Comments to Florida Department of Transportation
Pavement Type Selection Process

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Policy Issues related to Concrete Pavement Design

As mentioned during the PTS Rule Development Workshop on June 23, 2010; Rule Development is not about the “values for the inputs” used in pavement design or Life Cycle Cost Analysis (LCCA), but rather it is to define the process as to “how” and “when” to do the PTS. Having said that, there are policies in the design process that affect the PTS because they increase the concrete pavement’s initial and life cycle costs. While at times the items discussed below may be needed, their blanket use is not required or justified. As such, we recommend a review and change to the following design issues:

1. Drainage Systems (permeable and edge drains)
2. Diamond Grinding of the Final Surface
3. Full Depth Concrete Shoulders

1. Permeable Bases and Edge Drains

The primary reason that edge drains and permeable bases, such as a Permeable Asphalt Treated Bases (PATB), are used with concrete pavements is to minimize water under pavement, which prevents pumping of subgrade soils.

To have pumping, three conditions are required:

1. A subgrade soil that will go into suspension in water (silts and/or clays)
2. Water to suspend and carry out the silt and/or clay materials
3. Rapid differential deflection at a joint or crack to act as a pump to eject the suspended clays and/or silts

Eliminating any of these 3 items eliminates pumping. Furthermore, research and performance has shown that of these three, minimizing the rapid differential deflections with dowels has the greatest impact and at the lowest costs (see Table 1).

Table 1: Methods to Control Pumping

Options	How it Works	Cost
Dowels	Dowels cause the slabs to bend together eliminating the rapid differential deflection	$4.50 / SY
Bases & Subgrades	Stabilized & high quality granular bases eliminate the fine materials that go into suspension in water	$8.77 / SY
Drainage	Edge drains and permeable bases minimize the amount of water flowing under a pavement that can carry out the silt and/or clay materials	Edge Drains = $11.25 / SY PATB = $23.66 / SY

As shown in Table 1, a PATB is very expensive and furthermore research is finding that their use may not be adding to performance. For example, in the NCHRP Report 583 on Subsurface Drainage,[1] the primary finding was:

> "*These tests and analyses did not identify any aspect of the behavior or performance of the HMA and PCC pavement structures in the SPS-1 and SPS-2 experiments that could be shown to have been improved by the presence of subsurface pavement drainage. Instead, the measures of pavement behavior and performance analyzed for these pavements— namely, deflection response, roughness, rutting, faulting, and cracking—were found to be influenced by the stiffness, rather than the drainability, of the base layers*."

As such, we do not believe that FDOT should use a PATB unless there are overriding circumstances as to why it should be used over standard stabilized or granular base. Furthermore, when it is used, its use should be justified on a cost/benefit analysis that shows the drainage layer extends the life long enough to cover its NPV. Figures 1and 2 show an example of this for a medium volume road (8.5 million ESALS). In Figure 1, Design 1 is a typical FDOT design using the ATPB and drainage system. Design 2 is alternate design using only a 6" granular base. The difference in initial costs is $845,128. For the drainage layer to be effective, it must extend the pavements life to overcome this differential.

Figure 1: Cost Example on looking at the benefits of a Drainage Layer

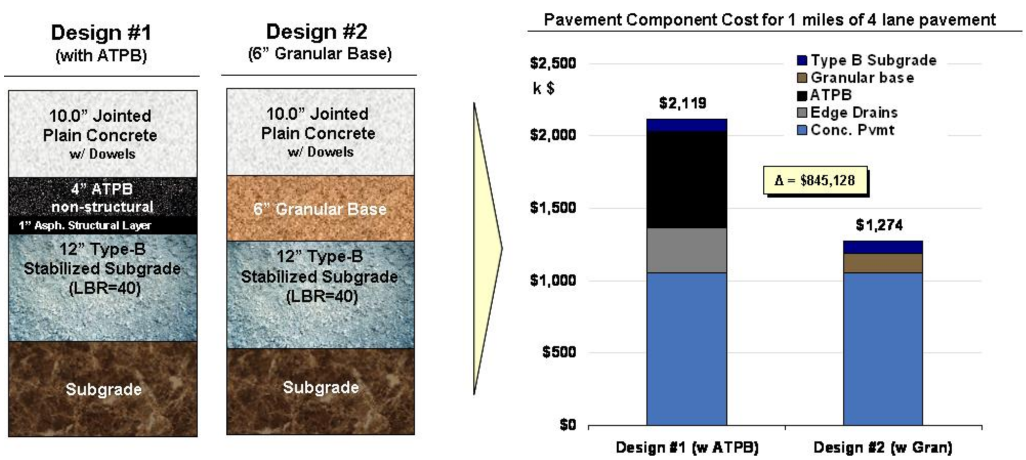
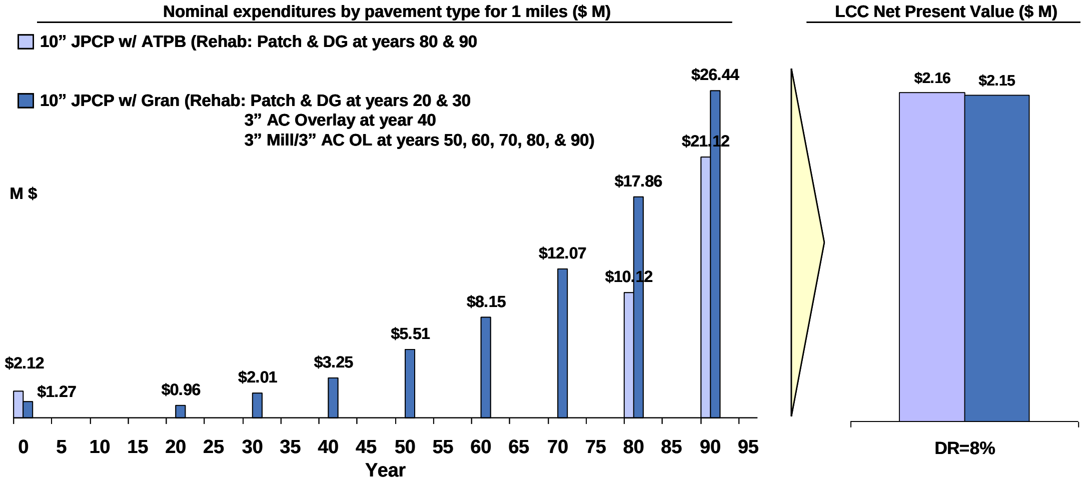


Figure 2 is the life cycle cost analysis for these pavements assuming that Design 2 last 20 years. Based in this analysis, Design 1 with the APTB needs to last an additional 60 years (eg 80 years before first rehabilitation) for the expenditure for the ATPB to be worth the costs. Note that while there may be some argument that Design 2 is a 20 year design, it is difficult to argue, at least in this example, that the use of the PATB is cost effective.

[1] Effects of Subsurface Drainage on Pavement Performance, Analysis of the SPS-1 and SPS-2 Field Sections, NCHRP Report 583, National Cooperative Highway Research Program, Transportation Research Board, Washington, DC 20001

Figure 2: Life Cycle Costs Comparison to determine if a Drainage Layer is a Cost Effective Expenditure



Recommendation

A drainage system should not be required for all concrete pavements, and when it is used, it should be based on the specific site conditions and justified using a cost / benefit analysis.

2. Diamond Grinding for the Final Surface

Section 250-13 “Surface Requirements” states that Diamond Grinding is to be used to create the final surface. We believe that the requirement is unnecessary and artificially drives up the cost of concrete pavements (DG typically adds between $2.00 and $4.00 / SY).

Diamond Grinding (DG) of concrete pavements is used to fix one of 3 issues: roughness (Profile Index or IRI), noise, and/or low skid resistance. While diamond grinding the surface of a new pavement can improve all of these, Florida is one of only 3 states that require Diamond Grinding of the final surface (South Carolina and New Jersey are the others and both of these states also do little concrete paving). Modern concrete pavements can be designed; have the materials selected; and/or have the construction practices altered to address all these issues. For example, concrete pavement contractors routinely meet smoothness specifications specified by other states that do extensive concrete paving, many of which are more stringent than FDOT’s. As such, FDOT should specify the smoothness they require, and let industry to achieve it by the most efficient means.

Likewise, noise in many new concrete pavements is caused by transverse textures which create a “whine” due to “tonal spikes.” By allowing longitudinal tining, FDOT can minimize the noise due to this issue. Note that while FDOT’s use of DG texture does do this; longitudinal tining, which is used in 18 states and imparts a similar texture, can have similar affects at a much lower cost[2].

Recommendation

Remove the requirement for diamond grinding and specify the required smoothness as found in Section 352-8. Add longitudinal tining as an option for the final surface texture.

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[2] Noise in old concrete pavement is caused by faulting and wheel slap (wide joints greater than 5/8 in). Modern concrete pavements use dowels to minimize faulting and have narrow joints (⅛” to ¼” wide) which minimizes noise due to these items.

3. Full Depth Concrete Shoulders.
Chapter 6 of the "Rigid Pavement Design Manual" provides guidance on shoulder design for concrete pavements and provides information for several types of potential shoulders (eg Tapered Depth Concrete, Full Depth Concrete, Partial Depth Concrete, Asphalt, and Grass).[3] Guidance on asphalt pavements is provided in chapter 8 of the "Flexible Pavement Design Manual." However, while shoulder designs for concrete are discussed in detail and potential standard cross sections are shown, there us much less guidance in the asphalt section (8 pages of detail in the concrete section and only 1 page in the asphalt section.

Furthermore, there is inconsistency in the shoulder requirements when comparing shoulder designs and for concrete and asphalt pavements. For example, in Section 6.3, it states that asphalt shoulders may be used and refer to Flexible Pavement Design Manual, but it also refers to Figure 6.1. In Figure 6.1, there is a note that that the thickness of the permeable base will be 4 inches. There is no such diagram or mention of the permeable base in the asphalt section.

Similarly, structural requirements of the shoulders are not the same. For example, the minimum thickness for a concrete shoulder for all roads is set at 6 inches, while the asphalt shoulder minimum for low volume roads is set at 1 inch of FC-12.5 or 1.5 inches of FC-9.5 over optional base group 1 (4 to 4.5 inches of base material). Clearly, 1.5 inches of asphalt over 4 inches of base material is not equivalent to 6 inches of concrete. On higher volume roads (ESAL greater than 10 million), the asphalt shoulder is designed to carry 3% of the traffic. For the concrete pavement, either a full depth shoulder or a tapered shoulder is used, but it is not designed to carry only 3% of the traffic. (Note: the partial depth shoulder option is designed to carry 3% of the traffic; however, it is not an option for higher volume applications).

Recommendation
FDOT should develop a "shoulder policy" and apply it equally to all pavements. For example, on high volume applications, use full depth shoulders to account for potential future maintenance or widening (eg use the same design as the pavement). For medium levels of traffic (eg 1 million to 10 million ESALS), design the shoulder to carry 3% of the mainline ESAL's. For applications less than 1 million ESALS, use 1 inch of FC-12.5 or 1.5 inches of FC-9.5 over optional base group 1. In all cases, asphalt or concrete shoulders can be used with either pavement type and the choice to which to use should be left to the designer.

For which ever shoulder option is chosen, future shoulder rehabilitation activities should be based on the expected shoulder performance.

[3] While all of these options are discussed and when to use each is adequately described, it is this author's understanding that in almost all cases a full depth concrete shoulder is used with concrete to account for potential future maintenance or widening.