Revised: 4/29/04 Laboratory: _____ Inspector(s): _____ Date: _____

S___F___

MAKING AND CURING CONCRETE SPECIMENS IN THE FIELD
ASTM C 31-03 **(REQUIRED PER ASTM C 1077-98)**

5. Apparatus:
5.1. Molds ___
5.2. Cylinder conforms to ASTM C 470 ___
Inside height twice the inside diameter ___
1% of nominal inside diameter ___, 2% of nominal inside height ___
5.3. Beams ___
6 ± 1/8 in. x 6 ± 1/8 in (150 ± 3 x 150 ± 3 mm) cross section ___
Length shall be > 3 times depth ___
5.4. Tamping rod ___
5/8-in (16-mm) diameter, 20 ± 4 in. (600 ± 100 mm) length for 6-in. (150-mm) ___
Hemispherical tip ___
5.5. Vibrator ___
¾ - 1½-in. (20-40-mm) diameter ___
7000-vpm ___
Length shall be 75-mm (3-in.) > specimen depth ___
5.6. Mallet comprised of rubber or rawhide, 1.25 ± 0.50-lb (0.6 ± 0.2-Kg) ___
5.7,5.8,5.9,5.10,5.11. Misc. Scoops, air meters, slump cones, pans, wheel barrow, thermometers ___

7. Sample in accordance with ASTM C 172 ___

9. Molding Procedure
9.1. Place, level, rigid surface, & free of vibrations & near storage area ___
9.2. Cylinders ___

Rodding ___
(1). 3 equal layers ___
(2). 25 rodding/layer ___
(3). 1 in. penetration previous layer ___
(4). 10 to 15 taps ___
(5). Strike-off, float, trowel ___

Vibration ___
(1). 2 equal layers ___
(2). 2 insertions/layer ___
(3). 1 in. penetration previous layer ___
(4). 10 to 15 taps ___
(5). Strike-off, float, trowel ___

9.3. Beams ___

Rodding ___
(1). 2 equal layers ___
(2). 1/ea. 2in.^{2}/layer ___
(3). 1 in. penetration ___
(4). 10 to 15 taps ___
(5). Strike-off, float, trowel ___

Vibration ___
(1). 1 layer ___
(2). <150 mm (6 in.) apart ___
(3). 10 to 15 taps ___
(4). Strike-off, float, trowel ___

9.6. Identification of specimens:
On side of molds ___, on surface with tags ___, on stripped specimen side ___

10. Curing:
10.1. Immediately cover and protect specimen ___
10.1.1. Move to initial curing place ___
10.1.2. Initial curing ___
Store @ 16 to 27°C (60 to 80°F) for <48 hr ___
>48 hr, de-mold @ 24 ± 8 hr, final cure @ 73 ± 3°F (23 ± 2°C) ___
10.1.3. Final curing ___
10.1.3.1. < 30 min to store in moist condition w/free water ___
Store @ 73 ± 3°F (23 ± 2°C) in tanks or moist room in accordance to ASTM C 511 ___
10.1.3.2. Beams 24 ± 4 hr prior to test, store in calcium hydroxide solution ___

Data Sheet ___

S___F___

COMPRESSIVE STRENGTH OF CYLINDRICAL CONCRETE SPECIMENS
ASTM C 39-03 **(REQUIRED PER ASTM C 1077-98)**

4.4. Person testing have Concrete Lab Tech Level I cert. or equivalent ___

5. Apparatus:
5.1. Testing machine ___
5.1.1. Verify in accordance w/ ASTM E 4 ___
5.1.1.1. Calibrate < 18-month, preferably 12-month ___
5.1.1.2. Calibrate when moved ___
5.1.1.3. Calibrate when repaired ___
5.1.1.4. Calibrate when accuracy is in doubt ___
5.1.2.1. Power-operated and apply continuous load ___
5.1.2.2. Space for elastic calibration device ___
5.1.3.1. Load indicator accurate to 1.0% of indicated load ___
5.2. Bearing blocks ___
Spherical seated upper block ___
Block faces 3% greater diameter than specimen ___
Steel blocks plane to 0.001-in. (0.025-mm) ___
Concentric rings for centering (when dia. of bearing face > dia. spec. > 0.5 in.) ___
5.2.1.1. Concentric rings on bottom bearing block (optional) ___
5.2.1.3. 1 in. thick (new), 0.9 in. (after resurfacing) bottom bearing block ___
5.2.2.4. Lubricated spherical surface ___
5.2.2.5. If sphere radius is < specimen radius, block thickness > difference of radius ___
5.2.2.6. Minimum 4° tilt of bearing block ___
5.3. Load indicator
5.3.1. Dial load indicator readability to 0.1% full-scale load ___
5.3.2. Digital load indicator numerical increment ≤ 0.1 % of full-scale load ___

6. Specimen:
6.1. < 2% change in diameter of a cylinder ___
6.2. < 0.5° change in perpendicularly of ends ___
Ends plane to 0.002-in. (0.050-mm) ___
Determine for cross-sectional area average mid-height diameter to nearest 0.01-in. (0.25-mm) ___
6.3. Measure 1:10 or 3/day from same lot of molds, measurement for diameter ___
> 0.02-in. (51-mm) diameter change, measure all cylinders ___
6.4. Length to 0.05 in. D when L/D < 1.8 or > 2.2 ___

7. Procedure:
7.1. Test soon as practicable from moist storage ___
7.2. Keep and test in moist condition ___
7.3. Test time tolerance - See table ___
7.4. Align w/ center of upper bearing block ___
7.4.1. Zero load pointer ___
7.5. Continuous load w/out shock ___
7.5.1. Load rate ___
0.05-in. (3-mm) /min for screw type machine ___
20 – 50-psi/sec (0.14 - 0.34 MPa/sec) for hydraulic machine ___
7.5.2. Faster rate may be applied up to first half ___
7.6. Apply load to failure ___
Note type of failure and appearance ___

8. Calculation:
8.1. Compressive strength to nearest 10-psi (69-kPa) ___
Maximum load / cross sectional area ___
8.2. If L/D ratio < 1.8, correct for L/D ratio ___

Data Sheet ___

S___F___

UNIT MASS, YIELD, AND AIR CONTENT (GRAVIMETRIC METHOD)
ASTM C 138-01 **(REQUIRED PER ASTM C 1077-98)**

4. Apparatus:
4.1. Balance accurate to 0.3% of test load ___
4.2. Tamping rod ___
Round straight steel rod w/hemi-spherical tip ___
5/8-in. (16-mm) diameter ___
Approximately 24-in. (600-mm) long ___
4.3. Internal vibrator ___
≥ 7000 vibrations/min ___
¾ - 1½-in. (19 – 38-mm) diameter ___
≥ 24 in. (600 mm) shaft length ___
4.4. Measure ___
Steel or other metal ___
Minimum capacity (see table 1) ___
Top rim smooth and plane to 0.01-in. (25-mm) ___
Air content bowls conforming to requirements in ASTM C 231 may be used ___
Calibrate annually in accordance w/ ASTM C 29 ___
4.5. Strike-off plate ___
Flat rectangular plate ___
Steel, ¼-in (6-mm) ___ or glass/acrylic, ½-in (12-mm) ___
End straight and smooth to 1/16-in. (1.5-mm) ___
4.6. Mallet may be rubber or rawhide, approx. 1.25 ± 0.50-lb (0.57 ± 0.23-kg) ___

5.1. Sample in accordance w/ ASTM C 172 ___

6. Procedure:
6.1. Consolidation ___
Rod concrete with slumps > 3-in. (75-mm) ___
Rod or vibrate with slumps > 1-in. (25 mm) or < 3-in. (75 mm) ___
Vibrate concrete with slumps < 1-in. (25-mm) ___
6.2. Rodding ___
Three equal volumetric layers ___
Rod 25 strokes/layer for ≤ 0.5-ft³ (14-L) measures ___
Rod 50 strokes/layer for 1-ft³ (28-L) measures ___
Penetrate entire bottom layer, but not forcibly ___
Penetrate other layers + 1-in. (25-mm) ___
Mallet tap each layer w/ 10 to 15 taps smartly ___
6.3. Internal vibration ___
Two equal volumetric layers ___
Insert at three-points/layer ___
Do not touch bottom or sides of measure ___
Penetrate into bottom layer 1-in. (25-mm) ___
Leave no air pockets ___
6.4. 1/8-in. (3-mm) excess is optimum ___
6.5. Strike-off w/strike-off plate ___
Cover 2/3 of surface w/strike-off plate and press down ___
Withdraw w/sawing motion ___
Cover 2/3 again and advance w/sawing motion and down pressure ___
Finish w/inclined plate edge for smooth surface ___
6.6. Clean excess concrete on measure and determine net mass (W_1) ___

7. Calculate unit mass, $W = W_1 / V$ ___

Data Sheet ___

S___F___

SLUMP OF PORTLAND CEMENT CONCRETE
ASTM C 143-03 **(REQUIRED PER ASTM C 1077-98)**

5. Apparatus
5.1. Mold ___
Thickness ≥ 0.060-in. (1.5-mm) ___
Thickness of spin mold ≥ 0.045-in. (1.15-mm) ___
Base diameter 8 ± 1/8-in. (200 ± 3-mm) ___
Top diameter 4 ± 1/8-in. (100 ± 3-mm) ___
Height 12 ± 1/8-in. (300 ± 3-mm) ___
Foot pieces & handles ___
No dents, projections, deformation, or mortar ___
5.2. Tamping rod ___
Round straight steel rod ___
Diameter 5/8-in. (16-mm) ___
Length 24-in. (600-mm) ___
Hemi-spherical tip ___

6.1. Sample in accordance w/ ASTM C 172 ___

7.1. Dampen mold ___
Place on flat, moist, non-absorbent, rigid surface ___
Stand on foot pieces ___
Fill in 3 equal volumetric layers [2 5/8-in. (70-mm) & 6 1/8-in. (160-mm)] ___
7.2. Rod 25 strokes/layer ___
Distribute strokes over cross section ___
Just penetrate underlying layer ___
7.3. Heap concrete above mold for top layer ___
Strike-off by screeding & rolling motion of tamping rod ___
Raise mold vertically in 5 ± 2-sec ___
Complete test in 2½-min ___
7.4. Measure slump from top of mold to displaced original center ___

8.1. Report to nearest ¼-in. (5-mm) ___
Slump = 12-in. - height of subsided center ___
Slump = 300-mm – height of subsided center ___

Data Sheet ___

S___F___

SAMPLING FRESH CONCRETE
ASTM C 172-99 **(REQUIRED PER ASTM C 1077-98)**

4.1. Sample first and last portion w/in 15-min for composite ___
4.1.1. Transport sample before composite made ___
4.1.2. Start tests for slump, temperature, and air content within 5-min ___
Start molding cylinder within 15-min ___
Protect from sun, wind, rapid evaporation, and contamination ___

5.1. Sample size 28-L (1 ft^3) ___
5.2.1. Sample from stationary mixer ___
Collect 2 or more portion ___
Middle portion, never first or last portion ___
Sample by passing receptacle completely thru discharge stream or divert stream ___
5.2.2. Sample from paving mixer ___
Obtain $\geq$ 5 portions from pile ___
Mix into composite ___
Avoid sub-grade material ___
5.2.3. Sample from drum truck mixer ___
Do not obtain samples until all water added ___
Collect 2 or more portions of the middle portion of batch ___
Mix into composite ___
6. Large maximum size aggregate concrete ___
6.1. Wet sieve ___
Unit mass test on full mixture ___

Data Sheet ___

S___F___

AIR CONTENT OF CONCRETE BY THE VOLUMETRIC METHOD
ASTM C 173-01 **(REQUIRED PER ASTM C 1077-98)**
(REQUIRED IF ASTM C 231-97 NOT PERFORMED)

4. Apparatus
4.1. Air meter ___
4.1.1. Material must resist high pH, high temperature, brittle or cracking ___
4.1.2. Bowl ≥ 0.075-ft³ (2.1-L) ___
4.1.3. Top capacity ≥ 20% larger than bowl, Graduation ≤ 0.5%, Water tight cap ___
4.2. Funnel with spout ___
4.3. Tamping rod, round straight rod, steel __, polyethylene ___, plastic ___
Diameter 5/8-in. (16-mm) ___, ≥ length 12-in. (300-mm) ___, Hemi-spherical tip ___
4.4. Strike-off bar ___
Flat straight steel bar, 1/8 x ¾ x 12-in. (3 x 20 x 300-mm) ___
Flat straight polyethylene or plastic bar, ¼ x ¾ x 12-in. (6 x 20 x 300-mm) ___
4.5. Calibrated cup, 1.03 ± 0.04% of bowl volume ___
4.6. Measuring vessel for alcohol, min 1 pt (500 ml) w/graduations not > 4 oz (100 ml) ___
4.7. Syringe, rubber w/ capacity of at least 2 oz (50 ml) ___
4.8. Pouring vessel, approximately 1-qt (1-L) container ___
4.9. Metal scoop ___
4.10. Isopropyl alcohol, 70% by volume (65% by mass) ___
4.11. Mallet, rubber or rawhide, 1.25 ± 0.50-lb (0.57 ± 0.23-kg) ___
5.1. Annually calibrate meter and calibrated cup ___
5.2. Determine accuracy to 0.1% ___
5.3.1. Add 1.0-% bowl volume of water to calibrate graduated range ___
5.4. Calibrate cup w/ water @ 70°F (21.1°C) ___
6. Sample in accordance w/ASTM C 172 ___
7.1. Fill in 2 layers of equal depth ___
Rod 25 strokes/layer, tap side 10 to 15 times/layer ___
7.2. Strike-off excess concrete with strike-off bar & clean flange ___
7.3. Attach top section & insert funnel ___
Add at least 1 pt (500 ml) water, add selected amt of alcohol (Note 2), record amt of alcohol & continue adding water to graduated neck (Note 3) ___
Remove funnel ___
Adjust meniscus to zero ___
7.4.1. Inverting & agitating for ≥ 45 sec ___
7.4.2. Tilt to 45° & maintain, and roll and rock for 1-min ___
7.4.2.2. Set upright, loosen top, let stand until liquid level stabilizes (not > 0.25 % in 2 min.) ___
7.4.2.3. If > 6 min. to stabilize, or foam > than 2 % divisions, discard, start new test, use larger amt alcohol ___
7.4.2.4. If level w/o excessive foam, read bottom of meniscus to 0.25%, record as *initial rdg* ___
7.4.2.5. If A/C is > than the 9 % range, add water in cal cups to bring to w/in graduated range, read bottom of meniscus to 0.25%, record No. of cups of water added to final rdg in 8.1.3 ___
7.5.1. When initial rdg obtained in 7.4.2.4, repeat 1-min rolling as in 7.4.2, 7.4.2.2, & 7.4.2.3 ___
7.5.2. When 7.4.2.2 & 7.4.2.3 met, read bottom of meniscus to 0.25 %, if not changed > 0.25 % record as *final rdg* ___
7.5.2.1. If rdg changes > 0.25 % from *initial rdg*, record as new *"initial rdg",* repeat 1-min rolling as in 7.4.2, read, if this rdg not changed > 0.25 %, from *"newest initial rdg"*, record as final rdg ___
7.5.2.2. If the rdg changes > 0.25 %, start new test on new spl of concrete ___
8.1.1. If > 2.5 pt alcohol added, final rdg is A/C except as modified in 8.1.3 or 8.2 ___
8.1.2. If > 2.5 pt alcohol added, subtract correction from Table 1 from final meter rdg ___
8.1.3. If cal cups of water added as in 7.4.2.5, add No. of cups to A/C in 8.1.1 or 8.1.2 ___
8.1.4. Report to nearest 0.25 % ___

Data Sheet ___

S___F___

AIR CONTENT OF CONCRETE BY THE PRESSURE METHOD
ASTM C 231-03 **(REQUIRED PER ASTM C 1077-98)**
(REQUIRED IF ASTM C 173-94 NOT PERFORMED)

4. Apparatus
4.1. Air meter: Type A, water displacement ___, Type B, equalizing pressure ___
4.2. Measuring bowl: steel ___, other metal ___, other material ___
Diameter 0.75 to 1.25 times height ___
Capacity, ≥ 0.20-ft³ (5.7 L) ___
Machined smooth interior ___
4.3.1. Cover assembly: steel ___, other metal ___, other material ___
Pressure tight ___
4.3.2. Pressure gage, 0 to 8% in 0.1% increments ___
4.4. Calibration vessel = to % of vol. of air to be tested ___
4.9. Tamping rod ___
Round straight steel rod w/hemi-spherical tip ___
Diameter 5/8-in. (16-mm) diameter ___, length ≥ 16-in. (400-mm) ___
4.10. Mallet, rubber or rawhide, 1.25 ± 0.50-lb (0.57 ± 0.23-kg) ___
4.11. Strike-off bar, flat straight steel or metal bar, 1/8 x ¾ x 12-in. (3 x 20 x 300-mm) ___
4.12. Strike-off plate, flat rectangular plate ___
Steel or metal, ¼-in. (6-mm) ___, glass/acrylic, ½-in. (12-mm) ___

5.1. Calibration of pressure gage ___

6.1. Determine aggregate correction factor, *G*, % ___
7.1. Sample in accordance with ASTM C 172 ___
8.1.1. Dampen bowl and place on flat, level firm surface ___
Place equal volumetric layers: by rodding, 3 ___, by vibrating, 2 ___
8.1.2. Rod 25 strokes/layer with 10 to 15 taps/ layer ___
Do not forcibly strike bottom and penetrate about 1-in. ___
8.1.3. Vibrate 3 insertions/layer over cross section ___
8.1.4. Strike-off w/bar w/ sawing motion ___
Strike-off w/plate in accordance with ASTM C 138 ___

Type A:
8.2.1. Clean bowl rim & cover assembly ___
Add water to halfway mark ___
Incline 30° & roll into circle ___
Fill water to zero mark ___
8.2.3. Apply >0.2-psi (1,380-MPa) pressure ___
Tap side sharply ___
Read pressure & water level (h_1) ___
Release pressure gradually ___
Record water level (h_2) ___
Calculate apparent air content (A_1) ___
Apply aggregate factor (G) ___

Type B:
8.3.1. Clean bowl rim cover assembly ___
Close air valve ___
Open petcocks ___
Inject water ___
Jar meter ___
8.3.2. Pump pressure to initial line ___
Close petcocks ___
Open air valve ___
Tap measure smartly ___
Tap gage lightly ___
Read % air (A_1) ___

9.1. Calculate air content, % = A1 – *G* ___

Data Sheet ___

S___F___

TEMPERATURE OF FRESH CONCRETE
ASTM C 1064-03 **(REQUIRED PER ASTM C 1077-98)**

4. Apparatus
4.1. Container ___
Non-absorptive material ___
Cover of ≥ 3-in. (75-mm) concrete in all directions ___
4.2. Temperature measuring device ___
Measure to ± 1°F (± 0.5°C) throughout range of 30 to 120°F (0 to 50°C) ___
Designed to allow 3 in. or more immersion ___
4.3. Partial immersion thermometer has permanent mark ___
4.4. Reference device ___
Readable and accurate to 0.5°F (0.2°C) @ verification points in 5.1 ___
Calibration certificate traceable to NIST ___

5. Calibration
5.1. Annually ___
Comparison @ 2 temperatures > 30°F (15°C) apart ___
5.2.1. Constant temperature bath, ± 0.5°F (± 0.2°C) ___
5.2.2. Minimum 5-min in bath before reading ___
5.2.3. Continuous circulation ___

6. Sampling:
6.1. In transporting equipment that provide ≥ 3-in. (75-mm) coverage ___
6.2. In the placement forms ___
6.3. For other containers prepare sample as follows:
6.3.1. Dampen w/water ___
6.3.2. Sample in accordance w/ ASTM C 172 ___
6.3.4. NMSA > 3-in. (75-mm) required 20-min to stabilize ___

7.1. Submerge sensor ≥ 3-in. (75-mm) ___
Press concrete around to prevent ambient air from sensor ___
7.2. Minimum 2-min before reading ___
7.3. Complete within 5 minute of sampling ___
8.1. Record temperature to ± 1°F (± 0.5°C) ___

Data Sheet ___

S___F___N/A___

OBTAINING & TESTING DRILLED CORES & SAWED BEAMS
ASTM C 42-03

4. Apparatus:
4.1. Core drill, to core cylindrical specimens, w/ diamond bits ___
4.2. Saw, w/ diamond or silicon-carbide cutting edge ___

5. Sampling:
5.1.1. Hardened concrete not taken until hard enough ___
5.1.2. Specimens w/ embedded reinforcement not used for splitting tensile strength ___
Specimens for flexural strength not used if reinforcement embedded in tensile part of test ___
5.2. Core drilling, taken ⊥ to the surface ___
5.3. Slab removal, sufficiently large, w/o concrete that has been damaged ___

6. Length of drilled cores:
6.1. Cores w/ dia. at least 3.75 in. (95 mm), measure length in accordance w/ ASTM C 174 ___
6.2. Cores not measured for structural dimensions, measure longest & shortest lengths parallel to core axis to nearest ¼ in. (5 mm) ___
7. Cores for compressive strength:
7.1. Test specimen, 3.70 in. dia., agg. size > 1 ½-in. dia. 3 X max particle size, length 1.9 – 2.1 X dia. ___
7.2. Length – 1.9 – 2.1 X dia ___
If L/D ratio > 2.1, reduce length to ratio of 1.9 – 2.1 ___
L/D ratio ≤ 1.75 use correction ___
Core w/ max length < 95% of dia or < its dia after capping or grinding not to be tested ___
7.3. Moisture conditioning as specified in this test method or as directed ___
7.3.1. After drilling, wipe off H_2O, allow surface H_2O to evaporate ___
When dry NTE 1hr, put in nonabsorbent containers or bags, maintain @ ambient temp, keep from sunlight, take to lab, keep in containers
7.3.2. If H_2O used for sawing or grinding, complete NTE 2 days after drilling, after completion store in same containers as in 7.3.1 ___
7.3.3. Keep in containers at least 5 days unless directed otherwise ___
7.4. Ends flat, ⊥ to longitudinal axis, saw if needed___
7.4.1. Projections not extend > 0.2 in. (5 mm) ___
7.4.2. Ends not depart from ⊥ more than 0.5° ___
7.5. Determine the density if required ___
7.6. Cap ends prepared in accordance w/ ASTM C 39 & C 617, measure length to 0.1-in, C 1231 not permitted ___
7.7. Measurement, prior to test, measure length to 0.1 in. (2.0 mm) for L/D ratio ___
Get average dia. from 2 midheight measurements @ right angles to 0.01 in. (2.0 mm) ___
7.8. Test in accordance w/ ASTM C 39 ___
7.9. Calculate compressive strength using cross-sectional area ___
7.9.1. L/D ratio 1.75 or <, correct by multiplying by appropriate factor ___
7.10. Report ___

8. Cores for splitting tensile strength:
8.1. Test specimens, same as 7.1, 7.2.1, & 7.2.2, ends not capped ___
8.2. Moisture conditioning, same as 7.3 ___
8.3. Bearing surfaces, line of contact between spec. & bearing strip straight, free of projections or depressions higher or deeper than 0.01 in. (0.2 mm) ___
8.4. Test in accordance w/ ASTM C 496 ___
8.5. Calculation & report ___

9. Beams for flexural strength:
9.1. Test specimens, 6 X 6 in. (150 X 150 mm), 21 in. long ___
9.2. Moisture conditioning, submerge in lime-saturated water @ 73.5 ± 3.5°F (23.0 ± 2.0°C) ___
9.3. Test in accordance w/ ASTM C 78 ___
9.4. Report ___

Data Sheet ___

S___F___N/A___

FLEXURAL STRENGTH OF CONCRETE
ASTM C 78-02

4.1. Testing machine verified in accordance w/ ASTM E 4 ___
Hand operated pumps > 1 stroke not permitted ___
Power operated @ continuous uniform rate of load ___
4.2. Third point loading method ___
4.2.1. Span tolerance of ± 0.05-in. (± 1.3-mm) ___
4.2.3. Height of load and support blocks ≤ 2½-in. (64-mm) ___
Bearing blocks plane to ± 0.002-in. (0.05-mm) ___

5.1. Beams and prisms w/ test span ± 2% of 3 times depth of specimen ___
Sides right angle to top and bottom ___
Smooth surfaces, free of scars, indentations, and holes ___
5.2. Person testing have Concrete Lab Tech Level II cert. or equivalent ___

6.1. Kept moist until test ___
6.2. Turn specimen on side and center on bearing blocks ___
Pre-load specimen to 3 to 6% of estimated ultimate load ___
Gage gap w/ feeler gage @ 0.004-in. (0.10-mm) & 0.015-in. (0.38-mm) ___
Grind, cap, or use leather shims ___
6.3. Load continuously & w/out shock to rupture ___
Load rate of 125 to 175-psi (0.86 to 1.21-Mpa) / minute ___
7.1. Measure dimensions after test to calculate modulus of rupture across 1 of fractured faces ___
Take 3 measurements, one @ ea edge, one @ center of cross-section ___
Tolerances to 0.05-in. (1-mm) ___
If fracture occurs @ capped section, include cap thickness in measurements ___

8.1. Calculate modulus of rupture, R ___
$R = PL/bd^2$ ___
Where:
R = modulus of rupture
P = max applied load
L = span length
b = avg. width of spec. @ fracture
d = avg. depth of spec. @ fracture
8.2. Fracture in tension surface outside of middle 3rd of span length not > 5 % of span length calculate R as follows:
$R = 3\ Pa/bd^2$ ___
Where:
a = average distance between line of fracture & nearest support measured on tension surface of beam

9. Report:
9.1.1. ID No. ___
9.1.2. Avg width to 0.05-in. (1-mm) ___
9.1.3. Avg depth to 0.05-in. (1-mm) ___
9.1.4. Span length, in. or mm ___
9.1.5. Max applied load in lb-force or newtons ___
9.1.6. Modulus of rupture to nearest 5 psi (0.05 Mpa) ___
9.1.7. Curing history & apparent moisture condition of specs @ time of test ___
9.1.8. If specs were capped, ground, or leather shims were used ___
9.1.9. Whether sawed or molded & defects in specs ___
9.1.10. Age of specs ___

Data Sheet ___

S___F___N/A___

COMPRESSIVE STRENGTH OF CONCRETE USING PORTIONS
OF BEAMS BROKEN IN FLEXURE
ASTM C 116-90

4. Apparatus:
4.1. Testing machine verified in accordance w/ ASTM E 4 ___
2 steel bearing blocks w/ hardened faces (not < HRC 60), dia. 75 % of width of specimen ___
4.2. Machined or ground bearing plates not < ¾-in. thick, meet planeness required in 5.2.1, & hardness required in 4.1 ___

5. Test specimens:
5.1. Length at least 2 in. (50 mm) > than width & not cracked, chipped, or obvious defects ___
5.2. Preparation of test specimens:
5.2.1. Bearing faces not depart from plane > 0.002 in. (0.05 mm) ___
If depart more, cap specimen in accordance w/ ASTM C 617 ___
5.2.2. Keep specimens in same condition set forth for making & curing flexural specimens ___

6. Procedure:
6.1. Width (B) ≤ height (D) ___
6.2. Center bearing plates so thrust of block of machine aligned w/ center of bearing plates ___
6.3. Rate of loading, screw type ~ 0.05in./min (1.3 mm/min) ___
Hydraulic, 35 ± 15 psi/sec (241 ± 104 kPa/sec) ___
6.4. Test to failure, recording load at failure ___

7. Calculation:
7.1. Calculate compressive strength to 10 psi (69 kPa)

8. Report:
8.1. Report the following:
8.1.1. Test method (C 116) ___
8.1.2. Specimen id No. ___
8.1.3. "B" & "D" dimensions, in. or mm ___
8.1.4. Cross-sectional area, $in.^2$ or $mm.^2$ ___
8.1.5. Max. load, lb-force or newtons ___
8.1.6. Compressive strength, nearest 10 psi (69 kPa) ___
8.1.7. Method of obtaining specimen ___
8.1.8. Age of specimen & details of curing ___
8.1.9. Orientation of specimen w/ respect to top of beam as cast ___
8.1.10. Type of failure & appearance of concrete ___
8.1.11. Conditions of curing specimens & moisture condition @ time of test ___

Data Sheet ___

S___F___N/A___

LENGTH CHANGE OF HARDENED HYDRAULIC-CEMENT MORTAR & CONCRETE
ASTM C 157-03

5. Apparatus:
5.1. Molds & length comparator conform to requirements in ASTM C 490 ___
5.2. Tamper, nonapsorptive, nonabrasive, rubber or oak, ½ X 1 in. (13 X 25 mm), 6 in. (152 mm) long __
5.3. Tamping rod, steel rod 3/8-in. (10 mm) in dia., not < 10 in. (250 mm) long, hemispherical tip ___
5.4. Drying room & controls w/ racks allowing conditioned air circulation ___
5.4.1 Room air temp. 73.4 ± 3°F (23.0 ± 1.7°C), humidity 50 ± 4 %, atmometer evap. rate 77 ± 30 ml/24 hr, or by Griffin low-form beaker ___
5.5. Atmometer as shown in Fig. 1 ___
5.5.1. Mounting as shown in Fig. 2 ___
5.5.2. Operation ___
5.6. Filter paper, white & smooth, 6 in. (152 mm) dia., 0.050 ± 0.003 in. (1.27 ± 0.08 mm) thick ___
5.7. Apparatus for demolding specimens in double mold as shown in Fig. 3 ___

6.1. Sample in accordance w/ ASTM C 192 & C172 ___

7. Test specimens:
7.1. Mortar, prism 1-in.^{2} (25 mm^2) cross-section, ~ 11 ¼ in. (285 mm) long, 3 specimens ___
7.2. Concrete, - 2-in. sieve, prism 4-in.^{2} (100 mm^2) cross-section, 11 ¼ in. (285 mm) long, 3 spec. ___

8. Procedure for mixing mortars & concrete:
8.1. If made to other requirements, take samples & mold as to sections on sampling & molding ___
8.2. Temp 65-75°F (18-24°C), proportion by mass ___
8.3. Mortar, mix in suitable mixer, determine flow to ASTM C 1437 to flow of 110 ± 5% ___
8.4. Concrete, mix in suitable mixer, get slump to ASTM C 143 to slump of 3 ½ ± ½ in. (90 ± 15 mm) ___

9. Procedure for molding specimens:
9.1. Mortar specimens, 2 = layers, compact, strike off excess ___
9.2. Concrete specimens, 2 = layers & rod to C192, strikes off excess ___

10. Procedure for curing of specimens:
10.1. Cure in molds in moist room in accordance w / C511, protect from dripping water ___
10.2. De-mold 23 ½ ± ½ hr. after adding water during mixing ___
Place in lime-saturated water @ 73.4 ± 1°F (23.0 ± 0.5°C) 15 min. ___
24 ± ½ hr. after adding water during mixing, remove from soak, dry, take comparator reading ___
10.3. After comp. reading, store in lime-sat. water @ 73.4 ± 1°F (23.0 ± 0.5°C) for 28 days ___

11. Procedure for storage of specimens:
11.1. After measurement @ end of curing, store in one or the following:
11.1.1. Water storage, lime-sat. water to C 511, comp. rdgs. @ 8, 16, 32, & 64 wks ___
11.1.2. Air storage, store in drying room, comp. rdgs. @ 4, 7, 14, & 28 days, 8, 16, 32, & 64 wks ___

12. Procedure for calculating length change:
12.1. Comparator reading, read w/ spec. in comp., read w/ reference bar in comp. ___
Calculate difference to C490 ___
12.2. Length change, calculate as follows:
ΔL_x = CRD – initial CRD/G X 100
ΔL_x = length change of specimen @ any age, %
CRD = difference between comp. rdg. of spec. & reference bar @ any age
G = gage length (10 in. or 250 mm)

13. Report ___

Data Sheet ___

S___F___N/A___

CONCRETE THICKNESS BY DRILLED CORES
ASTM C 174-97

3. Apparatus:
3.1 3-point calipering device, metal round bottom, 3 metal vertical rods at 60^{o} apart ___
3.2 Device with 3 short posts or studs of hardened steel ___
3.3 Device to accommodate specimen lengths over a range of 4 to 10-in. (100 to 250-mm) ___
3.5 Device with 0.25-in. (6-mm) diam. measuring rod in center ___
Scale for making length readings readable to 0.05-in. (1-mm) ___
3.6. Apparatus stable & rigid to maintain shape & alignment w/o distortion or deflection ___

4. Specimens:
4.1. Representative of concrete in structure from which they are removed ___
Drilled w/ axis normal to surface of structure ___

5. Procedure:
5.1. Calibrate apparatus ___
5.2. Place spec. w/ end that represents upper surface down w/ central postion over midpoint of upper end of spec. ___
5.3 Make 9 measurements, 1 at center, 8 at equal intervals along circumference of circle ___
Record each measurement to nearest 0.05-in. (1-mm) ___

6.1 Report average of 9 measurements to nearest 0.1-in. (1-mm) as the length of concrete core ___

Data Sheet ___

S___F___N/A___

MAKING AND CURING CONCRETE SPECIMENS IN THE LABORATORY
ASTM C 192-02

4. Apparatus:
4.1. Molds ___
4.2. Cylinder molds:
4.2.1. Molds for vertical specimens conforms to ASTM C 470 ___
4.2.2. Horizontal molds for creep test, meet symmetry & dimensional tolerance except verticality to ASTM C 470 ___, 2 1in. (25 mm) thick machined end plates if not capping ___
4.3. Beam & prism molds, 6 ± 1/8 in. x 6 ± 1/8 in (150 ± 3 x 150 ± 3 mm) cross section ___
Length shall be > 3 times depth ___
4.4. Tamping rods, 2 sizes, round, hemispherical ___
4.4.1. Larger rod, 5/8 in. (16 mm) dia., ~ 24 in. (600 mm) long ___
4.4.2. Smaller rod, 3/8 in. (10 mm) dia., ~ 12 in. (300 mm) long ___
4.5. Mallet comprised of rubber or rawhide, 1.25 ± 0.50-lb (0.6 ± 0.2-Kg) ___
4.6. Vibrator, ¾ -1½-in. (20 – 40 mm) dia., 7000-vpm, length 3-in. (75-mm) > specimen depth ___
4.7,4.8,4.9,4.10,4.11,4.12,4.13,4.14. Misc. Scoops, air meters, slump cones, pans, air content app., scales, temp measuring device, concrete mixer ___

5. Specimens ___

6. Preparation of materials ___

7. Molding Procedure:
7.4.2. – 7.4.3. Cylinders ___

Rodding ___
(1). 3 equal layers ___
(2). 25 rodding/layer ___
(3). 1 in. penetration previous layer ___
(4). 10 to 15 taps ___
(5). Strike-off, float, trowel ___

Vibration ___
(1). 2 equal layers ___
(2). 3 insertions/layer ___
(3). 1 in. penetration previous layer ___
(4). 10 to 15 taps ___
(5). Strike-off, float, trowel ___

7.4.3.3. Beams ___

Rodding ___
(1). 2 equal layers ___
(2). 1/ea. 2in.^{2}/layer ___
(3). 1 in. penetration ___
(4). 10 to 15 taps ___
(5). Strike-off, float, trowel ___

Vibration ___
(1). 1 layer ___
(2). <150 mm (6 in.) apart ___
(3). 10 to 15 taps ___
(4). Strike-off, float, trowel ___

8. Curing:
8.1. Immediately cover & protect specimen ___
Protect from water first 24 hr. after molding ___
8.2. De-mold 24 ± 8 hr. after casting ___
8.3. Cure moist @ 73 ± 3°F (23 ± 2°C) ___
Maintain free-water condition in tanks or moist room in accordance w/ ASTM C 511 ___
8.4. Flexural strength specimens:
Cure same as 8.1 & 8.2, except while in storage min. 20 hr. immediately prior to testing immerse in water saturated w/ calcium hydroxide @ 73 ± 3°F (23 ± 2°C) ___

Data Sheet ___

S___F___N/A___

FUNDAMENTAL TRANSVERSE, LONGITUDINAL, AND TORSIONAL RESONANT FREQUENCIES OF CONCRETE SPECIMENS
ASTM C 215-02

6. Apparatus:
6.1. Forced resonance apparatus (Fig 1):
6.1.1. Driving circuit w/ variable frequency audio oscillator, amplifier, & driving unit ___
Capable of producing voltage varying no more than ± 20 % over frequency range ___
6.1.2. Pickup circuit, generate voltage proportional to displacement, velocity, or acceleration ___
6.1.3. Specimen support, permit specimen to vibrate freely, resonant frequency outside range of use (100 – 10,000 Hz) ___
6.2. Impact resonance apparatus:
6.2.1. Impactor, steel or plastic, head wt. 0.11 ± 0.02 kg, striking end spherical w/ dia., 6 ± 1 mm ___
6.2.2. Sensor, piezo. accelerometer, wt. < 27 g, operating freq. 100 – 10,000 Hz ___
6.2.3. Frequency analyzer, digital waveform analyzer or a frequency counter ___
Sampling rate at least 20 kHz, record min. 1024 pts. of waveform ___
6.2.4. Specimen support to be provided as specified in 6.1.3 ___

7. Test specimens:
7.1. Preparation, cylindrical or prism in accordance w/ ASTM C 192, C 31, C 42 ___
7.2. Measurement of mass & dimensions, wt. & avg. length w/in ±0.5 % ___
Avg. cross-sectional dimensions w/in ±1 % ___
7.3. Limitations on dimensional ratio, length to max. transverse direction at least 2 ___

8. Determination of resonant frequencies – forced resonance method:
8.1. Transverse frequency:
8.1.1. Position support & driver to allow vibration in transverse mode ___
8.1.2. Vibrate specimen at varying frequencies ___
8.2. Longitudinal frequency:
8.2.1. Position support & driver to allow vibration in longitudinal mode ___
8.2.2. Vibrate specimen at varying frequencies ___
8.3. Torsional frequency:
8.3.1. Postion support & driver to allow vibration in torsional mode ___
8.3.2. Vibrate specimen at varying frequencies ___

9. Determination of resonant frequencies – impact resonance method:
9.1. Transverse frequency:
9.1.1. Support specimen to allow vibration in transverse mode, attach accel. near end ___
9.1.2. Prepare waveform analyzer or frequency counter for recording, use accel. trigger data acquis. ___
Strike w/ impactor ⊥ to surface end & at ~ middle ___
9.1.3. Record frequency, repeat 2 more times, if deviates > 10 %, discard reading & repeat ___
9.2. Longitudinal frequency:
9.2.1. Support specimen to allow vibration in longitudinal mode, attach accel. near center ___
9.2.2. Prepare waveform analyzer or frequency counter for recording, use accel. trigger data acquis. ___
Strike w/ impactor ⊥ to & at center of end w/o accel. ___
9.2.3. Record frequency, repeat 2 more times, if deviates > 10 %, discard reading & repeat ___
9.3. Torsional frequency:
9.3.1. Support specimen to allow vibration in torsional mode, prism attach accel. near edge, cylindrical attach accel. so direction of sensitivity is tangential to circular cross-section ___
9.3.2. Prepare waveform analyzer or frequency counter for recording, use accel. trigger data acquis. ___
Strike w/ impactor ⊥ to & at center of end w/o accel. ___
9.3.3. Record frequency, repeat 2 more times, if deviates > 10 %, discard reading & repeat ___

10. Calculation:

Data Sheet ___

S___F___N/A___

BLEEDING OF CONCRETE
ASTM C 232-99

4. Apparatus, Method A – sample consolidation by tamping:
4.1. Metal container, cylindrical w/ vol ½-ft^3, inside dia. 10 ± ¼ in. (254 ± 6.4 mm) ___
4.2. Scale w/ capacity to determine mass w/ accuracy of 0.5 % ___
4.3. Pipette ___
4.4. 100 ml glass graduate ___
4.5. Tamping rod, 5/8- in. (16 mm) dia., ~ 24 in. long, hemispherical tip ___
4.6. 1000 ml metal beaker **(optional)** ___
4.7. Balance **(optional)** sensitive to 1 g ___
4.8. Hot plate **(optional)** ___

5. Test specimen:
5.1. Concrete made in lab to ASTM C 192, made in field to ASTM C 172, 2 in. max. particle size ___
5.2. Fill to ASTM C 138 except fill to height of 10 ± 1/8 in. (254 ± 3.2 mm) ___

6. Procedure:
6.1. Maintain ambient temp. to 65 - 75°F (18 - 24°C) ___
Place on level surface free of vibration & cover ___
Draw off water w/ pipette @ 10-min. intervals 1^{st} 40 min., then 30-min. intervals ___
After w/drawal pour into graduate & record amount of water w/drawn & cumulative amount ___

7. Calculation:
7.1. Calculate volume of bleeding water per unit area of surface, V, $V = V_1/A$ ___
V_1 = vol. water during time interval, ml,
A = area of exposed concrete, cm^2
7.2. Calculate accumulated bleeding water, C = (w/W) X S, Bleeding % = (D/C) X 100 ___
C = mass of water in specimen, g
W = total mass of batch, kg
W = net mixing water (total amt. Water minus water absorbed by aggregate), kg
S = mass of sample, g
D = mass of bleeding water, g, or total volume in cm^3 X 1 g/cm^3
8. Apparatus, Method B sample consolidated by vibration:
8.1. Vibrating platform to mount filled container, provide intermittent periods of vibration ___
8.2. Timer ___
8.3. Steel container, 11½ in. (292 mm) top dia., 11 in. (279 mm) bottom dia., 11 1/8 in. (282 mm) high ___
8.3.1. Remainder of apparatus identical to Method A ___

9. Vibrating cycle:
9.1. 3sec. on 30 sec. off ___

10. Test specimen:
10.1. Prepared as described in Method A ___
10.2. Place to depth ~ ½ avg. dia. of container ___

11. Procedure:
11.1. Consolidation of specimen in container by vibration for duration to obtain desired compaction ___
11.2. Intermittent vibration, put cover on container, start motor & continue intermittent vibration 1 hr. ___
11.3. Intermittent vibration not allow determination of bleeding water, determine as in Method A ___

12. Calculation:
12.1. Calculate as described in Method A ___

Data Sheet ___

S___F___N/A___

COMPARING CONCRETES ON THE BASIS OF THE BOND DEVELOPED
WITH REINFORCING STEEL
ASTM C 234-91

4. Apparatus:
4.1. Molds, 2 types
For 6-in. (150-mm) concrete cubes w/ vertically embedded bar ___
For 6 x 6 x 12-in. (150 x 150 x300-mm) prisms w/ 2 horizontally embedded bars ___
4.2. Measuring apparatus to measure movement of bar, w/ 0.001-in. (0.025-mm) graduations ___
4.3. Testing apparatus, machined steel bearing plate 6-in. (150-mm) square, ¾-in (19-mm) thick, hole drilled through center of sufficient dia. to accommodate bar ___

5. Test specimens:
5.1. 3 specimens of each type (cube & prism) ___
5.2. Cubes, bar project down from bottom face 3/8-in. (10-mm), project up from top face needed distance to provide adequate length to be gripped for applying load ___
5.3. Prisms, bars ⊥ to long axis & parallel to & equidistant from vertical sides ___
Vertical direction, 1 bar 3 in. (75 mm) from bottom, 1 bar 9 in. (225 mm) from bottom ___
5.4. Reinforcing bars No. 6 deformed bars conforming to Specification A 615 ___

6. Mixing concrete:
6.1. Batched, mixed, molded, & cured in accordance w/ ASTM C 192 ___
After mixing measure slump & air content in accordance w/ ASTM C 143, C173 or C 231 ___

7. Casting specimens:
7.1. Coat inside of molds ___
7.2. Placing concrete in molds may be a variable in tests of bond, if no case use following:
7.2.1. For cubes place in 2 = layers, rod each layer 25 times w/ 5/8-in. dia. rod ___
7.2.2. For prisms place in 4 = layers, rod each layer 25 times ___
7.3. Strike excess on top, protect against evaporation according to paragraph 7.1 in C 192 ___
7.4. Make 3 standard 6 x 12-in. (150 x 300-mm) or 4 x 8-in. (100 x 200-mm) control cylinders from each batch for determining compressive strength ___

8. Curing specimens:
8.1. Remove from molds not < 20 hr., not disturbing bars ___
8.2. Cure in accordance w/ ASTM C511 for 28 days ___

9. Specimen preparation:
9.1. Between 7 & 14 days break cubes half to form 2 6-in. (300 mm) cubes ___
9.2. Cap surface of the 6-in. (300 mm) cube containing the bar ___

10. Procedure:
10.1. Mount in testing machine w/ so long end of bar contacts gearing block assembly ___
10.2. Measure to nearest 0.1 in. (2.5 mm) distance between bearing face of concrete & horizontal plane Through pt. on bar where cross bar of device for measuring is attached ___
10.3. Apply load at rate not > 5000 lbf/min. (22 kN/min.) ___
10.4. Record load & 2 dial gages, at least 15 rdgs. by time slip of 0.010 in. (0.25 mm) reached ___
10.5. Load & read until yield pt. of bar reached, concrete splits, or slippage of 0.10 (2.5 mm) ___

11. Calculation:

12. Report:

Data Sheet ___

S___F___N/A___

FLEXURAL STRENGTH OF CONCRETE (USING SIMPLE BEAM WITH CENTER-POINT LOADING)
ASTM C 293-02

4. Apparatus:
4.1. Testing machine ___
Verify in accordance w/ ASTM E 4 ___
4.2. Loading apparatus w/ load-applying block & 2 specimen support blocks ___
4.2.1. Apparatus for center-pt. loading similar to Fig. 1 ___
Maintain span length & central position of load-applying block w/ respect to support blocks constant w/in ±0.05 in. (±1.3 mm) ___
4.2.2. Reactions parallel to direction of load, ratio of horizontal distance between pt. of load application & nearest reaction of depth of beam 1.5 ± 2% ___
4.2.3. Load-applying & support blocks not > 2 ½ in. (64 mm) high ___
Bearing blocks plane to 0.002 in. (0.05 mm) ___
Angle subtended by curved surface of blocks at least 45° ___

5. Test specimen:
5.1. Specimen conform to requirements of ASTM C 31 or C 192 ___

6. Procedure:
6.1. Moist-cured specimens for flexural tests done as soon as possible after removal from soak ___
6.2. Specimen on side & center on support blocks ___
Center loading system in relation to applied force ___
Load 3 – 6 % of estimated ultimate load ___
Gage gap w/ feeler gage @ 0.004-in. (0.10-mm) & 0.015-in. (0.38-mm) ___
Grind, cap, or use leather shims ___

7. Measurement of specimens after test:
7.1. 3 measurements across each dimension (1 @ ea. edge & center) to nearest 0.05 in. (1 mm) to determine average width & depth @ pt. of fracture ___
If fracture occurs @ capped section, include cap thickness in measurements ___

8. Calculation:
8.1. Calculate modulus of rupture; $R = 3\ PL/2bd^2$
R = modulus of rupture
P = maximum applied load
L = span length
b = average width @ fracture
d = average depth @ fracture

9. Report:
9.1.1. ID No. ___
9.1.2 Avg width to 0.05-in. (1-mm) ___
9.1.3. Avg depth to 0.05-in. (1-mm) ___
9.1.4. Span length, in. or mm ___
9.1.5. Max applied load in lb-force or newtons ___
9.1.6. Modulus of rupture to nearest 5 psi (0.05 Mpa) ___
9.1.7. Record of curing & apparent moisture condition of specs @ time of test ___
9.1.8. If specs were capped, ground, or leather shims were used ___
9.1.9. Defects in specs ___
9.1.10. Age of specs ___

Data Sheet ___

S___F___N/A___

MECHANICAL MIXING OF HYDRAULIC CEMENT PASTES AND MORTARS
OF PLASTIC CONSISTENCY
ASTM C 305-99

4. Apparatus:
4.1. Electrically driven mechanical mixer, epicyclic, w/ planetary & revolving motion of paddle ___
Minimum 2 speeds, controlled by definite mechanical means (no Rheostat) ___
Slow speed revolve @ 140 ± 5 RPM, planetary motion @ ~ 62 RPM ___
Faster speed revolve @ 285 ± 10 RPM, planetary motion @ ~ 125 RPM ___
Electric motor at least 124 W (1/6 hp) ___
Have adjustment screw (Fig 1) for clearance between lower end of paddle & bottom of bowl not > 2.5 mm & not < 0.8 mm ___
4.2. Stainless steel removable paddle (Fig 2) ___
4.3. Mixing bowl w/ nominal capacity of 4.73 L (Fig 3) ___
4.4. Scraper w/ semi-rigid rubber blade ~ 75 mm long, 50 mm wide, thin edge ~ 2 mm thick ___
4.5. Balances, weights, glass graduates, & other apparatus conform to appropriate std ___

5. Temperature & humidity:
5.1. Temp of room, dry mat'ls, paddle, & bowl @ 20 – 27.5°C (68 – 81.5°F) ___
Temp of water 23 ± 1.7°C (73.4 ± 3°F) ___
5.2. Rel humidity of lab not < 50 % ___

6. Materials, proportioning, & consistency:
6.1. Mat'ls, proportions, & quantities conform to particular std ___

7. Procedure for mixing pastes:
7.1.1. Put all mixing water in bowl ___
7.1.2. Add cement to water & allow 30 sec for absorption ___
7.1.3. Mix @ slow speed (140 ± 5 RPM) for 30 sec ___
7.1.4. Stop mixer for 15 sec, scrape sides ___
7.1.5. Mix @ med speed (285 ± 10 RPM) for 1 min. ___

8. Procedure for mixing mortars:
8.1.1. Put all mixing water in bowl ___
8.1.2. Add cement to water, mix @ slow speed (140 ± 5 RPM) for 30 sec ___
8.1.3. Add all sand slowly for 30 sec while mixing @ slow speed ___
8.1.4. Stop, change to med speed (285 ± 10 RPM), mix for 30 sec ___
8.1.5. Stop, stand for 1.5 min, scrape sides during 1st 15 sec ___
8.1.6. Finish by mixing for 1 min @ med speed (285 ± 10 RPM) ___

Data Sheet ___

S___F___N/A___

LENGTH CHANGE OF DRILLED OR SAWED SPECIMENS OF HYDRAULIC-CEMENT MORTAR AND CONCRETE
ASTM C 341-03

5. Apparatus:
5.1. Length comparator to spec of C490, except constructed for specimens up to 3 in. ___
5.1.1. Gage studs in ends of specs. ___
5.1.2. Gage studs on sides of specs. ___
5.2. Gage studs, type 316 stainless steel ___
5.2.1. Gage studs for ends of specimens, rounded surface ___
5.2.2. Gage studs for sides of specimens, plane surface w/ dia. or diagonal of 3/8 - ½ in. (10 - 13 mm) ___, for dry setting, length ½ - 5/8 in. (13 - 16mm) ___
5.3. Drying room & controls as described in C 157 ___

6.1. Samples obtained in accordance w/ C142 ___
6.2. Field cast spls in accordance w/ C 31 ___
6.3. Mat'l for lab prepared spls to be sampled using applicable standards ___
6.3.1. Lab prisms or cylinders in accordance w/ C 192 & C 490 ___

7.1. Specimens, cores or rectangular prisms ___
Specimens to be compared not differ >10 % cross-section, or >20 % length ___
Gage length ≥ 6 X max. size of aggregate, but not < 3 in., &
min. cross-sectional dimension ≥ 3 X max. size of aggregate ___

8. Setting gage studs:
8.1. Gage studs either dry-set or cemented in drilled holes, or cemented directly to specimen ___
8.2. Drilling holes for cementing, holes slightly larger than studs ___
Dry-set, holes about 0.005 in. (0.1 mm) smaller ___
8.2.1. Studs in end, holes drilled so longitudinal axis same as specimen, studs extend 1/8 – 3/16 in. (3 – 5 mm) beyond end ___
8.2.2. Studs in sides, 2 holes opposite sides ___, both holes in plane containing longitudinal axis of specimens ___, center of holes at least 1 on. (25 mm) from end ___, depth so studs set about 0.1 in. (3 mm) below surface ___
8.3. Cementing methods:
8.3.1. Studs in holes, position to depths as specified in 8.2.1 or 8.2.2 ___, cement effective for wet or dry & up to 250°F (121°C) ___
8.3.1.1. Epoxy resins cure @ room temp ___
8.3.1.2. Portland-cement paste ___
8.3.1.3. Other cementing media, sulfur & rose metal ___
8.3.2. Studs cemented to surface, epoxy resin that sets @ room temp ___
8.4. Dry-setting, drive studs to specified depth specified in 8.2.1 or 8.2.2 ___
8.5. Reference pts on studs, on each side of specimen ___

9.2. Determine gage length to accuracy of 1 %, studs on sides measure between reference pts ___, Studs in ends measure between ends of studs ___

10.1. Prior to initial length measure soak specimens in lime-saturated water ___
10.2. Temp of water 73.4 ± 3.0°F (23.0 ± 1.7°C), last 1 hr 73.4 ± 1.0°F (23.0 ± 0.5°C) ___

11.1. After conditioning store as described in 11.2 or 11.3:
11.2. During water storage take length @ 1, 2, 4, 8, 16, 32, & 64 weeks ___
11.3. Air storage, 73.4 ± 2.0°F (23.0 ± 1.1°C) @ rel. humidity 50 ± 4 % ___

12. Report ___

Data Sheet ___

S___F___N/A___

BALL PENETRATION IN FRESHLY MIXED HYDRAULIC CEMENT CONCRETE
ASTM C 360-92

5. Apparatus:
5.1. Cylinder w/ hemispherically shapes bottom & handle 30 ± 0.1 lb. (14 ± 0.05 kg) ___
Stirrup or frame ___
5.1.1. Weight, ~ 6 in. (152 mm) dia. & 4 5/8 in. (117 mm) high ___
Bottom in the form of hemisphere of 3-in. (76-mm) radius ___
5.1.2. Handle, metal rod ½-in. (13 mm) dia., w/ ¼ in. (6.4 mm) graduations ___
5.1.3. Stirrup, 1 ½ in. (38 mm) wide ___
Each foot min bearing area of 9 $in.^2$ (57 cm^2) ___

7. Procedure:
7.1. Concrete smooth & level condition ___
During test, adjoining concrete not vibrated, jarred, or agitated ___
Set base of apparatus on leveled concrete surface ___
Lower weight to surface of concrete & release slowly ___
Read penetration to ¼ in. (6.4 mm) ___
Min 3 readings ___
Readings not to taken w/ foot w/in 6 in. (152 mm) of pt. foot rested in previous test ___
If difference between max & min rdgs, take more rdgs until 3 agree w/in 1 in. (25 mm) ___

8. Report:
8.1. Record penetration in terms of in. (or mm) ___
Report average of 3 or more rdgs w/in 1 in. (25 mm) ___
Report values to ¼ in. (6.4 mm) ___

Data Sheet ___

S___F___N/A___

TIME OF SETTING OF CONCRETE MIXTURES BY PENETRATION RESISTANCE
ASTM C 403-99

6. Apparatus:
6.1. Containers for mortar specimens, 6 X 6 in. (150 X 150 mm), surface area allow 10 rdgs. ___
6.2. Penetration needles, bearing areas of 1, ½, ¼, 1/10, 1/20, & 1/40 in.^{2} (645, 323, 161, 65, 32, & 16 mm^2) ___, each shank scribe mark 1 in. (25 mm) from bearing area ___
6.3. Loading apparatus, capacity 130 lbf (600 N), accuracy of ±2 lbf (10 N) ___
6.4. Tamping rod ___
5/8-in (16-mm) diameter, 24-in. (600-mm) length for ≥ 6-in. (150-mm) ___
Hemispherical tip ___
6.5. Pipet ___
6.6. Thermometer ___
Measure to ± 1°F (± 0.5°C) ___
Liquid-in-glass thermometer, 0 to 120°F (-18 to 49°C) ___

7.1. Prepare 3 specimens for tests under field conditions ___
7.2. Tests under lab conditions, No. of specimens depend on purpose of test ___
7.2.1. To prove compliance, 3 batches for each variable, 1 time of setting ea. batch ___
7.2.2. For other tests, 3 specimens from 1 batch for each variable ___
7.3. Record time of initial contact of cement & water ___
7.4. Field condition tests, get representative spl in accordance w/ C 172 ___
Lab conditions, make concrete in accordance w. C 192 ___
Perform slump (C 143) & air content (C173 or 231) ___
7.5. Get representative spl to fill test container from concrete remaining from tests in 7.4 ___
7.6. Obtain mortar spl by wet-sieving on # 4 sieve in accordance w/ C172 ___
7.7. Consolidate by rodding & tapping, mortar surface ½ in. (10 mm) below top edge of container ___

8.1. Store specimens for lab conditions @ 68 - 77°F (20 - 25°C) ___
8.2. Field condition specimens store ambient conditions or as specified ___
8.3. Measure ambient air temp. @ start & finish, keep specimens covered w/ suitable damp material ___

9.1. Prior to pen. test, remove bleed water w/ pipet ___
9.2. Using appropriate needle size, penetrate 1 ± 1/16 in. (2 ± 2 mm), record force & time ___
Calculate pen. resistance by dividing force by bearing area of needle ___
9.3. Mixtures @ lab temps. 68 - 77°F (20 - 25°C), make initial test after 3 – 4 hr ___
9.4. At least 6 penetrations, continuing until 1 rdg. ≥ 4000 psi (27.6 Mpa) ___
Mixtures containing retarders, or @ temps lower than lab, tests may be 4 – 6 hr ___

9.5. Plotting test results using one of the following paragraphs 9.5.1 – 9.5.4 ___

10. Calculation ___

11. Report ___

Data Sheet ___

S___F___N/A___

ABRASION RESISTANCE OF CONCRETE BY SANDBLASTING
ASTM C 418-98

4. Apparatus:
4.1. Scales ≥ 5000 g, ±5 g @ 5000 g ___
4.2. Weights, permissible variations for weights used in weighing in following table & permissible variations on new weights ½ of the values in following table; ___

Weight, g	Permissible Variations on Weights in Use, g
1000	±0.50
500	±0.35
300	±0.30
250	±0.25
200	±0.20

4.3. Sand blast apparatus, injector-type gun, nozzle consist of cold-rolled bar stock ___
40 mm (1.5 in.) long, or hardened steel HRC 48 ± 2, walls 45° bevel ___
~ 100 psi compressed air supply w/ pressure-control device ___
4.4. Shield, square or circular, 150 mm (6 in.) on a side or diameter ___
Zinc-coated steel sheet or equivalent, 0.90 – 1.90 mm (0.035 – 0.075 in.) thick ___
Shield opening 28.70 ± 0.25 mm (1.13 ± 0.01 in.) in diameter in center ___
4.5. Abrasive, conforming to C 778, graded to pass # 20 sieve & retained on # 30 ___

5.1. Immerse specimens in water 24 hr, surface dry w/ damp cloth to get SSD ___

6. Calibration of apparatus:
6.1. Adjust air pressure to 59.5 ± 1 psi, collect abrasive for 1 min. ___
Adjust rate of flow of abrasive to 600 ± 25-g/min. ___
6.2. Regrade or replace abrasive every 60 min. ___
6.3. Cold-rolled steel nozzle replaced every 60 min. ___
Hardened tool steel nozzle changed as necessary to maintain original uniform flow & blast pattern ___

7.1. Place specimen w/ surface to be tested normal to nozzle axis 75 ± 25 mm (3.0 ± 0.1 in.) from end ___

8. Calculation ___

9. Report: abrasion coefficient loss to nearest 0.01 cm^3/cm^2 ___

Data Sheet ___

S___F___N/A___

MICROSCOPICAL DETERMINATION OF PARAMETERS OF THE
AIR-VOID SYSTEM IN HARDENED CONCRETE
ASTM C 457-98

6.1. Apparatus & materials are described in C 856 ___

7. Sampling for either procedure:
7.1. Samples from field or lab, or by coring, sawing, or removing concrete from structures or products ___
7.2. For referee purposes or for compliance of hardened concrete w/ requirements of specifications for air-void system, get spls from at least 3 randomly selected locations ___

8. Preparation of sections (either procedure):
8.1. Saw section for observation ⊥ to layers concrete was placed or ⊥ finished surface ___
8.2. Grind (Lap) if irregularities w/ appropriate silicon carbide abrasive ___
8.3. Difficulty in preparing lapped surfaces ___
8.4. Parameters of air-void system near finished or formed surface ___

9. Apparatus for measurement of specimens for Procedure A – Linear Traverse Method
9.1. Apparatus in 9.2 – 9.1.6 is recommended minimum selection
9.1.2. Linear-traverse device ___
9.1.3. Stereoscopic microscope & support, 50 X to 125X ___
9.1.4. Microscope lamp ___
9.1.5. Spirit level, small circular type convenient ___
9.1.6. Leveling device ___

10. Procedure ___

11. Calculation ___

12. Apparatus for measurement of specimens for Procedure B – Modified Point-Count Method
12.1. Apparatus in 12.1.2 – 12.1.6 is recommended minimum selection
12.1.2. Point-count device ___
12.1.3. Stereoscopic microscope & support ___
12.1.4. Microscope lamp ___
12.1.5. Spirit level, small circular type convenient ___
12.1.6. Leveling device ___

13. Procedure ___

14. Calculation ___

15. Report ___

Data Sheet ___

S___F___N/A___

STATIC MODULUS OF ELASTICITY AND POISSON'S RATIO
OF CONCRETE IN COMPRESSION
ASTM C 469-02

4. Apparatus:
4.1. Testing machine conforming to E 4, spherical head & bearing blocks to C 39 ___
Load rate, screw-type, 0.05 in. (1.25 mm)/min ___
Hydraulic type, 35 ± 5 psi (241 ± 34 kPa)/sec ___
4.2. Compressometer ___
4.3. Extensometer ___

5. Test specimens:
5.1. Cylinders molded to C 192, or C 31, cured & tested at age for desired elasticity information ___
5.2. Drilled core specimens, drilling requirements & moisture conditioning to C 42 ___
5.3. ±0.5° change in perpendicularly of ends ___
Ends plane to 0.002-in. (0.050-mm) ___
If not plane, planeness achieved by capping to C 617, or lapping, or grinding ___
5.4. Dia. measured to 0.01 in. (0.25 mm), average 2 mid-height measurements at rt. angles ___
Length measured to 0.1-in. in accordance w/ C 174 ___

6. Procedure:
6.1. Temperature & humidity constant throughout test ___
6.2. Determine compressive strength w/companion cylinders to C 39 prior to test for mod of elast ___
6.3. Place specimen, w/ strain measuring device attached on lower platen & align w. upper block ___
6.4. Load specimen at least twice, don't record data on first loading ___
Apply load continuously w/o shock at prescribed load rate ___
Record applied load & longitudinal strain at the point (1) when longitudinal strain is 50 millionths & (2) when applied load is = to 40 % of ultimate load ___
For Poisson's ratio, record transverse strain at same 2 points ___
6.5. Modulus of elasticity & strength load continuously to C 39, take several rdgs, determine strain at 40 % of ultimate interpolation ___

7. Calculation:
7.1. Calculate modulus of elasticity to nearest 50,000 psi (344.74 Mpa) as follows:

$$E = (S_2 - S_1)/(\varepsilon_2 - 0.000050)$$

where:
E = chord modulus of elasticity, psi,
S_2 = stress corresponding to 40 % of ultimate load,
S_1 = stress corresponding to a longitudinal strain, ε_1, of 50 millionths, psi, and,
ε_2 = longitudinal strain produced by stress S_2.
7.2. Calculate Poisson's ratio to the nearest 0.01, as follows:

$$\mu = (\varepsilon_{\tau 2} - \varepsilon_{\tau 1})/(\varepsilon_2 - 0.000050)$$

where:
μ = Poisson's ratio,
$\varepsilon_{\tau 2}$ = transverse strain at midheight of the specimen produced by stress S_2, and,
$\varepsilon_{\tau 1}$ = transverse strain at midheight of the specimen produced by stress S1.

8. Report ___

Data Sheet ___

S___F___N/A___

MOLDS FOR FORMING CONCRETE TEST CYLINDERS VERTICALLY
ASTM C 470-02

3.1.2 Mold diam. not differ from nominal diam. by > 1%, mold height not differ from nominal height by > 2%

5.3.3 Mold manufacturer certifications (D 570, D 256, etc.) for single-use plastic molds ___

6.3.1 Test for dry rodding & water leakage ___

7.1. Measure at least 3 single-use molds from each shipment for compliance with 3.1.2 and 6.3.1 ___ ___

Data Sheet ___

S___F___N/A___

USE OF APPARATUS FOR THE DETERMINATION OF LENGTH CHANGE OF HARDENED CEMENT PASTE, MORTAR, AND CONCRETE
ASTM C 490-00

5. Apparatus:
5.1. Reference masses & devices for determining mass & volume conform to C 1005 ___
5.2. Molds w/ 1 or 2 compartments to dimensions in Fig 1 or Fig 2 ___
5.2.1. Gage length is nominal length between innermost ends of gage studs ___
Steel or hard metal molds tight-fitting & firmly held together when assembled ___
Sides of mold rigid to prevent spreading or warping ___
5.2.2. Ea end plate to hold one gage stud in Fig 1 or Fig 2 ___
Gage studs American Iron & Steel Institute Type 316 stainless steel or corrosion-resistant metal of similar hardness ___
Gage studs set so principal axes coincide w/ principal axis of spec ___
Fig 1 molds, gage studs extend 17.5 ± 0.5 mm & distance between inner ends 250.0 ± 2.5 mm & 250-mm is gage length for calculating length change ___
Fig 2 molds, gage studs extend 0.625 ± 0.025 in & distance between inner ends 10.00 ± 0.10 in & 10 in is gage length for calculating length change ___
5.3. Length comparator ___
5.3.1. Comparator w/ dial micrometer (Fig 1) to read 0.002 mm or less accurate w/in 0.002 mm in 0.020 mm range & w/in 0.004 mm in any 0.200 mm range & at least 8.0 mm range ___
5.3.2. Comparator w/ dial micrometer (Fig 2) to read 0.0001 in accurate w/in 0.0001 in. in 0.010 in range & w/in 0.0002 in. in any 0.0002 in range & at least 0.3 in range ___
5.3.3. Design to check device against reference bar ___

6. Procedure:
6.1. Seal molds to prevent leaks & cover inside w/ mineral oil ___
6.2. Check rdgs w/ ref bar @ specified intervals ___
6.3. Rotate specs in comparator while rdg is taken, record minimum rdg ___
6.3.1. Comparator rdgs of moist specs, clean hole in base ___
Read & record comparator indication of ref bar ___
Take 1 bar, blot pins, place in comparator & take rdg ___
Continue until all bars are read ___

7. Calculation of length change:
7.1. Calculation of length change @ any age as follows: $L = (L_x – L_i)/ G X 100$
Where:
L = change in length @ x age, %
Lx = rdg @ x age – rdg of ref bar @ x age; in mm for Fig 1 or in for Fig 2
Li = initial rdg – rdg of ref bar @ same time; in mm for Fig 1 or in for Fig 2
G = nominal gage length 250 for Fig 1 or 10 for Fig 2

8. Temperature, humidity, & time:
8.1. Temp of molding room & dry mat'ls 20 – 27.5°C (68 – 81.5°F, rel humidity not < 50 % ___
Temp of mixing water 23.0 ± 2.0°C (73.5 ± 3.5°F) ___
8.2. Temp & humidity of air in moist storage facility conform to C 511 ___
8.3. Comparator rdgs taken @ specified intervals, intervals & ages shall be met to w/in ± 2 % ___

Data Sheet ___

S___F___N/A___

COMPRESSIVE STRENGTH OF LIGHTWEIGHT INSULATING CONCRETE
ASTM C 495-99

4. Apparatus:
4.1. Testing machine in accordance to C 39 ___
4.2. Scales & weights conforming to Apparatus Section of C 109 ___
4.3. Drying oven at 110 ± 5°C (230 ± 9°F) ___
Evaporation rate of 25-g/h for 4-hr ___
4.4. Molds, nonabsorbent ___
Diameter 3 ± 1/16 in. (75 ± 1.6 mm) ___
Length 6 ± 1/8 in. (150 ± 3 mm) ___

5. Sampling:
5.1. Sample fresh lightweight concrete in accordance to C 172 ___
5.1.1. Sampling from pump equipment, fill bucket of ~ 10-qt (9-dm^3) ___
5.1.2. Remixing sample – Do not remix sample

6. Test Specimens:
6.1. Size & shape, cylindrical to size set in paragraph 4.4 & ⊥ as prescribed paragraph 6.7 ___
6.2. Number, Minimum 4 specimens ___
6.3. Molding, 2 layers ___, Tap sides w/ rubber mallet ___, Overfill second layer ___, Do not rod ___
6.4. Finishing surface, Strike off after filling ___, Cover specimens ___
6.5. Removal from molds, Don't remove until danger of damage is past ___, Remove w/in 7 days ___
6.6. Curing, 1st 24 hr. maintain 70 ± 10°F (21.1 ± 5.5°C) ___, After 24 hr. store moist condition at 73.4 ± 10°F (23.0 ± 1.7°C) ___, Not exposed to stream of running water ___, After 7 days store at 70 ± 10°F & rel. humidity of 50 ± 30 % for 18 days ___, 25 days dry @ 140 ± 5°F (60 ± 2.8°C) ___
6.7. Preparation for testing, Bearing surfaces w/in 0.02 in. (0.5 mm) otherwise grind or cap in accordance to C 617___, Ends do not depart from ± more than 1° ___
6.8. Measurement of specimen, Average of 2 diameters w/in 0.01 in. (0.25 mm) ___, Height to nearest 0.01 in. ___

7. Procedure:
7.1. Placing of specimen, Place on lower bearing block & align w/ upper block ___
7.2. Rate of loading, Load continuously w/o shock at constant rate ___, Maximum load reached in 65 ± 15 sec ___

8. Calculation:
8.1. Calculate compressive strength by dividing max load by average cross-sectional area ___, Record to nearest 10 psi ___

9. Oven-dried weight:
9.1. Mold 2 companion specimens & cure as in paragraph 6.6 __, Dry companion specimens @ 28 days @ 230 ± 18°F (110 ± 10°C) & weigh @ 24 hr. intervals until loss of wt. ≤ 1 % ___, Get weight & dimensions of oven-dried specimens & calculate unit weight in lb/ft^3 ___

10. Report ___

Data Sheet ___

S___F___N/A___

SPLITTING TENSILE STRENGTH OF CYLINDRICAL CONCRETE SPECIMENS
ASTM C 496-96

9. Apparatus:
9.1. Testing machine in accordance to C 39 ___
9.2. Supplementary bearing bar or plate if diameter of upper block < length of cylinder ___
Bar or plate plane to ± 0.001 in. (0.025 mm) ___
2 in. wide & plate used in manner that load applied over length of specimen ___
9.3. Bearing strips __
2 strips 1/8 in. (3.2 mm) thick X 1 in. (25 mm) wide & long or longer than specimen ___

10. Test specimens:
10.1. Specimens in accordance to C 31 or C 192 ___
Drilled cores size & moisture conditioning in accordance to C 42 ___
10.2. Curing for light-weight concrete ___
Specimens @ 28 days in air-dry condition after 7 days moist cure followed by 21 days drying @ 73 ± 3°F (23.0 ± 1.7°C) & 50 ± 5 % relative humidity ___

11. Procedure:
11.1. Marking, diametral lines on each end in same axial plane ___
11.2. Measurements ___
Diameter to 0.01 in. (2.5 mm) by averaging 3 diameters (near ends & middle) ___
Length to 0.01 in. (2.5 mm) by averaging 2 measurements ___
11.3. Positioning using marked diametral lines ___
Center 1 strip on center of lower bearing block ___
Place specimen on strip w/ line on end of specimen vertical & centered over strip___
Place second strip on specimen lengthwise centered on lines ___
7.3.1. The 2 lines on specimen aligned w/ center of upper bearing block ___
7.3.2. Supplementary bar or plate, if used, & center of specimen directly beneath center of thrust of spherical bearing block __

8. Calculation:
9.2. Calculate splitting tensile strength as follows:

$$T = 2P/\prod\pi ld$$

where
T = splitting tensile strength, psi (kPa),
P = maximum applied load indicated by the testing machine, lbf (kN0,
L = length, in. (m), and
D = diameter, in. (m).

10. Report ___

Data Sheet ___

S___F___N/A___

MOIST CABINETS, MOIST ROOMS, AND WATER STORAGE TANKS USED IN TESTING OF HYDRAULIC CEMENTS AND CONCRETES
ASTM C 511-03

4. Requirements for cement mixing rooms:
4.1. Temp of air near mixing slab, molds, & base plates 23 ± 4°C, rel humidity not < 50 % ___
4.2. Temp of mixing water 23 ± 2°C ___

5. Requirements for moist cabinets or moist rooms:
5.1. General – 23 ± 2°C (73 ± 3°F); rel. humidity not < 95% ___
Exposed surfaces look & feel moist ___
Recording thermometer & cal every 6 mo. ___
Reference therm. readable to 0.5°C w/ cal certificate ___
Door closed 5 min. prior to reading ___
If diff is > 1°C, adjust recording therm to w/in 0.5°C of reference therm. ___
5.1.1. Air in moist cabinet or room nearly saturated w/ water ___
5.1.2. Recording therm recordings shall be audited ___
5.1.3. Air temp. controlled by one of following 2 ways:
5.1.3.1. Thermostatically control air temp. w/in room when surrounding space no conditioned, sensing element located in room ___
5.1.3.2. Thermostatically control space surrounding room & manually control temp. w/in room ___
5.1.4. Charts indicate temps. w/in temp limits ___
5.2. Moist cabinets –Fog or water sprays, or curtains of water on inner walls & collect in pool ___
5.3. Moist rooms:
5.3.2. Used in cement testing – prevent droplets of water falling on specimens ___
5.3.3. Used in concrete testing –free water, not exposed to dripping or running water ___
6. Water storage tanks:
6.1. Provide auto control of temp. when not in temp-controlled room ___
Recording therm w/ sensing element in tank, when not in moist cabinet or room___
Recording thermometer & cal every 6 mo. ___
Group of tanks may be considered one if the following conditions met;
(1) All tanks interconnected w/ tubing to allow water to flow between tanks ___
(2) Some means of circulation is provided between tanks ___
(3) Temp variations between tanks must not exceed 1.0°C when checked & recorded weekly ___
Reference therm readable to 0.5°C w/ cal certificate ___
Reference therm adjacent to recording therm probe ___
If diff is > 1°C, adjust recording therm to w/in 0.5°C of reference therm. ___
Water saturated w/ lime @ 3 g/L, changed @ 24 mo. ___
Water thoroughly stirred once a mo ___

Data Sheet ___

S___F___N/A___

CREEP OF CONCRETE IN COMPRESSION
ASTM C 512-87 (94)

4. Apparatus:
4.1. Molds, cylindrical in accordance to C 192 or C470 ___
4.1.1. Horizontal molds in accordance to C 192 ___
4.2. Loading frame, capable of applying & maintaining the required load despite any dimension changes of specimen ___
4.3. Strain-measuring device to measure longitudinal strain to 10 millionths ___

5. Test specimens:
5.1. Specimen size, Diameter 6 ± 1/16 in. (150 ± 1.6 mm) ___, Length ≥ 11.5 in. (292 mm) ___, Specimens in contact w/ steel bearing plates, specimen length = to gage length of strain-measuring device + diameter of specimen ___, Ends of specimen in contact w/ other specimens, specimen length = to gage length of strain-measuring device + 1.5 in. (38 mm) ___
5.2. Fabricating specimens, Max aggregate size not > 2 in. ___, Vertical cylinders made to C 192 ___, Ends meet planeness to C 617 ___, Horizontal specimens to method in C 192 ___, Vibrate in 1 layer ___, Rod in 2 equal layers rodded 25 times each layer ___
5.3. Number of specimens, not < 6 specimens, 2 for compressive strength, 2 tested for total deformation, & 2 unloaded for controls to indicate deformation to causes other than load ___

6. Curing & storage of specimens:
6.1. Standard curing, before removing molds 73.4 ± 3.0°F (23.0 ± 1.7°C), & covered ___, Remove molds not < 20, not > 48 hr. & store 73.4 ± 3.0°F (23.0 ± 1.7°C) until 7 days ___, After moist curing store 73.4 ± 3.0°F (23.0 ± 1.7°C) & 50 ± 4 % until test completed ___
6.2. Basic creep curing, If loss or gain of water desired, enclose spec. in moisture proof jackets ___
6.3. Variable curing temperature regimen, when desired to introduce effect of temp. on elastic & inelastic properties of concrete, temps. Controlled to desired temp. history ___

7. Procedure:
7.1. Age at loading, to compare creep potential of different concretes, load @ 28 days ___, If complete creep behavior prepare specimens for 2, 7, 28, 90 days & 1 yr. ___
7.2. Loading details, Before loading creep specimens, determine compressive strength in accordance to C 39 ___, Unsealed specimens tested cover ends to prevent moisture loss ___, Load @ not > 40 % of comp. strength at age of loading ___, Strain rdgs. Before & after loading, 2 – 6 hr. later, daily for 1 wk, weekly for 1 mo., monthly for 1 yr. ___, Before strain rdgs. measure load ___

8. Calculation___

9. Report ___

Data Sheet ___

S___F___N/A___

DENSITY OF STRUCTURAL LIGHTWEIGHT CONCRETE
ASTM C 567-00

6. Apparatus:
6.1. Tamping rod, mallet, measure, balance, & molds in accordance w/ C 138 ___
6.1.1. Measure, 0.5 ft^3 ___
6.2. Controlled humidity enclosure to 50 ± 5 % & 23 ± 2°C (73.5 ± 3°F) ___
6.3. Drying oven at 110 ± 5°C (230 ± 9°F) ___
Evaporation rate of 25-g/h for 4-hr ___

7. Sampling, making & curing:
7.1. Sample field-mixed concrete in accordance w/ C 172 ___
7.2. Determine equilibrium & oven-dry densities on 150 X 300-mm (6 X 12-in.) cylinders ___
7.2.1. Make cylinders in accordance w/ C 192 or C 31 (3 for eq. Density, 3 for oven-dry density) ___
7.3.1. Cure eq. density cylinders in accordance w/ C 192 or C31 for 6 days ___
7.3.2. Store oven-dry density cylinders 24hr. or until test @ temp adjacent to cylinders 16 - 27°C (60 - 80°F) & that prevents loss of moisture ___

8. Procedure:
8.1. Determine density of freshly mixed concrete in accordance w/ C 138 ___
8.2. Eq. density, remove from curing on 6^{th} day, soak in water @ 23 ± 2°C (73.5 ± 3°F) 24 hr. ___
Measure apparent wt. suspended & submerged, record as "C" ___
Remove from water, drain 1 min. on ≥ 3/8-in. sieve cloth, weigh, record SSD as "B" ___
Dry cylinder in controlled humidity enclosure until wt. Changes < 0.5 % successive weighings 28 days apart, get wt. of dried cylinder & record as "A" ___
Calculate equilibrium density as follows:
$E_m(kg/m^3) = (A \times 997)/(B - C)$ ___
$E_m\ (lb/ft^3) = (A \times 62.3)/(B - C)$ ___
where:
E_m = measured equilibrium density
A = weight of concrete cylinder as dried
B = weight of saturated surface-dry cylinder
C = apparent weight of suspended-immersed cylinder
8.3. Oven-dry density, > 24 & < 32 hr demold ___
Measure apparent wt. suspended & submerged, record as "G" ___
Remove from water, drain 1 min. on ≥ 3/8-in. sieve cloth, weigh, record SSD as "F" ___
Dry @ 110 ± 5°C (230 ± 9°F) 72 hr, cool, weigh, record as "D" ___
Repeat oven-dry @ 24 hr intervals until wt. changes < 0.5 % successive weighings 24 hr apart ___
Calculate equilibrium density as follows:
$O_m(\text{Density, } kg/m^3) = (D \times 997)/(F - G)$ ___
$O_m\ (\text{Density, } lb/ft^3) = (D \times 62.3)/(F - G)$ ___
where:
O_m = measured oven-dry density
D = weight of oven-dry cylinder
F = weight of saturated surface-dry cylinder
G = apparent weight of suspended-immersed cylinder

9. Calculations & reporting for rapid information:
10.1. Calculation of oven-dry density ___
10.2. Calculation of approximate equilibrium density ___

11. Report ___

Data Sheet ___

S___F___N/A___

PULSE VELOCITY THROUGH CONCRETE
ASTM C 597-02

6. Apparatus:
6.1. Apparatus consists of pulse generator, pair of transducers (transmitter & receiver), amplifier, time measuring circuit, time display & connecting cables (Fig 1) ___
6.1.1. Pulse generator & transmitting transducer ___, 20 – 100 kHz, repetitive pulses not < 3/ sec ___
6.1.2. Receiving transducer & amplifier ___
6.1.3. Time-measuring circuit, overall time-measurement of 1μs ___
6.1.4. Display unit ___
6.1.5. Reference bar, metal or other durable mat'l that transit time of longitudinal waves is known ___
6.1.6. Connecting cables ___
6.1.7. Coupling agent, viscous mat'l (oil, petroleum jelly, water soluble jelly, or grease) ___

7. Procedure:
7.1. Functional check of equipment & zero-time adjustment ___
Verify equipment working properly & perform initial zero-time adjustment & check hourly___
7.2. Determination of transit time:
7.2.1. For existing construction select test locations in accordance w/ C 823 ___
7.2.2. Locate transducers opposite each other ___
7.2.3. Apply appropriate coupling agent to transducer faces, test surface, or both ___
Press faces of transducers against concrete until stable transit time displayed & measure ___

8. Calculation:
8.1. Calculate pulse velocity as follows:
$V = L/T$
where:
V = pulse velocity, m/sec,
L = distance between transducers, m, and
T = transit rime, sec.

9. Report:
9.1.1. Location of test or ID of specimen ___
9.1.2. Location of transducers ___
9.1.3. Distance between transducers, to greater precision than 0.5 % of distance ___
9.1.4. Transit time to precision of at least 0.5 % of transit time ___
9.1.5. Pulse velocity to nearest 10 m/sec ___

Data Sheet ___

S___F___N/A___

CAPPING CYLINDRICAL CONCRETE SPECIMENS
ASTM C 617-98

4.1. Capping plates ___
Glass, ≥ ¼-in. (6-mm) ___, metal, ≥ 0.45-in. (11-mm) ___, stone, ≥ 3-in. (76-mm) ___
Recess for sulfur, ≤ ½-in. (12-mm) ___
Planeness of ≤ 0.002-in. (0.05-mm) ___
Indentations, ≤ 0.010-in. (0.25-mm) deep, or ≤ 0.05-in.² (32-mm²) ___
4.2. Alignment device ___
Perpendicularity ≤ 0.5° (1/8-in. in 12-in.) (3.2-mm in 305-mm) ___
Caps centered ≤ 1/16-in. (2-mm) ___
4.3. Melting pot ___
Auto temp control ___
4.3.1.1. Exhaust hood to outdoors ___

5.1. Strength and thickness in Table 1 ___
5.1.1. If specified materials are used except neat cement paste for concrete >7000 psi (50 MPa), Manufacturer or user documentation required such that:
5.1.1.1. Strength 15 cyl. Not < 98% of avg. strength 15 companion cyl. capped w/ neat cem. paste Or 15 cyl ground plane to 0.002 in. (0.05 mm) ___
5.1.1.2. Std. Dev. Of strengths of capped cyl. not greater than 1.57 times std. Dev. of ref. cyl. ___
5.1.1.3. Cap thickness requirements met in qualification test, ___ and
5.1.1.4. Of the hardening time of caps used in qualification tests ___
5.2.2. Neat cement paste, 2 to 4-hr curing before use ___
5.3.1. Gypsum cement paste, qualification tests ___
5.4.1. Sulfur mortar, > 2 hr curing before use ___
5.4.2. Qualification tests (receipt of new lot & intervals not exceeding 3 months ___

6.1. Cap fresh cylinders w/ neat cement only ___
Remove water and laitance ___
Press cement w/plate and twist ___
6.2.3. Cap hardened cylinders w/gypsum or neat cement ___
Plates removed, < 45 min for gypsum, >12 hr for neat cement ___
6.2.4. Cap hardened cylinders w/ sulfur ___
Sulfur temperature of 265 to 290°F (129 to 143°C) ___
Warm plates ___
Oil plates lightly ___
Dry cylinder ends ___
7.1. Moist condition at all times, before and after capping ___
Do not place gypsum caps in water or in moist room for > 4-hr ___
7.2. Cure before test ___

Data Sheet ___

S___F___N/A___

DENSITY, ABSORPTION, AND VOIDS IN HARDENED CONCRETE
ASTM C 642-97

3. Apparatus:
3.1. Balance sensitive to 0.025 % of the mass of the specimen ___
3.2. Container suitable for immersing specimen & suitable wire for suspending specimen in water ___

4. Test specimen:
4.1. When possible spl consist of several individual portions of concrete ___
Volume of pieces not < 350 cm^3 (or for normal weight concrete ~ 800 g ___
Each portion free from cracks, fissures, or shattered edges ___

5. Procedure:
5.1. Oven-dry mass ___
Get weight & dry in oven @ 100 - 110°C not < 24 hr. ___
Remove from oven, cool to 20 - 25°C & weigh ___
If specimen was wet when first weighed, perform 2nd drying @ 24 hr. & weigh & if this value checks with 2nd (< 0.5 %), consider specimen dry & designate weight as A ___
5.2. Saturated mass after immersion, immerse in water after par 5.1 is complete ___
Water @ 21°C not < 48 hr. until 2 successive values increase in weight not < 0.5 % ___
Surface-dry by using towel, weigh, & designate as B ___
5.3. Saturated mass after boiling, place in container, cover w/ water, boil 5 hr. ___
Cool for not < 14 hr. to 20 - 25°C ___
Surface-dry by using towel, weigh, & designate as C ___
5.4. Immersion apparent mass, suspend in water, get apparent mass in water, designate D ___

6. Calculation:
6.1. Make following calculations:

Absorption after immersion, % = $[(B - A)/A] \times 100$
Absorption after immersion & boiling, % = $[(C - A)/A] \times 100$
Bulk density, dry = $[A/(C - D)] \times \rho = g_1$
Bulk density after immersion = $[B/(C - D)] \times \rho$
Bulk density after immersion & boiling = $[C/(C - D)] \times \rho$
Apparent density = $[A/(A - D)] \times \rho = g_2$
Volume of permeable pore space (voids), % = $(g_2 - g_1)/ g_2 \times 100$
or $(C - A)/(C - D) \times 100$

where:
A = mass oven-dried sample in air, g
B = mass surface-dry in air after immersion, g
C = mass surface-dry in air after immersion & boiling, g
D = apparent mass in water after immersion & boiling, g
g_1 = bulk density, dry, mg/m^3
g_2 = apparent density, dry, mg/m^3
ρ = density of water = 1 mg/m^3 = 1 g/cm^3

Data Sheet ___

S___F___N/A___

SOUNDNESS OF AGGREGATE BY FREEZE-THAW OF CONCRETE SPECIMENS
ASTM C 666-03

4. Apparatus:
4.1. Freeze-Thaw apparatus:
4.1.1. Automatic, continuous cycles ___
If not auto, 24 hour manual operation ___
4.1.2. Specimen container/s, non-rigid ___
Proc A – spls have 1/32 to 1/8 " H_2O around specimen ___
Proc B – spls surrounded by air for freeze phase & water for thawing phase ___
4.1.3. Cabinet heat exchange medium uniform w/in 6°F @ any time & place (Proc A) ___
Cabinet heat exchange medium uniform w/in 6°F @ on surface (Proc B) ___
4.1.3.1. Support bottom of container so temp not transmitted directly thru bottom of container ___
4.1.4. Proc B - Specimen bottom support w/o contact ___
4.2. Thermometers, resistance thermometers, or thermocouples to w/in 2°F ___
4.3. Dynamic sonic tester ___
4.4. Optional length change comparator conform to C 490 ___
4.5. Scales w/ capacity ~ 50% > spec wt accurate to 0.01 lb ___
4.6. Tempering tank, thaw temp w/in -2° & +4°F (cabinet @ thaw temp OK) ___

5.2. Cycle, 40° to 0° to 40°F, 2 to 5 hr ___
5.3. Diff between temp @ center of spec & surface NTE 50°F ___
5.4. Transition between freezing-and-thawing phases NTE 10 min. ___

6.1. Mat'l for specs made on lab – use applicable stds ___
6.2. Spls cut from hardened concrete obtain in accordance w/ C 823 __-

7.1. Prisms or cylinders in accordance w/ C 192 and C 490 ___
7.2. Specs NLT 3-in.or NGT 5-in. width, depth, or dia, & NLT 11-in. or NGT 16-in. long ___
7.3. May be cut cores or prisms & should be dried to moisture < from structure taken ___
Specs finished w/ gage studs in accordance w/ C 341 ___
7.4. Store in lime-water after de-molding until freeze-thaw tests started ___

8.1. Molded beam specs cure 14 days prior to test ___
Sawed beams soak in lime-water @ 73.4 ± 3°F (23.0 ± 2.0°C) 48 hr prior to test ___
8.2. Bring to w/in -2° & +4°F of target thaw temp ___
Determine mass & avg length & cross-section w/in tolerance req'd in C 215 ___
8.3. Start by placing in thawing water @ beginning of thaw phase ___
Remove in thawed condition @ intervals NTE 36 cycles ___
Test for fundamental transverse freq & measure length change (optional) w/in temp range in 4.6 ___
Continue for 300 cycles or rel dynamic mod of elasticity reaches 60 % of initial modulus ___
8.4. If sequence of freezing-and-thawing cycles is interrupted, store specs in frozen condition ___

9.1. Calculate rel dynamic mod of elasticity ___
9.2. Calculate durability factor ___
9.3. Calculate length change in % (optional) ___

10. Report ___

Data Sheet ___

S___F___N/A___

CRITICAL DILATION OF CONCRETE SPECIMENS SUBJECTED TO FREEZING
ASTM C 671-94

4. Apparatus:
4.1. Cooling bath to lower temp. from 1.7 to – 9.4°C (35 to 15°F) @ 2.8 ± 0.5°C/hr. (5 ± 1°F/hr.) ___
4.2. Constant-temperature water bath, maintain temp @ 1.7 to 0.9°C (35 to 2°F) ___
4.3. Strain-measuring & recording facilities ___
4.4. Room or cabinet for storing @ desired temp & relative humidity ___
4.5. Miscellaneous equipment, Molds & apparatus specified in C 192 ___

5. Calibration:
5.1. Strain frame & strain-measuring apparatus calibrated w/ invar bar w/ known thermal expansion characteristics ___
5.2. Cool apparatus to paragraph 8.2 w/ invar bar in strain frame ___
Record strain w/ change in temp ___
5.3. Calculate best fit line for length change-temperature decrease ___

6. Test specimens:
6.1. Concrete cylinders in accordance w/ C 192 ___
Specimens 75 mm (3 in.) diameter X 150 mm (6 in.) high ___
Fitted w/ axially centered SS gage plugs in top & bottom ___
6.2. Specimens may also be cores, cubes, or prisms cut from hardened concrete ___

7. Curing & conditioning:
7.1. Curing & conditioning carefully described ___

8. Procedure:
8.1. Test immediately after conditioning ___
8.2. Test cycle ___
Cool in silicone oil or water-saturated kerosene @ 1.7 to – 9.4°C (35 to 15°F) @ 2.8 ± 0.5°C/hr. (5 ± 1°F/hr.) followed by immediate return to water bath ___
8.3. Frequency, 1 test cycle every 2 weeks ___
8.4. Measurements, specimen strain & the cooling bath temps. ___
8.5. Duration of test & critical dilation, test until critical dilation reached or end of period of interest ___
8.6. Period of frost immunity, numerical difference between dilations increases sharply from 1 cycle to the nest, period of frost immunity is exceeded ___

9. Report ___

Data Sheet ___

S___F___N/A___

SCALING RESISTANCE OF CONCRETE SURFACES EXPOSED
TO DEICING CHEMICALS
ASTM C 672-98

4. Apparatus:
4.1. Freezing equipment, lower temps of specimens to –18 ± 3°C (0 ± 5°F) w/in 16 – 18 hr ___
4.2. Molds of proper size in accordance w/ C 192 ___
4.3. Tamping rod in accordance w/ C 143 ___
4.4. Small tools, wood strike-off board, trowel, & moderately stiff bristle brush ___
4.5. Slump cone in accordance w/ C 143 ___
4.6. Air meter in accordance w/ C 173 or C231 ___
4.7. Scales in accordance w/ C 192 ___
4.8. Concrete mixer in accordance w/ C 192 ___

5. Proportioning & mixing:
5.1. Proportioning, air content, cement factor, slump, water-to-cement ratio appropriate ___
5.2. Mixing & testing of freshly mixed concrete, machine mix & test in accordance w/ C 192 ___

6. Specimens:
6.1. Surface area 0.045 m^2 (72 $in.^2$), 75 mm (3.0 in.) deep ___
≥ 2 duplicate specimens each combination of variables ___
6.2. Fabrication of specimens:
6.2.1. Coat inside of mold w/ suitable nonreactive release material ___
6.2.2. Fill mold 1 layer, 1 rod/1400 mm^2 (2 $in.^2$) of surface ___
Excess mat'l above top, tap mold, level w/ wood strike-off board ___
6.2.3. After concrete sops bleeding, make 3 strike-off passes ___
Brush surface ___
6.2.4. Place dike 25 mm (1 in.) wide, 20 mm (3/4 in.) high on perimeter of top ___

7. Curing:
7.1. Cover w/ plastic sheet not allowing contact w/ concrete surface ___
7.2. De-mold @ 20 – 24 hr., moist storage in accordance w/ C 511 ___
7.3. Keep moist storage until desired strength level ___
Remove, store in air 14 days @ 23.0 ± 2.0°C (73.5 ± 3.5°F), 45 – 55 % rel. humidity ___
7.4. All other concretes remove @ age 14 days, store in air as in paragraph 7.3 ___

8. Protective coatings
8.1. If protective coatings to be evaluated, apply properly @ 21 days ___

9. Procedure:
9.1. Cover flat surface w/ ~ 6 mm (1/4 in.) $CaCl_2$ solution ___
9.2. Place in freezer 16 – 18 hr. ___
Remove, put in air @ 23.0 ± 2.0°C (73.5 ± 3.5°F), 45 – 55 % rel. humidity 6 – 8 hr. ___
Repeat each cycle daily for ~ 50 cycles ___

10. Report ___

Data Sheet ___

S___F___N/A___

MAKING, ACCELERATED CURING, AND TESTING CONCRETE
COMPRESSION TEST SPECIMENS
ASTM C 684-99

7. Apparatus:
7.1. Equipment, tools for making specimens, slump, air content in accordance w/ C 31 ___
7.2.1. Molds for procedure A, B, & C in accordance w/ C 470 ___
7.2.2. Molds for procedure D conform to following:
7.2.2.1. Stainless steel ___
7.2.2.2. Removable top & bottom metal plugs & o-ring seals ___
7.2.2.3. Heating element to 150 ± 3°C (300 ± 5°F) w/in 30 ± 5 min. ___
7.2.2.4. Devices to measure temp. in mild to get temp. of concrete ___
7.2.2.5. Equipped w/ companion loading component maintain pressure to 1500 ± 25 psi ___
7.3.1. Accelerated curing tank for procedure A & B ___
7.3.1.1. Suitable size for No. of specimens w/ proper clearance between cylinders ___
7.3.1.2. Equip tank w/ devices to provide & maintain appropriate temp. ___
7.3.1.3. Plate supporting specimens to be perforated ___
7.3.1.4. Close fitting lid for Procedure B, optional for A ___
7.3.2.1. Container for Proc. C have thermal insulation meeting requirements in paragraph 12.2.1 ___
7.3.2.3 Have max-min thermometer ___
7.3.2.4. Have Lid w/ heat seal ___
7.3.2.5. Capable of holding 1 or 2 specimens ___
7.3.3.1. Apparatus for Proc. D, have loading system, & special molds ___
7.4.1. If capping required, cap in accordance w/ C 617 or C1231 ___

10. Sampling ___

11. Preparation of apparatus ___

12. Standardization ___

13. Conditioning ___

14. Procedure ___

15. Interpretation of results ___

16. Report ___

Data Sheet ___

S___F___N/A___

ABRASION RESISTANCE OF HORIZONTAL CONCRETE SURFACES
ASTM C 779-00

4. Apparatus for Procedure A – revolving disks:
4.1. Revolving disks abrasion test machine ___
4.2. Disks free floating, driven in circular path @ 12 rpm while turning on own axis @ 280 rpm ___
4.3. Abrasive grit No. 60 silicon carbide, flow of abrasive @ 4 – 6 g/min. ___
4.4. Micrometer bridge machine- finish 1-in. rectangle steel bar X 12 in. ___
Measuring gage is depth micrometer w/ needle w/ depth 1 – 2 in., & 0.001 in. graduations ___

5.1. Test specimen up to ~ 3 ¾ in. thick ___

6. Procedure ___

7. Interpretation of results ___

8. Report ___

9. Apparatus for Procedure B – dressing wheels
9.1. Dressing wheel abrasion test machine ___
9.2. 3 sets of 7 wheels, each cuts ~ 1 ½ in. wide path ___
9.3. Motor-driven spider device turning @ 56 rpm ___
9.4. 3 shaft w/ yoke w/ 7 dressing wheels, mass of wheel assembly 7.5 kg (16.5 lb) ___
9.5. Wheels outside diameter 2 3/8 in., 1/8 in. thick, w/ 18 flattened points ___
9.6. Measuring gage is dial micrometer readable to 0.025 mm (0.001 in.) ___
Range of micrometer 7 mm (0.3 in.) ___

10.1. Test specimen 300 X 300 X 95 mm (12 X 12 X 3 ¾ in.) ___

11. Procedure ___

12. Interpretation of results ___

13. Report ___

14. Apparatus for Procedure C – ball bearings
14.1. Ball bearing abrasion test machine ___
14.2. Motor driven, hollow, vertical shaft resting on & turning ball bearings ___
14.3. Digital clock readable up to 9999 sec electrically connected to drive motor ___
14.4. Abrasion tool 8 18-mm (23/32-in) dia. balls equally spaced in retainer ring ___
14.5. Drive shaft have flanged bearing plate @ lower end, grooved to match ball circle of abrasion tool ___
14.6. Dial indicator w/ travel of 13 mm (1/2 in.), readable to 0.025 mm (.00001 in.) ___
14.7. 1-gallon plastic tank mounted on motor base ___
14.8. Machine base w/ vacuum hold-down device w/ 3 support points ___

15. Test Specimen 300 X 300 X 95 mm (12 X 12 X 3 ¾ in.) ___

16. Procedure ___

17. Interpretation of results ___

18. Report ___

Data Sheet ___

S___F___N/A___

DETERMINING THE MECHANICAL PROPERTIES OF HARDENED CONCRETE UNDER TRIAXIAL LOADS
ASTM C 801-98

4. Apparatus:
4.1. Loading device suitable to apply & measure axial load ___
4.2. Triaxial chamber, bearing faces of bearing blocks 55 HRC ___
4.3. Combination devices, alternatively devices that combine function of loading & pressure chamber ___
4.4. Pressure-maintaining device to maintain pressures in chamber ___
4.5. Strain-measuring devices readable to 0.0001 in. (0.00254 mm) ___
4.6. Flexible membrane suitable to exclude confining fluid from specimen ___

5. Test specimens:
5.1. Right circular cylinders w/in tolerances in accordance w/ C 192 ___
5.1.1. Sides smooth free of irregularities, straight to 0.005 in. (0.127 mm) ___
Ends plane to 0.001 in. (0.0254 mm), lapped, ground, or capped, capping to C 617 ___
5.4.1. Planenness checked w/ straightedge & feeler gage, minimum 3 measurements ___
Ends parallel, to 0.002 in. (0.0508 mm), 5 length measurements ___
Ends not depart $\perp$ more than 0.25° ___
L/D ratio of 2.0 $\pm$ 0.2, diameter not $<$ 2 in. (50.8 mm) __
5.5. Diameter specimen to 0.01 in. (0.254 mm), average 2 midheight @ right angles ___
5.6. Keep & test in moist condition ___
5.7. Number of specimens, no fewer than 2 from each batch ___

6. Procedure for shot-time behavior (3 types):
6.1.1. Type 1, hydrostatic pressure increased to desired level, held constant while axial stress increased to failure ___
6.1.2. Type 2, hydrostatic pressure increased to desired level, axial constant while lateral stress increased to failure ___
6.1.3. Type 3, ratio of axial to lateral stresses held constant & stresses increased to failure ___
6.1.4. For triaxial compression loads where lateral stress kept 0 while axial stress increased or vice versa to be avoided ___
6.2. Place specimen w/ proper alignment, put membrane on, assemble chamber ___
6.3. Load in desired direction(s) continuously w/o shock @ 35 $\pm$ 15 psi (241 $\pm$ 103 kPa/sec) ___

7. Presentation of data ___

8. Report ___

Data Sheet ___

S___F___N/A___

PENETRATION RESISTANCE OF HARDENED CONCRETE
ASTM C 803-03

6. Apparatus for resistance testing w/ probes:
6.1.1. Driver unit capable of driving probe into concrete so that probe remains embedded ___
6.1.2. Probe, hardened alloy-steel rod plated for corrosion protection, hardness 44 – 48 HRC ___
6.1.3. Measurement equipment:
6.1.3.1. Measuring instrument, caliper, depth gage or other, measure to 0.5 mm (0.025 in.) ___
6.1.3.2. Measuring instrument w/ reference base plate ___
6.1.4. Positioning device to position & guide probe ___
6.2. Apparatus for resistance testing w/ pins:
6.2.1. Driver unit capable of driving pin, creating a hole ___
6.2.2. Driver requires regular verification of amt of energy transferred to pin ___
Service whenever proper operation is in doubt ___
6.2.3. Pin, hardened alloy-steel drill rod, 1 end sharpened, hardness 62 – 66 HRC ___
6.2.4. Measuring equipment:
6.2.4.1. Measuring instrument, depth gage w/ reference plate ___
6.2.4.2. Measuring rod w/ dia. & tip angle < pin ___
6.2.4.3. Air blower ___

8. Sampling:
8.1. Resistance testing w/ probes ___
8.1.1. Concrete reach resistance to pen. so probe won't penetrate > ½ thickness of concrete & will remain imbedded ___
Probes not located NLT 7-in, (175-mm) from ea other & NTL 4-in. (100-mm) from edge ___
8.1.2. Min of 3 probes make 1 test ___
If range of 3 msrmts exceeds value in Table 1 (col. 3), make 4th msrmt & discard msrmt w/ greatest deviation from avg ___
If 3 remaining msrmts not meet limit in Table 1, get 3 new msrmts in different test area ___
8.2. Resistance testing w/ pins ___
8.2.1. Concrete reach resistance to pen. so pin won't penetrate to a depth > exposed length of pin when inserted in hammer of driver ___
8.2.2. No pin pen. < 2-in (50-mm) or > 6-in (150-mm) from other pin, NLT 2-in (50-mm) from edge ___
8.2.3. Avg depth of pen. for 6 pins in test area shall constitute 1 test ___
8.2.4. If pin hit coarse agg or air void, discard rdg ___
Discard if range of 6 pens. exceeds value in Table 2 (col. 3), make 7th msrmt & discard msrmt w/ greatest deviation from avg ___
If 6 remaining msrmts not meet limit in Table 2, get new msrmts in different test area ___

9. Procedure for resistance testing w/ probes:
9.1.1. Concrete surfaces coarser than burlap dragged finishes shall be ground ___
9.1.2. Position device on concrete & fire probe into concrete ___
9.1.3. Remove device, tap probe w/ small hammer, reject loose probes ___
9.1.4. Place measuring baseplate over probe & measure ___
9.2. Procedure for resistance testing w/ pins:
9.2.1. Heavy textured, soft or w/ loose mortar shall be ground flat ___
9.2.2. Insert new pin into driver unit ___
9.2.3. Load driver unit ___
9.2.4. Place driver unit & drive pin, remove unit & pin ___
9.2.5. Clean hole w/ air blower ___
9.2.6. Insert depth gage & measure depth of penetration to 0.002 mm (0.001 in.) ___

10. Report ___

Data Sheet ___

S___F___N/A___

REBOUND NUMBER OF HARDENED CONCRETE
ASTM C 805-02

6. Apparatus:
6.1. Rebound hammer, spring-loaded steel hammer ___
6.2. Abrasive stone, medium-grain silicon carbide or equivalent ___
6.3. Test anvil, 150 mm (6 in.) diameter X 150 mm (6 in.) high ___
Tool steel, impact area hardened to 66 ± 2 HRC as measured by E 18 ___
6.4. Verification - Hammers serviced & verified annually or when proper operation in doubt ___

7. Test area:
7.1. Selection of test surface, concrete 100 mm (4 in.) thick & fixed ___
7.2. Preparation of test surface, 150 mm (6 in.) diameter, ground smooth ___
Ground & unground surfaces not to be compared ___
7.3. Do not test frozen concrete ___
7.4. For comparison, direction of impact, horizontal, downward, upward or another angle must be same, or use established correction factors ___
7.5. Do not test directly over reinforcing bars w/ cover < 0.75-in. (20-mm) ___

8. Procedure:
8.1. Hold hammer ⊥ to test surface & push until hammer impacts ___
After impact, maintain pressure, lock button if needed ___
Estimate rebound No. to nearest whole No. ___
Get 10 readings w/ no 2 closer than 25 mm (1 in.) ___

9. Calculation:
9.1. Discard rdgs differing from average of 10 more than 6 units, get average of remaining rdgs ___
If > 2 rdgs differ more than 6 units, take 10 more rdgs @ different locations ___

10. Report:
10.1.1. Date & time of testing ___
10.1.2. ID of location tested & type & size of member tested ___
10.1.2.1. Description of concrete mixture proportions including type of coarse agg if known ___
10.1.2.2. Design strength of concrete tested ___
10.1.3.1. Surface characteristics (trowelled, screeded) of area ___
10.1.3.2. If surface was ground & depth of grinding ___
10.1.3.3. Type of form mat'l used for test area ___
10.1.3.4. Curing conditions of test area ___
10.1.3.5. Type of exposure to environment ___
10.1.4. Hammer ID & serial No. ___
10.1.4.1. Air temp @ time of testing ___
10.1.4.2. Orientation of hammer during test ___
10.1.5. Avg rebound No. for test area ___
10.1.5.1. Remarks regarding discarded rdgs of test data or any unusual conditions ___

Data Sheet ___

S___F___N/A___

EXAMINATION AND SAMPLING OF HARDENED CONCRETE IN CONSTRUCTIONS
ASTM C 823-00

5. Qualifications & instruction of personnel:
5.1. Qualifications, persons qualified by education & experience ___
5.2. Instruction of personnel, be told purposes of exam, info sought, & extent of exam & sampling ___
5.3. Agreements w/ consultants, purchaser & consultant determine nature, extent, & objectives ___

6. Procedural plan for examination of concrete in constructions:
6.1. Objective ___
6.2. Purpose ___
6.3. Scope of investigation ___

7. Preliminary investigations:
7.1. Purpose ___
7.2. Methods ___
7.3. Conclusions ___

8. Assembly of records:
8.1. Reports & legal documents ___
8.2. Interviews ___

9. Detailed investigations of concrete in constructions:
9.1. Procedures ___
9.2. Scope of field examination ___
9.3. Observations ___

10. Requirements for sampling in constructions ___

11. Sampling plan:
11.1.1. Situation 1 ___
11.1.2. Situation 2 ___
11.2. Recommended sampling method ___
11.5. Sample size ___
11.6. Evaluation of test results ___

12. Sampling for compliance w/ construction specifications ___

13. Sampling procedures ___

14. Information to accompany samples ___

Data Sheet ___

S___F___N/A___

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE
ASTM C 856-02

3. Qualifications of petrographers:
3.1. Education & experience ___

4. Purposes of examination:
4.2. Concrete from constructions ___
4.3. Test specimens from actual or simulated service ___
4.4. Concrete products ___
4.5. Laboratory specimens ___
5. Apparatus:
5.2.1. Diamond saw ___
5.2.2. Curing lubricant for diamond saw ___
5.2.3. Horizontal lap wheel or wheels, 16 in. (400 mm) diameter ___
5.2.4. Free abrasive machine ___
5.2.5. Polishing wheel, 8 in. (200 mm) diameter, ___
5.2.6. Hot plate or oven ___
5.2.7. Prospector's pick and/or bricklayer's hammer ___
5.2.8. Abrasives ___
5.2.9. Plate-glass squares, 12 – 18 in. (300 – 450 mm) on edge, 3/8 in. (10 mm) thick ___
5.2.10. Suitable medium or media ___
5.2.11. Microscope slides ___
5.2.12. Cover glasses ___
5.3. For specimen examination:
5.3.1. Stereomicroscope, 7X to 70 X or more ___
5.3.2. Dollies ___
5.3.3. Polarizing microscope, 3.5X, 10X, 20 to 25X, 43 to 50X w/ aperture 0.85 or more ___
5.3.4. Metallographic microscope, 25 to 500X ___
5.3.5. Eyepiece micrometer ___
5.3.6. Stage micrometer ___
5.3.7. Microscope lamps ___
5.3.8. Needleholders & points ___
5.3.9. Bottles & droppers ___
5.3.10. Assorted forceps ___
5.3.11. Lens paper ___
5.3.12. Refractometer & immersion media ___
6. Selection & use of apparatus ___
7. Samples ___
8. Examination of samples ___
9. Specimen preparation ___
10. Visual & stereomicroscope examination ___
11. Petrographic microscope examination ___
12. Paste Features ___
13. Report ___

Data Sheet ___

S___F___N/A___

COMPRESSIVE STRENGTH OF CONCRETE CYLINDERS CAST
IN PLACE IN CYLINDRICAL MOLDS
ASTM C 873-99

5. Apparatus:
5.1. Cast-in-place molds, diameter 3X max aggregate size ___
L/D 1.5 – 2.0, not < 1.0 ___
5.2. Molds watertight meet criteria in C 470 ___
Nonabsorbent mat'l ___
5.3. Exterior top have outwardly extending centering knobs & annular flange ___
Means for twisting & vertical withdrawal of molds ___
5.4. Support members right circular cylinders __
Rigid tubes of diameter to accept molds required in paragraph 5.1 ___

6. Installation of apparatus:
6.1. After reinforcing steel placed & other formwork, fasten support to slab ___
Adjust support so tops of molds aligned w/ elevation of other screeds ___
6.2. Place mold in support so flange of mold supported by sleeve ___

7. Procedure:
7.1. Fill molds when concrete placement is in vicinity of mold ___
7.2. Consolidation varied to simulate conditions of placement ___
Specimen finishing same as surrounding concrete ___
7.3. Cure & treat specimens same as surrounding concrete ___
Molds remain in place until time of removal to move to testing location ___
7.4. Remove molds from supports ___
Maintain temp. ± 10°F (± 6°C) of slab surface temp. @ time of removal ___
7.5. Remove from molds, cap in accordance w/ C 617, test to C 39, test "as received" moisture ___

8. Calculation:
8.1. Compressive strength, correct if L/D < 2.0 ___

9. Report ___

Data Sheet ___

S___F___N/A___

HALF-LIFE POTENTIALS OF UNCOATED REINFORCING STEEL IN CONCRETE
ASTM C 876-91 (99)

4. Apparatus:
4.1.1. Half cell, copper-copper sulfate half cell ___
4.1.2. Rigid tube/container I.D. not < 1 in. (25 mm), dia. porous plug not < ½ in. (13 mm), dia. of copper rod not < ¼ in. (6 mm), & length not < 2 in. (50 mm) ___
4.1.3. Criteria based on half-cell reaction of Cu $\longrightarrow$ $Cu^{++} + 2e$ ___
4.1.2. Electrical junction device ___
4.1.3. Electrical contact solution, to standardize potential drop thru concrete portion of the circuit ___
4.1.4. Voltmeter ___
4.1.5. Electrical lead wires, such that electrical resistance won't disturb circuit > 0.0001 V ___

5. Calibration & standardization:
5.1. Care of half-cell, porous plug kept covered ___

6. Procedure:
6.1. Spacing between measurements, ~ 4 ft. (1.2 m) acceptable ___
6.2. Electrical connection to the steel:
6.2.1. Use compression-type ground clamp ___
6.2.2. Attach directly to the reinforcing steel ___
6.3. Electrical connection to half cell, one end to half cell, other to ground of voltmeter ___
6.4. Pre-wetting of concrete surface:
6.4.1. Certain condition pre-wet by either method in paragraphs 6.4.3 or 6.4.4 ___
6.4.2. Test to determine pre-wetting as follows:
6.4.2.1. Place half cell on concrete & do not move ___
6.4.2.2. Observe voltmeter for one of following:
(a) Measured half-cell potential does not change or fluctuate w/ time ___
(b) Measured half-cell potential changes of fluctuates w/ time ___
6.4.2.3. Condition *(a)* no pre-wetting, *(b)* pre-wet for until voltage reading stable (±0.02 V) ___
6.4.3. Method A for pre-wetting concrete, for minimal amount pre-wetting ___
6.4.4. Method B for pre-wetting concrete ___
6.5. Underwater, horizontal, & vertical measurements ___

7. Recording half-life potential, to 0.01 V ___

8. Data presentation ___

9. Interpretation of results ___

10. Report ___

Data Sheet ___

S___F___N/A___

PULLOUT STRENGTH OF HARDENED CONCRETE
ASTM C 900-01

5. Apparatus:
5.1. Pullout insert, loading system, & load-measuring system ___
5.1.1. Insert, metal nonreactive w/ concrete, cylindrical head ___
5.1.2. Loading system, bearing ring placed concentrically around insert shaft ___
5.1.3. Test apparatus has centering features so that bearing ring concentric w/ insert shaft, & that applied load is axial to pullout shaft, $\perp$ to bearing ring, & uniform on bearing ring ___
5.2. Equipment dimensions as follows:
5.2.1. Diameter of head of insert (d_2) determined by specifier ___
Thickness & yield strength sufficient to prevent yield of insert ___
5.2.2. Length of shaft so that distance from head to concrete (h) = dia. of head (d_2) ___
Dia. of shaft @ head (d_1) not $>$ 0.60 X head dia. ___
5.2.3. Post-installed inserts, groove cut so distance between groove & concrete surface = insert dia after expansion (d_2) ___
5.2.4. Bearing ring inside dia. (d_3) 2.0 – 2.4 X head dia. w/ outside dia. (d_4) 1.25 X inside dia. ___
5.2.5. Tolerances of inserts $\pm$ 2 % ___
5.2.6. Capacity to provide appropriate load rate, & exceed max load expected ___
5.2.7. Gages have division not $>$ 5 % min. value of range ___
5.2.8. Pullout apparatus calibrated yearly & after repairs & adjustments ___
Calibrate in accordance w/ E 4, or w/ Class A load cell defined in E 74 ___
Indicated pullout force based on cal shall be w/in $\pm$ 2 % of force measured by testing machine or load cell ___

6. Sampling:
6.1. Pullout test locations clear spacing between inserts 8 X insert head diameter ___
Space between inserts & edges of concrete 4 X head diameter ___
6.2. Pullout tests such as formwork removal or post tensioning run 5 tests ___

7. Procedure:
7.1.1. For cast-in-place inserts assemble apparatus for testing appropriately ___
7.1.2. When concrete tested, remove hardware used for securing pullout inserts ___
7.2.1 For post-installed inserts test surface flat, drill hole $\perp$ surface ___
7.2.2 If necessary, use grinding wheel to prepare flat surface ___
7.2.3 Use milling tool to undercut groove to correct dia @ correct depth ___
7.2.4. Remove water (if used as coolant) from hole ___
7.2.5. W/ expansion tool, insert to proper size ___
7.3. Place bearing ring ___
7.4. Load @ specified rate to rupture or to specified pullout load reached ___
7.5. Reject a test if any of following occur:
7.5.1. Large end of conic frustum not circle of same dia. as bearing ring ___
7.5.2. Distance from surface to insert head not = to insert dia. ___
7.5.3. Dia. of groove in post-installed test not = design value ___
7.5.4. Expanded insert dia. in post-installed test not = design value ___
7.5.5. Reinforcing bar visible w/in failure zone after conic frustum removed ___

8. Calculation:
10.2. Convert gage readings to pullout force on basis of cal data ___
10.3. Compute avg & std deviation of pullout forces that represent tests of a given concrete placement ___

9. Report ___

Data Sheet ___

S___F___N/A___

MEASURING EARLY-AGE COMPRESSIVE STRENGTH AND
PROJECTING LATER-AGE STRENGTH
ASTM C 918-02

6. Apparatus:
6.1. Equipment & small tools for making & measuring concrete conform to C 31 or C 192 ___
6.2. Molds in accordance w/ C 470 ___
6.3. Temperature recorder:
6.3.1 To monitor temp as function of time (thermocouples, thermisters, or digital data-loggers ___
6.3.2 Alternatively, commercial maturity instruments that automatically compute & display temp-time factor or equivalent age as described in C 1074 ___

7. Sampling:
7.1. Sample & measure properties in accordance w/ C 31 or C 192 ___

8. Procedure for early-age & projected strengths:
8.1. Mold & cure in accordance w/ C 31 or C 192 ___
8.2. Embed temp sensor, activate temp recorder, continue curing at least 24 hr. ___
8.3. Capping & testing, remove specimens & cap in accordance w/ C 617 or C 1231 ___
8.3.1. Capping mat's develop strength = to or > than cylinders @ age of 30 min. ___
8.3.2. Specimens not tested < 30 min. after capping ___
8.4. Determine compressive strength in accordance w/ C 39 __
8.5. Determine maturity index using manual procedure in App. X1 in C 1074 ___
8.6. Use section 9 to project strength @ later age ___

9. Procedure for developing prediction equation:
9.1. Develop prediction equation for each concrete used on the job ___
9.2. Constant *b* used in Eq. 1 use one of 2 methods: (1) regression analysis, or (2) manual plotting ___
Eq 1 as follows:

$$S_M = S_m + b (\log M - \log m)$$

Where:
S_M = projected strength @ maturity index M,
S_m = measured compressive strength @ maturity index m,
b = slope of line,
M = maturity index under standard curing conditions, and
m = maturity index of specimen tested @ early age.

9.2.1. Regression analysis, convert by taking logs, plot avg. strength vs log of maturity index ___
Compute best-fit straight line w/ following equation 2:

$$S_m = a + b \log m$$

Where:
S_m = compressive strength at m,
a = intercept of line,
b = slope of line, and
m = maturity index.

9.2.2. Manual plotting, plot semi-log w/ y-axis compressive strength, x-axis maturity index ___

9.3. Use constant *b* & Eq 1 to determine projected strength based on early-age results ___

10. Interpretation of results ___

11. Report ___

Data Sheet ___

S___F___N/A___

ABRASION RESISTANCE OF CONCRETE OR MORTAR BY THE
ROTATING-CUTTER METHOD
ASTM C 944-99

4. Apparatus:
4.1. Abrasion device, drill press or similar device ___
Spin @ 200 rpm w/ force of 98 ± 1 N (22 ± 0.2 lbf) ___
4.2. Rotating cutter ___
4.2.1. Rotating cutter held raised, start motor, lower into contact w/ specimen ___
4.2.2. Periodically replace dressing wheels ___
4.3. Balance, capacity ≥ 4 kg, accurate to 0.1 g ___
4.4. Leveling plate, base plate capable of rotating in horizontal plane ___

5. Sampling:
5.1. Cores taken in accordance w/ C 42 ___

6. Specimens:
6.1. Surface to be tested, formed or finished, & positioned in plane of contact ___

7. Procedure:
7.1. Weigh to 0.1 g ___
7.2. Fasten specimens so surface to be tested normal to shaft ___
7.3. Mount rotating cutter in abrasion device ___
7.4. Start motor, lower cutter slowly to specimen surface ___
7.5. Load @ 98 ± 1 N (22 ± 0.2 lbf) for 2 min., for not < 3 2-min. periods ___
@ end of each 2-min, remove specimen & clean, weigh to 0.1 g ___
7.6. Concrete highly resistant to abrasion, double load and/or time to following:

Abrasion Cycle	Load, N (lbf)	Test Frequency/Period
Normal	98 (22)	3 X 2 min.
Double load	197 (44)	3 X 2 min.

7.7. Testing surfaces in place, depth of wear determined due to significant differences in surface density, refer to C 779 Procedure B ___

8. Report:
8.1.1. Description of surface ___
8.1.2. Size of specimen ___
8.1.3. Type of finish ___
8.1.4. Concrete compaction, age, & strength ___
8.1.5. Applied surface treatment ___
8.1.6. Load & time of abrasion used in normal or severe test ___
8.1.7. Average loss in grams or depth of wear in mm ___
8.1.8. Loss in mass & time abraded ___

Data Sheet ___

S___F___N/A___

DENSITY OF UNHARDENED AND HARDENED CONCRETE IN PLACE BY NUCLEAR METHODS
ASTM C 1040-93 (00)

4. Apparatus:
4.1. Satisfy requirements in paragraph 10.1 ___
4.1.1. Gamma source, encapsulated & sealed ___
4.1.2. Gamma detector ___
4.1.3. Probe ___
4.1.4. Readout instrument ___
4.1.5. Gage housing ___
4.1.6. Reference standard (block) ___
4.1.7. Guide plate & hole-forming-device ___
4.1.8. Calibration adjustment container, volume in accordance w/ C 29 ___
4.1.9. Scale, accurate to 0.5 lb. (0.2 kg) ___
4.1.10. Strike-off plate or bar, at least 2 in. in length, width, or dia. of cal. adjustment container ___

5. Calibration:
5.1. Established by determining count rate of several mat's @ different & known densities ___
5.2. Adjusting calibration curves, if needed ___

6. Standardization:
6.1. Standardize @ start of each day & when measurements in doubt ___

7. Procedure for test method A – direct transmission (unhardened concrete):
7.1.1. At least 9 in. (230 mm) from pavement edge or object ___
7.1.2. Reinforcing steel not where probe will extend ___
7.1.3. Concrete 1 in. deeper than probe depth ___
7.2. Surface preparation ___
7.3. Probe in contact with side of hole ___
7.4. Take appropriate readings ___

8. Procedure for test method B – backscatter (unhardened & hardened concrete):
8.1.1. At least 9 in. (230 mm) from pavement edge or object ___
8.1.2. No reinforcing steel w/ $<$ 3 in. (75 mm) concrete cover directly under source-detector ___
8.2.1. Unhardened concrete, smooth w/ wood float ___
8.2.2. Hardened, find smooth surface, & remove loose mat'l, ___
No voids $>$ 1/8 in. (3 mm), fill voids w/ sand ___
8.3. Seat gage ___
8.4. Take appropriate readings ___

9. Report:
9.1.1. Test method (direct transmission or backscatter) ___
9.1.2. Nature of concrete (hardened or unhardened) ___
9.1.3. Depth of probe, (direct transmission) ___
9.1.4. Thickness of layer tested ___
9.1.5. Identification of raw materials ___
9.1.6. Mixture proportions ___
9.1.7. Count rate for standardization ___
9.1.8. Count rate each rdg & converted mean density, or corrected direct rdg, lb/ft^3 (kg/m^3) ___

Data Sheet ___

S___F___N/A___

ESTIMATING CONCRETE STRENGTH BY THE MATURITY METHOD
ASTM C 1074-98

7. Apparatus:
7.1. Device to monitor & record concrete temp. as function of time ___
Devices, thermocouples or thermisters connected to chart recorders or digital data-loggers ___

8. Procedure to develop strength-maturity relationship:
10.4. Prepare at least 15 cylinders in accordance w/ C 192 ___
10.5. Embed temp sensors to ±15 mm of centers of at least 2 specimens ___
10.6. Moist cure in accordance w/ C 511 ___
10.7. Perform compression tests @ 1, 3, 7, 14, & 28 days in accordance w/ C 39 ___
Test 2 specimens @ each age, average the strength ___
10.8. At each age record average maturity index ___
8.5.1. If maturity instruments used, record average values ___
8.5.2. If temp recorders used, evaluate maturity by Eq 1 or Eq 2 in paragraph 6 ___
8.6. Plot avg. compressive strength as function of avg. value of maturity index ___

9. Procedure to estimate in-place strength:
9.1. Embed temp. sensors as soon as possible into the fresh concrete ___
9.2. Connect sensors to devices & activate as soon as possible ___
9.3. Strength @ location of sensor estimated, read maturity index or estimate from temp. ___
9.4. Use strength-maturity in 8, read compr strength corresponding to measured maturity index ___
9.5. Prior to performing critical operations, supplement determination of maturity w/ other tests ___
Appropriate tests include
9.5.1. In-place tests such as C 803, C873, C 900, or C 1150 ___
9.5.2. Early-age compressive strength in accordance w/ C 918 ___
9.5.3. Compressive strength on molded spls from concrete as delivered & subjected to accelerated curing in accordance w/ C 684 ___

Data Sheet ___

S___F___N/A___

DETERMINING THE CEMENT CONTENT OF FRESHLY MIXED CONCRETE
ASTM C 1078-87 (92)

7. Apparatus for procedure A – manual volumetric titration:
7.1.1. Balance, capacity 2600 g, sensitive to 0.1 g ___
7.1.2. Shovels, hand scoops, & rubber gloves as required ___
7.1.3. Polyethylene sample tub, 5-qt (4.7-L) ___
7.1.4. Polyethylene specimen tub, 2-qt (1.9-L) ___
7.1.5. Washing machine, domestic portable ___
7.1.6. Sieve nest, rectangular steel frame, No. 50 @ bottom, No. 4 @ mid-height ___
7.1.7. Linked pipets, 125 ± 10 ml, glass, w/ attached 100 ± 10 ml auto pipet w/ 3-way tap ___
7.1.8. Automatic pipet, 300 ml ± 25 ml w/ 3-way tap ___
7.1.9. Magnetic stirrer, variable-speed w/ TFE-fluorocarbon-coated magnetic stirring rod ___
7.1.10. Buret, 100 ml acrylic Class A or B ___
7.1.11. Pipet, 25 ml volumetric glass, Class A or B ___
7.1.12. Conical beakers or Erlenmeyer flasks, 500, 800, or 1000 ml capacity ___
7.1.13. Fixed volume dispenser, 5 ml polyethylene or polypropylene ___
7.1.14. Reagent dispensing containers, 500 ml polyethylene wash bottle, 30 ml polyethylene dropping bottle, 2 rectangular carboys 2- or 5-gal (7.6- or 18.9 L), & amber rubber tubing ½ in. (12.7 mm) inside dia. X 20 ft (6.1 m) long ___
8. Reagents:
8.1. Ammonium hydroxide-ammonium chloride buffer (pH = 10) ___
8.2. Eriochrome black T indicator ___
8.3. Nitric acid (1 + 19) ___
8.4. Di-sodium ethylenediamine tetraacetate (0.01 M) ___
9. Calibration ___
10. Procedure ___
11. Calculation ___
13. Apparatus for procedure B – instrumental fluorometric determination (same except as follows):
13.1.5. Cement suspension tank, 10 gal (38 L) polypropylene w/recirculating pump ___
13.1.6.2. If washing machine in 7.1.5 used instead of susp. tank, use sieves as in 7.1.6 ___
13.1.8. Syringe-type pipet, 30 ml ___
13.1.10. Disposable pipet tips ___
13.1.12. Calcium analyzer ___
13.1.13. Carboys ___
14. Reagents:
14.2. Nitric acid, (5 %) ___
14.3. Ethylene glycol bis (aminoethylene tetra-acetic acid ___
14.4. Calcein indicator ___
14.5. Calcium standard ___
14.6. Potassium hydroxide, (1.0 N) ___
15. Calibration ___
16. Procedure ___
17. Calculation ___
19. Report ___
Data Sheet ___

S___F___N/A___

DETERMINING THE WATER CONTENT OF FRESHLY MIXED CONCRETE
ASTM C 1079-87 (92)

7. Apparatus for procedure A – by volumetric titration method:
7.1.1. Balance, capacity 2600 g, sensitive to 0.1 g ___
7.1.2. Shovels, hand scoops, & rubber gloves as required ___
7.1.3. Polyethylene sample tub, 5-qt (4.7-L) ___
7.1.4. Wide-mouth jar, 5-qt (4.7-L) w/ screw closure & lid ___
7.1.5. Universal mixer ___
7.1.6. Conical beakers or Erlenmeyer flasks, 500 ml capacity ___
7.1.7. Pipet, 25 ml volumetric glass, Class A or B ___
7.1.8. Automatic pipet, 25 & 10 ml glass w/ polytetrafluoroethylene (PTFE) plug ___
7.1.9. Amber reagent bottles, 2 round 32-oz. (0.95 – 1 L) ___
7.1.10. Buret, 100 ml acrylic Class A or B ___
7.1.11. Volumetric flask, two 500-ml polyethylene ___
7.1.12. Fixed volume dispensers, 1 5 ml & 2 5-ml polyethylene w/ polypropylene chambers ___
7.1.13. Carboys, rectangular, aspirator-type, 2-gal (7.6 L) ___
7.1.14. Clamps ___
8. Reagents:
8.1. Nitric acid (1 + 1) ___
8.2. Ferric alum indicator ___
8.3. Nitrobenzene ($C_6H_5NO_3$) (G_s 1.20) ___
8.4. Potassium thiocyanate (0.05 N) ___
8.5. Silver nitrate (0.5 N) ___
8.6. Sodium chloride (0.5 N) ___
9. Calibration ___
10. Procedure ___
11. Calculation ___
13. Apparatus for procedure B – coulometric reference technique(same except as follows):
13.1.5. Centrifuge, variable-speed, 4-place, for 15-ml tubes ___
13.1.6. Centrifuge tubes, 15-ml, disposable polystyrene ___
13.1.7. Automatic pipet, 100 μL tip-ejector fixed-volume ___
13.1.8. Disposable pipet tips ___
13.1.9. Chloride meter, accept 20-μL or 100μL samples ___
13.1.10. Volumetric flask, 250-ml polpropylene ___
14. Reagents:
14.2. Sodium chloride (0.5 N) ___
14.3. Acid buffer ___
15. Procedure ___
16. Calculation ___
18. Report ___

Data Sheet ___

S___F___N/A___

PORTLAND-CEMENT CONTENT OF HARDENED HYDRAULIC-CEMENT CONCRETE
ASTM C 1084-02

5.1. Choose concrete spl in accordance w/ purpose of investigation ___
5.2. Minimum length 4 X max aggregate size ___
5.3. Crush to pass # 4 sieve, get representative spl. of 0.45 kg (1 lb) ___

5.1. Apparatus applicable from C 114 & the following ___
10.8.3. Chipmunk (jaw ore crusher) ___
10.8.4. Disk pulverizer ___
10.8.5. Rotary mill (rotating puck) ___
10.8.6. No. 4, 16, & 50 sieves ___
10.8.7. Ice bath or electric cooling apparatus ___
10.8.8. Steam bath ___
10.8.9. Buchner-type porcelain funnel ___
10.8.10. Filter paper, Type II, class F & G ___
10.8.11. Beakers, 250 & 1000 ml ___
10.8.12. Magnetic variable speed stirrer ___
10.8.13. Volumetric flask, 500 & 1000 ml ___
10.8.14. Filtering flask, 2000 ml ___
10.8.15. Vacuum pump ___
10.8.16. Watch glass, 135 mm ___

6. Reagents & materials:
6.1. Soluble silica sub-procedure:
6.1.1. Hydrochloric acid, reagent grade, 1.19 Mg/m^3 ___
6.1.2. Hydraulic acid (1:3) ___
6.1.3. Hydraulic acid (1:9) ___
6.1.4. Sodium hydroxide (10 g/L) ___
6.1.5. Hydrofluoric acid, 48 %, reagent grade ___
6.1.6. Sulfuric acid, 1.84 Mg/m^3, reagent grade ___
6.2. Calcium oxide sub-procedure:, reagents as required in C 114 ___
6.3. Maleic acid procedure:
6.3.1. Maleic acid, technical grade ___
6.3.2. Methanol, technical grade, anhydrous ___
6.3.3. Maleic acid solution, 15 % maleic acid in methanol ___
6.3.4. Fuller's earth, clay-like mat'l, porous colloidal aluminum silicate ___
6.4. Water, reagent Types I – IV of specification D 1193 ___

7. Sampling ___

8. Cement content procedure ___

9. Unit weight & loss of free water ___

10. Additional calculations ___

11. Report ___

Data Sheet ___

S___F___N/A___

THE BREAK-OFF NUMBER OF CONCRETE
ASTM C 1150-96

5. Apparatus:
5.1. Loading mechanism, load generating device, load measuring instrument, tubular sleeve & seating ring, tubular sleeve remover, & gage for calibrating or adjusting loading system ___
5.2. Diamond tipped drill bit for already hardened concrete ___
5.3. Loading mechanism, tubular shaped fits into counterbore, & hydraulic piston ___
5.4. Load generating device, hydraulic pump connected to loading mechanism ___
5.5. Load measuring device, pressure gage w/ range to 15 Mpa (150 bars) ___
Readable to 0.2 Mpa (2 bars) ___

6. Sampling:
6.1. Test locations separated so center to center distance 150 mm ___
6.2. At least 5 individual break-off tests ___
6.3. Evaluate strength in existing structure, No. & locations determined by investigator ___

7. Procedure:
7.1. Preparation of cylindrical specimens by tubular sleeves:
7.1.1. Insert tubular sleeve that is coated w/ release agent ___
7.1.2. Tap surface next to sleeve to reconsolidate concrete ___
7.1.3. Remove sleeve w/ removal tool __
7.2. Preparation of cylindrical specimens by coring:
7.2.1. Core concrete $\pm$ to surface ___
7.3. Testing:
7.3.1. Set up apparatus, load @ rate to cause break-off w/ in 60 $\pm$ 15 sec ___
7.3.2. Record nature of break @ base of core, measure dia. & height ___

8. Calculation:
8.1. Calculate average break-off to 0.1 Mpa (1 bar) ___

9. Report:
9.1.1. Location of each test ___
9.1.2. Date & time of test, identification symbols, & name of operator ___
9.1.3. Method of specimen preparation (sleeve or core) ___
9.1.4. Maximum aggregate size ___
9.1.5. Load range setting (if equipped w/ high- & low-range settings) ___
9.1.6. Break-off No. each specimen & average break-off No. ___
9.1.7. Description of nature of break @ base, & whether fracture shows reinforcement or other abnormalities ___
9.1.8. Approx. average height each specimen to 5 mm, average diameter @ base to 1 mm ___

Data Sheet ___

S___F___N/A___

ACID-SOLUBLE CHLORIDE IN MORTAR AND CONCRETE
ASTM C 1152-97

4. Apparatus:
4.1. Sampling equipment:
4.1.1. Apparatus for coring or sawing in accordance w/ C 42 ___
4.1.2. Use following for drilling (pulverization):
4.1.2.1. Rotary impact drill ___
4.1.2.2. Spoon ___
4.1.2.3. Sample containers of sufficient size ___
4.2. Sample processing apparatus – choose for suitably of investigation ___
4.2.1. Samples larger than 25 mm (1 in.), reduce size w/ jaw crusher or hammer ___
4.2.2. Crush particles larger than 25 mm (1in.) ___
4.2.3. No 20 sieve conforming to E 11 ___
4.3. Apparatus for chloride determination in accordance w. C 114 ___
4.4. Glazed paper to which fine particles do not adheres ___

5. Reagents:
5.1. Reagents in accordance w/ C 114 ___

6. Sampling:
6.1. Sample in accordance w/ C 823 or as required for investigation ___
6.1.1. 10 g of mortar pieces representative of large volume of mortar ___
6.1.2. Core concrete in accordance w/ C 42 ___
6.1.3. Powdered concrete requires several samples to be combined ___
6.1.3.1. Drill ± to surface to get representative sample at least 20 g powdered mat'l ___
6.1.3.2. Put powdered sample into container ___

7. Sample preparation:
7.1. Pulverize so passé No. 20 sieve ___
Blend mat'l by conning in accordance w/ C 702 from 1 glazed paper to another 10 times ___

8. Procedure:
8.1. Get 10 g to nearest 0.01 g, place in 250-ml beaker, use method for chloride in C 114 ___

9. Calculation ___

Data Sheet ___

S___F___N/A___

ELECTRICAL INDICATION OF CONCRETE'S ABILITY TO RESIST
CHLORIDE ION PENETRATION
ASTM C 1202-97

11. Apparatus:
6.1. Vacuum saturation apparatus ___
6.1.1. Separatory funnel, 500 ml ___
6.1.2. Beaker, 1000ml ___
6.1.3. Vacuum dessicator, 250-mm (9.8 in.) inside diameter ___
6.1.4. Vacuum pump, maintain pressure less than 1 mm Hg (133 Pa) in dessicator ___
6.1.5. Vacuum gage or manometer accurate to ±0.5 mm Hg (±66 Pa) over range 0-10 mm Hg (0-1330 Pa) ___
6.2. Coating apparatus & materials:
6.2.1. Coating, rapid setting & electrically nonconductive ___
6.2.2. Balance or scale, paper cups, wooden spatulas, & disposable brushes ___
6.3. Specimen sizing equipment (not required if samples cast to final size) ___
6.3.1. Movable bed water-cooled diamond saw or silicon carbide saw ___

7. Reagents, materials, & test cell:
7.1. Specimen-cell sealant such as RTV silicone rubbers, silicone greases, rubber gaskets ___
7.2. Sodium chloride solution, 3.0 % by mass (reagent grade) in distilled water ___
7.3. Sodium hydroxide solution, 0.3 N (reagent grade) in distilled water ___
7.4. Filter papers, No. 2, 90-mm (3.5-in.), not required if rubber gasket used ___
7.5. Applied voltage cell ___
7.6. Temperature measuring device (optional), 30 - 250°F (0 - 120°C) ___
7.7. Voltage application & data readout apparatus capable to hold 60 ± 0.1 V ___
Display voltage accurate to ± 0.1 V & current to ± 1 mA ___, 7.7.1 – 7.7.5 possible devices:
7.7.1. Voltmeter, digital, 3-digit, 0 – 99.9 V range, accurate to ± 0.1 % ___
7.7.2. Voltmeter, digital, 4 1/2 –digit, 0 – 200 mV range, accurate to ± 0.1 % ___
7.7.3. Shunt resistor, 100 mV ___
7.7.4. Constant voltage power supply, 0 – 80 V dc ___
7.7.5. Cable, 2 conductor, No. 14 (1.6 mm), insulated, 600 V ___

8. Test Specimens ___

9. Conditioning ___

10. Procedure ___

11. Calculation & interpretation of results ___

12. Report ___

Data Sheet ___

S___F___N/A___

WATER-SOLUBLE CHLORIDE IN MORTAR AND CONCRETE
ASTM C 1218-99

4. Apparatus:
4.1. Sampling equipment:
4.1.1. Apparatus for coring or sawing in accordance w/ C 42 ___
4.1.2. Use following for drilling (pulverization):
4.1.2.1. Rotary impact drill & drill or pulverizing bits ___
4.1.2.2. Spoon ___
4.1.2.3. Sample containers of suitable size ___
4.2. Sample processing apparatus chosen for suitability ___
4.2.1. Samples larger than 25 mm (1 in.), reduce size w/ jaw crusher or hammer ___
4.2.2. Crush particles larger than 25 mm (1 in.) w/ rotating-puck apparatus, or disc pulverizer, or mortar & pestle ___
4.2.3. No. 20 sieve conforming to E 11 ___
4.3. Apparatus for chloride determination in accordance w. C 114 ___
4.4. Glazed paper to minimize adherence of fine particles ___

5. Reagents:
5.1. Reagents in accordance w/ C 114 ___

6. Sampling:
6.1. Sample as required for purpose of investigation ___
6.1.1. Concrete cores in accordance w/ C 42 ___
6.1.2. Powdered concrete by rotary impact drill ___
6.1.2.1. Drill $\pm$ to surface, get at least 20 g ___
6.1.2.2. Place powdered sample into container ___

7. Sample preparation:
7.1. Pulverize to pass No. 20 sieve, blend by transferring from 1 glazed paper to another 10 X ___

8. Procedure ___

9. Calculation ___

Data Sheet ___

S___F___N/A___

UNBONDED CAPS FOR HARDENED CONCRETE CYLINDERS
ASTM C 1231-00

5. Materials & apparatus
5.2. Pads ___
Elastomeric - polyurethane, neoprene, natural rubber ___
Thickness ½ ± 1/16-in. (13 ± 2-mm) ___
Diameter ≤ 1/16-in. (2-mm) smaller than retainer ___
Durometer hardness, Shore A, per Table 1 as follows:
Table 1:

Cylinder compressive Strength, psi (Mpa)	Shore A Durometer Hardness	Qualification Tests Required	Max Reuses
1500 – 6000 (10 – 40)	50	None	100
2500 – 7000 (17 – 50	60	None	100
4000 – 7000 (28 –50)	70	None	100
7000 – 12000 (50 –80)	70	Required	50
> 12000 (80)		Not permitted	

5.3. Retainers ___
Metal: steel ___ or aluminum ___
Cavity ≥ 2 times pad thickness ___
ID ≥ 102% or ≤ 107% of specimen ___
Bearing block plane to 0.002-in. (0.05-mm) ___
Indentations, ≤ 0.010-in. (0.25-mm) deep or ≤ 0.05-in.² (32-mm²) area ___

6. Test specimens:
6.1. Ends perpendicularity ≤ 0.5°, 1/8-in. in 12-in. (3-mm in 300-mm) ___
6.2. Depressions, ≤ 0.20-in. (5-mm) ___

7. Procedure:
7.2. No excessive wear or cracks > 3/8-in. (10-mm) long ___
7.3. Center specimen ___
Align in test machine ___
@<10% load, check vertical alignment, 1/8-in. in 12-in. (3.2-mm in 300-mm) ___
7.4. Load to failure in accordance with ASTM C 39 ___

8. Qualification of pads:
9.2. Table 1 for qualification of pads (depending on concrete strength & Durometer A rdg):

8.4. Companion cylinder tests, 98% companion strength ___
8.4.1. Durometer change < 5 ___
8.4.2. Reuse verification, 100 reuses w/o demonstration ___
Test @ highest strength level ___
Record pad reuses ___

Data Sheet ___

S___F___N/A___

SOUNDNESS OF AGGREGATE BY FREEZE-THAW OF CONCRETE SPECIMENS
CRD-C 114-97

2. Freezing-and-Thawing apparatus and procedure:
2.1. Apparatus and procedure conform to CRD-C 20-94 (ASTM C 666-03), Proc A ___

3.1.1. Cement Type II ___
3.1.2. Air entraining admixture - 6.0 ± 0.5 % air ___
3.1.3. Fine aggregate -Test or standard sand graded to Table ___
3.1.4. Coarse aggregate - Test or standard coarse aggregate graded to Table ___
3.1.6. Water cement ratio = 0.49 by mass ___
3.1.7. Air content - 6.0 ± 0.5 % air ___
3.1.8. Slump - 64 ± 13 mm (2½ ± ½ in.) ___
3.1.9. Cement content - 279 to 390 kg/m³ (470 to 660 lb/yd³) ___

4.1. Prepare materials - CRD-C 10 (ASTM C 192) & CRD-C 49 ___

5.1. Mix concrete in 0.034 m^3 batches in 0.0708 m3 tilting-drum mixer to CRD-C 10 & ASTM C 49 ___

6.1. Spl according to CRD-C 4 ___
Determine air-content according to CRD-C 41 ___
Determine slump according to CRD-C 5 ___

7.1. Get NLT 3 groups of similar beams ___

8.1. Determine fundamental transverse freq (day 14) to CRD-C 18 ___
Place into containers w/ fresh water ___
Put container in 4 ± 1.7°C (39 ± 2°F) water, 1 hr ___
Place into freeze-thaw chamber ___
Remove in thawed condition & determine frequency after 1 cycle ___
Return cycle up to 10^{th} & determine frequency ___
Continue cycling & frequency determination NTE 36 cycles until dynamic E decreases to 50 % @ 14 days or until test reaches 300 cycles ___
Put container in 4 ± 1.7°C (39 ± 2°F) water prior to frequency test ___
Turn specimen ends & replace in container ___
Randomly return to freezer ___

9. Faulty specimens:
9.1. Specs found to be faulty upon stripping ___
9.2. Specs broken in handling during testing ___
9.3. Specs giving anomalous results ___

10.1. Calculate dynamic modulus of elasticity ___
10.2. Calculate relative dynamic modulus of elasticity ___
10.3. Calculate durability factor (modulus of elasticity ___

11.1. Report avg durability factors (DFE) for ea group of 3 specs ___
Report avg durability factors (DFE) for the 3 groups of similar specs ___
Include graph of avg progressive change in rel dynamic mod vs No. of cycles of freezing & thawing for the 3 groups of similar specs ___
Include any comments concerning faulty specs ___

Data Sheet ___

S___F___N/A___

COMPRESSION TESTING MACHINE
ASTM E 4-03

5.1.3.1. Dial indicator ___ 5.3.2. Digital indicator ___

Test Machine Reading, lbf, (A)	Load Cell Reading, lbf, (B)	Error, % 100 - ((B/A) x 100)