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Modelling of Bridge Structure Performance in a Bridge Management System

Modèlisation de la performance de structures dans un système de gestion de ponts

Modellierung des Verhaltens von Brücken in einem Datenverwatungssystem

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1. BRIDGE MANAGEMENT SYSTEM IN FINLAND

Finland's National Roads Administration is currently developing a bridge management system for its 12,000 bridges. The system will identify the preferred set of bridge actions throughout the network of bridges, and over time recommend what actions should be taken and to what scale and cost.

The network level optimization algorithm works with populations of bridge components that are similar in their construction and use. Altogether 25 bridge items are modelled for optimization processes. The condition of bridge components is expressed in terms of discrete condition states. Changes in condition are expressed as stochastic transition probabilities from one condition state to another. The mathematimatical process used defining the year-by-year changes in condition is the Markov chain method.

2. MARKOV CHAIN METHOD

The probabilities of transition from one state to another are presented in a so called transition probability matrix (or simply transition matrix). The probabilities are for changes in condition in the space of 1 year. Changes after N years can be predicted by multiplying the original state vector (present distribution of condition states) by the transition matrix N times. The transition probabilities are assumed to be unchanged during these years.

Generally the original state vector is known or at least easily determinable. The greatest difficulty with the Markov chain method is the determination of the transition probabilities.

The scheme for producing transition probability matrices in the Finnish management system is shown in Figure 1.

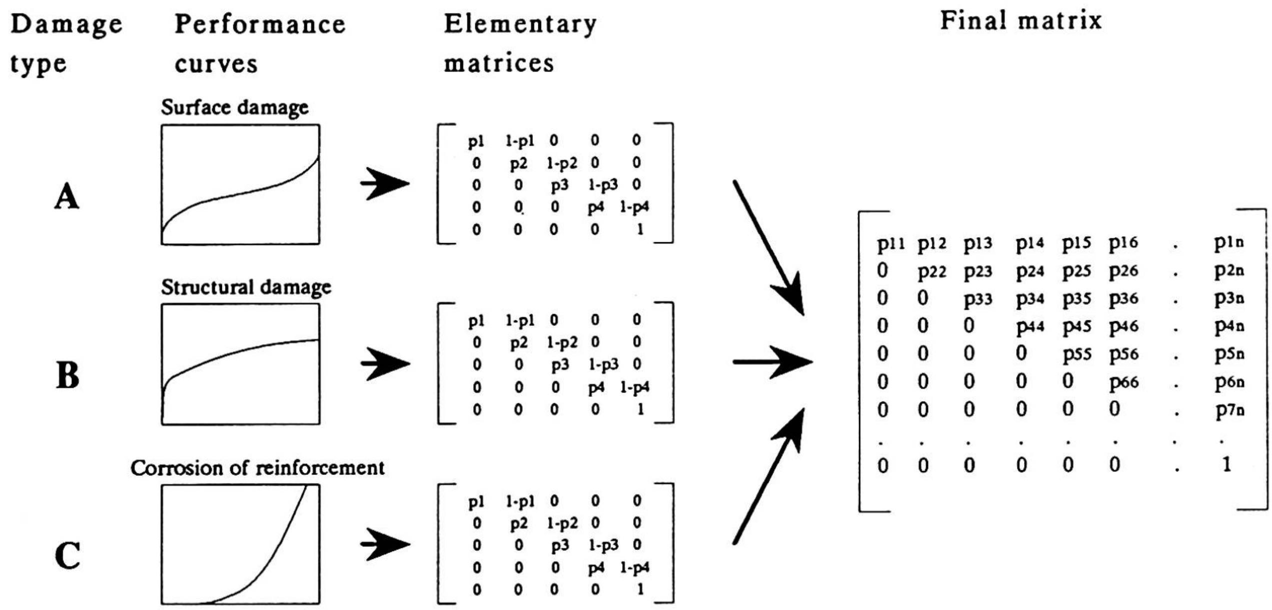

Fig 1. Basic principle behind transition probability matrices for bridge items.

A Delphi questionnaire was considered the best techniques for producing performance curves. It was sent to the best specialists available including bridge inspectors, other bridge officers and research scientists.

The respondents were asked to draw the performance curves for all damage types pertaining to all bridge items, assuming that the structures are never repaired. They were also asked for information concerning the dependences between damage types.

Several methods are available for the process of transforming performance curve data into transition probabilities. The method used in the Finnish application is in principle the same as that given by Jiang et al. [1]. A specially tailored computer program uses "iteration" for finding the final solution for transition probabilities.

The elementary matrices created as described above are combined to the final matrices respective to each bridge item. The number of final states (which determines the size of the final matrix) is the product of the numbers of states in the elementary matrices.

The transition probabilities of the final matrix are estimated as the product of the corresponding elementary transition probabilities, taking into account, however, the possible dependences between damage types.

REFERENCES

1. JIANG Y., SAITO M., SINHA K.C., Bridge performance prediction model using Markov chain. Transportation research record 1180. p. 25-32.