Bulletin of the New Zealand Society for Earthquake Engineering, Vol. 49, No. 4, December 2016

DISCUSSION

"BUILDING TYPOLOGIES AND FAILURE MODES OBSERVED IN THE 2015 GORKHA (NEPAL) EARTHQUAKE" VOL. 49, NO. 2

LETTER TO THE EDITOR

Richard Sharpe

The Editor,

Bulletin of the New Zealand Society for Earthquake Engineering

I refer to the paper "Building Typologies and Failure Modes Observed in the 2015 Gorkha (Nepal) Earthquake" by Dizhur, Dhakal, Bothara and Ingham published in Vol. 49, No. 2 of the NZSEE Bulletin published in June 2016.

I was perplexed on reading this paper to find the response spectrum of the 25th April earthquake recorded in Kathmandu compared with a design spectrum in the Indian Building Code. Why not compare the spectrum with those of the Nepal National Building Code? After all, to my knowledge, the zoning factor given by the Indian Building Code was not derived from any form of probabilistic seismic hazard analysis whereas the seismic zoning for Nepal is derived from a rigorous country-wide analysis undertaken using a comprehensive seismicity model prepared by a reputable consultancy. Yes, it is understood that some structural designers in Nepal use the Indian Building Code - perhaps because of their historical familiarity with it, but not necessarily in compliance with their own laws and regulations. Moreover, there is no reference at all to the Nepal Building Code in the rest of the paper, and the lengthy list of references does not include any describing its development such as that presented at the 14th World Earthquake Engineering Conference in Auckland in 2000. NZSEE sponsored the attendance of the Nepalese authors at that conference, and the drafting of the building code was led by an international and national team chosen and led by Beca. My amazement was then compounded by no reference to the excellent work (including strengthening of many buildings by the National Society of Earthquake Technology-Nepal (www.nset.org.np) - now a non-governmental organisation with more than 50 fulltime staff originally modelled on the NZSEE. In addition, there is no reference in the paper to modern high-rise buildings which I observed (in the company of some of the authors) to have survived the earthquakes remarkable well in contrast to clearly less well-designed similar buildings.

Knowing that a majority of the authors are very aware of these two matters, this makes me wonder whether this paper had been reviewed by suitable people before publication. The authors, by their omissions, have chosen to present a narrow view of the damage experienced in the April and May earthquakes last year.

Readers of the NZSEE Bulletin should be aware of the back story to Nepal's tentative preparedness for earthquakes and their post-earthquake response.

The Nepal Building Code was drafted about 22 years ago in response to the impact of the 1988 M 6.9 earthquake near the Indian border above the Indian state of Bihar. The process involved continuous interaction with the country's Department of Building, its architects' and engineers' national organisations, government earth scientists and university departments over an 18-month period. Although legislation to implement it was drafted as part of the project, it was a number of years before it was passed into law by parliament.

The seismic aspects of the draft code were innovative. With the input of the renowned Dr Anand Arya of India, the code contains three levels of compliance – requirements for engineered buildings, mandatory rules-of-thumb for small buildings not exceeding meeting specified sizes and layouts, and guidelines for less formal buildings. Subconsultants Golder Associates from North America derived the seismicity model for the country and surrounding areas, and a probabilistic seismic hazard analysis was undertaken by Beca to determine seismic zoning. Minimum seismic design parameters were set at a lower level than in more developed nations in acknowledgement of the financial impost of a code. As per the terms of reference, the detailing requirements of the Indian Code were adopted. The code allows international codes to be used for engineered buildings as long as their requirements exceed those of the Nepal Code. In addition, extensive studies were made of existing building practices, possible alternative materials, and the training required for implementation and consenting of buildings. A countrywide study of 55 types of vernacular residential buildings was undertaken, each being documented and recommendations made for strengthening. Demonstration studies were undertaken of the mapping of areas subject to liquefaction, landslides and lateral spread.

Subsequently, the national leaders of the project and others empowered by the project formed NSET-Nepal to advance and implement the of mitigation of the seismic risk. In time, NSET morphed into a contracting non-profit entity with full-time staff led by Dr Amod Dixit who was an engineering geologist. NSET has undertaken and delivered an incredible number of projects (many funded by USAID and other such organisations) in Nepal and surrounding countries. It has worked with school communities to strengthen schools, with municipalities to help introduce controls, and with radio stations to transmit regular building tips to far-flung isolated communities. It developed guidelines for rapid post-earthquake assessment (based on ATC-20 guidelines), and has interacted with other professional groups such as doctors. After the 2010 Darfield earthquake, NSET organised for the Christchurch mayor Bob Parker to come to address a meeting with the objective of convincing all the leaders in Kathmandu to work together to mitigate the huge seismic risk their capital city faces. The other project leader, architect Yogeshwar Parajuli, has recently become the head of the Kathmandu Valley Development Authority (www.kvda.gov.np), and is working hard to introduce landing planning into the valley that addresses the seismic hazard of different parts of it.

Immediately after the April 2015 earthquake, NSET undertook training in rapid assessment of hundreds of local engineers. Under memoranda of understanding with government departments, it has assisted them in a number of ways.

As the photographs in the authors' paper demonstrate, Nepal has a long way to go to lift the resilience of their buildings and infrastructure. A year on, there are moves to revise the building code – perhaps to "international" levels seismically. A number of those who have called for such a lift appear to be ignorant of the rationale and careful consideration/consultation undertaken in the drafting of the Code. The level of design loads is, obviously, almost irrelevant if there is little compliance with the Code.

Finally, the New Zealand Ministry of Foreign Affairs and Trade's (MFAT) volunteer team that went to Kathmandu soon after the first earthquake (and experienced the second one) was not sent there for Learning from Earthquakes (reconnaissance) purposes. It was in response to an urgent request from the Nepal Government's Department of Urban Development and Building Construction to assist them in the rapid assessment of government and some private buildings. MFAT has recognised the value that we earthquake engineers in New Zealand can bring to such international crises.

Yours sincerely,

Richard Sharpe

Life Member NZSEE

AUTHORS' RESPONSE

Dmytro Dizhur, Rajesh P. Dhakal, Jitendra Bothara and Jason Ingham

The authors are thankful to Dr Richard Sharpe for his insightful and informative comments on several aspects of earthquake engineering practices in Nepal. Dr Sharpe is correct: the paper does not try to correlate observations back to the Nepal Building Code; neither does it present the status of earthquake preparedness in Nepal, nor does it elaborate on the roles played by different institutions before and after the earthquakes. These aspects were intentionally not addressed as these topics were not the focus of the paper. As is evident from the title, the purpose of the paper was almost exclusively to report observations and in particular the failure modes most commonly-observed following the Nepal earthquakes. It was also never our intention to make any comment on fragilities, probabilities, or proportions of failed versus non-failed buildings, hence we have not reported in detail on buildings that exhibited low (or no) damage.

The authors are well aware of the National Society for Earthquake Technology (NSET), a non-governmental organisation, and the contribution that NSET has made towards earthquake risk awareness and preparedness in Nepal. The authors are also aware of many other governmental and non-governmental institutions in Nepal - both national and international, who have made significant contributions towards earthquake disaster risk reduction (both in pre and post-earthquake scenarios) in Nepal. Hence, the authors felt it would be unjust to these institutions if particular focus was directed towards NSET only. Also, as mentioned earlier it was beyond the scope of the paper to record the contributions of these organisations.

The comparison of the observed ground motions with the Indian Standard Design demand was merely for a context without any further follow up in the paper. The Indian Standard was chosen as to the authors' surprise, it was observed that more structural designers in Nepal follow the Indian Standard than the Nepal Building Code, notwithstanding the fact that only a small proportion of buildings are designed by properly following a seismic design code. In the authors' opinion, there are two reasons for the Indian Standard's extensive use. The first is due to a historical reason (as Dr Sharpe has rightly alluded to), and the second is because Nepal does not have its own full set of material design standards, and designers then have to defer to the information that is available in the Indian Standards.

The authors had access to the building Standards developed by Dr Sharpe and his team and we found these to be a pragmatic set of documents considering capability and logistics available in Nepal at that time. In particular the Building Code NBC105 [1] appears to have been ahead of its time in the Nepal context. The authors also agree with Dr Sharpe that the level of design loads is almost irrelevant if there is little compliance with the Code, so efforts to strictly implement the Building Codes should take priority. The authors are aware that the Government of Nepal has recently made some legislative changes around the requirement of building design and has already started a process to revise NBC105 and other building standards through the Department of Urban Development and Building Construction (DUDBC).

In hindsight, the authors realize that not comparing the Nepal seismic design spectra with the observed spectra in Kathmandu Valley or omission of reference to the Nepal Building Code in the paper was an oversight. The third author Mr Bothara, who was part of the Nepal Building Code Development Project under Dr Sharpe's leadership, is particularly apologetic to Dr Sharpe for this oversight. For readers' information, in Figure 1 below we include a comparison of the response spectra of the ground motions recorded at one of the stations in Kathmandu Valley during the 25 April 2015 main earthquake with the Nepal Building Code NBC105 [1] design spectrum. Note that NBC105 [1] provides a reduced spectrum for a fully ductile structure, and the spectrum plotted below is an adjusted spectrum for a non-ductile (i.e. unreinforced masonry) structure on soft soil. Note that the plotted spectrum gives the demand for the Working Stress Method of design, and needs to be multiplied by a load factor of 1.25 to arrive at a demand for the Limit State Method of design [2].