Design of the Times: Thin Concrete Overlays

An innovative approach using proven concrete pavement design techniques can save DOT's and taxpayers money across the country.

Many state Departments of Transportation (DOT's) are facing an ever increasing shortage of transportation funding dollars. Such hardships are causing pavement design engineers to investigate ways to quickly implement technologies and techniques that can save the DOT and taxpayers money. Such was the case when, in the early 1990s, the Colorado Department of Transportation (CDOT) started experimenting with a thin bonded concrete overlay of an asphalt pavement, something they call thin whitetopping (TWT).

CDOT has lead the charge to construct many TWT projects across the state of Colorado and, along the way, developed a mechanistic-based design procedure for TWT that the Federal Highway Administration (FHWA) acknowledges.

Slim but Still Strong

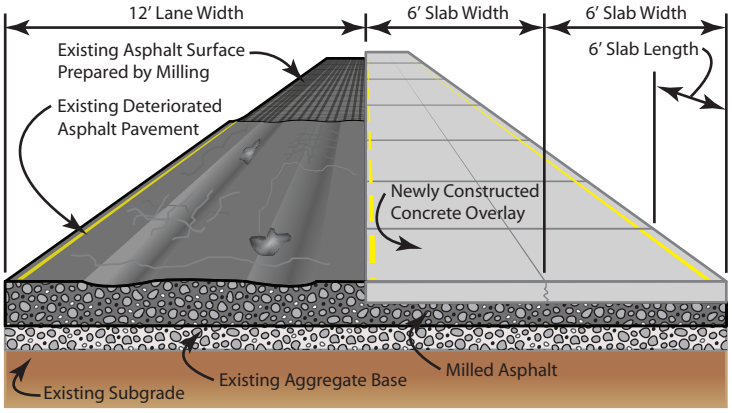
TWT is a unique type of bonded concrete overlay of an exiting asphalt pavement. Its thickness ranges from 4 to 6 in., with a joint spacing of approximately 6 ft in both the transverse and longitudinal directions.

Existing asphalt pavement typically makes an excellent subbase for a concrete pavement overlay because, once milled, a uniform support condition can easily be attained. Equally important, because the milled asphalt surface provides a partially bonded condition with the concrete pavement, the tensile stresses at the base of the concrete slab due to applied loads are significantly reduced. Evidence suggests that tensile stresses are reduced by as much as 25% when compared to a totally unbonded condition.

The decreased tensile stress due to the composite action is what allows slabs as thin as 4 in. to endure 20 years or more on heavily trafficked primary roads and interstate highways. The Colorado experience tells us that TWT can last upwards of 20 years on an interstate and, more importantly, the TWT option can save over 10 percent in life-cycle cost when compared to an asphalt overlay option.

Common CDOT TWT Design Features

- Concrete thickness: 4 to 6 in.
- Concrete panel size: 6 ft by 6 ft.
- Concrete mixture: 4,000 to 4,500 psi at 28 days (similar to conventional mixtures), 4 to 8 percent air content, and maximum w/cm ratio of 0.44. Laboratory trial mixture typically must produce 28-day flexural strength of 650 psi.
- Milling and cleaning asphalt surface prior to placing concrete overlay.
- Deformed tie bars across the longitudinal joints, spaced at 36 in.
- No dowel bars across transverse joints.
- Tied concrete shoulder.



The existing pavement is utilized as a subbase in a CDOT TWT; the asphalt is simply milled and the new concrete overlay is constructed on the milled asphalt surface.

"PCC Overlays are increasingly being used as a rehabilitation technique for … hot mix asphalt pavements. The use of PCC overlays offers a potential for extending service life, increased structural capacity, reduced maintenance requirement, and lower life-cycle cost when compared with other overlay alternatives."

- FHWA

Keys to a Successful TWT

Through research and field experience, CDOT has concluded the following:

- A good bond between the TWT and the asphalt subbase is essential.
- Milling and thorough cleaning of the asphalt surface prior to overlaying is recommended by CDOT to enhance the bond.
- TWT is not recommended on a newly constructed asphalt surface because concrete does not bond well to fresh asphalt, milled or not.

Slipform Paving and Curing Operations

The Simple Way to Savings

The significant savings associated with TWT are realized through simplicity of design, ease of construction and proven long-term durability. The construction of a TWT involves just three activities:

- Surface preparation — CDOT recommends that the existing asphalt surface be milled and thoroughly cleaned to enhance bond to the TWT. The depth of milling can be as little as 0.5 in., but removal depths of around 2 in. are fairly typical; the final asphalt subbase should be at least 3 in. thick after milling. The milled asphalt surface should be swept multiple times, air-blasted until all debris is removed, and moistened immediately prior to concrete placement.
- Concrete placement and curing — Both conventional and high-early-strength concrete mixtures can be used for TWT. Concrete placement (both fixed form and slipformed) and curing is no different for TWT than for conventional concrete paving operations.
- Joint sawing and sealing — Conventional sawcut equipment and timing techniques can be used, with transverse joints being sawed first. Then, a gang of concrete saws can be spaced along a guide bar to saw the longitudinal joints. Lastly, if it is common practice in the state, all joints are sealed.

Gang Mounted Joint Sawing Operation

A detailed life-cycle cost analysis conducted by CDOT in 2005 showed only a 1 percent advantage in agency costs for an asphalt overlay over a TWT. With user-delay costs included in the analysis, the cost of the TWT was 11 percent less than the cost of the asphalt overlay option, clearly making it the preferred choice. Of course, this analysis was conducted prior to some the major cost increases in asphalt over the last few years, and results of such an analysis conducted today will be even more favorable for TWT.

Joint Cleaning and Sealing Operations

For more detailed information on several CDOT projects, download the free FHWA publication "Thin Whitetopping – the Colorado Experience" at: http://www.fhwa.dot.gov/pavement/concrete/pubs/07025/07025.pdf

Completed Thin Whitetopping Pavement

References

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