World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:12, No:06, 2018

Observation on the Performance of Heritage Structures in Kathmandu Valley, Nepal during the 2015 Gorkha Earthquake

Authors : K. C. Apil, Keshab Sharma, Bigul Pokharel

Abstract : Kathmandu Valley, capital city of Nepal houses numerous historical monuments as well as religious structures which are as old as from the 4th century A.D. The city alone is home to seven UNESCO’s world heritage sites including various public squares and religious sanctums which are often regarded as living heritages by various historians and archeological explorers. Recently on April 25, 2015, the capital city including other nearby locations was struck with Gorkha earthquake of moment magnitude (Mw) 7.8, followed by the strongest aftershock of moment magnitude (Mw) 7.3 on May 12. This study reports structural failures and collapse of heritage structures in Kathmandu Valley during the earthquake and presents preliminary findings as to the causes of failures and collapses. Field reconnaissance was carried immediately after the main shock and the aftershock, in major heritage sites: UNESCO world heritage sites, a number of temples and historic buildings in Kathmandu Durbar Square, Patan Durbar Square, and Bhaktapur Durbar Square. Despite such catastrophe, a significant number of heritage structures stood high, performing very well during the earthquake. Preliminary reports from archeological department suggest that 721 of such structures were severely affected, whereas numbers within the valley only were 444 including 76 structures which were completely collapsed. This study presents recorded accelerograms and geology of Kathmandu Valley. Structural typology and architecture of the heritage structures in Kathmandu Valley are briefly described. Case histories of damaged heritage structures, the patterns, and the failure mechanisms are also discussed in this paper. It was observed that performance of heritage structures was influenced by the multiple factors such as structural and architecture typology, configuration, and structural deficiency, local ground site effects and ground motion characteristics, age and maintenance level, material quality etc. Most of such heritage structures are of masonry type using bricks and earth-mortar as a bonding agent. The walls' resistance is mainly compressive, thus capable of withstanding vertical static gravitational load but not horizontal dynamic seismic load. There was no definitive pattern of damage to heritage structures as most of them behaved as a composite structure. Some structures were extensively damaged in some locations, while structures with similar configuration at nearby location had little or no damage. Out of major heritage structures, Dome, Pagoda (2, 3 or 5 tiered temples) and Shikhara structures were studied with similar variables. Studying varying degrees of damages in such structures, it was found that Shikhara structures were most vulnerable one where Dome structures were found to be the most stable one, followed by Pagoda structures. The seismic performance of the masonry-timber and stone masonry structures were slightly better than that of the masonry structures. Regular maintenance and periodic seismic retrofitting seems to have played pivotal role in strengthening seismic performance of the structure. The study also recommends some key functions to strengthen the seismic performance of such structures through study based on structural analysis, building material behavior and retrofitting details. The result also recognises the importance of documentation of traditional knowledge and its revised transformation in modern technology.

Keywords : Gorkha earthquake, field observation, heritage structure, seismic performance, masonry building
Conference Title : ICEES 2018 : International Conference on Earthquake Engineering and Seismology
Conference Location : San Francisco, United States
Conference Dates : June 06-07, 2018