HDOT TM 1-00

Standard Test Method for Density of Soil In-Place by the Sand-Cone Method

1. Scope

1.1 This test method covers the determination of the in-place density of soils, base courses and, in general, all backfill material.

2. Apparatus

2.1 Density Apparatus - The density apparatus shall be of molded plexiglass of the type issued by the Department. (See Figure 1 and Note 1).

Note 1: Other apparatus of similar proportions as in AASHTO T191 or ASTM D1556 will perform satisfactorily so long as the basic principles of the sand-volume determinations are observed. This apparatus when full can be used to test holes having a volume of approximately 0.003 m^3 (0.1 cubic feet). The base plate shall be used and considered part of the lower cone in the procedure of this test method.

2.2 Sand - Any clean, dry, free flowing uncemented sand having few, if any, particles passing the 75 μm (No. 200) or retained on the 1.18 mm (No. 16) sieves. The loose density shall be determined in accordance with Hawaii Test Method, HDOT TM 2, "Determining the Loose Density of Sand".

2.3 Balances - Any suitable or appropriate balances or scales generally having capacities of 20 kg readable to 5 g (0.01 lb.) for density samples and 300 g readable to 0.01 g for moisture samples.

2.4 Drying Apparatus - Stove, oven or other suitable apparatus adapted for drying moisture content samples.

2.5 Miscellaneous Apparatus - Chisel, hammer, spoon, and brush for digging test holes; sack or other containers for soil sample and density sand; seamless tin cans with lids for moisture sample; thermometer for determining temperature of the drying unit; tongs to handle heated container of moisture sample, etc.

3. Procedure

3.1 Surface Voids Determination:

3.1.1 Prepare the surface of the location to be tested so that it is a level plane.

3.1.2 Brush the surface lightly of all loose material. Position and seat the base plate to attain a stable and firm bearing. Mark its outline on the surface.

3.1.3 Fill the plastic cylinder with approximately 1500 grams (3.3 pounds) of prepared sand.

Note 2: Units of pre-measured prepared sand of 1500 grams and 4000 grams and a density sample container are available at the Materials Testing and Research Laboratory for use by HDOT personnel.

3.1.4 Attach the cone assembly to the plastic container. Be sure that the valve is closed. Invert the apparatus and position it carefully on the base plate.

3.1.5 Open the valve to the full open position and allow the sand to flow freely without disturbances until the flow stops.

Note 3: Vibration or disturbance of the sand during any sand-volume determination will increase the bulk density of the sand and decrease the accuracy of the test.

3.1.6 Check the lower cone for voids or unusual flow. If everything is in order, close the valve sharply.

3.1.7 Remove the apparatus from the base plate, invert it, and open the valve to allow the entrapped sand in the valve to flow into the plastic container. Remove the plastic container from the cone assembly and return the sand to its original container.

3.2 Digging the Test Hole

3.2.1 Carefully brush the sand away without disturbing the original surface. Replace the base plate to its original position by using the pre-marked outline as a guide.

3.2.2 Dig the test hole within the inner limits of the base plate being very careful to avoid disturbing the soil that will bound the hole. (Note 4). Extreme care should be exercised to avoid spilling or loosing any portion of the sample. Place all loosened soil into the sample container. (Notes 5 and 6).

Note 4: The hole should be approximately 15 cm (6 inches) in diameter with neat vertical sides extending the full depth of the lift. The minimum depth shall be the depth of the lift but not less than 6 cm (2-1/2 inches) and the maximum depth shall be 18 cm (7 inches).

Note 5: Large stones embedded in the sides of the test hole should not be disturbed as much as possible. Any stone greater than 5 cm (2 inches) in minimum dimensions that is removed shall be replaced as described in Note 7.

Note 6: Several factors which will decrease the accuracy of the test are:

- **(a) prying against and excessively disturbing the sides of the test hole;**
- **(b) attempting to chip rocks embedded in the sides of the test hole;**
- **(c) careless handling and loss of any portion of the sand or material;**
- **(d) creating large voids on the perimeter of the test hole;**
- **(e) external disturbances and vibration caused by construction equipment; and**
- **(f) careless handling of the apparatus while closing the valve.**

3.2.3 Brush the sides and bottom of the test hole to remove all loose material. Gather all the loosened material and place them in the soil sample container.

3.2.4 Reposition the base plate and fill the plastic container with approximately 4000 grams of prepared sand. Repeat the procedures described in Paragraphs 3.1.4 to 3.1.7. (Note 7)

Note 7: Whenever any stone larger than 5 cm (2 inches) is to be replaced, stop the flow of sand when the test hole is partially filled. Remove the apparatus and replace the stone carefully and gently without disturbing or compressing the sand any more than the weight of the stone. Reposition the apparatus carefully on the base plate and continue the test.

3.3 Determining the Mass of the Samples

3.3.1 Weigh the containers with the remaining sand and soil sample from the test hole.

Note 8: All pertinent data shall be recorded on a format similar to Figure 2. See Figure 3 for sample of completed form.

3.4 Determining the Moisture Content of the Soil Sample

3.4.1 The soil sample shall be thoroughly mixed and representative samples shall be taken. The procedures as described in Hawaii Test Method, HDOT TM 3, "Field Determination of Moisture Content of Soils", shall be followed.

3.5 Calculations

3.5.1 The steps outlined in Figure 2, Field Compaction Test Data shall be followed.

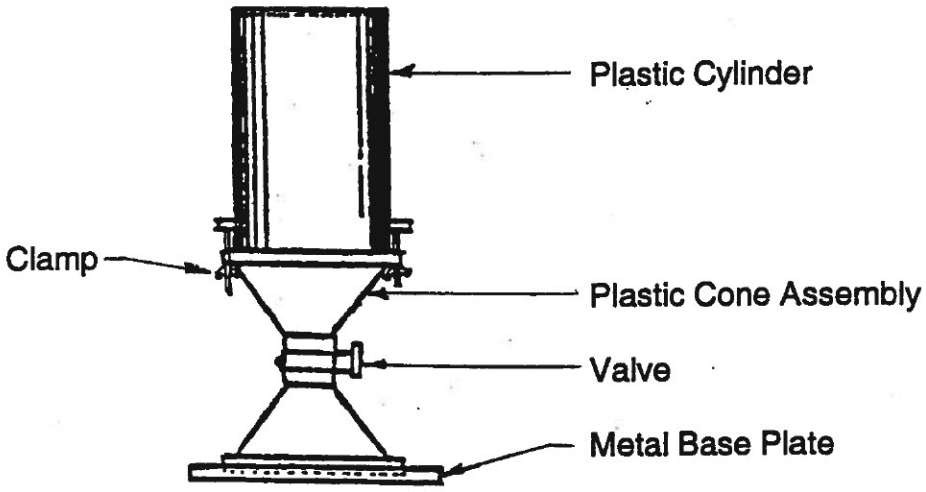

FIGURE 1 - DENSITY APPARATUS

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

FIELD COMPACTION TEST

Sample No. _____ Station No. _____

Project _____ Location _____

Description, Color and Type of Sample _____ Elevation of Lift _____

_____ Finish Elevation _____

Date _____ Test Performed by _____

SURFACE VOIDS DETERMINATION **Apparatus No.** _____

a. Mass of Sand + Container Before Determination ..... _____ grams

b. Mass of Sand + Container After Determination ..... _____ grams

c. Mass of Sand Used for Determination (a - b) ..... _____ grams

IN-PLACE DENSITY **Tare Number** _____ **453.6 GRAMS = 1 LB.**

d. Mass of Sand + Container Before Test ..... _____ grams

e. Mass of Sand + Container After Test ..... _____ grams

f. Mass of Sand Used for Test (d - e) ..... _____ grams

g. Mass of Sand Used for Voids Determination (c) ..... _____ grams

h. Net Mass of Sand Used for Test (f - g) ..... _____ grams _____ lbs.

i. Loose Density of Sand ..... _____ pcf

j. Volume of Hole (h ÷ i) ..... _____ cu . ft.

k. Mass of Wet Sample + Container ..... _____ grams

l. Mass of Container ..... _____ grams

m. Mass of Wet Sample from Hole (k - l) ..... _____ grams _____ lbs.

n. In-Place Density of Wet Sample (m ÷ j) ..... _____ pcf

MOISTURE CONTENT DETERMINATION **Tare Number** _____

o. Soil Sample + Container ..... _____ grams

p. O D Soil + Container ..... _____ grams

q. Mass of Moisture (o - p) ..... _____ grams

r. O D Soil + Container (p) ..... _____ grams

s. Container Weight ..... _____ grams

t. Mass of O D Soil (r - s) ..... _____ grams

u. Moisture Content (q ÷ t) X 100 ..... _____ %

DRY DENSITY AND RELATIVE COMPACTION

v. In-Place Density of Wet Sample (n) ..... _____ pcf

w. Moisture Content (u) ..... _____ %

x. Dry Density v ÷ (100 + w) X 100 ..... _____ pcf

y. Maximum Dry Density (Proctor Results)..... _____ pcf

z. Relative Compaction (x ÷ y) X 100 ..... _____ %

NOTE _____

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Figure 2 - FIELD COMPACTION TEST DATA

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

FIELD COMPACTION TEST

Sample No. 7 | Station No. 391+25
Project F-090-1(10) Kam Hwy | Location Inbound Lane
Description, Color and Type of Sample Select Borrow | Elevation of Lift 13.39
Finish Elevation 15.53
Date March 17, 1999 | Test Performed by Gary Abe

SURFACE VOIDS DETERMINATION	Apparatus No. 21		
a. Mass of Sand + Container Before Determination	1500 grams		
b. Mass of Sand + Container After Determination	469 grams		
c. Mass of Sand Used for Determination (a - b)	1031 grams		
IN-PLACE DENSITY	Tare Number 22		453.6 GRAMS = 1 LB.
d. Mass of Sand + Container Before Test	4000 grams		
e. Mass of Sand + Container After Test	521 grams		
f. Mass of Sand Used for Test (d - e)	3479 grams		
g. Mass of Sand Used for Voids Determination (c)	1031 grams		
h. Net Mass of Sand Used for Test (f - g)	2448 grams	5.40	lbs.
i. Loose Density of Sand		93.3	pcf
j. Volume of Hole (h ÷ i)		0.05788	cu. ft.
k. Mass of Wet Sample + Container	3725 grams		
l. Mass of Container	55 grams		
m. Mass of Wet Sample from Hole (k - l)	3670 grams	8.09	lbs.
n. In-Place Density of Wet Sample (m ÷ j)		139.8	pcf
MOISTURE CONTENT DETERMINATION	Tare Number 12		
o. Soil Sample + Container	59.71 grams		
p. O D Soil + Container	54.86 grams		
q. Mass of Moisture (o - p)	4.85 grams		
r. O D Soil + Container (p)	54.86 grams		
s. Container Weight	13.92 grams		
t. Mass of O D Soil (r - s)	40.94 grams		
u. Moisture Content (q ÷ t) X 100		11.8	%
DRY DENSITY AND RELATIVE COMPACTION			
v. In-Place Density of Wet Sample (n)		139.8	pcf
w. Moisture Content (u)		11.8	%
x. Dry Density v ÷ (100 + w) X 100		125.0	pcf
y. Maximum Dry Density (Proctor Results)		127.5	pcf
z. Relative Compaction (x ÷ y) X 100		98	%

NOTE Retake of Sample No. 3 tested on Mar. 15, 1999

Figure 3 - FIELD COMPACTION TEST DATA, SAMPLE OF COMPLETED FORM