Development of Computer Applications for Bridge Management System

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Summary

This paper presents the development of sustainable bridge maintenance and management system (BMMS) for concrete highway bridges of Thailand DOH. The methodology framework for designing the computer-based BMMS is presented. Six major processes of the proposed BMMS are briefly described including planning, inspecting, adjusting, predicting, alternative establishing, and implementing. Computer applications are developed to support the proposed BMMS program. Components of BMMS program are organized into a series of modules reflecting different bridge maintenance and management activities. The proposed computer-based BMMS provides comprehensive capabilities for condition rating, deterioration predicting, alternative generating, and scenarios prioritizing, as well as accomplishment tracking. Although the presented BMMS is developed for Thailand DOH, the methodology can easily be extended to other bridge agencies.

Keywords: Bridge Maintenance and Management System (BMMS), BMMS Program, Bridge Condition Rating, Bridge Deterioration Models, Bridge Life Cycle-Cost Analysis, Bridge Optimization and Prioritization

1. Introduction

Thailand Department of Highway (DOH) has a responsible for a huge number of concrete bridges in highway network. Preservations of these bridges at satisfied service level is necessary to use an efficiently management software to deal with an enormous database of bridges. Interviews bridge experts of Thailand DOH officials revealed that a software program to assist in managing highway bridges as an entire system is not available. This shortcoming is a main difficulty not only in preserving and monitoring the existing bridges but also in strategic planning and optimizing the limited resources of bridge MR&R tasks. This study developed a computer application as a tool to support the requirements of DOH in managing their bridges. The developed BMMS software provides comprehensive capabilities for predicting, prioritizing, and generating alternative scenarios, as well as tracking for accomplishments. The program can be applied appropriately to analyze Thailand concrete bridges with the defaulted parameters which are specific features for Thailand bridges, such as the bridge element condition rating and deterioration models, categories of MR&R actions, improvement costing models, relative environments, and optimization and prioritization policies of bridge MR&R programs. Although the BMMS software was developed for Thailand DOH, the program can easily be applied to other bridge agencies.

2. Development of Sustainable Bridge Maintenance and Management System

To develop BMMS, an overall framework of the proposed methodology is presented. Six major processes are divided including planning, inspecting, adjusting, predicting, alternative establishing, and implementing. As a cycle loop, the first procedure might be started at consideration of the planning process. The results after following the MR&R planning process are monitored and tracked in database system. Bridge condition inspecting is conducted based on the developed rating systems. In adjusting process, additional information updated from existing condition inspections is

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utilized to modify the initial proposed deterioration models. Developed deterioration models are used to predict future condition of bridge under specific characteristics.
According to predicted condition over service life, feasible alternatives to preserve bridge at satisfied level are listed. Costs and effectives of different actions to find an optimal alternative can be analyzed from MR&R works library. Applying the life-cycle cost analysis technique (LCCA), an optimal MR&R alternative is recommended and conducted in practices. Results and feedbacks after implementing a proposed alternative are systematically tracked in database. They will be synthesized to modify the MR&R planning in order to increase accuracy and efficiency of new plans.

3. Development of Computer Applications for Bridge Management System

Main components of the developed BMMS software are organized into a series of modules reflecting the different bridge management activities; inventory, prediction, optimization, prioritization, and monitoring. The paper illustrates an overall module with the relationship among them; there are five main modules. An inventory module is designed for convenience and efficiency uses in inputting and storing the specific bridge inventory. Existing condition of assessed bridges are stored in a database of inspection module for updating the bridge deterioration models. Future conditions over lifetime of bridge elements can be forecasted as outputs from the prediction module. The developed condition prediction model is applied in this process. The MR&R planning module has capabilities to analyze what work is needed for any bridge element and design the MR&R alternatives throughout a bridge service period. Guidelines and recommendations on alternatives designs were analyzed on the basis of the bridge MR&R works library. Optimization and prioritization module will seek the optimal alternatives for MR&R recommendations. The results of analyses in an element-, a single bridge-, and the network-level optimization strategies will be presented through the reporting module.

4. Conclusions and Discussions

This study proposed a computer-based bridge maintenance management system (BMMS) to response the requirements of Thailand Department of Highway (DOH). The condition rating system to evaluate separately an existing condition of bridge elements is developed as standard guidelines in practices of inspection procedure. Bridge element deterioration prediction models are established in primary by sampling a number of existing bridges in different characteristics on the basis of the proposed rating system. The models present an estimated future condition of any bridge element associated with its different surrounding environment. Library of MR&R works is formulated to recommend and analyze the bridge MR&R strategic planning. Life-cycle cost analysis (LCCA) technique is applied to determine an optimal long-term MR&R policy that minimizes expected life cycle costs while keeping the bridge at desired service level. The developed BMMS program has capabilities to enhance the efficiencies and facilitate the decision-making process of MR&R optimization and prioritization module. It provides comprehensive functionalities for predicting, prioritizing, and generating alternative scenarios, as well as tracking for accomplishments. A huge database is designed to store the inventory and inspection data and tracks the bridge MR&R implementations.

The results of program present what work is needed on each bridge element and the requirements of a bridge as well as priority setting deciding on the order and timing of projects. In addition, at network-level preservation and improvement policies, the program presents priority and optimized strategy of bridges in a network under the analysis of life-cycle costing approach. Interviews the experienced experts of bridge agencies of Thailand department of highway reveal that the proposed system is possible in actual practices and suitable for efficient applying in managing the nation bridge network of Thailand. Although the computer-based BMMS was developed to response the specific bridge characteristics of Thailand DOH, the proposed methodology can easily be extended to other bridge agencies.