Thermal Segregation of HMA Pavements - What Have We Learned So Far?

James Mahoney
Connecticut Advanced Pavement Lab - CTI
University of Connecticut
Over 3 Construction Seasons
thermal imaging conducted on
40 paving projects

We are currently documenting the pavement performance to determine the influence of the thermal segregation on service life.
At Time of Construction

- Used Infra-Red Camera to Take Thermal Images of Pavement at Truck Changes
- Used Handheld GPS Receiver to Locate Point Where Image Taken
- Took Limited Density Measurements with Nuclear Density Gauge
Findings at the Time of Construction
Two Methods to Convey Material to Paver Hopper

- End dump transfer of material to paver hopper
- Material Transfer Vehicle
  - Remixing
  - Non-remixing
End Dump Cold Spots

- Occur with virtually every truck change
- Are located approximately 20-30 feet from “screed stop”
- Appear to be caused by cooler material out last from haul unit combined with cool material first out of haul unit along with cooled material from sides of paver hopper
Typical V-Shaped Cold Spot
End Dump $\Delta t=60 \text{ F}$
Non V-Shaped Cold Spot
End Dump $\Delta t=76$ F
Material Transfer Vehicles

- Remixing MTV
  - Greatly reduces temperature differentials
- Non-remixing MTV
  - Reduces temperature differentials significantly but not as much as Remixing MTV
Average Temperature
Differential for Transfer Methods

- End dump = 50.2 F
- Non Remixing MTV = 32.1 F
- Remixing MTV = 13.5 F
Typical Mat Using a Remixing MTV $\Delta t=15$ F
Typical Mat Using a Non-Remixing MTV $\Delta t = 25 \, ^{\circ}F$
The next slide was taken after 45 minute wait for the next load
End Dump 45 minute wait $\Delta t=80$ F
Visual Image Same Spot - 2005
Constructed 2001
Performance to Date

- Current condition for most pavements thermally imaged - average
- Expecting in the next couple of years to see the spread of performance for these pavements increase
Two Projects Have Stood Out

- Route 44
  - Constructed in 2001
  - $\Delta t = 52.1$ °F
- Route 7
  - Constructed in 2002
  - $\Delta t = 34.5$ °F
Route 44 and Route 7

- Both were produced from the same HMA Plant
  - The JMF was different between projects
- Were essentially the same paving crews/equipment
- Both were placed July/August timeframe
- Both had approximately 30 haul units/day
- Haul time one-way - by far the longest
  - Route 44 - Approx. 85 min
  - Route 7 - Approx 110 min
One Significant Difference

- Route 44 - End dump into paver hopper
- Route 7 - Material Transfer Vehicle
  - Non-remixing
Route 44 and Route 7 2005

- The following two road surface images were taken on 6-23-05.
- Note the surface distress.
- These were areas that were observed to have cold spots when viewed with the thermal camera during paving just a few years ago.
Route 44

- Wide variation in surface texture throughout project
- Cores cut from the “worst” surface textured areas had an average air voids content = 13.8%
  - Cores took over a month to dry on countertop
- Cores cut from areas with less texture had an average air void content = 4.1%
Route 44
Route 44 - Road Surface Has Required Patching
Route 44 - Same Location - Opposite Direction
Route 44 - Salt Creeping Out of Voids, Va=17.2%
Route 44 - Core
Route 44 - Raveling
Route 44 - Raveling
Route 7

- Surface texture throughout project is generally uniform
- Cores cut from the “worst” surface textured areas had an average air voids = 8.2%
- Cores cut from the more typical surface texture had an average air content = 5.4%
Route 7 - 3 Years After Paving
Route 7 - 3 Years After Paving
Gradations

- Gradations between “good” and “bad” areas do not show any significant differences in gradations within each project.
Conclusions

- A MTV should be considered when hauling excessive distances even during warm weather.
- It is very difficult to differentiate between gradation and thermal segregation just by looking at the pavement.
- Thermal segregation does appear to shorten pavement’s service life.
Questions?

James.mahoney@uconn.edu
860.486.5956