MPC-365

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Project Title:
Improved Understanding of Pavements Impacts and Cost-Effective Designs based on Mechanistic Empirical Methods.

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University of Wyoming
North Dakota State University

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Research Needs:
In the past, all pavement design was completed using the 1993 version of the AASHTO Guide for Design of Pavement Structures (AASHTO 1993). This guide was developed solely from data collected during the AASHTO road tests completed from 1958 to 1961 in Ottawa, Illinois. Since these road tests were conducted over 50 years ago and only in a single location, they lack the ability to accurately predict pavement performance in differing climates, traffic volumes, construction methods, and the capacity to account for the new improvements to pavement materials. As a result, the Mechanistic Empirical Pavement Design Guide (MEPDG) was developed as a fully comprehensive guide to allow for more cost effective designs that are suited to a particular area based on input parameters.

The Wyoming Department of Transportation (WYDOT) has observed the benefits of the MEPDG and has decided to start implementing the MEPDG on the interstate highway system. However, additional research needs to be conducted to discover the benefits for the MEPDG use on local roads. The local roads that have been affected by the increase in traffic associated with

oil drilling are a great candidate for redesign using the MEPDG. This is especially true since the specialized trucks used in the oil industry today are vastly different from the traditional ones used to transport grain and other commodities produced in rural regions. The continuous operation of heavy trucks poses great challenges to the state of good repair, especially in areas of suboptimal soils and freeze-thaw cycles. Roads designed to last for 20 years under traditional truck traffic are lasting five years under intense oil-related movements. Oilfield pavement analyses conducted thus far have utilized adjustments to traditional design procedures (e.g., AASHTO 1993) based on equivalent single axle load (ESAL) factors originally derived from road tests. While these methods have proven useful, the trucks used during the AASHTO road tests are modest in comparison to the trucks utilized in the oil industry today. To address some of the limitations of its original design guide, AASHTO developed a new Mechanistic Empirical Pavement Design Guide (MEPDG), which combines mechanistic and empirical methodologies by making use of calculations of pavement responses such as stress, strain, and deformation using site specific inputs from climate, material and traffic properties. With the new guide, various implementation challenges must be overcome by agencies wanting to use it. The primary objective of this project is to facilitate the implementation of the newly developed MEPDG so that roads serving the energy industry can be designed to carry the very heavy and unique traffic associated with drilling activities. In addition, regional strategies for mitigating the impact of drilling activities on local roads will be investigated. Initiating a regional effort of this type will ensure more effective allocation of limited resources to impacted local governments. Furthermore, ensuring the adequacy of local roads will provide oil and gas industries with the means to get equipment to drilling sites and deliver their products efficiently to markets year round.

Research Objectives:

Research the effectiveness of the MEPDG compared to the AASHTO 1993 guide for improvement and reconstruction to local paved roads in Wyoming and North Dakota affected by increased oil truck traffic. The effectiveness will be determined by comparing reconstruction and rehabilitation designs created using the MEPDG and the AASHTO 1993 guide. The dataset will first be evaluated using the AASHTO 1993 design procedures to come up with a recommended pavement improvement and reconstruction design. Next, using that same data and additional applicable input parameters, the process will be completed again with the MEPDG. Finally, the results will be reviewed to determine which guide provides the most suitable design for rehabilitation and reconstruction work for local paved roads in south east Wyoming and North Dakota.

Research Methods:

After researching the MEPDG and AASHTO 1993 design guides to determine the necessary data and input parameters, data will then be collected and complied into a dataset. Using the compiled dataset, a reconstruction and rehabilitation design will be developed using the AASHTO 1993 and the MEPDG guides. A statistical model and economic evaluation will then be conducted to illustrate differences between the designs for the AASHTO 1993 and MEPDG guides. Finally, a methodology for reconstructing and rehabilitating local roads subjected to oil truck traffic will be developed to aid roadway designers in Wyoming and North Dakota.

Expected Outcomes:
Due to the limitations associated with the AASHTO 1993 guide and the available input parameters for the MEPDG it is expected that a more economical, reliable and durable pavement section will be developed from the MEPDG compared to the AASHTO guide. After this research is conducted the outcome will provide local governments with recommendations for future designs of local paved roads.

Relevance to Strategic Goals:
This project will provide the most up to date information on applying the MEPDG or the AASHTO 1993 guide to future local road reconstruction and rehabilitation projects. Knowing which guide provides the most economical, durable and reliable section can save agencies time and money which can free up resources to repair additional roads. Keeping pavement infrastructures in good conditions is consistent with the MPC overall strategic goals.

Educational Benefits:
By completing this project University students will gain a working knowledge of the MEPDG while also reinforcing the basic procedures used in the AASHTO 1993 guide. Having a strong background in both will be very beneficial to any student looking to work in the field of transportation especially since the MEPDG is just starting to be implemented.

Work Plan:
The following work plan summarizes the tasks to complete the project.

1) Conduct a Literature Review

An extensive literature review will be conducted with an emphasis on the applications of the MEPDG and AASHTO 1993 guide for reconstructing and rehabilitating local paved roads subjected to heavy truck traffic. The final report will include applicable literature results found during the review. (Timeline: Two Months)

2) Study Design Standards

It is necessary to identify MEPDG and AASHTO 1993 data requirements for local road reconstruction and rehabilitation design. Additionally, determining the specific effects heavy oil trucks are having on local roads compared to the state highway system will yield a more appropriate design. UW researchers will attend a WYDOT training course on the use of the MEPDG for the Wyoming state highway system. Skills learned at this training can then be applied to using the MEPDG for local road design. (Timeline: Two Months)

3) Data Collection

Once data requirements are understood, the next step will be to obtain the necessary data to complete the design for Wyoming and North Dakota local roads. This data will include oil truck traffic counts, axle numbers, truck weight and additional MEPDG input parameters. To gather data on North Dakota roads, several site visits will be required. These visits will also be used as an opportunity to collaborate on the project. (Timeline: Four Months)

4) Design

The design phase of the project will use the collected data to design local road reconstruction and overlay using the MEPDG and the AASHTO 1993 design guides. Furthermore, during this time, a sensitivity analysis will be conducted to learn how varying input parameters within the MEPDG changes the output design pavement section. (Timeline: Six Months)

5) Analysis of Results

Once reconstruction and overlay designs for the MEPDG and AASHTO 1993 guide have been completed on representative local roads, an economic evaluation and a statistical model will be performed to illustrate the structural and economic differences between the two guides. (Timeline: Six Months)

6) Recommendations

After completing the design and analyzing the results, recommendations for design parameters will be provided for reconstruction and overlay of local roads that are heavily impacted by truck traffic. (Timeline: Four Months)

7) Final Report

A final report for the project will be written. This report will include a summary of the literature review, acquired data, developed pavement designs and finally recommendations for mitigating local roads affected by heavy oil truck traffic. (Timeline: Two Months)

Project Cost:

Total Project Costs: $159,106.60
MPC Funds Requested: $79,277.80
Matching Funds: $79,828.80 Source of Matching Funds: WYLTAP & WYDOT

TRB Keywords:

MEPDG, Mechanistic-Empirical, pavement design guide, pavement design, local road, oil traffic