5.9.73 DENSITY, ABSORPTION AND VOIDS IN HARDENED CONCRETE  
(Kansas Test Method KT-73)

1. SCOPE

This method covers the determinations of density, percent absorption and percent voids in hardened concrete. KT-73 reflects testing procedures found in ASTM C 642.

2. REFERENCED DOCUMENTS

2.1. Part V, 5.9; Sampling and Test Methods Forward

2.2. KT-22; Making and Curing Compression and Flexural Test Specimens in the Field

2.3. KT-49; Method for Obtaining and Testing Drilled Cores

2.4. ASTM C 642; Standard Test Method for Density, Absorption, and Voids in Hardened Concrete

3. APPARATUS

3.1. The balance shall conform to the requirements of Part V, 5.9; Sampling and Test Methods Forward, Class G5. The balance shall be equipped with suitable apparatus for suspending the sample container in water from the center of weighing platform or pan of the balance into a bucket with an overflow device to maintain a constant water level.

3.2. Container suitable for immersing the specimen and suitable apparatus for suspending the specimen in water. The container must be large enough to keep the specimens covered with boiling water for a period of 5 hours.

3.3. Forced draft oven capable of maintaining a temperature of 230 ± 9 °F (110 ± 5 °C).

4. TEST SPECIMEN

4.1. Prepare 3 samples per mix design. The samples shall consist of 2” thick by 4” diameter specimens taken from the top portion of cylinders or cores. Remove not more than 3/8” from the top of the cylinder or core and obtain the sample from the next 2”. Each portion shall be free from observable cracks, fissures, or shattered edges. Cylinders molded and cured in accordance with KT-22 of this manual, shall be used for mix design approval and most verification samples. Cores obtained in accordance with KT-49 of this manual, may be used for verifications on PCCP.

5. PROCEDURE
Testing is usually scheduled so that the boiling of the samples takes place when the sample is between 27 and 29 days of age. Other timeframes may be required in the contract documents.

5.1. Determine the mass of each specimen. Place each specimen on its edge in a forced draft oven directly on the oven rack, and dry the sample at a temperature of 230 ±9 °F (110 ± 5 °C) for not less than 24 hours. Do not lay the specimens inside a pan, any other container. Do not lay the specimens on the flat surface of the cylinder. Allow enough room between samples for complete airflow around each sample. After removing each specimen from the oven, allow it to cool in dry air (preferably in a desiccator) to a temperature of 72 ± 5 °F (22 ± 3 °C) and determine the mass. If the specimen was comparatively dry when its mass was first determined, and the second mass agrees with the first within 0.5%, consider it dry. If the specimen was wet when its mass was first determined, place it in the oven for a second drying treatment of 24 hours and again determine the mass. In case of any doubt, redry the specimen for 24 hour periods until check values of mass are obtained. If the difference between values obtained from two successive values of mass exceeds 0.5% of the lesser value, return the specimens to the oven for an additional 24 hour drying period, and repeat the procedure until the difference between any two successive values is less that 0.5% of the lowest value obtained. Designate this last value A.

5.2. Immerse the specimen on its edge in water at 72 ± 5 °F (22 ± 3 °C). Do not place the specimen on the flat surface of the cylinder. Continue soaking the specimen in water for not less than 48 hours and until two successive values of mass of the surface-dried sample at intervals of 24 hours show an increase in mass of less than 0.5% of the larger value. Surface-dry the specimen by removing surface moisture with a towel, and determine the mass. Designate the final surface-dry mass after immersion B.

5.3. Begin boiling tap water in a suitable container. Verify that the water is rapidly boiling prior to placing the specimens in the water for testing. Place the specimen on its edge on a rack in the boiling water a minimum of 1/4” from the bottom of the container. The water must return to boiling in not less than 1 hour. Boil the specimen completely submersed for a minimum of 5 hours. Do not add additional water during boiling. Allow it to cool by natural loss of heat for not less than 14 hours to a final temperature of 72 ± 5 °F (22 ± 3 °C). Continue to store the samples on their edge in the boiled water until the final two steps are completed.

5.4. Suspend the specimen in the bucket at a constant water level by the suitable apparatus and determine the apparent mass of the sample in water at 77 ± 2 °F (25 ± 1 °C). Designate this apparent mass D.

5.5. Remove the sample from the water. Quickly damp dry the sample with a damp absorbent cloth and determine the mass of the specimen. Designate the soaked, boiled, surface-dried mass C.

6. CALCULATION
6.1. By using the values for mass determined in accordance with the procedures described in Section 5 of this test method make the following calculations:

Absorption after immersion, % = [(B-A)/A] x 100

Absorption after immersion and boiling, % = [(C-A)/A] x 100

Bulk density, dry = [A/(C-D)]·ρ = g₁

Bulk density after immersion = [B/(C-D)]·ρ

Bulk density after immersion and boiling = [C/(C-D)]·ρ

Apparent density = [A/(A-D)]·ρ = g₂

Volume of permeable pore space (voids), % = (g₂-g₁)/g₂ x 100 or [(C-A)/(C-D)] x 100

Where:
A = Mass of oven dried sample in air
B = Mass of surface-dry sample in air after immersion
C = Mass of surface-dry sample in air after immersion and boiling
D = Apparent mass of sample in water after immersion and boiling
g₁ = Bulk density, dry
g₂ = Apparent density
ρ = Density of water