Binder Selection for Airfield Pavements

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Sustainability and Airfields

• “The ability to provide for the needs of the world's current population without damaging the ability of future generations to provide for themselves. When a process is sustainable, it can be carried out over and over without negative environmental effects or impossibly high costs to anyone involved.”

• Asphalt pavement is the most sustainable material

• Must design and construct for long life to achieve maximum sustainable benefits
Why use Superpave?

• Conversion from Marshall to Superpave is one key to extending pavement life

• Asphalt cement has been PG graded since about 1995 – soon it may not be possible to get CGSB Pen-Vis graded cement

• Superpave aggregate gradations are prevent from Ontario eastward and are starting to be used in the western Provinces
Superpave

• Developed in response to pressures on the US highway system
• Strategic Highway Research Program (SHRP), authorized by Congress in 1987
• A highly focused, $150 million, 5-year effort designed to improve the performance of highway materials and highway maintenance practices with two subsequent extensions
• Adopted by all states within a few years (funded)

• On of the first products was the PG system for binder selection
PG Grading System

Performance Grade

High Temperature
Average 7-day maximum pavement design temp

Low Temperature
Minimum pavement design temp

PG 58 – 28
## Grade Bumping P-401

<table>
<thead>
<tr>
<th>Aircraft Gross Weight (pounds)</th>
<th>High Temperature Adjustment to Base Binder Grade</th>
<th>Pavement Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Runway</td>
<td>Taxiway/Apron</td>
</tr>
<tr>
<td>Less than 12,500</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Less than 60,000</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>Less than 100,000</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>Greater than 100,000</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**NOTES:**
1. PG grades above a -22 on the low end (e.g. 64-16) 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 not recommended. These binders are very stiff and difficult to work and compact.

## Grade Bumping P-401 (SP)

Determine binder requirements from the LTTP Bind software using 98 percent reliability with no traffic or speed adjustments. Increase the high temperature grade by the number of grade equivalents indicated (1 grade is equivalent to 6 degrees C) below. Use the low temperature grade as determined from LTTP Bind. (see NOTES)

<table>
<thead>
<tr>
<th>Aircraft Gross Weight (pounds)</th>
<th>High Temperature Adjustment to Binder Grade</th>
<th>All Pavement Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight &lt; 12,500</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>12.500 &lt; weight &lt; 100,000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>weight &gt; 100,000</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** PG grades above a -22 on the low end (e.g. 64-16) are not recommended. Limited experience has shown an increase in block cracking with -16 or -10 grade asphalts.
LTPPBIND Software

• Use LTPPBInd to determine local environmental temperature

• Available free of charge

• Version 2.1 and 3.1 are both available on line

• For EB 59A and likely for AC 150/5370-10E dated Sept 30, 2009 (contains Item P-401(SP) approved for all runways and taxiways) still use LTPPBInd 2.1
Airfield Asphalt Pavement Technology Program (AAPTP)

- FAA sponsored Research program carried out at Auburn University
- Several research reports on using Superpave highway specifications for airport work
- Program was suspended in 2010

- Webinars and Full Reports still available online
  - www.aaptp.us
• Many very interesting research reports
• Binder selection
  – 04-02: *PGAC for Airfield Pavements*
  – Authors state that their recommendations are based on existing Superpave mix design procedures and if 04-03: *Superpave Mix Design for Airfield Pavements* makes significant changes, the recommendations should be re-evaluated
  – States that LTPPBind v3.1 should be used
• Consult full reports for details of recommendations
Grade Bumping for Airfields

• Why do we grade bump?
  – Environmental high temperature recommendations in LTPPBind may not ensure against permanent deformation (rutting) under high wheel loading and/or slow moving traffic
  – Bumping, or raising the high temperature grade by one or two grades is a method of increasing performance

• Superpave grade bumping is based on ESALs (Equivalent Single Axle Loads) which were used in the ASHTO road test

• How do you convert from highway loading to airfield loading?
Grade Bumping

PG Binder Selection

Parameter | A=8 km | B=11 km | C=12 km | D=13 km | E=16 km
--- | --- | --- | --- | --- | ---
Station ID | PQ7386 | PQ0392 | PQ4629 | PQ7755 | PQG266
Elevation, m | 61 | 53 | 15 | 61 | 15
Degree-Days >10 C | 1977 | 2067 | 2087 | 1981 | 2071
Low Air Temperature, C | -34.6 | -30.7 | -32.6 | -33.8 | -32.5
Low Air Temp. Std Dev | 3 | 3 | 3.2 | 2.9 | 2.9

Input Data

| Latitude, Degree | 45.74 |
| Lowest Yearly Air Temperature, C | -32.8 |
| Yearly Degree-Days>10 Deg.C | 2039 |
| Low Air Temp. Standard Dev., Deg C | 3.0 |

Temperature Adjustments

Base HT PG | 52 |
Desired Reliability, % | 96 |
Depth of Layer, mm | 0 |

Traffic Adjustments for HT

<table>
<thead>
<tr>
<th>Traffic Loading</th>
<th>Traffic Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 3 M. ESAL</td>
<td>Fast</td>
</tr>
<tr>
<td>0.0</td>
<td>2.8</td>
</tr>
<tr>
<td>3 to 10 M. ESAL</td>
<td>7.8</td>
</tr>
<tr>
<td>10 to 30 M. ESAL</td>
<td>13.2</td>
</tr>
<tr>
<td>Above 30 M. ESAL</td>
<td>15.5</td>
</tr>
</tbody>
</table>

PG Temperature

<table>
<thead>
<tr>
<th>PG Temp. at 56% Reliability</th>
<th>HIGH</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>47.8</td>
<td>-24.8</td>
<td></td>
</tr>
<tr>
<td>PG Temp. at Desired Reliability</td>
<td>51.2</td>
<td>-31.0</td>
</tr>
<tr>
<td>Adjustments for Traffic</td>
<td>17.7</td>
<td></td>
</tr>
<tr>
<td>Adjustments for Depth</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Adjusted PG Temperature</td>
<td>68.9</td>
<td>-31.0</td>
</tr>
<tr>
<td>Selected PG Binder Grade</td>
<td>70</td>
<td>-34</td>
</tr>
</tbody>
</table>

Recalculate PG | Save | Cancel
• Determine EHE (Equivalent Highway ESALs)
• Method of evaluating loading on airfield as compared to pavements
  – Tire pressure
  – Wander (Pass-to-Coverage Ratio)
• Developed recommendation in chart form
Equivalent Highway ESALs (EHE)

Maximum Gross Aircraft Weight, lb:

- 1,000,000
- 300,000
- 100,000
- 30,000
- 10,000

EHEs for Binder Grade Selection

Annual Departures
### Recommendations

Table A. High-Temperature PG Grade Adjustments for Airfield Type and Aircraft Speed and Stacking, Including Provisions for Polymer Modified Asphalt Binders.

<table>
<thead>
<tr>
<th>Aircraft Stacking</th>
<th>Typical Speed Mph</th>
<th>Grade Adjustment ºC</th>
<th>Non-Modified Binders</th>
<th>Polymer Modified Binders*</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>≥ 45</td>
<td>15 to &lt; 45</td>
<td>&lt;300,000</td>
<td>0</td>
</tr>
<tr>
<td>Little or none</td>
<td>≥ 45</td>
<td>15 to &lt; 45</td>
<td>300,000 to &lt; 3 million</td>
<td>+7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 million to &lt; 10 million</td>
<td>+7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>≥ 10 million</td>
<td>---</td>
</tr>
<tr>
<td>Occasional</td>
<td>---</td>
<td>5 to &lt; 15</td>
<td>&lt; 10 million</td>
<td>+14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>≥ 10 million</td>
<td>---</td>
</tr>
<tr>
<td>Frequent</td>
<td>---</td>
<td>&lt; 5</td>
<td>Any</td>
<td>---</td>
</tr>
</tbody>
</table>

*Polymer modified binders must have a minimum elastic recovery value of 60% at 25 ºC, following procedures described in AASHTO 301.
New Developments

• MSCR (*Multiple Stress Creep Recovery*)
  – Tests only at the environmental temperature
  – “Bumping” based on loading
    • Standard, High and Very High (and Extreme)
    • Uses Jnr – Non-recoverable creep compliance
  – M320 = PG 58-34 → PG 64-34 → PG 70-34
  – MSCR = PG 58-34S → PG 58-34H → PG 58-34V

• Second part of test – MSCR % Recovery
  – Indicator of polymer modification
  – Much better system than Elastic Recovery
More New Developments

- Recently published AAPTP reports
  - 06-01: *A Laboratory And Field Investigation to Develop Test Procedures for Predicting Non-load Associated Cracking of Airfield HMA Pavements*
  - 06-01II: *Guide for Prevention and Mitigation of Non-load Associated Distress*

- Very recent publication presented this spring at the AAPT conference by Dr. Michael Anderson (AI Director of Research)
  - Based on research on unmodified asphalt cement grades
  - Needs research on modified grades
  - Needs more verification before implementation
A Fast Overview!
Thank You!