FDR at FedEx Ground Charlotte Hub

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Why does FDR matter to FedEx?

• A unique process for reconstructing pavement that’s:
  - More durable
  - Less expensive
  - Faster
  - Less disruptive

• FedEx Ground has many yards past their design life

• Challenged with reconstructing vital part of the facility without impeding operations
Definition of Full-Depth Reclamation (FDR)

- Method of flexible pavement reconstruction that utilizes the existing asphalt, base, and subgrade material to produce a new stabilized base course for an asphalt, chip seal, or concrete wearing surface.

A new cement recycled base will be stronger, more uniform, and more moisture resistant than the original base, resulting in a long, low-maintenance life.
Advantages of the FDR process

• Use in-place materials
  - Saves money
  - Conserve virgin material
  - Saves energy by reducing mining and hauling

• Limits hauling of materials from site
  - Saves fuel and reduces traffic

• Maintains existing grade and restores the cross section
  - Meet existing structures
Advantages of the FDR process

- Reliably treats all types of pavement distress
  - Versatile and robust
- Reduce construction time
- Increases the load-carrying capability of the pavement
- Reduces the environmental sensitivity of the pavement
Thickness is key to rigid base performance

<table>
<thead>
<tr>
<th>Base Thickness (inches)</th>
<th>Tensile Stress (psi)</th>
<th>Stress Ratio</th>
<th>Loads to failure (MEPDG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>181</td>
<td>1.3</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>0.71</td>
<td>1,200</td>
</tr>
<tr>
<td>8</td>
<td>71</td>
<td>0.51</td>
<td>389,000</td>
</tr>
<tr>
<td>9</td>
<td>61</td>
<td>0.44</td>
<td>2,900,000</td>
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<tr>
<td>10</td>
<td>53</td>
<td>0.38</td>
<td>14,460,000</td>
</tr>
<tr>
<td>12</td>
<td>40</td>
<td>0.29</td>
<td>196,700,000</td>
</tr>
</tbody>
</table>
When is FDR appropriate?

- Distress indicates the pavement distress is in the base or subgrade
- Full-depth patching is required on more than 15 to 20 percent of the total surface area
- Pavement structure is inadequate for current or expected future traffic.
Pulverize, Shape, Add Cement, Mix In Place, Compact, and Surface

**Asphalt Surfacing**

- **Granular Base**
- **Subgrade**
  - Existing road
  - Pulverization to desired depth

**Pulverized**

- **Subgrade**
  - Subgrade
  - Removal of excess material (if necessary) and shaping

**Stabilized**

- **Subgrade**
  - Addition of cement, mixing, reshaping, and compaction
  - **New Surfacing**
    - Subgrade
    - Final surface application
Inside a Reclaimer

- Deep recycled layer
- Injection of water and/or fluid stabilizing agents
- Operating direction
- Milling drum
- Distressed pavement
- Granular material

- Image of a reclaimed area
- Image of a reclaimed area with a worker in high-visibility gear
Reclamation Train
Where is FDR with cement used?
Roads

• South Carolina DOT
  - Approximately 5 million sy/year
  - Over 40 million sy since 2009
  - Cost savings over $250 million

• Virginia DOT
  - Reconstruction of I-85, I-81, I-66, I-64

• Many counties and cities in the Carolinas, Virginia, and Georgia
Twenty-four years after FDR
Twenty-four years later
Airports

- Joint Base Andrews, Maryland
- Dover AFB, Delaware
- Marine Corps Base Camp Lejeune, NC
- Elizabeth City Coast Guard Air Station, NC aprons
- Dulles International, VA
- Nashville International, TN
- Raleigh Executive, NC
- Richmond International, VA aprons
- Piedmont Triad International, NC aprons
Elizabeth City, NC
Parking lots

• Retail
  - Walmart
  - Publix
  - Food Lion

• Academic
  - Duke University
  - George Mason University
  - Multiple public school districts in NC, VA, and GA

• Transportation
  - Charlotte Douglas Airport (landside improvements)
  - Raleigh Executive Jetport (landside improvements)
Duke University, Durham, NC
Other

• Federal Parks
  - Blue Ridge Parkway, VA
  - Great Smoky Mountains Parkway, TN
  - Natchez Trace Parkway, MS

• Resource Extraction
  - Wind turbine farms
  - Natural gas/fracking roads
  - Solar farms
Cement treated base is proven technology

1935

Cutting in Cement
Cement treated base is proven technology
80 years later...
Charlotte, NC Hub Case Study
Charlotte, NC Photos and Initial Recommendation

<table>
<thead>
<tr>
<th>Asphalt Section Thickness (inches)</th>
<th>Full Depth Patching/Replacement Light-Duty</th>
<th>Full Depth Replacement Heavy-Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½</td>
<td>1 ½</td>
<td>1 ½</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>6+ *</td>
<td>8+ *</td>
<td>8+ *</td>
</tr>
<tr>
<td>9 ½ +</td>
<td>15 ½ +</td>
<td>15 ½ +</td>
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Traditional Pavement Reconstruction Challenges

- Huge impacts to Hub traffic
  - Required to shut down areas for at least a week-main drives, dock doors, etc
  - Work area not open to traffic during process
  - Impacts on hub efficiency and lost profitability for FXG

- Budget-Nearly $10,000,000 Expected Costs

- Schedule-Expected duration of 7-8 Months

- Large potential for undercut change orders, delays

- Reconstruction susceptible to weather delays-wet base

- Safety-deep excavations within yard to protect
Decision for FDR:

- **Reduced impact to Hub:**
  - Work areas shut down only a day at a time, opened back up
  - No long shut down of docks, lanes, etc
  - Provides suitable drive surface even during construction process
  - Substantially less construction vehicle traffic on site

- **Budget-** $4,000,000. $6,000,000 savings, not accounting for savings on hub efficiency.

- **Schedule-** 4 months. Nearly a 50% decrease vs Traditional

- **Much less potential for weather delays.**

- **Superior long-term product**

- **Able to regrade poor drainage areas with little effort**

- **Less potential for undercut change orders**
  - Entire project completed without any undercut change orders.
Mixing, grading, and compaction
Cement transferred from tanker to spreader
Minimal disruption of operations
Minimal disruption of operations
Asphalt paving on day-old FDR base
Reclaiming and paving occur in parallel
The Result: 40
Questions?

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