State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR MAKING AND CURING CONCRETE BEAM SPECIMENS IN THE FIELD AND FOR DETERMINING FLEXURAL STRENGTH OF CONCRETE USING SIMPLE BEAM WITH THIRD-POINT LOADING

SCOPE

This test method describes the procedure for making and curing beam specimens from representative samples of fresh concrete and the procedure used for determining the flexural strength of concrete by the use of a simple beam with third-point loading.

APPARATUS

1. Beam breaking machine, machines having the capacity, in one continuous stroke, to complete a test without requiring replenishment are permitted and shall be capable of applying loads at a uniform rate without shock or interruption. The testing machine shall conform to the requirement of the section on Basis of Verification, Corrections, and Time Interval between Verifications of Practices, ASTM E4.

2. Beam molds, molds shall be made of steel, cast iron, or other nonabsorbent material that is not reactive with concrete containing Portland or other hydraulic cements. Molds shall hold their dimensions and shape under all conditions of use and shall be watertight. Molds shall produce specimens that are 150 mm (6 in.) x 150 mm (6 in.) in cross section and at least 500 mm (20 in.) in length. Maximum variation from the nominal cross section shall not exceed 3 mm (1/8 in.). The inside surface shall be smooth. The sides, bottom, and ends shall be at right angles to each other and shall be straight and true and free of warpage.

3. Tamping rod, rod shall be made of steel and be round and straight. The rod shall be approximately 16 mm (5/8 in.) in diameter and 600 mm ± 100 mm (24 ± 4 in.) in length, with both ends rounded to a hemispherical tip of the same diameter.

4. Internal vibrators, vibrators may have rigid or flexible shafts. The frequency of vibration shall be 7000 vibrations per minute or greater while in use. The outside diameter or the side dimensions of the vibrating element shall be at least 19 mm (3/4 in.) and not greater than 38 mm (1 1/2 in.). The length of the shaft shall be at least 600 mm (24 in.).

5. Small hand tools, such as wood floats, 150 mm (6 in.) blunt end stainless steel trowel, rubber head mallet with a mass of 567 ± 227 g (1.25 ± 0.50 lb) and measuring tape or ruler with at least 1 mm (1/16 in.) graduations.

SAMPLING

1. Obtain a representative sample per Test Method Nev. T425. In the case of concrete deposited in front of a "slip-form paver," the sample shall be taken from random points throughout the dumped loads in front of the paving machine.

2. Transport samples obtained as described above in watertight containers to the place where the test specimens are to be molded. A minimum of three samples shall be molded. Samples must be remixed with a shovel on a non-absorbent surface to assure that there is no segregation of the coarse aggregate or mortar.

MOLDING TEST SPECIMENS

1. Place the concrete in lightly oiled molds using a scoop. The oil used shall be mineral oil. If using a vibrator for consolidation, place concrete in one lift. Place enough concrete such that the mold will be slightly overfilled after consolidation. If a vibrator is not used for consolidation, place concrete in two layers of approximately equal volume and rod each layer. Place enough concrete in the second layer such that the mold will be slightly overfilled after consolidation. In placing each portion of concrete, the scoop or trowel shall be moved around the top edge of the mold as the concrete slides from it in order to ensure a symmetrical distribution of the concrete and minimize segregation of the coarse aggregate within the mold. The concrete may be further distributed by use of a tamping rod prior to the start of consolidation.

2. Preparation of satisfactory specimens requires different methods of consolidation. Concrete with a slump equal to or greater than 25 mm (1 in.) can be rodded or vibrated. Concrete with a slump of less than 25 mm (1 in.) shall be vibrated.

3. The number of roddings per layer shall be based upon the top surface area of the beam. Provide one rodding for each 1400 mm^2 (2 $in.^2$) of surface area. Rod each layer throughout the depth without forcefully striking the bottom of the mold. After each layer is rodded, tap the outsides of the mold 10 to 15 times with a mallet to close any holes and to release any large air bubbles that may have been trapped.

4. Vibrate by inserting the vibrator at intervals not exceeding 150 mm (6 in.) along the centerline of the long dimension of the specimen. Place all concrete in the mold before starting vibration. Insert the vibrator slowly and do not allow the vibrator to touch the bottom or sides of the mold. Withdraw the vibrator slowly so no large air pockets are left in the specimen. Generally, no more than 5 seconds of vibration should be required for each insertion. Usually, sufficient vibration has been applied as soon as the surface of the concrete has become relatively smooth. Longer times may be needed for lower slump concrete. Once vibration is complete, tap the outsides of the mold 10 to 15 times with a mallet to close any holes and to release any large air bubbles that may have been trapped. After tapping, spade along the sides and ends of the beam molds with a trowel.

5. After consolidation, strike off excess concrete from the surface and float with a hand trowel. Finish with the minimum manipulation necessary to produce a flat even surface that is level with the rim of the mold and that has no depressions or projections larger than 3 mm (1/8 in.).

CURING TEST SPECIMENS

1. Place earth around the sides and ends of the molds to prevent excessive loss of heat generated by the chemical reaction in the concrete.

2. During the initial 24 hours, apply the same curing compound to the top surface of the test beam as is applied to the pavement. Apply the curing compound promptly to the surface of the beam or cover the beam immediately with a double thickness of burlap or other fabric that shall be kept thoroughly damp until the curing medium is applied. The objective sought in curing the beam is to provide the same temperature environment as that of the pavement.

3. At the end of the initial 24 hour cure time, remove from test site and transport the beam to the curing location. Then, carefully remove the beam from the mold and bury the beam in damp earth with at least 100 mm (4 in.) of cover over the top of the beam. Keep the earth surrounding the test beams damp at all times. Cover with a tarp or plastic sheeting to prevent excessive evaporation.

BEAM BREAKING PROCEDURE

1. Testing schedule

    a. Break one beam at 10 days of age and one at 28 days of age. Thus, there will be one spare beam to test in case of a faulty break or if it is desired to vary the breaking schedule. The breaking schedule may be varied, if necessary, to determine the strength of the concrete before opening the pavement to traffic.

    b. Keep beams thoroughly damp throughout the curing process until immediately prior to testing time. If beams are allowed to dry prior to testing, test results may be inaccurate.

    c. Test beams promptly upon removal from the curing bed.

2. Testing procedure

    a. Locate the testing machine on a firm foundation, away from the influence of vibrations. Break strength may be decreased if this step is disregarded.

    b. Follow the operation manual to prepare the beam breaking machine for testing.

    c. Brush the beam clean, place in the testing machine on its side with respect to its position as molded, and center it on the support blocks. Center the loading system in relation to the applied force. Bring the load-applying block in contact with the surface of the specimen at the third points and apply a load of between 3 and 6 percent of the estimated ultimate load. Use leather shims on the specimen contact surface to eliminate any gaps. Leather shims shall be of uniform 6 mm (1/4 in.) thickness, 25 to 50 mm (1 to 2 in.) in width, and shall extend across the full width of the specimen.

d. Apply the load to the specimen continuously and without shock. The load shall be applied at a constant rate to the breaking point. Apply the load at a constant rate between 0.86 and 1.21 MPa/min (125 and 175 psi/min) until rupture occurs. When the loading rate needs to be calculated use the following equation:

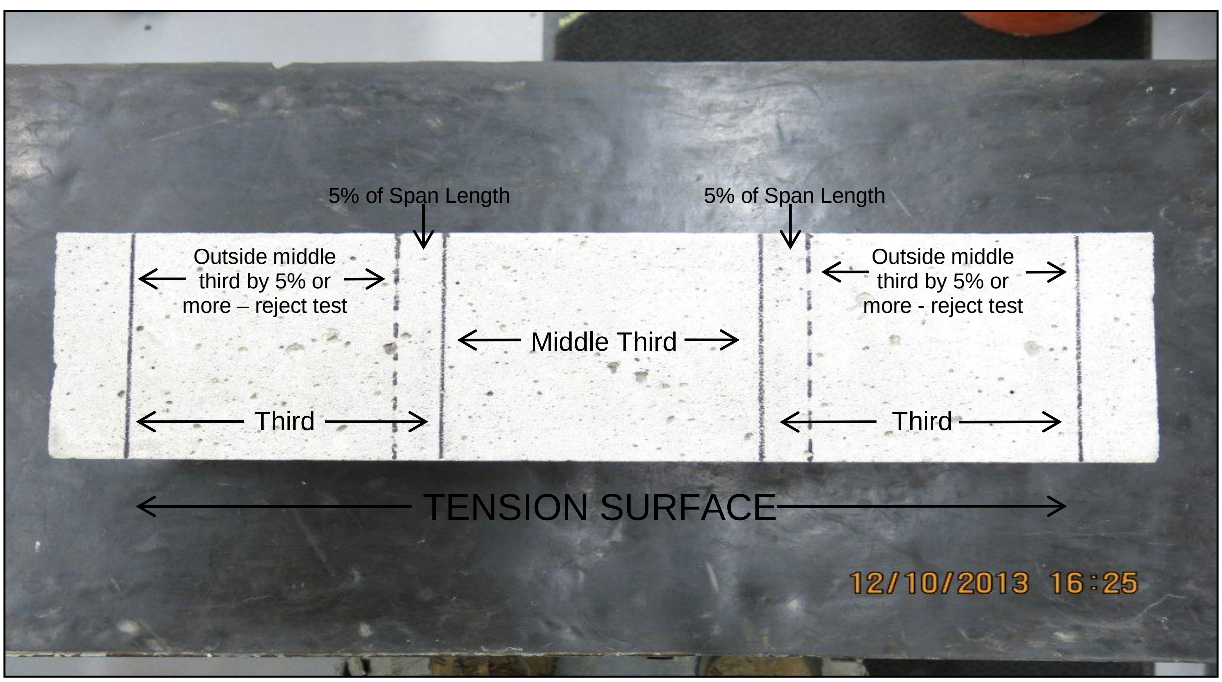
$$r = Sbd^2/L$$

where:
r = loading rate, MN/min (lb/min),
S = rate of increase in extreme fiber stress, MPa/min (psi/min),
b = average width of the specimen, mm (in.),
d = average depth of the specimen, mm (in.),
L = span length, mm (in.).

3. Measurement of Specimens after Test

a. To determine the dimensions of the specimen cross section for use in calculating modulus of rupture, take measurements across one of the fractured faces after testing. For each dimension, take one measurement at each edge and one at the center of the cross section. Use the three measurements for each direction to determine the average width and the average depth. When necessary, calculate the average distance between the line of fracture and the nearest support measured on the tension surface of the beam by measuring from the nearest support to the fracture along both edges of the beam and along the centerline of the tension surface, and average the three measurements. Take all measurements to the nearest 1 mm (1/16 in.).

CALCULATIONS



1. If the fracture initiates in the tension surface within the middle third of the span length and the testing machine supplies modulus of rupture (R), record results per the REPORT section.

   If the fracture initiates in the tension surface within the middle third of the span length and the testing machine supplies maximum applied load (P), calculate the modulus of rupture (R) as follows:

$$R = PL/bd^2$$

where:
R = modulus of rupture, MPA (psi),
P = maximum applied load indicated by the testing machine, N (lbf),
L = span length, mm (in.),
b = average width of specimen, mm (in.) at the fracture,
d = average depth of specimen, mm (in.) at the fracture.

2. If the fracture occurs in the tension surface outside of the middle third of the span length by not more than 5% of the span length, and the testing machine supplies modulus of rupture (R), calculate maximum applied load (P) as follows:

$$P=Rbd^2/L$$

where:
P = maximum applied load, calculated, N (lbf),
R = modulus of rupture supplied by testing machine, MPA (psi),
L = span length, mm (in.),
b = average width of specimen, mm (in.) at the fracture,
d = average depth of specimen, mm (in.) at the fracture.

Then calculate an adjusted modulus of Rupture, (R) as follows:

$$R= 3Pa/bd^2$$

where:
R = adjusted modulus of rupture, MPA (psi),
P = maximum applied load calculated above, N (lbf),
a = average distance between the line of fracture and the nearest support measured on the tension surface of the beam, mm (in.),
b = average width of specimen, mm (in.) at the fracture,
d = average depth of specimen, mm (in.) at the fracture.

If the fracture occurs in the tension surface outside of the middle third of the span length by not more than 5% of the span length and the testing machine supplies maximum applied load (P), calculate the modulus of rupture, (R) as follows:

$$R = 3Pa/bd^2$$

where:
R = modulus of rupture, MPA (psi),
P = maximum applied load indicated by the testing machine, N (lbf),
a = average distance between the line of fracture and the nearest support measured on the tension surface of the beam, mm (in.),
b = average width of specimen, mm (in.) at the fracture,
d = average depth of specimen, mm (in.) at the fracture.

3. If the fracture occurs in the tension surface outside of the middle third of the span length by more than 5% of the span length, discard the results of the test.

REPORT

Report the modulus of rupture to the nearest whole number. Record the results on NDOT form 040-016.