An expert system for bridge management in Sri Lanka

C.S. Lewangamage[1], T.M.C.H. Menike[1], G. Sureshkumar[1], P.K.P.Pushpakumara[1] R.M.M.R Rathnayaka [1], K. Amaraweera [2] and N.B.G.Imali [2]

[1]Department of Civil and Environmental Engineering, Faculty of Engineering, University of Ruhuna, Hapugala, Galle, [2] Road Development Authority, Galle.

Abstract

Bridge management authorities in Sri Lanka have not developed a computer based system for bridge management, which is a rational and systematic approach to organizing and carrying out the activities related to planning, design, construction, maintenance, rehabilitation and replacement of bridges. This paper discusses the development of bridge management system for Sri Lanka. At first stage of the study, software was developed with complete bridge database (inventory). Bridge inventory was prepared with selected bridges in Galle district. Then, bridge inventory was used for condition assessment of the selected bridges. The software would be further developed as a complete bridge management system and as a tool for disaster management.

Key words: Bridges, bridge management, bridge inventory and condition assessment

Introduction

Bridge is a key element in a road network, which is built to serve the country for years to come and to give the users trouble-free service for long period. Sri Lanka has large numbers of bridges, which are between 50-100 years of age on A & B class roads and on railway network. However, the bridge management authorities in Sri Lanka have not developed a computer based system for the bridge management which is a rational and systematic approach to organizing and carrying out the activities related to planning, design, construction, maintenance, rehabilitation and replacement of bridges [1],[2]. Few soft wares for bridge management have been developed in several developed countries. The development and use of bridge management software heavily depends on the available technologies and the economic conditions of a country. The basic requirement for bridge management is a bridge inventory, which includes bridge location, type, functional classification, importance within network, condition and maintenance history etc. The bridge inventory can be used to make effective decisions on the bridge management. This paper discusses the development of bridge management system for Sri Lanka. At first stage of the study, software is being developed with complete bridge database (inventory). Bridge inventory is prepared with selected bridges in Galle district. Then, the inventory is used for the condition assessment of the selected bridges. The software is being developed further as a complete bridge management system and as a tool for disaster management.

Methodology

At first, the structural and non-structural components of a bridge, types of bridges, materials, construction methodologies etc. were identified in order to classify the components of the software into several parts. It makes easy to determine the condition of a given bridge and easy to identify the components which are necessary for bridge maintenance. Then, the bridge inspection forms and the inspection manual were prepared for regular inspections. The completed inspections forms for the bridges by a bridge inspector can be used to complete the inventory in the software. Further, in order to develop condition assessment criteria, literature survey on existing conditions assessments on bridges were done. The bridge management software called RUH2006.EBMSSL is being developed. A database in the software is created including all the information of bridges. Then the information of given bridge is used to develop a virtual bridge in the system. The virtual bridge can be maintained within the system and decisions can be taken accordingly. The decisions made based on the virtual bridge can be applicable for the real bridge. This database is a repository of data related to bridges that can be used to store data and extract it whenever required. The data can be stored and extracted from the database in SQL (Structured Query Language) statements. A user-friendly interface is being developed to communicate with database. Finally, XML (Extensible Markup Language) and SOAP (Simple Object Access Protocol) technology is used to mark up and transfer data over Internet from a local server to the head office and vice versa.

The following important features are available in the <u>RUH2006.EBMSSL</u>:

- User Authentication

Use of the system is limited only to the authorized persons by User Ids and Passwords. This avoids and limits the access to the information by the unauthorized persons.

- Bridge Identification

Each bridge has unique ID and location (GPS co-ordinate).

Menu

Menus were designed to provide groups of related commands for the application. They make user actions possible without unnecessary cluttering of buttons.

- Tab Pages

This provides all the forms to user that required for a task. User can select the task from the Menu and guide the direction to proceed.

- Multiple Document Interface Windows

This enables user to work in multiple windows at once.

- Map, Images and Tree-view

Maps, images and tree-view assist the users to recognize the correct bridge without misleading, identifying the existing damages and development of image analysis method for damage estimation.

While software is being developed, data collection has been done in selected bridges in Galle district. The rating system (Figure 1) is introduced to determine condition of each element (non-structural or structural) of a bridge.

Excellent
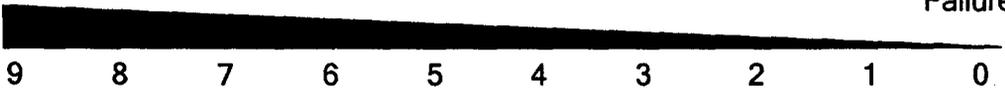
Failure

| 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Figure 1: The element rating system.

The total condition of a bridge is evaluated for structural safety, aesthetics and un-protective measures. The total condition of a bridge is given by

$$\text{Total condition} = \frac{\sum^{n} (\text{weight factor} \times \text{Condition Value})}{\sum^{n} \text{weight factor}}$$

$$\text{Condition Value} = c^9 - c^{(9\text{-rate})}$$

Where c is constant depend on the type of bridge and the type of condition, which is going to evaluate and n is number elements considered for condition evaluation. The weight factor is introduced to prioritize main structural elements in a bridge and the other components. Different weight factors are used to get accurate condition of the bridge under structural, aesthetic and un-protective conditions. Rating for the total condition evaluation is done based on the experienced and the condition evaluation by existing bridge models.

Results and Discussion

A computer based system for bridge management in Sri Lanka is being developed. At first stage of the developments, the system consists of bridge inventory and condition assessment methodologies of the bridges. The system can be further developed as network and authorized users in different locations can access to the system and it can be updated. GPS co-ordinates for the each bridge can be given to the system and bridge network around the country can be created. System can automatically generate the warning for the relevant authorities if there is any trouble within the network. The system can be used easily to calculate the budget requirements for the year, estimate the lifetime of bridges, as a disaster management tool etc., The system can be developed to make wireless communication through internet between sub stations and bridge inspectors, this helps bridge inspectors to update the system from the top of the bridge. This is a powerful tool for RDA (Road Development Authority), Provincial Councils and Railway Department to maintain their bridges effectively.

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