RESEARCH PROGRAMS USE ONLY
RESEARCH TOPIC STATEMENT NO: 15-008
DATE OF RECEIPT: 4/28/15

RESEARCH PROGRAMS

RESEARCH TOPIC STATEMENT

I. TITLE (required):

Guidelines for Chemically Stabilizing Problematic Soils

II. TOPIC STATEMENT (required):

Primary objective of the proposed project is to establish some initial protocols for conducting efficient chemical stabilization design for soils with and without soluble sulfates within the state of Montana.

III. BACKGROUND STATEMENT (required):

Chemical stabilization of soils has been around for about 70 years now, primarily due to the reduction in the construction costs and improvement in the road surface performance. It is documented that the success of a chemical stabilization project depends on; appropriate material type (such as PI) and gradation, proper concentration of the chemical stabilizer, adequate mixing and curing, adequate density and moisture, adequate short-term and long term strength and stiffness development, and, proper construction methods. Also, the performance of chemical stabilization depends on the interactions between the chemical additive and the soil minerals. There is a wide array of chemicals available for stabilization which include Lime, Cement, Fly ash, Cement Kiln Dust, among others. It is important to evaluate these chemicals for some Montana specific soils and develop guidelines for their use. In addition, special considerations need to be made in case of soils with high sulfate concentrations as these lead to sulfate-induced heaving where an expansive mineral called Ettringite is formed.

The Montana Department of Transportation has very limited experience with chemical stabilization, and while there is a desire to potentially use chemical stabilization, a major concern with this approach is the presence of potential high sulfate concentrations. This proposal aims at addressing this issue from a design perspective. Even though there is awareness and knowledge on chemical stabilization of expansive soils from other DOTs (particularly Texas DOT) and NCHRP pool funded research projects (Harris et al., 2006; Little and Nair, 2009; Puppala et al., 2011; Puppala et al., 2014) there is a need to develop design guidelines for Montana specific soils. The above mentioned variables including soil types – with and without soluble sulfates, additive types and amounts must be studied for Montana specific soils and guidelines should be developed based on these studies.

In addition, knowledge gaps exist in understanding what levels of sulfate concentration is problematic (lower threshold level) and what levels of sulfate are treatable (upper limit). This is not an easy question to answer, as soil stabilization not only depends on the chemical interactions of the soil minerals and the additives but also on the physical characteristics such as porosity, availability of moisture. This study will not only improve the MDTs capabilities of addressing these problematic soils but also contribute to the DOT research at a national level.

IV. RESEARCH PROPOSED (required):

The main goal of the proposed research is to develop protocols for chemically stabilizing problematic soils with and without soluble sulfates. The following specific objectives will be met as a part of this research:

1. **Determine the effectiveness of common soil stabilizing agents for mitigating problematic soil in Montana by:**
   a. **Conducting an investigation into the initial mineralogy of the soil in select geographic regions and the extent of mineralogical changes of the soil with the introduction of an additive.**
   b. **Quantifying the effects of mineralogical changes on the chemical, engineering, and physical properties of soils.**

CONTINUED ON BACK

c. Recommending methods for determining both type and quantity of additive based on clay mineralogical analysis.

2. Propose, investigate, and recommend methods of determining the efficacy of additives stabilizing pavement layers by:
   a. Developing and demonstrating the validity of accelerated testing methods that minimize the time required for sample preparation, curing, conditioning and testing.
   b. Investigating the effects of changes in processing materials to better simulate field conditions by incorporating variables such as particle gradation, compaction effort, and curing criteria.

3. Understand sulfate heaving issues and shed light on the effects of factors such as soil fabric, reactive alumina and silica and additive types and addition methods on sulfate attack in soils by:
   a. Determining how soil fabric/texture affects ettringite formation,
   b. Developing a practical technique to quantify the Si and Al content in the soil,
   c. Determining if cement and lime pose different levels of risk in formation of ettringite, and
   d. Determine the interaction between fly ash and sulfate-rich soils.

4. Determine cost-benefit of using stabilizing agents to mitigate problematic soils using life cycle cost analysis (LCCA) approach.

V. IT COMPONENT (required): Identify if the project includes an IT component (purchasing of IT hardware, development of databases, acquisition of existing applications, etc) or not. If so, describe IT component in as much detail as possible.

The work proposed herein does not require IT hardware or software support.

VI. URGENCY AND EXPECTED BENEFITS (required): This section must include a description of how this research will serve the public by providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality and/or sensitivity to the environment.

The stabilization design protocols developed as a part of this project can help MDT more effectively determine if chemical stabilization is a viable method for Montana specific soils, particularly in the Great Falls and Glendive districts where clay soils are very common. By conducting this research MDT will invest in gaining the much needed knowledge in chemical stabilization of problematic soils specific for Montana.

This research will also help quantify the necessary resources (i.e. investigation frequency, lab testing, design protocols) that would be required to effectively assess whether chemical stabilization can be incorporated at MDT with an acceptable level of risk on a wide spread approach while considering the existing resources.

VII. IMPLEMENTATION PLAN (required): Identify MDT office or entity outside of MDT responsible for implementation. Describe initial implementation plan, include timeframe for implementation.

The MDT Geotechnical Section will incorporate the results of this study in determining the suitability of chemical stabilization for select projects.

VIII. SUBMITTED BY: (required)

NAME Bhaskar Chittoori
TITLE Assistant Professor
AFFILIATION Boise State University
ADDRESS 1910 University Drive,
Boise, ID 83725
PHONE NO. 208-426-3794
E-MAIL bhaskarchittoori@boisestate.edu

IX. CHAMPION (optional): Must be internal to MDT, feel strongly that the research will benefit the Department, and is willing to chair the technical panel.

NAME Jeff Jackson, P.E.
TITLE Geotechnical Engineer
AFFILIATION Montana Department of Transportation

ADDRESS

PHONE NO. 406-444-3371
E-MAIL jejackson@mt.gov

X. SPONSOR(S) (optional): Must be internal to MDT (Division Administrator or higher) and willing to ensure implementation occurs, as appropriate.
NAME(S)
PHONE #(S)
E-MAIL(S)

Note: Submitter may attach continuation sheets if necessary. All research topics submitted become public property and submitters are not guaranteed to receive a contract for any work resulting from any submitted research topic.