would you write a note here regarding records or intervals of verification.*

SAMPLE MASSES

Maximum Particle Size (>99% passing)	Alternative Sieve Designation	Method A Minimum Mass (required for both composite and samples >No. 4 sieve)	Method B Minimum Mass (only allowed for testing by both single-set and <No. 4 sieve)
0.425 mm	No. 40	50 g	75 g
2.00 mm	No. 10	50 g	100 g
4.75 mm	No. 4	75 g	200 g
9.5 mm	3/8 in.	165 g	--
19.0 mm	3/4 in.	1.3 kg	--
25.4 mm	1 in.	3 kg	--
38.1 mm	1 1/2 in.	10 kg	--
50.8 mm	2 in.	25 kg	--
76.2 mm	3 in.	70 kg	--

Note: *It is recommended that samples not exceed the minimum mass by more than 50%.*

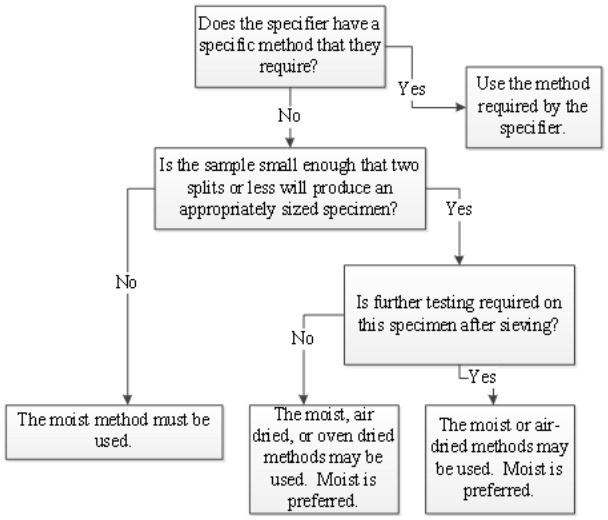
COMMENTS (D6913): (D6913)

PARTICLE SIZE DISTRIBUTION (GRADATION) OF SOILS USING SIEVE ANALYSIS (D6913)

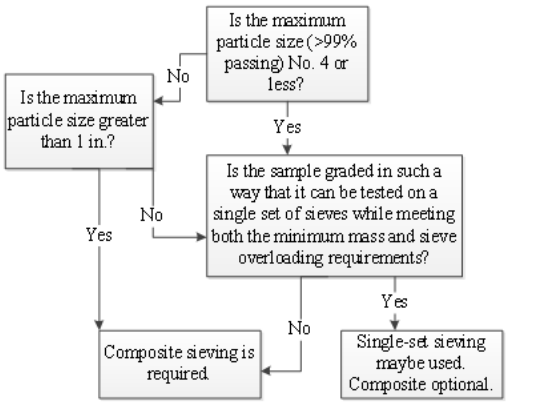
FLOW CHART AND OVERLOAD TABLE Date: _____

Note to Assessors: Work through the flow charts presented here to determine which sieving method and which sample preparation method applies to the material being demonstrated by the laboratory. The requirements of each section of the flow charts are listed on the subsequent pages of the worksheets. Any sections that do not apply should be dashed out.

Determining whether to use moist, air-dried, or oven dried specimen preparation:



Determining whether to use Single Set or Composite Set sieving:



Note to Assessors: The following table displays the maximum allowable mass on each size of sieve during testing.

SIEVE OVERLOAD TABLE

Standard Sieve Designation	Alternative Sieve Designation	Maximum Mass Retained on 8-in. sieve (g)	Maximum Mass Retained on 12-in. sieve (g)	Max. Mass Retained on 14.6- by 22.8-in. rectangular sieve (g)
75 mm	3 in.	2700	6100	18000
50 mm	2 in.	2000	4500	13000
37.5 mm	1 1/2 in.	1500	3400	10000
25 mm	1 in.	1100	2500	7000
19.0 mm	3/4 in.	900	2000	6000
9.5 mm	3/8 in.	550	1200	3600
4.75 mm	No. 4	325	730	2000
2.00 mm	No. 10	180	410	1000
850 µm	No. 20	115	260	800
425 µm	No. 40	75	170	500
250 µm	No. 60	60	140	400
150 µm	No. 100	40	90	300
106 µm	No. 140	20	70	200
75 µm	No. 200	20	50	100

1. All masses retained on individual sieves conform to the requirements of this table? ..... _____

COMMENTS (D6913): (D6913)

PARTICLE SIZE DISTRIBUTION (GRADATION) OF SOILS USING SIEVE ANALYSIS (D6913)

SAMPLE PREPARATION Date: _____

Moist Preparation Method (Preferred)

1. Unless the sample is too wet or dry to handle, is it processed in its as-received and moist condition? ..... _____
   (a) If too dry, is it moistened and mixed to a workable moisture content? ..... _____
   (b) If too wet, is it brought back to a moist but workable state by either air-drying or oven drying at no more than 60°C? ..... _____
2. Representative sample obtained by using one of the following methods? ..... _____
   (a) Entire sample? ..... _____
   (b) Miniature stockpile:
      (1) Sample obtained by taking one or more scoops from the sample (single scoop should only be used with small samples consisting of material passing the 3/8 in. sieve)? ..... _____
      (2) Scoops taken from various locations in the pile? ..... _____
      (3) Each scoop has approximately equal mass? ..... _____
      (4) Specimen not reduced to an exact size by the addition of very small amounts of material? .... _____
      (5) For soils that readily segregate, material not shaken off the edge of the scoop? ..... _____
   (c) Quartering (composite sieving only):
      (1) Material thoroughly mixed on a clean, smooth, nonporous surface? ..... _____
      (2) Mounded and flattened into a disk? ..... _____
      (3) Disk divided using a straightedge or a knife into wedge-shaped quarters? ..... _____
      (4) Opposing quarters removed, remaining material remixed? ..... _____
      (5) Process repeated until the minimum mass requirement is met without exceeding the requirement by more than a factor of 1.5? ..... _____
3. For single-set sieving, is the specimen oven dried in a tared container at 110 ± 5°C and then sieved? ..... _____
4. For composite sieving, is the specimen processed as follows and then sieved? ..... _____
   (a) Specimen processed over the designated separating sieve? ..... _____
      (1) Both the fine and the coarse portions collected? ..... _____
      (2) Large agglomerations of material broken up to pass the separating sieve? ..... _____
      (3) Pressure that could damage the sieve not applied? ..... _____
      (4) Fines adhering to large particles brushed or scraped away if needed? ..... _____
      (5) Less than 0.5% of the total sample mass adheres to the coarser particles, or the sample washed with a minimal amount of water and the washings added to the finer portion? ..... _____
   (b) Coarser portion oven dried in a tared container at 110 ± 5°C and oven dry mass determined? ..... _____
   (c) Moist mass of finer portion determined? ..... _____
   (d) Finer portion mixed and a moisture content specimen obtained? ..... _____
      (1) Stockpile procedure used to obtain the subspecimen for both moisture content and sieving? . _____
      (2) Mass conforms to the minimum mass requirements based on the separating sieve? ..... _____
      (3) Oven dried at 110 ± 5°C and the moisture content calculated? ..... _____
   (e) Oven dry mass of the whole specimen (coarser and finer) determined by adding the dry mass of the coarser portion to the dry mass of the finer portion as calculated from the moisture specimen? ..... _____

COMMENTS (D6913): (D6913)

PARTICLE SIZE DISTRIBUTION (GRADATION) OF SOILS USING SIEVE ANALYSIS (D6913)

SAMPLE PREPARATION Date: _____

Air-Dried Preparation Method

1. Material as-received dried either on a smooth surface that prevents the loss of fines or in an oven at a temperature of no more than 60°C? ..... _____
2. Noticeable aggregations of particles broken apart, either by hand or using a mortar and rubber-covered pestle or similar? ..... _____
3. Either the whole sample used as the test specimen or a specimen obtained using a splitter? ..... _____
   (a) No more than two reductions in mass performed? ..... _____
   (b) Loss of fines avoided during splitting? ..... _____
   (c) Number of splits per run is two? ..... _____
4. For single-set sieving, is the sample placed oven dried in a tared container at 110 ± 5°C, the dry mass obtained and then the sample sieved? ..... _____
   Note: *for non-referee specimens, the moisture content may be based on an air-dried moisture content of similar material.*
5. For composite sieving, is the specimen processed as follows and then sieved? ..... _____
   (a) Specimen processed over the designated separating sieve? ..... _____
      (1) Both the fine and the coarse portions collected? ..... _____
      (2) Large agglomerations of material broken up to pass the separating sieve? ..... _____
      (3) Pressure that could damage the sieve not applied? ..... _____
      (4) Fines adhering to large particles brushed or scraped away if needed? ..... _____
      (5) Less than 0.5% of the total sample mass adheres to the coarser particles, or the sample washed with a minimal amount of water and the washings added to the finer portion? ..... _____
   (b) Coarser portion oven dried in a tared container at 110 ± 5°C and oven dry mass determined? ..... _____
   (c) Air-dried mass of finer portion determined? ..... _____
   (d) Finer portion mixed and a moisture content specimen obtained? ..... _____
      (1) Mechanical splitter used to obtain the subspecimen for both moisture content and sieving? ..... _____
      (2) Mass conforms to the minimum mass requirements based on the separating sieve? ..... _____
      (3) Oven dried at 110 ± 5°C and the moisture content calculated? ..... _____
   (e) Oven dry mass of the whole specimen (coarser and finer) determined by adding the dry mass of the coarser portion to the dry mass of the finer portion as calculated from the moisture specimen? ..... _____

Oven-Dried Preparation Method

1. Sample as-received oven dried at 110 ± 5°C over night or until thoroughly dry? ..... _____
2. Noticeable aggregations of particles broken apart, either by hand or using a mortar and rubber-covered pestle or similar? ..... _____
3. Either the whole sample used as the test specimen or a specimen obtained using a splitter? ..... _____
   (a) No more than two reductions in mass performed? ..... _____
   (b) Loss of fines avoided during splitting? ..... _____
   (c) Number of splits per run is two? ..... _____
4. For single-set sieving, is the oven-dried mass of the sample determined and the sample sieved? ..... _____
5. For composite sieving, is the sample processed as follows and sieved? ..... _____
   (a) Specimen processed over the designated separating sieve? ..... _____
      (1) Both the fine and the coarse portions collected? ..... _____
      (2) Large agglomerations of material broken up to pass the separating sieve? ..... _____
      (3) Pressure that could damage the sieve not applied? ..... _____
      (4) Fines adhering to large particles brushed or scraped away if needed? ..... _____
      (5) Less than 0.5% of the total sample mass adheres to the coarser particles, or the sample washed with a minimal amount of water and the washings added to the finer portion? ..... _____
   (b) Oven dried mass of the finer and coarser portions determined? ..... _____
   (c) Finer portion mixed and a representative specimen obtained? ..... _____
      (1) Mechanical splitter used to obtain the subspecimen for sieving? ..... _____

COMMENTS (D6913): (D6913)

PARTICLE SIZE DISTRIBUTION (GRADATION) OF SOILS USING SIEVE ANALYSIS (D6913)

SINGLE-SET SIEVING PROCEDURE Date: _____

Single-Set Sieving Procedure

1. Specimen dispersed using one of the following procedures? _____
   - (a) Soaking without a dispersant:
     - (1) Covered with tap water and allowed to soak for at least 5 minutes (longer soaking is usually necessary for samples containing significant amounts of fines)? _____
     - (2) Agitated with a spatula or similar tool if necessary? _____
     - (3) If clumps and clods of particles are still present, is the specimen further soaked under the "Soaking with a dispersant" method? _____
     - (4) If the soil is relatively clean and well-graded, dispersion shakers are not permitted? _____
   - (b) Soaking with a dispersant:
     - (1) Sodium hex. added either dry or in solution as prescribed in the apparatus section? _____
     - (2) Specimen soaked following the requirements of "Soaking without a dispersant" (above)? _____
   - (c) Dispersing with an ultrasonic water bath:
     - (1) Water mixed with the specimen includes dispersant? _____
     - (2) Specimen dispersed in portions if necessary? _____
2. Material washed over a No. 200 sieve according to applicable parts of Method B of D1140? _____
   - (a) If the specimen contains material larger than a No. 4 sieve, the entire specimen not placed on the sieve screen (coarser sieve used above the No. 200 to separate out larger particles)? _____
   - (b) Specimens larger than 200 g washed in portions? _____
   - (c) Specimen placed on the No. 200 sieve (or protective sieve) and washed using the spray nozzle? _____
   - (d) Clogging of the No. 200 sieve avoided (a wash shaker may be used to assist in this)? _____
   - (e) Material does not splash out of the sieve(s)? _____
   - (f) Light hand manipulation permitted, with no downward pressure exerted on the material or sieve cloth? _____
   - (g) If a protective sieve is used, is it removed once the material is clean and the washing continued on the No. 200 sieve until the wash water runs clear? _____
3. Specimen completely transferred back to a sample container? _____
4. If decantation is required, is the specimen decanted without losing material? _____
5. Specimen oven dried at 110 ± 5°C? _____
6. Sieved on a sieve stack starting with a sieve through which 100% of the sample will pass and continuing down through the No. 200 sieve, containing at a minimum the sieves from the apparatus section (additional sieves in between are permissible)? _____
7. Material placed on the top sieve of the stack? _____
8. Loss of material and creation of dust avoided? _____
9. Sieves shaken as appropriate to the design of the shaker for the pre-determined sieving period? _____
10. Overloading of sieves avoided (see table following flow chart)? _____
    - (a) If overloading occurs, is the material recombined and resieved in several smaller portions? _____
11. After sieving, mass of material on each sieve determined either cumulatively or individually? _____
12. Calculations for percent retained or percent passing performed according to the test method? _____

COMMENTS (D6913): (D6913)

PARTICLE SIZE DISTRIBUTION (GRADATION) OF SOILS USING SIEVE ANALYSIS (D6913)

COMPOSITE SIEVING PROCEDURES Date: _____

Composite Sieving

1. Either a single-separation or double-separation composite sieving performed (double separation usually only performed on specimens where the subspecimen [finer portion from the first separation] still contains material 3/4 in. and larger)? ..... _____
2. Coarser portion:
   - (a) Washed unless not being used for referee testing and either clean (<0.5% of the sample would pass the designated separating sieve) or already washed? ..... _____
   - (b) Specimen dispersed using one of the following methods (soaking without a dispersant is usually sufficient for the coarser portion)? ..... _____
     - (1) Soaking without a dispersant (see single-set)? ..... _____
     - (2) Soaking with a dispersant (see single-set)? ..... _____
     - (3) Dispersing with an ultrasonic water bath (see single-set)? ..... _____
   - (c) Specimen washed over the designated separating sieve? ..... _____
   - (d) Retained portion oven-dried to constant mass at 110 ± 5°C? ..... _____
   - (e) Sample sieved over a stack where the largest sieve allows 100% of the material to pass and the smallest sieve is the designated separating sieve over which the sample was processed? ..... _____
     - (1) Material passing the separating sieve collected in a pan? ..... _____
     - (2) Total material passing the separating sieve from both the wash and the sieving process does not exceed 0.5% of the total sample mass? ..... _____
     - (3) Sieves not overloaded during the sieving process (see table below)? ..... _____
3. Finer portion:
   - (a) If the finer portion from the specimen (subspecimen) contains material 3/4 in. and larger, is it either sieved in multiple portions or sampled again to obtain a second subspecimen using a splitter? ..... _____
     - (1) All of the requirements of the first sampling applied to the second as well? ..... _____
   - (b) Specimen dispersed using one of the following methods? ..... _____
     - (1) Soaking without a dispersant (see single-set)? ..... _____
     - (2) Soaking with a dispersant (see single-set)? ..... _____
     - (3) Dispersing with an ultrasonic water bath (see single-set)? ..... _____
   - (c) Specimen washed over a No. 200 sieve (or designated separating sieve from the second splitting)? .... _____
   - (d) Specimen oven dried at 110 ± 5°C? ..... _____
   - (e) Sieved over a stack starting with the designated separating sieve and ending with a No. 200 sieve (or ending with the second designated separating sieve from the second splitting)? ..... _____
     - (1) No more than 2% of the specimen retained on the top sieve during this process, otherwise the test is in nonconformance and steps taken to determine the cause? ..... _____
     - (2) If material is retained, the percent retained from the coarser portion of the analysis used during calculation? ..... _____
     - (3) Sieves not overloaded (see table after flow chart)? ..... _____
4. Calculations to determine percent passing or percent retained performed according to the test method? ..... _____

COMMENTS (D6913): (D6913)

COMPRESSIVE STRENGTH AND ELASTIC MODULI OF INTACT ROCK CORES (D7012)

APPARATUS Date: _____

1. Loading system:
   Manufacturer (if known) _____ Capacity: _____
   (a) Hydraulic or mechanical system, maintained in good operation? ..... _____
   (b) Verified annually or more frequently if required, not to exceed 18 months, according to E4? ..... _____
   (c) **Optional** - equipped with a displacement transducer that can be used to advance the loading ram at a specified rate? ..... _____
2. Two Platens, made of tool-hardened steel:
   (a) One is a plane rigid platen? ..... _____
   (b) One platen is spherically seated? ..... _____
      (1) Diameter of spherically seat at least as large as the diameter of the test specimen, but not greater than twice the diameter of the test specimen? ..... _____
      (2) Center of the spherical seat coincides with the bearing face of the test specimen? ..... _____
      (3) Properly lubricated to assure free movement? ..... _____
      (4) Movable portion of the platen held closely in the spherical seat? ..... _____
      (5) Bearing face can be rotated and tilted through small angles in any direction? ..... _____

   or

   (c) If not spherically seated, platen diameter is at least as great as that of the specimen and has a thickness-to-diameter ratio of at least 1:2? ..... _____
3. Protective shield placed around the test specimen suitable to prevent injury from flying rock fragments? ..... _____

Equipment as specified in D4543 (Practice for preparing rock cores as cylindrical test specimens): ❖

1. Support surface, flat test surface that does not depart from a plane by more than 0.0005 in (0.0013 mm)? ..... _____
2. V-block, machinist quality, smooth to within 0.0005 in. (13 µm), and a 90° included angle? ..... _____
3. Dial or electronic displacement gage stand, supports gage at correct height to take measurements? ..... _____
4. Dial or electronic displacement gage:
   (a) Sensitivity of at least 0.001 in (0.2 mm) for measurements of cylindrical surfaces? ..... _____
   (b) Displacement gage readable to 0.0001 in (0.002 mm) for measurements of end surfaces? ..... _____
5. Feeler gage set, thicknesses between 0.04 mm and 1.00 mm? ..... _____
6. Surface grinder, machinist's grinder equipped with V-block to hold sample during grinding? ..... _____
7. Diamond saw, segmented circular diamond saw appropriate for cutting rock samples? ..... _____
8. Machinist calipers, or similar device, readable to 0.01 in. (0.25 mm)? ..... _____

COMPRESSIVE STRENGTH AND ELASTIC MODULI OF INTACT ROCK CORES (D7012)

PROCEDURE Date: _____

Sample Preparation: performed in accordance with D4543 (Practice for preparing rock cores as cylindrical test specimens)❖

1. Drill cored obtained directly from the natural testing site? ..... _____
   or Obtained from block samples cored in the field or in the laboratory? ..... _____
2. Cores represent a valid average type of rock under consideration, as determined by visual observation of mineral constituents, grain sizes and shape, partings and defects, or other methods? ..... _____
3. Specimen prepared according to the procedures in Section 8.2 - Core Drilling Block Samples, 8.3 – Specimen Cutting, 8.4 – Cylindrical Surface Grinding, as appropriate? ..... _____
4. End surfaces prepared by either Section 8.5.1 Method ES1 - Surface Grinding, Section 8.5.2 Method ES2 – Lapping, or Section 8.5.3 Method ES3 – Machinist Shaper? ..... _____

Shape Conformance Verification

Specimen requirements	Procedure used	Status
7.1 Specimens are right circular cylinders?		
7.2 Length-to-diameter ratio of 2.0 to 2.5, diameter at least 47 mm (1 7/8 in.)?		
7.3 Cylindrical surfaces smooth and straight to within 0.020 in. (0.50 mm)?	S1 (feeler gauge) or S2 (V-block)	
7.4 Ends cut parallel to each other and at right angle to longitudinal axis? End surfaces ground or lapped flat to a tolerance of 0.001 in. (25 µm)?	FP1 (V-block) or FP2	
7.5 & 7.6 Capping or end surface treatments used are only grinding, lathing, or lapping. Low strength rocks may also be capped?		
7.7 Melted sulfur capping compounds NOT permitted? ***Note:*** *Dental plaster and high strength gypsum cements are commonly used and acceptable.*		
7.8 Ends of specimen are perpendicular to axis within 0.25°?	Section 9	
7.9 Parallelism tolerance is the maximum angular difference between the opposing best-fit straight line on each specimen end, shall be not more than 0.25° for spherically seated test machines and 0.13° for fixed end test machines?	Section 9 (see testing machine platens in equipment section)	

Note: *An optical or electronic device with an equivalent or better sensitivity & accuracy may be used in place of a mechanical dial gage.*

1. Side straightness verified by performing procedure S1 or S2? ..... _____
   (a) S1: Roll the specimen on a flat surface and use the feeler gauge to determine straightness.
   (b) S2: Place specimen on V-block, run dial gage along length, determine min and max readings. Rotate 120° and repeat. Maximum of three $\Delta < 0.020$ in. (0.50 mm).
2. End flatness and parallelism checked using procedure FP1 or FP2? ..... _____
   (a) FP1: Run dial gage across end of specimen, record reading every 1/8 in. (3 mm) across diameter. Rotate 90° and repeat. Repeat on other end. Flatness determined from visual best-fit straight line data.
   (b) FP2: Set specimen upright. Move dial gage across three different diameters, note min. and max. readings. Flatness determined from visual best-fit straight line data.
3. Perpendicularity of the ends checked using procedure P1 or P2? ..... _____
   (a) P1: Calculate from the data from FP1.
   (b) P2: Set specimen upright on flat surface against the base of a true square. Rotate specimen, determine maximum gap, measure gap, and calculate perpendicularity.
4. If specimen does not pass perpendicularity and/or flatness conformance criteria, specimen evaluated to determine if best effort was achieved for the rock type, and professional judgment used to determine if the specimen should be discarded, tested as is, capped, or started over? ..... _____

Determining Specimen Dimensional and Moisture Properties, determined in accordance with D4543 as follows:

1. Diameter of the test specimen determined perpendicular to the core axis, using a machinist caliper, or similar device, to the nearest 0.01 in (0.25 mm) by average two diameters measured at right angles to each other at about mid-height of the specimen? ..... _____
2. Average diameter used to calculate the circular cross-sectional area perpendicular to the core axis of the specimen, to three significant digits? ..... _____
3. Length of the specimen determined using a machinist caliper, or similar device, to the nearest 0.01 in. (0.25 mm) at the centers of the end faces? ..... _____
4. Volume of the specimen determined to three significant digits using the area and length values? ..... _____
5. Moisture condition of the sample at the time of receipt and at the completion of specimen prep recorded? ..... _____

COMMENTS (D7012): (D7012)

COMPRESSIVE STRENGTH AND ELASTIC MODULI OF INTACT ROCK CORES (D7012)

PROCEDURE (Continued) Date: _____

Specimen Seating:

1. Spherical seat rotates freely in its socket? ..... _____
2. Lower platen placed on the base or actuator rod of loading device? ..... _____
3. Bearing faces of the upper and lower platens and of the test specimen wiped clean? ..... _____
4. Test specimen placed on lower platen? ..... _____
5. Upper platen placed on specimen and aligned correctly? ..... _____

Sample Testing:

1. Load applied continuously and without shock until the load becomes constant, is reduced, or a predetermined amount of strain is achieved? ..... _____
2. Load applied produces a stress rate of 0.5 to 1.0 MPa/s (73 to 145 psi/s)? ..... _____

or Load applied at a constant strain rate? ..... _____

3. Failure occurs between 2 and 15 minutes after the start of the loading procedure? ..... _____
4. Maximum load sustained by the specimen recorded? ..... _____
5. Load readings (kN) recorded to 2 decimal places? ..... _____
6. Stress readings (MPa) recorded to 1 decimal place? ..... _____

Calculations:

1. The uniaxial compressive strength calculated by the following equation? ..... _____

Compressive strength = Failure Load / Cross-sectional Area

Report, displays the following information:

1. Source of sample, project name, and location reported? ..... _____
2. Moisture condition of specimen at start of test? ..... _____
3. Specimen diameter and height? ..... _____
4. Rate of loading or deformation? ..... _____
5. Description of physical appearance of the specimen after test (describe visible end effects like cracking, spalling, or shearing at the platen-specimen interfaces)? ..... _____
6. Temperature noted if test is not performed at room temperature? ..... _____
7. Uniaxial compressive strength determined? ..... _____
8. Information as required in D4543 reported?
   - (a) Straightness surfaces by either Procedure S1 or Procedure S2? ..... ❖ _____
   - (b) Flatness and parallelism by either Procedure FP1 or Procedure FP2? ..... ❖ _____
   - (c) Perpendicularity by either Procedure P1 or Procedure P2? ..... ❖ _____
9. List of equipment used to prepare the specimens and for conformance measurements? ..... ❖ _____

COMMENTS (D7012): (D7012)

LIMEROCK BEARING RATIO (FM 5-515)

APPARATUS Date: _____

1. Metal Cylindrical Molds:

Inside diameter: 151.89 – 152.91 mm (5.98 – 6.02 in)*?						
Height: 151.89 – 152.91 mm (5.98 – 6.02 in)*?						
Extension collar approximately 63.5 mm [AMRL: at least] (2.5 in) high?						
Perforated base plate?						

*If the molds are calibrated according to T19 (water-filled method) and this calibrated volume used in the calculations, tolerances may be exceeded by up to 50%:

OPTIONAL: As an alternative, CBR molds presented (height ~ 7-in.) with a spacer disk so that the effective height of the mold meets the specifications for LBR molds? ..... _____

2. Surcharge Weights:
   (a) Annular surcharge weights, 2.27 kg (5 lb) [AMRL: ± 0.1 lb]? ..... _____
   (b) Slotted surcharge weights, 2.27 kg (5 lb) [AMRL: ± 0.1 lb]? ..... _____
   Note: *The laboratory should have several slotted weights and at least one annular weight.*

3. Metal Spacer Disc:
   (a) Diameter: 150.0 - 151.6 mm (5 15/16 ± 1/32 in.)? ..... _____
   (b) Height: 35.29 – 36.31 mm (1.39 – 1.43 in.)? ..... _____

4. Rammer (either manual or mechanical):
   (a) Manual Rammer:
      (1) Flat circular face? ..... _____
      (2) Diameter of 50.80 ± 0.25 mm (2.000 ± 0.010 in.)? ..... _____
      (3) Weight of 4.536 ± 0.009 kg (10.00 ± 0.02 lb)? ..... _____
      (4) Height of drop of 457 ± 2 mm (18.0 ± 0.06 in.)? ..... _____
      (5) Guide sleeve with 4 vent holes spaced approximately 90 degrees apart? ..... _____
      (6) Hammer falls freely within the sleeve? ..... _____
   (b) Mechanical Rammer:
      (1) Provides complete coverage of the specimen surface in 8 to 10 blows per revolution? ..... _____
      (2) Sector face with a radius of 73.70 ± 0.51 mm (2.90 ± 0.02 in.)? ..... _____
      (3) Calibration at least once per year or more frequently as needed by D2168 Method A? ..... _____
      Note: *D2168 Method A involves parallel determinations of density of samples compacted using the mechanical rammer and the manual rammer. The lead plug method is not permitted.*

5. Swell Plate, perforated, weighing approximately 1.13 kg (2.2 lb)? ..... _____

6. Penetration Piston:
   (a) Diameter of 49.5 mm (1.95 in.) [AMRL: 1.95 to 1.96 in.]? ..... _____
   (b) Length of approximately 190.5 mm (7 in.) when used with manual loading devices, 127 mm (5 in.) when used with automatic testing machines? ..... _____

COMMENTS (FM 5-515): (FM 5-515)

LIMEROCK BEARING RATIO (FM 5-515)

APPARATUS (Continued) Date: _____

7. Loading Device:
   (a) Can load at rate of 1.27 mm (0.05 in.) per minute [AMRL: ±20%, (1.016 to 1.524 mm / minute)]?..... _____
   (b) Capable of applying uniformly increasing load up to a capacity sufficient for the material being tested? ..... _____

8. Soaking Tank:
   (a) Sufficient in size to hold the specimens required for the testing performed by the laboratory? ..... _____
   (b) Raised ridges or spacers to allow free access of water to the bottom of the mold? ..... _____
   (c) Has an overflow placed so that the height of water in the tank remains within 6.35 mm (1/4 in.) of the same elevation as the top of the soil sample in the mold? ..... _____

9. Balances:
   (a) Balance for weighing samples of at least 11 kg (24 lb), sensitive and readable to 5 g (0.01 lb)?..... _____
   (b) Balance for weighing moisture samples of at least 1000 g, sensitive and readable to 0.1 g? ..... _____
   (c) Both balances (or single balance that meets both requirements), conform to AASHTO M231?..... _____

10. Oven, capable of maintaining 110 ± 5ºC (230 ± 9ºF)?..... _____

11. Straightedge, at least 12 inches in length, has one beveled edge, and at least one longitudinal surface plane to within 0.012 in.? ..... _____

12. Sieves, 2 in., 3/4 in., and No. 4?..... _____

13. Containers for moisture content determination, resistant to corrosion and not subject to change in mass or disintegration on repeated heating and cooling? ..... _____

14. Mixing tools, as needed to thoroughly mix the soil sample? ..... _____

COMMENTS (FM 5-515): (FM 5-515)

LIMEROCK BEARING RATIO (FM 5-515)

PROCEDURE Date: _____

Sample Preparation

1. If sample is damp when received it shall be air or oven dried at no more than 60°C (140°F) until friable? _____
2. Base Material Preparation Procedure: [**Assessor:** only review procedures for applicable material types]
   (a) Material greater than the 19 mm (3/4 in) sieve shall be crushed by the use of a mechanical jaw crusher having a minimum jaw plate dimension of 60 x 90 mm. Pieces not reduced by mechanical crushing shall be manually broken up to pass the 3/4 in sieve? _____
   (b) Resulting material passed through a 4.75 mm (No. 4) sieve and the percent retained recorded? _____
3. Subgrade Material Preparation Procedure: [**Assessor:** only review procedures for applicable material types]
   (a) Material passed through the 2 in., ¾ in., and No. 4 sieve without crushing, breaking up the material in a way to avoid reducing the natural size of individual particles? _____
   (b) Percent retained on each sieve recorded? _____
   (c) Material retained on the 2 in. sieve discarded? _____
   (d) Material passing the 2 in. and retained on the ¾ in. sieve weighed and replaced in the final sample with an equal mass of material passing the ¾ in. and retained on the No. 4? _____
   Note: *If the total material retained on the No. 4 sieve comprises less than 7 percent of the total sample mass, it may be added back into the specimen used for the test with no correction being made.*
4. Total sample broken into individual specimens for compaction, each weighing approximately 12 lb? _____
5. Samples thoroughly mixed with water to the appropriate moisture content? _____
6. Target moisture contents start approximately 3% below optimum, increasing 1% at a time to bracket the optimum moisture content? _____
7. After being mixed, are the samples placed in covered containers and allowed to stand for the required time:
   (a) For materials conforming to grade A-3 of M145, no minimum soak time is required? _____
   (b) For materials conforming to grade A-2-4 (Non-Plastic) of M145, minimum soak time is 3 hours? _____
   (c) For all other subgrade materials, minimum soak time is 12 hours? _____

Compaction Procedure

1. Material remixed immediately prior to compaction? _____
2. Representative sample taken for a moisture content determination at this time:
   (a) Moisture sample weighed immediately and the weight recorded? _____
   (b) Dried in an oven at 110 ± 5ºC for at least 12 hours, or until constant mass? _____
   (c) Specimen mass at least 500 g? _____
3. Spacer disc inserted into the bottom of the mold and collar attached? _____
4. Specimen compacted in 5 equal layers to a total depth of approximately 5 inches? _____
5. Each layer compacted with 56 uniformly distributed blows of the rammer? _____
6. Mold rests on a uniform rigid foundation during compaction (for example of a concrete block weighing not less than 200 lb is provided)? _____
7. Extension collar on the mold removed and soil trimmed even with the top of the mold using the straightedge? _____
8. Any holes in the surface patched using material passing the No. 4 sieve? _____
9. Coarse filter paper placed over the top surface of the specimen? _____
10. Mold inverted and the base plate removed? _____
11. Spacer disc removed and filter paper placed on the exposed surface? _____
12. Mold and moist soil weighed and the weight recorded? _____
13. These procedures repeated for each specimen (at least 4 specimens run for a normal test)? _____
14. Moisture-density relationship plotted for the specimens as compacted? _____

COMMENTS (FM 5-515): (FM 5-515)

LIMEROCK BEARING RATIO (FM 5-515)

PROCEDURE Date: _____

Soaking

1. Surcharge of approximately 1.13 kg (2.5 lb) (the weight of the swell plate) placed on top of each specimen? ... _____
2. Specimens placed in the soaking tank so that the water is within ¼ in. of the top surface of the specimen? ..... _____
3. Soak time 48 ± 4 hours? ..... _____
4. Swell plate left on the specimen throughout soaking and draining? ..... _____
5. Specimen removed from the soaking tank and allowed to drain on a level surface for 15 ± 2 minutes? ..... _____
6. Draining surface allows free water to drain away from the bottom of the mold? ..... _____
7. Swell plate removed and the specimen tested immediately? ..... _____

Penetration Testing

1. Appropriate surcharge weight applied to each specimen prior to penetration:
   (a) For subgrade specimens, surcharge weight of 6.8 kg (15 lb) applied? ..... _____
   (b) For embankment specimens, surcharge weight of 9.1 kg (20 lb) applied? ..... _____
   (c) For base material specimens, no surcharge weight applied? ..... _____
2. A seating load of 4.54 kg (10 lb) applied to the specimen if a manual machine is used (seating not required for automatic recording machines)? ..... _____
3. Load and deflection gauges zeroed? ..... _____
4. Load applied at a constant rate of approximately 1.3 mm (0.05 in.) per minute? ..... _____
5. Load readings obtained for each 0.25 mm (0.01 in.) of penetration up to 5.08 mm (0.2 in.)? ..... _____
6. Load readings above 0.2 in. obtained at 0.225, 0.250, 0.275, 0.300, 0.325, 0.350, 0.375, 0.400, 0.450, and 0.500 in. of penetration? ..... _____
   Note: *If the LBR is obviously obtained very early in penetration, higher penetration readings may be waived.*
7. Calculations performed according to the test method? ..... _____

COMMENTS (FM 5-515): (FM 5-515)