RESISTANCE OF CONCRETE TO RAPID FREEZING AND THAWING C 666-15 ____
C 511-13 ____

APPARATUS

1. Freezing and thawing apparatus capable of continuous operation to the temperature cycle requirements of section 5 (40 to 0°F and 0 to 40°F (-18 to 4^0 C) in not less than 2 or more than 5h)……. ____

2. Temperature measuring equipment to monitor temperature in the apparatus and specimens ____
3. Dynamic Testing Apparatus conforming to the requirements of ASTM C 215 ..... ____
4. Length Change Comparator conforming to the requirements of ASTM C 490..... ____
5. Scale with a capacity of 1.5 times the weight of a specimen, readable to 0.01lb (0.5g)..... ____
6. Tempering tank to maintain the specimens in water at -2°F to +4°F (-1 to $+2^0$ C) when tested ____
7. Procedure A, rapid freezing and thawing in water, water used..... ____
8. Procedure B, rapid freezing and thawing in air, air and water used ..... ____

FREEZING AND THAWING CYCLE

1. Control specimens with imbedded temperature measuring devices of similar concrete? ….. ____
2. Nominal cycle consists of lowering temperature of specimens from 40°F to 0°F and then raising the temperature from 0°F to 40°F (-18 to 4^0 C) in not less than 2 or more than 5 hours? ..... ____
3. For procedure A, not less than 25% of the time shall be used for thawing?..... ____

OR For procedure B, not less than 20% of the time shall be used for thawing?..... ____

4. At the end of the cooling period, temperature at center of specimen is 0 ± 3°F (-18 $\pm$ 2^0 C)? ____
5. At the end of the thawing period, temperature at center of specimen is 40 ± 3°F (4 $\pm$ 2^0 C)? ____
6. No specimen at any time reaching temperature lower than -3°F (-19^0 C) or more than 43°F (6^0 C)? ..... ____
7. Time required to reduce temperature at center of any single specimen from 37°F to 3°F (3 to -16^0 C) is not less than 1/2 the cooling period? ..... ____
8. Time required to increase temperature at center of any single specimen from 3°F to 37°F (-16 to3^0 C) is not less than 1/2 the heating period?..... ____
9. For specimens that are to be compared, time required to reduce temperature at center of any single specimen from 35°F to 10°F (2 to -12^0 C) is not less than 1/6 the time required for any specimen? ..... ____
10. For specimens that are to be compared, time required to increase temperature at center of any single specimen from 10°F to 35°F (-12 to 2^0 C) is not less than 1/3 the time required for any specimen? ..... ____
11. The difference between the temperature at the center of any specimen and the temperature at its surface shall at no time exceed 50°F (28^0 C)? ..... ____
12. The period of transition between freezing and thawing cycles is not more than 10 minutes?. ____

TEST SPECIMENS

1. Prisms or cylinders made and cured in accordance with ASTM C 192 and C490? ..... ____
2. Specimens are not less than 3 inches (75mm) or more than 5 inches (125 mm) in width or height or diameter? ..... ____
3. Specimens are not less than 11 inches (275mm) or more than 16 inches (405 mm) in length? ____
4. Specimens may be cores or prisms cut from hardened concrete in accordance with ASTM C 823 and not allowed to dry to a moisture condition below that of the parent structure?..... ____
5. Specimens furnished with gage studs in accordance with ASTM C 341?..... ____
6. Specimens stored in saturated lime water from demoulding to testing time?..... ____
7. All specimens to be compared with each other are initially the same nominal dimensions? .. ____

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PROCEDURE

1. Initial measurements of specimens done at -2°F to +4°F (-1 to +2^0 C) of target freeze-thaw temperature and to the tolerances required in ASTM C 215?..... ____
2. Unless otherwise specified, testing commences immediately after curing period? ..... ____
3. Freeze - thaw tests started by placing specimens in thaw water at beginning of thaw cycle? ____
4. Specimens removed from apparatus at intervals not exceeding 36 cycles and measured as in #1 above? ..... ____
5. Specimens held in tempering tank to ensure complete thawing? ..... ____
6. Specimens protected against moisture loss while out of apparatus? ..... ____
7. Specimens turned end for end and then returned to apparatus? ..... ____
8. Specimens returned to random positions or to some predetermined arrangement in tank? ... ____
9. Specimens tested until at least 300 cycles or until relative dynamic modulus reaches 60%? ____
10. Failed specimen is replaced by dummy specimen for remainder of test? ..... ____
11. When rapid deterioration is anticipated, testing is at 10 cycles or less? ..... ____
12. When the sequence of freezing and thawing must be interrupted, specimens stored in frozen condition? ..... ____

Calculation

1. Relative dynamic modulus of elasticity: ..... ____

$$P_c = \frac{n_1^2}{n^2} \times 100$$

Where: P_c = relative dynamic modulus of elasticity, after *c* cycles of freezing and thawing, %
n = fundamental transverse frequency at 0 cycles of freezing and thawing, and
n_1 = fundamental transverse frequency at *c* cycles of freezing and thawing.

2. Durability factor: ..... ____

$$DF = \frac{PN}{M}$$

Where: DF = durability factor of test specimen
P = relative dynamic modulus of elasticity at N cycles, %
N = number of cycles at which P reaches the specified minimum value for discontinuing the test or the specified number of cycles at which the exposure is to be terminated, whichever is less, and
M = specified number of cycles at which the exposure is to be terminated.

3. Length change in Percent (optional): ..... ____

$$L_c = \frac{(l_2 - l_1)}{L_g} \times 100$$

Where: L_c = length change of the test specimen after *c* cycles of freezing and thawing, %
l_1 = length comparator reading at 0 cycles,
l_2 = length comparator reading after *c* cycles,
L_g = the effective gage length between the innermost ends of the gage studs as shown in the mold diagram in Specification C 490.

Comments: