DANISH TECHNOLOGICAL INSTITUTE

TI-B 101 (94)
Test Method
Expansion Coefficient of Concrete

Danish Technological Institute
Building Technology

Test Method
Expansion Coefficient of Concrete

Descriptors:

Concrete, Thermal Expansion Coefficient

Version: 1
Date: March 1994
No. of pages: 5
Approved by: SOO

Test Method Concrete Thermal Expansion Coefficient

0. Foreword

This TI-B method replaces DTI-method "Test method for Thermal Expansion Coefficient of concrete".

1. Background and Scope

This TI-B method describes a method for the determination of the thermal expansion coefficient of concrete in the temperature range of 5°C to 30°C on sealed test specimens. The test specimens are exposed to change in temperatures in the specified temperature range. For each change in temperature the longitudinal deformation (expansion) is measured.

2. References

NT BUILD 367
Concrete, repair materials: Coefficient of Thermal Expansion

3. Definitions

Thermal expansion: change in length due to thermal variations.

Thermal expansion coefficient:

α = $\Delta\varepsilon/\Delta T$
α = thermal expansion coefficient [$°C^{-1}$]
$\Delta\varepsilon$ = strain [m/m]
ΔT = change in temperature [°C]

4. Test Method

This test method determines the thermal expansion coefficient of concrete. The thermal expansion is measured on concrete specimens at three different temperatures. The measured thermal expansion coefficient is corrected with regard to the temperature sensitivity of the measuring device and with regard to the shrinkage of the concrete.

The change in length, caused by the change in temperature in the range of 5°C to 30°C, is compared to the length l_0 at 20°C at the beginning of the test.

The test specimens are exposed to changes in temperature in the range of 5°C to 30°C. See Figure 1.

The temperatures are obtained by storing the sealed test specimens in a water bath with a constant temperature (1°C).

The length between the measuring points on each test specimen is measured when the test specimen is in thermal balance, i.e. the difference between the temperature in the middle of the test specimen and the temperature of the water is less than 1°C. The seal on each test specimen is shortly removed during the measurement.

The lengths l_0, l_1 and l_2 between the measuring points are measured at 20°C at the beginning, in the middle and at the end of the test procedure.

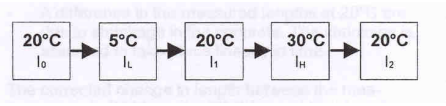

Figure 1: Changes in temperature and length measurements on the test specimens

5. Equipment

A measuring device for measuring the length changes with a strain accuracy of minimum $10 \cdot 10^{-6}$ [mm/mm]. See example in annex.

Thermocouples for measuring the temperature in the middle of at least 1/3 of all test specimens and in the water baths with an accuracy of 1°C.

Three water baths with a water temperature of 5°C, 20°C and 30°C.

6. Test Specimens

A set of test specimens consists of at least three concrete prisms of 100x100x400 mm. The prisms are sealed in a heavy plastic bag and stored in a water bath at 20°C until testing.

7. Procedure

The concrete prisms are cast as described in DS 423.21 for cubes.

The forms are removed and possible surface defects are reported.

After removing the forms each test specimen is given a number and the measuring points are placed according to the test method, see annex.

The test specimens are sealed in a heavy plastic bag and stored in a water bath at 20°C.

A measurement is carried out as follows:

- Report starting hour
- Measure the temperature in the water bath and the test specimens
- Measure the length between the measuring points. This procedure is repeated for all test specimens
- Measure the temperature in the test specimens
- Report ending hour.

During the test the change in temperature and the measurements are carried out according to the following items:

1 The test specimens are removed from the water bath and the plastic bag and isolated until measuring. A measurement is carried out.

2 The test specimens are sealed in the plastic bag and placed in the water bath at 5°C.

3 When a test specimen is in thermal balance at 5°C.(1°C) it is removed from the water bath and the plastic bag and isolated until measuring. A measurement is carried out.

4[1)] The test specimens are sealed in the plastic bag and placed in the water bath at 20°C.

5[1)] When a test specimen is in thermal balance at 20°C.(1°C), it is removed from the water bath and the plastic bag and isolated until

6 The test specimens are sealed in the plastic bag and placed in the water bath at 30°C.

7 When a test specimen is in thermal balance at 30°C.(1°C), it is removed from the water bath and the plastic bag and isolated until measuring. A measurement is carried out.

8 The test specimens are sealed in the plastic bag and placed in the water bath at 20°C.

9 When a test specimen is in thermal balance at 20°C.(1°C), it is removed from the water bath and the plastic bag and isolated until measuring. A measurement is carried out.

After this procedure the test specimens are sealed in the plastic bag and stored at 20°C, if the measurement has to be repeated at another term.

8. Test Result

The measured lengths are corrected with regard to the temperature sensitivity of the measuring device and with regard to the shrinkage of the concrete. The corrections are made on the following conditions:

- A difference in the measured lengths at 20°C are due to shrinkage in the concrete. The shrinkage is assumed to take place linearly in time.

The corrected change in length between the measurements l_H (30°C) and l_L (5°C) is used to calculate the thermal expansion coefficient. The thermal expansion coefficient is calculated according to the following formula:

$$\alpha = \frac{\Delta l}{l_0 \bullet \Delta T}$$

α = thermal expansion coefficient [1/°C]
Δl = corrected change in length [m]

[1)] Items 4 and 5 may be omitted in case of late terms

l_0 = actual measured length at 20°C at the beginning of the test [m]
ΔT = temperature difference at the measured lengths [°C].

The test results are reported as average and standard deviation.

9. Calibration

The measuring device must be in calibration at the time of testing and must be calibrated according to the instructions for this type of device.

10. Data Accuracy

Repeatability: if normal care and accuracy are shown, it can be expected that the test can be repeated with a 95 % confidence range for an average value of approximately $0.03 \cdot 10^{-5}$.

Reproducibility: if normal care and accuracy are
shown, it can be expected that the test can be repeated with a 95 % confidence range for an average value of approximately $0.05 \cdot 10^{-5}$.

11. Test Report

A test report shall include at least the following information:

a) Name and address of testing laboratory.
b) Date and identification of the report.
c) Name and address of the client.
d) Test method (No. and title).
e) Deviations from the test method, if any.
f) Identification of the concrete:
Date of receipt of test specimens/selections.
Description of test specimens/selections.
Marking of test specimens e.g. mix design, casting specification etc.
g) Date of test period.
h) Records of surface defects.
i) Measuring equipment.
j) Test result.
k) Further information of significance for the evaluation of the result.
l) Evaluation of the result, if included in the assignment.
m) Signature.

Example of a measuring device: DEMEC measuring device type MAYERS, model MD with a measuring length of 200 mm and an accuracy of 0.002 mm.

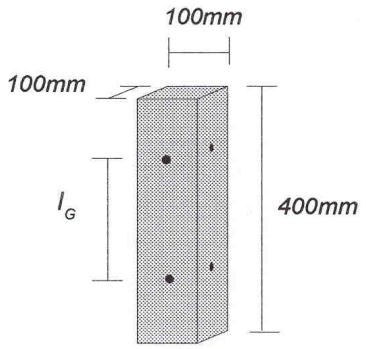

Figure 2 DEMEC: measuring points and dimensions of the test specimens.

12. Annex

Example of a measuring device: SYLVAC measuring device model 100 with a measuring length of 400 mm and an accuracy of 0.001 mm.

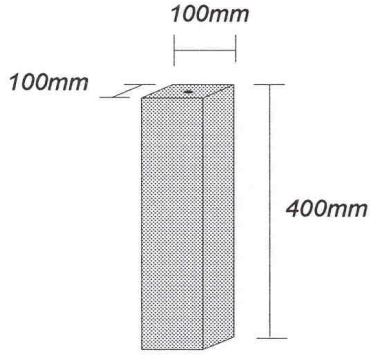

Figure 3 SYLVAC: measuring points and dimensions of the test specimens.