Asset Management Framework for Evaluation of Optimum Maintenance Plan of Road Slope

Kyoto University, Student, **Nutthapon Supawiwat**
Kyoto University, Member, **Hiroyasu Ohtsu**
Kyoto University, Member, **Yuzo Ohnishi**

1. Introduction

The issue of the maintenance/repair/renewal of road slopes has conventionally been addressed in the context of disaster prevention. While such an approach is undoubtedly essential, it is also necessary to introduce the asset management concept to deal with the issue of optimizing the maintenance/repair/renewal of structures. Generally, asset management is not concerned with the execution of repair work as the primary countermeasure. Instead, it requires comprehensive judgment of structural stability and return on repair investment for deciding which location should be repaired first, and thus it involves uncertainties. Recently, a number of infrastructure management systems, designed for specific asset classes, have existed for several decades, such as the development of pavement management systems and bridge management system. However, in consideration of road slopes, current asset management systems are quite limited. In this context, this paper aims to present a framework based on asset management concept for evaluating optimum maintenance/ repair plan of road slope.

2. Asset Management Framework

In this paper, the issues to be covered in asset management are: (1) determination of the current status of structural performance and functions; (2) prediction of future conditions in the face of performance deterioration or potential natural hazards; and (3) formulation of maintenance/repair/renewal rules considering appropriate locations and timing, covering the evaluation of cost-effectiveness. Fig.1 shows the proposed framework, which is divided into 3 parts: data collection, analysis models and management strategy, for managing maintenance/repair plan of road slope. The framework is detailed as the followings.

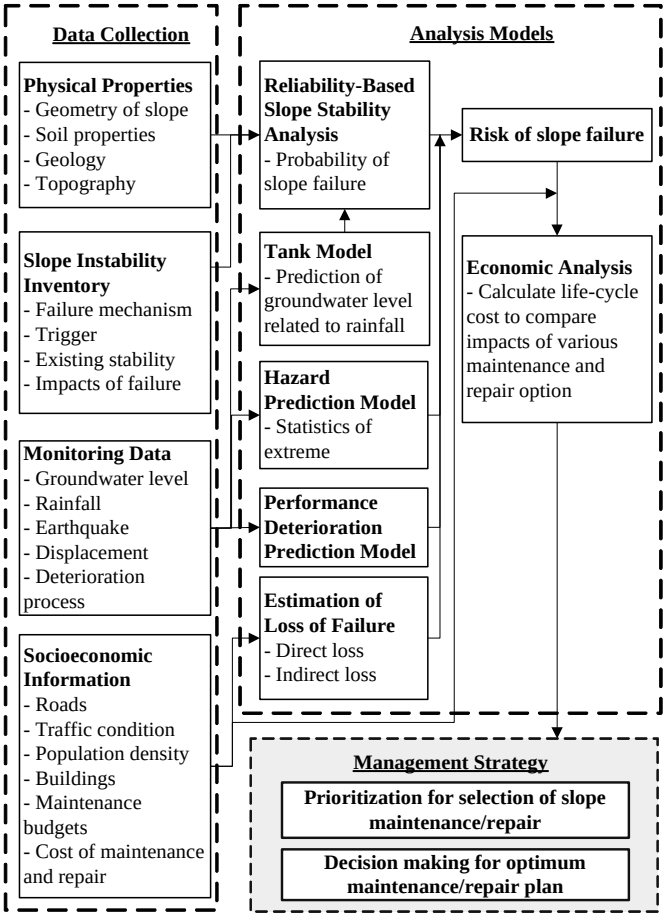

Fig.1 Asset management framework for managing the maintenance/repair plan of road slope

2.1 Data collection

Generally, data are central to the asset management system for any particular infrastructure. Therefore, in order to develop an effective management system, the availability and quality of such data is required. In case of road slope asset management, essential data are listed in part of data collection as shown in Fig.1.

2.2 Analysis models

In order to assess risk and probability of slope failure, reliability-based analysis along with some prediction models are adopted. In this study, change of groundwater level

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Contact address: Geofront Environmental Engineering, Dept. of Urban and Environmental Engineering, Kyoto University, Yoshida Honmachi, Sakyo-ku, Kyoto, Japan, 606-8510; Tel.&Fax: 075-753-5129, E-mail: oat@geotech.kuciv.kyoto-u.ac.jp

related to rainfall can be determined by tank model, whereas the statistics of extreme is adopted to predict the occurrence of hazards such as rainfall and earthquake. Subsequently, combing results on economic loss, risk of slope failure can be assessed. The basic risk calculation concept for the slope rain hazard is the same as the concept of calculating annual risks by obtaining the convolution of rain hazard probability based on reliability analysis, as shown in the authors' previous research [1].

Furthermore, considering long-term performance of slope, deterioration process of structure is of concerned. However, when treating a slope as a structure, the deterioration of its performance is supposed to be caused by the performance deterioration of remedial works such as the groundwater drainage system and ground anchors. Therefore, prediction model of such deterioration process also required. Finally, impact of various maintenance and repair options can be assessed by performing life-cycle cost analysis.

2.3 Management strategy

According to analysis results, prioritization for selection of slope maintenance using risk as an index as well as decision-making for optimum maintenance and repair plan of road slope can be evaluated.

3. Application of the Proposed Framework

The proposed framework can be successfully applied to the real-world slope. Detailed of such analyses can be referred to the authors' previous researches [1, 2]. Some results of such researches are illustrated in Figs.2 and 3.

For the purpose of prioritization for selection of slope maintenance, annual risk of slope failure is adopted as an index supporting the decision-making. Results of analysis are shown in Fig.2.

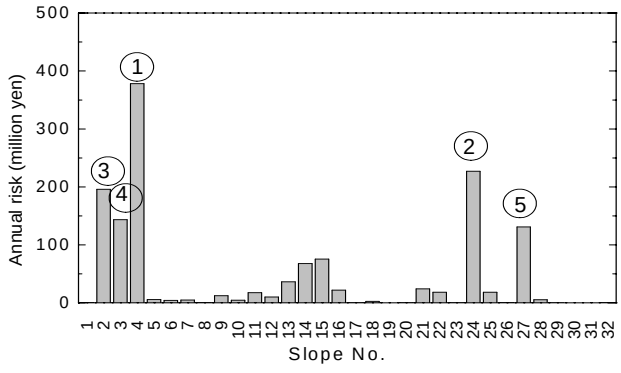

Fig.2 Prioritization for selection of slope maintenance based on annual risk of slope failure

On the other hand, in consideration of evaluation of optimum maintenance and repair plan, life-cycle cost (LCC), calculated by the summation of cumulative expected losses considering socio-economic losses and investment to recover the performance of the countermeasures, is considered as an index for selection of repair interval. As shown in Fig.3, optimum repair interval can be obtained at minimum LCC.

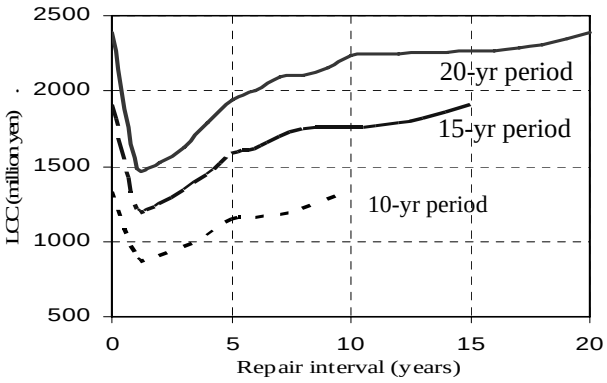

Fig.3 Relationship between life-cycle cost and cleaning interval of groundwater drainage system

4. Conclusions and Suggestions

This paper has proposed a strategic framework associated with maintenance and repair of road structures considering the road slopes based on the asset management concept. Results from analysis show that the proposed method can be successfully applied to the real-world slope. Therefore, it provides a fundamental concept for road administrators to effectively investigate and manage a performance of the road slope throughout the service life, considering both safety and cost-effectiveness. However, as aforementioned, data are central to the asset management system. Therefore, in order to develop an effective road slope management system, a comprehensive information system or database is required in further study.

5. References

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