

Research on Method and System for Bridge Safety Assessment

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Summary

Abstract: In this paper a concept for a method that can be used to assess the risk assessment of bridge is presented. The presented method can be taken into consideration major loading status, such as displacement, deformation and crack. In order to combine quantitative factor assessment, fuzzy synthetic assessment method based on analytic hierarchy process is used to evaluate bridge safety, in which experience of experts can be used sufficiently. The three general steps used to estimate bridge risk are, 1) index system of fuzzy synthetic assessment, 2) Fuzzy comprehensive assessment and 3) risk response. Based on matlab platform, bridge risk assessment system is developed. The system could produce the result automatically, when mathematical model is definition. Its function is concentrated on simulation analysis, which can deal with the quantitative and semi-quantitative risk assessment according to the engineering practice. The system has been used in many projects with a good result.

Keywords: bridge hazard; assessment method; simulation analysis; system.

1. Introduction

The risk exists in the planning stage, the design stage, the construction stage, and the service stage of bridge engineering. In order to improve the risk research of bridge engineering and emergency handling ability, and to furthest reduce the probability and loss of engineering accident, the engineering risk assessment must be carried out.

The software system suitable for bridge engineering with quantitative or semi-quantitative calculation is not perfect, which could not satisfy the requirements of actual engineering. Based on matlab platform, bridge risk assessment system BRE2.0 is developed.

2. Quantitative calculations

If the limit state equation is explicit, structural reliability analysis can use the traditional methods such as FORM, SORM, and JC. But when limit state equation cannot be explicitly expressed, the traditional methods alone will not be able to complete the analysis of the complex structure. For such problems, using BP neural network method can break this limitation through switching the implicit function to an explicit one.

In order to facilitate the implementation of the new methods, the analysis procedures IM2EX is prepared. The procedure consists of two parts. One is neural network calculations, which is done based on MATLAB toolbox Procedures; the other is used to create the explicit formula, which is developed by using MATLAB language completely. The FEM software, ANSYS is used to calculate the training samples. Based on the above knowledge, bridge risk assessment system BRE2.0 which will be described in latter parts is developed.

3. Semi-quantitative calculation

The research of risk assessment shows that semi-quantitative calculation methods is used generally at present, such as Fuzzy analytic hierarchy process (FAHP). Main task being of FAHP is to identify risk source. Improved from traditional analytic hierarchy process (AHP), FAHP uses fuzzy matrix in decision-making, then converts it into coincidence matrix. Multi-goal optimization of formula

schemes of risk identification system of bridge engineering disaster was made by FAHP. The general steps used to identify risk source are, 1) definition of comparison matrix, 2) determination of the priority weights of hierarchy elements, 3) determination of index weight and subordinate degree.

FAHP is attractive because of its simple use. On the other side, accuracy of the method is decided by analyst level of professional knowledge and familiarity, and the results would be predisposed to one-sidedness by analyst subjective factors.

The selection of quantitative calculation and semi-quantitative calculation is decided by the problem that will be solved, and the engineering purpose that will be obtained, and the effective information which obtained in the process of risk analysis. Different risk assessment method will be used in different life stages of bridge engineering.

4. Index system of fuzzy synthetic assessment

Safety or not needs a determination of risk level. Based on "Guideline of Risk Assessment for Safety Construction of Highway Bridge" [4] and general practice, classification of frequency, consequence is shown in table 2~6, and a risk matrix for the determination of risk level is shown in table 7~8. It is important to note that the risk classification system must be defined for each particular project in consideration of the specific risk policy.

In addition to published statistics about a few instances where these are available, expert judgment drawn from a number of sources may be used to arrive at the classification.

5. Risk assessments system

Risk assessment is effective way to increase the constructions safety and to decrease the loss. With the use of MATLAB platform, a risk assessment system is established. The system includes the input output module, query module, data management module (see figure 3), and risk identification, risk analysis, risk assessment, risk controlling modules (see figure 4). All subsystem linking each other, and complete the ability of cooperation with all subsystem. The system will produce the result automatically, when mathematical model is definition. Its functions are concentrated on simulation analysis, which can deal with the quantitative and semi-quantitative risk assessment according to the engineering practice. The system has been used in many projects with a good result, which has some popularization value.

6. Conclusion

Bridge engineering risk assessment with quantitative or semi-quantitative calculation has not been very good development. The method of IM2EX can acquire the failure probability for quantitative risk calculation. For the main factor of failure of bridge engineering can be identified, the idea of FAHP is applied to engineering risk innovatively. The method can exert the brain advantage of evaluation, and simplify the computation process.

The principle of balance between economy, technology and safety is studied. According as the principle, the risk assessment is presented to estimate the risk.

The software BRE2.0 for bridge engineering risk assessment is built. This system has Friendly interface and easy operation, and has both the quantitative and semi-quantitative method of bridge engineering risk assessment. The software is very practical and very flexible.