How to Really Know Your Pavements

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S&ME

2018 FDR Symposium
What’s Wrong with These Pictures?

Source: Gizmodo
Why Measure Pavements? – Transportation Infrastructure and Beyond

- Pavements are Large Ticket Item - $$$
- Design-Build Roadway Projects – Minimize risk
- Network evaluation projects
- Maximize Use of Funds – FDR is one of the treatment options
- Preserve Assets
- Safety
- Local Roads and Parking Lots
- Large Facilities
Where are we now? - Pavement Condition Index

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>Pavement Area</th>
<th>Unit</th>
<th>Pct Area</th>
<th>Num Sections</th>
<th>Pct Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failed</td>
<td>285,500.01</td>
<td>SqFt</td>
<td></td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Serious</td>
<td>0</td>
<td>SqFt</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Very Poor</td>
<td>316,486.01</td>
<td>SqFt</td>
<td></td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Poor</td>
<td>313,843.01</td>
<td>SqFt</td>
<td></td>
<td>7</td>
<td>6</td>
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<tr>
<td>Fair</td>
<td>2,040,516.05</td>
<td>SqFt</td>
<td></td>
<td>47</td>
<td>9</td>
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<td>Satisfactory</td>
<td>222,717.81</td>
<td>SqFt</td>
<td></td>
<td>5</td>
<td>7</td>
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<tr>
<td>Good</td>
<td>1,179,820.53</td>
<td>SqFt</td>
<td></td>
<td>27</td>
<td>16</td>
</tr>
</tbody>
</table>

40% Drop in Quality

75% of Life

40% Drop in Quality

12% of Life

Spending $1 on preservation here...

...eliminates or delays spending $6 to $10 on rehabilitation or reconstruction here.
This presentation covers S&ME’s pavement services and how those services are used on various projects.
What is FWD? - FastFWD

Falling Mass
Load Cell
Geophones
FWD is used to simulate a truck load on a pavement to measure pavement response.
The FWD can be used on various projects:

Overlay Design  
Joint Testing  
Subgrade Modulus
Most commonly, FWD is used to calculate overlay requirements for pavements.
Results: NC 211

- NC 211 NB from NC 73 in West End to SR 1241

Deflection Limit = 13.63 mils

Location #

Deflection (Mils)
Results: NC 211

NC 211 NB from NC 73 in West End to SR 1241

Subgrade Modulus (psi) vs. Location #
Results: NC 211

NC 211 NB from NC 73 in West End to SR 1241

Overlay Depth (inches)

Location #
FWD used to measure load transfer efficiency on a Jointed Concrete Pavement

<table>
<thead>
<tr>
<th>I-40 Tested Section</th>
<th>Number of Tested Joints</th>
<th>Minimum LTE</th>
<th>Maximum LTE</th>
<th>Average LTE</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westbound at Jones Sausage Rd.</td>
<td>167</td>
<td>64.9%</td>
<td>96.8%</td>
<td>88.2%</td>
<td>4.6%</td>
</tr>
<tr>
<td>Eastbound at Jones Sausage Rd.</td>
<td>153</td>
<td>24.7%</td>
<td>92.7%</td>
<td>72.8%</td>
<td>15.1%</td>
</tr>
<tr>
<td>Westbound between US 70 Bypass and US 70 Bus.</td>
<td>160</td>
<td>4.2%</td>
<td>82.9%</td>
<td>18.3%</td>
<td>16.5%</td>
</tr>
<tr>
<td>Eastbound between US 70 Bus. and US 70 Bypass</td>
<td>156</td>
<td>4.8%</td>
<td>83.6%</td>
<td>26.2%</td>
<td>23.2%</td>
</tr>
</tbody>
</table>
FWD use for characterization of pavement layers stiffness including subgrade. Kinston, NC

ISM for Runway 5-23 Sides

ISM, Kip/in

NDT Stations

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FWD use for characterization of pavement layers stiffness including subgrade. Grand Stand – Myrtle Beach

<table>
<thead>
<tr>
<th>NDT Station, ft</th>
<th>Elastic Modulus (E), psi</th>
<th>Subgrade, E</th>
<th>Subgrade Design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From</td>
<td>To</td>
<td>AC</td>
</tr>
<tr>
<td>0+00 at 170’ before RW 5 threshold, keel</td>
<td>0+00</td>
<td>15+00</td>
<td>265,820</td>
</tr>
<tr>
<td></td>
<td>15+00</td>
<td>30+00</td>
<td>198,304</td>
</tr>
<tr>
<td></td>
<td>30+00</td>
<td>59+00</td>
<td>265,820</td>
</tr>
<tr>
<td>Side</td>
<td>0+00</td>
<td>59+00</td>
<td>363,828</td>
</tr>
</tbody>
</table>

ISM for Runway 5-23 Sides

### ISM, kips/ln

- **20’ Right**
- **20’ Left**

<table>
<thead>
<tr>
<th>NDT Station No.</th>
<th>ISM, kips/ln</th>
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<tbody>
<tr>
<td>100</td>
<td>1,400</td>
</tr>
<tr>
<td>200</td>
<td>1,300</td>
</tr>
<tr>
<td>300</td>
<td>1,200</td>
</tr>
<tr>
<td>400</td>
<td>1,100</td>
</tr>
<tr>
<td>500</td>
<td>1,000</td>
</tr>
<tr>
<td>600</td>
<td>900</td>
</tr>
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<td>700</td>
<td>800</td>
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<td>1100</td>
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<td>1200</td>
<td>300</td>
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<tr>
<td>1300</td>
<td>200</td>
</tr>
<tr>
<td>1400</td>
<td>100</td>
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</tbody>
</table>

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GPR for transportation projects

Bridge Deck Assessments

Pavement Evaluations

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Example Applications

- Pavement Thickness Evaluations
- Bridge Deck Condition Assessments
- Rebar Cover Depth
- Void Identification
- Honeycombing
- Dowel Placement Analysis

Advantages

- Fast, non-destructive, and can be performed at highway speeds which can eliminate the need for lane closures
- Coring is locally accurate, but is performed at wide intervals, damaging, very labor intensive, and time consuming (i.e. not very cost effective)
- GPR offers continual data compared to coring while also providing accurate thicknesses (~5-10%)
- Completely integratable with GPS positioning
GPR for transportation projects

GPR transmits electromagnetic waves into the pavement from an antenna at a specific frequency which are then reflected back to a receiver by interfaces between materials with differing dielectric properties (e.g. asphalt/stone, asphalt/concrete, stone/soil, concrete/steel, etc.) whereby general locations of subsurface objects/features can be determined.

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Recent Example GPR Projects

NCDOT

NC 150; between SR 1840 and US 21
Pavement Thickness
Pavement Thickness

Interstates and Ramps

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Recent Example GPR Projects

Wachesaw Plantation East Subdivision Murrells Inlet, SC
Recent GPR Projects

Sub-Divisions
Asphalt Thickness

Sub-Divisions
Stone Thickness

Sub-Divisions
Recent Example GPR Projects

- Thin Asphalt Overlay
- Concrete Pavement
- Stone

**NCDOT**

**I-440 Buried Patches**
Recent Example GPR Projects

New Bridge Construction in NC

Approximate Depth (inches)

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Recent Example GPR Projects

New Bridge Construction in NC

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Recent Example GPR Projects

I-440 between I-40 and I-24
Nashville, TN

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Recent Example GPR Projects

I-440 between I-40 and I-24
Nashville, TN
Recent Example GPR Projects

I-440 between I-40 and I-24
Nashville, TN

I-440 Bridge Deck – Railroad Crossing (EB; GPR Line 10)

Top of Upper Transverse Bars

Area of Relatively Weaker Amplitudes
The Inertial Profiler with macrotexture laser is used on ride quality and surface texture projects.
The Inertial Profiler is used on ride quality and surface texture projects.

IRI (International Roughness Index)
Inertial Profiler is used to measure ride quality of a road. A macrotexture laser is measuring the surface texture of the pavement.
All state DOTs have smoothness specification limits for contractors to adhere to in order to get paid.

- Acceptance requirements
- Incentives – disincentives
- Corrective measures
- New construction
- Rehab projects
- Bridges

<table>
<thead>
<tr>
<th>MRI Price Adjustment Per 0.10-Mile Section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MRI after Completion (Inches Per Mile)</strong></td>
</tr>
<tr>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>45.0 and Under</td>
</tr>
<tr>
<td>45.1-55.0</td>
</tr>
<tr>
<td>55.1-70.0</td>
</tr>
<tr>
<td>70.1-90.0</td>
</tr>
<tr>
<td>Over 90.1</td>
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</table>
Macrotexture measurements have been used to relate to friction management for pavements in terms of safety and skid resistance.
Pavement Design Investigation Projects - PDI

- Take Pavement Cores
- Conduct DCPs
- Obtain Soil Samples
- Lab Soil Classification
- Planview
- Used for Pavement Design Recommendations
Conclusion

The FWD, GPR and Profiler give access to effective, nondestructive technologies to provide additional value to Agencies’ managers for optimizing pavements service life, public safety and funding utilization.