Project Summary

Texas Department of Transportation

0-6590: Material Selection for Concrete Overlays

Background

The infrastructure of the state of Texas is in poor condition, and in the 2011 Texas Infrastructure Report Card Update, the state's roads and bridges were given a grade of D. However, increases in the expected road capacity of the state roads will put an enormous demand on the transportation infrastructure. Thus, it is important that roadway repairs are done quickly so that traffic congestion in minimized. Portland cement concrete overlays (herein referred to as concrete overlays) constructed on top of existing concrete pavement or asphalt concrete pavements are cost-effective rehabilitation strategies. Concrete overlays are simply an additional layer of concrete placed on top of existing pavements to increase the load bearing and serviceability capacity. When properly placed, overlays provide an optimum utilization of the existing pavement, increasing the structural capacity, improving the durability, and increasing the serviceability.

The goal of this research was to develop a laboratory-based method for developing constituent materials and construction guidelines that can produce a good performing concrete overlay. These guidelines will be instrumental in educating TxDOT personnel for training design engineers, construction personnel, and inspectors.

What the Researchers Did

In order to fully address the existing knowledge on concrete overlay usage, materials selection, and performance, a comprehensive literature review was performed. Moreover, condition surveys on existing concrete overlays in Texas were performed to determine performance and to identify factors including material constituents, bonding agents, mixture design, and concrete placement factors that had a significant influence on the performance of concrete overlays.

Based on the literature review and condition surveys, candidate materials were selected for the laboratory and outdoor studies. The study helped to define the necessary limits for material properties and to determine if performances of these materials were either adequate or inadequate for concrete overlays. Then, the data collected were evaluated using a performance prediction model. Finally, all the findings in the project were used to develop guidelines for materials selection and construction of concrete overlays.

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What They Found

Conclusions from the research include new findings and confirmation of previously obtained knowledge on concrete overlays. Key findings can be discussed that are crucial in constructing successful concrete overlays.

Current compressive and flexural strengths specified by TxDOT are adequate; however, for bonded concrete overlays (BCOs) maximum compressive strength should be controlled, so that, the resulting modulus of elasticity is less than that of the existing pavement. Similarly, the coefficient of thermal expansion of the concrete overlay must be equal or lower than that of the existing pavement. The minimum bond strength should be greater than 200 psi using AST C 1583 test procedure. If average residual strength (ARS) is one of the criteria, fibers should be well dispersed to increase consistency and the residual strength. Efforts should be made to minimize shrinkage to reduce stresses at the interface. At this point we do not know the influence of ARS values on performance of concrete overlays.

Type I/II cement is adequate for normal concrete overlays. For BCOs, there should be enough paste available to coat the interface to increase bond strength. Fly ash can be used to reduce cost, increase durability and workability. However, the main drawback is that as larger amounts of cement are replaced by fly ash, initial strength gain is significantly retarded, and overlay pavements need a longer time to cure until traffic loads can be allowed; in colder weather the delays may not be practical. Maximum nominal size of coarse aggregate should be less than one-third the thickness of the concrete overlay (not to exceed 1 to 1.5 in.). The minimum allowable maximum nominal size should be 0.5 in. Also, uniform gradation reduces the paste requirement, thus reducing shrinkage. Finally, bonding agents are not necessary if the existing pavement surface is properly prepared – bonding agents can even act as a bond breaker if not used properly.

For BCOs, surface preparation is crucial in promoting efficient bond. Proper surface repair, texturing, cleaning, and placement of concrete are key points that will decrease the chance of debonding. The final report of this project includes some values of minimum mean texture depth that will ensure good bonding. For unbonded concrete overlays (UBCOs), proper surface repair, separation layer placement, and placement of concrete will ensure complete separation of the new concrete overlay and the existing pavement, which will prevent reflective cracking. During construction, environmental conditions must be accommodated. Post construction, proper curing and monitoring will reinforce successful construction of concrete overlays.

What This Means

The findings of the project should be made known to TxDOT personnel for training design engineers, construction personnel, and inspectors to ensure that concrete overlays perform as intended. Materials selection and construction are relatively simple, but there are many steps to be taken in order to produce successful concrete overlays. Concrete overlays are a very important rehabilitation option if all of the required steps in the design and construction are carefully followed. BCOs may be the best option to extend the life of old CRC pavements.

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