APPENDIX XIIA:

MODIFIED PROVIDENCE VIBRATED DENSITY TEST

1. INTRODUCTION. The modified Providence vibrated density test is used to determine the maximum density of a cohesionless soil when the use of a vibratory table (as described in Appendix XII, RELATIVE DENSITY) is not feasible, especially in field laboratories. The apparatus and procedure are similar to those used for the Providence vibrated density test,† except that the surcharge is applied with a 38.5-lb weight (equivalent to 1 psi) instead of the 1000-lb calibrated spring (equivalent to 26 psi). In this test, a sample of oven-dried soil is placed in a heavy steel mold, compressed under the surcharge, and vibrated to maximum density by repeatedly striking the side of the mold with a hammer.

2. APPARATUS. The apparatus shall consist of the following:

a. Cylindrical steel mold having a capacity of about 0.16 cu ft and an inside diameter of 7 in., as shown in Figure 1.

b. Surcharge assembly, as shown in Figure 2, consisting of a surcharge weight with guide rod, a surcharge baseplate with lifting rod, and a guide yoke with clamping bolts.

c. Depth gage consisting of a dial indicator, having 0.004 in. graduations and a 2-in. range, fitted with a depth gage base and an extra long stem to reach from the top of the guide yoke to the top of the surcharge baseplate.

d. Calibration bar, metal, 2 in. by 1/8 in. by 7-1/2 in. long.

e. Hammer, 2-1/2-lb ball peen.

f. Pouring device (as shown in Figure 3 of Appendix XII,

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†U. S. Army Engineer Division, New England, CE, New England Division Laboratory Procedure for Performing the Providence Vibrated Density Test to Determine the Maximum Density of Cohesionle ss Soils (Waltham, Mass., August 1957).

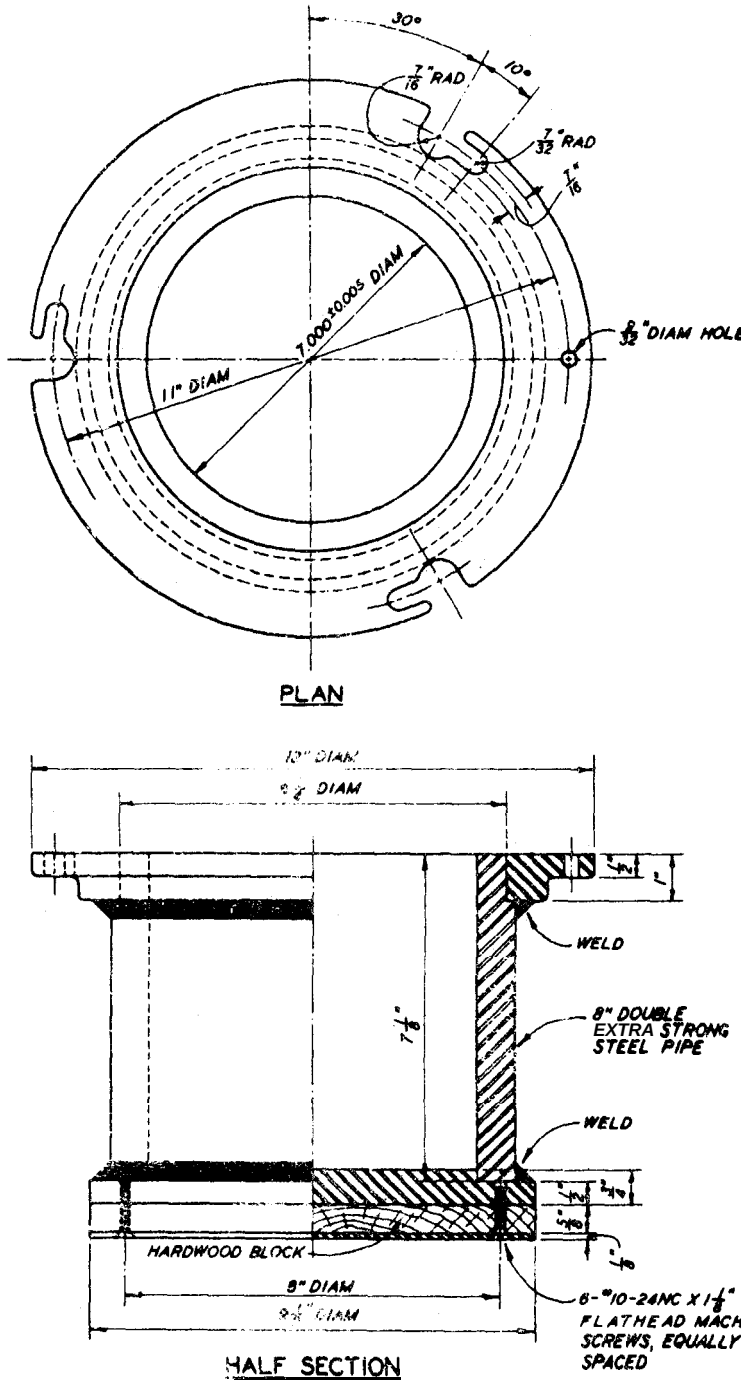

Figure 1. Details of mold

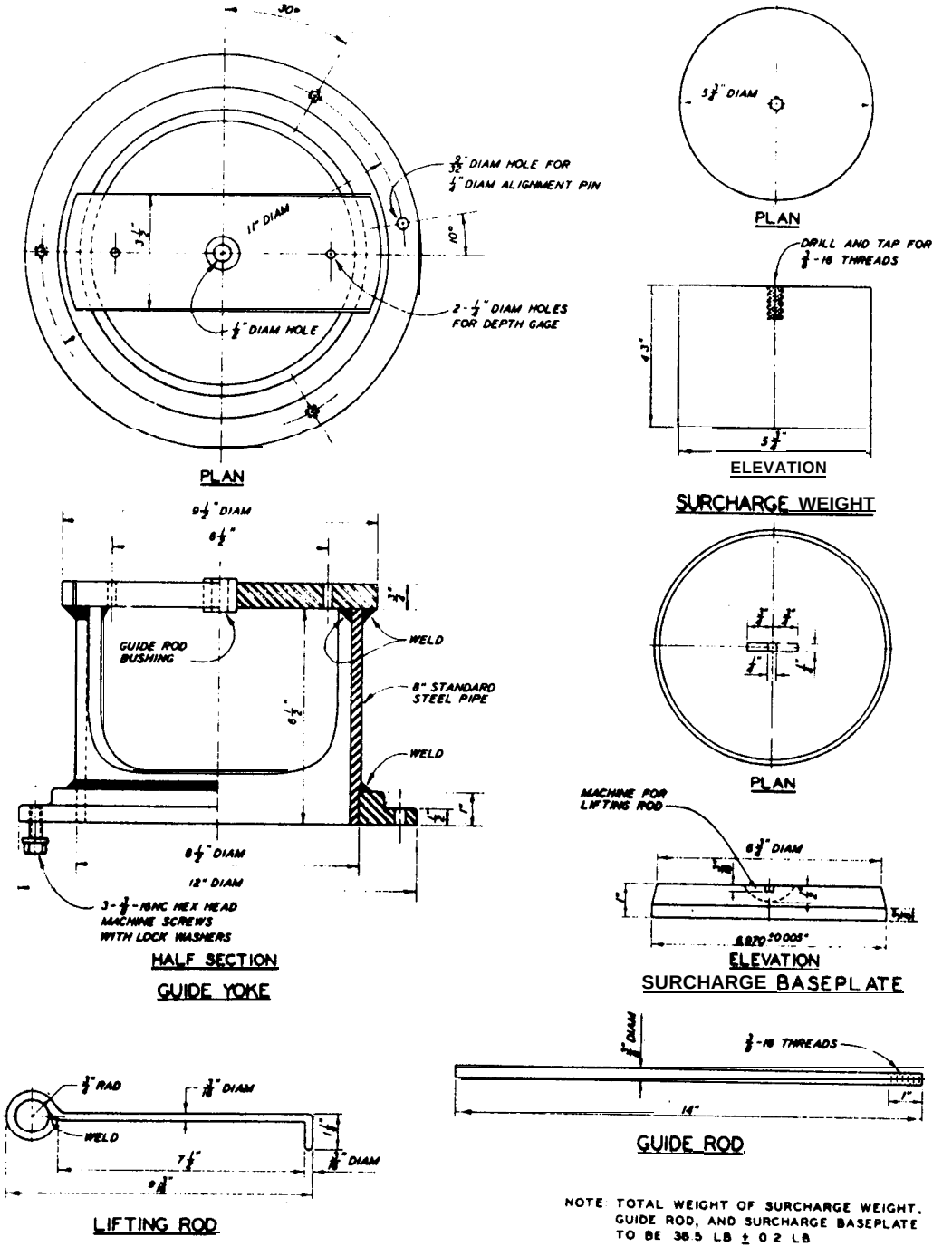

Figure 2. Equipment for maximum density determination

RELATIVE DENSITY) having metal funnels with 1/2- and 1 -in. -diameter cylindrical spouts, each attachable to a metal can 6 in. in diameter by 12 in. high.

g. Hand scoop large, metal.

h. Mixing pans, large, metal.

i. Sample splitter or riffle.

j. Straightedge, 15-in., steel.

k. Balance or scale of at least 25-lb capacity sensitive to 0.01 lb.

l. Oven (see Appendix I, WATER CONTENT - GENERAL).

3. CALIBRATION OF EQUIPMENT. The mold shall be calibrated as follows:

a. Determine the capacity, or total inside volume, V_m, of the mold to the nearest 0.0001 cu ft.†

b. Determine the inside cross-section area, A_m, at the open end of the mold to the nearest 0.0001 sq ft.

c. Determine the initial dial reading, h_o, in the following manner:

(1) Measure the thickness of the calibration bar, t_c, and of the surcharge baseplate, t_s, to the nearest 0.001 in.

(2) Attach the guide yoke to the mold, tightening the clamping bolts firmly.

(3) Place the calibration bar inside the guide yoke so that it lies on top of. the mold in alignment with the top of the yoke.

(4) Place the depth gage on the top of the yoke with the dial indicator stem passing through one of the depth gage holes to rest on top of the calibration bar, and note the dial reading. Then insert the stem through the other hole and note the dial reading.

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† Since the weight, W_m, of this heavy mold, if included as a tare, would detract from the accuracy of weighing the soil in the mold, the soil should be removed from the mold for weighing.

(5) Compute the average, h_r, of the two dial readings.

(6) Compute the initial dial reading, h_o, by the equation

$$h_o = h_r + t_c - t_s$$

4. PREPARATION OF SAMPLE. The sample shall be prepared as described in paragraph 4 of Appendix XII, RELATIVE DENSITY, except that the maximum particle size of the sample must be less than 2-1/2 in. The sample should weigh at least 25 lb.

5. PROCEDURE. a. Minimum Density Determination. The procedure for determining the minimum density shall consist of the following steps:

(1) Proceed in accordance with paragraphs 5a(1) through 5a(3) of Appendix XII, RELATIVE DENSITY.

(2) If the maximum density of the oven-dried sample is not to be determined,† empty the contents of the mold into a mixing pan and weigh the pan and soil to the nearest 0.01 lb. Record the weight on the data sheet.

(3) Paragraph 5a(3) of Appendix XII, RELATIVE DENSITY, and step (2) above should be repeated until consistent results (within 1 percent) are attained.

b. Maximum Density Determination. The procedure for determining the maximum density shall consist of the following steps:

(1) Proceed in accordance with paragraphs 5a(1) through 5a(3) of Appendix XII, RELATIVE DENSITY.

(2) Rap the side of the mold gently with the hammer until the surface of the soil settles at least 1/8 in. below the top of the mold, taking care that the surface of the soil remains parallel with the top of the mold.

(3) Lower the surcharge baseplate onto the surface of the soil

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† If the maximum density of the oven-dried sample is to be determined also, proceed in accordance with paragraphs 5b(2) through 5b(8).

and remove the lifting rod. Place the surcharge weight on the surcharge baseplate so that it is centered on the plate. Lower the guide yoke onto the top of the mold, threading the guide rod through the center hole in the top of the yoke, and clamp the yoke firmly to the mold.

(4) Strike the side of the mold between the flanges with sharp, forceful blows of the ball-peen hammer, rotating the mold as each blow is delivered. The blows shall be uniformly distributed over the height and circumference of the mold at a rate not exceeding 40 blows per minute

(5) When the vertical movement of the guide rod becomes imperceptible, place the depth gage on the top of the yoke with the dial indicator stem passing through one of the depth gage holes to rest on top of the surcharge baseplate, and note the dial reading. Then continue striking the mold in cycles of about 25 blows, reinserting the depth gage into the same hole after each cycle and noting the dial reading. The sample shall be considered to have attained the maximum density when the change in dial reading for any 25-blow cycle is less than 0.005 in.

(6) Obtain final dial readings with the depth gage inserted through each of the holes in the yoke. Record the dial readings on the data sheet.

(7) Remove the guide yoke, surcharge weight, and surcharge baseplate from the mold.

(8) Empty the contents of the mold into a mixing pan and weigh the pan and soil to the nearest 0.01 lb. Record the weight on the data sheet.

6. COMPUTATIONS. The computations shall be made as described in paragraph 6 of Appendix XII, RELATIVE DENSITY.

7. POSSIBLE ERRORS. Besides the errors given in paragraphs 7a and 7b of Appendix XII, RELATIVE DENSITY, following are possible errors that would cause inaccurate determinations of maximum density:

a. Loosening of yoke during vibration. The clamping bolts should be checked before each dial reading to ascertain that the yoke is

tightly secured to the mold.

b. Nonuniform distribution of hammer blows over the height and circumference of mold.

c. Vibration of mold stopped too soon.

d. Mold used as tare when determining weight of contents.