Asphalt Institute Method
Mechanistic-Empirical Methodology

Material Properties

Climate Models

Climate Information

Structural Models

Pavement Response

Traffic Information

Failure Criteria

Final Layer Thicknesses

Trial Layer Thicknesses

Satisfactory

Unsatisfactory
Asphalt Institute Methodology

- Freeze/Thaw Asphalt Temp
  - MAAT (°F)
  - E_{ac}, E_{bs}, E_{sg}
  - ν_{ac}, ν_{bs}, ν_{sg}

- DAMA (LEA)
  - max asphalt ε_{t}
  - max subgrade ε_{c}

- ESALS

- N_{f} (fatigue)
- N_{d} (rutting)

- Final Layer Thicknesses
- h_{ac}
- h_{bs}

- Satisfactory
- Unsatisfactory
Pavement Response

(a) Full-Depth asphalt concrete and emulsified asphalt base pavements

(b) Pavements with granular base
Pavement Response

(a) Full-Depth asphalt concrete and emulsified asphalt base pavements

(b) Pavements with granular base
Pavement Response

FULL-DEPTH ASPHALT PAVEMENT

(6) Pavements with granular base

(a) Full-Depth asphalt concrete and emulsified asphalt base pavements

DEEP-STRENGTH ASPHALT PAVEMENT

h₁, E₁, 0.35

h₂, E₂, 0.35

h₃, E₉, 0.35

∞, E₉, 0.45

Not to Scale

h₁, E₁, 0.35

h₂, E₂, 0.35

h₃, E₉, 0.35

∞, E₉, 0.45

Not to Scale
Fatigue Failure Criterion

\[ N_f = 0.0796 \left( \varepsilon_t \right)^{-3.291} E^* \]

- \( N_f \): Asphalt Fatigue Life
- \( \varepsilon_t \): Asphalt Tensile Strain
- \( E^* \): Asphalt Resilient Modulus
Rutting Failure Criterion

\[ N_d = 1.365 \times 10^{-9} (\varepsilon_c)^{-4.477} \]
Traffic

\[ ESAL = (ADT)(T)(T_f)(D)(L)(G)_{365} \]
## Climatic Regions

<table>
<thead>
<tr>
<th>MAAT (°F)</th>
<th>Asphalt Grades</th>
<th>Viscosity, $\lambda$ ($10^6$ poise)</th>
<th>Frost Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>AC-5, AC-10</td>
<td>0.6</td>
<td>Yes</td>
</tr>
<tr>
<td>60</td>
<td>AC-10, AC-20</td>
<td>1.6</td>
<td>Possible</td>
</tr>
<tr>
<td>75</td>
<td>AC-40</td>
<td>5.0</td>
<td>No</td>
</tr>
</tbody>
</table>
Mean Monthly Air Temperatures

South Carolina (MAAT = 60°F)

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>45°F</td>
</tr>
<tr>
<td>Feb</td>
<td>38°F</td>
</tr>
<tr>
<td>Mar</td>
<td>43°F</td>
</tr>
<tr>
<td>Apr</td>
<td>45°F</td>
</tr>
<tr>
<td>May</td>
<td>56°F</td>
</tr>
<tr>
<td>Jun</td>
<td>70°F</td>
</tr>
<tr>
<td>Jul</td>
<td>78°F</td>
</tr>
<tr>
<td>Aug</td>
<td>81°F</td>
</tr>
<tr>
<td>Sept</td>
<td>78°F</td>
</tr>
<tr>
<td>Oct</td>
<td>73°F</td>
</tr>
<tr>
<td>Nov</td>
<td>58°F</td>
</tr>
<tr>
<td>Dec</td>
<td>54°F</td>
</tr>
</tbody>
</table>
Pavement Temperatures

The graph shows the temperature variations of asphalt and air over a period of five years from August 1, 1997 to August 1, 2001. The temperature values are measured in degrees Celsius (°C). The graph indicates that the temperature of asphalt closely follows that of the air, with slight variations due to direct contact and heat dissipation.
Pavement Temperature

\[ M_p = M_a \left(1 + \frac{1}{z + 4}\right) - \frac{34}{z + 4} + 6 \]

Mean monthly air temperature (°F)

Mean monthly asphalt temp. (°F)

Depth (in)
Asphalt Modulus

\[
\log |E^*| = c_1 + c_2 \left( P_{200} f^{-c_3} \right) - c_4 V_a + c_5 \lambda + c_6 f^{-c_7} \\
+ c_8 V_b^{0.5} T^{(c_9+c_{10}\log f)} \left( c_{11} - c_{12} f^{-c_{13}} \right)
\]
Unbound Base Modulus

\[ M_R = K_1 \theta^{K_2} \]
Unbound Base Modulus

\[ E_2 = 10.447 h_1^{-0.471} h_2^{-0.041} E_1^{-0.139} E_3^{0.287} K_1^{0.868} \]
Unbound Base Modulus

\[ 3\sqrt[3]{E_1} = \frac{h_s \sqrt[3]{E_s} + h_b \sqrt[3]{E_b}}{h_s + h_b} \]

\[ s = \text{surface course} \]
\[ b = \text{binder course} \]
Subgrade Modulus

South Carolina (60°F MAAT)

- Frozen Subgrade Modulus: 50,000 psi
- Normal Subgrade Modulus: 4,000 psi, 12,000 psi, 22,500 psi
- Thaw (Reduced) Subgrade Modulus: 1,350 psi, 7,200 psi, 18,000 psi

Month Freeze Started: January

2 Months, 4 Months, 5 Months, 12 Months, January
Asphalt Institute Method

FULL-DEPTH ASPHALT PAVEMENT

Asphalt Concrete Surface

Asphalt Concrete or Emulsified Asphalt Base

Subgrade

Not to Scale

(a) Full-Depth asphalt concrete and emulsified asphalt base pavements
Full-Depth Asphalt Concrete

MAAT 60°F

Design Chart A-25
Asphalt Institute Method

(b) Pavements with granular base
Asphalt Institute Method

<table>
<thead>
<tr>
<th>Traffic EAL</th>
<th>Traffic Condition</th>
<th>Minimum Thickness of Asphalt Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^4$ or less</td>
<td>Light traffic parking lots, driveways and light rural roads</td>
<td>75mm (3.0 in.)*</td>
</tr>
<tr>
<td>Between $10^4$ &amp; $10^6$</td>
<td>Medium truck traffic</td>
<td>100mm (4.0 in.)</td>
</tr>
<tr>
<td>$10^6$ or more</td>
<td>Heavy truck traffic</td>
<td>125mm (5.0 in.) or greater</td>
</tr>
</tbody>
</table>

*For Full-Depth asphalt concrete or emulsified asphalt pavements a minimum thickness of 100mm (4 in.) applies in this traffic region, as shown on the design charts.