

CRD-C 37-73

**METHOD OF TEST FOR  
THERMAL DIFFUSIVITY OF MASS CONCRETE**

1. Scope

1.1 This method of test serves determine the thermal diffusivity of specimens of mass concrete consisting of 8-cu-ft (0.0227 m<sup>3</sup>) cubes.

2. Apparatus

2.1 The apparatus used shall consist of:

2.1.1 An insulated cabinet containing heating element, blower, shower heads, and drain, as shown in Figs. 1 and 2.

2.1.2 A six-point recording potentiometer.

2.1.3 A source of constant-temperature cooling water, providing

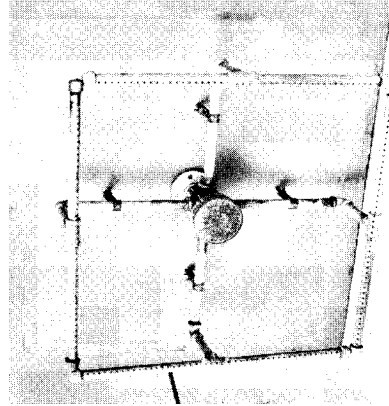


Fig. 2. Shower head mounted under lid of cabinet

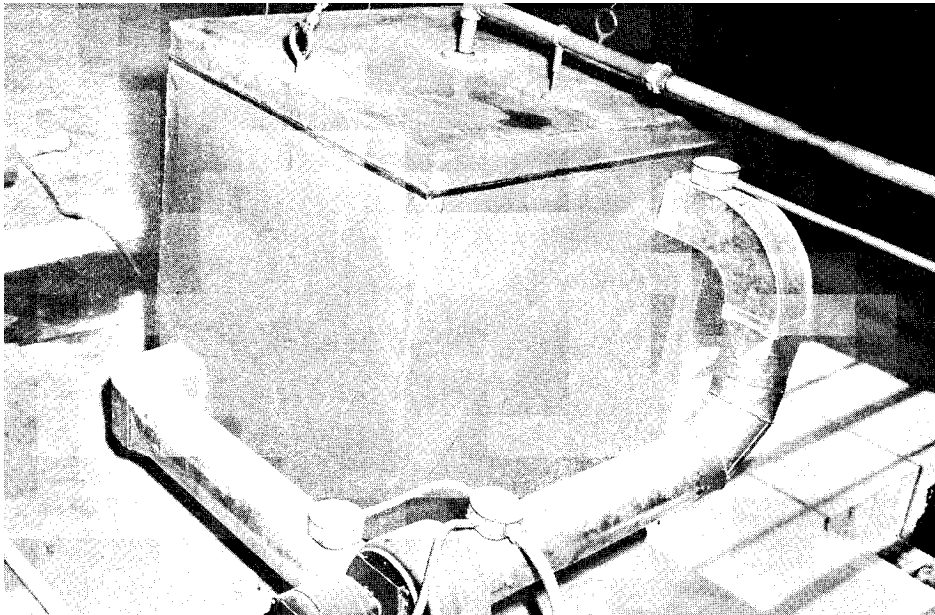


Fig. 1. Insulated cabinet used in test for thermal diffusivity of mass concrete

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at least 2000 gph (2.103 X 10<sup>3</sup> m<sup>3</sup>/s).

2.1.4 An overhead crane to place specimens.

2.1.5 Two thermostats set for 150 F (66 C) and 100 F (38 C), placed inside cabinet for controlling heating of cabinet and specimens.

2.1.6 A time clock capable of settings up to 9 hr, which will switch control from 150 F (66 C) thermostat to 100 F (38 C) thermostat.

2.1.7 Necessary relays actuated by time clock.

2.1.8 A source of 115 v AC power. The operation of the controls is effected by setting the time clock to provide heating controlled at 150 F (66 C) for a specified time, at the expiration of which the clock actuates relays changing control to the 100 F (38 C) thermostat until the power is manually cut off.

### 3. Specimens

3.1 The specimens shall consist of 8-cu-ft (0.227 m<sup>3</sup>) cubes of concrete made in accordance with the applicable provisions of CRD-C's 10 and 49. A metal ring shall be embedded in the concrete to permit hoisting of the specimen and a thermocouple shall be embedded at the center of mass at the time of casting. After hardening and curing for from 21 to 28 days, a second thermocouple shall be placed upon one face of the cube and secured by a metal plate screwed to the face of the cube. This thermocouple shall be placed tightly against the face of the cube so as to indicate the true surface temperature of the concrete specimen. The metal plate shall be approximately 4 by 4 by 1/8 in. (102 by 102 by 3.2 mm) in size and will be screwed tightly against the thermocouple to insure intimate contact between the thermocouple and the concrete. The screw which holds the plate may be run into a lead plug which has been set into a small hole drilled into the cube.

### 4. Procedure

4.1 The specimen shall be placed in the cabinet so that the bottom corners rest on metal plates approximately 2 by 2 by 1/2 in. (51 by 51 by 13 mm) in size, located so that the

flow of water from the shower heads will fall equally on the top and vertical surfaces of the specimen. The bottom surface shall be kept covered with water to a depth of not more than 1/4 in. (6.4 mm) by proper location of the elevations of drain openings in the cabinet with respect to the metal plates that support the specimen. By this procedure an equal distribution of cooling water will be secured for all surfaces of the specimen. The specimen then shall be heated by hot air at a temperature not exceeding 150 F (66 C) for approximately 7 hr 20 min, at which time a relay actuated by the time clock will operate, placing the cabinet under control of the 100 F (38 C) thermostat for a period of at least 6 hr longer. The specimen will be in thermal equilibrium at 100 F (38 C). At this time the heater switch will be opened and water admitted to the spray nozzles. The flow shall be of sufficient intensity to cover the bottom face of the block continuously. This will immediately cool the surface of the block to the temperature of the water, and this condition will be maintained until the central temperature of the block is within 5 F (2.8 C) of the surface temperature. Thereupon, the flow of water will be cut off, and heating of the block will be resumed. Three similar runs will be made for each specimen. The surface, water, cabinet, and central temperatures will be continuously recorded to 0.1 F (0.06 C) by the recording potentiometer throughout the entire heating-and-cooling cycle.

### 5. Calculations

5.1 The record of surface and central temperatures of the cube during the cooling period shall be taken from the potentiometer chart for 15-min intervals. The diffusivity shall be determined from the time-temperature history of the cooling run by computing:

$$Y = (t' - t)/(t' - t_c)$$

$$X = \alpha \theta / r^2$$

where:

t' = surface temperature during

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cooling (may be averaged if variation is less than 3 F (1.7 C) for entire cooling period, essentially equal to the temperature of the immersing water), degrees F,

$t$  = temperature at center of cube at time  $\theta$ , degrees F,

$t_c$  = initial temperature of cube prior to cooling, degrees F,

$\alpha$  = thermal diffusivity of the cube, ft<sup>2</sup>/hr, m<sup>2</sup>/s,

$\theta$  = time after commencement of cooling, hr, and

$r$  = distance from center to surface (for 8-cu-ft (0.0227 m<sup>3</sup>) cube,  $r = 1$ ), ft.

5.2 Values of  $Y$  computed from the temperature readings at quarter-

hour intervals using equation (1) shall be compared with the chart on Fig. 3,<sup>1</sup> and values for  $X$  obtained thereby. The diffusivity shall then be calculated from equation (2). Results of these calculations for the first 2 or 3 hr (depending on the diffusivity) will be discarded due to inaccuracies in estimates of  $X$ . At least eight values for  $X$  shall be obtained for each run, and the average value of  $\alpha$  determined. The average values for  $\alpha$  in successive runs shall vary not over 0.005 ft<sup>2</sup>/hr ( $1.290 \times 10^{-7}$  m<sup>2</sup>/s).

<sup>1</sup>Williamson and Adams, Phys. Rev. (2), 14 (1919). p-99.

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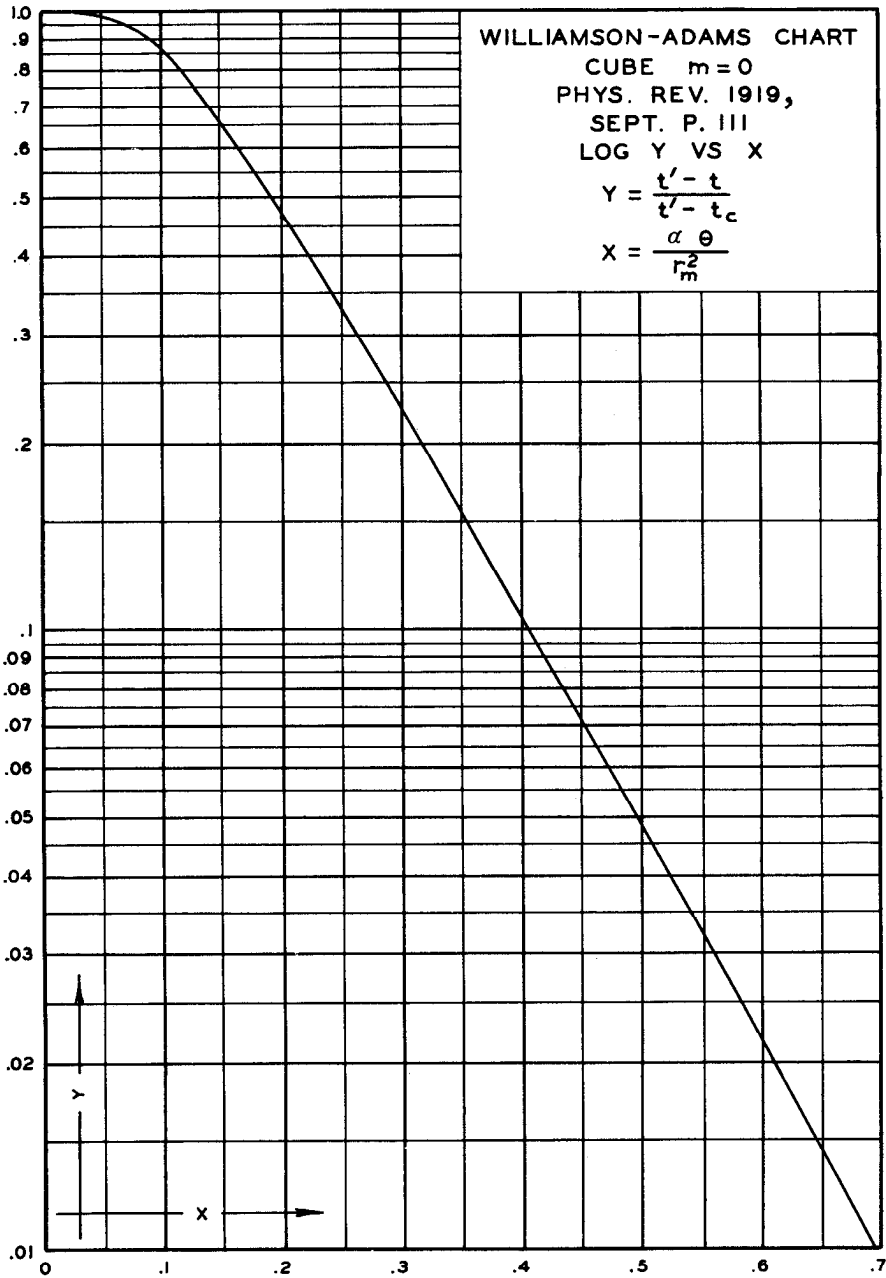


Fig. 3