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Time Series Analyses of Bhatwari Landslide Triggered by 1991 Uttarkashi Earthquake

Neha Gupta[1], Josodhir Das[2], Debi Kanungo[3]

[1]Research Scholar, Department of Earthquake Engineering, Indian Institute of Technology Roorkee, 247664, India
[2]Professor, Department of Earthquake Engineering, Indian Institute of Technology Roorkee, 247664, India
[3]Chief Scientist & Professor, Geo Hazard Risk Reduction (GHRR) Group, CSIR- Central Building Research Institute (CBRI), Roorkee 247664, India

Abstract

Uttarkashi earthquake (1991) triggered many landslides in the lower Garhwal Himalayas, primarily affecting Uttarkashi and surrounding areas. Few of the slides are still active in this zone, and it is advisable to investigate the entire zone against instabilities to avoid further calamities. The present study investigated one such landslide – Bhatwari landslide (Uttarkashi, India). Forensic analysis of a landslide site has been performed to ascertain the possibility of landslide activity over a period of time. Several factors have been considered while performing the stability analysis, such as the effect of fluctuating water table in the static and pseudo-static condition, the impact of the 2013 Kedarnath flood, and the potential of failure and permanent displacement if an earthquake similar to Uttarkashi, 1991 ever strikes again. It was found that the landslide is still active after being triggered by the 1991 Uttarkashi earthquake, with factor of safety (FoS) values degrading with the passage of years. It was verified that the slope failure also occurred post the 2013 Kedarnath flash flood event based on the sudden-drawdown analysis results. The present study suggests that the slope may collapse during heavy rainfalls. The FoS was found less than unity under saturated conditions. The possibility of failure also exists against an earth-quake of similar magnitude that of Uttarkashi, 1991 based on obtained potential Newmark displacement values.

Keywords: Uttarkashi earthquake 1991, Slope stability analysis, Sudden drawdown, Newmark displacement