STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

METHOD OF TEST FOR VOID CONTENT AND SPECIFIC GRAVITY OF AGGREGATES AND CEMENT/AGGREGATE COMBINATIONS BY THE VOIDMETER METHOD

VT AOT-MRD-36-85

1. SCOPE

This method covers the determination of voids in and specific gravity of fine, coarse or mixed aggregates and cement/aggregate mixtures.

2. APPARATUS

2.1 Voidmeter - an apparatus consisting of a sample container, cover assembly, calibrated measuring tube, water reservoir and connecting flexible tubing illustrated in Figure 1. The operational principle of this apparatus consists of a means of allowing a column of water in the measuring tube to act on the total volume of air within the apparatus (volume of air in the sample plus the volume of air from the top of the sample to the water level in the glass bulb) causing an increase in volume and a corresponding decrease in pressure. Equilibrium of the water column is reached when the pressure of air in the system plus the pressure due to the height of the water column is equal to the atmospheric pressure. As the volume of air above the sample is constant, variation in the distance that the water column falls is directly related to the volume of air in the sample. The apparatus is calibrated to a volume of 3.5 liters and takes into account the volume of air which is constant in the apparatus above the 3.5 liter mark on the sample container.

2.2 Tamping Piston - The tamping piston illustrated in Figure 2 shall consist of a steel disc with rubber discs at the top and bottom, as a protection against damage to the glass container. The piston shall be approximately 5¼ inches in diameter with the thickness such that when the volume of the sample is 3.5 liters, the top of the piston is flush with the top of the sample container. The tamping piston shall weigh 3.15 kilograms.

2.3 Balance - The balance shall conform to the requirements given for Class E balances in Table 3 of AASHTO M 231.

2.4 Scoop - A small metal scoop.

2.5 Spoon - A metal spoon approximately 12 inches long.

2.6 Mixing Container - A pan made of metal or plastic having a capacity of approximately 0.5 cu.ft.

3. CALIBRATION OF APPARATUS

3.1 The voidmeter sample container and calibrated measuring tube are matched and calibrated at the factory. Upon receipt, the sample container and calibrated measuring tube should be labeled and used together. If the sample container needs replacement, the measuring tube must be returned to the factory to be recalibrated and matched to a new sample container. Likewise, if the measuring tube needs replacement, the sample container must be returned.

3.2 Place the apparatus on a level, rigid surface. Fill the leveling bulb with distilled water and place the bulb in the upper retort ring. Adjust the water level in the leveling bulb to a height that brings the bottom of the meniscus to the initial water level mark near the top of the calibrated measuring tube.

3.3 Calibration for zero percent of voids - The zero percent of voids should be checked when the voidmeter is first placed in service and when the sample container and calibrated measuring tube are replaced. Fill the sample container with water to the 3.5 liter mark and place the container on the voidmeter base between the hold down rods. Center the cover assembly on top of the sample container with the air release valve facing the front of the apparatus. Secure the cover assembly to the sample container and attach the hose from the top of the measuring tube to the cover. With the leveling bulb in the upper retort ring, close the air release valve. Move the leveling bulb from the upper retort ring to the bottom retort ring and check the level of the water in the calibrated measuring tube. The bottom of the meniscus should be at the zero percent of voids mark. If the water level does not rest at the zero percent mark, adjust the position of the measuring tube and repeat the steps outlined in 3.2. Repeat the operations outlined in this section and in 3.2 until several repetitions indicate the apparatus is calibrated for zero percent voids. If difficulty is encountered in obtaining consistent readings, check hose connections and cover gasket for leaks.

3.4 Calibration for one hundred percent of voids - The one hundred percent of voids should be checked when the voidmeter is first placed in service, when the sample container and calibrated measuring tube are replaced and daily when the apparatus is in use. Place the empty sample container on the voidmeter base, secure the cover assembly and attach the hose from the

measuring tube as outlined in 3.3. With the leveling bulb in the upper retort ring, close the air release valve. Move the leveling bulb from the upper retort ring to the bottom retort ring and check the level of the water in the calibrated measuring tube. The bottom of the meniscus should be at the one hundred percent of voids mark. If difficulty is encountered in obtaining consistent readings, check hose connections and cover gasket for leaks. If after several determinations the apparatus cannot be calibrated at the one hundred percent mark, replacement of the sample container and calibrated measuring tube may be necessary.

4. PREPARATION OF SAMPLES

4.1 Sampling of aggregates should generally be accomplished in accordance with AASHTO T2, and sample reduction in accordance with AASHTO T248. Dry samples of aggregate to essentially constant weight.

4.2 Sampling of cement should generally be accomplished in accordance with AASHTO T 127.

5. PROCEDURES FOR DETERMINATION OF PERCENT OF VOIDS

5.1 Individual aggregates - Place the material in the sample container in 25mm layers. Compact each layer by dropping the tamping piston through a height of 25mm, 10 times. Place the final layer so that after tamping the container is filled to the 3.5 liter mark. When the con-

tainer is filled to the proper depth, the top of the tamping piston, after compacting the material, will be flush with the top of the sample container. Place the sample container on the voidmeter base and secure the cover assembly to the container with the air release valve facing the front of the apparatus. Attach the hose from the top of the calibrated measuring tube to the cover assembly. With the leveling bulb in the upper retort ring, close the air release valve. Move the leveling bulb from the upper retort ring to the bottom retort ring. Read the percent of voids at the bottom of the meniscus of the water in the calibrated measuring tube, after thirty seconds and again after sixty seconds have elapsed. Any significant difference between readings may indicate there is an air leak in the apparatus. Readings may be repeated as necessary without disturbing the sample. Normally, three readings are sufficient to establish a mean. Record the percent of voids to the nearest 0.1 percent.

5.2 Combinations of materials - when the sample is a mixture of several sizes of materials, weigh and thoroughly mix the materials in the correct proportions in quantities equal to a 25mm layer in the sample container. Place the mixed material in the container in a 25mm layer and compact as noted in 5.1. This operation is repeated until the container is filled to the 3.5 liter mark. Place the filled sample container on the voidmeter base, secure the cover assembly and obtain readings for percent of voids as outlined in 5.1. Record the percent of voids to the nearest 0.1 percent.

Note 1. It has been found that when larger quantities of materials are mixed and poured into the sample container, segregation can occur which leads to false readings. Methods which involve excessive manipulation or vibration of materials should be avoided, as fine materials tend to migrate to the bottom of the sample. When the sample contains cement or other very fine materials, placing a plastic bag (approximate dimensions 9" x 10") over the sample container and tamping piston will help eliminate dusting during compaction.

6. PROCEDURE FOR DETERMINATION OF SPECIFIC GRAVITY

6.1 Bulk Specific Gravity - Fine and coarse aggregate on which the bulk specific gravity is to be determined shall be prepared as described in AASHTO T 84 and T 85 respectively. The saturated-surface-dry sample shall then be placed into the sample container and the percent voids obtained as described in section 5. Following void determination, the sample shall be removed from the container, weighed and dried to a constant weight. Calculate the bulk specific gravity (dry basis) and bulk specific gravity (saturated-surface-dry basis) as follows:

$$V_v = \frac{V \times C}{100}$$

$$V_s = C - V_v$$

$$W_w = V_s \times 1.0 \text{ gm/cm}^3$$

$$\text{Bulk Sp. Gr. (Dry)} = \frac{W_{(Dry)}}{W_w}$$

$$\text{Bulk Sp. Gr. (SSD)} = \frac{W_{(SSD)}}{W_w}$$

Where: C = Volume of container (3500cm^3)
V = Percent voids
V_v = Volume of voids (Sample SSD)
V_s = Volume of sample
$W_{(Dry)}$ = Weight of dry sample
$W_{(SSD)}$ = Weight of saturated-surface-dry sample
W_w = Weight of equal volume of water

6.2 Apparent Specific Gravity - Samples on which the apparent specific gravity is to be determined shall be dried to a constant weight. The sample shall then be placed in the sample container and the percent voids obtained as described in section 5. Remove the sample from the voidmeter and determine the weight of the sample. Calculate the apparent specific gravity as follows:

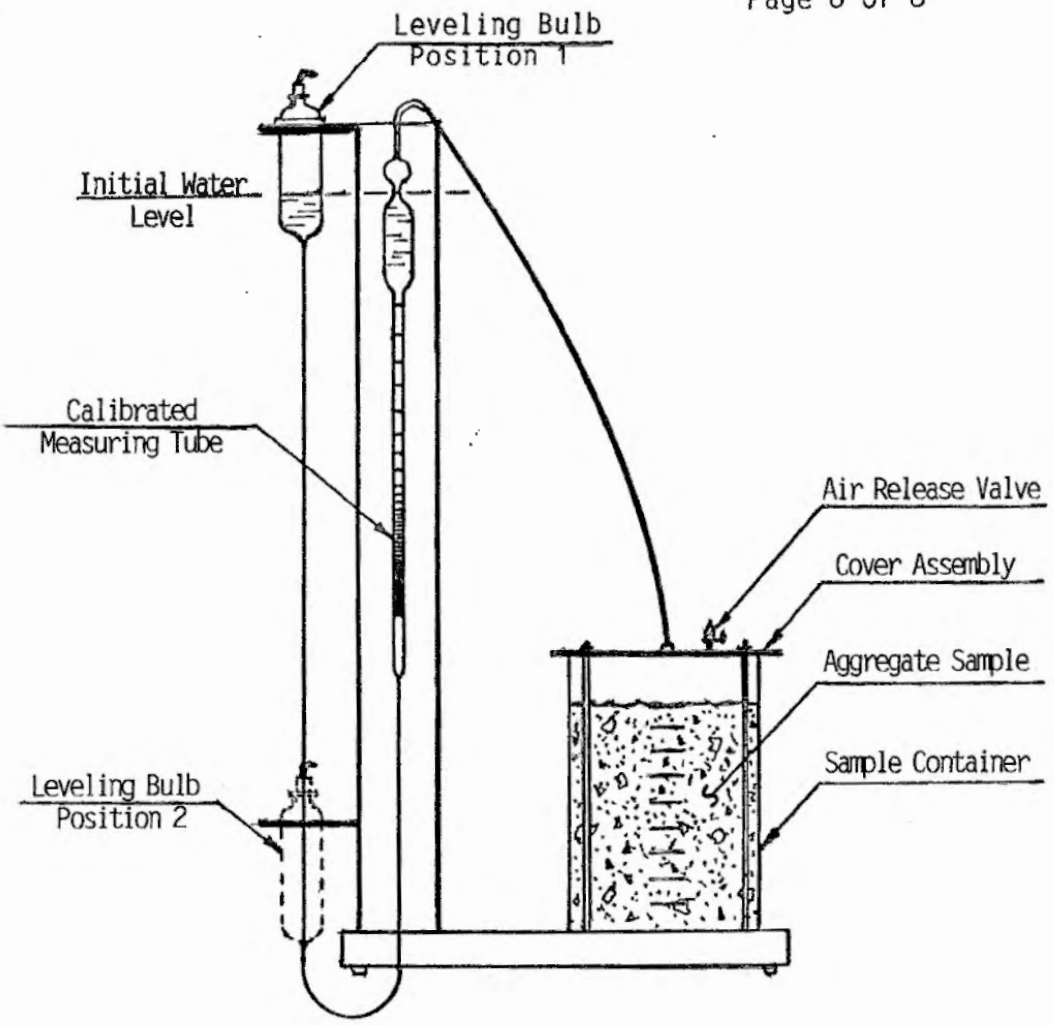
$$V_v = \frac{V \times C}{100}$$

$$V_s = C - V_v$$

$$W_w = V_s \times 1.0 \text{ gm/cm}^3$$

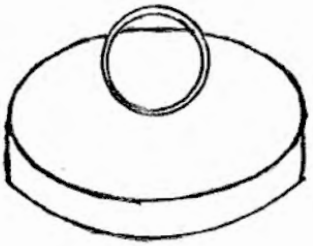
$$\text{Apparent Sp. Gr.} = \frac{W_{(Dry)}}{W_w}$$

Where: C = Volume of container (3500cm^3)
V = Percent voids
V_v = Volume of voids (Sample dry)
V_s = Volume of sample
$W_{(Dry)}$ = Weight of dry sample
W_w = Weight of equal volume of water



KEMPSTER VOID MEASURING APPARATUS

FIGURE I



5 1/4 inches diameter

1 3/8 inches depth

TAMPING PISTON

FIGURE II