Comparable Pavement Designs at GDOT

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Comparable Pavement Designs

- **GDOT's Traditional Design Practice**
  - **Flexible Pavements**
  - **Rigid Pavements**
- Constraints of the Traditional Practice
  - In-Service PCC Pavement Design Features
  - Design Examples
- Practice for Comparable Designs
  - Proposed Revisions

Flexible Pavement Design

- Based on the 1972 AASHTO Interim Guide for the Design of Pavement Structures
- Is a “thickness design” method that gives the required Structural Number (SN)
- SN expresses pavement strength required for a given combination of soils, traffic loading, and serviceability

Flexible Pavement Design Inputs

- MATERIALS
  - Soil Support Value, SSV
  - Regional Factor, RF, ***Climatic***
- TRAFFIC
  - Traffic Volumes
  - Truck Composition
- SERVICEABILITY
  - Change in Serviceability over design life ~ 2.0

Flexible Pavement Design Outputs

- SN required for the project
- SN combines layer coefficients with layer thicknesses as follows
  - $SN = a_{surface} D_{surface} + a_{binder} D_{binder} + a_{base\ AC} D_{base\ AC} + a_{GAB} D_{GAB}$
  - *AC layers and GAB layer are required to carry design loads*

Typical Layer Thicknesses

- $D_{surface}$ >> 1.25 or 1.5 inches
- D_{binder} >> 2 inches
- $D_{base\ AC}$ >> 3 inches minimum
- D_{GAB} >> 8,10, or 12 inches

Typical Layer Coefficients

- AC~
  - 0.44 ~ *new to 4.5 in max*
  - 0.30 ~ *Existing Pavement and Layers below 4.5 in*
- GAB & LRB~ 0.16
- Soil Cement Base ~ 0.2
- Sand Clay Base ~ 0.10

Rigid Pavement Design

- Based on the 1981 Revision of the 1972 Interim AASHTO Design Guide
- Is a “working stress design” method that determines total slab thickness D
- D assumes little edge support typical of earlier PCC pavements

Rigid Pavement Design Inputs

- MATERIALS
  - Effective Modulus of Subgrade Reaction, k_{eff}
  - Modulus of Elasticity, E_c
  - Modulus of rupture, f_r
- TRAFFIC
  - Traffic Volumes
  - Truck Composition
- SERVICEABILITY
  - Change in Serviceability over design life ~ 2.0

Rigid Pavement Design Features

- BASE
  - GAB is preferred due to performance
- GEOMETRY
  - 15 foot slab length ~ aspect ratio
  - Dowelbars ~ improves slab to slab support
    - minimizes or eliminate faulting
- EDGE SUPPORT
  - Prefer full depth or partial depth shoulders

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Constraints of Traditional Designs

- Up to February 2008, the same GAB thickness was used for both pavement types
  - ***Geotechnical recommendation***
- Up to February 2008, all rigid pavement designs had an interlayer
  - ***Permeability***
- Flexible pavements are under-designed by 10%-15%
  - ***To allow future resurfacing in 10 years***

Since…

- Flexible pavements are intentionally under-designed ***to allow future resurfacing, and***
- And since rigid pavements can not be under-designed, ***a 1 ½ in JPC overlay is not an option***
- ***This resulted in a rigid pavement whose total thicknesses always being greater*** than the corresponding flexible pavement
  - ***GAB + Interlayer = Zero Point for JPCP***

Research Showed That...

- Up to early 2000's GDOT 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
  - ***Contributes to long term performance***

Historically

- The following pre-2000 PCC Pavements *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
- *They have no Interlayer*

And…

- The following post 2000 PCC Pavements are also *showing good performance*
  - Homer Bypass
  - Jefferson Bypass
- *They also have no interlayer*

Question

- 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

Additionally...

- Important SPS Conclusions

- The SPS 1 experiment concluded that:
  - *The best performing flexible pavements had a stiff base*

- The SPS 2 Experiment concluded that:
  - *The best performing rigid pavements had a uniform base*

Using Traditional Design

- 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 was also 12 inches
  - The rigid pavement had an additional 3 inch layer of of 19 mm SP
  - The effective k value (k_{eff}) is 260 pci

Heavy State Route (HSR) 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

Another Way to look at HSR

- 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%***

Local Collector (LC) 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 Way to look at LC

- Without the GAB and AC Interlayer,
  - $k_{eff} = k_{subgrade} = 110$ pci
  - 7.5 inches of JPC Pavement is needed
- With the GAB and AC Interlayer
  - $k_{eff} = 260$ 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 contributes
  - ***30 to 40% of the structure (SN)***
- In the rigid pavement, the GAB layer and the asphalt concrete Interlayer contribute
  - ***5 to 10% of the structure (D)***

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Proposed Direction for Comparable Designs

- ***Implement MEPDG…***

…In 2 – 3 years

- ***BUT In the meantime…***

Current Practice for Comparable Designs

- **Base Guidelines**
- If SSV < 3.0, use 10 inches GAB
- If SSV ≥ 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 Traditional and Current Design Guidelines for Comparison

Pavement Designs for SSV = 2.0

Flexible		Traditional		Current	
AC Layer (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)
9.5	12	**8.3**	**12**	**8.5**	**10**
$AADT_{20\ year}$ = 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

Flexible		Traditional		Current	
AC Layer (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)
6.25	12	**7.1**	**12**	**7.6**	**10**
$AADT_{20\ year}$ = 4,720 MU=1 SU=5		Interlayer = 3 in k_{design} = 280 pci		Interlayer = 0 in k_{design} = 195 pci	

Pavement Designs for SSV = 2.5

Flexible		Traditional		Current	
AC Layer (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)
11.5	12	**10.2**	**12**	**10.4**	**10**
$AADT_{20\ year}$ = 9,900 MU=6 SU=4		Interlayer = 3 in k_{design} = 280 pci		Interlayer = 0 in k_{design} = 195 pci	

Pavement Designs for SSV = 3.0

Flexible		Traditional		Current	
AC Layer (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)
11.5	12	**11.6**	**12**	**11.9**	**8**
$AADT_{20\ year}$ = 18,200 MU=7 SU=7		Interlayer = 3 in k_{design} = 270 pci		Interlayer = 0 in k_{design} = 195 pci	

Pavement Designs for SSV = 3.5

Flexible		Traditional		Current	
AC Layer (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)	Slab Depth (inches)	GAB Layer (inches)
6.5	12	**10.3**	**12**	**10.5**	**8**
$AADT_{20\ year}$ = 8,775 MU=8 SU=3		Interlayer = 3 in k_{design} = 300 pci		Interlayer = 0 in k_{design} = 215 pci	

Any Questions ???