Objective of this workshop

- Make sponsors, consultants, contractors, testing labs and material suppliers familiar with the FAA requirements for hot mixed bituminous pavement specifications
- P-401 and P-403 specifications found in AC 150/5370-10 (currently 10f)
- Use of ERLPM versus Asphalt Institute MS-2. References to ERLPM recently removed in national P-401 and P-403 specs.
- List of people familiar with ERLPM and NICET
- Eastern Region and other regions

The consultant’s world

- Pavement Design: Selection of pavement structure
- Preparing contract specifications for each layer using approved FAA specification and selecting the appropriate elements
- Apply for modification of standards when needed

Pavement Design

- Arrangement of layers to transmit loads (aircraft) to a prescribed area on the surface of the earth
- Philosophy of load distribution: two philosophies
  a) Loads are transmitted gradually, like a trapezoid, from the surface of the pavement to the top level of soil (flexible)
  b) Loads are widely distributed like a beam (Rigid)
- Sub grade: level surface of soil where pavement layers will be placed. Strength expressed in CBR for flexible pavement and K value for rigid pavement
- Bituminous pavement is considered flexible pavement
RIGID PAVEMENT

Typical Flexible Pavement Structure

Basic Premise of CBR method:
Provide sufficient “cover” above each layer to protect that layer from shear failure

Flexible Pavement Design

Three Basic Design Parameters
- Subgrade Support
  - (CBR)
- Types of Aircraft
  - Gear type and Gross Load
- Traffic
  - Annual Departures

Aircraft Grew in Size

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>B-747-400</th>
<th>B-777-200</th>
<th>A300 B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>873,000 lbs</td>
<td>752,000 lbs</td>
<td>304,000 lbs</td>
</tr>
<tr>
<td>Airplanes</td>
<td>A-380</td>
<td>A-340</td>
<td>A-330</td>
</tr>
<tr>
<td>Gross Load</td>
<td>807,000 lbs</td>
<td>469,000 lbs</td>
<td>304,000 lbs</td>
</tr>
<tr>
<td></td>
<td>A-340</td>
<td>A-330</td>
<td>A-300</td>
</tr>
<tr>
<td></td>
<td>970,000 lbs</td>
<td>583,000 lbs</td>
<td>358,000 lbs</td>
</tr>
</tbody>
</table>

Aircraft weight
Sample Gear Configurations

Flexible Pavement Failure Modes

Pavement failure modes in LEDFAA are the same as all flexible design methods.

Subgrade Support
Wearing Surface
Subgrade
Subbase
Base Course

Approximate Line of Wheel-Load Distribution
Area of Tire Contact
Wheel Load

CUMULATIVE DAMAGE FACTOR (CDF) for Traffic Model

- Sums Damage From Each Aircraft - Not From Equivalent Aircraft
- CDF = Summation \( n_i / N_i \) where:
  - \( n_i \) = number of load repetitions from individual aircraft
  - \( N_i \) = allowable load repetitions of individual aircraft
- When CDF = 1, Design Life is Exhausted

- Must Input Traffic Mix, NOT Equivalent Aircraft

LEDFAA now FAARfield

Layered Elastic theory versus CBR procedure

<table>
<thead>
<tr>
<th>Layer</th>
<th>Elastic Modulus (E)</th>
<th>Poisson’s Ratio (( \mu ))</th>
<th>Thickness (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subbase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgrade</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CBR Method vs. Layered Elastic Method

E = Elastic Modulus
\( \mu \) = Poisson’s Ratio
h = Thickness
CBR = California Bearing Ratio

CUMULATIVE DAMAGE FACTOR (CDF) for Traffic Model

- Sums Damage From Each Aircraft - Not From Equivalent Aircraft
- CDF = Summation \( n_i / N_i \) where:
  - \( n_i \) = number of load repetitions from individual aircraft
  - \( N_i \) = allowable load repetitions of individual aircraft
- When CDF = 1, Design Life is Exhausted

- Must Input Traffic Mix, NOT Equivalent Aircraft

Computer Design

Click on desired pavement section
Then click on the project where the section will be saved
Enter Traffic Mixture

Certain aircraft may appear in the list twice. This is to address the presence of wing gears and belly gears. LEDFAA treats these as two aircraft, however the weight and departures are interlocked.

Pavement Design

Select the layer type you want to include. Change P-209 to P-154 in this example. Click OK.

LEDFAA v1.3 Sample Design

Preparing contract specifications from FAA approved specs

- AC150/5370-10F
- Three bituminous specifications, P-401, P-402 and P-403.
- Section 110 and 110 for calculating Percent Within Limits (PWL)

Specification for Hot Bituminous pavement AC 150/5370-10F

- P-401 Surface course and defined by AC 150-5320-6 Requires most testing and estimates a quality level. It must be used in the calculate top layer.
- P-402: Porous Friction Course rarely used
- P-403: base (binder) course, stabilized sub-base course, less than 12,500 lbs. aircraft. Has a pass/fail
Consultant decision on P-403

- Specification for Stabilized Bituminous Base
- Binder Course
- Truing and Leveling Courses
- Testing requirement has been reduced: pass/fail condition

Writing the specification P-401

- Selection of aircraft weight
- Selection of gradation and asphalt cement
- Use of recycle material (RAP)?
- Selection of method of payment
- Use of Notes to the engineer
- Deviating from standards, what to do?

First selection - Aircraft weight

- 12,500 lbs. but less than 60,000 Lbs.
- 60,000 lbs. or more

Second selection

Aggregate gradation

- Large aggregates use less asphalt. Used as binder courses
- Smaller size aggregates (3/4” or 1/2”) used as surface course
Provide longevity of the mix
Selected from maximum size aggregates
Eastern Region used to allow 2% less than national standards.

The Eastern Region has traditionally allowed a reduction of 2% for each size. This practice will be eliminated and approved on a case by case situation.

The Eastern Region used to allow 2% less

### Third selection

**Void in Mineral Aggregates (VMA)**
- Provide longevity of the mix
- Selected from maximum size aggregates
- Eastern Region used to allow 2% less than national standards.

#### Fourth Selection

**Binder material (Asphalt)**
- Old systems: AC and Penetration
- Performance Grade composed of two numbers representing higher and lower temperature of the areas: PG 64-22
- Based on Highway Research program. For airport there is a need to increase the high temperature value (Bumping requirement)
- Some binders used Polymer Modified additives

Note: Performance Graded (PG) asphalt binders should be specified wherever available. The same grade PG binder used by the state highway department in the area should be considered as the base grade for the project (e.g., the grade typically specified in that specific location for dense graded mixes on highways with design Equivalent Standard Axle Loads (ESALS) less than 10 million). The exception would be that grades with a low temperature higher than PG XX-22 should not be used (e.g., PG XX-16 or PG XX-10), unless the engineer has had successful experience with them. Typically, rutting is not a problem on airport runways. However, at airports with a history of stacking on end of runways and taxiway areas, rutting has accrued due to the slow speed of loading on the pavement. If there has been rutting on the project or it is anticipated that stacking may accrue during the design life of the project, then the following grade "bumping" should be applied for the top 125 mm (5 inches) of paving in the end of runway and taxiway areas: For aircraft tire pressure between 100 and 200 psi, increase the high temperature one grade; for aircraft tire pressure greater than 200 psi, increase the high temperature two grades. Each grade adjustment is 6 degrees C. Polymer Modified Asphalt, PMA, has shown to perform very well in these areas. The low temperature grade should remain the same.
Table 4. Binder Grade Selection and Grade Bumping Based on Gross Aircraft Weight.

<table>
<thead>
<tr>
<th>Aircraft Gross Weight (pounds)</th>
<th>High Temperature Adjustment to Base Binder Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 12,500</td>
<td>Temperature Type</td>
</tr>
<tr>
<td>Over 40,000</td>
<td>0</td>
</tr>
<tr>
<td>Over 100,000</td>
<td>1</td>
</tr>
<tr>
<td>Greater than 100,000</td>
<td>2</td>
</tr>
</tbody>
</table>

Notes:
1. PG grades above 64 on the low end (e.g., PG 64-22) are not recommended. Limited experience has shown these to be poor performers.
2. PG grades below 64 on the high end (e.g., PG 22-22) are not recommended. These binders often provide tender tendencies.
3. PG grades above 76 on the high end (e.g., PG 82-22) are very stiff, making it difficult to work and compact.

Table 5: Marshall Acceptance Limits

<table>
<thead>
<tr>
<th>Test Property</th>
<th>Frequency, Design for Average Gross Weight of Aircrafts Less Than 10000 lbs</th>
<th>Frequency, Design for Average Gross Weight of Aircrafts Greater Than 10000 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Mixes</td>
<td>Specified Acceptance Limits</td>
<td>Specified Acceptance Limits</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>U</td>
</tr>
<tr>
<td>Stability, maximum, percent</td>
<td>100</td>
<td>--</td>
</tr>
<tr>
<td>Air Voids, maximum, percent</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Aggregate Gradation Coefficient</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Aggregate Gradation Coefficient, percent</td>
<td>40.8</td>
<td>40.8</td>
</tr>
<tr>
<td>Max. Course Max. Density, percent</td>
<td>52.3</td>
<td>52.3</td>
</tr>
<tr>
<td>Min. Course Min. Density, percent</td>
<td>32.2</td>
<td>32.2</td>
</tr>
</tbody>
</table>

Payment – One side for density

<table>
<thead>
<tr>
<th>Percentage of Marshall Specified Limits (%)</th>
<th>Lag Pay Factor (Percentage of Contract Total Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 - 100</td>
<td>1.0</td>
</tr>
<tr>
<td>50 - 85</td>
<td>0.95L + 0.1</td>
</tr>
<tr>
<td>75 - 85</td>
<td>0.85L + 0.1</td>
</tr>
<tr>
<td>65 - 75</td>
<td>0.75L + 0.1</td>
</tr>
<tr>
<td>Below 65</td>
<td>Exempt</td>
</tr>
</tbody>
</table>

What to expect in contract documents

- One P-401 with one gradation or,
- One P-401 specification with two gradation. Usually the gradation at the bottom is greater (1 - 3/4" maximum size aggregates) because it uses less asphalt, and the smaller aggregate size gradation at the top (1/2" maximum size aggregate) for more smooth surface
- One P-401 on top and P-403 on the bottom
What is the ERLPM

- Eastern Region Laboratory Procedures Manual
- Born in the Eastern Region to use statistical methods to determine quality versus range or media (average)
- Origen – Military specs
- Document to be used in combination with P-401. required in Eastern Region
- Provide forms for project submittal - Appendices

ERLPM

- Section 1: Definitions
- Section 2: Development of JMF
- Section 3: Quality Assurance – Plant produced material
- Section 4: Field Density
- Section 5: Laboratory Equipment
- Section 6: Random Sampling
- Section 7: Quality Control
- Section 8: Method to estimate PWL

ERLPM - Appendices

- Appendix A: Material acceptance
- Appendix B: Sample of mix design
- Appendix C: Contractor Quality Control
- Appendix D: PWL calculation-plant material
- Appendix E: In-place density calculation

Workshop objectives

- Discuss principles and practices of Job Mix Formula
- Discuss use of SuperPave design in airport (EB 59)
- Discuss principles and practices for sampling and testing bituminous mixes
- Discuss principles and practices to determine Quality Assurance of material
- Explain statistical methods to determine quality of materials and pay factors
- Present Contractor testing plan to control the quality of the material and mixes
- What happen after this workshop?

Benefits of this workshop

- Knowledge of FAA specifications
- Knowledge of statistical analysis
- Form to submit/approve JMF
- Form to record testing
- Form to calculate pavement quality
- Job seeking

Material distributed

- ERLPM Appendices
- Specifications P-401 and P-403
- Table for ASTM E 178
- Test to be completed and submitted to FAA
Documents in electronic format

- ERLPM (PDF)
- Specification in words
- Engineering Brief 59 (SuperPave)
- Computer software
- Exam #18
- Current list of people familiar with ERLPM

AGENDA

- Mix Design – Chris Brower from Advance Testing
- SuperPave: Roy McQueen from McQueen and Associates
- Quality Assurance – R. Patton
- Statistical Analysis – Carl Steinhauer
- Computer Software – Guillermo Felix
- Contractor’s Quality Control – R.Patton
- ERLPM Test and List - Guillermo

How many of you are

- Consultants?
- Testing laboratories?
- Contractors?
- Material supplier?
- Government?

Questions you are bringing to this workshop