The 2014 Eastern Region Annual Airports Conference

Workshop for Asphalt Pavement for Airports

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Eastern Region Paving Engineer

Presentation outline

- Objective of the workshop
- The consultant’s role
  a) Pavement design
  b) Specifications for hot mix bituminous materials
- Eastern Region laboratory Procedures Manual (ERLPM) versus Asphalt Institute MS-2 manual
- How this workshop helps me? – List of people familiar with ERLPM
- Workshop agenda
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 Role

- 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
Typical Flexible Pavement Structure

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

Assumed Failure at subgrade

CURRENT DESIGN METHOD
LAYERED ELASTIC DESIGN LEDFAA/FAARFILED
Flexible Pavement Failure Modes

Layered Elastic theory versus CBR procedure

<table>
<thead>
<tr>
<th>LAYERED ELASTIC METHOD</th>
<th>CBR Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURFACE</td>
<td>E_s, μ_s, h</td>
</tr>
<tr>
<td>BASE</td>
<td>E_b, μ_b, h_b</td>
</tr>
<tr>
<td>SUBBASE</td>
<td>E_sb, μ_sb, h_sb</td>
</tr>
<tr>
<td>SUBGRADE</td>
<td>E_sg, μ_sg, h_sg</td>
</tr>
</tbody>
</table>

Subgrade Support

E = Elastic Modulus
μ = Poisson’s Ratio
h = thickness
CBR = California Bearing Ratio

Flexible Pavement Failure Modes

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

Horizontal Strain and Stress at the bottom of the asphalt
Vertical Subgrade Strain

Approximate Line of Wheel-Load Distribution
Area of Tire Contact
Wearing Surface
Base Course
Subbase
Subgrade
Flexible Pavement Design

Three Basic Design Parameters

- Subgrade Support
  - CBR

- Types of Aircraft
  - Gear type and Gross Load

- Traffic
  - Annual Departures

Type of Aircraft: Aircraft weight
Aircraft Grew in Size

- A380-800F: 1,305,000 lbs
- A340-600: 807,000 lbs
- A330-200: 469,000 lbs
- A300 B2: 304,000 lbs

B747-800 at 970,000 lbs

- B-747-400: 873,000 lbs
- B-777-300: 752,000 lbs
- B-767-700: 451,000 lbs
- DC-10-30: 583,000 lbs
- DC 8-71: 358,000 lbs

Sample Gear Configurations
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
Click on desired pavement section

Then click on the project where the section will be saved

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.
Working with a pavement section

The selected sample pavement will appear.

The structure may be modified if desired.

Modifying a pavement section

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

Click OK.
Preparing contract specifications from FAA approved specs

- AC150/5370-10F
- Three bituminous specifications, P-401, P-402 and P-403.
- Section 100 and 110 for calculating Percent Within Limits (PWL)

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

- P-401 Surface course as 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. To be deleted
- P-403: base (binder) course, stabilized sub-base course, less than 12,500 lbs. aircraft Has a pass/fail
PART V – FLEXIBLE SURFACE COURSES
ITEM P-401 PLANT MIX BITUMINOUS PAVEMENTS

DESCRIPTION

401-1.1 This item shall consist of pavement courses composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

This specification is intended to be used for the surface course for airfield flexible pavements subject to aircraft loadings of gross weights greater than 12,500 pounds (5670 kg) and is to apply within the limits of the pavement designed for full load bearing capacity.

The dimensions and depth of the “surface course” for which this specification applies shall be that as is defined by the Engineer’s pavement design as performed in accordance with FAA Advisory Circular 150/5320-6, current edition.

For courses other than the surface course, such as stabilized base courses, binder courses and/or truing and leveling courses; for pavements designed to accommodate aircraft gross weights of 12,500 pounds (5670 kg) or less; and for pavements intended to be used for roads, shoulder pavements, blast pads, and other pavements not subject to full aircraft loading, specification Item P-403 may be used.

State highway department specifications may be used for shoulders, access roads, perimeter roads, stabilized base courses under Item P-501, and other pavements not subject to aircraft loading. When state highway specifications are approved, include all applicable/approved state specifications in the contract documents.

Consultant decision on P-403

- Specification for Stabilized Bituminous Base
- Binder Course
- Truing and Leveling Courses
- Testing requirement has been reduced: pass/fail condition
ITEM P-403 PLANT MIX BITUMINOUS PAVEMENTS
(BASE, LEVELING OR SURFACE COURSE)

DESCRIPTION

403-1.1 This item shall consist of a [ ] course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

Specify base and/or leveling course(s). Surface course may also be specified but only for those pavements designed to accommodate aircraft of gross weights less than or equal to 12,500 pounds (5,670 kg) or for surface course of shoulders, blast pads, service roads, etc. Item P-401 is to be specified for surface courses for pavements designed to accommodate aircraft gross weights greater than 12,500 pounds (5,670 kg).

This specification is to be used as a base or leveling course for pavements designed to accommodate aircraft of gross weights greater than 12,500 pounds (5,670 kg). State highway department specifications may be used in lieu of this specification for access roads, perimeter roads, stabilized base courses under Item P-501, and other pavements not subject to aircraft loading, or for pavements designed for aircraft gross weights of 12,500 pounds (5,670 kg) or less.

Where a state highway department specification is to be used in lieu of this specification, the state specification must have a demonstrated satisfactory performance record under equivalent loadings and exposure. When a density requirement is not specified by a state specification, it is to be modified to incorporate the language found in paragraphs 403-5.1, 403-5.2 and 403-5.3. When state highway specification are approved, include all applicable/approved state specifications in the contract documents.

Writing the specification

P-401

- Selection of aircraft weight
- Selection of gradation and asphalt cement
- Compaction Method (Marshall or Gyratatory)
- 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

Compacting Effort

- Marshal method: falling mass of standard weight and falling distance. There are number of blows on each face of the specimen (75 or 100): Regular P-401
- Gyratory compactor: gyratory apparatus with standard weight and angle. Spec identify number of gyrations in function of aircraft weight. It needs approval of a Modification of Standard. SP-401
Differences between the methods

6 inches diameter mold

4 Inches diameter mold
• Impact Hammer
  - 10 lbs
  - 18' Drop
• Compact with 50 or 75 blows per side depending on aircraft weight
  - > 60k lbs = 75
  - < 60k lbs = 50

Approval of Modification of Standards for the use of Gyratory compactor

- Gross aircraft weights <100,000 pounds: approval at Regional Office

- Gross aircraft weights > 100,000 pounds: approval by AAS-100
MARSHAL COMPACTION SPECIFICATIONS

<table>
<thead>
<tr>
<th>Test Property</th>
<th>PAVEMENTS DESIGNED FOR AIRCRAFT GROSS WEIGHTS OF 60,000 LBS. OR MORE OR TIRE PRESSURES OF 100 PSI OR MORE</th>
<th>Pavements Designed for Aircraft Gross Weights Less Than 60,000 Lbs. or Tire Pressures Less Than 100 Psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Blows</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>Stability, pounds (Newton)</td>
<td>2150 (9564)</td>
<td>1350 (6005)</td>
</tr>
<tr>
<td>Flow, 0.01 in. (0.25 mm)</td>
<td>10-14</td>
<td>10-18</td>
</tr>
<tr>
<td>Air Voids (percent)</td>
<td>2.8-4.2</td>
<td>2.8-4.2</td>
</tr>
<tr>
<td>Percent Voids in Mineral Aggregate (minimum)</td>
<td>See Table 2</td>
<td>See Table 2</td>
</tr>
</tbody>
</table>

TABLE 1
SUPERPAVE DESIGN CRITERIA
Pavements for gross aircraft weights of 60,000 pounds or more.

<table>
<thead>
<tr>
<th>Test Property</th>
<th>Design Criteria for Nominal Maximum Aggregate Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Number of Gyrations ($N_{ini}$)</td>
<td>8 (19 mm Nom.)</td>
</tr>
<tr>
<td>Design Number of Gyrations ($N_{des}$)</td>
<td>85</td>
</tr>
<tr>
<td>Maximum Number of Gyrations ($N_{max}$)</td>
<td>130</td>
</tr>
<tr>
<td>Air voids @ $N_{des}$</td>
<td>4.0</td>
</tr>
<tr>
<td>Voids in Mineral Aggregate @ $N_{des}$, %</td>
<td>13.0 min.</td>
</tr>
<tr>
<td>Voids filled with Asphalt @ $N_{des}$, %</td>
<td>65-78</td>
</tr>
<tr>
<td>Dust proportion</td>
<td>0.6-1.2</td>
</tr>
<tr>
<td>Dust proportion (coarser gradations(^1))</td>
<td>0.6-1.6</td>
</tr>
<tr>
<td>Fine Aggregate Angularity</td>
<td>45 min.</td>
</tr>
<tr>
<td>%$G_{mm}$ @ $N_{ini}$</td>
<td>$\leq 90.50$</td>
</tr>
</tbody>
</table>
TABLE 1
SUPERPAVE DESIGN CRITERIA
Pavements designed for gross aircraft weights of less than 60,000 pounds.

<table>
<thead>
<tr>
<th>Test Property</th>
<th>3/4&quot; Nom. (19 mm Nom.)</th>
<th>1/2&quot; Nom. (12.5 mm Nom.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Number of Gyrations ($N_{ini}$)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Design Number of Gyrations ($N_{des}$)</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Maximum Number of Gyrations ($N_{max}$)</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Air voids @ $N_{des}$</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Voids in Mineral Aggregate @ $N_{des}$, %</td>
<td>13.0 min.</td>
<td>14.0 min.</td>
</tr>
<tr>
<td>Voids filled with Asphalt @ $N_{des}$, %</td>
<td>65-78</td>
<td>65-78</td>
</tr>
<tr>
<td>Dust proportion</td>
<td>0.6-1.2</td>
<td>0.6-1.2</td>
</tr>
<tr>
<td>Dust proportion (coarse gradation')</td>
<td>0.6-1.6</td>
<td>0.6-1.6</td>
</tr>
<tr>
<td>Fine Aggregate Angularity</td>
<td>42 min.</td>
<td>42 min.</td>
</tr>
<tr>
<td>$%G_{mm} @ N_{ini}$</td>
<td>$\leq$ 90.50</td>
<td>$\leq$ 90.50</td>
</tr>
<tr>
<td>$%G_{mm} @ N_{max}$</td>
<td>$\geq$ 98.00</td>
<td>$\geq$ 98.00</td>
</tr>
</tbody>
</table>

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
### AGGREGATE - BITUMINOUS PAVEMENTS

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage by Weight Passing Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-1/2&quot; max</td>
</tr>
<tr>
<td>1-1/2 in. (37.5 mm)</td>
<td>100</td>
</tr>
<tr>
<td>1 in. (24.0 mm)</td>
<td>86.98</td>
</tr>
<tr>
<td>3/4 in. (19.0 mm)</td>
<td>68.93</td>
</tr>
<tr>
<td>1/2 in. (12.5 mm)</td>
<td>57.81</td>
</tr>
<tr>
<td>1/4 in. (9.5 mm)</td>
<td>49.69</td>
</tr>
<tr>
<td>No. 4 (1.75 mm)</td>
<td>34.54</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>22.42</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>13.33</td>
</tr>
<tr>
<td>No. 30 (0.600 mm)</td>
<td>8.24</td>
</tr>
<tr>
<td>No. 50 (0.300 mm)</td>
<td>6.18</td>
</tr>
<tr>
<td>No. 100 (0.150 mm)</td>
<td>4.12</td>
</tr>
<tr>
<td>No. 200 (0.075 mm)</td>
<td>3.6</td>
</tr>
<tr>
<td>Asphalt percent: Stone or gravel Slag</td>
<td>4.5-7.0</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Gradation for SP-401

#### Table 3: AGGREGATE—BITUMINOUS PAVEMENTS

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Gradation Limits</th>
<th>Gradation Limits</th>
<th>Gradation Control Points Percent Passing by Weight</th>
<th>Gradation Control Points Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runway Pavements</td>
<td>1/2 inch (19 mm) Nominal Maximum Size Aggregate</td>
<td>1/2 inch (12.5 mm) Nominal Maximum Size Aggregate</td>
<td>1/4 inch (19 mm) Nominal Maximum Size Aggregate</td>
<td>1/4 inch (12.5 mm) Nominal Maximum Size Aggregate</td>
</tr>
<tr>
<td>1 in. (25.4 mm)</td>
<td>100</td>
<td>76-98</td>
<td>66-86</td>
<td>57-77</td>
</tr>
<tr>
<td>3/4 in. (19.0 mm)</td>
<td>76-98</td>
<td>100</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>1/2 in. (12.5 mm)</td>
<td>66-86</td>
<td>79-99</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>3/8 in. (9.5 mm)</td>
<td>57-77</td>
<td>68-88</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>40-60</td>
<td>48-68</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>26-46</td>
<td>33-53</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>17-37</td>
<td>20-40</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>No. 30 (0.60 mm)</td>
<td>11-27</td>
<td>14-30</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>No. 50 (0.30 mm)</td>
<td>7.19</td>
<td>9.21</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>No. 100 (0.15 mm)</td>
<td>6.16</td>
<td>6.16</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>No. 200 (0.075 mm)</td>
<td>3.6</td>
<td>3.6</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>Asphalt Cement</td>
<td>4.5-7.0</td>
<td>5.0-7.5</td>
<td>4.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>
A coarse gradation is defined as a gradation passing below the restricted zone. The restricted zone is defined in the Asphalt Institute’s Manual Superpave, Series 2 (SP-2).

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.
* 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.

<table>
<thead>
<tr>
<th>Maximum Particle Size</th>
<th>Minimum Voids in Mineral Aggregate, percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>in.</td>
<td>mm</td>
</tr>
<tr>
<td>½</td>
<td>12.5</td>
</tr>
<tr>
<td>¾</td>
<td>19.0</td>
</tr>
<tr>
<td>1</td>
<td>25.0</td>
</tr>
<tr>
<td>1-½</td>
<td>37.5</td>
</tr>
</tbody>
</table>

Eastern Region allowed a reduction of 2 percent, but not any more

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
Understanding PG binders

- PG stand for Performance Grade
- Compose of two number:
  a) the first one meaning the High temperature the pavement is exposed to
  b) The second one is the Low temperature the pavement is expose to. Starts with a minus sign

PG 64 -22

64: meets all requirements up to this temperature in °C

-22: meets all requirements down to this temperature in °C
Some rules of PG binders

- Grades are in 6 °C increments, high or low
- The highest the first number the stiffer the binder is
- The lower the second number is more resistance to thermal cracking
- Greater difference between the number more robust the binder is but more expensive
- If the difference is 92 or more the binder is modified
- PG 70-22 = 70 –(-22) = 70 + 22 = 92

More information for selecting binder

- Use grade typically use for the area where the airport is located. More information can be found in www.asphaltinstitute.org
- Grades above the -22 in the low end are not recommended. Little experience available
- Grades below 64 in the high end, let’s say 58, may result in tender mixes
- Grades above 76 in the high end are very stiff and difficult to compact
Example

- Local PG used PG 64-22
- Pavement is a taxiway to serve +100,000 lbs aircraft
- Bumping requirement: 2
- $64 + 6 + 6 = 76$ (not too stiff to compact)
- -22 is the lowest we want to go
- PG 76-22

<table>
<thead>
<tr>
<th>Grade Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration Grade</td>
</tr>
<tr>
<td>ASTM D 946</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>40-50</th>
<th>60-70</th>
<th>85-100</th>
<th>100-120</th>
<th>120-150</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-5</td>
<td>AC-10</td>
<td>AC-15</td>
<td>AC-20</td>
<td>AC-30</td>
</tr>
<tr>
<td>AR-1000</td>
<td>AR-2000</td>
<td>AR-4000</td>
<td>AR-8000</td>
<td></td>
</tr>
</tbody>
</table>

In general, the Engineer should choose a PG-asphalt binder that has been approved for use in the vicinity by the State DOT, and is locally available. In general, a high reliability (98 percent) on both the high and low temperature categories is sufficiently conservative.
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 A. 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></td>
<td>Runway</td>
</tr>
<tr>
<td>Less than 12,500</td>
<td>--</td>
</tr>
<tr>
<td>Less than 60,000</td>
<td>--</td>
</tr>
<tr>
<td>Less than 100,000</td>
<td>--</td>
</tr>
<tr>
<td>Greater than 100,000</td>
<td>1</td>
</tr>
</tbody>
</table>

NOTES:
1. PG grades above a –22 on the low end (e.g. 84-16) are not recommended. Limited experience has shown this to be a poor performer.
2. PG grades below a 64 on the high end (e.g. 58-22) are not recommended. These binders often provide tender tendencies.
3. PG grades above a 76 on the high end (e.g. 82-22) are very stiff and may be difficult to work and compact.
Fifth selection
Quality acceptance criteria

- Marshall acceptance limits
- Gyratory Compactor (SP) acceptance limits

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Table 5: Marshall Acceptance Limits

<table>
<thead>
<tr>
<th>TEST PROPERTY</th>
<th>Pavements Designed for Aircraft Gross Weights of 60,000 Lbs. or More or Tire Pressures of 100 Psi or More</th>
<th>Pavements Designed for Aircraft Gross Weights Less Than 60,000 Lbs. or Tire Pressures Less Than 100 Psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Blows</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Specification Tolerance Limits</td>
<td>Specification Tolerance Limits</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>U</td>
</tr>
<tr>
<td>Stability, minimum, pounds</td>
<td>1800</td>
<td>--</td>
</tr>
<tr>
<td>Flow, 0.01-inch</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Air Voids Total Mix, percent</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Surface Course Mat Density, percent</td>
<td>96.3</td>
<td>[101.3]</td>
</tr>
<tr>
<td>Base Course Mat Density, percent</td>
<td>95.5</td>
<td>[101.3]--</td>
</tr>
<tr>
<td>Joint density, percent</td>
<td>93.3</td>
<td>--</td>
</tr>
</tbody>
</table>
Gyratory compactor acceptance criteria

> 60,000 lbs.

- 2.5% < Air Voids < 5.5% @ 85 gyrations
- Compaction
  - L = 92.5% Gmm
- Joint 90.5% G_{mm}

< 60,000 lbs.

- 2.5% < Air Voids < 5.5% @ 60 gyrations
- Compaction
  - L = 92.5% Gmm
- Joint 90.5% G_{mm}

---

ACCEPTANCE LIMITS

<table>
<thead>
<tr>
<th>Test Property</th>
<th>Specification Tolerance Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Voids, (% @ N_{des})</td>
<td>Lower: 2.5</td>
</tr>
<tr>
<td>Mat Density, %G_{mm}</td>
<td>Lower: 92.8</td>
</tr>
<tr>
<td>Joint Density, %G_{mm}</td>
<td>Lower: 90.5</td>
</tr>
</tbody>
</table>
Payment Options

### Payment – One side for density

**TABLE 6 - PRICE ADJUSTMENT SCHEDULE**

<table>
<thead>
<tr>
<th>Percentage of Material Within Specification Limits (PWL)</th>
<th>Lot Pay Factor (Percent of Contract Unit Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>96 – 100</td>
<td>106</td>
</tr>
<tr>
<td>90 – 95</td>
<td>PWL + 10</td>
</tr>
<tr>
<td>75 – 89</td>
<td>0.5 PWL + 55</td>
</tr>
<tr>
<td>55 – 74</td>
<td>1.4PWL – 12</td>
</tr>
<tr>
<td>Below 55</td>
<td>Reject 2</td>
</tr>
</tbody>
</table>
Payment – two sided for density

TABLE 6. PRICE ADJUSTMENT SCHEDULE

<table>
<thead>
<tr>
<th>Percentage of Material Within Specification Limits (PWL)</th>
<th>Lot Pay Factor (Percent of Contract Unit Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>93 – 100</td>
<td>103</td>
</tr>
<tr>
<td>90 – 93</td>
<td>PWL + 10</td>
</tr>
<tr>
<td>70 – 89</td>
<td>0.125PWL + 88.75</td>
</tr>
<tr>
<td>40 – 69</td>
<td>0.75PWL +45</td>
</tr>
<tr>
<td>Below 40</td>
<td>Reject ²</td>
</tr>
</tbody>
</table>

Options to pay bonus

- Any percentage above 100% can be used to compensate penalties
- Depending on importance of the project the sponsor may select “actual payment” however, he(she) is risking funds allocations.
- Change order are subject to Grant limits.
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

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
- Random Sampling – Guillermo Felix
- Quality Assurance – Chris Brower
- Statistical Analysis – Carl Steinhauer
- Computer Software – Guillermo Felix
- Contractor’s Quality Control – John Savastio
- ERLPM Test and List - Guillermo

How many of you are

- Consultants?
- Testing laboratories?
- Contractors?
- Material supplier?
- Government?
Questions you are bringing to this workshop