Pavement Preservation

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...also a human being
• Pavement Performance
• Pavement Infrastructure Condition
• Pavement Preservation
• Decision Making
• Wrap-up
What is the purpose of a pavement structure?

Contact Stress ($\sigma_o$) = Tire Pressure

$\sigma_i$ = Stress at Subgrade
Pavement Performance

Define pavement performance

“The serviceability trend of a pavement segment with increasing number of axle applications.”

- Highway Research Board, 1972

FUNCTIONAL

SAFETY

STRUCTURAL
ROUGH ROAD AHEAD
THE ECONOMIC IMPACT OF AMERICA'S FAILING TRANSPORTATION INFRASTRUCTURE BY 2020

FAMILIES HAVE A LOWER STANDARD OF LIVING.
American families would earn $700 less each year.
And spend $360 more each year.
Total impact on each family's budget: $1,060 per year.

AMERICAN BUSINESSES AND WORKERS PAY A HEAVY PRICE.
America would lose 877,000 jobs.
Another 234,000 jobs exist only if many more workers agree to paycuts.
Between now and 2020 transportation costs increase $430B.

AMERICA LOSES GROUND in the global economy.
U.S. exports would drop by $28 billion.
Exports drop in 79 of 93 different tradable commodities.
America's gross domestic product underperforms by $897B.

FOR AN ADDITIONAL INVESTMENT OF $94B PER YEAR WE CAN:
+ Create millions of jobs
+ Protect another 1.1 million jobs
+ Save nearly 2 billion hours in travel time
+ Save each family $1,060 per year
+ Add $2,600 in GDP for every person in the U.S.

Source: American Society of Civil Engineers
Activities in the Life of a Pavement

Planning Activities
- Assess network deficiencies
- Establish priorities
- Program & budget

Design Activities
1. Input information (materials, traffic, climate, costs, etc.)
2. Alternative design strategies
3. Analysis, economic evaluation, & optimization

Construction Activities

Pavement Evaluation

Maintenance Activities

Rehabilitation Activities

Research Activities

Data Bank
1. Collect information on pavements.
2. Set up criteria for making decisions.
3. Identify alternative strategies.
4. Predict cost and performance of alternative strategies, and compare them.
5. Select and implement the most cost-effective strategy.
The State of our Infrastructure

- America’s roads: Grade of D
- SC has the 4th largest state-maintained highway system.
- 66,262 miles of public roads in SC.

- 29% of SC traffic is riding on good pavement.
The State of our Infrastructure

SCDOT System (90,598 lane-miles)

- Interstate, 3,795
- Primary, 23,983
- Federal Aid Secondary, 41,393
- Non-Federal Aid Secondary, 21,427

SCDOT System Condition

- Good 18%
- Fair 29%
- Poor 53%

SCDOT Non-Federal Aid System Condition

- Good 13%
- Fair 31%
- Poor 56%
The State of our Infrastructure

Non-Federal Aid Secondary System

Percent of Network

Year


Good

Fair

Poor

Good  Fair  Poor

2008  33  53  14
2009  35  53  12
2010  44  42  14
2011  46  41  13
2012  45  42  13
2013  50  40  10
2014  54  34  12
2015  56  31  13

Percent of Network
The unfortunate reality…

Pavement Condition

- Very Good
- Good
- Fair
- Poor
- Very Poor

Time (Years)

Major Rehabilitation Trigger
Pavement preservation is...

...a planned system of treating pavements to maximize their useful life as cost-effectively as possible.

Key concepts

- proactive & progressive, not reactive
- can be simple or more complex
- managers have strong control
- emphasis on preventive maintenance
- early intervention is essential

The ultimate goal is...

...to keep the good roads in good condition.
Pavement Condition

- Good
- Fair
- Poor
- Very Poor

Time (Years)

Pavement Preservation Action

Major Rehabilitation Trigger
Pavement Treatment Toolbox
Pavement Treatment Toolbox

**Pavement Condition**
- Very Good
- Good
- Fair
- Poor
- Very Poor

**Time (Years)**
- 0
- 5
- 10
- 15
- 20
- 25

**Fog Seal Rejuvenation** ($7,040/lane-mile; +3 yr; $0.33/yd²/yr)

**Slurry Seal, Chip Seal or Microsurfacing (Single)** ($12,672/lane-mile; +5 years; $0.36/yd²/yr)

**Chip Seal or Microsurfacing (Double)** ($27,808/lane-mile; +8 years; $0.49/yd²/yr)

**Cape Seal** ($32,736/lane-mile; +9 years; $0.52/yd²/yr)

**HMA Overlay** ($56,320/lane-mile; +11 years; $0.73/yd²/yr)

**Mill & HMA Overlay** ($70,400/lane-mile; +11 years; $0.91/yd²/yr)

**In-Place Recycling & Overlay** ($112,640/lane-mile; +15 years; $1.07/yd²/yr)

**Crack Filling (as needed)**

**Full Depth Reconstruction** ($176,000/lane-mile; +20 years; $1.25/yd²/yr)
Serji, wake up, it is your turn!!
Numbers, numbers, numbers everywhere

- ~4.1 million miles of public roads
- 1.3 million miles are unpaved
- ~18 billion tons of asphalt pavement in American roads
- 65% of the asphalt pavement market is publicly funded highway projects
- Residential and non-residential construction making up the remaining 35%
- Capital spending on highways, roads, and bridges by all levels of government (federal/state/local): $80 billion annually, about half of which comes from federal funding
Economic Impact

- For each $1 billion invested = 28,000 jobs are supported
- Every $1 billion spent = 4 million to 5 million tons of asphalt pavement.
- Without regular maintenance and investment in the nation's transportation network, the economic activity it is capable of supporting will decline.
Over the long term, maintenance outlays for highways, streets and bridges have continued to trend upwards:

- 2009: $37.7 billion
- 2016: $42.6 billion
- 2022: $47 billion
DOTs Revenue Mix: 2000 vs 2015

2000 State Highway Program Revenues

- 24% Federal Investment $20.8B
- 55% Highway User Fees, Tolls & Taxes $46.6B
- 11% Bond Issues $8.9B
- 10% Other State Revenue* $8.7B

2015 State Highway Program Revenues

- 23% Federal Investment $40.5B
- 42% Highway User Fees, Tolls & Taxes, $74.1B
- 15% Bond Issues $26.8B
- 20% Other State Revenue* $34.4B

*Note: Other State Revenue includes State gas taxes, vehicle registration fees, licenses, etc.
PP: Not a bad investment!!

- The United States highway system: an asset valued at over $1.75 trillion in total
- Steadily deteriorating
- Expenditures are not keeping pace with proven needs
- Pavement preservation fills that gap
- On average, pavement preservation projects support 25% more jobs on a dollar-for-dollar basis, compared with new construction or rehabilitation projects.
SC’s Story!!

Boy, it took you a long enough time to get to this point.
Level 1: PP Certification Program (over 5 years):
- Technicians
- Engineers
- Contractors
- Consultants

Level 2: In development phase (Ready to go)
- DOT engineers
- DOT contract staff
Level 1: PP

- Seal Coat
- Micro Surfacing
- Concrete
- Can be certified in all 3 or just any of them
Level 1: PP Technician Certification Program

- Intro to PP
- Methodologies / Definitions
- PMS
- Advantages/disadvantages of each technique
- Cost issues
- Life expectancy
- SC DOT’s Guidelines / Recommendations
- Specifications
Level 1: PP Treatments

- Crack seal
- Fog Seal
- Chip Seal
- Scrub Seal
- Slurry Seal
- Microsurfacing
- Recycling Treatments
- Ultra Thin Lift HMA Layer
- Full Depth Patching
Pavement Preservation Techniques for Microsurfacing

• Intro
• Mix Design Issues
• Testing
• Construction
• Inspection
• Specifications
Pavement Preservation Techniques for Concrete Pavements

- Joint/crack sealing
- Diamond grinding
- Diamond grooving
- Ultrathin bonded wearing course
- Micro-surfacing
- Undersealing
- Load transfer restoration
- Maintenance of drainage features
Treatment Decision Trees

How to select the best treatment(s)?

- Type of Distress
- Cause(s)
- Treatment Options
- Costs
  - Select Treatment
  - Tracking
Pavement Preservation

• Optimization model based on

A Quick Check of Your Highway Network Health

by Larry Galehouse, Director,
National Center for Pavement Preservation
and
Jim Sorenson, Team Leader,
FHWA Office of Asset Management
The Network Health Concept

• Based on the **Remaining Service Life** (RSL) concept

• Every roadway segment in a network has a **Remaining Service Life**

• If you have 500 lane–miles of pavements in your network and do no repairs or maintenance in a given year, the network will lose 500 *lane–mile–years* of **Remaining Service Life**
Example Case Study

- Roadway Network: 244 lane-miles
- Annual Budget: $1,000,000
- Current Remaining Service Life: 2746 lane-mile-years
Do Nothing

Do Nothing

Lane-Mile-Years vs. Year

Year

Do Nothing

Lane-Mile-Years

0 5 10 15 20
Worst First

- Year 0 (2476 lane-mile-years)
- Year 1 (2303 lane-mile-years)
- Year 5 (2033 lane-mile-years)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Life Extension</th>
<th>Unit Cost</th>
<th>Lane-Miles</th>
<th>Total Cost</th>
<th>RSL Extension</th>
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<tbody>
<tr>
<td>CIR + Overlay</td>
<td>15</td>
<td>$112,640</td>
<td>4</td>
<td>$450,650</td>
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<tr>
<td>Mill + Overlay</td>
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<td>$70,400</td>
<td>8</td>
<td>$563,200</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>12</strong></td>
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<td><strong>$1,013,850</strong></td>
<td><strong>148</strong></td>
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</table>
### Treatment Life Extension Unit Cost Lane-Miles Total Cost RSL Extension

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<td><strong>148</strong></td>
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<td>(-)</td>
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</table>
# Mix of Fixes

## Year 0 (2476 lane-mile-years)

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<th>Treatment</th>
<th>Life Extension</th>
<th>Unit Cost</th>
<th>Lane-Miles</th>
<th>Total Cost</th>
<th>RSL Extension</th>
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</thead>
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<td>Microsurfacing</td>
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<td>Chip Seal</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>41</strong></td>
<td><strong>$943,712</strong></td>
<td><strong>250</strong></td>
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## Year 1 (2532 lane-mile-years)
### Strategy Comparison

- Roadway Network: 244 lane-miles
- Annual Budget: $1,000,000
- Current Remaining Service Life: 2746 lane-mile-years

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Lane-Miles Treated</th>
<th>Total Cost</th>
<th>Δ RSL (1 Year)</th>
<th>Δ RSL (10 Years)</th>
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<tbody>
<tr>
<td>Do Nothing</td>
<td>0</td>
<td>$0</td>
<td>-233</td>
<td>-1830</td>
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<tr>
<td>Worst First</td>
<td>12</td>
<td>$1,013,850</td>
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<tr>
<td>Mix of Fixes</td>
<td>41</td>
<td>$943,712</td>
<td>+56</td>
<td>+</td>
</tr>
</tbody>
</table>
Level 2: PP: Early 2019

• Why?
• How? Distresses
• What?
• Case Studies
• Potential Solutions / Treatments
• LCCA
• Selection Process
• Potential Issues / Problems
Course Format: Level 2 PP

- Lecture/discussion
- Workshops / Case Studies
- Protocol:
  - Informal
  - Questions are encouraged
  - Class participation is essential
Workshops: Level 2: PP

- Opportunity to apply course concepts
- Interactive sessions
  - Evaluating pavement condition and pavement selection
  - Identifying feasible treatments
  - Selecting treatments
Ranking of Pavement Preservation Practices and Methods

Report No. FHWA-SC-16-05

Final Report
December 2016

Sponsor Agency:
South Carolina Department of Transportation

In Cooperation with:
US Department of Transportation
Federal Highway Administration

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Summary of Preventive Maintenance Characteristics

- Planned strategy
- Uses cost-effective treatments (LCCA)
- Applied when no or minimal deterioration exists
- Maintains or improves functional condition
- Delays major rehabilitation (extends pavement life)
- Improved customer satisfaction
New Course: Why Men Die Younger!!
1913 way of doing things
A bridge in Vietnam
Go sit down, you’ve done enough damage!!
Get ready, the taller and the smarter guy is going to start talking
Treatment Benefit

PQI vs Year

- T_{pre}
- T_{3.0}
Benefit
Area from $T_{app}$ to $T_{3.0}$
($PQI \cdot years$)

Benefit/Cost Ratio
$\frac{\text{Benefit}}{\text{Cost}} \times 10^5$
Preservation Candidates

Secondary Roads
219,848 segments
20,618 miles

Preservation Candidates
49,495 segments
4,725 miles
Proportion of Candidate Segments

Legend
- South Carolina Counties

Proportion of Candidate Miles
- < 6%
- 6% - 10%
- 10% - 15%
- 15% - 20%
- > 20%
Wrap-Up

• US Pavement Infrastructure Challenges

• Pavement Condition

• Pavement Preservation System

• Remaining Service Life and Overall Network Health

• Candidate Identification
Thank You

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