

METHOD OF TEST FOR COMPRESSIVE STRENGTH OF MOULDED CYLINDERS

1. SCOPE

1.1 This method covers apparatus and procedures for testing compressive strength of normal concrete using 150 mm diameter and 300 mm long cylinders or 100 mm diameter and 200 mm long cylinders. It is not intended for high performance concrete and high strength concrete.

1.2 The method may be used for compressive strength determination of treated aggregate known as unshrinkable backfill with exceptions as noted.

2. RELEVANT DOCUMENTS

2.1 ASTM C39 Compressive Strength of Cylindrical Concrete Specimens

2.2 ASTM E4 Standard Practices for Force Verification of Testing Machines

2.3 CSA-A23.2-9C Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete

3. PROCEDURE

3.1 Procedure of CSA A23.2-9C shall be followed, except as noted below.

4. EXCEPTIONS

4.1 APPARATUS

4.1.1 Calibration of compression testing machine: The compression testing machine shall be calibrated, at 6-month intervals or more frequently, in accordance with ASTM E4.

4.1.2 The maximum calibrated and certified load of the compression testing machine shall not be less than 1300 kN.

4.1.3 Compression testing machine used for testing of unshrinkable backfill shall have load indicating mechanism capable of showing load changes of 100 newtons or less.

4.1.4 The bearing faces of blocks used for compression testing of concrete must have a Rockwell hardness of not less than 55 HRC.

4.2 MATERIALS

4.2.1 Capping materials: Compressive strength of capping material shall be tested every week, at a minimum. Capping materials shall not be re-used.

4.3 PROCEDURES FOR TESTING CONCRETE CYLINDERS

4.3.1 Receiving, De-moulding, and Examination of Cylinders

Immediately after arrival at the laboratory, each concrete cylinder shall be de-moulded, laboratory identification number marked on it, and date and time of arrival noted. The type of mould used and the cylinder laboratory identification numbers shall be recorded.

Each cylinder shall be examined for its condition on arrival and its mass shall be determined to the nearest 0.05 kg with the results recorded. All cylinders having a condition on arrival of 2, 3 or 4 shall be immediately reported to the Owner.

Cylinders with a condition 2, 3, or 4 as detailed in Table 1, shall not be tested and shall be stored by the testing laboratory until advised otherwise by the Owner.

Table 1

Condition of Cylinder on Arrival	
1	Cylinder is acceptable for testing
2	Cylinder improperly made, testing not possible
3	Cylinder damaged, testing not possible
4	Concrete frozen

4.3.2 Curing of Cylinders

4.3.2.1 Cylinders for Determination of Early Age Compressive Strength

Cylinders for determination of early age compressive strength shall receive no curing and shall be tested immediately after receiving, de-moulding, and examination.

4.3.2.2 All Other Contract Cylinders

All contract cylinders shall be placed in the moisture room or temperature-controlled water tank immediately after their arrival in the laboratory and de-moulding. The cylinders shall be kept there until cylinder end preparation and testing in compression, except for referee cylinders as detailed below.

4.3.3 Procedure for Testing Cylinders

4.3.3.1 General

Each set of two 150 mm or three 100 mm diameter acceptance cylinders shall be accompanied by a duplicate set of two 150 mm or three 100 mm diameter referee cylinders, respectively. Acceptance cylinders shall be tested at 28 days of age. Cylinders for early strength determination shall be tested at the age indicated on Form PH-CC-322. Cylinders for information shall be tested at 28 days unless specified otherwise.

4.3.3.2 Specimen Diameter

The diameter of each cylinder shall be determined with two measurements at right angles to each other at about mid-height of the cylinder and recorded to the nearest 0.1 mm. The two measurements shall then be averaged to the nearest 0.5 mm. The average diameter of each cylinder shall be recorded and used for calculating the cross-sectional area of the cylinder. If the two diameter measurements on a cylinder differ by more than 2% of the smaller reading, the cylinder shall not be tested.

4.3.3.3 Cylinder End Preparation

The cylinder ends may be prepared by grinding or capping with sulphur mortar. The cylinders shall be kept moist after end preparation. If the cylinder ends are prepared more than 3 hours prior to the scheduled

testing time, the cylinders shall be kept in a curing facility after the completion of end preparation until the time of testing.

4.3.3.4 Specimen Tolerances

The planeness and perpendicularity of both prepared ends of every cylinder shall be measured and recorded.

Planeness: The surface of prepared ends of cylinders shall not depart from a plane by more than 0.05 mm.

Perpendicularity: Either prepared end of a cylinder shall not depart from the perpendicularity to the axis by more than 0.5° (approximately equivalent to 2 mm in 200 mm).

4.3.3.5 Prepare Cylinder Ends by Grinding

The grinding operation shall be carried out when the concrete has adequate strength to sustain the operation.

4.3.3.6 Prepare Cylinder Ends by Capping:

Each laboratory shall establish the time-strength development relation curve or table for its capping material up to 72 hours at least once every three months or once per batch of capping material whichever is more frequent.

4.3.3.7 Before placing the capped cylinder in the machine, check caps for any damage or contamination of the surface with sand grains, etc. that might affect the test result. If the cap is damaged, it shall be removed and the cylinder recapped. To avoid contamination of the caps with debris, place capped cylinders only on clean, dust-free surfaces.

4.3.3.8 Testing Compressive Strength

All cylinders shall be tested to complete failure. The type of failure shall be recorded according to ASTM C39 (Section 9.1.6 and Figure 2).

4.3.3.9 Calculation of Compressive Strength for a Set of Two Large Cylinders

Where a set of two 150 mm diameter and 300 mm long cylinders is tested, the compressive strength of the set shall be obtained by calculating the compressive strength of each cylinder and the mean compressive strength of the two cylinders.

4.3.3.10 Calculation of Compressive Strength for a Set of Three Small Cylinders

Where a set of three 100 mm diameter and 200 mm long cylinders is tested, the compressive strength of the set shall be calculated as follows:

4.3.3.10.1 Calculate the compressive strength of each cylinder and the mean compressive strength of the set of cylinders.

4.3.3.10.2 Calculate the difference in compressive strength between individual cylinders and the mean and record the difference in the form of percentage of the mean.

4.3.3.10.3 If none of the three results differs more than 8% (of the mean) from the mean, the mean is considered valid and shall be recorded as the compressive strength of this set.

4.3.3.10.4 If one or more of the three individual results differs more than 8% (of the mean) from the mean, the lowest result should be discarded and compressive strength calculated as the mean of the remaining two cylinders.

4.3.4 Additional Requirements for Referee Cylinders

4.3.4.1 Curing

Cylinders for referee testing shall be removed from the moisture room or water bath at the age of 28 days. From the age of 28 days until they are delivered to the designated referee laboratory or disposed of, referee cylinders shall be protected from loss of moisture and kept at a temperature of 5°C or higher.

4.3.4.2 Procedure on Arrival at the Designated Referee Laboratory

Immediately after arrival of referee cylinders at the designated referee laboratory, each cylinder shall be properly identified by a laboratory number, and date and time of arrival noted.

Each cylinder shall be examined for its condition on arrival, and its mass shall be determined to the nearest 0.05 kg with the results recorded. All cylinders having a condition on arrival of 2, 3, or 4 shall be immediately reported to the Owner and Contract Administrator.

Cylinders with a condition 2, 3, or 4 as detailed in Table 1, shall not be tested and shall be stored by the testing laboratory until advised otherwise by the Owner.

4.3.4.3 Testing

Testing of referee cylinders shall be carried out according to this test method. The testing shall be carried out 24 ± 3 hours after the samples arrive at the designated referee laboratory. At the completion of testing, the referee laboratory shall document the form of breaking by taking photographs.

4.3.4.4 Storage of Broken Pieces of the Referee Cylinders

Broken pieces of the referee cylinders shall be identified and stored for one hundred and twenty days from the time of testing. After sixty days and at two month intervals, the referee laboratory may request, in writing, permission from the Regional Head of Quality Assurance to dispose of the broken pieces of the referee cylinders and upon written confirmation, these remnants shall be properly disposed of by the laboratory.

4.3.5 Testing Compressive Strength

All cylinders shall be tested to complete failure. The type of failure shall be recorded according to ASTM C39 (Section 9.1.6 and Figure 2).

4.4 PROCEDURES FOR TESTING UNSHRINKABLE BACKFILL CYLINDERS

After arrival at the laboratory, each unshrinkable backfill cylinder shall be properly identified by a laboratory number, and date and time of arrival noted. The type of mould used and the laboratory number shall be recorded.

The cylinders shall be left in their moulds in laboratory air until time of testing. The de-moulding shall be carried out on the same day of testing for compressive strength. The cylinder ends shall be prepared by capping with sulphur mortar. The loading rate shall be 0.11 MPa/s or lower.

5. REPORTING OF RESULTS

The report shall include:

- a. Diameter of each cylinder to the nearest 0.5 mm;
- b. Cross-sectional area of each cylinder in square mm;

- c. Mass of each cylinder, to the nearest 0.05 kilograms;
- d. Maximum load in Newton;
- e. Compressive strength of each cylinder;
- f. Mean compressive strength of the set calculated according to this test method, to the nearest 0.1 MPa;
- g. Deviation of result of each cylinder from the mean in percentage of the mean and identification of any discarded test results, where sets of three 100 mm diameter and 200 mm long cylinders are used;
- h. The type of fracture (according to ASTM C39 Section 9.1.6 and Figure 2);
- i. Method of end preparation, i.e. capping or grinding;
- j. If the cylinders are capped, the compressive strength of the capping material to the nearest 0.1 MPa and testing time in hours after casting;
- k. The planeness and perpendicularity measurements of both ends of each cylinder;
- l. For all cylinders, age at the time of testing;
- m. Name and signature of laboratory staff who reviewed the test report;
- n. For referee cylinders, photographs of the type of failure.

Test results obtained on acceptance cylinders from MTO construction contracts shall be reported on Concrete Construction Report Form PH-CC-322.