U.S. Department of Transportation
Federal Highway Administration

Technical Brief

Conventional Whitetopping Overlays

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Introduction

Conventional whitetopping is the construction of a new portland cement concrete (PCC) pavement over an existing hot-mix asphalt (HMA) pavement (see figure 1). These PCC overlays are defined as being greater than 102 mm (4 in) thick, but typically range from 203 to 305 mm (8 to 12 in) when placed on primary interstate highways, and from 127 to 178 mm (5 to 7 in) when placed on secondary roads (ACPA 1998).

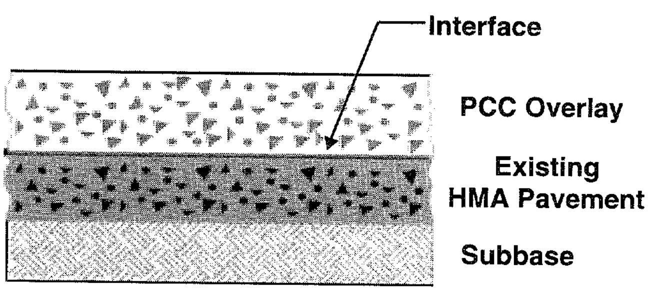

Figure 1. Conventional whitetopping overlay (McGhee 1994).

Whitetopping is an appropriate rehabilitation alternative for badly deteriorated HMA pavements, especially those that exhibit distresses such as rutting, shoving, and alligator cracking (ACPA 1998). Because the PCC surface is capable of bridging a significant amount of deterioration in the underlying HMA pavement, minimal preoverlay repairs are required.

Structurally, conventional whitetopping overlays are similar to new PCC pavements, and they are designed as such. All recommended design and construction practices for new PCC pavement are directly applicable to conventional whitetopping. The only significant difference is that whitetopping overlays require a deeper sawcut to ensure proper formation of joints. Whitetopping overlays can be constructed as jointed plain, jointed reinforced, or continuously reinforced concrete pavement (JPCP, JRCP, or CRCP), with the use of JPCP designs being most common. Current practices are away from JRCP designs, and they are rarely constructed any more.

Conventional whitetopping is contrasted from *thin* and *ultra-thin* whitetopping overlays in that these latter designs employ a milled HMA surface to develop a mechanical bond between the PCC overlay and the existing HMA pavement; conventional whitetopping assumes an unbonded condition, although some bonding does occur. Ultra-thin whitetopping is constructed between 50 and 102 mm (2 and 4 in) thick whereas thin whitetopping is constructed between 102 and 203 mm (4 and 8 in) thick.

General Design Considerations

The design of whitetopping overlays involves consideration of factors that apply to rehabilitation projects, as well as those that apply to new pavements, as shown in table 1. In urban areas, where traffic congestion is already a daily problem, management of detour traffic during construction can be a critical issue. For projects in congested areas, the use of fast-track paving techniques may be appropriate to minimize lane closure times.

Pavement Evaluation

The evaluation of the existing pavement is an essential part of any overlay design, and typically consists of a visual distress survey, deflection testing using a falling weight deflectometer (FWD), and coring. Coring is important in order to characterize the thickness and condition of the HMA layers.

The FWD testing results will provide information on the foundation support value. However, one problem in determining this value for whitetopping is that for existing HMA pavements the subgrade support is generally characterized by the resilient modulus (M_R), whereas the input needed for PCC pavement design is the modulus of subgrade reaction (k-value). Although the 1993 AASHTO Guide contains an approximate correlation between M_R and k, the more appropriate approach is to consider the contribution of the HMA layer in improving the bending stiffness of the PCC surface (Darter, Hall, and Kuo 1994). This approach is adopted in the 1998 AASHTO Supplement for the consideration of stabilized bases in new PCC pavement design (AASHTO 1998).

Table 1. Design factors for whitetopping overlays.

Design Factors Unique to Rehabilitation Design	Design Factors Common to New and Rehabilitation Design
• Existing pavement condition • Overlay pavement type • Preoverlay repair	• Slab thickness • Joint spacing • Load transfer design • Reinforcement design • Edge support (tied PCC shoulder or widened slab design) • Subsurface drainage • PCC mix design

Preoverlay Repair

The most critical issue in considering repairs to the existing HMA pavement is to ensure that uniform support is provided for the PCC surface. To obtain the desired performance, areas of subgrade or base failure must be removed and replaced with a stable material (McGhee 1994). In addition, the repair of badly deteriorated areas is recommended; these include severe rutting, shoving, and potholes (ACPA 1998). Guidelines for preoverlay repairs for conventional whitetopping are given in table 2.

Surface Preparation

For conventional whitetopping, no special efforts are made to encourage bonding between the overlay and the underlying HMA surface; however, a surface preparation step may be required to address distortions in the existing HMA pavement surface or to correct surface profile. Three common methods of surface preparation are used for conventional whitetopping overlays:

- Direct placement. In this approach, the PCC overlay is placed directly on the existing HMA surface after sweeping. Any ruts in the existing pavement are filled with PCC, resulting in a thicker PCC pavement in rutted areas. The direct placement method is recommended when the rutting on the existing HMA pavement does not exceed about 25 mm (1 in).
- Milling. In this approach, the existing HMA surface is milled to obtain a uniform surface. Milling thicknesses typically range from 25 to 76 mm (1 to 3 in) and can be used to remove all surface distortions and adjust cross slopes if needed (ACPA 1991). This approach requires less surveying time and cost than direct placement, but results in additional costs for milling (and disposal, in some cases). Milling can also be used in combination with direct placement.
- Placement of leveling course. In this approach, a leveling course of HMA is used to produce a uniform surface for paving (ACPA 1991). The leveling course typically consists of 25 to 50 mm (1 to 2 in) of HMA. Because this method involves the additional expense of HMA work, this option is usually not considered when the distortion depths exceed about 50 mm (2 in) (McGhee 1994). In such cases, milling is typically less expensive (ACPA 1991).

A minimum HMA thickness of 50 mm (2 in) (after any milling) is recommended for conventional whitetopping overlays (ACPA 1998).

Structural Design

Thickness Design

Conventional whitetopping is designed as a new PCC pavement, treating the existing HMA pavement as a stabilized base course. An unbonded condition is assumed, and the required overlay thickness is determined using any established PCC pavement design procedure, such as the AASHTO procedures (AASHTO 1993; AASHTO 1998) or the Portland Cement Association (PCA) procedure (PCA 1984). The overlay thickness is taken as the new PCC slab thickness required to handle future traffic for the given design conditions.

In addition to the general pavement design procedures, simple design charts have been developed for selecting PCC thicknesses for whitetopping overlays (ACPA 1998). In these charts, the slab thickness is selected based on the number of trucks per day, the design PCC flexural strength, and the subgrade k-value. The ACPA (1998) recommends a minimum overlay thickness of 152 mm (6 in) for conventional whitetopping of primary and interstate roads.

Table 2. Guidelines for repair of existing HMA pavement distresses prior to PCC overlay (ACPA 1998).

General Pavement Condition	Recommended Repair*
Rutting (< 50 mm [2 in])	None or milling**
Rutting (≥ 50 mm [2 in])	Milling or leveling
Shoving	Milling
Potholes	Fill with crushed stone cold mix or hot mix
Subgrade failure	Remove and replace or repair
Alligator cracking	None
Block cracking	None
Transverse cracking	None
Longitudinal cracking	None
Raveling	None
Bleeding	None

* Other factors to consider: adding edgedrains, costs of direct placement vs. milling or leveling.

** Consider increasing the joint sawing depth.

Joint Spacing

The maximum joint spacing recommended for conventional whitetopping constructed as JPCP is 21 times the slab thickness (ACPA 1998). For example, the recommended maximum joint spacing for a 203-mm (8-in) whitetopping is 4.2 m (14 ft). As a basic rule of thumb, this guideline is adequate, although it may provide excessive joint spacings for thicker slabs. If used, JRCP designs should have a maximum joint spacing of 9.1 m (30 ft) (FHWA 1990).

Load Transfer Design

Load transfer designs for conventional whitetopping are identical to those for new PCC pavements. In general, doweled joints are recommended for all pavements that will be subjected to significant truck traffic. Experiences in Wyoming and Utah showed that whitetopping projects built without dowels develop significant faulting in a few years under interstate traffic (McGhee 1994).

Job-Site Considerations

Several job-site factors require special consideration, including bridge approaches, overhead clearances, and shoulders. At bridge underpasses, reconstruction of a short section may be necessary to satisfy the vertical clearance requirement. Reconstruction requires sections at both ends to provide a smooth transition between the overlay and the reconstructed section. The recommended taper length for the transition is 90 to 150 m (300 to 500 ft) (ACPA 1991). A similar transition section is also needed at bridge approaches

During paving, if the HMA pavement surface becomes uncomfortable to touch with an open palm, water fogging or whitewashing is recommended to reduce the surface temperature (ACPA 1998). Although the use of water fogging has worked well in reducing the surface temperature, the use of whitewashing should be used cautiously as it can reduce the friction between the PCC overlay and the HMA.

Joint Sawing

The sawcut depth is a concern for conventional whitetopping overlays because the distortions in the underlying HMA pavement can effectively increase the slab thickness, especially in rutted areas (see figure 2). A minimum sawcut depth of one-third the PCC thickness is recommended (ACPA 1998). A deeper cut should be made where the overlay thickness varies more than 25 mm (1 in) over the nominal thickness.

Performance of Whitetopping Overlays

The majority of whitetopping overlays have provided good to excellent performance (McGhee 1994). The success of this design is often attributed to the uniform support and bond provided by the underlying HMA pavement (McGhee 1994).

California has used whitetopping extensively since the 1960s, and has enjoyed considerable success with the treatment (Hutchinson 1982). Iowa also has had outstanding performance from whitetopping overlays, many of which have been placed on their county highway system (ACPA 2000). Both agencies report performance in excess of 20 years.

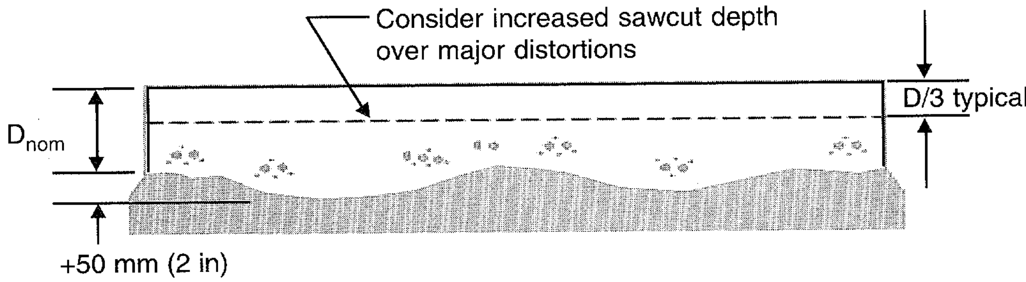

Figure 2. Consideration of HMA rut depth in determining appropriate sawcut depth (ACPA 1991).

Where the performance of whitetopping overlays has not been satisfactory, the problem can often be traced to a design flaw or inadequacy. For example, the Wyoming DOT reported that nondoweled whitetopping overlays developed significant faulting after a few years of Interstate highway traffic (McGhee 1994). Similar findings were made on nondoweled whitetopping overlays in Utah (McGhee 1994).

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