Transport Roads & Maritime Services

NSW GOVERNMENT

# Test method T321

## Drying shrinkage of 100 x 100 x 280 mm concrete prisms

**OCTOBER 2012**

# Revision Summary

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Note that Roads and Maritime Services is hereafter referred to as 'RMS'.

The most recent revision to Test method T321 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

# Test method T321

# Drying shrinkage of 100 x 100 x 280 mm concrete prisms

## 1. Scope

This test method sets out the procedure for the determining the length changes of 100 x 100 x 280 mm concrete specimens due to drying in air.
The method provides for tests on specimens in which the concrete has been prepared in the laboratory and the maximum aggregate size is such that all aggregate passes the 37.5 mm AS sieve.

## 2. Apparatus

(a) Moulds of metal substantial enough to hold their form without distortion and without leaking during the moulding of the specimens. The internal faces of the moulds are to be machined to a smooth finish. Each mould is to comprise a base plate to which two end plates are securely fastened; two side plates which are fastened to the end plates; and two partially loose end plates referred to as gauge stud holders. The gauge stud holders are to be machined to fit snugly inside the end of the mould and to locate and secure a gauge stud during the setting period of the concrete. The gauge stud holders are to be held in position against the end plate by a retaining screw and shall be capable of release after compaction of the concrete.

The dimensions of the moulds and a recommended method of construction are set out in AS 1012, Part 13 except that the dimensions be adjusted to produce a specimen of nominal dimensions of 100 mm x 100 mm x 280 mm length and the thickness of gauge stud holder be increased from 10 mm to 12.5 ± 0.5 mm.

(b) Gauge studs of stainless steel conforming to the dimensions given in AS 1012, Part 13, radius of the gauge ends being approximately 5 mm.

(c) A length gauge, for checking the nominal length between the gauge studs, made of metal with a diameter of approximately 6 mm and a length of 250 ± 0.2 mm.

(d) A tamping bar for compacting the concrete in the moulds. The tamping bar is to be straight, rectangular prismatic, with a 25 mm x 10 mm cross section and approximately 300 mm long with the ramming face square to the axis.

(e) An external vibrator of table type with a frequency of vibration of at least 50 Hz.

(f) A vertical length comparator fitted with a high grade dial gauge or micrometer screw gauge graduated to read in 0.001 or 0.002 mm units, accurate to within 0.002 mm in any 0.10 mm range and with a travel of at least 10 mm.

The frame of the comparator is to be sufficiently rigid to prevent distortion when handled or when supporting the specimen, with means provided to ensure that the length of the specimen is measured along its longitudinal axis.

The upper and lower measuring anvils are to be of tungsten carbide, each with a concave surface of radius approximately 25 mm to locate the specimen vertically. The diameter of the lower anvil shall be approximately 10 mm and that of the upper anvil 6.10 ± 0.05 mm. The upper anvil is to be fitted to the stem of the dial gauge and also be fitted with a tightly fitting collar extending down 1.2 to 1.4 mm to retain the specimen

The dial gauge is to be positioned so that the centre of travel of the gauge corresponds approximately to the overall length to be measured, namely 295mm. The frame clearance is to be sufficient for the specimen to be rotated freely when located in the comparator.

(g) A specific reference bar, consisting of invar or equivalent, not less than 6 mm in diameter and with an overall length of 295 ± 1.5 mm to be used with the comparator. The bar is to be constructed as specified in AS 1012, Part 13.

(h) The bar is to be used for checking the precision of the comparator and the competence of the operator by carrying out the recording of the difference in length between the bar and a typical

specimen 20 times, replacing each in comparator for each reading. The standard deviation of these 20 length differences shall not exceed 0.002 mm.

(i) A lime saturated bath.

(j) A drying room with the temperature regulated to 23 ± 2°C and the relative humidity maintained at 50 ± 5 percent. The flow of air through the room is to be regulated so that the rate of evaporation of water from a 400 mL low-form beaker of internal diameter of 78 ± 5 mm, initially containing approximately 375 mL of water, is 10 ± 4 mL per 24 hours.

## 3. Test Specimens

The test specimens shall consist of prisms 100 mm x 100 mm in section, by approximately 280 mm long. Stainless steel gauge studs are cast into the ends of the specimen so that their principal axis coincide with the principal axis of the test specimen and they extend into the specimen approximately 15 mm.

At least three specimens are to be prepared from each sample of concrete.

## 4. Concrete Samples

Specimens shall be prepared from a sample of concrete obtained in accordance with AS 1012, Part 1 or prepared in accordance with AS 1012, Part 2.

## 5. Moulding Specimens

(a) Assemble the apparatus, after treating the whole of the inside surface of each mould with a thin coating of light mineral oil.

(b) Oil the threading of the gauge stud holder and screw the gauge stud into it, making sure that no mineral oil or other contaminant remains on the surface of the stud which comes into contact with the concrete.

(c) Set the effective gauge length (which is the length between the innermost ends of the gauge studs) to 250 mm as measured by the setting bar.

(d) Take the sample of concrete and after a minimum of remixing to offset segregation, place concrete in the mould without delay in two approximately equal layers by means of a scoop. The first layer is to be thick enough to ensure that the studs are just covered when compaction has been completed. Distribute the concrete symmetrically and avoid segregation within the mould.

(e) The aim is to achieve full compaction of the concrete. As the method of compaction can have an influence on the strength and density of the concrete, the method used shall be subject to the following limitations:

(i) Tamping shall not be used for concrete having a slump less than 40 mm (see Notes 1 and 3).

(ii) External vibration - no limitations (see Note 2)

(iii) Ramming shall not be used for concrete having a compactibility index greater than 90 (see Note 3).

**Notes:**

(a) For concrete having a slump less than 40 mm, compaction by vibration is normally preferred to compaction by tamping.

(b) Extreme care should be taken to avoid segregation when using vibration to compact concrete with slump greater than 100 mm.

(c) Other methods of measuring consistence are not appropriate for setting a limit on the compacting method to be used.

## 6. Hand Compaction

(a) Compact each of the two layers fully by tamping with the tamping bar, the strokes being distributed uniformly over the area of the specimen. Care is to be taken to avoid striking the gauge studs.

(b) The number of strokes per layer required varies according to the type of concrete but in no case is the number of strokes to be less than 50.

(c) Compact the top layer round the gauge stud axis with the fingers, taking care not to loosen the gauge stud.

(d) Tap the sides of the moulds lightly to close any voids. Slightly overfill the mould and after the top layer has been compacted, strike off the surface and level with a wood float.

## 7. Compaction by Vibration

(a) Place all the concrete for each layer in the mould before vibrating the layer.

(b) Attach the mould rigidly to, or hold tightly against the vibrating surface of the external vibrator until the surface becomes relatively smooth in appearance. Vibration should not be prolonged beyond the point at which mortar commences to collect on the surface.

(c) After the top layer has been compacted, strike off level with a wooden float.

## 8. Curing the Specimens

(a) Immediately after moulding, place the mould containing the specimens on a rigid horizontal surface in the initial curing environment at a relative humidity not less than 95 percent and a temperature of $23 \pm 2°C$ and leave undisturbed for $22 \pm 2$ hours. Then transfer to lime saturated water bath (specimens still in mould).

(b) Loosen the gauge stud holder retaining screws to prevent restraint of the gauge stud during the initial shrinkage of the concrete.

## 9. Demoulding and Moist Curing

(a) Demould the specimens with extreme care at an age of $48 \pm 3$ hours, ensuring that the gauge stud is not disturbed while the gauge stud holder is being unscrewed from the stud.

(b) If gauge studs are loose repair by carefully pressing a stiff cement paste mixture around them and return to 95% curing environment for approximately another 3 hours.

(c) Mark each specimen for identification and for subsequent positioning in the comparator using an indelible ink which is not removed by soaking in water.

(d) Return the specimens to lime saturated water at $23 \pm 2^{\circ}C$ immediately or, otherwise, within three hours of demoulding where repair is effected in accordance with (b) above.

**Notes:**

(a) Change the water at regular intervals to avoid excessive build-up of alkalis or other deleterious materials.

(b) It is advisable to carry out the initial moist curing inside the drying room in a covered container and to make all measurements inside the room.

## 10. Air Drying of Specimens

(a) Remove the specimens one at a time from the lime-saturated water at the age of 7 days measured from the time of moulding. Wipe with a damp cloth to remove excess water and measure for length within 5 minutes.

(b) Store the specimens in racks in the drying room so that there is a gap of at least 50 mm on all sides of each specimen and ensure that all spaces in racks are full either with current or dummy specimens.

(c) Make length measurements after a total period of air drying at 1, 2, 3, and if possible 4 and 8 weeks.

## 11. Length Measurement

(a) Set the dial gauge of the length comparator by use of the reference bar at least at the beginning and the end of the readings made within half a day. If variations of more than 0.002 mm are noted, make more frequent checks.

(b) Record the length reading for each specimen as the difference in length between the specimen and the average of the reference bar readings.

(c) Take the reference reading by rotating the reference bar slowly in the comparator holding the bar lightly with the fingers near the lower anvil and recording the minimum reading of the dial.

(d) Always place the reference bar in the comparator with the same end up.

(e) Measure each specimen by locating it centrally in the comparator whilst rotating the specimen slowly, with a finger providing light downwards pressure on the top of the dial gauge to maintain central seating of the gauge studs in the upper and lower anvils, and record the minimum reading. Always place the specimen in the comparator with the same end up and face of the specimen at the front.

## 12. Records

(a) Record the following information:

(b) Concrete sample identification number

(c) Date and time of moulding

(d) Temperature of concrete immediately prior to moulding

(e) Whether compacted by vibration or by hand, and if by hand the number of strokes per layer

(f) Curing history of specimen, any deviations from standard conditions in either initial curing or drying stage

(g) Date and time of demoulding

(h) Specimen identification number

(i) Date and time of initial length comparator readings

(j) Initial length readings of reference bar and specimen

(k) For each subsequent length reading for each specimen: date, length of drying period, readings of length comparator for reference bar and specimen, and calculated drying shrinkage.

## 13. Calculation and Reporting

(a) The drying shrinkage of each specimen after any period is the difference between the initial length when taken immediately before exposure to the drying environment and the length reading at the particular time.

(b) Express the shrinkage as a strain by dividing by the original effective gauge length (taken as 250.0 mm).

(c) Report the strain, supplying the following information:

(i) Identification of the concrete

(ii) Date of moulding

(iii) Drying shrinkage for each specimen, and the average drying shrinkage, at each drying period, namely 1, 2, 3, and if possible 4 and 8 weeks after air drying, expressed to the nearest 10 microstrain

(iv) Any variations from conditions specified in this Test Method

(v) Such other information contained in the sampling records as may be requested

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