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Design and development of instrumentation network for landslide monitoring and issue an early warning

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CSIO, Chandigarh has designed and developed an instrument network around standard geo-technical and geo-physical sensors and advanced associated electronics. Network was installed in 2006 for continuous instrumental monitoring of the site at Mansa Devi near Haridwar. The paper highlights design approach for network and explains technical details of different sub modules. Network performance in terms of functional reliability, data generation capability and failure rate in the field has been evaluated and necessary design modifications have been incorporated.

Keywords: Geo-physical sensors, Instrumentation network, Landslides monitoring

Introduction

Landslides most often occur as ground water builds up in a slope due to rain, snowmelt or landscape irrigation. This water increases material weight in the slope, increases pore pressure, hydrates and expands clay minerals, dissolves minerals that may hold particles together, and decreases material strength; all of which weaken the slope. In every slope, stresses due to gravity exist and it increases with the slope height, slope inclination and unit weight of the material forming the slopes. Shearing stress also develops in surface zone due to thermal expansion, contraction/ shrinkage, freezing and swelling etc. When shearing stress along vulnerable and weak surface exceeds shearing resistance of the slope, a landslide occurs. Vibrations generated by movement of heavy vehicles create oscillations in rocks and thus change stress pattern reducing shear strength. Rainfall over some areas in Himalayan region is in excess of 200 cm/year and is a cause for landslides. Sometimes, people also contribute to the slope failure by diverting rainwater and roof water, which alters hydrology of the slopes. An important cause of mass movements or surface failure is the absence of surface drainage system or proper opening for seepage. This causes frequent occurrence of landslides during or after heavy prolonged rainfall.

This paper presents technical details of building modules of CSIO developed instrumentation network and its performance analysis.

CSIO developed Network for Landslides Monitoring

CSIO have successfully developed and configured an instrumentation network around state of the art sensors to monitor inclination of natural slopes, tilt of rock slope and surface deformation, amount of rain fall, anchor tensioning in retaining walls, deep rock movements, soil Stress, crack & movements in rock masses and water pore pressure and associated advanced field operated electronics. Instrumentation has been designed around modern data acquisition system, advanced signal conditioners, digital data communication links and necessary software. This complete system has been installed at Haridwar (Mansa Devi) active landslide site. The system is operational round the clock on solar panel and under observation from June 2006 (Fig. 1).

Design approach and Network Configuration

Landslide monitoring system[1-3] consists of: i) Field units (FUs) located within landslide zone; ii) Local control station (LCS) at nearby stable area; and iii) Central Data Recording & Analysis Centre. FUs along

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