

Abstract of Doctoral Thesis

Title : Development of Monitoring Soil Moisture and Groundwater Level Using Ultrasonic Waves for Predicting Slope Failure

Doctoral Program in Advanced Architectural, Environmental and Civil Engineering
Graduate School of Science and Engineering
Ritsumeikan University

ふりがな ひらおか のぶたか
氏名 Hiraoka Nobutaka

Monitoring of soil moisture and groundwater level is important for predicting slope failure caused by heavy rainfall. We have been developing a new device using ultrasonic waves for monitoring soil moisture and groundwater level. There are 3 major advantages of the method. Ultrasonic detector can be installed in underground at low cost, the ultrasonic measuring system offers useful technique for multipoint monitoring, and the system requires less frequency of maintenance. The soil moisture is measured by the reflective intensity of ultrasonic waves at the soil surface, while the groundwater level is measured by the propagation time of the reflected waves. Both measurements can be achieved using one ultrasonic detector.

In this paper, in order for the ultrasonic measuring system to be put to practical use, the basic and applied study on ultrasonic measuring system is examined. In the basic study, the shape of ultrasonic detector has been optimized, and ultrasonic measuring instrument has been developed. In addition, the ultrasonic detector has been improved to correct temperature, and ultrasonic transducer frequency was changed into high frequency. In this way, base configuration of the ultrasonic measuring system has been determined. In the applied study, threshold level has been validated for prediction of slope failure using the reflective intensity and the propagation time which obtained by ultrasonic measuring system by slope collapse experiment. As a result, ultrasonic measuring system can detect quasi-saturated state, saturated state of soil, and rise of groundwater level, are warning signal of collapse.

At last, the ultrasonic measuring system has been set up on natural slope, and has been measured for half a year. The ultrasonic measuring system can catch the rising of soil moisture and groundwater level quickly and greatly compared to tensiometer which measures pore water pressure. This result shows that ultrasonic measuring system has effectiveness.