Comparable Pavement Designs at GDOT

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June 3

2008 SEPMDC
N Little Rock, Arkansas
Comparable Pavement Designs

- Current Design Practice

- Constraints of the Current Practice

- Interim Direction for Comparable Designs
Flexible Pavement Design

Based on the 1972 AASHTO Interim Guide for the Design of Pavement Structures

- INPUTS: Soil Support Value, Regional Factor, Traffic Volumes and Truck percentages
- OUTPUT: Structural Number (SN)

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Flexible Pavement Design

- Layer Thicknesses \( (D_i) \) are multiplied by appropriate layer coefficients \( (a_i) \)

\[
SN = a_{\text{surface}} D_{\text{surface}} + a_{\text{binder}} D_{\text{binder}} + a_{\text{base AC}} D_{\text{base AC}} + a_{\text{GAB}} D_{\text{GAB}}
\]

- The aggregate base course is part of the pavement structure
Typical Flexible Layer Thicknesses

- $D_{\text{surface}}$ >> 1.25 or 1.5 inches
- $D_{\text{intermediate}}$ >> 2 inches
- $D_{\text{base AC}}$ >> 3 inches minimum
- $D_{\text{GAB}}$ >> 8,10, or 12 inches
Rigid Pavement Design Method

- Based on the 1981 Revision of the 1972 Interim AASHTO Design Guide

- INPUTS: Effective Modulus of Subgrade Reaction ($k_{eff}$), Modulus of Rupture, Traffic Volumes, and Truck percentages

- OUTPUT: slab thickness (D)
Typical Rigid Design Inputs

- **Subgrade**
  - $k_{\text{Subgrade}}$ ranges from 110 to 200 pci

- **Interlayer**
  - $D_{\text{AC Interlayer}} : 3$ inches of 19 mm SP

- **Aggregate Base**
  - $D_{\text{GAB}} : 8, 10, or 12$ inches
Typical Rigid Design Inputs

- **Concrete**
  - Modulus of Rupture $f_r = 600$ psi
  - Design Tensile Strength
    $$f_t = 0.75 \times f_r \Rightarrow 450 \text{ psi}$$
  - $E_c = 3,200,000$ psi
Other Rigid Design Inputs

- Traffic loading volumes are same as in Flexible Design.
  - Rigid ESAL factors are higher.

- Load Transfer Coefficient (J) of 3.2
  - Assumes little edge support

- Reliability of 80% - 85%
ESAL Factors Used

- **MU**
  - Flexible = 1.500
  - Rigid = 2.680

- **SU**
  - Flexible = 0.400
  - Rigid = 0.500

- **Vehicles**
  - Flexible is not calculated
  - Rigid = 0.004
Comparable Pavement Designs

- Current Design Practice

- Constraints of the Current Practice

- Interim Direction for Comparable Designs
Constraints of the Current Practice

- The same GAB thickness is used for both pavement types
  - Geotechnical recommendation

- Flexible pavements are under-designed by 10%-15%
  - To allow future resurfacing in 10 years
Constraints: cont’d

- Rigid pavements are not under-designed
  - Difficult to overlay JPC with a thin JPC layer

- Rigid pavements have an interlayer
  - Permeability

- Total thicknesses of rigid pavements are greater than the flexible pavements
In General

- With a Soil Support Value of 2.0,
  - The required GAB layer thickness is 12 inches
  - The SN of the GAB is 1.92
And

- For the same soil, the k value of the subgrade is 110 pci,
  
  - The required GAB layer is also 12 inches
  
  - The rigid pavement has an additional layer of 3 inches of 19 mm SP
  
  - The effective k value ($k_{eff}$) is 260 pci
Heavy State Route Example

- Required flexible pavement
  - Required SN = 6.4±
  - Required Structure
    - 10.5 inches AC
    - 12 inches of GAB (30% Contribution)

- Required rigid pavement
  - Required Thickness = 10.3 inches
  - Additional Structure
    - 3 inches of 19 mm SP
    - 12 inches of GAB
Local Collector Example

- Required flexible pavement
  - Required SN = 4.7±
  - Required Structure
    - 6.5 inches AC
    - 12 inches of GAB (41% Contribution)

- Required rigid pavement
  - Required Thickness = 7 inches
  - Additional Structure
    - 3 inches of 19 mm SP
    - 12 inches of GAB
Another Look at Heavy State Routes

- Without the GAB and AC Interlayer,
  - $k_{eff} = k_{subgrade} = 110$ pci
  - 10.8 inches of JPC Pavement is needed

- With the GAB and AC Interlayer
  - $k_{eff} = 260$ pci
  - 10.3 inches of JPC Pavement is needed
  - Therefore, the GAB and Interlayer system reduced the total slab thickness by 5%
Another Look at Local Collectors

- Without the GAB and AC Interlayer,
  - $k_{\text{eff}} = k_{\text{subgrade}} = 110$ pci
  - 7.5 inches of JPC Pavement is needed

- With the GAB and AC Interlayer
  - $k_{\text{eff}} = 260$ pci
  - 7 inches of JPC Pavement is needed
  - Therefore, the GAB and Interlayer system reduced the total slab thickness by 7%
Design Summary

- In the flexible pavement, the GAB layer is an essential element of the final structure.
  - 30 to 40% of the SN

- In the rigid pavement, the GAB layer and the asphalt concrete Interlayer are
  - 5 to 10% of the thickness
Design Considerations

- Should the GAB layer and asphalt interlayer be eliminated?
  - **NO.** They are needed for handling constructability and permeability issues.

- Can the GAB layer and asphalt interlayer be reduced?
  - **YES.** On state routes and not interstates.
History of the Current Practice

- GDOT up to early 2000’s used to selectively use AC Interlayer on state route projects

- Interlayer was omitted when traffic volumes do not justify the additional costs

- Interlayer was used on Interstates
Performance

- These pre-2000 PCC Pavements with no interlayer are showing good performance
  - I-285 in Decatur County b/w I-20 to I-85
  - GA 400 in Fulton and Forsyth Counties
  - Zell Miller Parkway

- The newer PCC Pavements without the interlayer are also showing good performance to date
  - Homer Bypass
Comparable Pavement Designs

- Current Design Practice

- Constraints of the Current Practice

- Interim Direction for Comparable Designs
Proposed Direction For Comparable Designs

Implement MEPDG…

...In 2 – 3 years

BUT In the meantime…
Interim Direction For More Comparable Designs

- **Base Guidelines**
  - If $SSV < 3.0$, use 10 inches GAB
  - If $SSV \geq 3.0$, use 8 inches GAB

- **Interlayer Guidelines**
  - For Interstates, use 3 inches of 19 mm SP
  - For State Routes, 3 inches of 19 mm SP is waived, unless truck traffic (volume, ESALs, etc…) warrant its use.
Comparison of Designs

The following pavement designs were prepared for

- Life Cycle Cost Analysis (LCCA) / Pavement Type Selection (PTS)

- Used Old and Interim Design Guidelines for Comparison

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## Old and Interim GAB Layers

<table>
<thead>
<tr>
<th>SSV</th>
<th>$k_{\text{subgrade}}$</th>
<th>GAB$_{\text{old}}$</th>
<th>GAB$_{\text{interim}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>110</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>2.5</td>
<td>130</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>3.0</td>
<td>150</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>3.5</td>
<td>175</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>
Old And Interim AC Interlayer
And $k_{\text{design}}$

<table>
<thead>
<tr>
<th>Old Interlayer</th>
<th>$k_{\text{design}}$</th>
<th>Interim Interlayer</th>
<th>$k_{\text{design}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>260</td>
<td>0</td>
<td>175</td>
</tr>
<tr>
<td>3</td>
<td>280</td>
<td>0</td>
<td>195</td>
</tr>
<tr>
<td>3</td>
<td>270</td>
<td>0</td>
<td>195</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>0</td>
<td>215</td>
</tr>
</tbody>
</table>
## Pavement Designs for SSV = 2.0

<table>
<thead>
<tr>
<th>Flexible</th>
<th>Old Rigid</th>
<th>Interim Rigid</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Layer (inches)</td>
<td>GAB Layer (inches)</td>
<td>Slab Depth (inches)</td>
</tr>
<tr>
<td>9.5</td>
<td>12</td>
<td>8.3</td>
</tr>
</tbody>
</table>

- **AADT<sub>20 year</sub> = 11,550**
- **MU=1**
- **SU=3**

- Interlayer = 3 in
- $k_{design} = 260$ pci

- Interlayer = 0 in
- $k_{design} = 175$ pci
# Pavement Designs for SSV = 2.5

<table>
<thead>
<tr>
<th></th>
<th>Flexible</th>
<th>Old Rigid</th>
<th>Interim Rigid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC Layer (inches)</strong></td>
<td>6.25</td>
<td>7.1</td>
<td>7.6</td>
</tr>
<tr>
<td><strong>GAB Layer (inches)</strong></td>
<td>12</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td><strong>Slab Depth (inches)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GAB Layer (inches)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Slab Depth (inches)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GAB Layer (inches)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **AADT$_{20 \text{ year}}$ = 4720**
- **MU=1**
- **SU=5**
- **$k_{\text{design}} = 280$ pci**
- **$k_{\text{design}} = 195$ pci**

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## Pavement Designs for SSV = 2.5

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<tr>
<td>AC Layer (inches)</td>
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<td>Slab Depth (inches)</td>
</tr>
<tr>
<td>11.5</td>
<td>12</td>
<td>10.2</td>
</tr>
</tbody>
</table>

$\text{AADT}_{20 \text{ year}} = 9900$

| MU=6 | SU=4 |
|  |  |

$k_{\text{design}} = 280 \text{ pci}$

$k_{\text{design}} = 195 \text{ pci}$

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## Pavement Designs for SSV = 3.0

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
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<td>Slab Depth (inches)</td>
<td>GAB Layer (inches)</td>
</tr>
<tr>
<td>11.5</td>
<td>12</td>
<td>11.6</td>
<td>12</td>
</tr>
</tbody>
</table>

**AADT\textsubscript{20 year} = 18,200**

- MU=7
- SU=7
- Interlayer = 3 in
- $k_{\text{design}} = 270$ pci
- Interlayer = 0 in
- $k_{\text{design}} = 195$ pci

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# Pavement Designs for $SSV = 3.5$

<table>
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<td>10.3</td>
<td>10.6</td>
</tr>
<tr>
<td>GAB Layer (inches)</td>
<td>12</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Slab Depth (inches)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Slab Depth (inches)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>GAB Layer (inches)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- $AADT_{20\text{ year}} = 8775$
- $MU=8$
- $SU=3$
- $k_{\text{design}} = 300 \text{ pci}$
- $k_{\text{design}} = 215 \text{ pci}$

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Questions ? ? ?