RUSS COLLEGE of Engineering and Technology

Warm Mix Asphalt Perpetual Pavement

WMA Technical Working Group Meeting
Baltimore, Maryland
December 12-13, 2007

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Dept. of Civil Engineering Ohio University
Ohio Research Institute for Transportation and the Environment (ORITE)

In cooperation with
Profs. J. Ludwig Figueroa and Sang-Soo Kim

OHIO UNIVERSITY


Ohio SR 541
Warm Mix Asphalt
Field Trial Open House
Flexible Pavements OF OHIO
APA ASPHALT PAVEMENT ALLIANCE
FHWA

Warm Mix Asphalt
Technical Working Group (TWG)

ORITE Warm Mix Asphalt Research Project

- Detailed **field**, **controlled environment**, and **laboratory evaluation** of
  - Aspha-min, Evotherm, and Sasobit and Conventional
- Field study in Guernsey County, OH on State Route 541
- Controlled load and environment test at ORITE's Accelerated Pavement Load Facility (APLF) in Lancaster, OH
- Laboratory studies of cores, field-procured beams and prepared specimens
- Project sponsored by the Ohio Department of Transportation (ODOT) and the the US Federal Highway Administration (FHWA)

ORITE Warm Mix Asphalt Research Project

GUE-541 WMA Field Study

- Four test sections on asphalt overlay Kimbolton and Plainfield, West of I-77, just north of I-70
  - Site selected by ODOT
  - Overlay constructed first half of September 2006
  - Contractor: Shelley and Sands, Inc.
- Overlay layers
  - Top: 1.25 in (3.18 cm) of selected mix
    - Aspha-min, Sasobit, Evotherm, & conventional (HMA)
  - Bottom: 0.75 in (1.90 cm) HMA
- Section lengths: 2.70 miles (4.34 km) to 3.07 miles (4.94 km)

GUE-541 Forensic Assessment of Existing Pavement Structure

Preliminary Investigation

- **Falling Weight Deflectometer (FWD)**
  - **Back calculate pavement layer stiffness**
- **Surface Profile**
- **Dynamic Cone Penetrometer (DCP)**
- **Forensic analysis used to identify weak spots needing remediation prior to overlay**

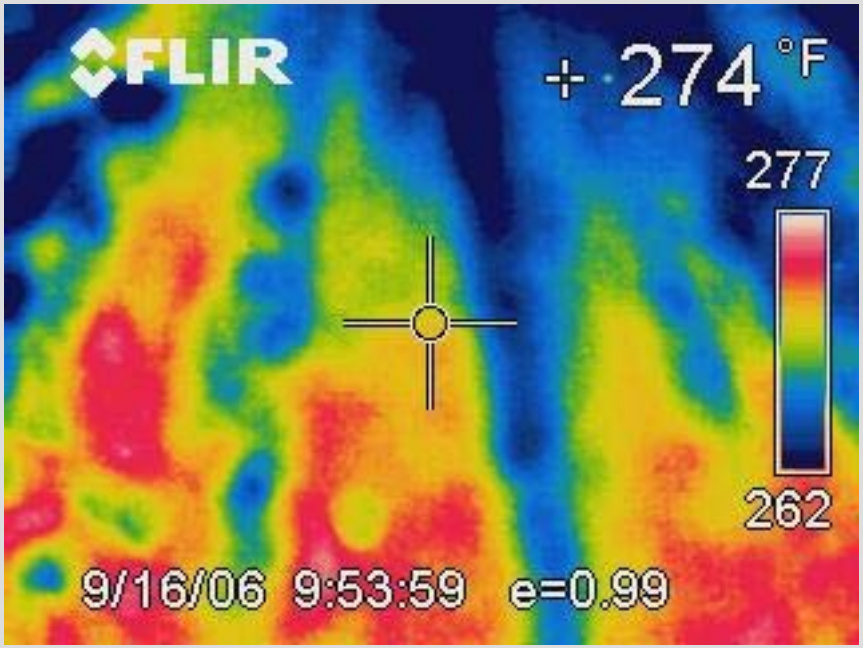
Energy, Emissions, and Cost Assessment

Investigations During Construction:

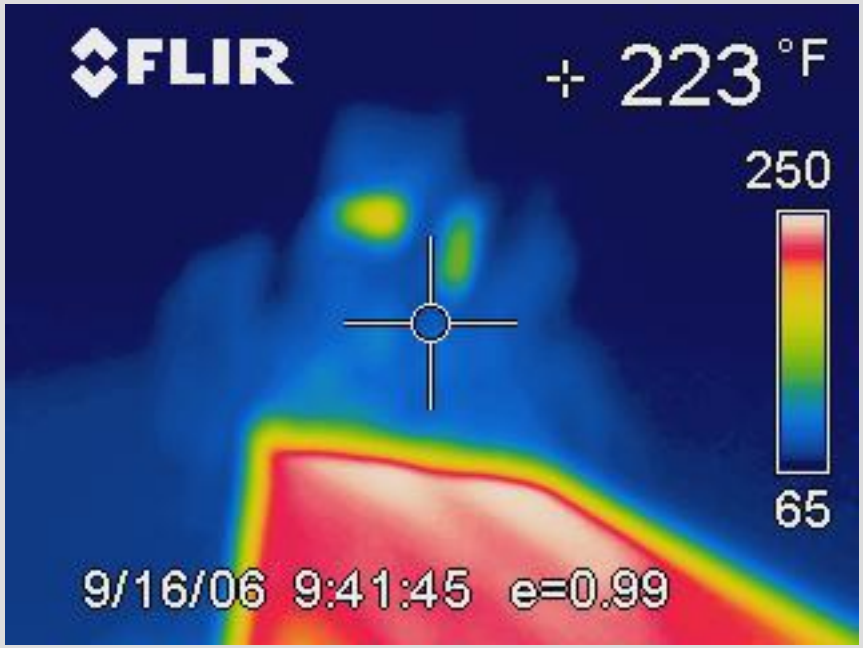
- **Stack and Emissions tests**
- **Infrared camera to measure temperature during laydown**
- **Exposure/emissions sampling**
  - **Environmental sensors placed on paver and along side of road**
- **Construction costs for each section were also noted**

Infrared Camera

Images from GUE 541



Sasobit WMA



Sasobit WMA

Temperatures in Fahrenheit (216°F=102°C, 301°F=149°C)

Emissions sampling on paver

Roadside emissions sampling

GUE-541 Construction Monitoring

Subsequent Investigations:

- **FWD after overlay prior to traffic and at future intervals**
- **Periodic visual surveys of pavement surface condition**
- **Profilometer measurements**
- **Forensic analysis following SHRP protocol of distresses during three-year research period**

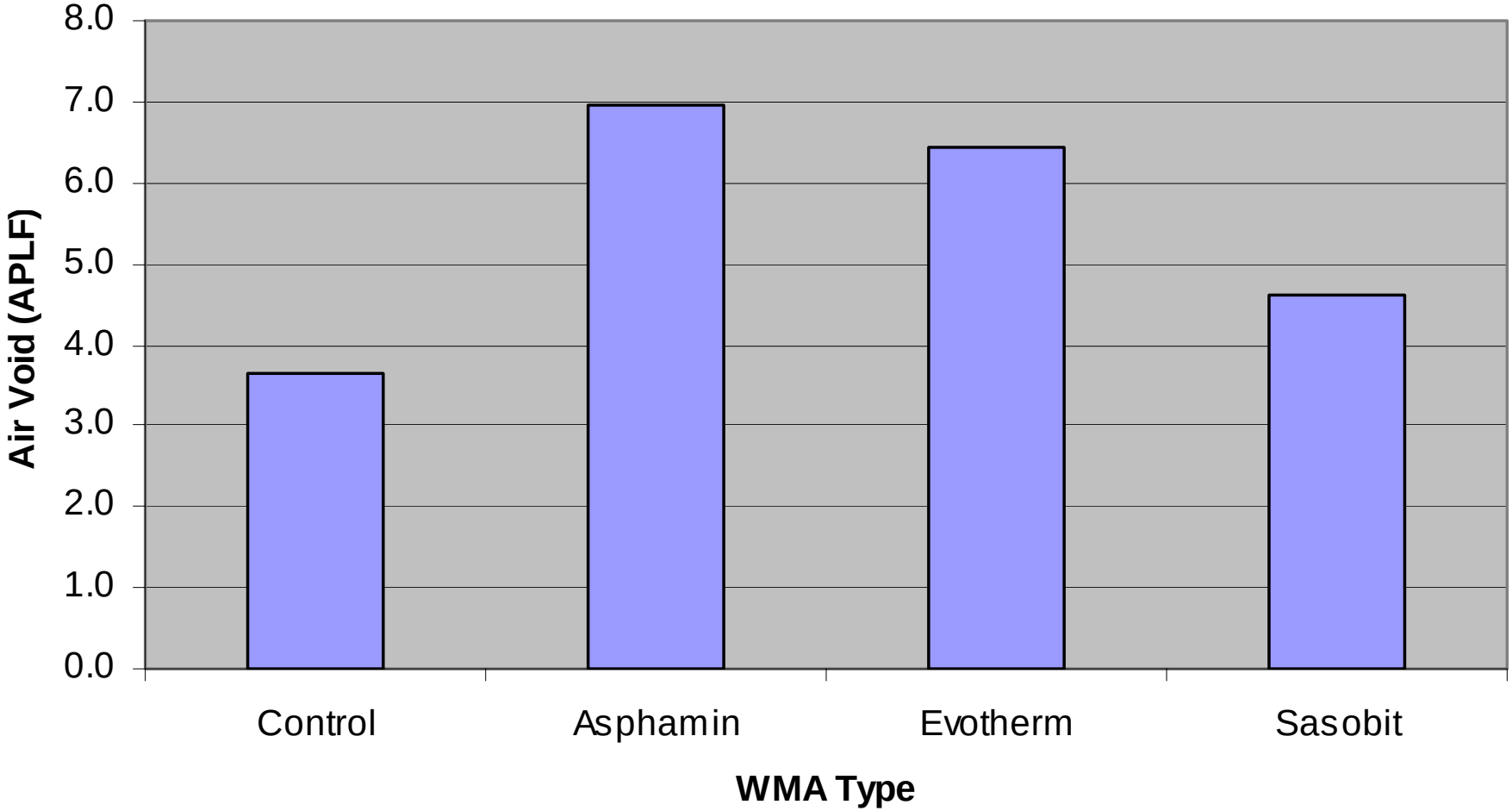
Laboratory Tests

- **Based on samples of mixes and additives taken at the APLF and at GUE-541**
- **Samples taken at the time of construction**
- **Additional core samples taken or to be taken after construction**
  - **Three months, one year, two years**
- **Testing by both ORITE and NCAT**

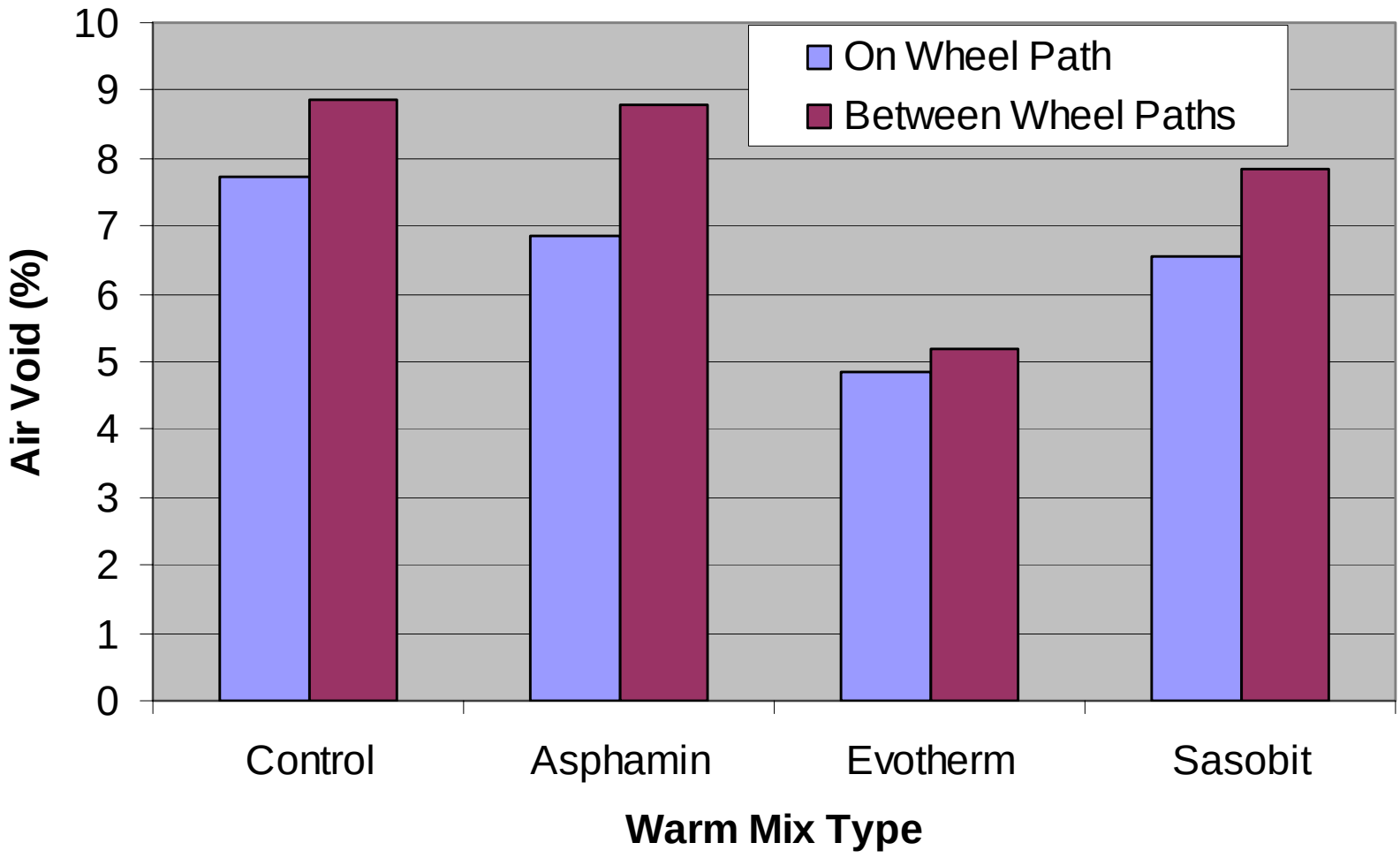
ORITE Laboratory Tests

- Density Tests during construction, and after 3, 12, 24 months
- Bond strength between layers
- Assessment of reduced aging during construction.
- Indirect tensile strength at 3, 12, 24 months
- Assessment of in-place densification under traffic, related to air voids at time of construction.
- Aging of binder as a function of time.
- Beam fatigue tests (AASHTO T321).
- Fracture energy – an alternative method of assessing resistance to cracking.
- Other methods of assessing cracking potential may also be used, such as the TTI overlay tester.
- Low-temperature cracking (IDT test (AASHTO T322))

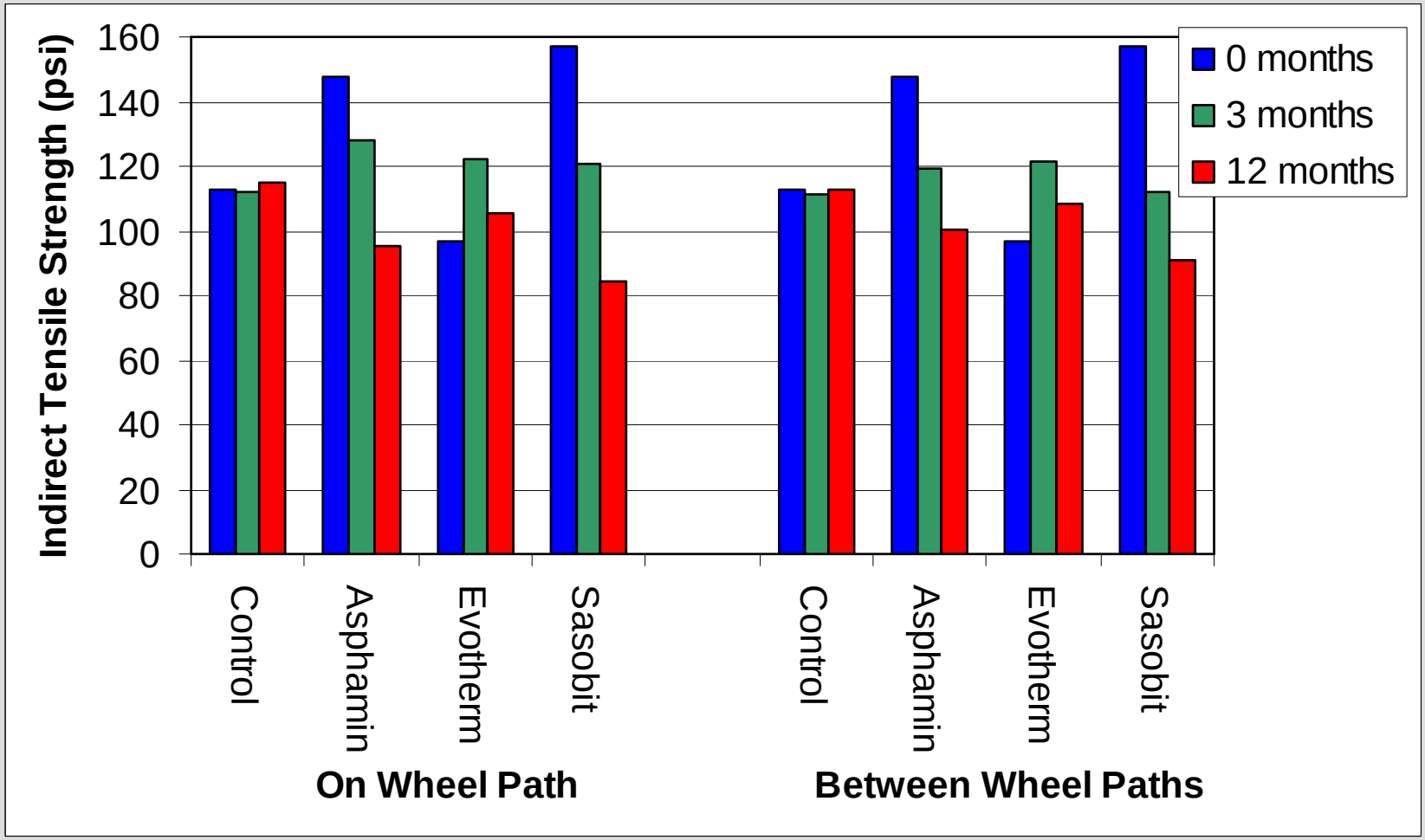
Air Voids of APLF Pavements



Air Void of Cores (3 Months after Construction)



Indirect Tensile Strength (0, 3, 12 month cores)



NCAT Laboratory Tests

- Moisture content in truck at time of application,
- Gyratory compaction,
- Volumetric properties,
- Hamburg Tests for moisture susceptibility and rutting,
- Rutting potential,
- Maximum specific gravity,
- Tensile strength ratio test,
- Anticipated in-place field density
- Thermal stress restricted specimen test may be conducted as an option

Accelerated Pavement Load Facility (APLF)

- **Full-scale two-lane pavement, with base, and subgrade**
- **Asphaltic Materials and PCC.**
- **Full environmental control to regulate humidity and temp from 10°F (-12°C) to 130°F (54°C).**
- **Multiple test paths across the 32-ft (9.75 m) wide pavement.**

- **A rolling tire load of 9000 lb (40 kN) to 30,000 lb (133 kN) to simulate a slowly moving truck (≤5 mph (≤8 km/h)) with single or dual tires or wide single tires**

Controlled Load and Environment Testing at the Accelerated Pavement Load Facility (APLF)

- Built Identical WMA and HMA surface layers
  - Same mix used (Aspha-min, Evotherm, Sasobit, & HMA)
  - Built on perpetual pavement sections at two thicknesses
- Testing under load at three temperatures:
- FWD
- Collect Pavement Response data
- Infrared camera (during construction)

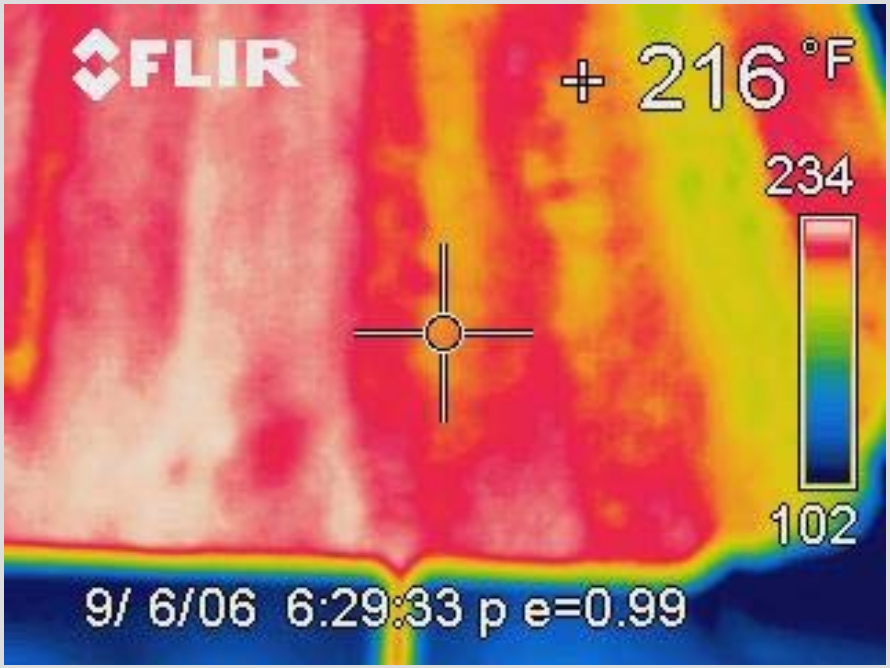
Installation at the APLF

← Paving in the APLF

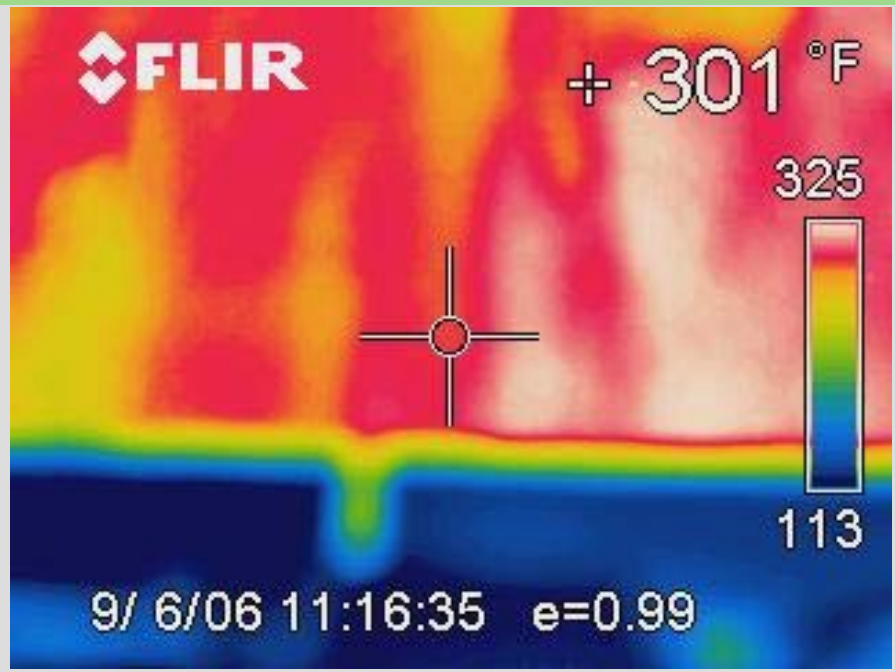
Sensor placement →

Infrared Camera

Images from APLF



Evotherm

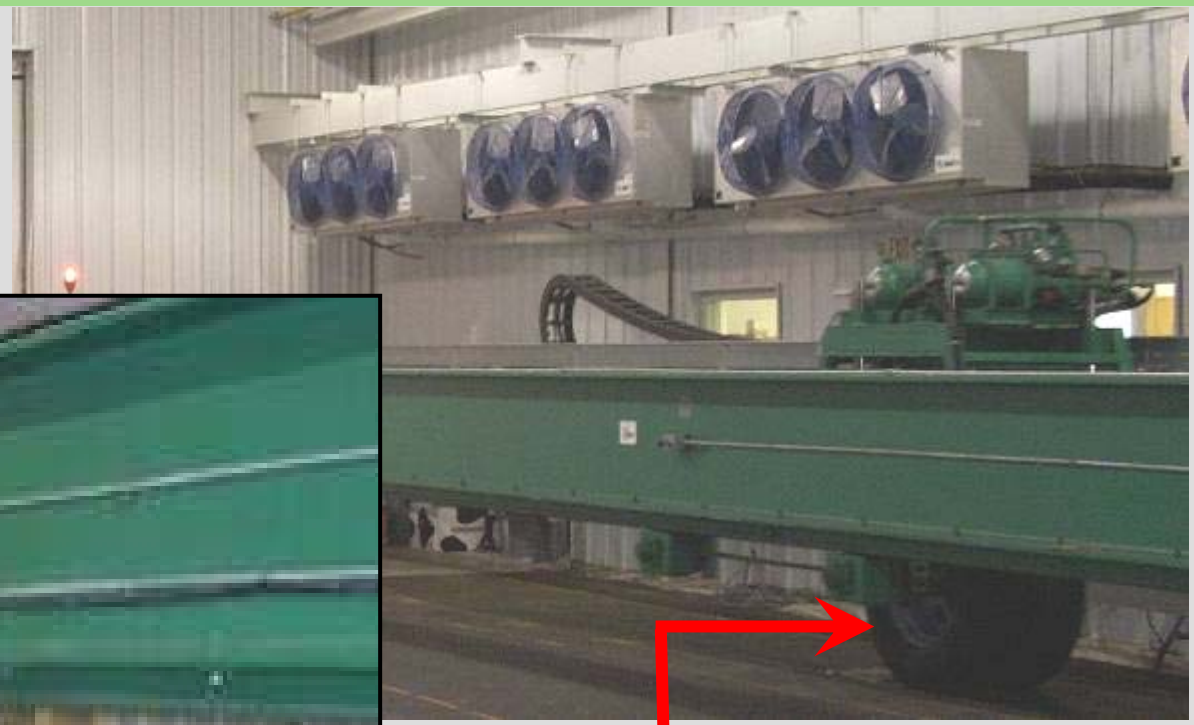


Conventional HMA

Note with software program cursor can be moved and temperature read off upper right corner.

Temperatures in Fahrenheit (216°F=102°C, 301°F=149°C)

APLF Equipment



Load Wheel behind beam

← Profilometer placed under load wheel beam

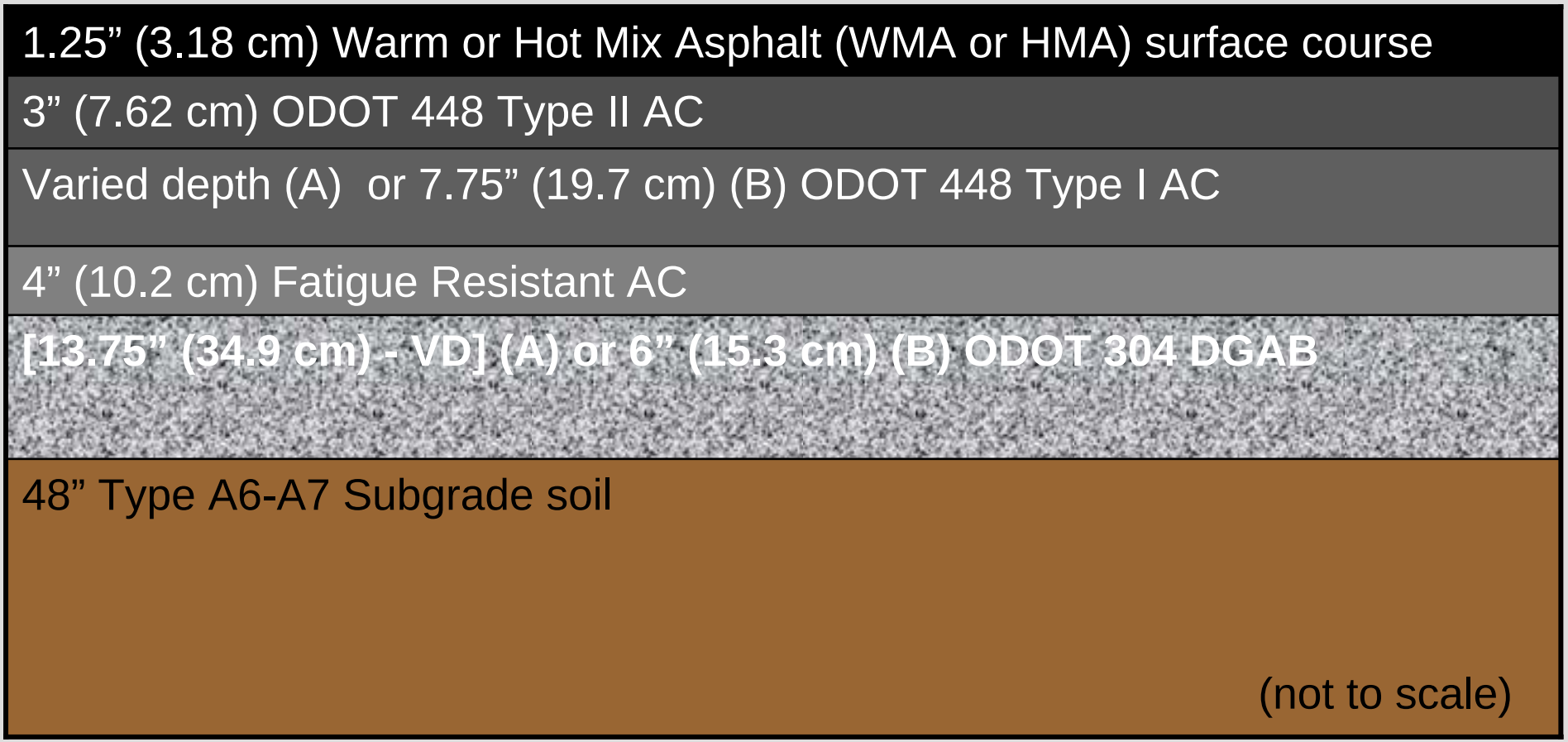
APLF Monitoring

- Environmental parameters
  - pavement layer temperature
  - Base temperature and moisture
  - Subgrade temperature, moisture, and groundwater table
- Load parameters
  - Displacement
  - Strain
  - Pressure
- Also seasonal response in terms of displacement and pressure

APLF Test Method

- Tests conducted in this order:
  - Low temperature (40°F (4.4°C))
  - Medium temperature (70°F (21.1°C))
  - High temperature (105°F (40.6°C))
- At each temperature and for each pavement:
  - Collect data from instruments at beginning with tire loads of 6 kip (27 kN), 9 kip (40 kN), and 12 kip (53 kN)
  - 10,000 passes at tire load of 9 kip (40 kN) at 5 mph (8 km/h)
  - Collect data at end with same loads as at beginning

Layers of WMA pavements constructed in APLF profile view



Surface courses and VD (“varied depth”) of Type I AC displayed on next slide

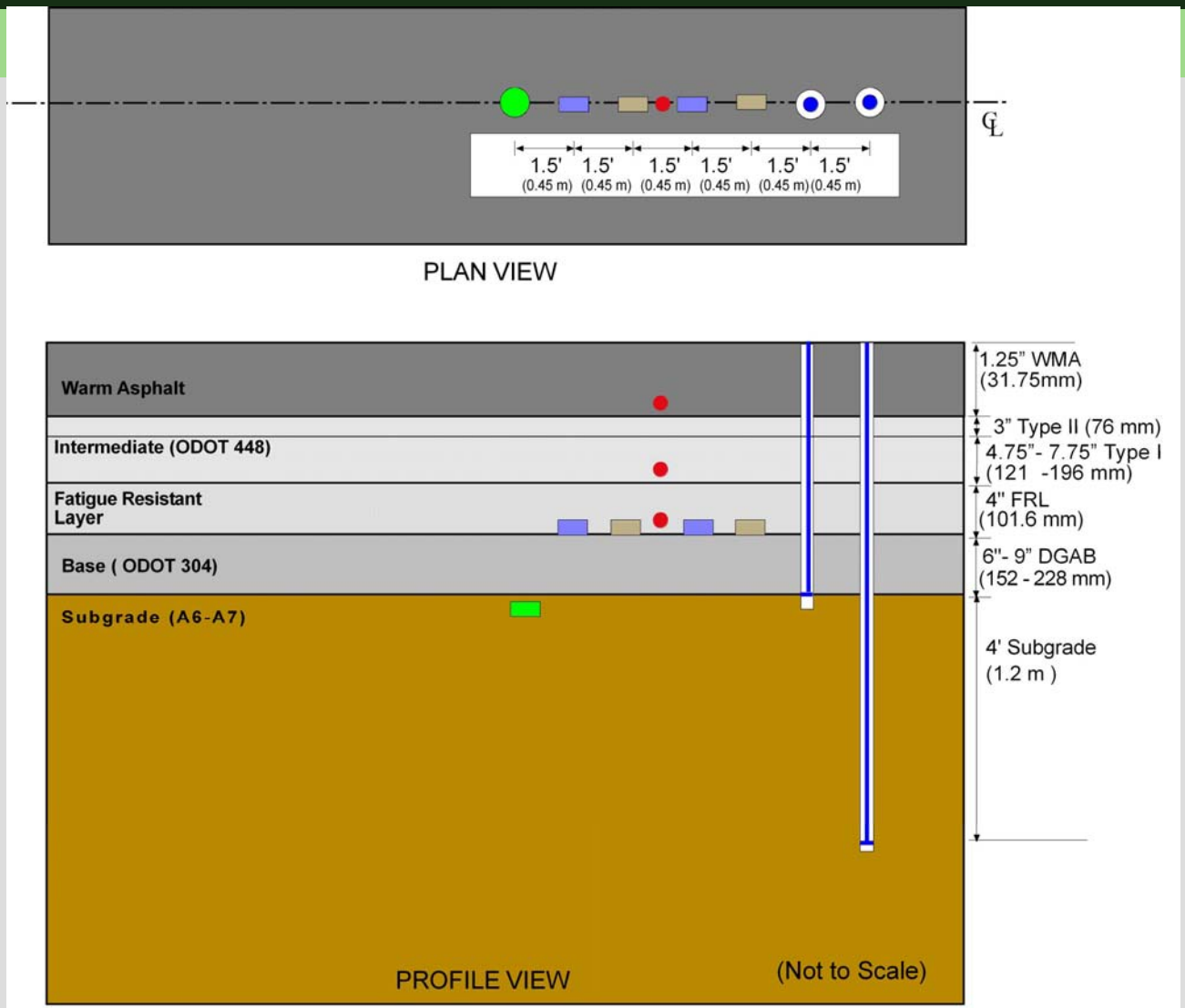
Layout of WMA pavements constructed in APLF plan view

A Load wheel direction → **B**

Evotherm WMA VD=4.75” (12.1 cm)	Evotherm WMA Standard depth	8 ft (2.44 m)
Sasobit WMA VD=5.75” (14.6 cm)	Sasobit WMA Standard depth	8 ft (2.44 m)
Aspha-min WMA VD=6.75” (17.1 cm)	Aspha-min WMA Standard depth	8 ft (2.44 m)
Conventional HMA VD=7.75” (19.7 cm)	Conventional HMA Standard depth	8 ft (2.44 m)
← 22.5 ft (6.9 m) →	← 22.5 ft (6.9 m) →	

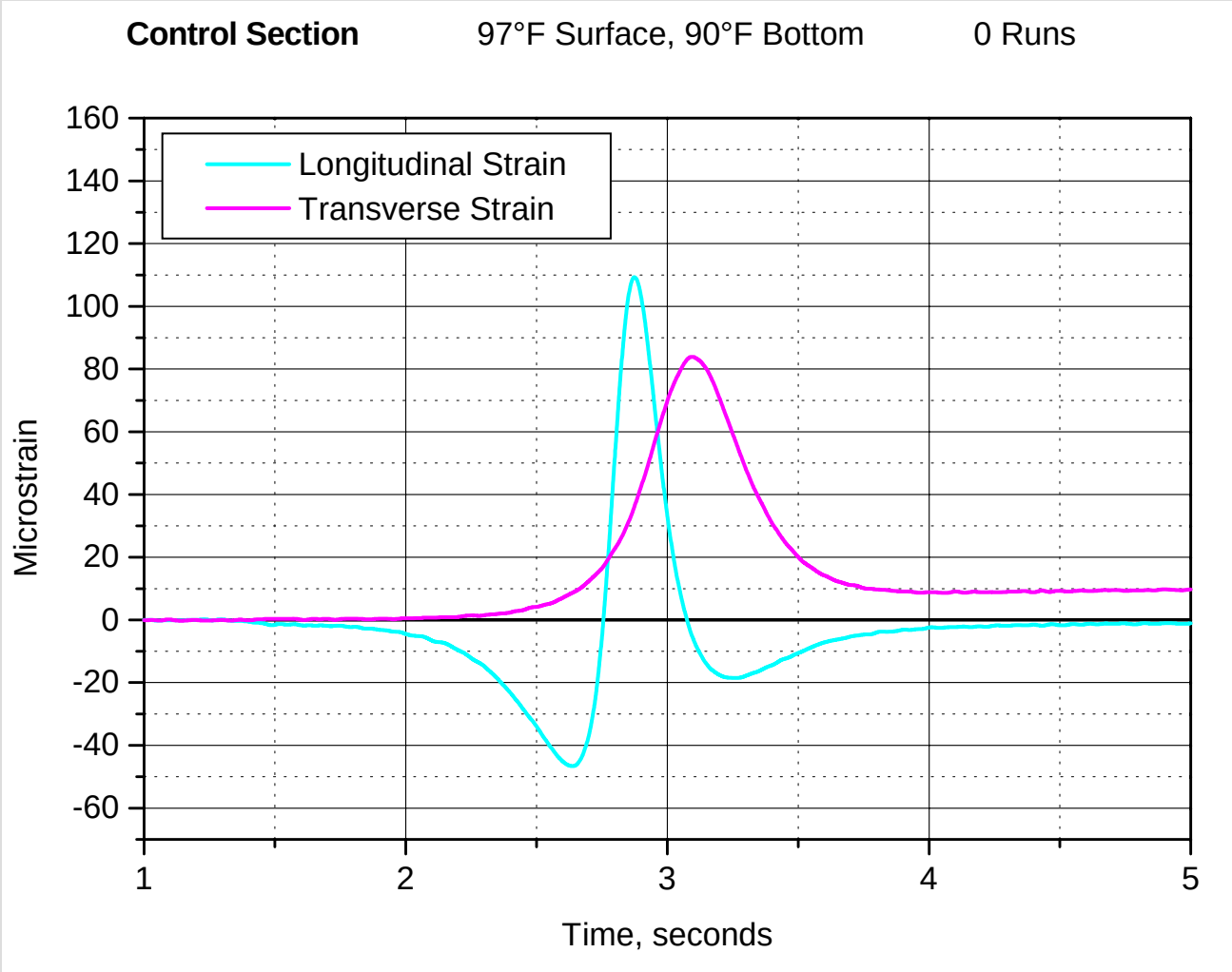
Notes: WMA or HMA surface layer is 1.25” (3.18 cm);
VD=varied depth of ODOT 448 Type I AC; Standard Depth is 7.75” (19.7 cm);
DGAB layer is 13.75” (34.9 cm)-VD (Standard DGAB layer is 6” (15.3 cm));

Instrumentation in APLF



Control (HMA) Section Results from APLF

0 Runs at high temperature



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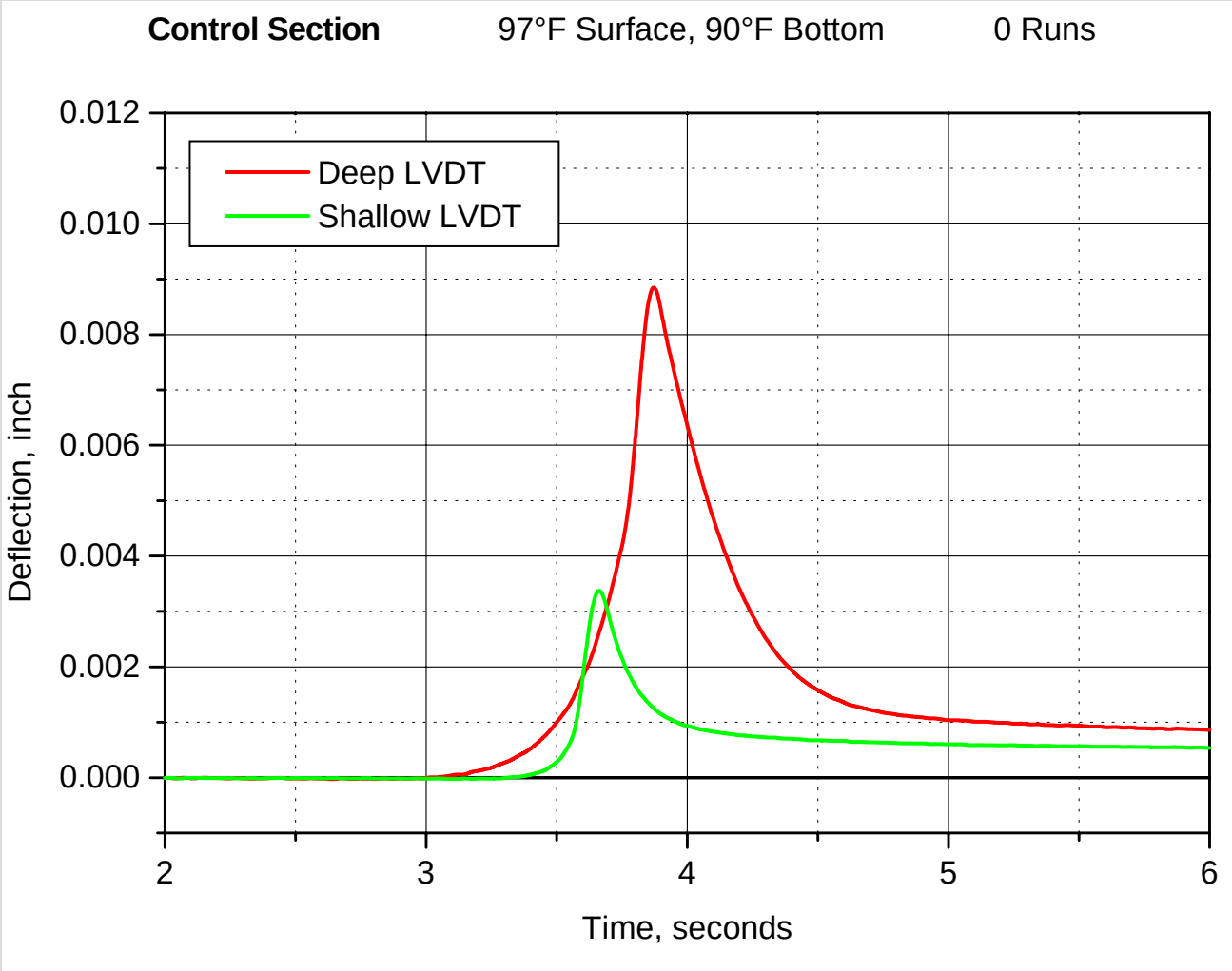

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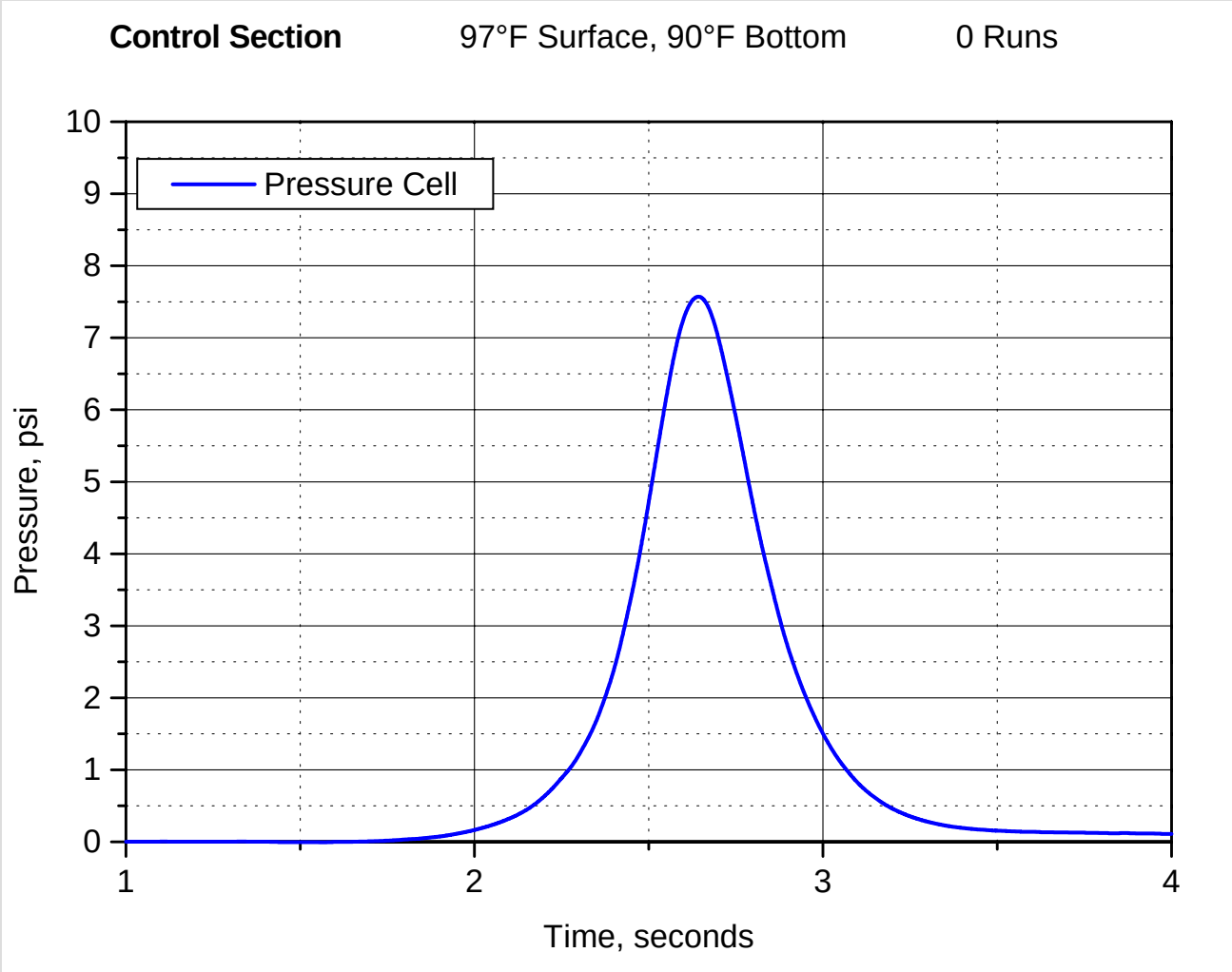
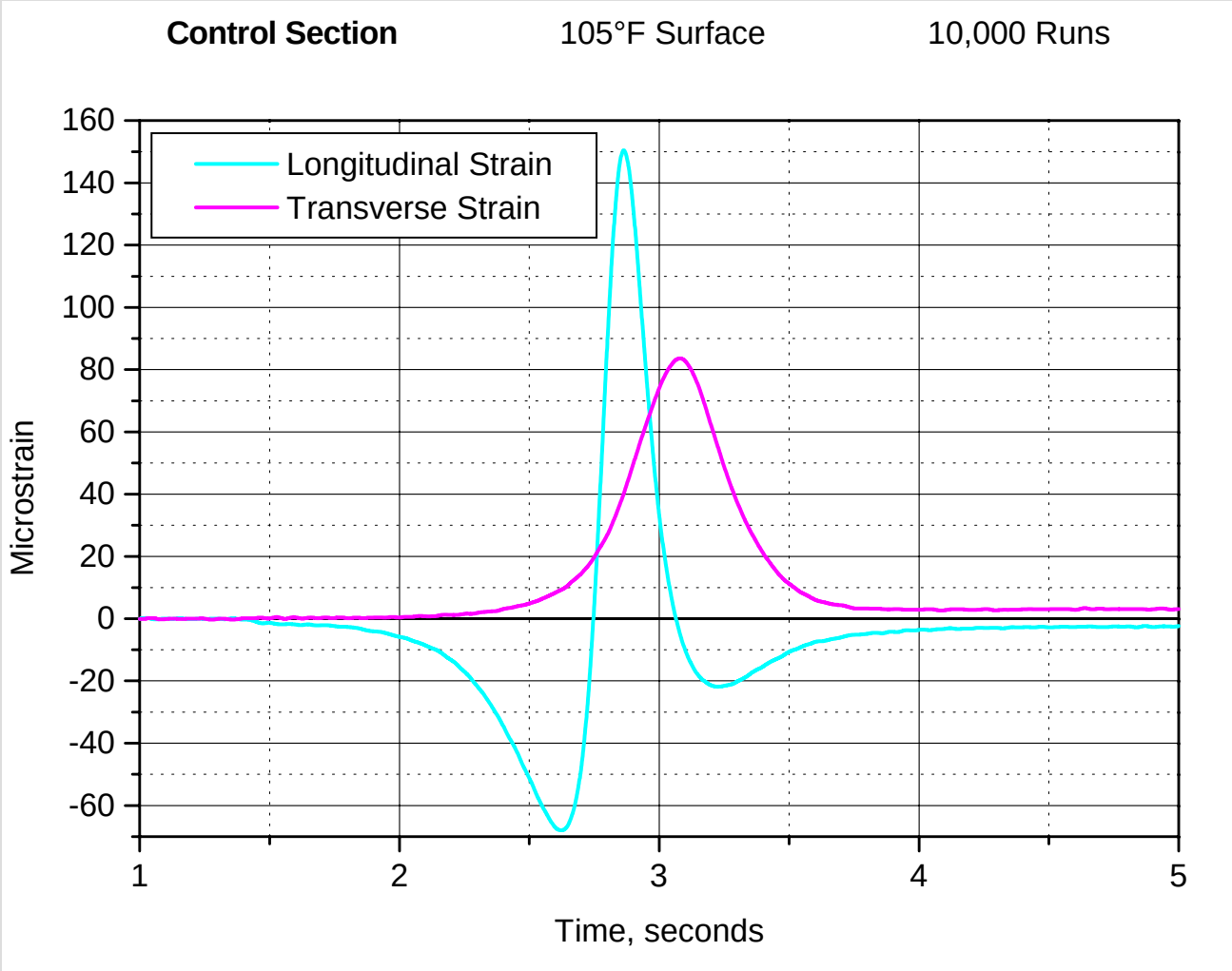


Control (HMA) Section Results from APLF

After 10,000 Runs at high temperature



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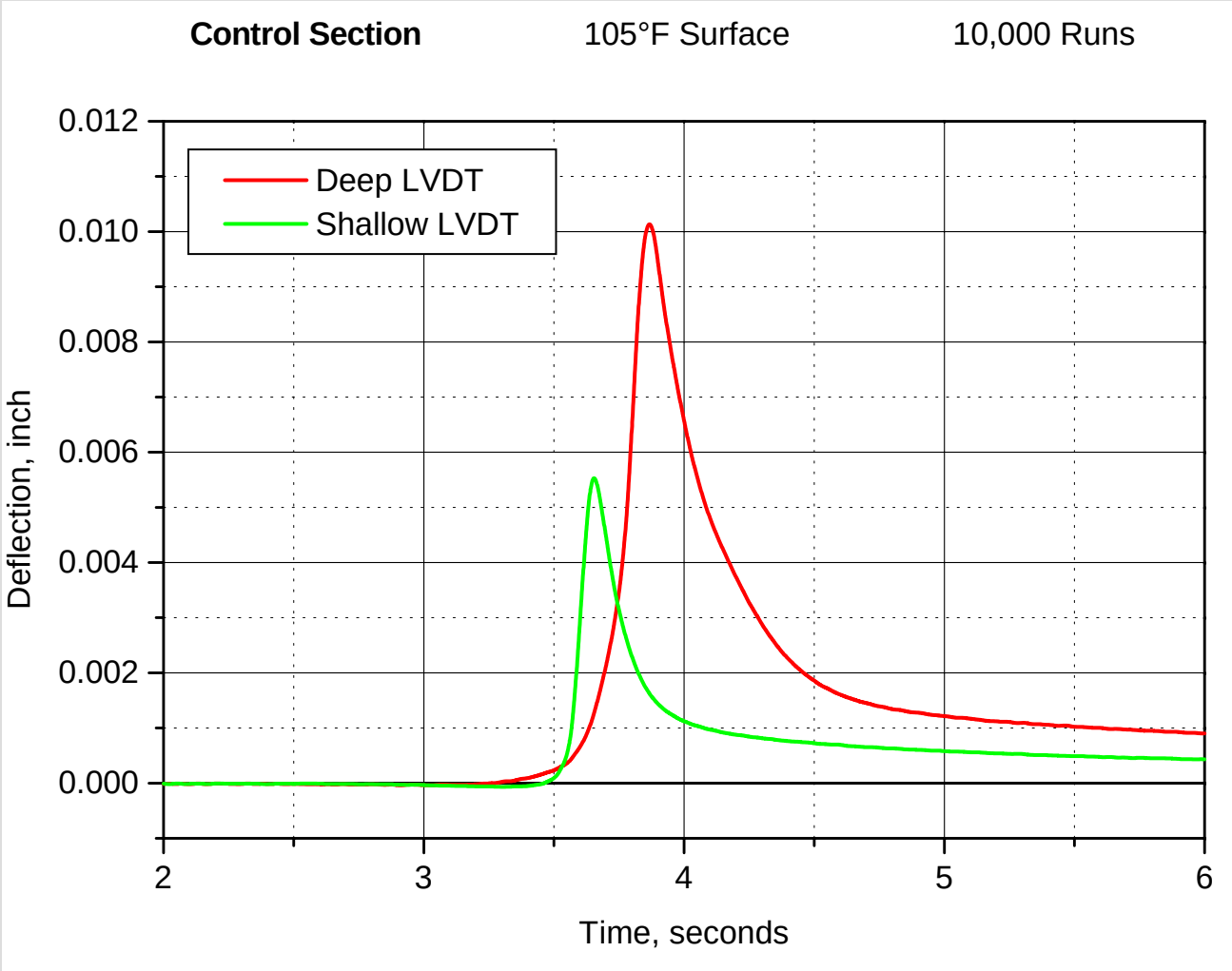

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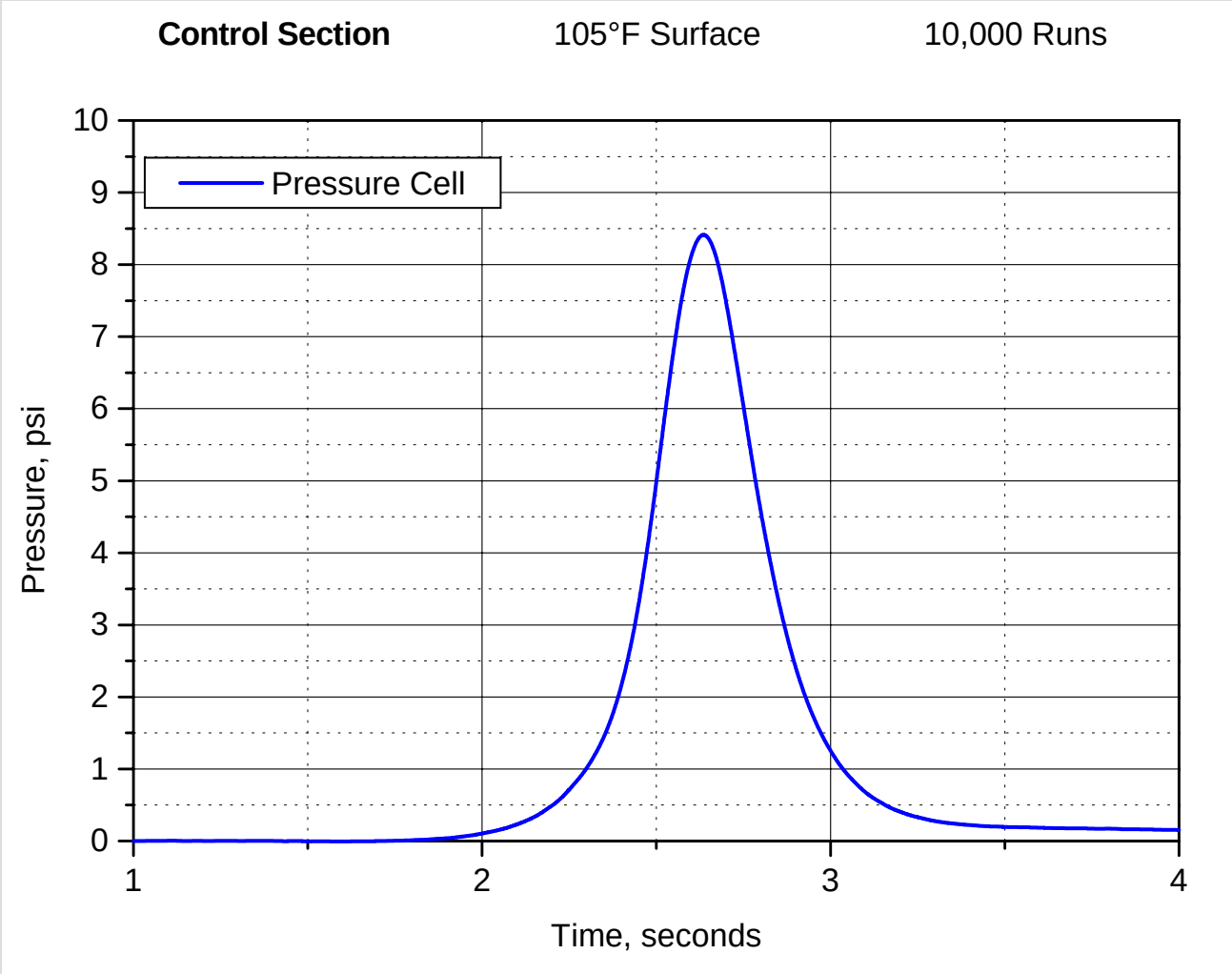

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