A Technical Note on

Monitoring of Jhakri Landslide in Bari Village Area of Himachal Pradesh

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ABSTRACT

The occurrence of landslides is quite common on natural slopes and tectonically active region showing high degree of rock instability. A slope failure is developed due to progressive external loads and deteriorations of slope geo-materials and is major cause of landslides. In our country, till date, some research institutes are carrying out scattered efforts to analyse the landslide hazards. Landslide analysis is too complex and needs systematic studies. CSIR-Central Scientific Instruments Organisation (CSIR-CSIO) is pursuing a research on instrumental monitoring of landslide and developing prediction algorithms. Under this research a part of Jhakri landslide in Bari village area of Himachal Pradesh (H.P.), an Indian State in the Himalayas, is instrumented in May 2012, and real-time data is being acquired round the clock. Installed instrumentation is modular and two-tier structured system. It is observed that monitoring network will be populated with more sensors and three-four years data will be acquired to develop and validate prediction algorithms.

Keywords: Landslide; Slope failure; Natural slopes; Tectonically active; Monitoring; Real-time data

1. INTRODUCTION

It is mentioned in a world bank report, 2005 that 3.7 million squares kilometers of land area of the globe is exposed to landslides and the population exposed to it is 300 million i.e. 5% of world population. Area of the order of about 8,20,000 km^2 is identified under high risk category, covering a population of 66 million at high risk. It has been observed that Asia is the worst affected continent due to landslides and within the Asian countries, South Asian countries are more affected and even among the South Asian countries, India is the most affected nation.

The occurrence of landslides is quite common on natural slopes and tectonically active region showing high degree of rock instability. Mountain regions of India are facing the serious problem of landslides, which cause disruption of road and rail traffic besides loss of precious human lives. A slope failure is developed due to progressive external loads and deteriorations of slope geo-materials. This progressive and dynamic development results in occurrence of landslides. About 25% of the India's landmass (~0.82 million square kilometers) is prone to landslides. These unstable hill slopes are spread across 22 states and 2 Union Territories to varying extent. In India, the Himalayan states suffer more due to landslide compared to western ghats, Niligiris etc. Some of the studies have indicated that on an average, a landslide occurs at almost every two kilometers along the highways in Himalayan terrain.

Landslide analysis is too complex involving a multitude of factors which needs to be studied systematically. In our country, till date, some research institutes are carrying out only scattered efforts by using a few imported instruments to measure only some parameters of landslides. As such, there are no organized scientific efforts to acquire good quality instrumental data and to make its real-time analysis for issuing early warnings to handle this natural hazard.

The loss of human lives and properties are directly associated with unpredictive nature of landslide hazard. So systematic instrumental monitoring and prediction are the need of the society for landslide hazard mitigation. In this regard, CSIR-CSIO is pursuing a project sponsored by Department of Science & Technolohy (DST), New Delhi on slope stability analysis and development of early warning system. Under this research work a part of landslide site at Bari village, Jhakri (H.P.) has been instrumented in May 2012 and the results are presented in this paper.

2. JHAKRI LANDSLIDE SITE AND ITS MONITORING

2.1 Landslide Study Area

The instrumented Jhakri landslide site is located at longitude (77º41' 43" E) and latitude (31º29'08" N) and lies near Rampur in the Satluj valley of Himachal Pradesh. Structurally the landslide is located near to the main central thrust and East-west trending Nogli Fault (Gill, 2011). The most characteristic features of the geology of this region are that the rocks are unfossiliferous and reverse metamorphism. Strata of instrumented site is overburden slipped mass which is predominantly comprised of quartz mica schist big slipped boulders, mica schist broken rock pieces set in matrix of sand, silty sand and mica schist fines (Mittal and Singh, 2012) . A Google Earth view of the study area is given in Fig. 1.

2.2 Landslide Monitoring Instrumentation Network

Installed landslide monitoring instrumentation system is designed as two-tier structured modular system and its block diagram is given in Fig. 2 (Mittal et al. 2008, 2009a, 2009b).

Fig. 1 - Google Earth image showing study area

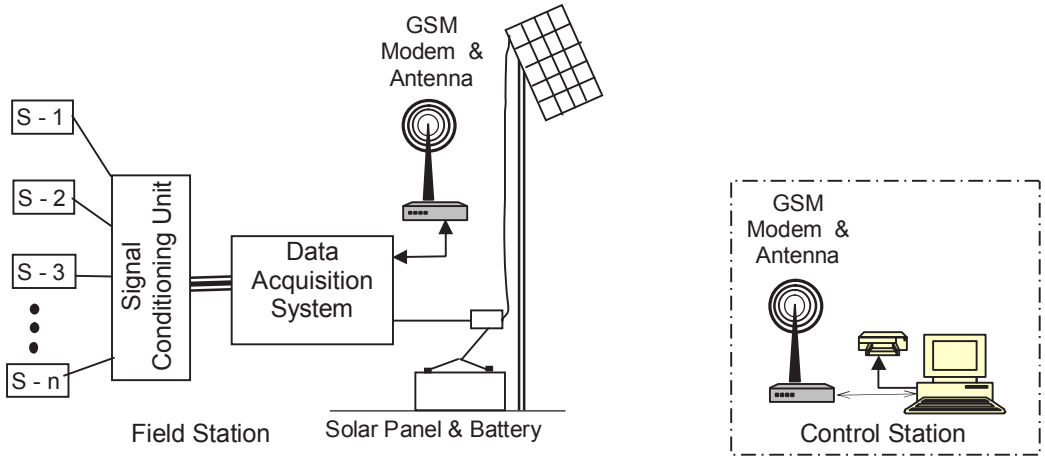

Fig. 2 - Block diagram of landslide monitoring instrumentation network

It consists of a series of geotechnical sensors: piezometer, raingauge, total earth pressure cell, crackmeter, tiltmeter and inclinometer; located within the landslide zone. Data acquisition unit and solar power station are kept in nearby stable area. This cluster of instrumentation is named as field station (FS). Piezometer is installed at 50m depth. Inclinometer casing is 50m deep which crosses the NH-22 elevation level. FS is also

equipped with GSM/GPRS modem to communicate with Control Station (CS) situated at CSIR-CSIO, Chandigarh. Complete instrumentation was made operational in May 2012. CS allows the remote, automated management of FS over GSM/GPRS interface and retrieves recorded data and analyses it. To monitor the whole landslide area; more numbers of sensors can be interfaced to existing FS and also more FS can be configured and linked with CS.

Fig. 3 - A view of instrumented landslide site from SJVNL guest house side

Fig. 4 - A view of instrumented landslide site from Rampur side hill

2.3 Recorded data and observations

Data of rain gauge, piezometer, total earth pressure cell and crackmeter is recorded at six hour interval in real-time mode from May 2012 to March 2013. Graphs showing the change in recorded parameter is shown in Fig. 5. It is evident from Fig. 5 that in the middle of monsoon season crack was widened by one millimetre but no change occurred in pore pressure.

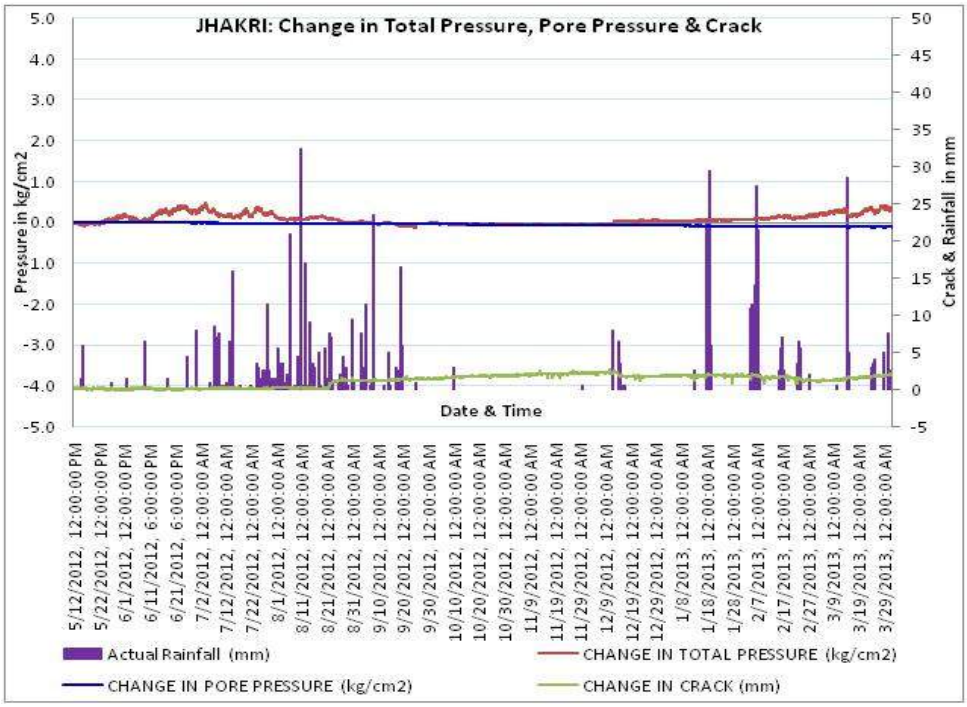

Fig. 5 - Graph showing change in recorded pore pressure, total earth pressure, rainfall and crack

3. CONCLUSIONS

As per the field investigations carried out at the study area and results of various index tests carried out on strata samples collected during borehole drilling, it is observed that strata is overburden slipped mass which is predominantly comprised of quartz mica schist big slipped boulders, mica schist broken rock pieces set in matrix of sand, silty sand and mica schist fines. The sub soil water level in the drill hole was not encountered upto the drilled depths of 50m. Also no significant change in piezometric pressure at 50m depth throughout the monsoon season is recorded. But progressive movement at 7.5 m depth along EW axis in inclinometer casing is noticed. So it is a debris slide.

There is a need to populate the FS with more piezometers at different depths and more inclinometer casings. After that data for three-four years will be recorded to develop and validate early warning algorithm.

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