A Study on Development of GNSS-based Measurement System for Monitoring Slope Site

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Abstract

A GNSS based measurement system was constructed with not only the core sensors of a GNSS receiver, a TRS sensor and a soil moisture sensor but supplementary installation of power supply and radio communication for monitoring steep slope sites. The sensor combination extracts and transfers not only ground displacement in real-time but soil moisture content.

I. Introduction

Precaution and advance response is required urgently through systematic management which uses a regular measurement management system for monitoring slope sites.

This helps swift inhabitant evacuation guide and investment priority of slope site maintenance business decide.

Because cessation of traffic and loss of lives due to collapse of slopes incurs enormous national loss, it is needed to develop monitoring sensors suitable to various geological states and collapse types and make a connection to regular measurement management system.

In this research, we tried to develop GNSS based monitoring sensor, called Smart Pole, do acceleration task of the developed monitoring sensor and then perform site adaptiveness experiment.

Ⅱ. Construction of Smart Monitoring System and Measurement Experiment

The smart monitoring system built in this research cosists of data receiving section, data transfer section and data processing section largely. Smart Pole is composed of GNSS receiver, TRS(Translation, Rotation & Settlement) sensor and soil moisture sensor.

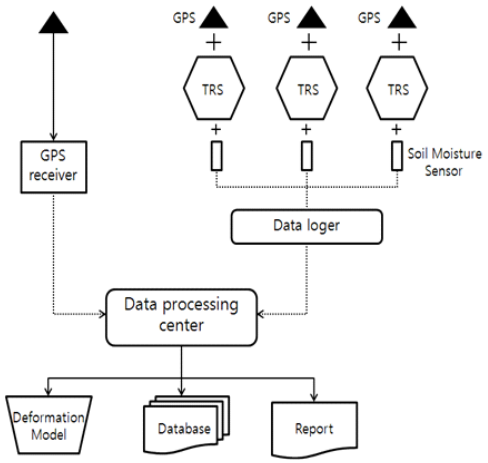

Fig.1 Composition of smart pole monitoring system (ⅰ)

It reflects not only translation and slopingness of ground but rotation of ground including soil moisture content. The monitoring result, that is displacement data acquired from the monitoring sensor is able to be connected with web-based monitoring management system for steep slope management.

Fig 2 shows smart pole monitoring sensors installed on monitoring station, radio transmission system, solar photovoltatic power generation system and data processing center. Sensor data, which are collected in the data logger, are tramsmitted to data processing center in the office.

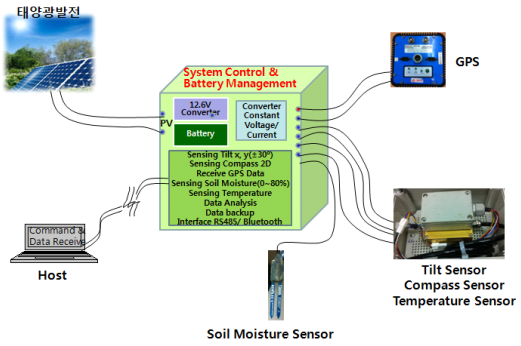

Fig.2. Composition of smart pole monitoring system (ii)

The displacements(△N,△E) extracted from sensor data are based on TM coordinates projected on plane on the basis of WGS84 ellipsoid. However it is not so easy to understand the direction of ground movement at site with these amounts(△N,△E) and so it is needed to represent displacements(△X,△Y) with slope longitudina direction and slope direction. Therefore the data processing program was produced to transform △N,△E of smart pole station to △X,△Y by inputting TM coordinates of any two points on slope longitudina direction.

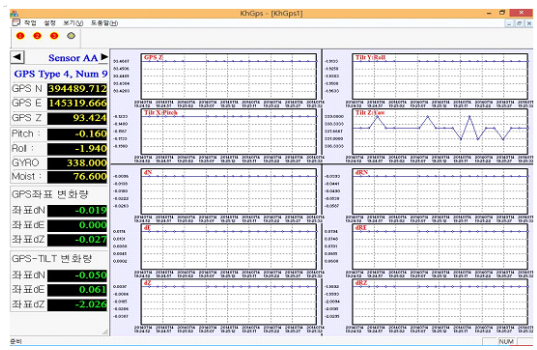

Fig.3. Main screen with real time coordinates, displacement data and displacement chart

The experiment was conducted devoting the pole intentionally stage by stage at intervals of five degree from 0 deg. to 20 deg.

Fig.4. displacement chart from TRS sensor data when sloping by 10 deg.

Table 1. Compare Actual and theoretical displacements of GNSS-TRS combination measurement

dx ($l\sin\theta$)	dy ($l\sin\theta$)	r (GNSS)	r' (GNSS-TRS)	dh	dh'
-0.058	-0.010	0.095	0.058	-	-
-0.097	-0.009	0.124	0.098	0.060	0.003
-0.235	-0.010	0.240	0.235	0.075	0.018
-0.397	-0.010	0.388	0.397	0.106	0.054
-0.546	-0.010	0.540	0.546	0.159	0.104

Ⅲ. Conclusion

The smart pole measurement system composed with three different typesr was constructed and updated through enhencement. And the software was made and updated for system operation, data processing and displacement extraction. It is expected that GNSS-based measurement system developed in this research by connecting with Web-EOC system for collapse prediction and advance response system.

▮ Acknowledgement ▮

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▮ Reference ▮

[1] Xiufeng He, Guang Yang, Xiaoli Ding, Yongqi Chen, "Application and evaluation of a GPS multi-antenna system for dam deformation monitoring", Earth Planets Space, 56, 1035-1039, 2004.