of PCC overlay and fatigue cracking of asphalt as controlling performance. Again, 3-D FEM was the basis for the development of design method, followed by adjustment to field conditions, especially the partial bond between PCC and HMA. According to ACPA, UTW is essentially a maintenance strategy and is not to be designed for a life as long as TW or conventional concrete pavements.

A three-dimensional finite element has been instrumental in identifying the critical stress to determine potential failure modes. A 3-D FEM was used to illustrate the stress conditions on STH 82, a 5-inch thick whitetopping pavement. The layout of slabs is shown in Figure 3(a). Since the 5-inch thickness of PCC overlay is close to the borderline of TW and UTW, both top and bottom of PCC overlay are studied. For the center slab, the maximum tensile stress induced by the load is located at the corner of slab at the bottom of slab, as shown in Figure 3(b) (red being tensile stress). This agrees with the distresses found in STH 82.

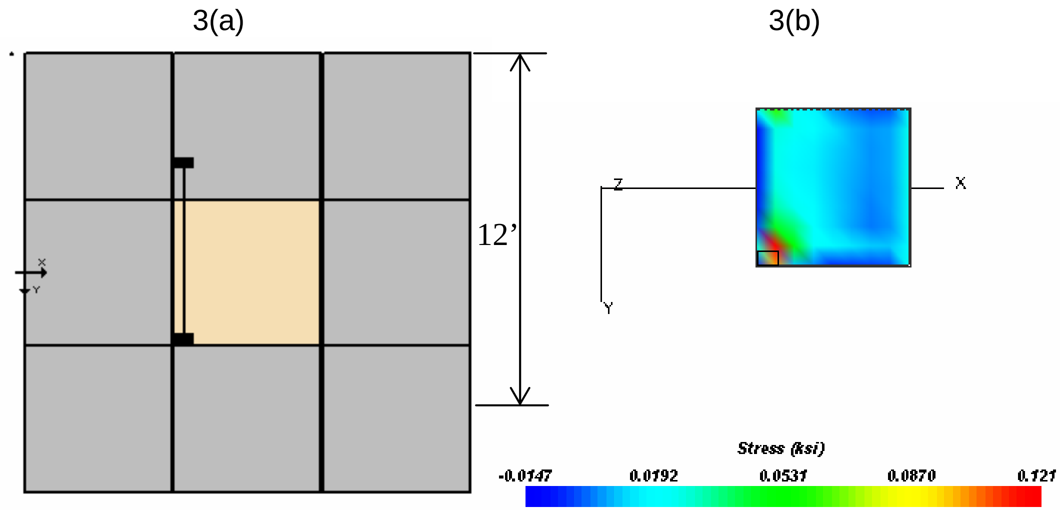

Figure 3. (a) Slab Layout in STH 82; and (b) Critical Stress in Center Slab from 3-D FEM

4. BENEFITS

This information can be used by WisDOT to produce guidance on the use of WT or UTW as an effective pavement improvement technique. Specifically, this study will identify design or construction issues that affects the performance of whitetopping pavements so that WisDOT could address these issues in future whitetopping projects.

5. IMPLEMENTATIONS

WisDOT's technical experts can use the findings from this study to develop guidance and/or policy regarding these two pavement improvement techniques.

6. DETAILED RESEARCH PLAN

To accomplish the research objectives, the following tasks are proposed:

Task 1: Literature Review

The research team will conduct a literature review related to whitetopping pavements. The literature search by CTC & Associates provides a good starting point. The research team plans to conduct additional comprehensive review of available domestic and international literature in the relevant subject areas. On-line sources of information as well as conventional search databases will be utilized. The literature of special interests are the forensic investigations of whitetopping pavements.

At the conclusion of the literature review phase of the study, a summary report of the findings will be prepared. This document will be a part of the quarterly and final reports.

Task 2: Develop a Database of Wisconsin's WT and UTW projects.

The research team will collect the project information related to whitetopping pavements in Wisconsin, including historic and in service pavements. The data to be collected will include project location, construction date, base and asphalt thickness, pre-overlay asphalt condition, pre-overlay repair, PCC overlay thickness, joint spacing, dowel/tie bar, fiber additive, traffic, PCC overlay performance, and design information. Wisconsin Concrete Pavement Association keeps a list of whitetopping projects in Wisconsin. WisDOT documents, such as ride report or "PCC Office All" file, could also be used to identify those whitetopping pavements in STH or IH system.

As-built plans will be reviewed to obtain project location, construction date, base and asphalt thickness, pre-overlay repair, PCC overlay thickness, and joint spacing. Information related to special requirements of concrete, such as fiber additive, could be found in the special provision. The traffic information could be obtained from as-built plans in terms of projected equivalent single axle load (ESAL), or Meta-Manager file in terms of counted AADT and percentage of truck traffic. The pavement thickness information could also be obtained from Base and Layer File.

Task 3: Assess Each Project's Performance.

The pre-overlay and post-overlay performance will be collected. For the in-service whitetopping pavements, the current performance will be obtained from distress survey. The pre-overlay condition and historic performance could be found in Pavement Information Files (PIF), if these pavements are located in STH or IH system. The historic performance evaluation is recorded in the format of pavement distress index (PDI) which is a combination of a dozen of distresses, as well as individual distress severity and extent. The research team will perform a detailed distress survey of in-service whitetopping pavements, following the guidelines in WisDOT Pavement Surface Distresses Survey Manual. This will be in line with historic performance of whitetopping pavements to observe the performance trend. In addition, the field survey will collect the distresses unique to whitetopping pavements which are not covered in the Manual, such as PCC-asphalt debonding, and joint opening. The distress survey will be detailed measurement of distresses for both the calculation of PDI and pavement condition index (PCI). In addition, only detailed measurements could be used to calibrate the whitetopping pavement performance prediction model in M-E Design Guide which will be addressed later in this proposal. The whitetopping pavements located in local roads will have to be evaluated to obtain enough data for future statistical analysis. The team had been collecting similar data for previous WHRP study (ID 0092-04-05) and is familiar with how to access as-built plan, special provision, PIF, and distress survey.

Task 4: Forensic Investigation of Whitetopping Pavements in Wisconsin.

Iowa shear strength tests will be conducted to evaluate the effects of PCC-asphalt bond on whitetopping pavement performance. The shear strength tests will follow the test protocol of Iowa Shear Test. The test will be conducted by Center for By-products Utilization at University of Wisconsin at Milwaukee. To evaluate the structural integrity of whitetopping pavements, falling weight deflectometer (FWD) tests will be conducted in wheelpath, center of slabs, corner, and joints of slabs to obtain deflections, load transfer efficiency (LTE), layer modulus, and k-value on top of asphalt (AASHTO 1993). The results from FWD tests will be input to a 3-D FEM program to identify the critical stresses and correlate with field distresses.

The exact number of whitetopping pavements is unknown. The shear tests and FWD tests will focus on whitetopping pavements with performance issues and will also be conducted on pavements with good performance as a comparison. The team proposes to conduct shear tests and FWD tests on 5 whitetopping pavement with performance issues and another 5 pavements with good performance. A minimum of five pavement cores will be drilled from each of these projects, depending on the project length. The final number of projects for FWD and pavement coring will depend on the results of pavement performance assessment. The definition of good performance is involved in next task, comparing performance of whitetopping pavements in Wisconsin to regional or national research. The traffic control and pavement coring will be subcontracted to local contractors, depending on the locations of projects. The team has been performing pavement evaluation using FWD with the cooperation of WisDOT on CTH JK in Wisconsin from 2001 through 2006. The team is conducting analysis of FWD tests on test cells on MnROAD in Minnesota, funded by U.S Department of Energy.

Based on the data collected, statistical analysis will be conducted to identify the design and construction factors that affect the performance of whitetopping pavements in Wisconsin. Analysis of Variance (ANOVA) or analysis of co-variance (ANCOVA) analysis will be used, if the data are balanced. Multiple regression is more appropriate if the data are unbalanced which is very likely for this observational study, as opposed to an experimental study. The team used statistical analysis to study the initial roughness of concrete pavements in Wisconsin.

The performance of whitetopping pavements will be the dependent variable. The independent variables include two types of data, as follows:

(1) Categorical variables: dowel/tie bar, fiber additive, and high-early strength concrete;
(2) Continuous variables: base thickness, asphalt thickness, PCC overlay thickness, traffic, shear strength, milling depth, and pre-overlay conditions.

For the pre-overlay pavement performance and PCC overlay performance, it will be necessary to study both overall conditions, such as PDI and IRI, and individual distresses. It has been reported that transverse cracks in asphalt could cause reflective cracking in PCC overlay (Burnham et al, 2005).

It is also noted that some whitetopping projects have a project length of up to 12 miles, such as STH 82 in Adams County. However, the existing asphalt pavement conditions may vary significantly among segments (typically one mile) divided by WisDOT while the effects of construction practices on PCC overlay performance are minimal. This provides a good opportunity to study the effects of pre-overlay conditions on PCC overlay.

Task 5: Compare the Performance of Wisconsin's Projects to Regional or National Research.

The performance of whitetopping projects in Wisconsin will be compared to those in other states from literature review. Of particular interest is a study by Akers et al, titled "Ultrathin Whitetopping in California and Nevada: A 13-Year Performance Perspective of Performance Based on Joint Spacing, Thickness, and Traffic Loading" (Akers D.J. and Warren R. 2005). Illinois, Minnesota, and Michigan DOTs also published the performance of whitetopping pavements, which have similar climatic conditions to Wisconsin. A direct comparison of pavement performance is the service life of whitetopping pavements, which will be involved in Task 6. Akes et al used pavement condition index (PCI) as a performance indicator. While PDI is used in Wisconsin, the pavement distresses collected in Wisconsin could be converted into PCI for the purpose of comparison. Since PCI is a function of age, PCI progression over age, namely PCI progression rate, is a more appropriate performance comparison parameter, based on the findings from project 0092-04-05.

Only the design of WT pavements, not UTW pavements, is included in the Mechanistic-empirical design and could have been used as a comparison using the default values. However, it was found that the performance models for WT pavements in M-E design guide simply used the performance models for newly constructed concrete pavements on unbound or chemically stabilized base courses, due to unavailability of performance data of WT pavements, according to the M-E design guide. Thus, the WT design in M-E design guide can not be used for comparison. Instead, the team will use the WT pavement performance data collected in this study to calibrate the performance prediction model in the M-E design guide. The team calibrated the roughness prediction model of asphalt overlay on concrete pavements in the M-E design using Wisconsin data in a previous study for WHRP (ID 0092-04-05).

Task 6: Estimate a Service Life for WT and UTW in Wisconsin.

The team will perform survival analysis to estimate the service lives for WT and UTW, respectively. The pavements used in survival analysis will include those in service and those that have failed. The failure of a pavement is defined as a pavement has received significant rehabilitation/reconstruction or the performance has reached threshold. The service life could be considered either time to failure or the cumulative number of trucks experienced by the pavement by the time of failure.

Functional class of highways or climatic condition might be factors to estimate a service life. However, the research team does not believe there are enough projects to perform such an estimate of breakdown of service life. Depending on the number of whitetopping pavement still in service for survival analysis, the team will use parametric or non-parametric analysis. The statistical analysis will be conducted using SPSS program.

Task 7: Prepare and Submit Final Report

The results and findings from the work plan, along with recommendations for implementing into practice will be documented. This will include a recommendation for design parameters and applications for use, detailing the reasons for the proposed recommendations. The findings of this research project will be included in the project report. It will also cover the research approach and detailed analysis procedures.

7. WORK TIME SCHEDULE

The total project length will be one year. The following table shows the timing of the different tasks selected for the project.

Table: Time Table for Completing Various Activities of the Study

Tasks	2007			2008								
	10	11	12	1	2	3	4	5	6	7	8	9
Task 1: Literature Review	■	■										
Task 2: Database Development		■	■	■								
Task 3: Performance Assessment				■	■	■	■					
Task 4: Forensic Investigation							■	■	■	■		
Task 5: Performance Comparison							■	■	■	■	■	
Task 6: Estimate Service Life										■	■	
Task 7: Final Report											■	■

8. REPORT

The interim findings from this study will be included in quarterly report. The final report will include literature review results, database covering the whitetopping projects in Wisconsin, performance of whitetopping pavements in Wisconsin, and estimated service life. A draft final report will be submitted for the committee to review and comment. The team will also present the findings in a committee meeting. The comments from the committee will be addressed in the final report.

9. ROPOSED BUDGET