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Effects of topographic and geological features on building damage caused by 2015.4.25 Mw7.8 Gorkha earthquake in Nepal

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The Gorkha earthquake occurred at 11:56 NST on 25 April 2015. The focal depth was about 15 km. The epicentre was 77 km northwest of Kathmandu. Based on the information from the United Nations, eight million people have been affected by the massive earthquake in Nepal, which is more than a quarter of the Nepal's population [1, 2]. To understand the damage caused by the earthquake, and hope to find a solution to reduce future geo-disasters in Nepal, from 2 to 9 June 2015 we conducted a preliminary investigation on the 2015 Gorkha earthquake. In addition to the investigation on the cultural heritage and building damage in Kathmandu city, Gorkha Palace, Chautara town, and Sankhu town, we also visited the Kaligandaki River landslide dam, and conducted measurements and investigation. In this report, the observation, investigation and measurements on the following five geological settings will be described in detail separately. 1) Cultural heritage and building damage in Kathmandu city (lake deposits); 2) Damage in Gorkha Palace, Chautara and Changu Narayan (narrow mountain ridge); 3) Damage in Sankhu (alluvial fan); 4) Damage in Purano Naikap (landslide area); 5) An earthquake-induced landslide dam in Kaligandaki River.

Through our investigation, we summarize the reasons of the house collapse and damages in Fig. 1. Fig. 1 (a) shows the situation on the narrow mountain ridges. Because the ridge is narrow, houses used non-homogeneous foundations. One side of the house is directly located on the ground, and the other side is supported by piles, bricks, or concrete structures. If the outside foundation is located in a landslide area, the foundation is prone to collapse even if the landslide does not show obvious displacement; if the entire mountain ridge is located on a landslide, the amplified shaking can cause any types of failure. Fig. 1 (b) represents the geological structure in Sankhu town. In the upstream side, gravel and surface water is abundant, but on the downstream side, the grain size of the soil becomes finer and finer, surface water becomes groundwater, and the groundwater gradually becomes deeper. Fig. 1 (c) shows the failure pattern at the Purano Naikap area. In this kind of area, the structure of the lacustrine deposits overlaying the bedrock can form an enhanced structure for the occurrence of landslides. Because the lacustrine deposit landslide mainly consists of clay, generally they will not move for a long distance during an earthquake, but they can amplify the shaking and cause general destruction to the houses, especially if the houses in this area were located on shallow foundations on cut-slopes at the upper side, and infilled at the lower side.

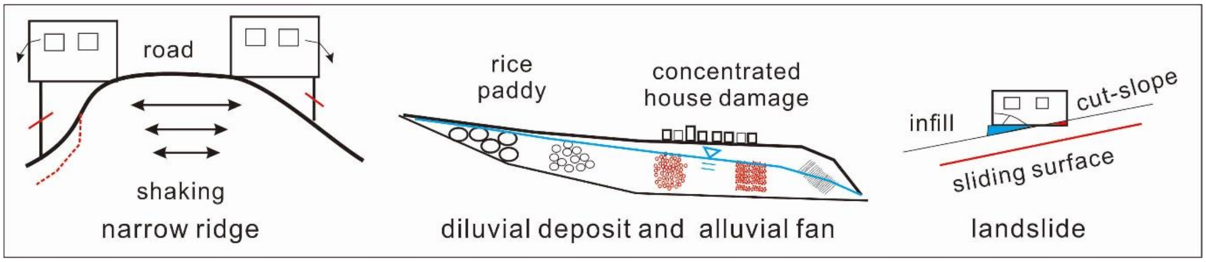

Fig.1 Three main patterns caused the house collapse and damages in 2015.4.25 Gorkha earthquake. (a) Building damage along narrow mountain ridge; (b) concentrated house damage on alluvial fan; and (c) house damage on existing landslide

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[1] Goda K et al (2015) The 2015 Gorkha Nepal ERQ: Insights from ERQ Damage Survey. F. Built Environ. 1:8.

[2] Dahal RK & Timilsina M (2015) Excursion for the 2015 Gorkha ERQ Damage Assessment. ICGdR, 29p.