

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 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. Balance or scale with a capacity of 1.5 times the weight of a specimen, readable to 0.01lb ..
1. Tempering tank to maintain the specimens in water at -2°F to +4°F when tested.....
2. Procedure A, rapid freezing and thawing in 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 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 $0 \pm 3^\circ\text{F}$?.....
5. At the end of the thawing period, temperature at center of specimen is $40 \pm 3^\circ\text{F}$?.....
6. No specimen at any time reaching temperature lower than -3°F or more than 43°F?
7. Time required to reduce temperature at center of any single specimen from 37°F to 3°F is not less than half the cooling period?
8. Time required to increase temperature at center of any single specimen from 3°F to 37°F is not less than half 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 is not less than one sixth 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 is not less than one third 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?
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 or more than 5 inches in width or height or diameter?
3. Specimens are not less than 11 or more than 16 inches 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 demolding to testing time?.....
7. All specimens to be compared with each other are initially the same nominal dimensions? ..

Procedure

1. Initial measurements of specimens done at -2°F to +4°F 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?

Procedure cont'd

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: _____

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: _____

Where: $DF = \frac{PN}{M}$
 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): _____

Where: $L_c = \frac{l_2 - l_1}{L_g} \times 100$ = 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: