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METHOD OF TEST FOR THE SUITABILITY OF MATERIALS FOR OVERLAYMENT AND REPAIR OF PORTLAND CEMENT CONCRETE PAVEMENT AND STRUCTURES

A. SCOPE

This test method describes the procedures to be used to determine the suitability of organic and inorganic materials to be used for overlay of portland cement concrete pavement or structures or for patching spalls in portland cement concrete. Material set time, compressive strength, flexural strength, bonding strength, chord modulus of elasticity, specific gravity, and absorption are covered. Further testing may be necessary to fully evaluate most materials.

This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use.

This test method is divided into the following parts.

- PART 1. Method Of Test For Compressive Strength And Flow Of Overlay And Patching Materials (Using Two-Inch Cube Specimens).
- PART 2. Method Of Test For Set Time Of Concrete Overlay And Patching Material By Gillmore Needles.
- PART 3. Method For Fabricating Concrete Specimens Of Overlay And Patching Materials.
- PART 4. Method Of Test For Flexural Strength Of Concrete Overlay And Patching Materials.
- PART 5. Method Of Test For Bonding Strength Of Concrete Overlay And Patching Materials To PCC.
- PART 6. Method For Fabricating PCC Blocks For Use In The Bond Test.
- PART 7. Method Of Test For Chord Modulus Off Elasticity Of Concrete Overlay And Patching Specimens (Compressometer Method).
- PART 8. Method Of Test For Specific Gravity And Absorption Of Concrete Overlay And Patching Materials.

B. REFERENCES

- ASTM C 78/C 78M - Flexural Strength of Concrete (Using Simple Beam with Third Point Loading)
- ASTM C 109/C 109M - Compressive Strength of Hydraulic Cement Mortars (Using 2 in. or [50 mm] Cube Specimens)
- ASTM C 192/C 192M - Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 230/C 230M - Cement	Standard Specification for Flow Table for Use in Tests of Hydraulic
ASTM C 231/C 231M -	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 266 -	Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
ASTM C 305 -	Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
ASTM C 511 -	Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Mortars
ASTM C 928/C 928M -	Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repair
California Test 504 -	Determining Air Content of Freshly Mixed Concrete by the Pressure Method
California Test 522 -	Chord Modulus of Elasticity of Concrete (Compressometer Method)
California Test 550 -	Determining the Surface Abrasion Resistance of Concrete Specimens
Caltrans Standard Specifications -	Section 90 Concrete

C. PROCEDURE

PART 1. METHOD OF TEST FOR COMPRESSIVE STRENGTH AND FLOW OF OVERLAY AND PATCHING MATERIALS (USING TWO INCH CUBE SPECIMENS)

1A. SCOPE

This method covers determination of the compressive strength of concrete overlay and patching materials using 2 in. cube specimens.

1B. APPARATUS

1. A balance or scale having a minimum capacity of 5000 g and sensitive to 1 g.
2. Cube specimen molds of 2 in. nominal dimension. Cube specimen molds shall be tight fitting; the molds shall have not more than three cube compartments and shall be separable into not more than three parts. The parts of the molds when assembled shall be positively held together. The molds shall be made of hard metal that is not attacked by cement mortar. The sides of the molds shall be sufficiently rigid to prevent spreading or warping. The interior faces of the molds shall be plane surfaces with a permissible variation of 0.005 in. The distances between opposite faces shall be 2 in. \pm 0.030 in.

The height of the molds, measured separately for each cube compartment, shall be 2 in. \pm 0.025 in. The angle between adjacent interior faces and top and bottom planes of the mold shall be $90^\circ \pm 1^\circ$ measured at points slightly removed from the intersection of the faces. As an alternate to the above requirements, molds may conform to ASTM C 109/C 109M, Section 5.3.

3. Electrically driven mechanical mixer with paddle and mixing bowl, as specified in ASTM C 305, Sections 4.1, 4.2, and 4.3.
4. Tamper constructed of a nonabsorptive, nonabrasive, nonbrittle material such as a rubber compound having a Shore A Durometer hardness of 80 ± 10 . Tamper shall have a cross section of approximately $\frac{1}{2}$ in. \times 1 in. and a length of 5 to 6 in. The tamping face shall be flat and at right angles to the length of the tamper.
5. Trowel or scraper having a steel blade at least 3 in. wide with a straight edge.

6. Testing machine as specified in ASTM C 109/C 109M, Sections 5.9, 5.9.1, and 5.9.2.
7. Flow table and flow mold, conforming to the requirements of ASTM C 230/C 230M.

1C. TEMPERATURE

Temperature of the air in the vicinity of the mixing area, the dry materials, molds, base plates, and mixing bowl shall be maintained from 68 to 77°F.

1D. TEST SPECIMENS

Three or more specimens shall be made for each age specified. In the case of slow setting materials, typical test ages may be 6, 24, and 48 hr, and 7, 14, and 28 d. For fast setting materials, typical test ages may be 1, 2, 3, 6, and 24 hr, and 28 d.

1E. PREPARATION OF SPECIMEN MOLDS

1. For testing portland cement based materials, thinly cover the interior and exterior of the assembled molds with a mist of light oil and wipe off any excess. Another suitable release agent may be used.
2. For testing materials containing magnesium phosphates, latex, epoxies or other polymers, cover the interior and exterior of the assembled molds with a mixture of paste wax and solvent and allow to dry before using. A mixture of one part paste wax dissolved in 2 to 3 parts solvent, such as toluene, and applied with a paintbrush is satisfactory.

1F. PREPARATION OF MATERIALS

The variety of materials used in concrete overlay and patching materials is extensive. Care must be taken to avoid contamination of individual components. The hazards of each individual component must be recognized.

1. Materials shall be brought to a uniform temperature in the range of 68 to 77°F prior to mixing.
2. Cement or fly ash shall be stored in a dry place, in moisture-proof containers, free from lumps, with 100 % passing the No. 16 sieve.
3. The moisture content of the fine and coarse aggregate shall not exceed one half of the absorption of the aggregate. The aggregate shall be 100 % passing the ½ in. sieve. Care should be taken to avoid segregation of aggregate.
4. Packaged material shall be marked in accordance with ASTM C 928/C 928M, Section 13. Do not test packaged material that is received in a broken package.
5. The entire package shall be thoroughly blended prior to taking a representative sample for testing.
6. All packaged patching materials shall be tested neat.

1G. PROCEDURE

1. Proportioning and Mixing of Materials:

Mix the concrete overlay or patching material as specified by the manufacturer in the electric mixer or by hand in a batch of such size to yield 10 % excess after molding test specimens. Hand-mixing procedures are not applicable to air entrained mixes or mixes with no measurable slump. Follow the manufacturer's recommendations as to the order of addition and mixing times. Materials shall be mixed thoroughly in the time allotted.

2. Determination of Flow:

The minimum size of a mix used to determine flow shall not be less than 2000 g total mass. The flow table must be clean and dry. Place the flow mold at the center. Place a layer of the mixed material about 1 in. thick in the mold and tamp 20 times with the tamper. The tamping pressure shall be just sufficient to ensure uniform filling of the mold. Then fill the mold with additional material and tamp as specified for the first layer. Strike off material to a plane surface, flush with the top of the mold, by drawing the straight edge of a trowel, held nearly perpendicular to the mold, with a sawing motion across the top of the mold. Wipe the tabletop clean and dry, being especially careful to remove any liquid from around the edge of the flow mold. Lift the mold away from the material within 1 min after completing the mixing operation. Immediately drop the table through a height of ½ in. 15 times in 10 s.

The flow is the resulting average base diameter of the material mass, measured on at least four diameters at approximately equally spaced intervals, expressed as a percentage of the original base diameter. If flow is specified, make trial mixes with varying percentages of liquid until the specified flow is obtained. Make each trial with freshly mixed material.

When testing materials, such as magnesium phosphate or others that may react with the tabletop, place a thin sheet of Mylar™ plastic on the tabletop.

3. Molding Compressive Test Specimens:

Start molding the specimens within 1 min after completion of the mixing. Fill each cube compartment to approximately one half of the depth of the mold. Tamp the material in each cube compartment 25 times with the tamper in a spiral motion, making sure that all corners are tamped. The tamping pressure shall be sufficient to ensure uniform filling of the mold. Tamping shall be completed in each compartment before going on to the next. When the tamping of the first layer in all of the compartments is completed, tap the sides of the mold with a rubber mallet or jig the mold to remove entrapped air along the sides.

Fill the compartments with the remaining material and tamp as specified for the first layer. Tap or jig the mold as before. On completion, the material in each cell shall extend slightly above the top of the mold. With the trowel or tamper, force the batch downward into the mold. Then, for the purpose of leveling the mixed material in the mold, draw the flat side of the trowel, with the leading edge slightly raised, along the length of the mold. Pressure applied to the trowel should result in a well-compacted sample. Cut off the mix to a plane surface flush with the top of the mold by drawing the straight edge of the trowel, held nearly perpendicular to

the mold, using a sawing motion over the length of the mold. Finish to a smooth surface. Clean off excess material on the mold.

1H. CURING

Follow the manufacturer or originator's recommendations as to the cure and when it shall be applied.

Curing Definitions:

1. Dry or Room Cure:

The test specimens are left in the molds uncovered in the mixing room in a place free from vibration. The set material in cube form is identified and removed from the mold as necessary. Removed samples shall be kept in the mixing room.

2. Damp Cure:

The test specimens are covered with a damp cloth or towel after the initial set. Plastic sheeting may be placed on the damp cloth to retard drying of the cloth. The set material is identified and removed from the mold as necessary. Curing is for the period specified.

3. Moist Cure:

Immediately upon completion of molding, place the test specimens in the moist closet or moist room. Keep all test specimens in the molds in the moist closet or moist room with their upper surfaces exposed to the moist air, but protected from dripping water. If the specimens are removed from the molds, keep them on the shelves of the moist closet or moist room for 24 hr, and then immerse the specimens in saturated lime water in storage tanks constructed of noncorroding materials. Keep the storage water clean by changing as required. Remove samples as required for testing.

4. Seal Cure:

The test specimens, after initial set, are covered with a liquid membrane forming compound to retard the loss of moisture during the early hardening period. Samples are kept in the mixing room.

5. Plastic Cure:

The test specimens, after initial set, are covered with a sheet of plastic film (eg. polyethylene, vinyl, or Mylar™) to prevent escape of liquid and the effect of air on the specimen material.

The cured material can be removed any time after final set if it can be ascertained that said removal will not damage the specimen. Typically, a safe period is twice the final set time.

1I. DETERMINATION OF COMPRESSIVE STRENGTH

1. Moist, Damp and Plastic Cures:

Test the specimens immediately after their removal from the curing environment. If more than one specimen is removed for testing, keep the remaining specimens covered with a damp cloth until time of testing.

2. Test Age:

All test specimens shall be broken within the permissible tolerance prescribed as follows:

<u>Test Age</u>	<u>Tolerance</u>
1, 2, or 3 hr	± 5 min
6 hr	± 10 min
24 hr	± 1/2 hr
3 d	± 1 hr
7 d	± 3 hr
28 d	± 12 hr

Intermediate test breaks shall be broken within the tolerance of the earlier specified test age.

3. Wipe each specimen to a surface dry condition, and remove any loose sand grains or incrustations from the faces that will be in contact with the bearing blocks of the testing machine.
4. Apply the load to the specimen faces that were in contact with the true plane surfaces of the mold. Carefully place the specimen in the testing machine below the center of the upper bearing block. Prior to testing each cube, it shall be ascertained that the spherically seated block is free to tilt. Cushioning or bedding materials should not be used except for plastic film (not exceeding 3 mils in thickness), which may be used to protect the bearing surfaces. The load may be applied at any rate, up to one half the expected breaking load. Thereafter, apply the load continuously, and without interruption, at the rate of 20,000 lb per min until the specimen fails.

1J. CALCULATION

Record the total maximum load indicated by the testing machine and calculate the compressive strength in pounds per square inch. If the cross sectional area varies more than 2 % from the nominal, use the actual area for the calculation of the compressive strength. The compressive strength of all acceptable test specimens (see Section 1K) made from the same sample and tested at the same period of time, shall be averaged and reported to the nearest 5 psi.

1K. SPECIMENS AND RETESTS

1. In determining the compressive strength, do not consider specimens that are manifestly faulty, or that give strength differing by more than 10 % from the average of all test specimens made from the same sample and tested at the same age. If, after discarding specimens or strength values, less than two strength values are left for determining the compressive strength at any given age, retest the material.
2. Reliable strength results depend upon careful observance of all specified requirements and procedures. Erratic results indicate that some requirements and procedures have not been carefully observed; for example, improper mixing or poor fabrication of mold specimens. Improper centering of cubes, resulting in oblique

fractures or lateral movement of the testing machine head during loading, will often result in lower strengths.

1L. REPORTS

The mixing report shall include the following information:

1. The material used is identified as bag, lot, receiving number, etc.
2. The amount and order of addition to mix.
3. The date, time, and mixing time.
4. Mixer used and by whom.
5. Personnel fabricating specimens.
6. Approximate working time of material.
7. Initial set time.
8. Final set time.
9. Workability of mix and flow percentage.
10. Unusual items such as, odor, heat rise, finishing characteristics, etc.
11. Number of cubes made.
12. Cure.

The testing report shall include the following information:

1. Test specimen identification.
2. Type of cure.
3. Date of test.
4. Test operators.
5. Age at time of test.
6. Area in square in.
7. Maximum load at failure for each specimen.
8. Average strength to the nearest 5 psi.
9. Description of break, if break is abnormal.

PART 2. METHOD OF TEST FOR SET TIME OF CONCRETE OVERLAY AND PATCHING MATERIAL BY GILLMORE NEEDLES

2A. SCOPE

This method covers determination of the time of setting of concrete overlay and patching materials by means of Gillmore needles.

2B. APPARATUS

1. Gillmore needles, as specified in ASTM C 266.
2. Concrete cylinder can lids. Steel can lids as furnished for use for fabricating PCC compressive cylinders. Approximate inside dimensions are 6 in. in diameter and $\frac{5}{8}$ in. in depth.

2C. TEMPERATURE

Temperature of the air, test material, and the Gillmore needles shall be maintained from 68 to 77°F.

2D. PROCEDURE

1. Molding Test Specimen:

From the mixed batch, take sufficient material to fill the can lid. With a trowel, use sufficient pressure on the mixed material to compact it similar to the density when fabricating 2 in. compressive cubes. Strike off the mixed material until it is flush with the edge of the lid. Place the lid on a piece of non-heat conductive material such as bare wood or a dry towel at least $\frac{3}{4}$ in. thick in the mixing room.

2. Time of Set Determination:

In determining the setting time, hold the needles in a vertical position and apply lightly to the surface of the sample. Consider the material to have acquired its initial set when the material will bear, without appreciable indentation, the initial Gillmore needle. Consider the material to have acquired its final set when the material will bear, without appreciable indentation, the final Gillmore needle.

3. PRECAUTIONS—The time of setting is affected by the amount and temperature of the liquid added, the material temperature, and the temperature and the humidity of the air. A minimum of three tests should be taken at each time interval. Care must be taken to avoid testing over coarse aggregate particles.

2E. REPORTS

When reporting the initial and final set time, express the time in minutes. Also record the air temperature at time of test.

PART 3. METHOD FOR FABRICATING CONCRETE SPECIMENS OF OVERLAY AND PATCHING MATERIALS

3A. SCOPE

This method describes the fabrication of concrete overlay and patching material specimens for use in California Tests for flexure, bonding, compressive strength, modulus of elasticity, specific gravity, absorption, lineal dimension change and abrasion tests.

3B. APPARATUS

Concrete mixer, scales, tamping rods, and miscellaneous equipment conforming to ASTM C 192/C 192M.

Molds constructed of metal not reactive with portland cement: Molds for all specimens except abrasion shall have internal dimensions of 3 in. × 3 in. × 12 in. Abrasion specimen molds shall be 4 in. diameter and 2 in. high.

3C. TEMPERATURE

Temperature can be critical to the setting time of the completed mix and will affect the strength of the material. Temperature of the air in the vicinity of the mixing area, materials, molds, and mixers shall be maintained from 68 to 77°F.

3D. TEST SPECIMENS

1. The number of specimens and number of test batches are dependent on the amount of available material and the nature of the test program. In general, two or more specimens are made for each test age and test condition unless otherwise specified.
2. For slow setting materials typical test ages are 1, 3, 7 and 28 d.
3. For fast setting materials typical test ages are 3, 6 and 24 hr, and 28 d.

3E. PREPARATION OF SPECIMEN MOLDS

1. For testing portland cement or gypsum based materials, thinly cover the interior and exterior of the assembled molds with a mist of light oil and wipe off excess oil.
2. For testing materials containing magnesium phosphates, latex, epoxies or other polymers cover the interior and exterior of the assembled molds with a mixture of paste wax and solvent and allow to dry before using. A mixture of 1 part paste wax dissolved in 2 to 3 parts solvent, such as toluene, and applied with a paintbrush is satisfactory.

3F. PREPARATION OF MATERIALS

The variety of materials used in concrete overlay and patching materials is extensive. Care must be taken to avoid contamination of individual components. The hazards of each individual component must be recognized.

1. Temperature: Materials shall be brought to a uniform temperature from 68 to 77°F prior to mixing.
2. Cement or fly ash shall be stored in a dry place, in moisture-proof containers, free from lumps, with 100 % passing the No. 16 sieve.

3. The moisture content of the fine and coarse aggregate shall be less than one-half of the SSD absorption unless otherwise required. The maximum size aggregate shall be 100 % passing the 1 in. sieve. Care should be taken to avoid segregation of aggregate.
4. Water used in mixes shall be potable. The water temperature shall be from 68 to 77°F.
5. Packaged materials shall be marked in accordance to ASTM C 928/C 928M, Section 13. Do not test packaged material that is received in a broken package.
6. Pre-packed materials shall be tested at the maximum aggregate extension recommended by the material supplier.

3G. MIXING PROCEDURE

Mix the concrete overlay or patching materials as specified by the material supplier in an electric mixer, drum or open tub type, or by hand, in a batch of such size to yield 5 % excess after molding test specimens. Hand mixing procedures are not applicable to air-entrained mixes or for mixes with no measurable slump. Follow the material suppliers' recommendations as to the order of addition to mixes and mixing times. Materials shall be mixed thoroughly in the time allotted.

1. Mixing Time:
 - a. Mixing time starts when the liquid or powder component that initiates the setting reaction is added.
 - b. Mixing times will vary with the material being tested. Some portland cement mixes may be mixed for 3 min followed by a rest period of 3 min, then continue mixing for 2 min (3-3-2). Some fast setting materials may require only 1 min of mixing.

2. Tests on Freshly Mixed Material:

If the working time of the material is long enough, tests such as slump, density and air content may be taken if desired. Return all uncontaminated material to the mixer and mix for a minimum of 30 s before proceeding to mold specimens.

3. Begin molding the specimens within 1 min after completion of the mixing.

3H. MOLDING OF SPECIMENS

1. Molding of Abrasion Test Specimens for California Test 550:

Place a layer of the batched material in each compartment of the mold approximately 1 in. deep. Tamp the batch in each compartment 25 times with a ½ in. × 1 in. × 6 in. rubber tamper in a spiral motion, making sure all edges are tamped. Tamping shall be completed in each compartment before going on to the next. When the tamping of the first layer in all compartments is completed, jig the mold to remove entrapped air along the sides. Fill the compartments and tamp as specified for the first layer. Upon completion, the material should extend slightly above the top of the molds. With a trowel, force the batch downward into the mold. When compaction is completed, strike off the top surface and finish to a smooth surface with a steel straightedge.

2. Molding of Flexure Test Specimens:

Place the batched material in the mold in approximately two equal layers. Compact each layer with a wooden tamper approximately $\frac{3}{4}$ in. \times 3 in. \times 18 in. long, 40 strokes for each layer or until a homogeneous specimen is obtained. Jig the mold between each layer to remove entrapped air. After the top layer has been compacted, strike off the material flush with the top of the mold, and finish to a smooth surface with a steel trowel.

3. Molding of Bonding Test Specimens:

- a. PCC bonding test blocks shall be fabricated in accordance with PART 6, "Method For Fabricating PCC Blocks For Use In The Bond Test."
- b. Follow the material suppliers' instructions for applying a bonding coat, if recommended, to the bond surface of the PCC sample blocks in the mold.
- c. Place the batched material in the mold in two equal layers. Compact each layer with a wooden tamper approximately $\frac{3}{4}$ in. \times 3 in. \times 18 in., 20 strokes for each layer or until a homogeneous specimen is obtained. Spade the PCC bond block-bonding surface with a spatula to effect maximum contact of the batched material with the PCC. Jig the mold between each layer to remove entrapped air. Compact and strike off the material to the top of the mold, and finish to a smooth surface with a steel trowel.

4. Molding of Lineal Dimension Change Specimens:

- a. Follow the instructions for molding of flexural test specimens, making sure that the material is well worked into the corners and around the gage studs.
- b. Immediately after fabricating the specimen, loosen the gage studs at each end of the mold in order to prevent any restraint during initial shrinkage of the specimen.

5. Vibration of Molded Specimens:

- a. If the mixed batched material has a slump of 3 in. or less, an external vibrator may be used in lieu of rodding and tamping.
- b. Maintain a standard duration of vibration for the particular kind of material, vibrator, and specimen mold involved. The duration of the vibration will also depend upon the workability of the material and the effectiveness of the vibrator. Usually, sufficient vibration has been applied as soon as the surface of the material becomes relatively smooth. Vibrate only long enough to achieve proper consolidation of the material. Over vibration may cause segregation. Fill the molds and vibrate in two approximately equal layers. Add the final layer so as to avoid overfilling by more than $\frac{1}{4}$ in. After vibration finish to a smooth surface with a steel straightedge.
- c. When external vibration is used, ensure that the mold is rigidly attached to or securely held against the vibrating element or vibrating surface.

3I. CURING

1. In general, follow the material suppliers curing recommendations.
2. Curing methods are defined as specified in PART 1, "Method Of Test For Compressive Strength And Flow Of Concrete Overlay And Patching Materials (Using 2 in. Cube Specimens)," Section 1H.
3. Specimens may be removed from the molds after the final set provided that the molds can be removed without damage to the specimen. Typically, molds may be removed after twice the final set time. All specimens should be removed from the molds within 48 hr.
4. Prior to, or shortly after removal from mold, identify each specimen using a waterproof marking pen.

3J. TEST AGE

1. All test specimens shall be broken within the permissible tolerance prescribed as follows:

<u>Test Age</u>	<u>Tolerance</u>
1, 2, or 3 hr	± 5 min
6 hr	± 10 min
24 hr	± 1/2 hr
3 d	± 1 hr
7 d	± 3 hr
28 d	± 12 hr

2. Intermediate test ages shall be broken within the tolerance of the earlier specified test age.

3K. MIXING REPORT

1. The mixing report shall include the following:
 - a. Identification of overlay or patching material.
 - b. Tests to be run.
 - c. Number of specimens for each condition and age.
 - d. Identification and source of each material employed including lot numbers.
 - e. Type, maximum size, moisture condition, and gradation of the aggregate.
 - f. Mixing equipment used.
 - g. Order of addition of material into the mix.
 - h. Date, time, and air temperature at time of mixing.
 - i. Consistency of mix, odors, hazards, workability.
 - j. Method of fabricating and vibration information.

- k. Curing procedure used.
- l. Test operators
- m. Any other pertinent information, such as type, application of bond coat, test results or finishing characteristics.

PART 4. METHOD OF TEST FOR FLEXURAL STRENGTH OF CONCRETE OVERLAY AND PATCHING MATERIALS

4A. SCOPE

This method covers determination of the flexural strength of concrete overlay and patching materials by the use of a simple beam with third-point loading on 3 in. × 3 in. × 12 in. specimens.

4B. APPARATUS

Apparatus shall be in accordance with ASTM C 78/C 78M.

4C. TEST SPECIMENS

The test specimens shall be fabricated and cured as specified in PART 3, "Method of Fabricating Concrete Specimens of Overlay and Patching Materials." The sides of the specimen shall be at right angles with the top and bottom. All surfaces in contact with load applying and support blocks shall be smooth and free of scars, indentations, holes, or inscribed identifications.

4D. PROCEDURE

The procedure shall be in accordance with ASTM C 78/C 78M, Section 6. Loading rate above 50 % of the ultimate load shall be 1500 lb/min.

4E. CALCULATIONS

Calculations shall be in accordance with ASTM C 78/C 78M, Section 8.

4F. REPORT

The report shall include the following:

- 1. Identification number.
- 2. Curing history.
- 3. Age of test specimen.
- 4. Maximum applied load in pounds.
- 5. Modulus of rupture calculated to the nearest 5 psi.
- 6. Test operators.
- 7. Defects in specimen or anything unusual.

**PART 5. METHOD OF TEST FOR BONDING STRENGTH OF CONCRETE OVERLAY AND
PATCHING MATERIALS TO PCC**

5A. SCOPE

This method covers the determination of the bonding strength of concrete overlay and patching materials by a simple beam with center-point loading.

5B. APPARATUS

1. Testing Machine:

The testing machine shall conform to ASTM C 78/C 78M.

2. Apparatus for bonding test:

a. The Base Plate for this test shall be similar to the one specified in ASTM C 78/C 78M with a support length (L) of 9 in.

b. A diagram of the apparatus and load-applying bar is shown in Figures A1 and A2. The load-applying bar shall provide a uniform point load along the length of the bond interface.

5C. TEST SPECIMENS

The test specimens shall be fabricated and cured as specified in PART 3, "Method For Fabricating Concrete Specimens Of Overlay And Patching Materials." The sides of the specimen shall be at right angles with the top and bottom. All surfaces in contact with the load-applying bar and support block shall be smooth and free of scars, indentations, holes or inscribed identifications.

5D. PROCEDURE

Turn the test specimen on its side with respect to its position as molded so the top as molded is facing the operator. Center the bond face line on the support block. Center the loading system in relationship to the applied force. Lower the spherical head of the testing machine until there is just enough clearance between the spherical head and the test specimen to permit insertion of the load-applying bar without it tipping over. The load-applying bar shall be placed directly on the bond face line of the specimen.

Apply the load continuously at a rate of 1500 lb/min until the specimen breaks. The specimen will break at the bond line, in the PCC or in the material being tested.

5E. CALCULATIONS

Calculate the modulus of rupture in bond as follows.

$$R = \frac{3Pl}{2bd^2}$$

Where: R = modulus of rupture, psi
 P = maximum applied load indicated by the testing machine, lb
 l = span length, in.
 b = average width of specimen, at the point of fracture, in.
 d = average depth of specimen, at the point of fracture, in.

5F. REPORT

The report shall include the following:

1. Identification number and name.
2. Curing history.
3. Age of test specimens.
4. Maximum applied load in lb.
5. Modulus of rupture, to the nearest 5 psi.
6. Location of break and percentage. Since the failure can be in bond, PCC, or cohesive failure of the test material, it is important to note where the break occurred and note the approximate percentage of material broken.
7. Date tested and operator.
8. Defects in specimen, or anything unusual.
9. If bond test is to a dry or SSD surface.

PART 6. METHOD FOR FABRICATING PCC BLOCKS FOR USE IN THE BOND TEST

6A. SCOPE

This method covers procedures for making and curing PCC blocks for use in PART 5, "Method Of Test For Bonding Strength Of Concrete Overlay And Patching Materials To PCC."

6B. APPARATUS

The concrete mixer, scales, tamping rods, miscellaneous equipment and molds shall conform to ASTM C 192/C 192M, Section 4, "Apparatus." The internal dimensions of the molds shall be 3 in. × 3 in. × 12 in.

6C. SPECIMENS

Portland cement concrete block specimens shall be made from aggregate passing the $\frac{3}{8}$ in. sieve. The concrete mix shall have a nominal cement content of 675 lb/yd³ and achieve a minimum compressive strength of 4500 psi in 28 d. Concrete specimens used for freeze-thaw bond tests shall have an air content of 5 to 7 % as determined by ASTM C 231/C 231M, meter type B. Admixtures shall conform to Sections 90-1.01C(4) "Admixtures", 90-1.01D(1) "General," and 90-1.02E(1-3) "Admixtures" of the Caltrans Standard Specifications.

6D. PREPARATION OF MATERIALS

As specified in ASTM C 192/C 192M, Section 6.

6E. PROCEDURE

Mix concrete according to the procedure specified in ASTM C 192/C 192M, Section 7.

6F. CURING

1. As specified in ASTM C 192/C 192M, Sections 8.1 and 8.2.
2. Specimens shall be cured in a moist cabinet or moist room where the temperature is approximately 73°F and relative humidity not less than 95 % (ASTM C 511) for a period of at least 28 d.
3. After 28 d in the moist room, remove the specimens and place in dry storage. Samples should preferably be aged 6 months prior to use.

6G. DIAMOND BLADE CUTTING

1. Cut the 3 in. × 3 in. × 12 in. PCC blocks approximately in half with a concrete saw with a water-cooled, diamond matrix cutting edge blade. The saw cut shall be at right angles to the length of the block.
2. Care shall be taken to avoid contamination of the cut face, especially with oil. After cutting, wash the PCC blocks with clean water to remove all loose particles.

6H. SATURATED SURFACE DRY BOND BLOCKS

1. PCC blocks for use as Saturated Surface Dry (SSD) PCC shall be placed in a rustproof container and covered with a minimum of 1 in. of water for a minimum of 48 hr prior to use.
2. Remove PCC blocks from the water, rinse them with clean water and dry them with a clean paper towel.
3. Apply $\frac{3}{4}$ in. wide masking tape around the perimeter of the cut face. The tape application shall be even with the cut face and not protrude more than $\frac{1}{32}$ in. beyond the cut face.
4. Place the taped block into a 3 in. × 3 in. × 12 in. mold coated with a suitable mold release. The cut face shall be not less than 5 in. from the end of the mold. Secure the block in the mold.
5. Cover the SSD bond blocks with a damp towel until ready to place the material to be tested. This is done to retain the SSD condition of the block.

6I. DRY PCC BLOCKS

1. PCC blocks used for a dry bond shall be placed in an oven at 230°F ± 9°F for at least 48 hr prior to use.
2. Blocks shall be cooled to room temperature before using.
3. Apply a $\frac{3}{4}$ in. masking tape around the perimeter of the cut face. The tape application shall be even with the cut face and not protrude more than $\frac{1}{32}$ in. beyond the cut face.
4. Place the taped block into a mold coated with a suitable mold release. The cut face shall not be less than 5 in. from the end of the mold. Secure the block in the mold.

PART 7. METHOD OF TEST FOR CHORD MODULUS OF ELASTICITY OF CONCRETE OVERLAY AND PATCHING SPECIMENS (COMPRESSOMETER METHOD)

7A. SCOPE

This procedure is used in determining the modulus of elasticity of concrete overlay and patching specimens using a compressometer.

7B. APPARATUS

1. The apparatus shall consist of a testing machine and compressometer in accordance with California Test 522.
2. An adapter capable of holding a 3 in. × 3 in. specimen in the compressometer.

7C. TEST RECORD FORM

Record the concrete test data and the deformation readings from a dial compressometer on a suitable form. If a linear variable differential transformer (LVDT) and chart recorder are used, attach the plots.

7D. TEST SPECIMENS

1. The test specimens may be cut from 3 in. × 3 in. × 12 in. concrete beams broken in flexure. The minimum length of the specimens is 6 in., cut flush on a concrete saw. Both ends of the specimen shall have a square, plane surface. If not, cap the ends with capping compound. Use a cardboard shim not less than 0.030 in. thickness when testing uncapped specimens to protect the bearing surfaces of the testing machine.
2. Test the specimens in a dry or room cure condition unless otherwise specified.

7E. TEST PROCEDURE

The test procedure is in accordance with California Test 522, Section F, except that the rate of loading shall be at the rate of 20,000 lb/min.

7F. CALCULATIONS

Calculations are in accordance with California Test 522, Section G.

7G. TEST REPORT

The test report shall contain the following:

1. Specimen identification.
2. Cure history.
3. Condition of sample at time of testing.
4. Age of test specimen.
5. Test date and operator.

6. Calculation data.

H. PRECAUTIONS

Precautions are in accordance with California Test 522, Section H.

PART 8. METHOD OF TEST FOR SPECIFIC GRAVITY AND ABSORPTION OF CONCRETE OVERLAY AND PATCHING MATERIALS

8A. SCOPE

This test method, which is a modification of ASTM C 127, covers the determination of bulk specific gravity and absorption of cured concrete overlay and patching materials.

8B. APPARATUS

1. A balance or scale with a minimum capacity of 5000 g and accuracy of ± 1 g.
2. Suitable apparatus for holding the sample from the scale so that the sample can be weighed immersed in water. Apparatus shall include a container of sufficient size to allow complete immersion of the sample while weighing.
3. A corrosion resistant vessel deep enough to permit immersing of samples during the soaking period.

8C. PREPARATION OF SAMPLES

Each sample shall be a cured specimen free of surface cracks and shall have a dry mass of 800 g or more. All loose surface material shall be removed.

8D. TEST PROCEDURE

1. Immerse the specimen in water with a minimum of 1 in. of water covering the specimen and allow to soak for a minimum of 48 hr. The water temperature shall be $68^{\circ}\text{F} \pm 9^{\circ}\text{F}$.
2. Remove the sample from the water, rinse clean, and place sample in an apparatus suspended from the scale or balance. Immerse the sample completely and weigh. Record the reading as "apparent mass of sample in water" (C).
3. Remove the sample from the water and dry the surface with a large absorbent towel to remove all visible water. Avoid the loss of absorbed water by drying the sample to a saturated surface dry condition as rapidly as possible and then weigh the sample immediately. Record reading as "mass of saturated surface dry sample" (B).
4. Put the sample in an oven and dry to constant weight at $230^{\circ}\text{F} \pm 9^{\circ}\text{F}$.
5. Cool the sample to room temperature and weigh. Record the reading as "oven-dry mass" (A).

8E. CALCULATIONS

1. Description of Factors:

A = Mass, in g, of sample in oven dry condition.

B = Mass, in g, of sample in saturated surface dry condition.

C = Apparent mass, in g, of saturated sample immersed in water.

2. Bulk specific gravity equals

$$\frac{A}{(B - C)}$$

3. Percent absorption equals

$$\frac{(B - A)}{A} * 100$$

8F. REPORTING OF RESULTS

Report specific gravity to the nearest hundredth and percent absorption to the nearest tenth.

D. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

End of Text
(California Test 551 contains 21 pages)

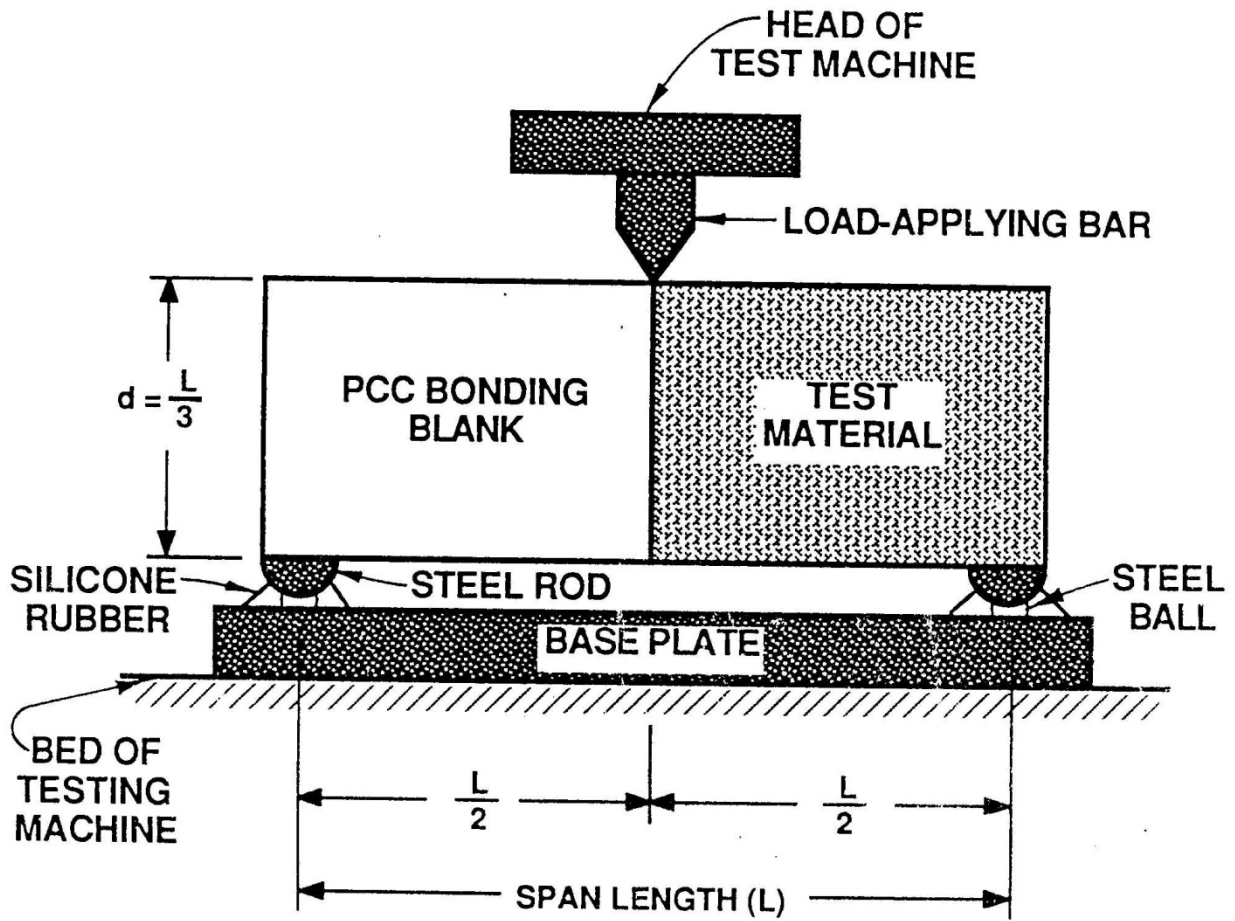
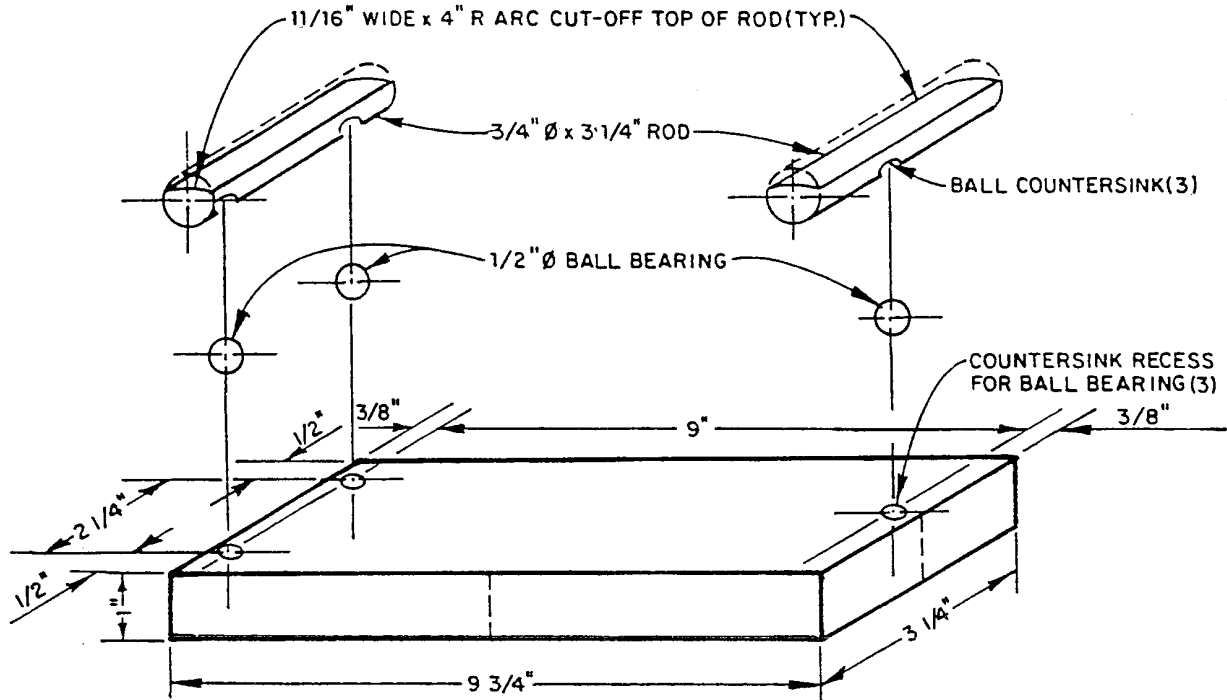
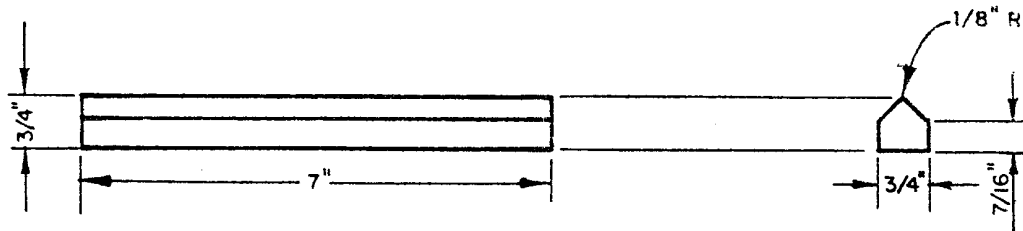


FIGURE A1. Apparatus for Bonding Strength Test in Center Point Loading



BASE PLATE



BAR FOR "BOND" TEST

NOTE:

1. Ball bearings silver soldered to counter-sink in $\frac{3}{4}$ in. diameter \times $\frac{3}{4}$ in. rod.
2. Rods cemented to base with silicon rubber.

FIGURE A2. Plan of Apparatus for Bond Test of Concrete Overlay and Patching Materials