Maintenance system for slope around existing structure by GIS

Background

Ground information on the slope around an existing structure resulting from geological structure, surface survey, and the ground displacement measurement data has been used for maintenance. Those data have been often individually managed in each branch that relates to the structure. Because that information is not unitarily managed, if the problem of slope stability will occur, the solution of the problem may need much cost and labor. It is necessary to unify this ground information for efficient slope maintenance. Moreover, the maintenance support system that is able to analyze the data and evaluate the slope stability is necessary. Therefore, it is necessary to develop tools that are able to manage and analyze data, and evaluate the stability on general Geographical Information System (GIS) as the analysis tool of ground information.

Objectives

In maintenance of the slope around the existing structure, the system that can reasonably analyze ground information on GIS is developed. And the applicability of the function is verified on the slope around a water power plant.

Principal Results

1. Development of tools for slope maintenance support system by GIS

Maintenance of the slope around existing structures has three stages, i.e. inspection of the slope, observation of the slope, and stability evaluation of the slope. Ground information obtained by the maintenance is spatial information consisting of an attribute and a position. The spatial information can be expressed as a map, and can be unified by the GIS database. We surveyed the data management support tools that could make maps corresponding to those stages. As the result, there were some tools to make each map, but those had not been effectively used in GIS. And each map by the tools had not been unitarily managed. So, we developed the following tools shown in Fig.1 to ensure unitary management.

(1) The database system (DB) to store the ground information corresponding to the results of inspection of the slope, the results of surface survey, and the ground displacement measurement data. And a movement map made from the DB.

(2) The whole behavior analytical tool on GIS by the principal component analysis to grasp the major slope movement, based on measurement information on ground displacement that reflects complex movement of the slope. And a whole behavior map by this tool.

(3) The visualization tool on GIS that makes deformation and risk map from slope stability evaluation by numerical analysis.

2. Function verification of the system

We applied the developed system to the slope around an existing water power plant, and verified the function of tools by making the maps according to the maintenance stage. It was clarified that the developed system can be analyzed by overlaying each map individually managed (Fig.2). It becomes easy to examine the validity of ground information in each stage, and the decision of a new measuring or checking point by this system. As a result maintenance work will become prompt and efficient.

Future Developments

We will examine a reasonable operation method of this system on World Wide Web or Local Area Network.

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Reference

H. Kobayakawa et al., 2007, "Slope maintenance system using GIS, and application to slope around the existing structure," CRIEPI Report N06029 (in Japanese)
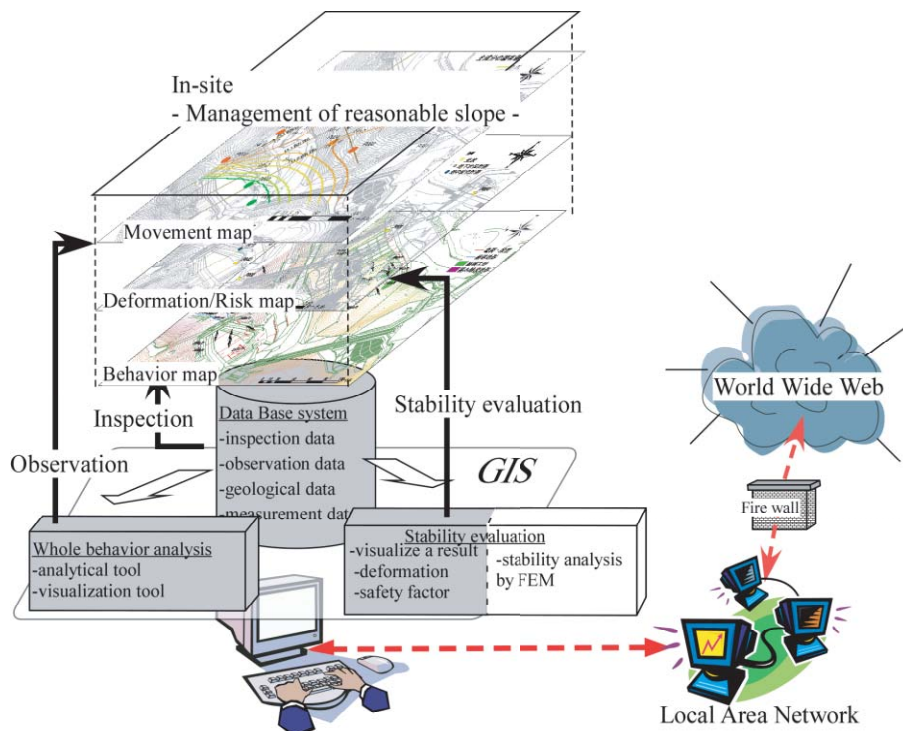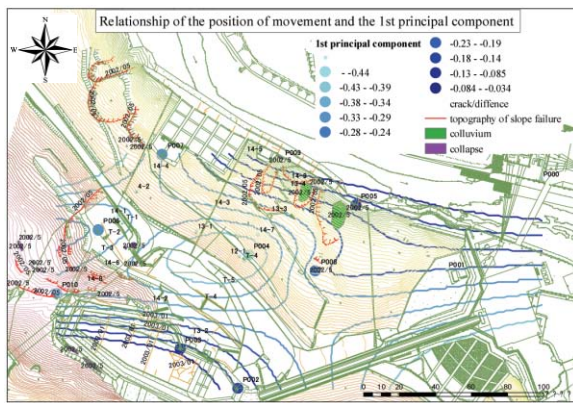
**Fig.1** Scheme of slope maintenance support system by GIS

This system consists of three tools on GIS that are a database system, whole behavior analysis, andthe stability evaluation.
The map according to the stages of maintenance (inspection, observation, and stabilityevaluation) can be made with these tools.
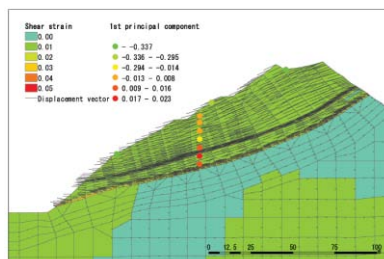

Overlaying the movement map and the behavior map

· Validity examination of inspectionand measurement position
· Examination of new measurement and inspection position

Prompt and efficient maintenance work
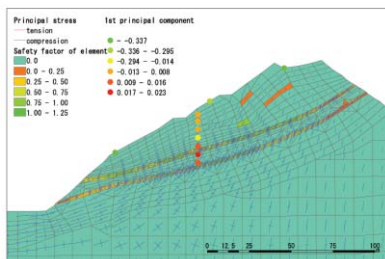
Overlaying the distribution of safety factor (Fs) of element and the behavior map; we can grasp the relation between a position of low Fs and a position of large displacement.

Overlaying the distribution of shear strain of element and the behavior map; we can grasp the relation of the position of large strain and a position of large displacement.

· Validity examination of analytical result
· Specific in dangerous position
· Examination of new measurement position etc.

Overlaying the behavior map and result of stability analysis

Fig.2 Example of applying system

Maintenance work will become prompt and efficient by the analysis overlaying each map made frothree tools.