Project Abstract

Background and Significance of Work

What is Microsurfacing?

Application of multilayer-multiple layers of an asphalt mixture to improve skid resistance and correct wheel path rutting in both low and high volume roads is referred to as microsurfacing. The asphalt mixture used for microsurfacing includes polymer modified emulsified asphalt cement, well-well-graded crushed mineral aggregate, mineral filler (normally Portland cement or lime), and water, often with an emulsifying agent. Additives may be added used to provide the control of the quick-traffic properties. The mixture is applied cold (unlike hot mix asphalt concrete application) to allow application of a thin layer. The thickness of a microsurface layer is about approximately the same the size of as the maximum aggregate size. Cement is used to accelerate chemical breakdown of the emulsion. Application of microsurface layers layer prevents moisture penetration in asphalt which causes loss of asphalt elasticity and strength. Penetration The penetration of dissolved oxygen causes asphalt oxidation, which leads to weathering, raveling, and surface cracking. By applying a microsurface layer on an existing surface, the moisture permeability is reduced. In addition, microsurfacing reduces other moisture related road damage such as stripping. Typically a road under microsurface treatment is open to traffic within an hour in a normal environmental condition and the service life of microsurfacing is five to seven years for high volume roads and much longer for low volume roads. Figure 1 below shows the road quality improvement made by microsurfacing.
Figure 1: Comparison of road quality before and after microsurfacing (courtesy of CalTrans)

Scanning Electron Micrograph (SEM) the polymer constituent of a three-year-old microsurfacing showing polymer constituent of the mixture is shown in Figure 2. The fine aggregate particles are surrounded by the polymer-containing asphalt to improve the road friction and the ride quality improvement.

Figure 2: SEM micrograph of a sample from three-year-old (paved 1998, sampled 2001) microsurfaced Highway 84 near Waco, Texas (courtesy of Chris Lubbers: BASF Corporation)
Although microsurfacing has been used effectively in the past 20 years, there have been cases where premature failures of microsurfaced roads occurred. This project seeks to compile experience with microsurfacing application by the Texas Department of Transportation (TxDOT), other states DOTs, and as-well-as international DOTs. Based on past experience, microsurfacing quality depends on the mix design, temperature, and humidity while applying the treatment on the road. The Microsurfacing quality also depends on the applicator qualification. Highly trained personnel have produced good quality microsurfacing that have lasted ten years, while poor workmanship has shown to produce poor quality microsurfacing that underwent failure prematurely. The scope of this project encompasses all aspects including materials used, environmental conditions applied, and construction practices implemented.

Correctable Rutting Failure by Microsurfacing

Rutting, also known as permanent deformation, can be defined as the accumulation of small amounts of unrecoverable strains as a result of the applied loading to the pavement [1]. Rutting occurs when the pavement consolidates under traffic loads and/or there is a lateral movement of the hot-mix asphalt (HMA). The lateral movement is caused by the shear failure in the upper portion of the pavement surface. As a result of rutting, the pavement service life is reduced. If the rutting depth is significant, water may accumulate in the rutted area, which can lead to the vehicle hydroplaning. Microsurfacing is not effective for roads with extensive damage such as alligator cracking or other structural damages that may cause the road structurally nonfunctional. Figure 3 compares the schematics of correctable and uncorrectable roads by using microsurfacing.

![Diagram](image_url)

**Figure 3: Examples of correctable and uncorrectable road conditions using microsurfacing**
Existing Guidelines for Microsurfacing

The first detailed report on microsurfacing in Texas can be traced back to 1996, the TxDOT sponsored project 0-1289. The report described the background of microsurfacing and proposed a field observation checklist; the quality assurance tests needed before, during, and after microsurfacing; and possible problems and corrections for microsurfacing application [2]. Then Mansour Solimanian and Thomas Kennedy [3] worked on TxDOT project 0-1788 in 1998 and provided suggestions for effective microsurfacing. Reports of those projects are not in a guideline format yet. In 2001, International Slurry Surfacing Association (ISSA) published a national microsurfacing standard (A143), Recommended Performance Guidelines for Microsurfacing, which provides aids in material selection, mix design, testing methods, equipment, construction, environmental limitations, measurement methods, and payments for the application of microsurfacing [4]. In 2004, TxDOT adopt ISSA’s format and published a guideline of microsurfacing application in items 350, 520, and 524 of Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges [5]. This guideline is still in use in Texas. The City of San Antonio Texas (2008) developed a local standard specification for construction [6], Item 239 of which is related to microsurfacing, which consists of seven sections: description, materials, equipment, construction, measurement, payment, and bid (per square foot/per ton). Item 239 of the specification is related to microsurfacing.

Work Plan

Task 1 - Literature Survey

The purpose of this task is to collect background information about all aspects of microsurfacing in the United States and worldwide. This will be accomplished by both literature searches and interviews with knowledgeable individuals and organizations. Resources at the University of North Texas (UNT) Library will be utilized to perform an exhaustive comprehensive literature review. UNT Libraries provide access to both print and electronic materials to support research in this area. The major electronic databases for engineering, INSPEC and Compendex, permit comprehensive searching of journal articles, conference papers, technical reports, theses, dissertations, and monograph chapters. Access is provided from 1969 to the present. UNT Libraries also provide print or electronic access to journals from Elsevier (over 1800 titles in ScienceDirect), American Society of Civil Engineers (all journals, many conference papers), IEEE (all journals, conference proceedings, and standards through IEEE Electronic Library), and the American Society of Mechanical Engineers (all journals), as well as journals from the major publishers in mathematics, physics, chemistry, and engineering. Resources at the other public universities in Texas will also be utilized. The Center for Transportation Research (CTR) of The University of Texas at Austin (http://library.ctr.utexas.edu/index.html) offers a dedicated library to support transportation research. CTR’s online reports are open to the public from 1977 to the present. The Texas
Transportation Institute (TTI) of Texas A&M University system (http://tti.tamu.edu/publications/) has well over 10,000 research reports addressing transportation issues.

Resources available from publications of the Federal Highway Administration and Transportation Research Board will also be searched. TRIS Online and the National Transportation Library (NTL) are the two essential public tools for research in transportation. TRIS Online (http://ntlsearch.bts.gov/tris/index.do) is the bibliographic database for the Transportation Research Information Services, produced through the cooperative efforts of the Transportation Research Board (part of the National Academies) and the National Transportation Library. This database covers technical reports, books, conference proceedings, and articles from over 480 journals. The National Transportation Library is the “virtual library for the transportation community” (http://ntl.bts.gov/), providing a centralized location for a variety of online materials, a searching environment of all fifty State Department of Transportation websites, and a combined search option for TRIS and NTL’s Digital Collection. Resources from the Federal Highway Administration could also be found through Internet search engines. Science-specific search engines such as Scirus (www.scirus.com) or government-maintained searching websites such as USASearch.gov (http://www.usa.gov/) are especially appropriate for such searches. Some states such as Virginia have their own research centers focused on transportation issues. The Virginia Transportation Research Council (VTRC) sponsors a sizable budget for transportation research and the results of such activities are archived (http://vtrc.virginiadot.org/PROJECTS.aspx).

Pavement Management Information System (PMIS) by TxDOT, which is an automated system for storing, retrieving, analyzing, and reporting pavement condition information, will be used to retrieve and analyze pavement information, compare maintenance and rehabilitation on microsurfaced roads, and correlate the information to actual road performance. Following is the typical data format that will be used in this project:

- distress data—describes surface defects
- ride quality data—measures pavement roughness
- skid resistance data—measures surface friction using the TxDOT Skid Truck

Besides the large body of research underway in the United States by Departments of Transportation, many other countries are engaged in transportation materials research. For example, research activities underway at the Swedish National Road and Transport Research Institute can provide resources and information on their activities. The National Research Council of Canada is another example. Table 1 presents a list of worldwide organizations involved with microsurfacing.
Table 1: List of worldwide organizations involved with microsurfacing

Asphalt Emulsion Manufacturers Association (AEMA)
American Society for Testing and Materials (ASTM)
Australian Asphalt Pavement Association (AAPA)
South African Bitumen Association (SABITA)
U.K Slurry Association, and the French Society for Bitumen Emulsions (SFERB)
International Slurry Surfacing Association (ISSA)

All of the above-mentioned resources will be utilized to compile up-to-date information available on the microsurfacing successes and failures. As a conclusion, the useful resources for this project include University libraries, University research centers, national transportation agencies, state departments of transportation, local government, international research centers and associations, and the transportation industries. Useful information needed for this project are: current mix design procedures, critical factors relating to performance, performance of existing projects, existing guidelines and specifications, failure modes, benefits and limitations, intended use and expectations, constructability issues, and thickness, age, traffic, surface conditions, climate and history.

Task 2 - Survey of Different Entities Involved with Microsurfacing

Entities involved in microsurfacing technology include chemical manufacturers, construction contractors, and departments of transportation (end users). Each one of these entities has experienced successes and failures of microsurfacing applications. Their experiences can provide valuable information in formulating a successful microsurfacing plan. Chemical manufacturers are involved in the mix design, which is an extremely important factor. Construction organizations control the application of microsurfacing chemicals, a crucial step in assuring the microsurfacing quality. And engineers and technicians of Departments of Transportation are at the forefront of the battle with road defects such as raveling, cracking, delamination, aging, wear, stripping, and deformation. Survey of personnel involved in these sectors will be performed. Compilation of their experience will be used for developing a new microsurfacing guideline. For example, contractors will be surveyed on the critical factors such as the thickness of microsurface, the existing surface conditions, and climate and the required time to for traffic ability. The state DOTs and international agencies which are involved in microsurfacing will be surveyed on the use of current mix design procedures, the satisfaction with each method and procedure, methods and procedures needed for improvement or elimination. The Pavement Preservation Microsurfacing Application Checklist (2002) published by the Federal Highway Administration will be used as a starting model. Detailed questions will be decided in consultation with the project director assigned to this project.
Task 3 - Site Visits and Identification of Failure Modes of Microsurfaced Roads

A number of sites with microsurfacing application will be visited. Through literature search and surveys/interviews with engineers and technicians of different TxDOT districts, a group of sites will be identified where microsurfacing has been implemented in Texas. A reasonable number of these sites will be selected to visit. Condition of each site such as mixing, curing, and service performance will be documented. Microsurface thickness, age, traffic, surface conditions, climate, and rehabilitation history will be considered in evaluating performance. Special attention will be given to the failure modes where visible damages are observed by noting characteristics of the damage. The failure modes in microsurfacing include raveling, cracking, delaminating, aging, wear, stripping, and deformation. And the failure modes that are addressed by microsurfacing include loss of skid resistance, raveling, and resistance and rutting. Possible reasons of the failure will be investigated.

Task 4 - Documentation of Existing Guidelines and Specifications

A compilation of existing guidelines and specifications on materials and construction procedures for microsurfacing will be produced. Based on the existing versions and modifications of these guidelines and specifications, best practices for implementation of microsurfacing will be developed for different environmental conditions. In this subtask, specifications from both the United States and overseas (based on available literature information) will be collected and analyzed. The literature search and the survey will result in identifying the critical factors of microsurfacing performance. In addition, environmental effects of environment will also be analyzed. The results will be documented as the best practices by contractors, suppliers, and users. Following is a list of expected specific outcomes of this synthesis project.

- Identification of the influence of raw material interactions on microsurfacing performance
- Identification of the performance parameters for the mixing, curing, and spreading of the microsurfacing mixtures
- Identification of the in-service performance parameters for the cured mixture
- An analysis of practices, guidelines, and specifications around the world, will be used to create a summary showing the current best practices and modifications needed to adopt these practices to local conditions of the State of Texas.
Task 5 - Final Report Preparation

A comprehensive report of work performed, methods used, and results achieved will be prepared and delivered. The report will include recommendations on the future use of microsurfacing in TxDOT and the scope of what research that will be needed in Texas to apply this material successfully.

References


Assistance or Involvement by TxDOT

The principal investigator of this proposal has reached out for assistance from engineers of Dallas and Fort Worth districts in identifying sites where recent microsurfacing projects has been completed and is hopeful to be granted such a-support. Engineers of other TxDOT districts with consultation of the project director will be contacted for collection and compilation of successes and failures of microsurfacing projects in the past two decades. Attempts will be made not to add strain on TxDOT resources and manpower in successful completion of this project.

Termination date: August 31, 2011

Timeline: Proposed period for this project is November 1, 2010 through August 31, 2011.