TECHSUMMARY March 2009

State Project No. 736-99-1342 / LTRC Project No. 04-2P

Development of Index Based Pavement Performance Models for Pavement Management System (PMS) of LADOTD

INTRODUCTION

A research study was initiated by the Louisiana Department of Transportation and Development (LADOTD) in conjunction with the Federal Highway Administration (FHWA) to evaluate the overall performance and effectiveness of LADOTD's Pavement Management System (PMS). The study was divided into two phases. The first phase focused on the assessment of the state-of-the-practice of LADOTD's PMS regarding accessibility, PMS reports, reference location systems, and distress indices. Part of the assessment was conducted through the analysis of the responses of all district engineers to specially designed survey questionnaires and personnel interviews. The details of first phase of the study can be found in the LTRC Report No. 430. This report (LTRC Report No. 460) focuses on the second phase of the study, which includes a review and update of both pavement performance and treatment models. During the second phase, a comprehensive evaluation and analysis of the pavement performance and treatment models were conducted using LADOTD pavement distress data and historical data. Statistical analyses were used to generate the model for pavement condition prediction and treatment performance evaluation. It should be noted that most existing LADOTD pavement performance models were developed using the initial few years of distress data, which tends to either underpredict or overpredict the pavement condition. Pavement performance models based on the available 10 years were developed to enhance the predicting capabilities of LADOTD's PMS section.

OBJECTIVE

The objective of this study was to evaluate and update the pavement performance and treatment models using the current LADOTD indexes. These models will assist the LADOTD network- and project-level PMS in allocating future budgets, planning and recommending appropriate maintenance, and rehabilitation activities.

METHODOLOGY

LADOTD pavement distress data and historical data were utilized to calibrate and develop project- and network-level models. Once the main database was generated, the data were sorted based on various control sections. The main database was divided into four categories based on the highway system classification including the Interstate Highway System (IHS), National Highway System (NHS), State Highway System (SHS), and Regional Highway System (RHS). Each of these highway systems was further divided into four pavement types: flexible pavement (ASP), composite pavement (COM), jointed concrete pavement (JCP), and continually reinforced concrete (CRC) pavements. The data analysis was conducted for each of the distresses (roughness, fatigue cracking, longitudinal and transverse cracking, and patching) for the respective pavement type. Statistical analysis was used to develop the regression model (individual control section, consolidated, and generalized models) for pavement condition prediction and treatment performance evaluation. The developed models were utilized to predict pavement condition, the

LTRC Report 460

Read online summary or final report:
www.ltrc.lsu.edu/publications.html

PRINCIPAL INVESTIGATOR:
Mohammad Jamal Khattak, Ph.D., P.E.

LTRC CONTACT:
Zhongjie "Doc" Zhang, Ph.D., P.E.
225.767.9162

Louisiana Transportation Research Center

4101 Gourrier Ave
Baton Rouge, LA 70808-4443

www.ltrc.lsu.edu

remaining service life (RSL) (to facilitate pavement network health evaluation), and uniform pavement section development. It should be noted that a comprehensive literature review was also conducted to facilitate pavement model development, analyses, evaluation, and remaining service life determination.

CONCLUSIONS

- Index-based pavement performance models were developed for all the control sections that exhibited good performance data and historical records. The models were established for each distress type for the four pavement types and four highway system classifications. Such models were classified in three categories; upper, middle, and lower 1/3rd percentile for each control section. The results indicated that the models followed the power function, and the predicted values exhibited good agreement with the actual values.
- In order to reduce the number of the models, the developed models were clustered and consolidated based on pavement rate of deterioration. It was found that the consolidation process substantially reduced the number of models and showed good predictions with up to 90 percent of data exhibiting ± 7.5 percent error between the predicted and observed values.
- A fundamental relationship between the pavement rate of deterioration and pavement age was evaluated for various distress type, pavement type, and highway system classification. The data indicated that, with the increase in age of the pavement, the rate of deterioration increases. Based on this fundamental concept, generalized models were established for most of the distress types. The results of the analyses showed good agreement of predicted index values with the actual index values for randomly selected control sections. Furthermore, on the average, 65-90 percent of data exhibited ± 7.5 percent error between the predicted and actual values for all the models.

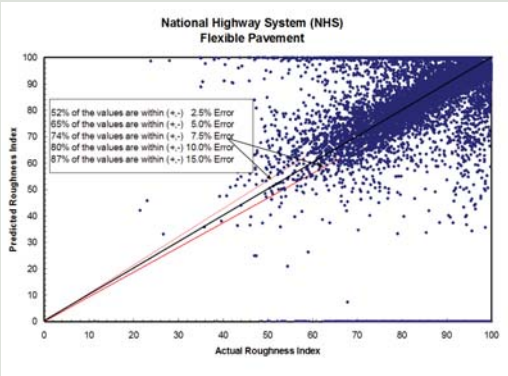

Figure 1: Predicted versus actual roughness index values based on generalized model-NHS

- The results of the statistical analysis indicated that the average life for chipseal, microsurfacing, and 2-in. overlay treatments for the selected projects were 6, 7.5, and 12.5, years, respectively. It was observed that the condition of the pavement prior to the treatment affects the overall performance. For the same threshold, index value of treatment the pavement projects with higher indexes prior to the application of the treatment exhibited better performance. The analyses of treatment life revealed that, for every 5 unit increase the treatment, life increased by 4 and 1.6 years for microsurfacing and chipseal, respectively. Moreover, for the average life of microsurfacing and 2-in. overlay treatments, the roughness threshold indices were observed to be 85 and 70, respectively.
- The RSL takes into account the index value and rate of deterioration of the pavement section in question. This concept can effectively be applied not only to establish the uniform control sections but also to evaluate and optimize the pavement network condition.

RECOMMENDATIONS

- The generalized pavement performance models that are developed based on the actual data trend should be utilized to predict pavement network conditions. The models are similar to the existing LADOTD family curves and can be implemented immediately.
- The individual control section models and the consolidated models have better prediction capabilities relative to generalized models. These models should be used for project level PMS analysis. However, these models may need a gradual and steady implementation plan due to the fact that application of these models may require initial preparation and formatting of the PMS data set along with some computer logic and scheme of analysis.
- In conjunction with the distress index, the RSL can be utilized to identify uniform pavement section categories, subcategories, and candidate projects. The main advantage of using the RSL to divide the network into uniform pavement sections is that all pavement segments within any uniform section would have similar pavement conditions and rates of deterioration.