Transportation Literature Search

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Concrete Overlays of Flexible Pavement – Construction, Performance, Failures

Prepared for
Bureau of Transportation Infrastructure Development,
WHRP Flexible Pavements Technical Oversight Committee

November 4, 2005

Transportation Literature Searches are prepared for WisDOT technical staff in highway development, construction and operations. The bibliography below is representative, rather than exhaustive, of available studies on the topic. Primary online resources for the literature searches are the Transportation Libraries Catalog (TLCat), the Transportation Research Information Service (TRIS Online), and various academic and scientific databases. Online copies of publications are noted when available. Hard copies of all cited literature may be obtained through the WisDOT Library.

KEYWORDS

Keywords used in Searches of Web-based data bases included: concrete, overlay, asphalt, pavement, bonded, unbonded, whitetopping, ultra-thin, thin, ultra, cracking, reflection.

CITATIONS

Title: NCHRP Synthesis 338, Thin and Ultra-Thin Whitetopping
Author(s): Robert O. Rasmussen and Dan K. Rozycki
Date: 2004
Doc ID/URL: http://trb.org/publications/nchrp/nchrp_syn_338.pdf.
Description: 96 pp.
Contents: TRB's National Cooperative Highway Research Program (NCHRP) Synthesis 338: Thin and Ultra-Thin Whitetopping summarizes available information to document how state departments of transportation and others are currently using thin and ultra-thin whitetopping overlays among various pavement rehabilitation alternatives. The report covers all stages of the proper application of whitetopping overlays, including project selection, design, materials selection, construction, maintenance, and eventual rehabilitation or replacement.

Title: A Behavior Analysis of Concrete Overlay Based on the Characteristics of Asphalt Pavements
Author(s): Yoon-Ho Cho and Han-Mo Koo
Date: 2003
Doc ID/URL: TRB 2003 Annual Meeting CD-ROM; http://www.ltrc.lsu.edu/TRB_82/TRB2003-001563.pdf.
Description: 23 pp.
Contents: Previous research results show that the major distress types of Ultra Thin Whitetopping (UTW) are transverse cracking and corner cracking, and the major factors contributing to these distresses are the physical properties and thickness of the concrete and asphalt layers as well as the bond strength between the two layers. This research evaluated how the physical properties and thickness of asphalt pavements influence the behavior of UTW. Mechanistic analysis by the 3-Dimensional finite element method revealed that the thickness and elasticity modulus of asphalt and concrete layers, bond strength between the two layers, size of the slab, and temperature, strongly affected the critical distress. Based on these results, HWLS (Heart Wheel Load Simulator), a developed simulator that can show distress progression under controlled traffic and temperature, and a device modified from current wheel tracking device, was used to carry out an experiment to see behavior variation according to the thickness of asphalt, concrete layer, and the temperature. It showed that the effect of the thickness of the asphalt layer and the temperature change was insignificant when the thickness of the concrete was 100mm. In addition, the increased ratio of the tensile strain as the load increased was relatively smaller when compared to the 50mm thick concrete layer. Furthermore, when the thickness of the concrete layer was 50mm and that of the asphalt layer was less than or equal to 150mm, the increased ratio of the tensile strain at the bottom of the concrete slab was significantly higher. Thus, it is proposed that a sufficient thickness of the asphalt layer after milling be required in order to apply UTW safely.

Title: Forensic Investigation of Ultra-Thin Whitetopping Failures in Taiwan
Author(s): Deng-Fong Lin and Her-Yuan Wang
Date: May, 2005
Doc ID/URL: *Journal of Performance of Constructed Facilities*, vol. 19, no. 2, pp. 165-171.
Description: 7 pp.
Contents: This paper addresses the causes of the premature failures observed on newly constructed ultra-thin whitetopping (UTW) sections. The key factors contributing to premature failure were high pouring temperature and an insufficient underlying asphalt layer. Severe cracking and deep rutting were observed on sections placed during the daytime when the weather was hot and dry. Pouring temperature was even more critical when river gravel aggregate was used because it has a high thermal coefficient of expansion. Also, a low water-cement ratio magnified the effect of thermal cracking at high pouring temperature. On the basis of field results, it was found that the use of high-strength concrete should be discouraged when the pour temperature is high, since high shrinkage and premature cracking can result. It was concluded that the deep rutting was caused by the pumping of fines from the underlying base layer, in locations where there was no erosion-resistant asphalt layer. Sections poured at temperatures below 30°C with 100 mm of underlying asphalt performed well, and those two criteria are recommended for future UTW application.

Title: Ultra-Thin Whitetopping Rehabilitation Technology and its Bonding Evaluation
Author(s): Xicheng Qi, Terry Mitchell, James A. Sherwood, and Michael Dallaire
Date: May 26, 2004
Doc ID/URL: *ASCE Conference Proceedings* – Transportation Engineering 2004: Applications of Advanced Technologies in Transportation Engineering, 8th International Conference on Applications of Advanced Technologies in Transportation Engineering 2004, May 26-28, 2004, Beijing, China, 105.
Description: 1 p.
Contents: A comprehensive bonding evaluation was conducted on an Ultra-Thin Whitetopping (UTW) experiment with eight full-scale pavement sections constructed with various design features. Strain responses were measured to monitor the bonding condition change during the accelerated loading. After the completion of loading, laboratory Iowa shear tests and field pull-off tests were performed to quantify the bond strength of the UTW-asphalt interface. Additional factors such as asphalt binder type, shearing direction, and the variability of the tests were also included in the evaluation.

Title: Design and Quality Control of Concrete Overlays
Author(s): Norbert Delatte, Shen-en Chen, James Davidson, Anshuman Sehdev, Nader Amer, and Mark Endfinger
Date: Dec. 31, 2001
Doc ID/URL: UTCA Report No. 01220; http://utca.eng.ua.edu/projects/final_reports/01220rpt.htm.
Description: 48 pp., html
Contents: This research developed and tested a range of plain and fiber reinforced concrete overlay mixes that allow reliable, economic, and durable overlay construction as well as early opening to traffic. This report documents the benefits of using nondestructive testing technologies, including spectral analysis of surface waves, in overlay investigation, planning, construction, and quality control. Analytical modeling using the HIPERBOND module of the program HIPERPAVE was used to investigate behavior and performance prediction for the eight overlay concrete designs investigated in the laboratory testing program. So far, two ultra-thin whitetopping overlays have been constructed in Alabama, on heavily traveled asphalt pavements in Selma and Jasper. Both projects were constructed in the outside lanes at intersections, where stopped trucks caused considerable rutting over the years. Performance of the two overlays to date has been very good. Recommendations are made in this report for materials selection, design, and construction controls for overlay construction.

Title: IPRF Whitetopping Project Underway
Author(s): The Transtec Group
Date: unknown
Doc ID/URL: http://www.whitetopping.com/news.asp#iprf.
Description: 1 p., with hyperlinks to sites and documents
Contents: Description of early findings for Task 3(99), Performance and Design of Whitetopping Overlays on Heavy-Loaded Pavements. The Federal Highway Administration (FHWA) has maintained several pavement test sections comprised of hot-mix asphalt (HMA) for some time at its Accelerated Loading Facility (ALF). Recently, eight Ultra-thin Whitetopping (UTW) test lanes 48 ft. (14.6 m) long were placed over the existing HMA pavements. The intent of the ALF tests of the UTW pavements is to determine the effects of vehicular loading. The test sections, located at the Turner-Fairbank Highway Research Center (TFHRC) in McLean, Virginia, presented an excellent opportunity for the performance testing of whitetopping overlays. The arrangement simulated a real application of UTW since the underlying HMA pavements had been loaded previously. The new UTW overlays were placed at varying thickness, joint spacing, addition of fibers, and HMA base types. Both during and after the field visits, The

Transtec Group and the FHWA carefully reviewed the records of the various types of information collected at the ALF. This information included data on the UTW as well as the underlying HMA support layers. Through evaluation of the existing information, as well as analysis of the information collected to date from the ALF Facility, a number of interim hypotheses and conclusions have been drawn. *A key finding is that the performance of UTW pavements seem to be closely correlated with the characteristics of the support layers, especially the HMA layer.* From a comparative analysis, it may be concluded that the common element of each of the observed distress types (mid-slab transverse cracking, mid-slab longitudinal cracking, corner cracking, joint faulting, and spalling) is believed to be the permanent deformation (rutting) characteristics of the support layers. It is believed that by accurately characterizing this effect, a more reliable and accurate design method can result.

Title: Accelerated Pavement Testing of Ultrathin Whitetopping
Author(s): Lawrence W. Cole, James Sherwood, Xicheng Qi
Date: unknown; estimate early 1999
Doc ID/URL:
http://scholar.google.com/scholar?hl=en&lr=&q=cache:m0zOD_NTi_oJ:www.ksu.edu/pavements/trb/A2B09/CS01C2.PDF.
Description: 18 pp. (html version)
Contents: Eight sections of existing asphalt pavement were whitetopped and subjected to FHWA's accelerated loading facility (ALF) in McLean, Virginia. This paper reports the construction and instrumentation of the UTW sections and subsequent load testing and evaluation of one of the eight sections for which testing is complete. After over 800,000 applications of heavy wheel loads, clear evidence of bond between the concrete and asphalt was evident. This bond decreases the critical tensile stresses in the concrete overlay. Strain measurements at two locations showed moving loads cause less strain in the overlay than static loads. Dynamic strain measurements indicate that, in the direction of load application, the concrete overlay experiences a significant stress reversal as the wheel load rolls over the pavement. After 1,072,630 ALF load applications, the test lane showed no significant distress.

Title: Applications of High Performance Concrete for Ultra-Thin Pavement Overlays (Whitetopping)
Author(s): J. T. Balbo
Date: unknown; estimate after 1998
Doc ID/URL: http://www.ptr.poli.usp.br/lmp/download/WTU.PDF.
Description: 19 pp.
Contents: Employment of High Performance Concrete (HPC) for thin overlays construction for aged flexible pavements has become a reality during the 90's, especially in USA and some northwest European countries. While whitetopping old pavements was a technique employed from earlier decades of the twentieth century, the construction of ultra-thin concrete overlays (by 100 mm) for rehabilitation of pavements has been enhanced by the availability of technology for manufacturing HPC and the possibility of fast tracking. Ultra-thin whitetopping is a technique requiring several field conditions to be met concerning the old asphalt pavement in order to perform well as an overlay. They are full bond condition at the interface of HPC and asphalt concrete (generally provided by milling), asphalt concrete without fatigue cracking and rational joint spacing. All these factors, by the other hand, must be taken into account on the basis of the peculiar resistance of the HPC are going to be used. Within this context, in this paper is presented a study with regard to the HPC strength to be achieved for UTW purposes, supported by a numerical analysis based on a finite element solution for slabs-on-grade and taking into account the elastic properties for both HPC and old asphalt, as well as slab dimensions and the load critical position. An international review of HPC applied on whitetoppings around the world is also presented that includes recent works in this field.

Title: A Concrete Overlay on an Asphalt Road
Author(s): Robert C. Rea and Wayne G. Jensen
Date: June, 2005
Doc ID/URL: *International Journal of Pavement Engineering*, vol. 6, no. 2, June, 2005: pp. 111-114.
Description: 4 pp.
Contents: Placing a concrete overlay directly on top of an older asphalt pavement is a procedure that has been used sporadically by transportation agencies for the past quarter century. This practice is now receiving more attention because of initial cost savings and because this type of concrete overlay has shown better than average long-term performance as a resurfacing strategy. Nebraska Department of Roads (NDOR) has three white-topped sections that have been in service for between 13 and 23 years. Based upon evaluation of pavement performance for existing white-topped sections and a cost comparison of alternatives, NDOR recently authorized construction of a new white-topped section on U.S. Highway 2. Performance of this new section is being closely monitored to obtain data on the long-term cost effectiveness of whitetopping as a pavement rehabilitation strategy.

Title: Addressing Cracks During Overlay Preparation
Author(s): ACPA
Date: January 31, 2005
Doc ID/URL: *Concrete Pavement Progress*, vol. 41, no. 1 (Pre-Paving Construction Issue), Jan. 31, 2005; http://www.pavement.com/CPP/2005/CPP-January-05.htm#3.
Description: short article
Contents: common question during whitetopping preparation is whether it is necessary to repair cracks in distressed asphalt prior to overlay. The short answer is it depends on the severity of the cracking.

Title: Simplified Design Expedites Concrete Overlay
Author(s): Randell C. Riley
Date: September 26, 2005
Doc ID/URL: *Construction Digest*, Sept. 26, 2005; http://www.acppubs.com/article/CA6258374.html.
Description: brief article
Contents: Usually the time from planning to construction of a public roadway takes months, sometimes years. In the market of rapid pavement rehabilitation, the concrete pavement industry — in conjunction with Illinois Department of Transportation (IDOT) — has developed new techniques to meet public agencies' resurfacing needs. Following a whitetopping open house at District 1 headquarters in Schaumburg, The Prairie Group made the decision to put the techniques into practice and white-top the roadway leading to its quarry on N. Lorang Road near Elburn.

Title: Thin Portland Cement Concrete (PCC) Overlay of Hot Mix Asphalt (HMA) Surfaced Pavement
Author(s): Paul J. Mack, New York State Department of Transportation
Date: April 02, 2001
Doc ID/URL: Engineering Instruction EI 01-008, New York State Department of Transportation; http://www.dot.state.ny.us/cmb/consult/eib/files/ei01008.pdf.
Description: Technical memo, 14 pp.
Contents: Consider this technique at HMA intersections and ramps where rutting or shoving has occurred. Extend the PCC overlay limits to the locations where vehicle braking begins. Arrange coring with the Regional Materials Engineer to determine the condition of the existing HMA and the required milling depth. Indicate the required milling depth in the contract documents. Generally, 100mm of structurally sound HMA must remain after milling to progress this technique.