NS 543: The Impact of Deferred Maintenance in Minnesota: Literature Search
Thursday, July 19, 2018

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Resources searched: ASCE Library, MnDOT Library Catalog, Transport Database, Research in Progress, Web

Summary: Results are compiled from the databases named above. Links are provided for full-text, if applicable, or to the full record citation. I completed my searches using the following terminology: deferred maintenance, local transportation, local road, cost, finance. The results are divided into most relevant and less relevant

Most Relevant Results
The case for spending more on maintenance
https://www.brookings.edu/blog/up-front/2017/01/31/the-case-for-spending-more-on-infrastructure-maintenance/

Comparing Pavement Performance and Its Effect on Maintenance and Rehabilitation

Defeating Deferred Maintenance
http://www.geaslin.com/invers-square_rule.htm

The True Cost of Deferred Road Maintenance

Sheflin, M.J.E., “Your Choice: Bad Roads At High Cost Or Good Roads At Low Cost”, Oklahoma State University, 1980

Optimum Decision Policy for Management of Pavement Maintenance and Rehabilitation
Abstract
An effective practical decision policy has been developed for use in the selection of an optimum maintenance and rehabilitation program. Its main objective is the optimization of pavement condition under constrained budgets. The developed policy utilizes a discrete-time Markovian model with five condition states labeled a, b, c, d, and f. State a represents pavements in excellent condition, and State f indicates pavements in bad condition. Several decision options have been introduced based on either maximizing the proportion of "good" pavements or minimizing the proportion of "bad" pavements. State probabilities at some desired future time have been used as the main objective functions in the development of optimum maintenance and rehabilitation programs. The unknown variables in these programs are those representing improvements to pavement condition through implementation of maintenance and rehabilitation work. The resulting optimum programs are nonlinear in form, and therefore the penalty function method with functional evaluations has been successfully used to yield optimum solutions. The optimum solution to a particular program defines the type and extent of maintenance and rehabilitation work required for annual or biennial implementation. Pavement maintenance is mainly defined as routine maintenance consisting of filling cracks, patching potholes, and other applicable techniques such as chip seal coat or slurry seal. Pavement rehabilitation is defined as major
rehabilitation actions to include resurfacing (overlay), resurfacing with partial reconstruction (localized reconstruction), and complete reconstruction applied to pavements in States c, d, and f, respectively.

Transportation Research Record, 1655
https://trrjournalonline.trb.org/doi/abs/10.3141/1655-02

THE REAL COST OF BAD ROADS: A SYSTEM APPROACH

The effects of road and street deterioration are examined in a systems context. Consequences of such deterioration are considered both from the national viewpoint and that of the community. A wide variety of economic and social effects of poor roads and streets is shown to comprise a complex system containing a variety of interactions and feedback relationships. A reduced quality of life and a continuing erosion of the national highway investment which result from bad roads are themselves causes of further neglect of the highway transportation system. That is neglect of our roads and streets feeds upon itself and threatens serious damage not only to our economic infrastructure but to our national pride and to our image among the nations of the world. Community consequences of bad roads or streets include neighborhood instability, out-migration and inhibitions upon industrial development. These effects and others combine to reduce the quality of community life. Individuals are directly impacted by neighborhood consequence of neglecting street maintenance as well as the more obvious results of that neglect: increased travel cost, time, discomfort and inconvenience. But individual citizens must also suffer from lower levels of public services made necessary by reduced local tax revenues. Reduced local revenues follow inevitably from community consequences of bad roads and streets. Articles abound in the public press which point out the deplorable condition of many roads at all levels in our transportation system. And citizens regularly protest "potholes" in their streets, often accusing local officials of neglect or inefficiency. But it seems clear that a highway transportation network of adequate quality cannot be achieved without a deeper understanding by the public of the fundamental importance of that network to every aspect of daily life. Taxpayers must gain some appreciation of the complex relationships among the many results of neglect of the highway transportation system. Only thus can they appreciate the dangers of viewing road maintenance and development as isolated problems. (Author)

• **Supplemental Notes:**
  - This report appeared in NAPA's The Real Cost of Bad Roads, reports submitted in a national competition.

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  5100 Forbes Boulevard
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• **Authors:**
  - Colony, D C

• **Publication Date:** 1982-12

**Title**
Quantifying the Consequences of Hastened or Deferred Interventions.

**Source**

**URL**
http://amonline.trb.org/

**Abstract**
The mis-timing of interventions is a critical issue in asset management. A treatment that is applied too early (hastened) or too late (deferred) has consequences in terms of the agency cost, facility performance, and cost-effectiveness. This paper uses basic concepts in costing and effectiveness analysis to develop a methodology for
quantifying the consequences of hastening or deferring interventions that are intended to preserve highway assets. A case study involving pavement treatments is presented to demonstrate the practical application of the methodology. The results of the case study suggest that the consequences of hastened or deferred interventions can differ across asset classes as well as across intervention types: the consequent life-cycle cost increases and performance loss are more severe for non-interstate highways compared to interstate highways; and are more severe for maintenance compared to rehabilitation. Recognizing that in the practical world, the timing of interventions need not be at the exact levels prescribed in the earlier section of the paper, the paper goes on to show how an agency could use the developed methodology to establish acceptable ranges of intervention timing. Using the methodology, an agency could introduce flexibility in its preservation schedules by establishing the earliest and the latest times for applying an intervention.

Title Pavement Preservation: Performance Goal and Its Implications.
Source Transportation Research Record: Journal of the Transportation Research Board. 2010. (2150) pp 28-35 (5 Figs., 14 Refs., 3 Tabs.)
Abstract Preserving the asset value of existing pavement infrastructure requires resources to perform maintenance and rehabilitation (M&R) work on the pavement network. The amount of resources required is contingent on the expected level of condition of the pavement network, or the performance goal. A lower performance goal helps reduce the needs for M&R; it will also result in an increase in other costs, such as vehicle operating costs and deferred maintenance costs incurred from losing pavements that were eligible for less expensive treatment options, for example, preventive maintenance. Making an informed decision in setting an appropriate performance goal has always been a challenge to highway engineers and administrators because of the lack of a systematic procedure. A methodological framework is proposed as a rational tool for evaluating the effect of different performance goals on a highway agency's network needs and examining the goals' implications for overall costs and benefits. This framework is based on a comprehensive consideration of the M&R needs, vehicle operation costs, and deferred maintenance costs incurred during the analysis period. With a comparison of the long-term effects of an agency's performance goals, the benefits of adopting a particular performance goal can be demonstrated. In a case study of the proposed methodological framework, three performance goals were examined for the highway network managed by the Texas Department of Transportation. Conclusions and recommendations drawn from this study are presented.

Title THE COST OF NOT PAINTING.
Source: Journal of Protective Coatings and Linings. 2004/12. 21(12) p. 49-56 (6 Figs., 8 Photos., 2 Refs., 4 Tabs.)

Abstract: This article helps those assigned to manage coatings and corrosion control to educate management about the harm and cost of constantly deferring or avoiding maintenance painting in favor of more pressing problems (such as repair of equipment). The author focuses on the economic benefits of regular maintenance painting and the costs of corrosion; readers are referred to a related web site: www.corrosioncosts.com. The author includes a chart to help readers calculate the cost of delayed coatings before reaching the critical condition (weld repair or steel replacement). Another section considers the costs for project delays that go beyond just coatings to corrosion repairs. The author gives one case example of a deferred coatings project that led to extra repair costs.

Publication Year: 2004

Title: USING SIMULATION TO UNDERSTAND THE IMPACT OF DEFERRED MAINTENANCE.

Source: Computer-Aided Civil and Infrastructure Engineering. 2002/7. 17(4) p. 269-279 (5 Figs., Refs., 2 Tabs.)

Abstract: Understanding the impact of deferred maintenance on a highway system can help policy makers and transportation planners in the decision process on how to best utilize limited resources to provide for an area's total infrastructure needs. This paper presents the development of a framework and methodology to use dynamic simulation to understand and quantify the impact of deferred maintenance and the effect on user and non-user benefits. This simulation will allow the testing of policies or assumptions for their impact over time, in order to gain insight into the problem solution. A hypothetical region is used to demonstrate the use of the framework, and three possible measures of effectiveness, total net benefits per capita, revenues less expenditures, and benefit-cost ratio, are introduced that could be utilized to help decision-makers understand the impact of various maintenance funding rates on different interest groups being served within the community. The model can be calibrated to a region to provide specific impact information for that location.

Publication Year: 2002

Title: ANALYSIS OF THE EFFECT OF DEFERRING PAVEMENT MAINTENANCE.

Source: Transportation Research Record. 1988. (1205) p. 29-35 (6 Figs., 3 Refs., 6 Tabs.)

Abstract: This paper presents a methodology for quantifying increased maintenance and rehabilitation (M&R) costs due to delaying M&R action. The methodology used data collected from several U.S. Army installations. These data included (1) pavement performance measured in terms of the Pavement Condition Index (PCI), (2) structural history, and (3) detailed costs. The methodology is based on applying life-cycle cost
analysis to determine the Equivalent Uniform Annual Cost (EUAC) for various M&R alternatives. This was repeated at different pavement condition levels. The EUAC analysis for each M&R alternative included pavement surface preparation cost, initial cost of the M&R alternative, and future annual routine maintenance cost. The results of this study showed that considerable savings can be achieved if pavement sections are maintained while they are good condition and are not allowed to deteriorate into poor condition.

**Publication Year** 1988

**Title** The Domino Effect: It's Another Year of Deferred Maintenance as Government Coffers Continue to Shrink.

**Source** Public Works. 2010/1. 141(1) pp 36-40 (2 Figs., 1 Maps., 1 Phots., 3 Tabs.)


**Abstract** This article explores how local and regional municipalities are dealing with yet another year of deferred maintenance and tight budgets. The author first briefly reviews the recession, considering the anticipated time frame for growth and recovery. The author then reports on a survey of Public Works readers, most of whom are government employees tasked with maintaining their community's infrastructure and delivering services. The survey asked whether readers expect to spend more, less, or the same on operations and maintenance (O & M) and capital improvements (CIP) this year compared to last year. Results offer a snapshot of general trends within city, county, and state infrastructure operations. For the second year in a row, the largest group of respondents expects to postpone or suspend new construction and capital improvements; however, the majority report that they don't expect to postpone or reduce planned maintenance. The article includes comments from some of the respondents, who are concerned that continuing to defer smaller projects can cause those projects to evolve into capital projects.

**Publication Year** 2010

**Least Relevant Results**


This synthesis will collect information on and document the practices that agencies use to measure and articulate the benefits on highway system maintenance and operations. This will include the benefits of system preservation and the impacts of deferred maintenance.

- **Record URL:** [http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=38](http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=38)

**Language**

- English
Project

- **Status:** Completed
- **Funding:** $2000.00
- **Contract Numbers:**
  Project 20-05, Topic
- **Sponsor Organizations:**
  - **Federal Highway Administration**
    1200 New Jersey Avenue, SE
    Washington, DC  United States  20590
  - **American Association of State Highway and Transportation Officials (AASHTO)**
    444 North Capitol Street, NW
    Washington, DC  United States  20001
  - **National Cooperative Highway Research Program**
    Transportation Research Board
    500 Fifth Street, NW
    Washington, DC  United States  20001
- **Project Managers:**
  Lemer, Andrew
- **Principal Investigators:**
  Williams, Jon
  Vlasak, Donna
- **Start Date:** 20001113
- **Expected Completion Date:** 0
- **Actual Completion Date:** 20031115
- **Source Data:** RiP Project 5724

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**Title**
Deferred maintenance : roadside vegetation and drainage facilities : final report : prepared for Federal Highway Administration, Offices of Research & Development / [Marion F. Creech].

**Publisher**

**Location LC**
MDT MAIN TE220 .C74 1977

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**Title**
CAPTURING EFFECTS OF MAINTENANCE PRACTICES IN HIGHWAY ASSET VALUATION: REPLACEMENT-COST APPROACH VERSUS BOOK-VALUE METHOD.

**Source**
Transportation Research Record. 2003. (1824) p. 57-65 (5 Figs., 15 Refs., 5 Tabs.)

**URL**
http://dx.doi.org/10.3141/1824-07

**Abstract**
The replacement-cost approach and the book-value method as decision support tools for selecting maintenance alternatives under budget constraints and for capturing the effects of maintenance practices on highway asset value are investigated. By using a case study based on the Thailand Pavement Management System, the replacement-cost approach and the book-value method are applied to analyze maintenance alternatives for selected highways. The versatility of these asset-valuation methods is explored for capturing trade-offs in the type and timing of maintenance and for incorporating the added value of effective maintenance practices and the impact of
deferred maintenance in the overall asset value. The study demonstrated that the replacement-cost approach is a more versatile tool for considering the maintenance-related value of highways in maintenance decision making, whereas the book value may be a simpler financial accounting tool. The two approaches may be used together to clarify how maintenance expenditures are being translated into facility replacement value or how the overall value of the infrastructure is being preserved. The study results are potentially useful to agencies interested in capturing the added value of effective maintenance practices in the overall value of their asset base.

Publication Year 2003

Title SELECTION OF PAVEMENT MAINTENANCE ACTIVITIES. FINAL REPORT.

Source 1988/6. 32 p. (3 Figs., 16 Refs., 5 Tabs.)

Abstract Pavement condition data are presented and processed to aid in making better pavement maintenance related decisions. Three types of computer output are generated for each maintenance station to document pavement condition, identify any deficiencies that exist on these pavements, and recommend a potential strategy to correct these deficiencies. This information is intended to improve the selection of hard surface maintenance activities, better compare manpower needs with availability, identify sites for contractual maintenance, improve estimates of required material quantities, and more accurately obtain cost estimates for each maintenance activity. Steps are outlined to more closely coordinate maintenance activities with UDOT's overall Pavement Management System. The consequences of deferring pavement maintenance were investigated. An estimated $40 million could be saved annually by eliminating the existing shortfall of about $7 million.

Publication Year 1988

Title A COMPREHENSIVE RANKING SYSTEM FOR LOCAL AGENCY PAVEMENT MANAGEMENT.

Source Transportation Research Record. 1987. (1123) p. 67-76 (4 Figs., 24 Refs., 8 Tabs.)

Abstract Pavement management systems for local agencies (cities and counties) require a method to determine how to allocate funds for maintenance and rehabilitation of pavements. This should provide a reasonable analysis of the impact of budget decisions on the pavement network condition and future budget needs. However, most local agencies have limited funds to collect data concerning their pavements as well as maintain them. An approach has been developed that uses a minimum of information to make reasonable budget analysis concerning maintenance and rehabilitation needs with unconstrained funding. Described in this paper is the way in which funding needs are then allocated when funding is less than needs. It includes consideration of the condition of the pavement, change of condition over time, and stopgap maintenance generated by deferring maintenance. This was accomplished by
making it simple for the public works personnel to visualize and use. It is part of a network-level microcomputer-based pavement management system developed for San Francisco Bay Area agencies.

Publication Year 1987

Title EVALUATING ALTERNATIVE MAINTENANCE STRATEGIES.


Abstract A study is reported that attempted to develop procedures, guidelines, and criteria for state highway agencies to use in determining alternative maintenance strategies for highway pavements and bridges. The results of the study are considered applicable to budget/financial planning, legislatures and local governments, maintenance planning, maintenance management, and work prioritizing and assignment. The first phase of the study produced an Interim Report which presented background information on the consequences of deferring maintenance activities and provided a framework for the evaluation of such consequences. The second phase gathered secondary and, if necessary, primary data describing changes in: (a) deterioration of pavements and bridges arising from a range of maintenance strategies and varying climatic or regional conditions over the life cycles of such facilities; (b) user costs including safety; (c) the environment; (d) the economy; and (e) the impacts to the nonuser. This phase of the study also accomplished the following: developed cost models to evaluate the effects of different maintenance service levels on pavement and bridge life cycle costs; quantified the user costs associated with the condition of pavements and bridges; evaluated the impacts of maintenance service levels on various nonuser considerations; developed a methodology for evaluating different maintenance service levels; and provided example applications of the method for pavements and bridges. Details are given of the research approach, methodology criteria and implications, microprocessors, and programs. Interpretation, appraisal and application are discussed as well as conclusions and possible future research.

Publication Year 1986

Title Deferred maintenance : roadside vegetation and drainage facilities : final report : prepared for Federal Highway Administration, Offices of Research & Development / [Marion F. Creech].


Physical Details x, 114 p. : ill. ; 28 cm.
Officials of the Bay Area's cities and counties have become aware of a growing threat to the health of the region's local street and road network. Revenues for street and road maintenance have declined substantially in recent years, while costs have continued to spiral. As a result, maintenance programs have been trimmed back sharply. In an effort to define the magnitude of the problem and explore solutions, the Metropolitan Transportation Commission (MTC) undertook two landmark studies. Conducted with the cooperation of local public works and engineering officials, the first study investigated what is required to keep roadways in good working order, or "ongoing" maintenance needs. In the second study, MTC, in cooperation with the Alameda County Public Works Agency and 10 other jurisdictions, conducted a survey of "backlog" costs, the amount needed to repair damage already caused by deferred maintenance. This summary report presents major findings from both studies.

This is the second of two reports which provide information on local street and road conditions for the 93 cities and 9 counties in the San Francisco Bay Area. These reports were prepared by the Metropolitan Transportation Commission in response to a concern by local public works and engineering officials that the amount of funds being spent for maintenance is inadequate and that the streets and roads are deteriorating. This second report documents how much deterioration has occurred because of the lack of preventive maintenance, and how much it will cost to correct the problem. The costs to bring the roads back to an acceptable standard are called "backlog" costs.