Concrete Property Test

Shrinkage 5-1: Coefficient of Thermal Expansion

National Concrete Pavement Technology Center
www.cptechcenter.org

Purpose – Why Do This Test?

The expansion and contraction of concrete due to temperature changes can impact the durability of joints and the risk of cracking in concrete pavements.

Principle – What is the Theory?

Concrete expands and contracts as its temperature changes. When a saturated cylinder of concrete is exposed to changing temperature conditions, its change in length can be measured by a linear variable differential transformer (LVDT).

Test Procedure – How is the Test Run?

A saturated concrete cylinder or core is subjected to temperature changes from 10°C to 50°C (50°F to 120°F). The change in length of the cylinder is measured and recorded at different temperatures (AASHTO TP 60).

Test Apparatus (figure 1)

- Caliper to measure the initial length of the core specimen.
- Water tank: Maintains saturation of the sample and varies the temperature of the water from 10°C to 50°C (50°F to 120°F).
- Support frame: Holds the core specimen and the LVDT.
- Thermometer: Measures the water temperature.
- LVDT: Measures the length change of the specimen (resolution = 0.00025 mm [0.00001 in.]).

Test Method – Refer to AASHTO TP 60 for Comprehensive Guidance

1. Soak a 4-in. diameter core in water for a minimum of 48 hours.
2. Measure the length of the saturated core using calipers.
3. Place the core in the support frame that is submerged in the water tank.
4. Adjust the temperature of the water tank to 10°C (50°F).
5. Maintain the temperature until three consecutive LVDT readings taken every 10 minutes change by less than 0.00025 mm (0.00001 in.). Record the initial LVDT and temperature values.
6. Set the temperature of the water tank to 50°C (120°F).
7. Maintain the temperature until three consecutive LVDT readings taken every 10 minutes change by less than 0.00025 mm (0.00001 in.). Record the second LVDT and temperature values.
8. Adjust the temperature of the water tank to 10°C (50°F).
9. Maintain the temperature until three consecutive LVDT readings taken every 10 minutes change by less than 0.00025 mm (0.00001 in.). Record the final LVDT and temperature values.

Output – How Do I Interpret the Results?

The coefficient of thermal expansion (CTE) is a function of length change due to a change in temperature.

CTE = (measured length change / specimen length) / measured temperature change

The CTE reported is the average of two test values.

The CTE is reported in microstrain/°F. Typical values for concrete can range from $4(10^{-6})$°F to $7(10^{-6})$°F. CTE is most affected by aggregate type. Concrete produced with siliceous aggregates has a higher CTE than concrete produced with limestone aggregates.

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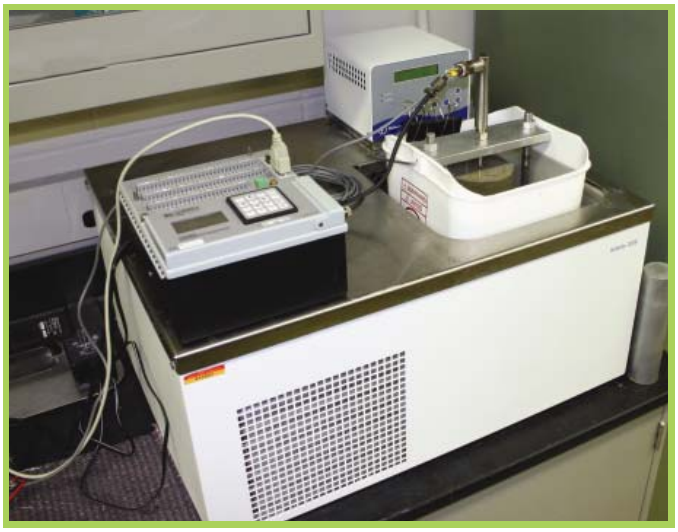

Figure 1. CTE testing equipment

FOR MORE INFORMATION
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Construction Issues – What Should I Look For?

Thermal expansion/contraction is a factor that should be considered in the design phase. During construction, the following items should be monitored for conformity with the plans to avoid the possible adverse effects of thermal expansion and contraction:

- Joint layout and spacing.
- Joint width.

APRIL 2008

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This test summary is one of a set of summaries originally published in chapter 7 of the *Testing Guide for Implementing Concrete Paving Quality Control Procedures* (Fick, G., Iowa State University, Ames, Iowa, 2008). The testing guide is a product of a 17-state, Federal Highway Administration pooled-fund project, Material and Construction Optimization for Prevention of Premature Pavement Distress in PCC Pavements, TPF-5(066). The project was managed by the National Concrete Pavement Technology Center at Iowa State University.