INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

TRB Subject Code:14-3 Financial Programming *June 2003*
Publication No.: FHWA/IN/JTRP-2002/27, SPR-2397 *Final Report*

THE EFFECTIVENESS OF MAINTENANCE AND ITS IMPACT ON CAPITAL EXPENDITURES

Introduction

With ever increasing traffic loadings coupled with aging of highway infrastructure, highway pavement maintenance needs continue to outpace the availability of resources, and transportation agencies seek cost-effective maintenance practices. It is envisaged that greater levels of maintenance lead to lesser frequency of capital investment such as rehabilitation, but the exact relationship has not been quantified or investigated in detail. Evaluation of pavement maintenance impacts on capital investment is associated with several issues. First, current maintenance practices at district and sub-district level may not be consistent and cost-effective, thus probably leading to shorter intervals of rehabilitation. Furthermore, current decisions on pavement investments arising from the use of existing pavement management software may not be reliable as it uses, in the absence of current data, default data on short-term maintenance effectiveness (performance jumps) that may not reflect the true or current situation. Finally, for long-term planning and budgeting purposes, it is necessary for Indiana DOT's districts and sub-districts to implement most cost-effective combinations of preventive maintenance treatment types and timings, for each pavement type. If the costs and benefits associated with individual maintenance treatments and strategies can be determined, the above issues could be addressed, and the impacts of maintenance on the frequency of capital investments can be assessed.

A study was conducted to identify the impacts of maintenance on capital investments. The study begun with a detailed review of current state-of-practice of preventive maintenance in Indiana through a questionnaire survey of districts and sub-districts. Short-term impacts of maintenance that were investigated include pavement performance jump and deterioration rate reduction due to application of each type of maintenance treatment. Long-term maintenance impacts were investigated through the formulation of a variety of maintenance strategies (combinations of treatment types and timings) for each pavement type. The costs and benefits associated with each strategy were determined and evaluated against the do-nothing strategy. This way, the relationship between preventive maintenance levels over pavement life-cycle and the cost-effectiveness of such efforts, were determined. Also, the marginal impacts of maintenance, traffic loading and weather effects on frequency of rehabilitation, were assessed. Finally, the analysis enabled identification of maintenance treatment types and timings that were associated with highest cost-effectiveness, for each pavement type.

Findings

The study found that there are significant benefits associated with maintenance treatments, and that such short-term impacts generally involve an increase in pavement condition or a decrease in deterioration rate. It was found that the timing of maintenance with respect to performance monitoring was vital for correct assessment of maintenance effectiveness, without which maintenance effectiveness could be greatly under- or over-estimated. For most

treatments, a greater benefit is generally obtained for a larger effort expended on the maintenance treatment, at a given level of pavement condition. The study also found that if chosen appropriately, maintenance strategies could be cost-effective in the long run, and that increasing levels of preventive maintenance was associated with increasing cost-effectiveness, but only up to a point. Cost-effectiveness was represented by the area under the pavement performance curve, which is a measure of pavement longevity (time interval between capital investments) and pavement condition within this interval. The most cost-effective strategy (treatment types and timings) was determined for each pavement family. Finally, the study determined that trade-off relationships do exist between rehabilitation intervals on one hand, and maintenance, traffic loading, and weather on the other hand: increasing maintenance leads to increased rehabilitation interval, while increasing traffic loads and weather severity leads to reduction in rehabilitation interval, albeit at different rates for each pavement family. Marginal effects models were used to determine the effect of unit changes in maintenance levels, traffic loading, and weather on changes in rehabilitation interval. This information is useful not only for pavement and maintenance management, but also for policy analyses involving truck weights, and pavement repair needs assessment to reflect changing traffic and weather conditions in the long-term. The data for the study was supplied by the Indiana Department of Transportation.

Implementation

Personnel from the Pavement Management System and Maintenance Management Systems at INDOT have been involved with the research team and the Study Advisory Committee regarding implementation issues.

a) The project has made available to PMS a set of values for short-term effectiveness (performance jump) of various standard maintenance treatments. Such data have replaced maintenance effectiveness "reset" values that were initially used in the PMS software. Mr. William Flora of INDOT's Pavement Management Unit, is expected to be involved in this aspect of the implementation.

b) The results of the agency survey (which provides details on application criteria and perceived benefits) as well as a more objective assessment of the benefits of preventive maintenance will be made available to the Operations Support Decision, so that more informed decisions can be made regarding the selection on maintenance practices at sub-district and district level, to promote cost-effective maintenance practices. Mr. Dennis Belter and Mr. Mark Burton are expected to be involved in this phase of the implementation plan.

c) Pavement and maintenance managers in the state now have a set of models that enable the determination of the longevity and cost-effectiveness corresponding to various levels of life-cycle pavement preventive maintenance, and impacts thereof in response to changing maintenance levels, for each pavement type and functional class. Operators of INDOT's Pavement Management System are expected to play a lead role in the use of such information for long-range planning for preserving the state highway pavements.

d) The optimal combinations of pavement maintenance treatment types and timings will be made available to INDOT's Program Development Division, as that would serve as a guide for determining what work must be done, and when, in order to maximize overall cost-effectiveness of pavement maintenance. Operators of INDOT's Pavement and Maintenance Management Systems, as well as personnel at INDOT's Budget and Fiscal Management Division are expected to play a lead role in the implementation.

Contacts

For more information:

Prof. Kumares C. Sinha
Principal Investigator
School of Civil Engineering
Purdue University
West Lafayette IN 47907
Phone: (765) 494-2211
Fax: (765) 496-1105
E-mail: sinha@ecn.purdue.edu

Indiana Department of Transportation
Division of Research
1205 Montgomery Street
P.O. Box 2279
West Lafayette, IN 47906
Phone: (765) 463-1521
Fax: (765) 497-1665

Purdue University
Joint Transportation Research Program
School of Civil Engineering
West Lafayette, IN 47907-1284
Phone: (765) 494-9310
Fax: (765) 496-1105