STUDY DOCUMENT

RESEARCH PLAN FOR TRANSPORTATION POOLED FUND STUDY: MECHANISTIC-EMPIRICAL DESIGN METHOD FOR THIN AND ULTRA-THIN WHITETOPPING

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Project Background:

Thin (TWT) and ultra-thin whitetopping (UTW) is a pavement rehabilitation option that has been increasing in popularity in the U.S. over the past 15 years. The recent International Conference on Best Practices for Ultra-thin and Thin Whitetoppings (April 2005)[1] demonstrated that many states now have experience with at least a couple of completed whitetopping projects. The recently completed NCHRP Synthesis 338 on Thin and Ultra-thin Whitetopping[2] also shows the use of this product is currently of great interest to the transportation community.

The one area of deficiency in the application of ultra-thin and thin whitetopping is the lack of a rational design method. While several local[3,4] and industry[5,6,7] design methods have been formulated, few are based on mechanistic-empirical research born out of actual field performance. Several major research studies on the accelerated[8] and field performance[9-13] of thin and ultra-thin whitetopping are underway or have been recently completed. The Minnesota Road Research Project (MnROAD) has contributed significantly to the understanding of the field performance of thin and ultra-thin whitetopping. Table 1 shows the experimental matrix of designs that have been, or currently are, under study at the MnROAD facility. Photo 1 shows the significant degradation (after 7 years of traffic and weather) caused by placement of the wheelpath near the edges of the UTW panels. Photo 2 demonstrates the extensive sensor network available at MnROAD, which can provide the valuable data needed for this study.

The objective of this project is the development of a rational and comprehensive mechanistic-empirical design method for thin and ultra-thin whitetoppings.

Table 1. TWT and UTW designs at the MnROAD project. All sections are(were) subject to interstate traffic and long term weather exposure.

Panel Size	Ultra-thin Whitetopping		Thin Whitetopping	
	3 in	**4 in**	**5 in**	**6 in**
4 ft x 4 ft	(Oct. 1997-2004) Sealed Joints Polypropylene Fibers	(Oct. 1997-2004) Sealed Joints Polypropylene Fibers		
5 ft x 6 ft	(Oct. 1997-2004) Sealed Joints Polyolefin Fibers	**Oct. 2004- Sealed/Unsealed Joints No Fibers**	**Oct. 2004- Sealed/Unsealed Joints No Fibers**	**Oct. 1997- Sealed Joints Polypropylene Fibers**
10 ft x 12 ft				**Oct. 1997- Doweled/undoweled Sealed Joints Polypropylene Fibers**

Photo 1. Major distress in ultra-thin whitetopping at the MnROAD project, observed before the forensic evaluation in 2004.

Photo 2:
Installation of sensors in new MnROAD thin-whitetopping cells, October 2004. The sophisticated set up of instrumentation in the whitetopping sections at MnROAD, provides valuable field data that can be used in the development of a whitetopping design method.

Research Process:

This research project would be carried out in 5 tasks:

1. Literature review of existing TWT and UTW design methods.
2. Identify when bond is and is not critical. Develop bond degradation models based on laboratory testing results.
3. Development of new, or improvement of existing, TWT and UTW pavement response and performance prediction models that account for the condition of the existing asphalt and bond degradation.
4. Development of a rational mechanistic-empirical design method. The design method would accommodate time dependent bonding conditions between the whitetopping and HMA layers. The design would also be formatted such that it might be incorporated into future mechanistic-empirical based pavement design methods such as the AASHTO 200X Design Guide.
5. Development of guidelines for calibrating the design guide for regional climates, construction practices and construction materials.

Estimated Project Duration: Three years
Estimated Project Cost: $600,000

References:

1. *Proceedings of International Conference on Best Practices for Ultra-thin and Thin Whitetoppings***.** FHWA. Denver, Colorado, April 12-15, 2005.
2. Rassmussen,R., Rozycki,D. *NCHRP Synthesis 338, Thin and Ultra-Thin Whitetopping, A Synthesis of Highway Practice.* Transportation Research Board, Washington, D.C., 2004.
3. Tarr,S.M., Sheehan,M.J., Okamoto,P.A. *Guidelines for the Thickness Design of Bonded Whitetopping Pavement in the State of Colorado.* Report No. CDOT-DTD-R-98-10. Colorado Department of Transportation, Denver. Dec, 1998.
4. *Development of a Design Guide for Ultra-thin Whitetopping.* SWK Pavement Engineering. Princeton, N.J., Jan. 1998.
5. Wu,C.L., Tarr,S.M., Refai,T.M., Sheehan,M.J. *Development of Ultra-Thin Whitetopping Design Procedure.* Report RD 2124. Portland Cement Association. Skokie, IL, 1998.
6. American Concrete Pavement Association, *Whitetopping – State of the Practice.* Engineering Bulletin EB210.02P. Skokie, IL, 2002.
7. Rasmussen, R.O., G.K. Chang, J.M. Ruiz, W.J. Wilde, P.K. Nelson, J. Dick, D.K. Rozycki. 2002, *New Software Promises to Put Whitetopping on the Map*, Public Roads, Volume 66, No. 1, Federal Highway Administration, Washington, DC.
8. Sherwood, J. *ALF Is Where the Rubber Meets the Ultra-thin Whitetopping*. Research and Technology Transporter. Federal Highway Administration. Washington, D.C., June 1998.
9. Lahue,S.P., Risser,R.J. *Ultra-thin Concrete Overlay Supports Truck Loads.* Concrete Construction. Sep. 1992, pp.664-667.
10. Cable,J.K. , Grove, J.D., Heyer,M. *Ultrathin Pavements Make the Grade*. Proceedings of the 6th International Purdue Conference on Concrete Pavement Design and Materials for High Performance, Vol. 2. Indianapolis, IN. 1997, pp 245-266.
11. American Concrete Pavement Association. *Thin Whitetopping Sections Measure Up at MN/ROAD*. Concrete Products, Vol. 103. No. 2. Feb. 2000, pp 8-10.
12. Tarr,S.M., Sheehan,M.J., Ardani,A. *Mechanistic Design of Thin Whitetopping Pavements in Colorado.* Transportation Research Record 1730, Transportation Research Board, National Research Council, Washington D.C., pp.64-72.

13. *Documentation of Great Falls Experimental Whitetopping Repair Project*. P.O. Number 305626. Montana Department of Transportation. Helena. June, 2001.