Concrete CTE

AASHTO Subcommittee on Materials Conference

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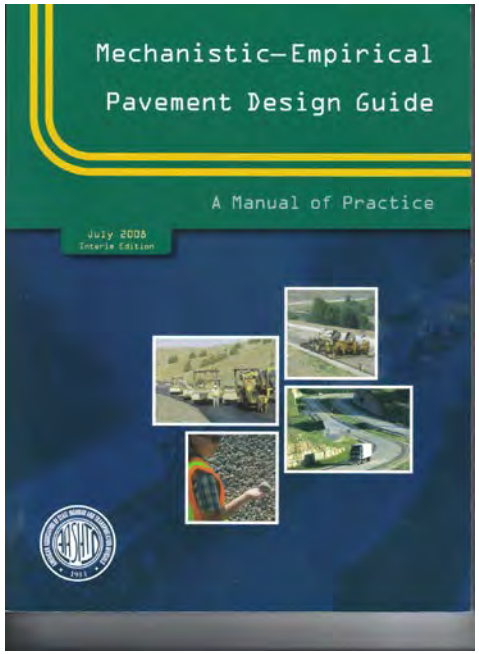
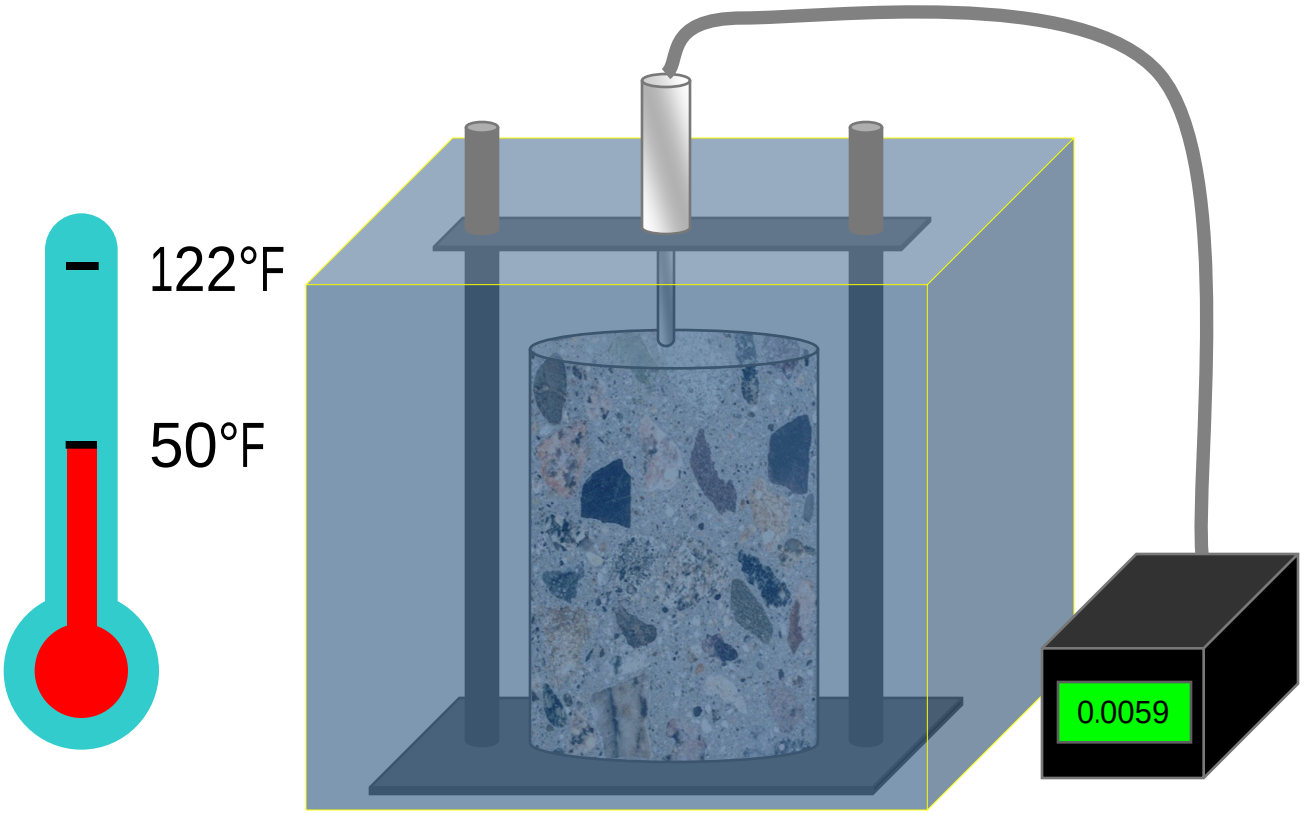
CTE Impact on Pavement Performance

- Early-age cracking (high CTE vs high slab restraint)
- Transverse/longitudinal cracking due to curling stresses
- Faulting (built-in curl, joint opening, curl)
- Joint spalling (excessive jt movement with high CTE)
- Crack spacing/width for CRCP (LTE and punchout)
- Edge punchouts (due to curl)



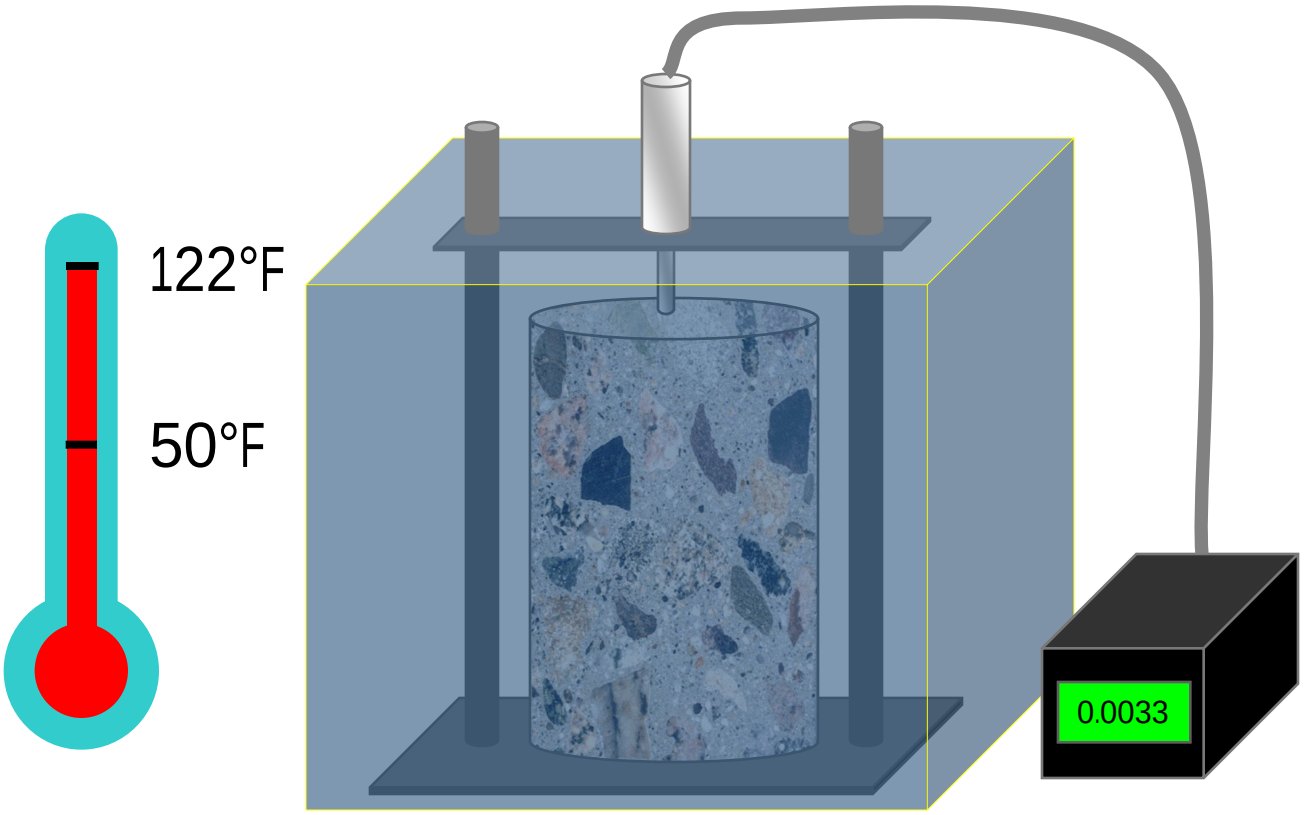
CTE=length change/unit length/degree



CTE=length change/unit length/degree

= 0.0026 in / 7.0 in / 72 F

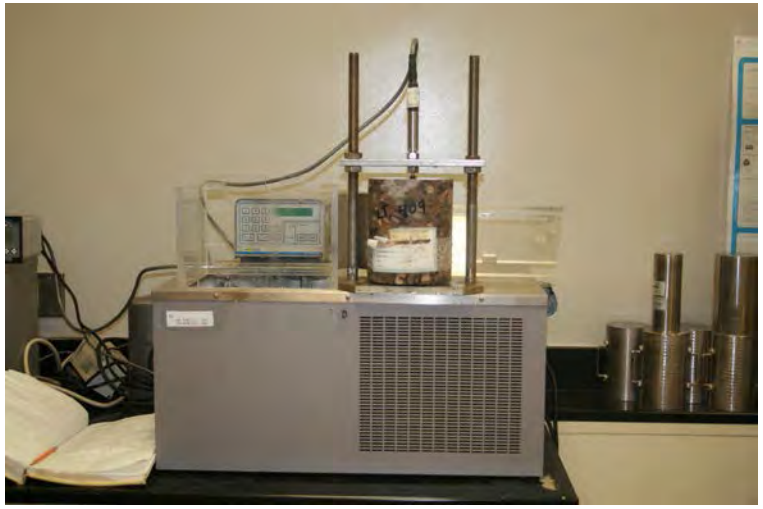
= 5.1 microstrain/F



Custom Built CTE Device

AASHTO TP 60-00

- Typical frames made from invar or stainless steel
- Typical calibration bar made from 304 stainless steel per TP 60 recommendations
- CTE of 304 SS stated as 17.3 x10^{-6}/^{o}C in TP 60



Independent Lab Result for 304 SS

Specimen ID	Avg.CTE(ppm/°C) (50° to 10°C)
Alumina bisque	5.4+/-0.1
304 Stainless Steel - Gilson reference bar	16.2+/-0.1
Titanium	8.9+/-0.1
304 Stainless Standard - Pine reference bar	15.9+/-0.1
410 Stainless Steel	10.4+/-0.1
304 Stainless Steel – TFHRC manual unit	15.8+/-0.1

Impact of Revised CTE Values

- LTPP Database
- AASHTO TP 60 Test Method
- MEPDG Models in version 1.0
- Testing Results from Other Labs

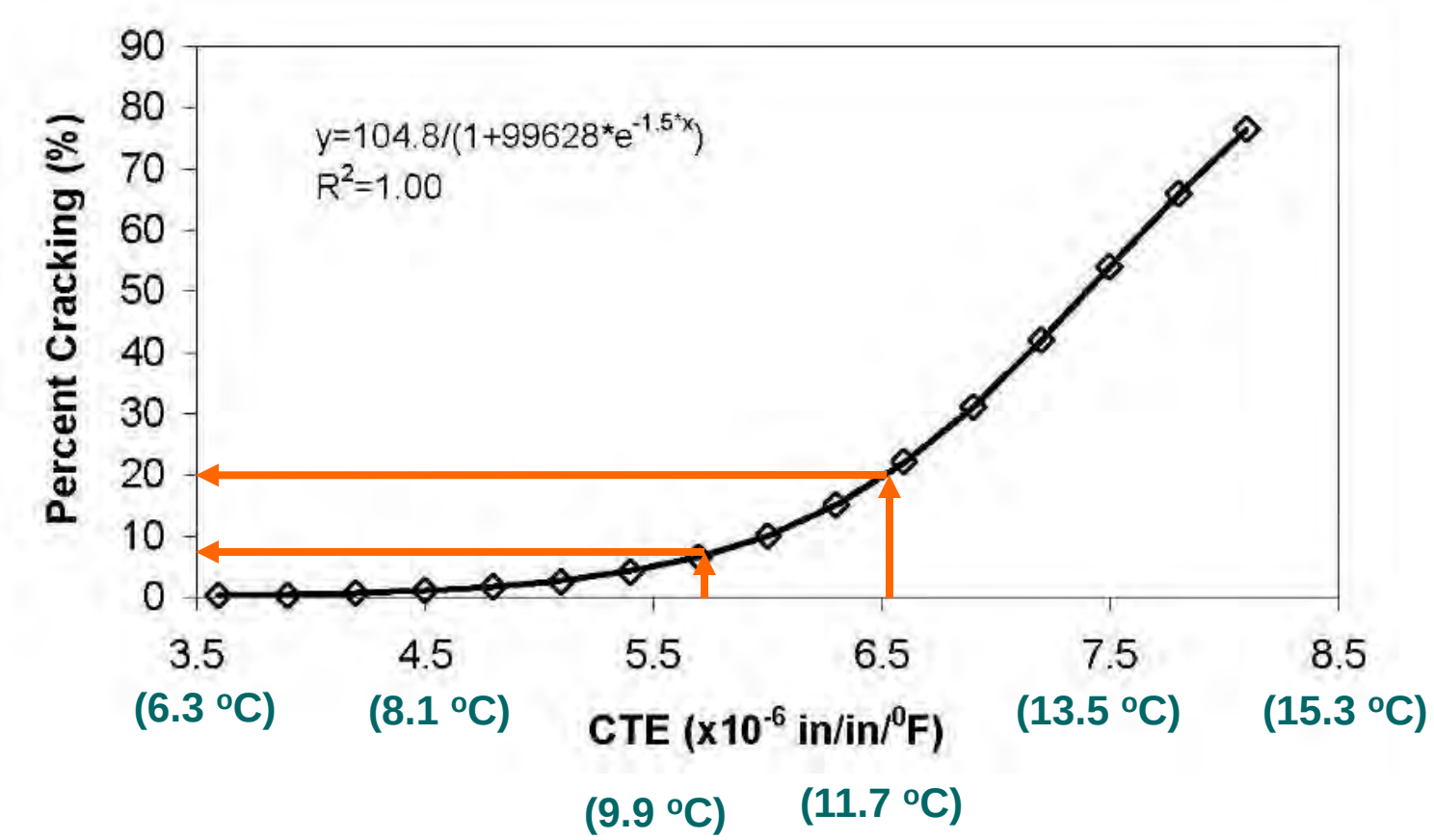
Standard Method of Test for Coefficient of Thermal Expansion of Hydraulic Cement Concrete AASHTO Designation: T 336-09

Section X2.1

The test procedure described in Section 7.2 is used to determine a correction factor to account for expansion of the measuring apparatus during the test. A calibration specimen with a known coefficient of thermal expansion should be used . The specimen should be composed of a material that is essentially linearly elastic , noncorroding, non-oxidizing, **non porous** and nonmagnetic, and it should have a known thermal coefficient as close as possible to that of concrete **e.g. a range of 9 to 18 x10^{-6}/^{o}C within the temperature range of 10 to 50 ^{o}C** (304 stainless steel is a suitable material) **An ISO 9001 or equivalent laboratory should determine the CTE of the calibration specimen according to ASTM E 228 or ASTM 289 within the temperature range of 10 to 50 ^{o}C and provide a certificate of the CTE value including the lot number of the sample tested.**

NOTE: When using version 1.0 of the MEPDG software, AASHTO TP 60-00 (2007) should be used.

Effect of CTE on the predicted percent of slabs cracked



Effect of CTE variability of Concrete Pavement Performance as predicted using the Mechanistic - Empirical Pavement Design Guide, Jussara Tanesi, M. Emin Kutay, Ala Abbas, and Richard Meininger, Transportation Research Board 2007.

Ongoing/Planned Activities

- Update LTPP Database (Aug 2009)
- Update AASHTO 336 (May 2009)
- Briefings
  - Joint Technical Committee on Pavements (May 2009)
  - DARWin-ME Task Force (June 2009)
- Recalibrate MEPDG Models (winter 2009)
  - JTCP drafting research problem statement for 20-7 funding (Aug 2009)
- FHWA Activities
  - Memo to field (Aug 2009)
  - Draft white paper (Aug 2009)
  - CTE inter-lab study- 17 labs (Aug 2009)
  - CTE ruggedness study (summer 2010)
  - Presentations at several TRB concrete/design committees (Jan 2010)

Recommendations

- MEPDG version 1.0 use TP 60 CTE values
- MEPDG version 1.x or version 2.0 use T 336 CTE values
- Local Calibration
  - Completed – verify after national recalibration of models (version 1.x or 2.0)
  - in process- delay determination of calibration coefficients until national recalibration of models (version 1.x or 2.0)
- *Correction factor to adjust CTE values is difference between assumed and actual CTE of calibration specimen*

Summary

- Current CTE research still valid
- MEPDG ver 1.0 or ver 1.x - use CTE based on TP 60 (17.3 x10^{-6}/C for 304 SS)
- MEPDG ver 2.0 - use CTE based on new AASHTO Test Method (T 336) and 2009 recalibrated models

Additional Information

- For additional CTE information contact:

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