North Kashmir earthquake — Reconnaissance survey

Civil Engineering faculty members of IIT Kanpur, Prof. Durgesh C. Rai and C.V.R. Murty undertook a reconnaissance survey of the earthquake affected regions in Kashmir during October 14 to 19, 2005 and visited worst affected major Indian towns Uri, Kupwara and Baramulla.

Earthquake and its seismological setting

The Mw 7.6 earthquake on October 8, 2005 struck 9:20:38 IST with its epicenter in Pakistan-occupied Kashmir (PoK) about 120 km west-northwest of Srinagar. The event which was similar in magnitude to the 2001 Gujarat earthquake and the 1935 Quetta earthquake caused widespread destruction. This earthquake is associated with the known subduction zone of active thrust fault in the area where the Eurasian and Indian tectonic plates are colliding and moving northward at a rate of 40 mm/yr giving rise to Himalayan mountain ranges. The affected region lies in the top two high risk seismic zones of IV and V of Indian seismic code IS:1893 with the expected intensity of IX or more in the zone V and intensity of VIII in the zone IV.

General observations

Damage to buildings and other structures in general agreed well with the intensity of ground shaking observed at various places, with the maximum of VIII at Uri, VII at Baramulla and Kupwara and V at Srinagar on MSK scale. However, the collapse of stone walls of random rubble types was a surprise even at shaking intensity of VI. Relief efforts in the affected areas have been seriously hampered by the difficult terrain and harsh Himalayan weather conditions. The immediate requirement is to provide temporary shelter along with medicine, food, blankets, etc. for survivors, before these areas become further inaccessible due to approaching winter.

Performance of structures

In Kashmir, traditional timber-brick masonry construction consists of burnt clay bricks filled in a framework of timber to create a patchwork of masonry. The resulting masonry referred as *Dhajji-dewari* (meaning patch quilt wall)

Fig 1 *Dhajji-dewari* system of timber-laced masonry for confining masonry in small panels withstood the earthquake without serious damage

Fig 2 Timber frame and timber-laced masonry held on as stone masonry walls in lower storeys collapsed

Fig 3 Collapse of stone masonry walls

Fig 4 Prestressed concrete girder bridge lacks restrainers to prevent unseating during earthquakes at this bridge in zone V

is quite different from typical brick masonry and its performance in this earthquake has been once again shown to be superior with no or very little damage. No collapse has been observed for such masonry even in the areas of higher shaking of intensity VIII, *Fig* 1. *Dhajji-dewari* system when used for only walls of upper stories (especially for the gable portion) has shown relatively less damage even when the walls in bottom stories have collapsed, *Fig* 2.

Undressed random rubble type masonry was responsible for the majority of the deaths and injuries. Most of government buildings, hospitals, schools, jails, etc., built in random rubble masonry without any seismic features suffered heavy damage, especially when the structure was old, *Fig* 3. This was primarily due to the fact that the walls could not maintain their integrity during the shaking.

The affected region has a number of major bridges which are extremely vulnerable due to inadequate seating and absence of other provisions to prevent unseating, *Fig* 4. Roads closer to epicentral area in the mountainous region suffered extensive landslides which resulted in the closure of traffic for many days. The road to Tangadhar from Kupwara was not open even a week after the quake. Pipelines for drinking water supply broke at several places causing severe hardships.

Closure

The damage to built environment, economic loss and human casualties caused by Himalayan earthquakes are increasing rather proportionally with the growth of settlements and population in its upper reaches. Significant damage to residential, community and government buildings resulted from prevailing stone masonry buildings, especially those with random-rubble types, which are well known for poor seismic performance.

Conventional unreinforced masonry laced with timber performed satisfactorily as expected. There is an urgent need to revive these traditional masonry practices which have proven their ability to resist earthquake loads, in contrast to contemporary colonial-style masonry buildings. Modern bridges, roads,, water tanks, etc., which have been constructed without due consideration of high seismic activities of the Himalayan region make such civil infrastructure extremely vulnerable for future earthquakes.

– IIT Kanpur press release

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