DEPARTMENT OF TRANSPORTATION
ENGINEERING SERVICE CENTER
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METHOD OF TEST FOR RELATIVE COMPACTION OF UNTREATED AND TREATED SOILS AND AGGREGATES

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section K of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. GENERAL SCOPE

This method of test shall be used to determine the relative compaction of untreated and treated soils and aggregates.

Relative compaction in this method is defined as the ratio of the in-place wet density of a soil or aggregate to the test maximum wet density of the same soil or aggregate when compacted by a specific test method.

The in-place, wet density shall be determined in accordance with Part I of this method of test.

The laboratory test maximum wet density and percent relative compaction shall be determined in accordance with Part II of this method of test.

PART I. IN-PLACE WET DENSITY

A. SCOPE

The principal use of the in-place wet density value is in the relative compaction control of earthwork construction; however, the identical procedure and apparatus are also employed to obtain data for volume-to-weight conversion factors and shrinkage or swell factors. The determination of the in-place wet density requires excavating and weighing a sample of soil from the area under investigation, measuring the volume of the sample excavation by back-filling with a calibrated test sand, and calculating the unit wet weight of the excavated sample.

B. APPARATUS

1. Complete sand volume apparatus as illustrated in Figure 1.
2. Miscellaneous hand tools consisting of digging chisels, scoops, and brushes included with the standard sand volume apparatus kit.
3. Weighing scale, graduated and sensitive to 45.4g or less.
4. Containers for the excavated material; 50mm x 305mm cylindrical tin cans with lids or equal.
5. Quartering canvas.

Note: Calibration of the sand volume apparatus is covered in California Test 110.

C. MATERIALS

1. Standard test sand consisting of clean, dry, free flowing particles which will not degrade under repeated use. Ottawa silica sand, passing the 20-mesh and retained on the 50-mesh sieve, has proved satisfactory. Beach sand containing deliquescent salts or sand having any hygroscopic properties are not acceptable.
2. Sample identification tags.

D. CALIBRATION OF STANDARD TEST SAND

1. The calibration of the standard test sand pertains to the determination of the weight per unit of volume of the sand when it is poured into a container under controlled conditions. The function of the sand volume apparatus displayed in Figure 1 is to assure that the sand will be poured under identical conditions in each instance. The sand calibration procedure and the test hole measurement procedure hereinafter outlined are identical, except that in the calibration procedure the sand is poured into a measuring vessel rather than into a test hole. The volume of the measuring cone is 4720 cc, and the volume of the measuring vessel is the same, for a total volume of 9440 cc; therefore, it is necessary to divide the weight of sand required to fill the calibration apparatus by 9440 to ascertain the unit weight in grams per cubic centimeter. The unit weight is also referred to as the sand density.

2. Calibrate each shipment of sand prior to using it in actual test hole measurements and check the calibration periodically—at least once a month.

3. Determine the weight of sand required to fill the calibration apparatus by averaging the results of three or more trial pours of the sand.

E. EXCAVATION OF TEST SAMPLE

1. The location of the test site should be such that the soil and the degree of compaction encountered would be representative of the average conditions prevailing in the area.

2. Preparatory to starting the excavation, clear away all loose surface material and level off a test site at least 610 mm square. In areas compacted by pneumatic-tired or smooth-wheel rollers, remove disturbed surface material to a depth of not less than 50 mm below the final surface on which the rollers have operated. Where sheeps-foot and similar type tamping rollers have been used, remove the loose surface material to a depth of not less than 50mm below the deepest penetration by the roller. The test sample excavation may be started at the surface if it is smooth, relatively level and free of loose material.

3. To maintain the necessary degree of accuracy in weighing and measuring operations, the test sample excavation should be not less than 4248 cc. The object is to dig a neat, clean-cut hole 150 mm to 200 mm in diameter without disturbing the surrounding material. Augers or hand chisels may be used to excavate the test hole. Augers are satisfactory in embankment testing where the material is fairly free of large stones and of sufficient depth to permit obtaining the required amount of material within the diameter provided by the auger. Hand chisels are required in shallow base courses and in most gravelly and rocky soils. To reduce breaking up of the surface outside the perimeter of the hole when starting the auger, use a hand chisel to first cut out a starting indentation in the surface slightly larger in diameter than the auger and about 50 mm deep. Following the completion of the auger excavation, trim the wall of the hole with a hand chisel an additional 10mm in diameter to remove material in the wall area disturbed by the auger. When hand chisels are used, do not pry back against the wall of the hole in any manner that will compress the area. Regardless of the method of excavation, trim the final sides and bottom of the hole reasonably smooth avoiding as far as possible any sharp projections or indentations.

4. Exercise care to prevent the loss of any of the excavated material, or its moisture, prior to weighing. Use a tightly covered container to reduce the loss of moisture. Remove all loose material from the hole and weigh carefully before starting the sand volume measurement.

5. Occasionally a large rock is encountered in a test hole in predominantly finer materials. As the weight of the rock is usually greater than that of a corresponding volume of the finer material, it may not be representative and its inclusion in the sample will result in an invalid weight of excavated material. Return this rock to the test hole prior to the volume measurement, and do not include it in the weight of the excavated material. The method used to measure the volume of the test hole will compensate for the volume of the rock returned to the hole.

6. Where different types of soil are deposited in layers, do not penetrate the different layers with a single test hole or combine the excavated material into a single sample. Each of these soil types might be compacted to specification requirements based on their individual maximum densities, but the test maximum density of the combination may be entirely different and result in an erroneous test result.

7. Exercise extreme care when performing a test in very wet material because the hole will tend to shrink and indicate a higher in-place density than actually exists. A working platform such as plywood, planks, etc., should be placed around the area to be tested to protect the hole from being squeezed in by the testing operation. A 1m x 1m piece of 191-mm plywood with a hole cut in the center large enough for the sand cone to be placed on the soil makes an excellent working platform. If the test indicates an unrealistic high in-place density or if there is free water in the test hole, the Engineer should consider the test invalid and perform a retest or declare the area too wet for testing.

F. SAND VOLUME MEASUREMENT OF TEST

1. After centering the sand volume apparatus over the test hole, accurately weigh, in a suitable pouring container, an amount of sand more than sufficient to fill both the test hole and the measuring cone. Pour this sand into the regulating funnel rapidly enough to maintain the sand level in the funnel at about 20 mm below the top edge until the hole and cone are filled, as indicated by sand overflowing into the overflow vessel. Tests have shown that control of the pouring is essential and that a variation in the flow of sand through the orifice may result in considerable error. Stop the sand pour immediately upon noting the overflow, and allow the balance of the sand remaining in the sand flow regulating funnel to completely empty into the overflow vessel. Then, hold the large measuring cone so that it cannot move, and rotate the overflow vessel a few turns to free it from the neck of the measuring cone preparatory to its removal. Remove the small sand-flow-regulating funnel and lift the overflow vessel off the measuring cone. As the sand that overflowed into the overflow vessel is not involved in the test hole measurement, return it to the balance of the original sand supply remaining in the pouring container and weigh. The difference between the initial weight of the sand in the pouring container and the weight remaining after the test hole and the measuring cone are filled represents the weight of sand required to fill the hole and the cone.

2. During the pouring of the sand, the apparatus must not be touched or vibrated; stop any equipment causing vibration of the ground during the period of actual pouring. Studies have indicated that the standard sand calibrated in the standard apparatus will reliably measure the volume of test holes up to 610mm in depth. For deeper holes a special calibration for the sand may be necessary.

3. Recover sand from the measuring cone by placing the edge of the large recovering scoop slightly under the edge of the cone and then sliding the cone onto the scoop. Do not slide the scoop completely under the cone, as irregularities in the ground surface will make this difficult and will force foreign material into the sand.

4. The sand contained in the measuring cone does not come into contact with the soil area under investigation and is salvaged for reuse. The sand in the test hole may have picked up moisture or foreign matter; while this sand may be washed and dried for reuse, it is not usually economical to do so and the common practice is to discard this portion.

G. COMPUTATION OF TEST HOLE VOLUME

Knowing both the weight per unit of volume of the sand when it is poured into the test hole by the standard procedure, and the weight of sand required to fill the test hole plus the measuring cone, the test hole volume in cubic centimeters may be computed from the formula:

$$V = (Ws/SD) - 4720 \quad g$$

Where V = the volume of the test hole in cubic cm; Ws = the weight of the sand (in grams) required to fill the hole + cone; SD = the sand density as determined from Section D of this Part; and 4720g is the weight of sand required to fill the cone.

The wet weight of excavated sample applies to the total weight of the material removed from the test hole in the condition in which it was excavated and regardless of the moisture content.

Wet density, in grams per cubic centimeter, is determined by dividing the total sample weight, in grams, by the volume of the test hole, in cubic centimeters.

H. MOISTURE DETERMINATION

1. Where it is desired to ascertain the in-place moisture, perform the test in accordance with California Test 226.

2. Dry density may also be determined from the previous data by relating dry weight of material to the volume of hole.

I. BULK SAMPLE

The test hole excavation alone seldom provides a sufficient volume of material for supplementary tests which may be required subsequent to the in - place volume determination; therefore, it is necessary to obtain a bulk sample of soil immediately adjacent to the excavated test hole following the completion of the sand volume measurement. The handling and processing of this sample depends on the subsequent tests.

J. RECORDING DATA

The block headed "Sand Volume Data" provides for the data accumulated at the in-place test hole site. Item B, designated "Wt. of Residue", refers to the sand remaining in the original container after the hole and cone are filled plus the sand returned from the overflow vessel, i.e., the second weighing of the sand. Unless otherwise indicated, the volume of the measuring cone (Item F) is 4,720 cc. The balance of the block is self-explanatory.

The example in Figure 4 shows weights for the sand volume determination in pounds. This is consistent with the type of field weighing scale presently utilized for this operation. Other measurements that require a higher degree of accuracy are generally accomplished with metric scales graduated in grams. Form T.L.-297 shows the proper conversions between pounds and grams.

PART 2. LABORATORY COMPACTED TEST MAXIMUM WET DENSITY AND PERCENT RELATIVE COMPACTION

A. SCOPE

A basic sample of soil is divided into smaller portions. These portions are prepared with varying moisture contents to form test samples, which are individually compacted by a uniform compactive effort, to determine the test maximum density for the particular soil under consideration.

NOTE: The test maximum density determination and percent relative compaction for Class A CTB is determined according to California Test 312.

B. APPARATUS

1. The standard California impact compaction test apparatus consisting of a split cylindrical mold, a 4.54 kg tamper, a metal piston, and a piston handling rod, as illustrated in Figure 2.

2. A concrete base block, or an equally rigid body, approximately 0.03 cubic m in size.

3. A balance or scale of at least 3 kg. capacity sensitive to 1 g.

4. Miscellaneous mixing bowls, spoons and spatulas.

NOTE: Calibration of the impact compaction apparatus is covered in California Test 110.

C. BULK SAMPLE

Obtain a bulk sample of soil 9 to 11.3 kg in weight at the site of the in-place density test hole. See Part I, Section I. *For this wet weight basis method of test, it is essential that the bulk sample be preserved at the same moisture as prevailed at the time of excavation.* Use only moisture proof containers and protect from high temperature.

D. PREPARATION OF TEST SAMPLES

1. Separate the bulk sample on the 19 mm sieve, weigh both the retained and the passing fractions and compute the percentage retained in terms of wet weight of the total basic

sample. If 10 percent or more of the total weight is retained on 19 mm sieve, follow the test procedure set forth in Section I of this Part II. If the retained 19 mm fraction comprises less than 10 per cent by weight of the total basic sample, discard it and divide the passing 19 mm fraction into representative test samples of exactly equal weight, each sufficient in amount to form a compacted test specimen 254 to 305 mm in height when compacted as specified in the following section E.

2. It is of the utmost importance that all of the basic sample material be thoroughly mixed. In addition, each test specimen must be representative of the mass, be of equal weight, be weighted in immediate succession, and be placed at one in covered individual containers.

3. The correct weight for each test specimen will depend on the soil type and the moisture content; 2300 to 2700 grams wet weight is the usual range of weight.

4. Record the actual weight of the individual test specimens on line "I" of form T.L.-297 as illustrated in the sample report of Figures 3 and 4.

E. COMPACTION OF TEST SPECIMENS

1. Divide one of the test specimens prepared as outlined in the foregoing Section D into five approximately equal portions by either weight or volume measurement. Place one portion in the test mold and compact it with 20 blows of the tamper dropping free from a height of 457 mm above the surface of the material in the mold. Repeat this operation for each of the remaining four portions. After the compaction of the fifth portion, place the piston in the mold and level the top of the compacted specimen with five blows of the tamper dropping free from a height of 457 mm above the surface of the piston.

2. With the tamper foot resting on the piston atop the compacted test specimen, read the graduated tamper shaft to the nearest graduation at a point level with the top of the mold. Enter this value on the line "J" of Form T.L.-297.

3. Obtain the density in grams per cubic centimeter from Table 1 corresponding to the tamper shaft graduation reading and record it on line "K".

4. Save the specimen temporarily for possible later use. (See first paragraph of Section G of the Part II).

5. Adjust the moisture contents of the remaining test samples to satisfy the following conditions:

   a. The object is to have at least one test sample with a moisture content below test optimum, one close to optimum and one above optimum, at about 2 percent moisture content increments, with a minimum of three test samples.

      While the actual moisture contents will not be known, the moisture content of the test specimen with the highest wet density is the test optimum moisture content even though the moisture content is unknown. Therefore, the primary objective is to have a number of test specimens and a range of moisture contents such that at least one specimen will be compacted at a moisture content less than, and one at a moisture content greater than, the moisture content of the specimen having the highest wet density. If this condition cannot be satisfied with the minimum three test specimens it will be necessary to fabricate additional specimens.

   b. The first test sample is generally compacted at the moisture content present in the basic sample. If this sample appears to be considerably drier than the optimum, mix additional water into each of the remaining samples. If it appears to be definitely wetter than the optimum, reduce the moisture content of the other samples by aeration. Partial oven drying may be used, but do not completely oven-dry the samples and then remix with water. If it appears to be close to the optimum, increase the moisture content of one of the remaining test samples and reduce it in the other one to bracket the initial sample thought to be at optimum.

   c. The test optimum moisture content will usually be the minimum moisture content which will ball the soil readily when compressed into a roll by the grip of the hand, but still permit the roll to be broken without crumbling or pulverizing appreciably at the breaking point.

d. The base plate of the test mold normally shows indications of dampness when a soil is compacted at the test optimum moisture content. Free water on the base plate definitely denotes excessive moisture content. A dry, dusty base plate signifies a deficiency of water.

6. After adjustment of the moisture content, compact each of the remaining test samples in the mold, then record the tamper reading and the corresponding wet density from the chart on Table 1. The weight of water so added or subtracted is not used in any calculations but is recorded as a plus or minus quantity in either grams or kilograms. Where dry densities are desired, determine moisture in accordance with California Test 226.

7. Regardless of the soil type or particle sizes involved, fresh soil (not soil from previously compacted specimens) must be used in the compaction of each test specimen. The compactive effort being equal for each layer, it is also important that the thickness of layers be equal to assure uniformity of compaction between test specimens.

8. Throughout the compacting operation the test mold must stand either on the standard concrete base block or on an equally rigid body.

9. In reassembling the test mold after removing a core, the wing nut should be drawn up only finger tight. The purpose of the wrench is to release the wing nuts when locked by expansive soils in the mold. Excessive tightening of the nuts distorts the circular cross-section of the mold. In gauging the 45.7 cm height of fall for the tamper, the hook and rod arrangement provided for this purpose should be used. (Figure 2).

F. COMPUTATION OF RELATIVE COMPACTION

Compute the percent relative compaction to the nearest 0.1 percent by the formula:

Percent Relative Compaction = $(D_1/D_2) \times 100$

Where:

D_1 = In-place wet density as shown on Line H of Figures 3 and 4.
D_2= Laboratory test specimen with highest wet density as determined by this method.

Show values used in computing the percent relative compaction as has been done in the example of Figure 4.

For reporting and specification compliance purposes, show the percent relative compaction as a whole number. If the computed value ends in a number with a fractional portion 0.5 percent or greater, report as the next higher whole number. If the computed value ends in a number with a fractional portion less than 0.5 percent, report without changing the whole number.

Example:

Computed Value	Reporting Value
94.5 to 95.0%	95%
95.0 to 95.4%	

G. MOISTURE CONTENTS

The moisture content of the specimen with the highest wet density is the optimum moisture. The moisture content of the specimen compacted without addition or reduction of water will also represent the in-place moisture content of the soil at the test site. If either moisture contents are desired or needed, the determination is made in accordance with California Test 226. Once the moisture contents are determined, percent relative compaction can also be determined by relating dry in-place density to dry test maximum density.

Provision is made at the bottom of Figures 3 and 4 for the determination of the Moisture Adjustment for Aggregate Base Pay Quantities.

H. MOISTURE-DENSITY CURVE

A moisture-density curve may be formed by plotting the wet density versus change in grams of water added or subtracted in adjusting the moisture contents of the test samples. The sample curve appearing on Figure 4 was plotted from the data presented on Line "K" and the "water adjustment" line.

The highest point on the curve represents the maximum density, in this instance 2.15 at 0 grams of water ("0 grams" thus means in-place moister content at test site is optimum moisture).

I. CORRECTION FOR OVERSIZE MATERIAL

1. The diameter of the test mold limits the size of particles that may be included in the test to that passing 19 mm sieve. In those instances where the original material from which the test specimen samples are obtained contains 10 percent or more by weight of particles retained on the 19 mm sieve, a correction must be applied to the test.

   The density correction is calculated by the following:

$$\text{Corrected Density} = \frac{100}{\dfrac{\%\ \text{of} -19\ \text{mm}}{G_1} + \dfrac{\%\ \text{of} +19\ \text{mm}}{YG_1}}$$

G_1 = Specific gravity of −19 mm material (compacted specimen)
G_2 = Specific gravity of +19 mm material
Y = Coefficient for +19 mm aggregate

% of +19 mm	Y
20 or less	1.00
21-25	0.99
26-30	0.98
31-35	0.97
36-40	0.96
41-45	0.95
46-50	0.94

2. Record the total weight of excavated sample as shown on line "L" of Figure 4.

3. Separate the basic sample on the 19 mm sieve, wash the retained 19 mm material, remove excess surface water by rolling sample in a large, absorbent cloth. Weigh in air and record on line "M" of Figure 4.

4. Weigh the retained 19 mm fraction in water and record on line "N" of Figure 4.

5. The impact test is performed on the passing 19 mm fraction as outlined in Sections C through E of this Part II.

6. The remainder of the calculations necessary to compensate for the retained 19 mm material and to determine percent relative compaction is shown on lines "O" through "V" of Figure 4.

7. When a number of tests on soil containing essentially the same nature of retained 19 mm material are anticipated, a constant may be developed to minimize the weighing in air and water operations.

J. SIMPLIFICATIONS FOR CONSTRUCTION CONTROL

Construction control by wet density tests may be expedited. If the relative compaction based on any test specimen density is below the specified minimum it may be immediately reported that the area under test has failed to meet the specifications. It is not necessary to fabricate additional test cores for the reason that if a higher wet density was reached with subsequent test cores the relative compaction based on this higher density would be still lower than that indicated by the single core. When the relative compaction indicated by a single test core is more than the minimum specified, additional cores are necessary to be certain that any increase in wet test maximum density attained with the subsequent cores does not lower the relative compaction value to below the specification minimum.

K. SAFETY AND HEALTH

Prior to handling, testing or disposing of any waste material, testers are required to read Part A, Section 5.0, Part B, Section 5.0, 6.0, 10, and Part C, Section 1.0 of Caltrans Laboratory Safety Manual. Users of this manual do so at their own risk

REFERENCES:
California Tests 231, 312 and 110

End of Text (California Test 216 contains 12 pages)

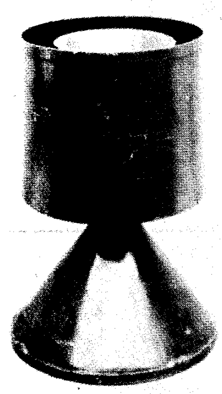
Table 1

CALIFORNIA IMPACT TEST APPARATUS CONVERSION TABLE

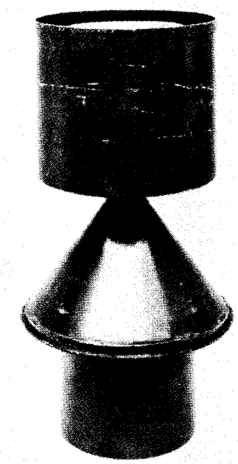
Tamper Reading to Grams Per Cubic Centimeter for Impact Test Core Weights
2200–2700 Grams

Tamper reading	Weight of test core in grams										
	2200	2250	2300	2350	2400	2450	2500	2550	2600	2650	2700
10.0	2.09	2.13	2.18	2.23	2.27	2.32	2.37	2.42	2.46	2.51	2.56
10.1	2.06	2.11	2.16	2.21	2.25	2.30	2.35	2.39	2.44	2.49	2.53
10.2	2.04	2.09	2.14	2.18	2.23	2.28	2.32	2.37	2.42	2.46	2.51
10.3	2.02	2.07	2.12	2.16	2.21	2.25	2.30	2.35	2.39	2.44	2.48
10.4	2.01	2.05	2.10	2.14	2.19	2.23	2.28	2.32	2.37	2.42	2.46
10.5	1.99	2.03	2.08	2.12	2.17	2.21	2.26	2.30	2.35	2.39	2.44
10.6	1.97	2.01	2.06	2.10	2.15	2.19	2.24	2.28	2.33	2.37	2.41
10.7	1.95	1.99	2.04	2.08	2.13	2.17	2.21	2.26	2.30	2.35	2.39
10.8	1.93	1.97	2.02	2.06	2.11	2.15	2.19	2.24	2.28	2.33	2.37
10.9	1.91	1.96	2.00	2.04	2.09	2.13	2.17	2.22	2.26	2.30	2.35
11.0	1.90	1.94	1.98	2.03	2.07	2.11	2.15	2.20	2.24	2.28	2.33
11.1	1.88	1.92	1.96	2.01	2.05	2.09	2.13	2.18	2.22	2.26	2.31
11.2	1.86	1.90	1.95	1.99	2.03	2.07	2.12	2.16	2.20	2.24	2.29
11.3	1.85	1.89	1.93	1.97	2.01	2.06	2.10	2.14	2.18	2.22	2.26
11.4	1.83	1.87	1.91	1.95	2.00	2.04	2.08	2.12	2.16	2.20	2.25
11.5	1.81	1.85	1.90	1.94	1.98	2.02	2.06	2.10	2.14	2.18	2.23
11.6	1.80	1.84	1.88	1.92	1.96	2.00	2.04	2.08	2.12	2.17	2.21
11.7	1.78	1.82	1.86	1.90	1.94	1.98	2.03	2.07	2.11	2.15	2.19
11.8	1.77	1.81	1.85	1.89	1.93	1.97	2.01	2.05	2.09	2.13	2.17
11.9	1.75	1.79	1.83	1.87	1.91	1.95	1.99	2.03	2.07	2.11	2.15
12.0	1.74	1.78	1.82	1.86	1.90	1.94	1.97	2.01	2.05	2.09	2.13

CALIFORNIA STANDARD SAND VOLUME APPARATUS



Apparatus in position to measure the volume of a test hole



Apparatus in position on the measuring vessel to determine the calibration of the test sand

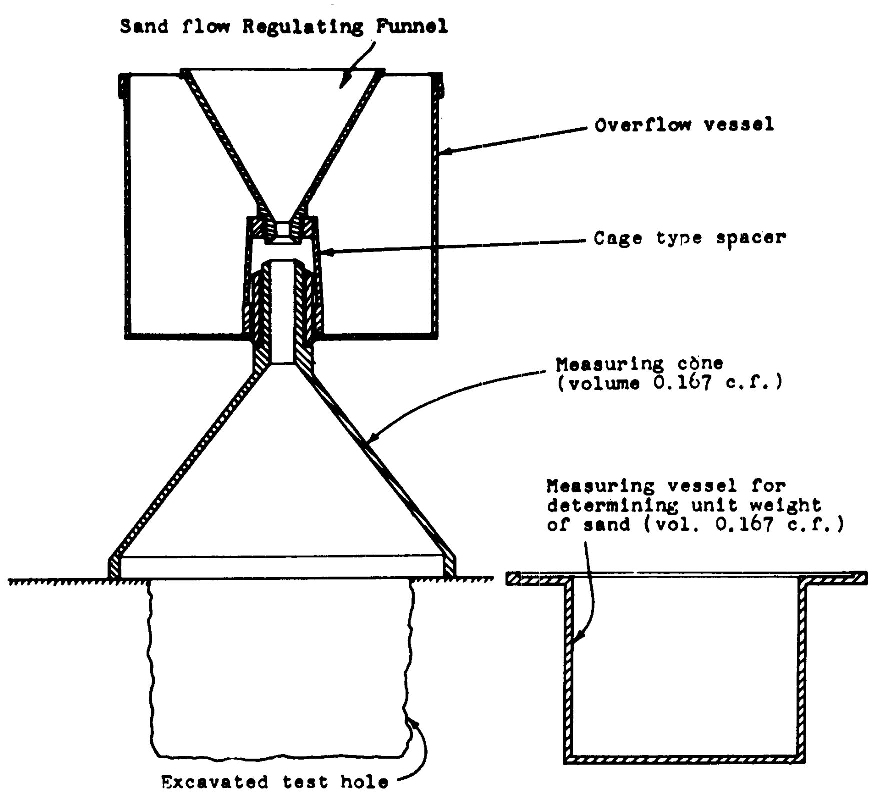


FIGURE 1

CALIFORNIA IMPACT COMPACTION APPARATUS

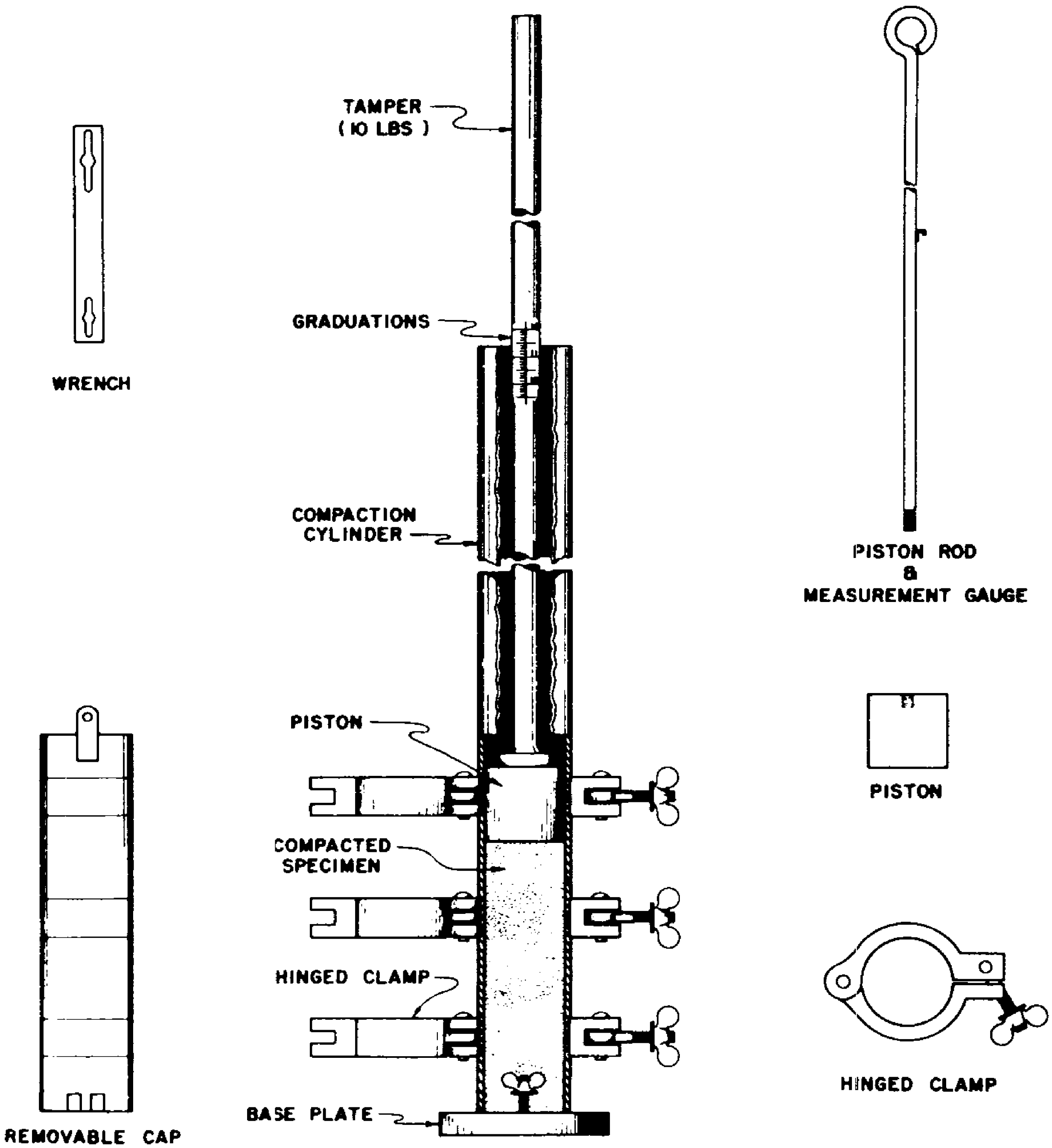


FIGURE 2

State of California	RELATIVE COMPACTION TEST	**Department of**

Job Stamp	Loc.	Test No.
	Mat'l.	From
	Impact by	Sand Vol. by
	Date	Date

SAND VOLUME DATA

A	Initial Wt. Sand	15000
B	Wt. of Residue	1329
C	Wt. of Sand Used (A-B)	13671
D	Sand Density	1.506
E	Vol. Hole + Cone (C/D)	9078
F	Vol. of Cone	4720
G	Vol. of Hole (E-F)*	4358
H	Wet Den. gm/cc (L/G)	2.06

*28,317 (E-F) to convert CF to CC

Remarks

IMPACT TEST DATA

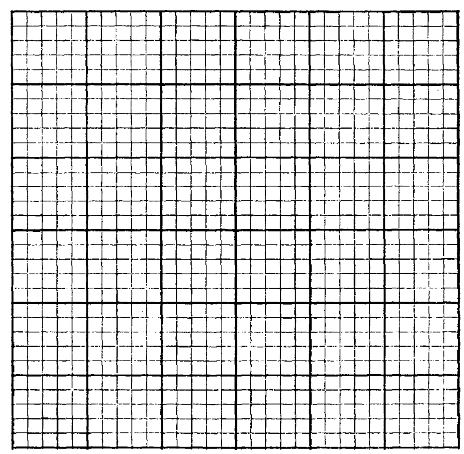
I	Initial Wet Weight of Test Specimen (Grams)					2700
	Increment	1	2	3	4
	Water Adjustment (grams)	0			
J	Tamper Reading	10.8			
K	Wet Den. g/cc fr. Table 1	2.37			

ROCK CORRECTION

L	Total Sample Wt. (lbs) 454 = (gm)		8975
M	+19 mm Weight in Air	(grams)	
N	+19 mm Weight in Water	(grams)	
O	+19 mm Volume	(M-N)	
P	% +19 mm 100	(M/L)	
Q	% -19 mm	(100 – P)	
R	Density of +19 mm	(M/O)	
S	(%+19 mm)/Density of +19 mm	(P/RY)	
T	(%-19 mm)/Density of -19 mm	(Q/K)	
U	Sum of S and T	(S+T)	
V	Average Adjusted Density	(100/U)	

Percent Relative* Compaction	Spec 90	Failed 87 or less
		Passed

*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm



Note: 62.4 x (gm/cc) = P.C.F.

MOISTURE ADJUSTMENT FOR AGGREGATE BASE PAY QUANTITY

a	In-place Wet Wt.		e	Test Spec. Wet Wt. (Opt.)	
b	In-place Dry Wt.		f	Test Spec. Dry Wt.	
c	In-place H_2O (a-b)		g	Test Spec. H_2O (e-f)	
d	In-place % H_2O (c/b)		h	Test Spec. % H_2O (g/f)	

Moist. Corr. (h + 1%) - d =

Moist. Corr. in excess of Opt. + 1% | % Moist. by T.M. 226

+19 mm Agg. Adj. (Y)

(%+19 mm) (P)	adj.
20 or less	1.00
21-25	0.99
26-30	0.98
31-35	0.97
36-40	0.96
41-45	0.95
46-50	0.94

FIGURE 3

State of California — Department of Transportation

RELATIVE COMPACTION TEST

Job Stamp		
	Loc.	Test No.
	Mat'l.	From
	Impact by	Sand Vol. by
	Date	Date

Remarks

SAND VOLUME DATA

A	Initial Wt. Sand	37.7
B	Wt. of Residue	5.9
C	Wt. of Sand Used (A-B)	31.8
D	Sand Density	95.1
E	Vol. Hole + Cone (C/D)	.334
F	Vol. of Cone	.167
G	Vol. of Hole (E-F)*	.167
H	Wet Den. gm/cc (L/G)	2.13

*28.317 (E-F) to convert CF to CC

IMPACT TEST DATA

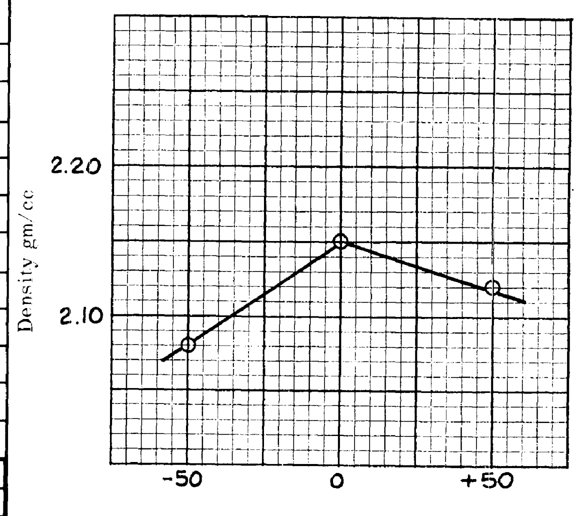
I	Initial Wet Weight of Test Specimen (Grams)	2,500			
	Increment	1	2	3	4
	Water Adjustment (grams)	0	+50	-50	
J	Tamper Reading	11.0	11.2	11.4	
K	Wet Den. g/cc fr. Table 1	2.15	2.12	2.08	

ROCK CORRECTION

L	Total Sample Wt. (lbs) 454 = (gm)		10 055
M	+19 mm Weight in Air	(grams)	3183
N	+19 mm Weight in Water	(grams)	1874
O	+ 19 mm Volume	(M-N)	1309
P	% + 19 mm 100	(M/L)	13.6
Q	% – 19 mm	(100 – P)	68.4
R	Density of + 19 mm	(M/O)	2.43
S	(%+19 mm) /Density of +19 mm	(P/RY)	13.4
T	(%-19 mm) /Density of +19	(Q/K)	31.8
U	Sum of S and T	(S+T)	45.2
V	Average Adjusted Density	(100/U)	2.21

Percent Relative* Compaction	Spec	Failed	or less
	95	Passed	96

*(H/K) for 10% or less +19 mm; (H/V) for > 10% + 19 mm



Note: 62.4 x (gm/cc) = P.C.F.

MOISTURE ADJUSTMENT FOR AGGREGATE BASE PAY QUANTITY

a	In-place Wet Wt.		e	Test Spec. Wet Wt. (Opt.)	
b	In-place Dry Wt.		f	Test Spec. Dry Wt.	
c	In-place H_2O (a-b)		g	Test Spec. H_2O (e-f)	
d	In-place % H_2O (c/b)		h	Test Spec. % H_2O (g/f)	

Moist. Corr. (h + 1%) - d =

Moist. Corr. in excess of Opt. + 1% | % Moist. by T.M. 226

+ 19 mm Agg. Adj. (Y)

% +19 mm (P)	adj.
20 or less	1.00
21-25	0.99
26-30	0.98
31-35	0.97
36-40	0.96
41-45	0.95
46-50	0.94

HMRT 297 (REV. 1/71)

FIGURE 4