Measuring In-Place Density of New Roadway Pavements in Connecticut

NESMEA 2013 – Portsmouth NH

Photo Courtesy Monika McGillicuddy.com
Connecticut HMA Pavements

- 3719 miles State maintained roads (20% of total).
- 1.2 million tons HMA placed in 2012.
- In-place density is measured for all lifts designed to be 1.5” thick or more.
- 4838 Core Samples in 2012.
- Use of 15% RAP is typical.
- AASHTO T-331 “…Automatic Vacuum Sealing Method” is used to determine density.
Lot limits - sample locations

- Joint Cores
- Mat Cores
Lot types

- Roadway
- Bridge
- Combination (for 2013)
  - Roadway and Bridge <500’
Notched Wedge Joint
Notched Wedge Joint

2nd Pass

1st Pass

Lift Thickness
1 1/2” – 3”

Bottom Notch
0 - 1/2”

Notch 1/2” – 1”

Lift Thickness
1 1/2” – 3”

Tack coat

8” – 12” Taper

Notched Wedge Joint
JOINT Core

Visible edge of notched wedge joint

5”
Core Removal and Labeling
Core Transport and Documentation

Project

Laboratory
Core Receiving and Sorting
Core Sorting and Storage

Secured cores ready for testing

Cores stored after testing
Core Preparation
Core Preparation
Core Sawing
Core Drying and Sealing
# Density Results per Lot

## Project Information
- **Project:** 171-364G3
- **Route:** 1-84
- **Town:** Manchester
- **District No.:** 1
- **Paving Contractor:** Tilcon
- **HMA Producer:** Tilcon Plainville
- **Lot #:** 5
- **Payable Tons Density Lot:**
- **Unit Price Per Ton:**

## Pavement Density Adjustment Detail

### Mat Density Cores

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Bridge Number</th>
<th>Date Placed</th>
<th>Thickness (in)</th>
<th>Bulk Specific Gravity</th>
<th>Theoretical Gravity</th>
<th>Compaction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5-1</td>
<td></td>
<td>9/23/13</td>
<td>2.000</td>
<td>2.448</td>
<td>2.669</td>
<td>.916</td>
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<td>M5-2</td>
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<td>9/23/13</td>
<td>2.000</td>
<td>2.470</td>
<td>2.669</td>
<td>.926</td>
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<td>M5-3</td>
<td></td>
<td>9/19/13</td>
<td>2.500</td>
<td>2.524</td>
<td>2.671</td>
<td>.945</td>
</tr>
<tr>
<td>M5-4</td>
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<td>9/19/13</td>
<td>2.125</td>
<td>2.590</td>
<td>2.671</td>
<td>.970</td>
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</tbody>
</table>

### Joint Density Cores

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Bridge Number</th>
<th>Date Placed</th>
<th>Thickness (in)</th>
<th>Bulk Specific Gravity</th>
<th>Theoretical Gravity</th>
<th>Compaction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>J5-1</td>
<td></td>
<td>9/22/13</td>
<td>2.250</td>
<td>2.469</td>
<td>2.669</td>
<td>92.4</td>
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<tr>
<td>J5-2</td>
<td></td>
<td>9/22/13</td>
<td>2.125</td>
<td>2.468</td>
<td>2.669</td>
<td>92.5</td>
</tr>
<tr>
<td>J5-3</td>
<td></td>
<td>9/22/13</td>
<td>2.250</td>
<td>2.447</td>
<td>2.669</td>
<td>91.7</td>
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<tr>
<td>J5-4</td>
<td></td>
<td>9/22/13</td>
<td>2.000</td>
<td>2.500</td>
<td>2.669</td>
<td>93.6</td>
</tr>
</tbody>
</table>

### Average Lot Compaction
- **Mat Bonus %:** 1
- **Joint Bonus %:** 1

### Tons Adjusted for Density ($T_D$)

### Density Adjustment Cost ($T_D \times \text{Unit } \$$)
Dispute Resolution Results

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Bridge Number</th>
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<th>Bulk Specific Gravity</th>
<th>Theoretical Gravity</th>
<th>Compaction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>J3-1D</td>
<td>7/28/13</td>
<td>2.375</td>
<td>2.339</td>
<td>2.673</td>
<td>87.5</td>
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<tr>
<td>J3-2D</td>
<td>7/28/13</td>
<td>2.000</td>
<td>2.454</td>
<td>2.673</td>
<td>91.8</td>
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<tr>
<td>J3-3D</td>
<td>7/23/13</td>
<td>2.250</td>
<td>2.388</td>
<td>2.670</td>
<td>89.5</td>
<td></td>
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<tr>
<td>J3-4D</td>
<td>7/28/13</td>
<td>2.375</td>
<td>2.271</td>
<td>2.673</td>
<td>84.9</td>
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</tbody>
</table>

**NEW AVERAGE LOT COMPACTON % (ALL 8 MAT CORES)**

**NEW AVERAGE LOT COMPACTON % (ALL 8 JOINT CORES)**

**MAT NOT DISPUTED**

**JOINT RESOLUTION DISINCENTIVE %**

**FINAL TONS ADJUSTED FOR DENSITY (T_d)**

**FINAL DENSITY ADJUSTMENT COST (T_d x UNIT $)**
Pre-Recycled Core Samples
Minimum Density Requirement Based on Maximum Theoretical Density

- 92% on the Mat
- 91% on the Joint
Density Adjustments
above minimum

% Payment

% Mat Density 2012 2013

% Payment

% Joint Density 2012 2013

2012

2013
Density Adjustments below the minimum

% Mat Density

% Payment

2012

2013

% Joint Density

% Payment
# 2012 Average Density Values

## 2012 Individual Core Results

<table>
<thead>
<tr>
<th>Bridge and Non-bridge</th>
<th>Avg % density</th>
<th>Stdev</th>
<th>Total Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat</td>
<td>92.81</td>
<td>2.13</td>
<td>2532</td>
</tr>
<tr>
<td>Joint</td>
<td>91.23</td>
<td>2.22</td>
<td>2306</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-bridge</th>
<th>Avg %</th>
<th>Stdev</th>
<th>Total Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat</td>
<td>93.02</td>
<td>2.07</td>
<td>2082</td>
</tr>
<tr>
<td>Joint</td>
<td>91.35</td>
<td>2.40</td>
<td>1863</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Avg %</th>
<th>Stdev</th>
<th>Total Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat</td>
<td>91.96</td>
<td>2.17</td>
<td>450</td>
</tr>
<tr>
<td>Joint</td>
<td>90.55</td>
<td>2.16</td>
<td>443</td>
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</tbody>
</table>

Required Minimum Density 92% Mat, 91% for Joint
2012 Adjustments by month

% of Adjustments – Air Temp °F

Month

- neg adj
- pos adj
- 100% pay
- high temp
- low temp
### IN-PLACE DENSITY (%) BY LOT TYPE 2013 Season based on cores

<table>
<thead>
<tr>
<th></th>
<th>Roadway</th>
<th>Bridge</th>
<th>Combo</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT</td>
<td>93.10</td>
<td>88.81</td>
<td>92.73</td>
</tr>
<tr>
<td>JOINT</td>
<td>91.83</td>
<td>89.00</td>
<td>91.89</td>
</tr>
<tr>
<td># of Lots</td>
<td>368</td>
<td>5</td>
<td>40</td>
</tr>
</tbody>
</table>
Conclusions

- Process is working well.
- Industry involvement critical.
- Data consolidation is very important.
- Consistent test method is vital.
- Analysis of industry data is priceless!
  - During the season
  - Year to year
- More Research is needed.
The End

Thanks for your attention!
Questions?