

# *RISK PERCEPTION OF PEOPLE AND RISK ASSESSMENT OF UNREINFORCED BRICK MASONRY BUILDING UNDER SHORING*

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**Abstract**— Gorkha earthquake on 25<sup>th</sup> April 2015 and its subsequent aftershock is believed to have taken the life of more than 9,000 people. Thousands of houses have been destroyed either partially or completely, especially in traditional places of Kathmandu valley. Houses which were partially damaged have been found to be re-used after applying some temporary supports which are technically called shoring. Meanwhile, some of the houses which were fully damaged are yet to be demolished. The research revolves around two research questions. How structurally stable these buildings are and how street dwellers perceive the risk? Two sets of data was collected in 2017. One set of data included 30 samples of buildings supported on shoring located in ward number 2, 3 and 4 of Bhaktapur municipality. The other set of data included interviews with 30 street dwellers of different demographical characteristics. This study will show insights on people's perception of risk alongside the shoring conditions on our study area with respect to studies conducted after 2 years of a destructive earthquake. In one hand, this study will help policy makers to understand the shoring practices and perception of people towards the risk. On the other hand, it will also help policy makers to develop new measures to achieve capacity resilience in a community

**Keywords**— Shoring, Risk perception, Risk

## I. INTRODUCTION

Simple experimental testing can be suitable to access the risk of one building but may not be suitable in case of multiple buildings. Representative sampling must be done for this desired case (Mohammad, 2009). Various methods has been found to be used for assessment of vulnerability of buildings (Lang, 2002). Observed vulnerability is being used for poorly constructed buildings like old masonry houses. It is based on the available building data. Observed Vulnerability is suitable for buildings whose vulnerability is difficult to determine using analytical or numerical methods (R.V. Whitman, 1974). Another method is 'Expert Opinion method' which is based on scholastic opinions of some scholarly people on various vulnerability functions. The experts evaluate damages in percentage destruction as assigned to them (ATC-13, 1985). Analytical or Numerical Methods are used for loss estimation of buildings on towns and cities. (D'Ayala, Spence, Oliveira, & Pomonis, July 1997). Finally, score Assignment is another popular method of assigning score for assessment of vulnerable buildings. It was developed by Applied Technology Council in 1987. (ATC-14, 1987). There are multiple ways to carried out detailed analysis. 4 models was proposed for detailed analysis in 2013 which included

nonlinear static Procedure, nonlinear dynamic procedure, linear dynamic procedure and linear static procedure. (Shrestha, 2013). Improvisations for risk assessment were also proposed in FEMA 154, FEMA 155, FEMA 178, and FEMA 310.

'Structural score' are assigned between 0-7 for a sample building using statistical analysis measures and tools.

Buildings getting low 'score level' is considered to fall under the category of 'potential seismic risk'. No structural calculation is needed since it is based on a 'rapid sidewalk survey' of buildings (FEMA-154, 2002).

The risk perception of rural residents of Sichuan Wolong was examined in 2015. The researchers relate perceived risk with household characteristics and financial preparedness and found that all other personal and household characteristics except household income didn't influence risk perception (Lo & O., 2015). The authors concludes that for building resilience in a community social channels are very important. Expresses Sociological factors are better than the spatial factors in explaining seismic risk perception. The authors believe that instructional vulnerability had been forgotten despite belonging to a very active domain of multidisciplinary research (Glatron & Beck, 2008).

As defined in the literature above, observed Vulnerability was selected for the risk assessment. Similarly for risk perception survey, some parameters like education, economic status, caste, age and other household characteristics were found to be vital in the study of risk perception. The literature help to design a questionnaire set based on these vital parameters. There has been extensive study on risk perception in both pre disaster and post disaster phases throughout the world. There has been some risk perception studies in Nepal too. However, a risk perception study based on structural vulnerability conditions of buildings standing on temporary supports (shoring) is in fact very unique. So, this research work fills this very gap apart from what mentioned in the literature.

## II. METHODOLOGY

The data collection work comprised of 2 phases. **The first phase** included the data collection work for preliminary survey. Purposive Cluster Sampling of 30 houses was performed in ward number 2 and 3 of Bhaktapur

Municipality. A visual assessment was performed to find out scenario of shoring in field. Meanwhile, involved

parameters such as cracks, severity of cracks, strengthening works, human settlement on houses, angle of shoring, type of shoring used, condition of tilting etc. were observed and recorded. Similarly, in the second phase, risk perception data of people were collected by interviewing people. 30 people including the local people and visitors of different demographical features were interviewed after making a standard questionnaire through extensive literature review.



Fig. 1. Study Area enclosed by boundary



Fig. 2. Unscientific placing of shoring



Fig. 3. Rastriya Kala Sangrahalaya, Bhaktapur



Fig. 4. A typical house supported by shoring



Fig. 5. A partially supported house on shoring

### III. RESULTS AND DISCUSSION

#### A. First Phase: Risk Assessment

In first phase, all houses surveyed supported on shoring were masonry houses with load bearing walls. 76.7% of the houses were tilted and found to be needing supports or shoring. 86.7% houses were supported on inclined shoring only. 96.7% buildings were found to be lacking sufficient space between them making it more vulnerable for the people. Surprisingly, People lived in 80% houses of all these houses that were surveyed.

93.3% of houses didn't have 'same slab height' with their adjacent buildings. 10% shoring on buildings were inclined at an angle of range  $<25^\circ$ . Similarly, 5% were found to be inclined at an angle of  $>65^\circ$ .

46.7% and 43.3% houses had restraint from 2 sides and 3 sides respectively. 40% houses were built on sloppy grounds. 80% buildings had 100% ground coverage. The average storey of houses in Bhaktapur was found to be a little over 3 storey.

For the placing of shoring, the load transferring mechanism must be studied. Static analysis can be performed

since the shoring practices in Bhaktapur can be found not to be fixed but rather hinged. The material properties can be known and load to be passed through the shoring post can be estimated. If the shoring is found to be facing more stress than the bearing capacity of shoring post it is found to be facing overstress condition otherwise okay (B. Dhakal, 2018).

Number of shoring to be provided =

$\frac{\text{Total Lateral load to be resisted by shoring}}{\text{Strength of a single shoring}}$

Spacing of shoring

$\frac{\text{length of total wall to be provided shoring}}{n - 1}$

The total lateral load to be resisted by shoring and strength of shoring can be calculated as stated above. Spacing of shoring here is end to end since 'n' equals to total number of shoring. (B. Dhakal, 2018).

#### B. Second phase: Risk Perception

The Newars resides in the study area forming a majority. Thus, 46.7% of the local street dwellers of Newar ethnicity were surveyed. Their perception of risk varies from other 53.3% who were not familiar with the area. 6 foreigners were asked to fill the questionnaire form too. Bhaktapur Durbar Square being a world heritage sites attracts a number of tourists which were also considered as street dwellers for the survey.

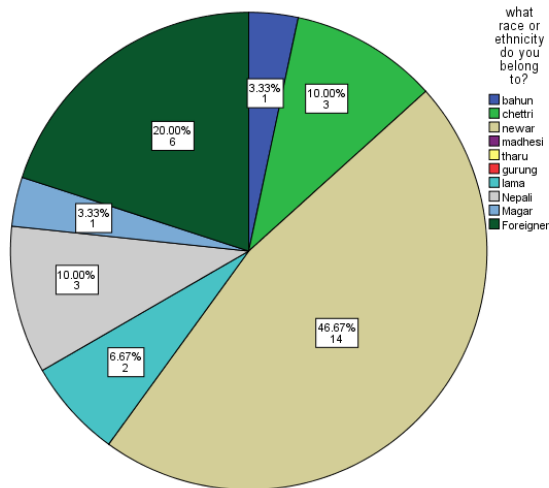


Fig. 6. Ethnicity of Survey Respondents

Surprisingly 30% of the street dwellers were found to have graduate degree. 16.7% found to have completed secondary schooling. 10 people didn't attend school out of which 5 could read and write. This means this study was done among a literate group of people comprising 83.3% demography sample who could read and write. Out of all psychological problems, 26.7% of that reported was found to be 'fear'. Another 13.3% was found to be insomnia along with fear.

Thus, a total of 40% people were reported to have psychological problems because of the previous earthquake.

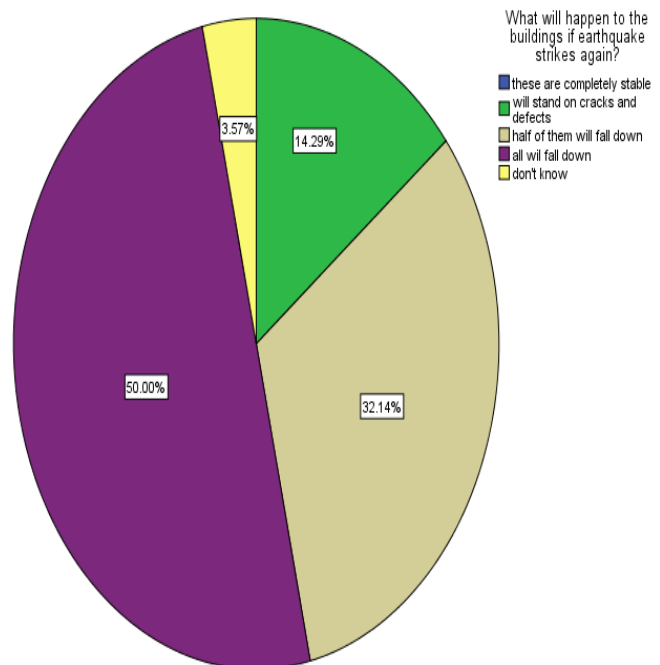
30% people were found to live on rent which implies that they are more vulnerable compared to the other 56.7% people who live in their own house.

43.3% reported that they felt 'little unsafe' while traveling by buildings on temporary supports. 23.3% people were found to feel 'very unsafe'. 26.6% reported that they have no safety issues with those buildings which states their negligence and 'state of mind' thus making them more vulnerable for a forthcoming earthquake.

43.3% reported that they change routes to avoid walking by these structures. 26.7% people reported that they used to change the routes but no they don't. Similarly, 43.3% aren't concerned about changing routes and are more vulnerable for a prospective earthquake in future.

53.3% knew the epicenter of the earthquake which was telecasted by a number of TV, radio and social media. They are more aware than the remaining 46.7% who don't know the basic information about the previous earthquake 50% stated clearly that they don't know when the earthquake would strike. This can be because of two reasons. Either because they had zero knowledge or because they did not want to make a hypothetical assumption on a very uncertain natural phenomenon or hazard. 36.7% reported that it may reoccur after 50 years or more. This was because there is a common saying in Nepal "in every 50 years or so earthquake reoccurs". 30% people reported that half of the buildings standing on temporary supports will fall down.

Another 50% people stated that all will fall down which makes them more aware of the possible damage that may occur because of the prospective earthquake in future.





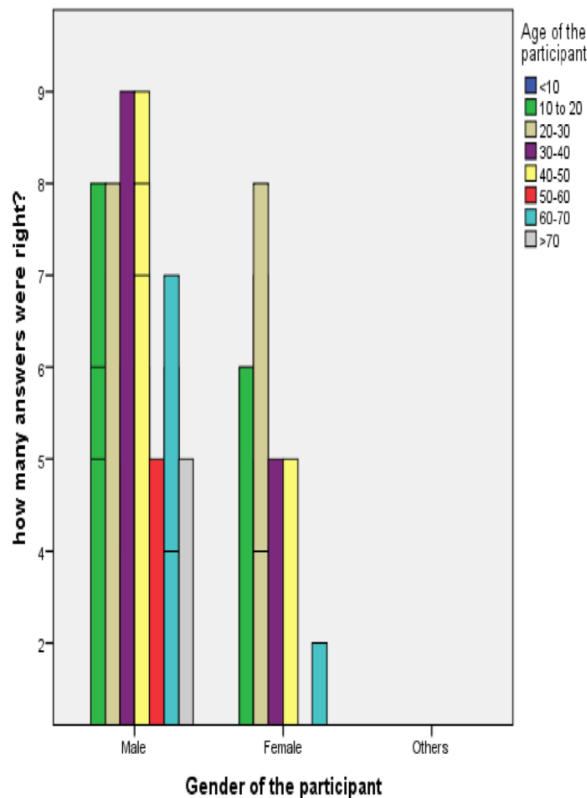


Fig. 7. Awareness check a total of 10 questions

### CONCLUSION

Risk perception is a term often practiced in disaster risk management. There has been extensive study in this field. However, an inter disciplinary study as this research which is a combined effort of engineering and social science doesn't seem to be used till date at least in Nepal. The study for street

dwellers that we conducted gave a lot of insights. The two third of the respondents were found to be male. The study implies how different parameters can be used to relate to risk perception. Furthermore, the results have enough space to analyze the results further using advanced statistical analysis. The results further help research to carry out risk perception studies in Nepal and precisely in Bhaktapur.

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