Research Need Statement 556

Date:	**April 30, 2018**
Need Statement Champion:	**LRRB – Brainstorming – Ron Bumann**
Agency:	**MnDOT State Aid**
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Idea Submitted by:	**SRF Consulting Group, Inc. – Michael Marti**
Idea Originated from:	**LRRB 2018 Brainstorming**

Select Program:

☐ MnDOT OR ☑ Local Road Research Board (LRRB)

☑ Research OR ☐ Implementation

Need Statement Title:

Optimizing Mix Designs – Low Volume Roads in Minnesota

Need Statement: Describe the problem or the opportunity. Include background and objective.

Is there a "go to" mix design that has been proven to work best for low volume roads? MnDOT specifications are generally for highways and high-volume roads. However, these mix designs may not be the best option for low volume roads. Although MnDOT does provide guidance, local agencies are going in different directions.

In theory, for lower volume roads, should a mix design with lower air voids be used? Can this be verified? What are other, neighboring states using for low volume mix designs?

The research study could include the following phases:

- Survey/synthesis of what other states are using for low volume road mix design
- Collect data and test results within MN to see what is working; including looking at in place density after traffic.
- Performance testing at MnROAD

Provide a summary of the potential benefits:

This study will help to determine if a better mix design is more suitable for low volume roads than what is currently being specified. A better mix design may result in longer lasting low volume roads.

How does this project build upon previous research (include title or reference to a completed research effort)?

No specific research was found on mix designs for low volume roads. There is an older LRRB study Best Practice for the Design and Construction of Low Volume Roads – Revised (2002). Additional research, via a recent literature search, is attached follows this needs statement.

Provide names to consider for a technical advisory panel:

Ron Bumann (MnDOT State Aid); Joel Ulring (MnDOT State Aid), John Garrity (MnDOT Bituminous Engineer), Guy Kohlnhofer (Dodge County), Dan Staebell (Asphalt Paving Association); Jim Foldesi (Saint Louis County); Mike Flaagan (Pennington County); Paul Sandy (City of Brainerd)

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Prepared for: Nicole Buehne
Prepared by: Jim Byerly, Electronic Resources Librarian
Resources searched: ASCE Library, MnDOT Library Catalog, Transport Database, Research in Progress, Web
Summary: Results are compiled from the databases named above. *Links are provided for full-text, if applicable, or to the full record citation.* I completed my searches using the following terminology: mix design, low volume roads, best practice, state of the art, state of the practice. The results are divided into most relevant and less relevant.

1. **Pavement Asset Design and Management Guide.**
   Source: 2013. xxvi, 460 p.
   Abstract: This Guide is a consolidation of Canadian pavement design and management practices. It provides a theoretical understanding of issues, a summary of best practices and is intended to be applicable across Canada for varying conditions and jurisdictions. Tools for the management of transportation infrastructure assets are included. The Guide emphasizes routine maintenance and preservation as important aspects of pavement management. Key industry issues such as sustainability, climate change and new innovations are highlighted. Low volume road design and management is addressed. The Guide explicitly highlights provincial practices in addition to municipal practices. State of the art is explored, and future opportunities are identified throughout the Guide. The document is a guide rather than a comprehensive design manual and each of its fifteen chapter provides numerous additional resources for further reference. The Guide is intended for a diverse range of users, practitioners and managers. Academic users will find this Guide a valuable reference. The private and public sector will use the Guide as a design and management tool, particularly when training new technologists, engineers and managers. (A)
   Year: 2013

2. **Mix Design for Full-Depth Reclaimed Asphalt Pavement with Cement As Stabilizer Advanced Characterization of Asphalt and Concrete Materials**
   Source: (1 - 8)
   Abstract: A rational rehabilitation design should be based on the understanding and knowledge of the existing pavement distress or condition. The purpose of this research was to investigate the effects of reclaimed asphalt pavement (RAP) content and cement content on the strength of full-depth reclamation (FDR) base. FDR for asphalt pavement with cement as the stabilizer was used as the base course. The full-factorial experimental design included five RAP contents and five cement contents. To ensure the reproducibility, there were three replicates for each specimen. The 7 days; unconfined compressive strength (UCS) was used as the control parameters. The five RAP contents consisted of 0%, 25%, 50%, 75%, and 100%. The five-cement blending content included 0.5%, 1.0%, 1.5%, 2.0%, and 2.5%. The test results indicate that the optimum design was 50% RAP and 2% cement.

3. **Warm-Mix Asphalt for Rural County Roads**

4. **Cold Regions Engineering 2009: Cold Regions Impacts on Research, Design, and Construction**
   Source: (438 - 454)
   Abstract: Warm-mix asphalt (WMA) is a group of technologies that allow for the placement of asphalt at production temperatures 35°F–100°F lower than traditional Hot-mix asphalt (HMA). Some of the benefits for using WMA are that it lowers fuel consumption, lessens the aging of the asphalt binder, decreases the production of greenhouse gases, allows for the placement of asphalt plants in more restrictive areas, and improves worker conditions. First used in Europe, WMA was introduced to the U.S. with a European scanning tour in 2002. In 2004 the first field tests in the

U.S. were constructed, with the first production paving jobs in 2006. Warm Mix Technology is divided into three distinct classifications based on the mechanism used to produce the end product. In one class, foaming, small amounts of water are mixed with the hot asphalt oil. A second process uses organic additives or waxes to decrease the viscosity of the oil. The last class use chemicals or surfactants to aide in the coating of the aggregate at lower temperatures. All three processes have been used in cold weather climates. A surfactant was chosen for Crow Wing County Road 108. Most surfactants require little if any plant modifications when compared to a foaming process in which the modifications could be as simple as adding another bin to a rap feeder or as complicated as adding manifolds and injectors to the plant. The use of a wax was rejected, as one of the ways to get a cost comparable product for this project was to substitute a warm mix product using PG 58-28 oil for a hot mix product using PG 58-34 oil. Research indicated that one of the benefits of warm mix using the foaming or surfactant process is that they generally perform better than the waxes for thermal cracking. On August 19th of 2008 2913 tons of WMA and 272 tons of HMA were placed on Crow Wing County Road 108 by Anderson Brothers Construction Company of Brainerd. A level 2 gyratory mix design was used incorporating Evotherm 3G in the asphalt binder. The additive was added at the Flint Hills refinery in Minneapolis at a rate of 0.5% by the weight of the binder. The product arrived at the paving plant ready to use, requiring no modifications to the plant or the paving equipment. During production the only change made to the normal testing procedure of the mix was the temperature at which the gyratory samples were made. The oil met all the requirements of a PG 58-28 oil and the mix met all of the requirements of a Level 2 gyratory design. The binder was cut 0.1% from the HMA design to bring the production air voids in the WMA up to the desired levels. The densities of the road cores of the WMA (ave. 92.7%) were found to be slightly below that of the HMA (94.1%) but still at a respectable level for a 2-inch lift on a 5-ton road over gravel. Answers that will come over time are whether or not WMA will perform better than HMA for thermal cracking, will it will have a longer life span and will prices become comparable to HMA. Some other countries currently believe the answers are "yes" and are willing to pay a higher price today to realize cost savings in the future.

5. **Green Initiatives at MnROAD**

6. **T&DI Congress 2011: Integrated Transportation and Development for a Better Tomorrow**
   Source: (720 - 730)
   Abstract: The transportation network and its supporting infrastructure have significant economic, social, and environmental impacts. Using more sustainable methods to design, construct, and preserve our roads will better protect the environment and meet our ongoing transportation needs. The Minnesota Department of Transportation (Mn/DOT) and our partners in government, industry, and academia have been researching and implementing ways to make our roads greener while maintaining and improving roadway quality. The Minnesota Road Research Facility (MnROAD), an accelerated pavement test facility near St. Paul, MN, is conducting research on several "green" pavement technologies that reduce environmental impacts, reuse roadway materials, or use recycled materials in pavement applications. Green pavement technology should maintain or improve the state of the practice of pavement engineering. This ensures the green product will be market-driven, cost-effective, and sustainable.

7. **Low Volume Road Asphalt Trial in SA**
   https://www.ipwea.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=4c1b2239-1e6e-4373-9f55-829be63430a1

8. **BEST PRACTICES FOR THE DESIGN AND CONSTRUCTION OF LOW VOLUME ROADS REVISED**
   Source: MnLRRB Report

URL: http://dotapp7.dot.state.mn.us/research/pdf/200217REV.pdf

9. **BEST PRACTICES TO SUPPORT AND IMPROVE PAVEMENT MANAGEMENT SYSTEMS FOR LOW-VOLUME PAVED ROADS – PHASE I**
   https://www.codot.gov/programs/research/pdfs/2018-Research-Reports/LVR-Phase-I/

10. **Benefits of MnROAD: Phase-II Research**
    https://www.lrrb.org/pdf/201519.pdf

11. **CONSTRUCTION OF LOW VOLUME SEALED ROADS: GOOD PRACTICE GUIDE TO LABOUR-BASED METHODS**
    http://www.epwp.gov.za/documents/Infrastructure/Techinical%20Support/Good_Practice_Guide_to_Labour-Based_Methods_2013.pdf