Research Need Statement 557

Date:	April 30, 2018
Need Statement Champion:	LRRB – Brainstorming – Chad Hausmann
Agency:	Wright County
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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:

Base Stabilization Additives – Effect on Granular Equivalency (GE)

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

Base stabilization is one technique used when constructing roads in areas of weak/susceptible soils. There are numerous materials that can be used to effectively stabilize bases, including propriety and non-propriety materials. A recent LRRB Implementation study, Base Stabilization Additives for Pavement Design (2017) developed a guidebook for engineers to promote a better understanding of base stabilization, its benefits, and best uses. However, the focus was on non-proprietary materials and the study recommended that further research be done.

Many local agencies have been using BaseOne, a local propriety stabilizer. In February of 2018 MnDOT State issued a memo *"Guidance for use of BaseOne® in State Aid Projects"* which provides information on use and GE factors for BaseOne.

Although this memo clarifies the use of BaseOne, industry representatives often present other stabilizing agents to local agencies. Continuing the recommendations of the earlier research and based on recent questions from local agencies, a research project should focus on answering the following questions about proprietary stabilizers (including BaseOne):

- How have stabilizers been used in the field?
- Develop a process to determine the quantity of stabilizers that should be used in various field conditions.
- How do base stabilizers affect pavement design?
  - Do they provide increased strength?
  - If so, how much (e.g. granular equivalency)?
- List of potential additives and their cost-benefit using 2019 cost per mile to treat upper 4 inches.
  - How much granular equivalency may be obtained by the additive?
- If the stabilizer is water based:
  - Does the stabilizer leech out over time thereby reducing effectiveness?
  - Is there a long-term granular equivalency benefit?

Research Need Statement 557

Provide a summary of the potential benefits:

The benefit of this study would be realized in understanding the structural benefits of proprietary stabilizers and applying GE factors to a pavement design to reduce the inches of material (gravel and/or asphalt). This reduction of materials could be a significant cost saving per project, not to mention the savings statewide.

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

In addition to the recent LRRB Implementation study, Base Stabilization Additives for Pavement Design, two other LRRB funded research studies on stabilization included:

- Strengthening Road Foundations with Cement Stabilization (2015)
- Subgrade Stabilization ME Properties Evaluation and Implementation (2012)

Provide names to consider for a technical advisory panel:

Chad Hausmann (Wright County), Mel Odens (Kandiyohi County), John Siekmeier (MnDOT Research), Aaron Budge (MN State University-Mankato), Ben Worel (MnDOT Research), Lon Aune (Marshall County), Rich Sanders (Polk County), Joe Triplett (Chisago County), Joel Ulring (MnDOT State Aid), Tom Wesolowski (City of Shoreview)

Research Need Statement 557

Prepared for: Nicole Buehne / Mitch Rasmussen – on behalf of LRRB
Prepared by: Karen Neinstadt
Resources searched: Transport, RiP, MnDOT Library Catalog, Web
Summary: Transport had only 1 relevant result from the past 5 years, but I included a result from 2012 that seemed applicable.

1. **Construction over Frozen Ground on the Port MacKenzie Rail Extension Project.**
   Author: Brennan Kyle
   Conference Title: 16th International Conference on Cold Regions Engineering. Location: Salt Lake City. Sponsored by: American Society of Civil Engineers. Held: 20150719-20150722. 2015/7. pp 488-499(Refs.)
   Abstract: The Port MacKenzie Rail Extension project is an approximately 51.5-km-long rail spur extending south from the existing Alaska Railroad mainline in Houston, Alaska, to Port MacKenzie on the north end of the Cook Inlet. The rail spur alignment crosses largely undeveloped land and approximately 8 km of poorly drained, boggy wetland areas. Many of the wetland areas are incapable of supporting construction vehicle traffic during the summer season. To facilitate embankment construction in these wetlands during the summer, an approach to constructing the base of embankments over firm, frozen ground during the winter (winter embankment base stabilization (WEBS)) was developed. Several configurations to the WEBS construction were considered using soil fill and geosynthetics. A test section was constructed and instrumented using horizontal slope indicators and vertical thermistor strings during the first winter season of construction for four variations of fill thickness and reinforcement. The results of the test section and observations during construction of the WEBS during the first summer construction season were used to refine the approach for subsequent construction seasons. After three construction seasons, a significant amount of real-world performance and construction observations were available to evaluate the effectiveness of the WEBS over seasonally frozen ground. Additional comparisons of the WEBS construction approach to several embankments constructed in wetlands under summer conditions were also available. This paper provides settlement and ground temperature data collected at the WEBS test sections, observations of WEBS performance, recommended construction approaches over seasonally frozen ground, and a review of the efficacy of the recommended approaches. Conditions where WEBS should be utilized, and lessons learned are discussed.
   Editor: Guthrie W Spencer
   Publication Year: 2015

2. **Base stabilization guidance and additive selection for pavement design and rehabilitation**
   Author: Wegman, Daniel E.: / prepared by Daniel E. Wegman, Mohammadreza Sabouri, Joe Korzilius, Renae Kuehl.
   Publisher: St. Paul, Minn.: Minnesota Department of Transportation, Research Services Section, 2017.
   Abstract: Significant improvements have been made in base stabilization practice that include design specifications and methodology, experience with the selection of stabilizing additives, and equipment for distribution and uniform blending of additives. For the rehabilitation of existing pavements, the stabilization of base material has delivered performance as good as or better than reconstruction at a reduced cost. Many additive products exist to stabilize base materials for roadway construction, but it is not always clear which additive is the right one to use. This guidebook intends to focus on stabilization for new construction and Stabilized Full Depth Reclamation (SFDR) and to help with the selection of suitable nonproprietary stabilization additives for individual specific project(s).
   URL: http://www.dot.state.mn.us/research/reports/2017/2017RIC02.pdf
   Citation: Mn/DOT Library Main Collection - MNDOT TE212. W44 2017

3. **Exploring Different Forms of Base Stabilization**
URL: https://mack-blackwell.uark.edu/Research/mbtc_dot_3033.pdf
Author: Braham Andrew; Hill Robert; Jackson Alexander; Smith Sadie
This report was sponsored by the U.S. Department of Transportation, University Transportation Centers Program.
Abstract: Our nation's roadways have experienced a growing demand over the past couple of decades. With decreasing funds and the need to provide the public with an efficient, safe, and cost-effective roadway system, there has been a remarkable increase in the need to rehabilitate our existing pavements. When a flexible pavement has deteriorated to the point where rehabilitation or reconstruction is necessary, pavement engineers have traditionally used either the mill and overlay strategy or complete reconstruction. With the advances made on road construction equipment over the last two decades, there has been a growth in asphalt recycling and reclaiming as a technically and environmentally friendly way of rehabilitating the existing, failed pavements. An example of rehabilitation is base stabilization, or Full-Depth Reclamation. This research identified two mix designs for Portland cement base stabilization, three mix designs for asphalt emulsion base stabilization, and two mix designs for asphalt foam base stabilization. These mix designs are currently being synthesized to produce one final mix design for each technology. Preliminary testing indicated that the modified proctor and Superpave Gyratory Compactor can produce similar moisture density curves. In addition, increasing the water content and asphalt foam content of asphalt foam base stabilization mixture increased the compressive strength.
Publication Year: 2012

4. **Structural evaluation of asphalt pavements with full-depth reclaimed base**
Author: prepared by Shuling Tang, Yuejian Cao, and Joseph E. Labuz.
URL: http://www.lrrb.org/pdf/201236.pdf
Abstract: Currently, MnDOT pavement design recommends granular equivalency, GE = 1.0 for non-stabilized full-depth reclamation (FDR) material, which is equivalent to class 5 material. For stabilized full-depth reclamation (SFDR), there was no guideline for GE at the time this project was initiated (2009). Some local engineers believe that GE of FDR material should be greater than 1.0 (Class 5), especially for SFDR. In addition, very little information is available on seasonal effects on FDR base, especially on SFDR base. Because it is known from laboratory studies that SFDR contains less moisture and has higher stiffness (modulus) than aggregate base, it is assumed that SFDR should be less susceptible to springtime thawing. Falling Weight Deflectometer (FWD) tests were performed on seven selected test sections on county roads in Minnesota over a period of three years. During spring thaw of each year, FWD testing was conducted daily during the first week of thawing in an attempt to capture spring thaw weakening of the aggregate base. After the spring thaw period, FWD testing was conducted monthly to study base recovery and stiffness changes through the seasons. GE of SFDR was estimated using a method established by MnDOT using FWD deflections, and the GE of SFDR is about 1.5. The value varies from project to project as construction and material varies from project to project. All the materials tested showed seasonal effects on stiffness. In general, the stiffness is weaker in spring than that in summer and fall.
Publisher: St. Paul, MN, MnDOT Research Services Section, 2012.
Citation: TE275. T36 2012
Funding: Sponsored by the Minnesota Local Road Research Board and performed by University of Minnesota, Department of Civil Engineering 89261, work order 156 CTS #2009083. MN-RC-2012-36.

5. **Team Lab**
URL: http://www.teamlab.net/

6. **Team Lab Base One Base Stabilizer (see "Case Studies" on right-hand sidebar)**
   URL: http://www.teamlab.net/product?id=base-one

7. **Evaluation of Load Transfer in Geogrids for Base Stabilization Using Transparent Soil.**
   Author: Peng Xin; Zornberg Jorge G
   Citation: Procedia Engineering. 2017. 189 pp 307-314(Figs., Refs., Tabs.)
   Abstract: The design of roadways with geosynthetic-stabilized base layers requires proper evaluation of the load-transfer mechanisms between soil particles and geosynthetics. In the case of geogrid reinforcements, the resistances mobilized on rib elements are key factors that determine the mechanical responses for both: (1) the ultimate pullout strength; and (2) the in-plane stiffness. Geogrids with different aperture shapes have rib elements along different orientations, and different rib orientations could generate different load transfer mechanisms. In this study, a new experimental testing program using transparent soil was conducted to visualize the load transfer of geogrids with different aperture shapes (e.g. rectangular, triangular). Specifically, small-scale soil-geosynthetic interaction tests were conducted using high-definition cameras. Consequently, image-processing techniques were used to obtain the displacements and deformations of geogrid specimens from digital images. The soil-geogrid interaction behaviors for geogrid specimens with different aperture shapes were evaluated and compared. Overall, multiple mechanisms for load transfer between soil and geogrids with different geometric characteristics could be characterized and quantified using new techniques involving transparent soil and digital image analysis.
   Publisher: Elsevier
   Publication Year: 2017

8. **How to Stabilize Road Costs**
   URL: http://www.pwmag.com/roadways/how-to-stabilize-road-costs_o

9. **Kandiyohi County Uses Aggregate Base Stabilizer on Damaged County Road**
   URL: http://www.betterroads.com/kandiyohi-county-aggregate/

10. **Investigation of Methodologies to Control Dust on County Roads in Western North Dakota**
    URL: https://cms.oilresearch.nd.gov/image/cache/dust_control.pdf

11. **Chemical Additive Usage on Unpaved Roads in the Mountain Plains States**
    (Team Lab contact has been updated since this report – please refer to the Team Lab website)
    URL: http://www.ugpti.org/pubs/pdf/DP130.pdf