Runway Pavement Analysis with Non-Destructive Testing (NDT)

2015 PURDUE ROAD SCHOOL
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Presenters

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  – FAA Design Analysis and Alternatives

• Michael Buening, PE (INDOT)
  – INDOT Chief Airport Engineer
  – Airport FWD Conclusions and Recommendations
PURDUE UNIVERSITY

PURDUE UNIVERSITY AIRPORT

PROJECT STUDY AREA

PRIMARY INSTRUMENT RUNWAY
6,600’ x 150’ with 10’ Shoulders

CROSSWIND VISUAL RUNWAY 4,250’ x 100’
The Problem

- Runway 10-28 Near End of Useful Life (20 Years)
- Variable Pavement Condition Index’s (PCI) > 20, Distresses
- Change in Aircraft Fleet Mix Overtime
- 2nd Busiest Airport in Indiana – Busiest in Spring/Fall
Introduction to NDT

- Measurement of pavement structural properties through the Falling Weight Deflectometer (FWD) is an accepted practice in pavement testing (with Geotechnical).

- There are two categories for designing airfield asphalt pavement based on the aircraft weight:
  - Pavements serving aircraft with gross weight of 30,000 pounds or more.
  - Pavements serving light aircrafts with less than 30,000 pounds.

- FWD can generate as high as 16,000 pounds loading and can be used for aircraft pavement evaluation.

Note: Sensor D8 is located 12 inches to the right of the load plate.
Scope of Evaluation

- In-situ modulus for pavement layers and subgrade California Bearing Ratio (CBR) (using ELMOD 6.0 software from the Dynatest equipment manufacturer)
- Load Transfer Efficiency (LTE) (using 1993 AASHTO Design Guide procedure and Advisor Circular 150/5370-11A)
- Pavement support condition or void estimation (using INDOT Procedure and Advisor Circular 150/5370-11A)
- Pavement existing structure number (using the 1993 AASHTO Design Guide procedure)
- New airport taxiway pavement thickness design (using FAARFIELD software developed by the FAA in its circular AC 150 /5320-6D)
- Overlay thickness for taxiway pavement (using FAARFIELD software developed by the FAA in its circular AC 150 /5320-6D)
Purdue Airport (Schematic Map)

- Runway 10-28 (6 Passes) - Shoulder (1), Blast Pad (2)
- Taxiway C1, C2, C3, C4, A1, A2 and B (1 Pass Each)
- Runway 5-23 (3 Passes)
Runway 10-18 Pass One to Three

**Pass #1 (Edge)**

- Deflection (Mils) vs. FWD Stations, DMI (Meters)
- Data points for Deflection (Mils) over different FWD Stations and DMI values.

**Pass #2**

- Deflection (Mils) vs. FWD Stations, DMI (Meters)
- Data points for Deflection (Mils) over different FWD Stations and DMI values.

**Pass #3 (Centerline)**

- Deflection (Mils) vs. FWD Stations, DMI (Meters)
- Data points for Deflection (Mils) over different FWD Stations and DMI values.

Graphs showing deviation from Surface Deflection and Subgrade Deflection criteria.
Runway 10-18 Pass Four to Six

- **Pass #4 (Centerline)**
- **Pass #5**
- **Pass #6 (Edge)**

Deflection (Mils) vs. FWD Stations, DMI (Meters)

- Labeled lines:
  - Surface Deflection
  - Surface Deflection Criteria
  - Subgrade Deflection
  - Subgrade Deflection Criteria
## Runway 10-18 Summary

### Pass #1 (Edge)

<table>
<thead>
<tr>
<th>In-Situ</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Modulus of Asphalt</td>
<td>416,600  psi</td>
</tr>
<tr>
<td>Elastic Modulus of Pulverized Asphalt</td>
<td>11,207   psi</td>
</tr>
<tr>
<td>Structural Number</td>
<td>2.34</td>
</tr>
<tr>
<td>Modulus of Resilience of Subgrade Soil</td>
<td>7,471   psi</td>
</tr>
<tr>
<td>CBR of Subgrade Soil</td>
<td>4.98     %</td>
</tr>
</tbody>
</table>

### Pass #2

<table>
<thead>
<tr>
<th>In-Situ</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Modulus of Asphalt</td>
<td>474,465  psi</td>
</tr>
<tr>
<td>Elastic Modulus of Pulverized Asphalt</td>
<td>11,331   psi</td>
</tr>
<tr>
<td>Structural Number</td>
<td>2.43</td>
</tr>
<tr>
<td>Modulus of Resilience of Subgrade Soil</td>
<td>6,796   psi</td>
</tr>
<tr>
<td>CBR of Subgrade Soil</td>
<td>4.51     %</td>
</tr>
</tbody>
</table>

### Pass #3 (Centerline)

<table>
<thead>
<tr>
<th>In-Situ</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Modulus of Asphalt</td>
<td>676,662  psi</td>
</tr>
<tr>
<td>Elastic Modulus of Pulverized Asphalt</td>
<td>22,686   psi</td>
</tr>
<tr>
<td>Structural Number</td>
<td>3.14</td>
</tr>
<tr>
<td>Modulus of Resilience of Subgrade Soil</td>
<td>7,923   psi</td>
</tr>
<tr>
<td>CBR of Subgrade Soil</td>
<td>5.23     %</td>
</tr>
</tbody>
</table>

### Pass #4 (Centerline)

<table>
<thead>
<tr>
<th>In-Situ</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Modulus of Asphalt</td>
<td>709,091  psi</td>
</tr>
<tr>
<td>Elastic Modulus of Pulverized Asphalt</td>
<td>23,680   psi</td>
</tr>
<tr>
<td>Structural Number</td>
<td>3.14</td>
</tr>
<tr>
<td>Modulus of Resilience of Subgrade Soil</td>
<td>8,490   psi</td>
</tr>
<tr>
<td>CBR of Subgrade Soil</td>
<td>5.57     %</td>
</tr>
</tbody>
</table>

### Pass #5

<table>
<thead>
<tr>
<th>In-Situ</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Modulus of Asphalt</td>
<td>462,496  psi</td>
</tr>
<tr>
<td>Elastic Modulus of Pulverized Asphalt</td>
<td>10,759   psi</td>
</tr>
<tr>
<td>Structural Number</td>
<td>2.35</td>
</tr>
<tr>
<td>Modulus of Resilience of Subgrade Soil</td>
<td>7,651   psi</td>
</tr>
<tr>
<td>CBR of Subgrade Soil</td>
<td>5.00     %</td>
</tr>
</tbody>
</table>

### Pass #6 (Edge)

<table>
<thead>
<tr>
<th>In-Situ</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Modulus of Asphalt</td>
<td>430,776  psi</td>
</tr>
<tr>
<td>Elastic Modulus of Pulverized Asphalt</td>
<td>10,486   psi</td>
</tr>
<tr>
<td>Structural Number</td>
<td>2.20</td>
</tr>
<tr>
<td>Modulus of Resilience of Subgrade Soil</td>
<td>8,595   psi</td>
</tr>
<tr>
<td>CBR of Subgrade Soil</td>
<td>5.50     %</td>
</tr>
</tbody>
</table>
Design Analysis

• Existing Pavement Section
  – 4” FAA/INDOT P-401
  – 10” Pulverized Asphalt
  – CBR = 5; 15-35% Moistures

• Existing Operations Mix
  – Single Wheel: 12,500-30,000 lbs.
  – Dual Wheel: 20,000-100,000 lbs.
  – Other: 150,000-175,000 lbs.

• Future Operations Mix
  – Other: 150,000-575,000 lbs.
Pavement Analysis/Options

• Option #1: 2” Bituminous Mill/Overlay
• Option #2: Bituminous Reconstruction
• Option #3: Concrete Reconstruction
• Option #4: 2” Bituminous Mill/Overlay with Reconstruction
Pavement Analysis/Options

• Option #5:
  5.5” Bituminous Mill/Overlay with NDT
  (Work with the FAA; Conservative NDT Value Consideration)
Pavement Analysis/Options

• Identifying the Preferred Option:
  – Concerns with Option #1 and Option #4:
    • Not Providing 20 Year Design Life
    • Ability to Handle Future Fleet Mix
    • Future Operations Interruption (Intersection)
  – Option #5 has a Better Initial Cost and 20 Year Life Cycle Cost Savings compared to Reconstruction Options #2/#3
    • Only a 1” Mill and 2” Overlay required with Future Fleet Mix
  – Option #5 Within FAA Grade Tolerance
• Airport FWD results are consistent with the FWD results found on Highways.
• FWD high pavement deflections at Purdue Airport are due to 4” existing pavement thickness.
• FWD data provides support for the selection of design values in FAARFIELD.
• FWD is a beneficial tool to evaluate and design airfield pavement.
Airport FWD Conclusions

• Questions?