# M.E.'s ME Report

*Newsletter on mechanistic-empirical pavement design implementation at the Michigan DOT* *February 2013*

I am pleased to announce that the ME Web page that has been promised for a while has finally been created. See the article in the column to the right for details and a link to the Web page. This edition features a guest article by Dr. Syed Waqar Haider from Michigan State University (MSU). Dr. Haider summarizes the work MSU did for us on traffic inputs for ME. Continuing with describing specific inputs in each newsletter, I have decided to highlight the area of the ME software known as "General Information."

*Mike Eacker*

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## AASHTO Renames DARWin-ME

AASHTO is rebranding its various software products. As a result, the ME software has officially changed names with the release of version 1.3. The new name is AASHTOware Pavement ME Design. As we move forward, I will try to reference the new name, but sometimes old habits die hard, and I may still use the name DARWin-ME.

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## ME Web Page

A Web page has been created to provide information on Michigan's efforts to implement the ME design methodology. It contains past versions of this newsletter, links to Michigan's ME-related research reports, and selected presentations. In the future, as design manuals and documents are developed, they will be posted on this Web page for easy access. Along the right side of the ME Web page are links to several resources that may be of interest. The link to the ME Web page is:

www.michigan.gov/mdot/0,4616,7-151-9623_26663_27303_27336_63969---,00.html

Alternatively, you can navigate to the page by going to MDOT's Web site at www.michigan.gov/mdot and clicking on the following items in the left navigation panel:

1. About MDOT
2. Highway Field Services
3. Construction Field Services

In the center of the display, under Resources & Publications, select Mechanistic-Empirical (ME) Pavement Design.

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# Characterization of Michigan Truck Traffic for ME Design

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## INTRODUCTION

The current AASHTO 1993 pavement design method utilizes 18-kip Equivalent Single Axle Loads (ESALs) for establishing pavement thicknesses. These ESALs are based on load equivalency factors that are a function of (i) pavement type, (ii) slab thickness or structural number, (iii) axle type and load, and (iv) terminal present serviceability index. The development of the Mechanistic-Empirical Pavement Design Guide (M-E PDG) under NCHRP Project 1-37 has significantly changed the traffic characterization requirements for pavement design. The M-E PDG traffic inputs include monthly distribution factors (MDF), hourly distribution factors (HDF) truck traffic classifications (TTC), axle groups per vehicle (AGPV), and axle load spectra (ALS) for different axle configurations.

To help understand and transition to these new traffic inputs, the Michigan Department of Transportation sponsored a research project titled *Characterization of Truck Traffic in Michigan for the New M-E Pavement Design Guide*. The research was conducted by a research team from Michigan State University. The project began in October 2007 and the final report was published in December 2009.

## TRAFFIC DATA ANALYSIS

The M-E PDG recognizes the fact that detailed traffic data, over the years, to accurately characterize future traffic for design may not be available. Thus, to facilitate the use of the M-E PDG regardless of the detail levels of available traffic data, a hierarchical approach has been adopted for developing required traffic inputs for the location to be designed:

- Level 1 – There is a very good knowledge of past and future traffic characteristics.
- Level 2 – There is a modest knowledge of past and future traffic characteristics.
- Level 3 – There is a poor knowledge of past and future traffic characteristics.

Level 1 traffic information can be collected only if weigh-in-motion (WIM) sites are present in proximity of the design project. The development of Level 2 inputs for Michigan allows for the use of regional values to ensure a certain measure of traffic reliability when Level 1 data is unavailable. Level 3 inputs would be statewide averages or M-E PDG default values that come from national averages.

Axle weight and vehicle classification data were obtained from 44 WIM and classification stations located throughout Michigan to develop Level 1 (site-specific) traffic inputs. Cluster analyses were conducted to group sites with similar characteristics for development of Level 2 (regional) inputs. An algorithm based on discriminant analyses was developed to help choose the appropriate cluster when using level inputs for pavement design. Finally, data from all sites were averaged to establish the statewide Level 3 inputs.

## RESULTS

The specific findings based on the Michigan traffic data show that traffic characteristics are unique depending on the local industry, land use and truck configurations. Therefore, for Level 3, the M-E PDG traffic defaults were not found suitable in Michigan. Instead, the results support using the statewide average as Level 3 inputs. For pavement design, it is recommended that site-specific data (Level 1) be used wherever available, especially in areas where agriculture and mining operations are likely to have significant directional distribution differences. However, for sites where Level 1 data are not available, it is necessary to know whether Level 2 or 3 data are acceptable for design. The most important aspect of the adopted approach includes the sensitivity of various input levels to identify the minimum needs for different traffic characteristics. Consequently, for certain traffic inputs, Level 3 data can be used without compromising the accuracy in performance predictions. Identifying a reduced list of needed Level 1 or 2 traffic inputs will assist state highway agencies in an earlier implementation of the M-E PDG.

Based on the traffic data analysis in Michigan, the following input levels are suggested for the above mentioned traffic inputs, when Level 1 (WIM) data is not available:

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*continued from page 2*

| Traffic Characteristic | Impact on Pavement Performance | | Suggested Input Levels (when Level I is unavailable) | |
|---|---|---|---|---|
| | Rigid Pavement | Flexible Pavement | Rigid Pavement | Flexible Pavement |
| TTC | Significant | Moderate | Level II | |
| HDF | Significant | Negligible | Level II | Level III |
| MDF | Negligible | | Level III | |
| AGPV | Negligible | | Level III | |
| Single ALS | Moderate | | Level III | |
| Tandem ALS | Significant | Moderate | Level II | |
| Tridem ALS | Negligible | Negligible | Level III | |
| Quad ALS | Negligible | Moderate | Level III | |

**RECOMMENDED PROCESS FOR TRAFFIC CHARACTERIZATION**

DARWin-ME requires detailed traffic data for analysis and design of pavements. Perhaps, for the implementation of DARWin-ME, traffic characterization is one of the initial steps to be considered by state highway agencies. Although several studies have been conducted in the past, the process developed herein further enhances the existing understanding for traffic characterization. The entire process can be divided into the following successive activities:

1. Selecting a well distributed WIM and vehicle counter locations
2. Collecting data, processing and quality control checks for raw loading and classification data
3. Converting raw data to the M-E PDG Level 1 (site-specific) traffic inputs for each location
4. Grouping traffic characteristics among different locations or regions based on similarities, this step will identify Level 2 traffic inputs
5. Determining the averages of all the traffic inputs to define statewide traffic inputs (Level 3)
6. Conducting sensitivity analysis to determine the impact of different input levels on the predicted performance
7. Identifying the preferred traffic input levels for different traffic characteristics based on step 6
8. Defining traffic inputs for the state
9. Classifying a site to groups for input Level 2 where pavement needs to be designed.

All the above steps were followed to effectively determine traffic inputs in the entire state of Michigan. While traffic inputs and the required input levels were identified for Michigan, the process highlights the necessary steps and a sound approach that can be followed by state departments of transportation or any region to accomplish similar objectives.

**FINAL REPORT**

The final report for this project (report #RC-1537) can be viewed at the following Web address:

www.michigan.gov/documents/mdot/MDOT_Research_Report_RC-1537_316196_7.pdf

Alternatively, you can go to MDOT's Web site. Along the left side of the Web site, select: Maps and Publications → Reports → Construction Field Services Research Reports. The report is listed under the Pavement Design category.

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## General Design Inputs

The ME design methodology introduces many more materials and traffic inputs as compared to past or existing methods. The most important of these have been, or will be, discussed in these newsletters. However, every design must start with some general design information. What follows is a brief description of these general inputs.

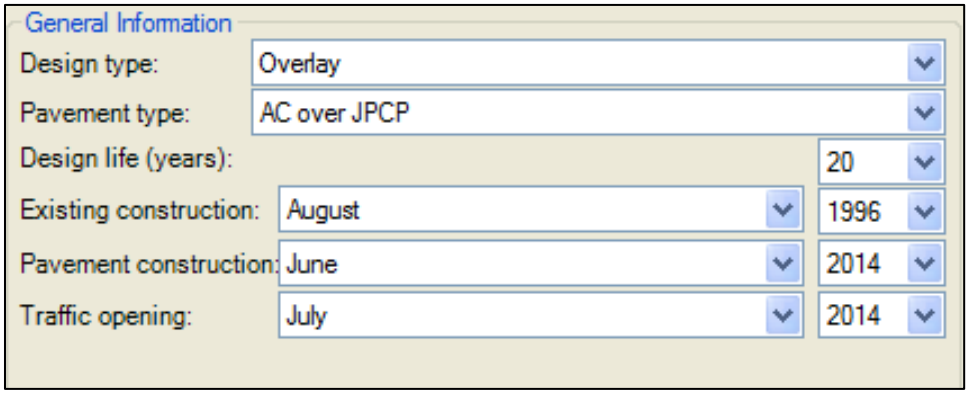


**Figure 1. Example of General Inputs for ME Design**

First, choose the design type. This consists of choosing whether the design will be a new pavement, overlay, or restoration. Next, the user must choose the pavement type. With new pavement you must choose whether it is a flexible pavement, jointed plain concrete pavement (JPCP), or continuously reinforced concrete pavement (CRCP). With the overlay category, there are several choices depending on what the existing pavement is and which material type will be the overlay. The restoration category is for repairs and smoothness grinding on JPCP.

Next, enter the design life. This is the time, in years, that the software will analyze to calculate damage by truck traffic. At the end of the design life, the software provides a prediction of the amount of distresses the pavement will experience, along with a level of reliability for that prediction.

Finally, in the general design inputs area, are the expected months of construction and when the pavement is expected to be opened to traffic. The month that the base is expected to be constructed is only needed for HMA designs. These are entered so that the software can use the appropriate month from the climatic data to begin altering the material properties according to moisture and temperature conditions. The “open to traffic” date is when the software will begin to apply traffic loads to the design and start calculating stresses, strains, etc. In addition, for overlay and restoration projects, the month and year of the original construction of the existing pavement is entered.

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For questions about information in this newsletter, further details on mechanistic-empirical pavement design implementation in Michigan, or to submit an idea for an article in a future newsletter, please contact:

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