Runway 9-27 Rehabilitation with FDR Treatment
Purdue Road School
Agenda

- Review Problem Statement and Sponsor’s Goal
- Consideration of Alternatives by Airport Authority
- History/Existing Conditions
- Field Studies: Traditional vs New Technologies
- Forensic Studies Accomplishments
- VPZ Selection Process
- Full-Depth Reclamation Treatment (General)
- Full-Depth Reclamation Treatment at VPZ
- Project Considerations/Lessons Learned
- Industry Initiatives
Problem Statement and Sponsor’s Goal

**Problem:**
Existing runway and taxiway pavements within the project area would historically deteriorate at a faster rate than design life expectancy would project.

**Goal:**
Design new reconstructed or rehabilitated pavements that meet or exceed expected design life with minimal maintenance.
Airport Authority: Consideration of Alternatives

How can we apply modern technology to improve and more efficiently manage pavements?
The Decision to be Made
(AIP Handbook)

- **Rehabilitation** is a more comprehensive restoration of an original functionality that results in a piece of pavement, piece of equipment, or building with a useful life of at least 10 years.

- **Reconstruction** is a complete restoration of an original functionality that results in a virtually new piece of pavement.
  - **FDR (Modification of Standards)**
History/Existing Conditions

- 6,000’ Runway 9-27 originally placed in 1966 (17 years)
- 1st Overlay 1983 (16 years)
  - Loss of centerline crown (16”)
  - Remanufactured materials (surface brittle)
- 2nd Overlay 1999 (15 years)
  - Slag Aggregate HMA
  - Severe cracking...again
History/Existing Conditions

1997 versus 1999 Pavements
VPZ Surface Comparisons

Similar Pavement: Runway 18-36

Failing Pavement: Runway 9-27
Minimum Service Level PCI Score:

- Runway = 60 & Taxiway = 55

Runway 9-27:
- Between 41 and 55 (Poor)

Taxiway A:
- Between 41 and 55 (Poor)

Cause for Distresses:
- 50-70% age related
- 30-45% materials & load related
VPZ Pavement Build-Out History

**Historic Performance:**

- Pavements installed with multiple, variable materials and pavement sections between 1962 and 1999
- Pavements not reaching the anticipated Life Cycle
- Partial underdrain installation
Field Studies: Traditional vs New Technologies
Why Mobile Mapping over Survey?

**Technology Benefits:**
- Increased airfield safety
- Reduce runway closure times
- Baseline for future assessments/analysis (crack, patch plan with locations and quantities)
- More detailed, high resolution dataset
- Geospatially referenced – a GIS supported
- Faster collection methods
- Future data extraction without additional field visits (lights, signs, markings, etc.)
Why VPZ and Mobile Mapping?

- Multiple imagery of existing conditions prior to construction (FAA Requirements) – baseline
  - This includes crack and patch plan
- More accurate cross section and transitional section data
- Would best supplement NDT
  - Image overlay with low-strength or distresses areas
- Can be merged with existing Mobile Data
- More feature information – GIS Layers – Bang for $$$
Supplemental Testing: Why Non-Destructive Testing (NDT) over Coring?
Non-Destructive Testing (NDT) using Falling Weight Deflectometer (FWD)

- Measures pavement surface deflections after applying a static or dynamic load to the pavement for material, strength information
- Provides GPS Relative Layer Strengths
Why NDT and VPZ?

- PCI’s may not be telling the whole story
  - Environmental and subsurface distresses
- Structural or Overload Concerns
  - “Thin” Asphalt Section, Limited As-Builts, Heavy Loading, Multiple Variable Pavement Sections
- Construction Cost Concerns
  - More design input will improve evaluation of alternatives, their justification and isolated areas
- Runway Closure Times
  - Traditional: 13-14 days
  - NDT: 6-7 days
**Time/Safety Difference:**
**MMS/NDT vs Traditional**

- **MMS/NDT**
  - Survey Targets/Scan: 2 Days Total 1 Each (15-min PPR)
  - Geotechnical: 30 cores performed at night (3 nights)
  - NDT: 3 Night Closures
  - Distress Map: 3-4 Office Days
  - **TOTAL Runway Closure Days**: 5 Days

- **Traditional**
  - Survey: 4 Days Total (15-min PPR)
  - Geotechnical: 90 cores performed at night (5 nights)
  - Distress Map: 2 Field Days and 5 Office Days
  - **TOTAL Runway Closure Days**: 11 Days
VPZ Cracking Conditions

- 202,725 LF of Mapped Cracks
- 82% on Runway, 18% on Taxiway
Forensic Study Accomplished

- Identification of the problem
- More accurate detail of cracking
- Allowed a forum of discussion between the stakeholders (Airport, FAA, INDOT)
- Justification as to the decision to rehabilitate or reconstruct
- Conventional Funding (FAA, INDOT)
- Leverage of additional funding (County, RDA)
### VPZ Selection Process

**Primary Objectives:**
- Construct an actual 20-year pavement
- Minimize runway closure as much as possible
- Minimize future maintenance/rehabilitation costs
- Apply a proven methodology
- Minimize subgrade exposure
- Minimize/Mitigate pavement distresses

**Secondary Objectives:**
- Minimize changes to pavement elevations
- Minimize disruptions at taxiway transitions
- Consider initial construction cost

**Outcome:**
- Option 3 was chosen and then modified to include Full-Depth Reclamation (FDR) treatment

<table>
<thead>
<tr>
<th>Repair Options</th>
<th>Object. #1 (20 pts)</th>
<th>Object. #2 (20 pts)</th>
<th>Object. #3 (20 pts)</th>
<th>Object. #4 (15 pts)</th>
<th>Object. #5 (15 pts)</th>
<th>Object. #6 (10 pts)</th>
<th>Total Points from Object. 1 to 6</th>
<th>Option Rank</th>
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</tbody>
</table>

- **Option 1:** Remove all AC layers and install new 9 inch P-401/P-403 section on existing limestone granular base
- **Option 2:** Remove all AC layers and install new 12 inch P-501 section on existing limestone granular base
- **Option 3:** Remove all AC layers western most 1,000 feet, mill and remove 8 inches of top AC layers for remaining 6,000 feet and install new 9 inch P-401/403 section on remaining existing AC layers and limestone granular base
- **Option 4:** Remove all AC layers western most 1,000 feet, mill and remove 9 inches of top AC layers for remaining 6,000 feet and install new 12 inch P-501 section on remaining existing AC layers and limestone granular base
- **Option 5:** Mill and remove 4 inches of top AC layers and install new 4 inch P-401 section on remaining AC layers and granular base
Full-Depth Reclamation (FDR) Treatment

**What is FDR?**
- A pavement stabilizing solution that utilizes blended pulverized asphalt and base materials to provide a homogeneous structure.
- 3 Types:
  - Mechanical Stabilization
  - Chemical Stabilization
  - Bituminous Stabilization

**Why do it?**
- Stronger base
- More uniform base
- Eliminates subsurface distresses
- Reduces potential for infiltration
- Sustainable
- Cheaper than total reconstruction but provides similar-type structure
- Leftovers great for topping haul routes/access roads

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**Types of Stabilization**
- Mechanical stabilization – 1st step in reclamation, also used to describe FDR without addition of a binder (Pulverization)
- Chemical stabilization – FDR with chemical additive (Calcium or Magnesium Chloride, Lime, Fly Ash, Kiln Dust, Portland Cement, etc.)
- Bituminous stabilization – FDR with asphalt emulsion, emulsified recycling agent, or foamed/expanded asphalt additive
- Combination stabilization – Any 2 or more of above

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**Emulsion Full Depth Reclamation Process**
- Injection of water and/or fluid stabilizing agents
- Milling/stoning
- Stabilized material
- Gravel base
- Overlay SEAL
- 6-10 inch emulsion stabilized material

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What's the process?

- Sampling
- Pulverization & Reshaping
- Distributing
- Mixing
- Compacting & Fine Grading
- Curing
- Paving

**FDR Construction Process**

Pulverize, Shape, Add Cement, Mix In Place, Compact, and Surface

<table>
<thead>
<tr>
<th>Bituminous Surfacing</th>
<th>Pulverized</th>
<th>Pulverized</th>
<th>Stabilized</th>
<th>Subgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granular Base</td>
<td>Subgrade</td>
<td>Subgrade</td>
<td>Subgrade</td>
<td>Subgrade</td>
</tr>
<tr>
<td>Subgrade</td>
<td>Pulverization to desired depth</td>
<td>Removal of excess material (if necessary) and shaping</td>
<td>Addition of cement, mixing, reshaping, and compacting</td>
<td>Application of final surface course</td>
</tr>
</tbody>
</table>

**1. EVALUATION OF EXISTING PAVEMENT**

**2. PULVERIZE DETERIORATED ASPHALT AND ROAD BASE**

**3. RESHAPE MATERIAL TO NEW ROAD PROFILE**

**4. DISTRIBUT CEMENT OVER RECYCLED MATERIAL**

**5. HYDRATE CEMENT AND BLEND WITH RECYCLED BASE**

**6. COMPACT MIXED MATERIALS**

**7. FINISH GRADE IN PREPARATION FOR NEW HMA**

**8. FINISH ROLL AND ALLOW RECYCLED MATERIAL TO CURE**

**9. OVERLAY WITH NEW HMA SURFACE**
Why FDR at VPZ?

- Multiple “Typical Sections”
- Exponential number of pavement distresses and structural decline
  - Typical AC Modulus values were very low for a 14-year pavement. Typical values should be greater than 500,000 psi whereas actual values ranged from 101,000 to 271,000 psi
- Subbase/Moisture concerns
  - NDT identified multiple weak areas
- Cheaper alternative than Full Reconstruction
  - Estimate: $8 Million vs $14 Million
  - Actual: $6.9 Million
- Provides full-depth structure
- Reduced long-term maintenance & life-cycle costs
FDR Treatment at VPZ

**FDR Design Parameters:**

- **MODIFICATION OF STANDARDS**
- No Subgrade allowed in Mix
- Cement Content: 4-6%
- Elasticity Modulus: 250,000 psi
- 7-Day Compressive Strength: 300-500 psi

**Runway Program Completion:**

- Two (2) Phases of Construction
  - Phase 1: RW/RW Intersection out to RSAs
  - Phase 2: Remaining east & west portions
Project Considerations/Lessons Learned

- Mix Designs are required to establish cement content
- Cement slurry should be considered where dust control is vital
- Designer should consider field-mixed proctors to test unconfined compressive strength
- Soils with over approximately 1,000 PPM of soluble sulfate should not be treated with an FDR method.
- Thicker lifts can decrease the integrity of the FDR base. 10” should be considered the maximum.
- Discuss Grade control

- Discuss Elasticity Modulus ranges:
  - 1-2% Cement: 15,000 psi
  - 3-4% Cement: 50,000-150,000 psi
  - 5-6% Cement: 250,000-500,000 psi
- Discuss timing of contractor mix design
- 7-Day Unconfined Compressive Strength Criteria:
  - INDOT RSP 413-R-634:
    - > 3” Overlay: 300 psi
    - 1.5-3” Overlay: 400 psi
    - <1.5” Overlay: 500 psi
- BYU Professor, Spencer Guthrie: 400-500 psi
Industry Initiatives

- INDOT RSP 413-R-634 is considering some additional requirements for FDR Treatments. These are as follows:
  - Just In-Time Training (JITT) for field personnel
  - Compaction required until pad foot rollers leave cleat indentation less than 3/16”
  - Compaction required to continue until pneumatic tire rollers do not leave any wheel impressions
  - Weather limitations require FDR not performed below 50⁰ F and may restrict work when heat index greater than 100⁰ F
  - FDR required to be performed after May 1st and before October 1st
Time Lapse Videos

**Camera 1:**
https://www.youtube.com/playlist?list=PLmuYdRh49akIsWncbgh2mrvvwMQ2MJ6iE

**Camera 2:**
https://www.youtube.com/playlist?list=PLmuYdRh49akIsWncbgh2mrvvwMQ2MJ6iE
Questions?