THERMAL IMAGING SYSTEMS

Ryan Barborak, P.E.
Texas Department of Transportation

Table of Contents

1. TxDOT’s Specification Regarding Thermal Segregation 3-4
2. Methods for Identifying Thermal Segregation 5
3. Pave-IR System 6-10
4. Pave-IR Scan System 11-13
5. Thermal Camera 14-15
7. Questions 29

TxDOT’s 2014 Specification Regarding Thermal Segregation

- Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F.

TxDOT’s Classification of Thermal Segregation

None Moderate Severe
0° - 25.0° 25.1° - 50.0° > 50.0°

3 Methods for Identifying Thermal Segregation

What Is the Pave-IR System?

- Method initially developed by Texas Transportation Institute (TTI) to detect thermal segregation in newly placed uncompacted asphalt mixture
- Uses a series of infrared sensors mounted to the screed
- Sensors are connected to a computer with color display
- Continuous monitoring of time, pavement temperature, location, paver speed, stops, and stop durations
- Thermal information is available and displayed in real-time
- Data stored on flash drive for post processing on PC
What Is the Pave-IR Scan System?

- Method developed by Moba to detect thermal segregation in newly placed uncompacted asphalt mixture
- Uses a temperature scanner mounted above the screed/paver deck
- Continuous monitoring of time, pavement temperature, location, paver speed, stops, stop durations, wind speed, air temperature, and humidity.
- Thermal information is available and displayed in real-time
- Data stored on MOBA Operand Computer
Data Collection Screen

What is the Thermal Camera?
• Camera requirements outlined in Tex-244-F, "Thermal Profile of Hot Mix Asphalt"
  - Minimum resolution of 19,200 pixels
  - Older cameras may not meet this requirement
• Camera on Blanket PO is FLIR E6
  - Handheld (not mounted, portable)
  - Thermal image is displayed in real time
  - Pull the trigger to take thermal images
  - A digital image is also taken
  - Use FLIR Tools to analyze images

Thermal Profiles for HMA Pavements

3 Goals for 2014 Specification to Address Thermal Segregation
1. Remove the handheld infrared thermometer from TxDOT’s specification
   - Then
   Use a thermal camera or an infrared thermometer to obtain thermal profiles on each sublot in accordance with Tex-244-F.
   In lieu of obtaining thermal profiles on each sublot using a thermal camera or an infrared thermometer, the Contractor may use the Pave-IR system (paver mounted infrared bar) to obtain a continuous thermal profile in accordance with Tex-244-F.
   - Now
   Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F.

2. Evaluate the Pave-IR Scan and compare it to the Pave-IR System
3. Develop a better procedure for using the thermal camera

Goal 2 – Evaluation of IR Bar and IR Scanner
• Conducted by Texas Transportation Institute (TTI)
• Paired t-test shows scanner and beam results are equivalent
• Scanner slightly more favorable results in classification of profiles

Goal 1 – Remove Language Allowing Handheld Thermometer
• Then
  Use a thermal camera or an infrared thermometer to obtain thermal profiles on each sublot in accordance with Tex-244-F.
• Now
  Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F.
Goal 2 – Evaluation of IR Bar and IR Scanner

IR Bar

IR Scanner

Goal 3 – Develop a Procedure for Using Thermal Camera

- Thermal Camera Guidance Document is a descriptive procedure for how to conduct a thermal profile
  - TxDOT website Construction and Materials TIPS
  - CST held a webinar recording in April 2016 to answer questions
    - Webinar was recorded and is available
  - CST and TxAPA provide training including a demonstration
    - Part of Level 1B certification

Goal 3 – Thermal Camera Guidance Document

- Three goals when conducting a temperature profile
  - Keep the same distance between you and the near edge of the pavement while walking parallel to the mat.
  - Keep the same arm angle
  - Maintain the same clearance at the top of the images
- Goal is to have a formal procedure that everyone can follow step by step to obtain the same thermal profile
  - Consistency is key

Guidance Document – Procedure

- Obtaining thermal images is the “proof” needed to justify the decisions made
  - Recommendation is 2 to 3 photos for the first 20 feet
  - 13 to 15 photos for the remaining 130 feet
- Decision to suspend operations and take corrective action if severe segregation is observed (greater than 50.0ºF temperature differential) is made before analyzing the thermal images
- Camera should be used to mark areas of concern, which can be followed up with a density profile
- Temperatures added to SiteManager are those recorded in the top left of the screen during the temperature profile (maximum baseline temperature during the first 20 feet and minimum profile temperature during the remaining 130 feet section)
  - Analyzing images using FLIR Tools is typically not needed

Thermal Camera Notes

Guidance Document – Procedure

- Far edge of pavement
- End of 2' wood

- Max 241°F
- 252

- Camera position with arm bent
- End of wood
- Near edge of pavement
- Driving board at opposite hand

- 101

- FLIR
Thermal Camera Examples of Thermal Segregation

Example of what thermal segregation may look like. Notice the abrupt color changes.

Source: http://www.nationalfirefighter.com/images/Thermal-Imaging.jpg

Questions

Source: http://www.nationalfirefighter.com/images/Thermal-Imaging.jpg

Thermal Camera Examples of Thermal Segregation

Screwed heaters remained on while the paver was stopped

Source: http://www.nationalfirefighter.com/images/Thermal-Imaging.jpg