Developing and Deploying Performance Specifications

Mark Woolaver
Vermont AOT Construction Paving Engineer

March 14 -15, 2017
Vermont Facts...

- Land Area = 9,248 Sq Miles (43)
- Population = 630k (49)
- Median Age = 42.8 yrs (2)
- Dairy Cows : People = 3.8 (1)
Putting Doves Inside the Freezer is Against the Law.
It's illegal to undress in public in Vermont, but if you leave your house naked, it's Totally Fine.
At one point in time, it was illegal to tie a giraffe to a telephone pole in Vermont.
Billboards have been outlawed in Vermont since 1968.
Developing and Deploying Performance Specifications

Mark Woolaver
Vermont AOT Construction Paving Engineer

March 14 -15, 2017
Brief Vermont AOT History

One Focus Area
Was / Is FDR

It Was Working Fine Until.....
We Added Cement....
Some Brief Woolaver Thoughts

What is Construction?
Construction Causes of Failure

- Workmanship: 66%
- Design Deficiency: 21%
- Material Failure: 9%
- Natural Disaster: 4%

Source: IBA Consultants, Inc
Vermont Construction Causes of Failure

- Workmanship: 79%
- Material Failure: 21%
Material Failure?
Workmanship Failure?

- **Fair Haven - Rutland, NH 9811**
- **Specification Target**
- **All Type IIIS**
- **Type IIIS #s 1 - 102**
- **Type IIIS #s 103 - 138**

**Percent Compaction**

88 90 92 94 96 98 100
Ramifications: What Did We Do?

- ETG Scanning Tour / Formed
- Moratorium on Cement at Executive Level
- **Had to Regain Executive Trust** / Buy in with approach to Specifications

- **RSB Scanning Tour (Agency Cross Section)**
  - Recommended Spec Revisions / Improvements (Redline)
  - **Workmanship** and **Material**-Related revisions in an Effort to improve **Field Performance**

- Solicited **IAP** and Other Assistance
  - Further Specification Revisions / Improvements (Blueline)
  - Ghost Implementation 2015 / Shadow 2016
Ramifications: 
What Did That Do?

• Did we get results?
• Did we improve our specifications?

• The jury is still out but here are a few examples of where we went with FDR (Remembering Longitudinally Differing Material)
MD Curves For RSB

Bethel-Randolph STP 2921(1)
AASHTO T-99
By: JPD
Date: 4/20/2016
Reviewed by: MRG
Date: 4/21/2016

Dry Density (pcf)

Moisture Content (%)

Blends:
- Blend A: 100% Subbase
- Blend B: 100% Aggregate
- Blend C: 50% Subbase, 50% Aggregate
Blends A-C Compressive Strength with Trials Averaged

- **Blend A**: 100% Subbase
- **Blend B**: 100% Aggregate
- **Blend C**: 50% Aggregate, 50% Subbase

Target Strength: 275 psi

**Graph Details**:
- **X-axis**: Cement Content (%)
- **Y-axis**: Compressive Strength (psi)
- **Legend**:
  - Blue line: Blend A: 100% Subbase
  - Black line: Blend B: 100% Aggregate
  - Green line: Blend C: 50% Aggregate, 50% Subbase
  - Red line: Target Strength (275 psi)

**Data**:
- **Bethel-Randolph STP 2921(1)**
- **ASTM D1633**
- **By**: JPD
- **Date**: 4/20/2016
- **Reviewed by**: MRG
- **Date**: 4/21/2016
T-27 Particle Size Analysis for Subbase and Supplemental Aggregate
Field Personnel Are Your Best Chance for Success (Or Failure)
# Soil-Cement: Design ad Molding 4"x4.6 Compressive Strength

<table>
<thead>
<tr>
<th>Date/Time: 05/28/16</th>
<th>Bethel-Randolph Lab/Location: Bethel-Randolph Lab</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather: Sunny</td>
<td>Date Rec'd #: Date/Time: 05/28/16</td>
<td>Target 175PSI</td>
<td>350PSI</td>
</tr>
<tr>
<td></td>
<td>Lab Login #:</td>
<td>Lot #:</td>
<td>-</td>
</tr>
<tr>
<td>AOT Contract #:</td>
<td>Cement Material ID: Reclaim</td>
<td>Sublot #:</td>
<td>-</td>
</tr>
<tr>
<td>Contractor: Pike</td>
<td>Material #:</td>
<td>-</td>
<td>Sample Location: Roadway</td>
</tr>
<tr>
<td>Pay Item #:</td>
<td>-</td>
<td>Sample #:</td>
<td>-</td>
</tr>
<tr>
<td>Source: Roadway</td>
<td>Sample Type:</td>
<td>-</td>
<td>Station: 0</td>
</tr>
<tr>
<td>Source: Roadway</td>
<td>Mike Sampled Duncan</td>
<td>By/Cert. #:</td>
<td>#1451</td>
</tr>
<tr>
<td>Source: Roadway</td>
<td></td>
<td></td>
<td>Offset: 0</td>
</tr>
<tr>
<td>PII Job Number 315134.00</td>
<td></td>
<td></td>
<td>#REF!</td>
</tr>
</tbody>
</table>

## Determination of Compressive Strength

<table>
<thead>
<tr>
<th>Station Number</th>
<th>A74+00LT</th>
<th>A67+00LT</th>
<th>A76+00RT</th>
<th>A65+00RT</th>
<th>A42+00LT</th>
<th>A35+00RT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen Number</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Specimen diameter, mm</td>
<td>101</td>
<td>101</td>
<td>101</td>
<td>101</td>
<td>101</td>
<td>101</td>
</tr>
</tbody>
</table>

### Correction factor for Surface area

| 0.35 | 0.35 | 0.4 | 0.35 | 0.35 | 0.3 |

| Cement Content, % | 1.25 | 1.25 | 1.25 |
| Total load, pounds | 812.0 | 793.0 | 1,195.0 | 795.0 | 795.0 | 654.0 |

### Corrected surface area of specimen, inches² of

| 4.35 | 4.35 | 4.97 | 4.35 | 4.35 | 3.73 | 0.00 | 0.00 | 0.00 | 0.00 |

| Avg. unit load, psi | 186.8 | 182.4 | 240.6 | 182.9 | 182.9 | 175.5 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! |
| Aged days | 3 | 3 | 3 |
Specification Revisions

- Agency Mix Design Based on Contractor Sampling
- Required QC Plan
- Defined “Supplemental Aggregate”
- Equipment Requirements
- Tightened Moisture Requirements
- 3- and 7-Day Split Molds Allowing QC Feedback
- Cement Application / Monitoring
- Fog Seal Required
- Microcrack Emphasized
- Soils Trailer Required
- Field Staff Roundtables
Did We Get What We Wanted?

Split Mold Break Normal Distributions

<table>
<thead>
<tr>
<th></th>
<th>Avg</th>
<th>Std Dev</th>
<th>Avg - 2s</th>
<th>Avg + 2s</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 day</td>
<td>223.2222</td>
<td>84.68837367</td>
<td>53.84547</td>
<td>392.599</td>
</tr>
<tr>
<td>7 day</td>
<td>248.7778</td>
<td>81.46799937</td>
<td>85.84178</td>
<td>411.7138</td>
</tr>
</tbody>
</table>
• Get Rid of the “Us vs Them” Mindset
• Belay Complacency through “Years of Experience” or “That’s How We’ve Always Done It” While Respecting the Same
• Solicit and Gain (Or Regain in VT’s case) Executive Support
• Engage All Internal Parties
• Engage Available External Parties Through IAP or Other Efforts
• Improve Training / Communication
• Believe that a “Design” is Achievable and Above a “Recipe”
• Repeat
PRS, If Confident In Your Game, Should Lessen or Equalize the Risk for Both Parties
Thoughts?

Mark Woolaver, VTrans
(802) 828-1475
Mark.Woolaver@vermont.gov