GUIDANCE FOR BRIDGE DECK OVERLAYS

Introduction

The intent of this document is to provide guidance on the design of pavement structures for bridge deck overlays on Connecticut Department of Transportation (CTDOT) bridge projects. It may be used by State and/or consultant personnel that are responsible for designing these transportation facilities.

The CTDOT has a standard practice to protect the condition of its bridge decks with one of several waterproofing membrane systems, and to place a bituminous concrete riding surface over the membrane. The current standard practice is to place a 3-inch bituminous concrete overlay atop the waterproofing membrane. This standard practice should be followed unless there are extenuating circumstances as discussed in the remainder of this document.

General Considerations

The general design considerations and constraints for placing a bridge deck overlay can be categorized into major topics according to the purpose and the constructability of the proposed bituminous concrete pavement structure, which are as follows:

(1) Protecting the waterproofing membrane over the bridge deck

Use the smallest aggregate size mix and minimum lift thickness to pave the first lift of bituminous concrete over the waterproofing membrane. Accordingly, CTDOT's standard practice is to use a 1-inch HMA S0.25 lift over the waterproofing membrane on bridge deck overlays.

The 1-inch lift thickness reduces the heat transfer to the underlying membrane and the chance of re-liquefying or re-melting the membrane, thus creating a slippage plane for the initial lift of the overlay. This concern primarily applies to bridges that utilize a woven glass fabric waterproofing membrane. Recently the CTDOT has moved to using mostly spray-applied cold liquid elastomeric waterproofing membranes to protect bridge decks, which are not at risk of re-melting during paving. Bridge designers are responsible for which type of waterproofing membrane system to incorporate.

In order to satisfy other design constraints, it may not be feasible or necessary to place the recommended 1-inch HMA S0.25 as the bottom lift of the overlay in every situation. If the selected membrane type is not susceptible to the issues outlined above, the following alternatives are acceptable:

- The lift thickness of HMA S0.25 may be altered to a minimum of 0.75 inches or a maximum of 1.25 inches.
- The mix can be changed to HMA/PMA S0.375 with a recommended lift thickness of 1.5 inches (minimum of 1.25 inches, maximum of 2.0 inches).

Additional concerns have been raised with using course-graded mixes, S0.5 and S1, on top of either waterproofing membrane system. The maximum aggregate size is such that these mixes may tear or puncture the membrane during paving and risk exposure to the bridge deck itself. For these reasons, it is recommended to avoid using these mix types for the bottom lift of the overlay.

(2) Providing a durable riding surface that can be subsequently maintained or replaced without disturbing underlying materials

The selected lift thickness should provide the best chance to achieve proper compaction of the surface lift, thus maximizing density and durability. In addition, maintaining a constant thickness for the surface lift helps minimize disruption of the underlying materials during future resurfacing. This is the aim of the standard practice of placing a lift of 2-inch HMA/PMA S0.5 for the riding surface, which is the generally recommended placement thickness for the S0.5 mix type on roadway sections. The top lift thickness should also be uniform through the project limits to promote placement of the approach pavement in conjunction with the bridge overlay.

(3) Minimizing permeability of the bituminous concrete layers

Protection of the bridge deck from water intrusion is a primary purpose of the membrane. All else being equal, reducing the maximum aggregate size of the asphalt mixture typically reduces the probability of having interconnected air voids, minimizing permeability of the bituminous concrete overlay. HMA S0.25 has the smallest aggregate size of all the Department's standard mix types.

When faced with a choice of lifts and maximum aggregate sizes, select the mix type with the smaller aggregate size to minimize permeability (e.g. HMA S0.25 is likely less permeable than HMA S0.375, and HMA S0.375 less permeable than HMA S0.5 – the same applies for the PMA equivalents). Mixes with smaller aggregate sizes are also more workable in tight areas or constrained edges where handwork would be necessary.

Using the recommended lift thickness for the selected mixture can help achieve the highest density for a given compactive effort, which is related to decreased permeability. This also reduces the chances of "dragging" of the mix at lower thicknesses, or instability at higher thicknesses.

Although thicker total overlays assist in increasing the path for moisture and chlorides down into the membrane of the bridge, there are practical and economic considerations that limit the maximum thickness of an overlay on a bridge deck. The 3-inch overlay standard practice balances these considerations.

(4) Achieving proper compaction and quality placement of bituminous concrete lifts

This is best done by adhering to the Department's published recommendations for placing Superpave bituminous concrete mixes. These recommendations include lift thickness guidelines

for each standard mix type, covering lifts of uniform thickness as well as lifts of varying thickness used in wedge course applications, for which there is a different set of limits.

(5) Maximizing constructability of the project by minimizing the different mix types where possible

Wherever possible, when faced with two feasible choices that achieve the remaining desired design features for the bituminous concrete overlay, select a combination that minimizes the number of mixes. Where limitations exist due to other considerations, attempt to strike a balance between minimizing different mix types and design needs. In most cases, two mix types can achieve the majority of the required design features of the bridge deck overlay.

Recommendations

As previously noted, the standard total overlay thickness that has been adopted by the Department is three (3) inches. This is typically made up of two lifts consisting of the following:

OPTION A1

- 2” HMA/PMA S0.5 Traffic Level 2/3, on,
- 1” HMA S0.25 Traffic Level 2

OPTION A2

- 2” HMA/PMA S0.375 Traffic Level 2/3, on,
- 1” HMA S0.25 Traffic Level 2

In cases where the existing bridge is only designed to support a total overlay thickness of 2.5 inches, and the project scope does not include adequate strengthening improvements to the structural capacity of the bridge, the recommended pavement structure is as follows:

OPTION B1

- 1.5” HMA/PMA S0.375 Traffic Level 2/3, on,
- 1” HMA S0.25 Traffic Level 2

OPTION B2

- 1.75” HMA S0.5 Traffic Level 2, on,
- 0.75” HMA S0.25 Traffic Level 2

Notes –

1. The decision to use HMA or PMA and Traffic Level 2 or 3 for the top surface lift will be made at the project level on a case-by-case basis. In general, PMA and Traffic Level 3 mixes should be used on high-volume roadways such as interstates and other expressways. The designer should consult with Pavement Management if unsure of what type of mix to use and a recommendation has not been previously provided.

2. Concerns have been raised from bituminous concrete producers about the ability to make a PMA S0.25 Traffic Level 3 mix. For this reason, HMA S0.25 Traffic Level 2 mixes are exclusively recommended as the first lift of the overlay as a standard practice.

3. PMA substitution is not allowed for the 1.75" HMA S0.5 lift (Option B2), as it is difficult to achieve the required density for the mix at this lift thickness on a bridge structure where vibration is not permitted as a compaction method.

4. Use of the S0.375 mix as a riding surface should be avoided for roadway sections that have a high pavement friction demand, such as sharp horizontal curves, steep grades, and/or areas with frequent braking and maneuvering. The options that utilize HMA/PMA S0.375 (Option A2 and B1) as the surface lift generally should only be considered for traffic speeds under 50 mph and for sections that do not have high pavement friction demand. A certain amount of engineering judgement is needed for these determinations.

5. When the cross slope of the bridge deck is different from the required cross slope of the riding surface, bituminous concrete wedge courses are often used in conjunction with the standard overlay design. Any variable depth wedge lifts should be meet the minimum and maximum lift thickness guidelines for each mix type, and be placed between the surface and bottom lifts of the overlay, which are to remain as uniform thickness lifts.

6. Other combinations of mixes and lift thicknesses may be considered for extenuating circumstances, but should follow the guidance provided in this document. Please consult with Pavement Management before incorporating alternatives.

<u>Special Surfacing Mixes</u>

There are cases where superior skid resistance is required on a bridge deck. In these cases, the wearing surface available at this time is "Ultra-Thin Bonded PMA Pavement (Type B)", which is placed at a thickness of 5/8 inches (0.625"). This can be best achieved by modifying the conventional 2" HMA/PMA S0.5 surface lift to 1.375" HMA/PMA S0.375. Additionally, other potential alternatives for the Ultra-Thin Bonded PMA are listed below in the case that the total overlay thickness is constrained to less than 3".

OPTION C1

- 0.625" Ultra-Thin Bonded PMA Pavement (Type B), on,
- 1.375" HMA/PMA S0.375 Traffic Level 2/3, on,
- 1" HMA S0.25 Traffic Level 2

OPTION C2

- 0.625" Ultra-Thin Bonded PMA Pavement (Type B), on,
- 0.875" HMA S0.25 Traffic Level 2, on,
- 1" HMA S0.25 Traffic Level 2

OPTION C3

- 0.625" Ultra-Thin Bonded PMA Pavement (Type B), on,

- 1.5” to 2” HMA/PMA S0.375 Traffic Level 2/3 (on cold applied membrane only)

Culverts

On culverts, where there is no true abutment or bridge deck, keep the same pavement structure as the adjacent roadway throughout the section. After designing the pavement structure to meet the needs of the roadway conditions, if there is not expected to be sufficient area between the bottom of the asphalt layers and top of the culvert to place a minimum of 6”-8” of subbase/processed aggregate base (for the purpose of facilitating drainage), it is recommended to remove the granular layer entirely and instead fill the remainder of the area with additional bituminous concrete pavement to the top of the culvert.

Please contact the Pavement Management Unit at 860-594-3280 if you have any questions.