Performance of Row Housing in Earthquake

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***Abstract*—After Gorkha earthquake the concrete structures were slightly damaged or severely damaged or collapsed. Due to unplanned urbanization and high cost of land, connected buildings are constructed over time. Even codes are being followed in the design and construction these connected buildings are vulnerable to disaster because only individual buildings response are considered in design. Though built individually, these buildings are connected to adjacent buildings, forming blocks and they behave as a single aggregate and there is no provisions for the response of connected buildings. In order to analyse the seismic response of connected buildings three buildings connected to eachother are chosen. These buildings are analysed individually and block is analysed separately to compare the seismic response and It is found that maximum storey displacement get reduced in combined effects.**

***Index Terms*—Gorkha Earthquake, Row Housing, pushover analysis, base shear, displacement, time period, combined effect**

I. Introduction

Nepal is one of the ten least urbanised countries in the world. However, it is also one of the top ten fastest urbanising countries (UN DESA, 2014). Urbanisation in Nepal is dominated by a few large and medium cities with an excessive population concentration in the Kathmandu Valley.Kathmandu Valley accounts for 24 per cent of the total urban population, with Kathmandu Metropolitan City alone accounting for 9.7 per cent (MoUD, 2015). According to the MoUD (2015: p.7), internal migration is the largest contributor to urban growth. Due to modernization and unplanned urbanization most of the cities, in addition to a very high population density, accumulate large numbers of buildings, infrastructures and facilities . More population is concentrated in the places where the facilities such as transportation, employment, education, health services, communication, etc. are available. As a result of internal migration, split of family and property etc the connected buildings are constructed over time in urban areas. One of the main reason of disaster in these region is poor seismic performance of these connected buildings. The design and earthquake-resistant construction and seismic codes are excellent tools for improving the seismic behavior of structures, but many of the current buildings were built in the past without any consideration to seismic actions. Nowadays codal provisions are being used in construction even though there is high potentiality of damage because in most of the cases, response of individual buildings are considered and there is lack of study regarding the performance and response of connected buildings. Furthermore, the seismic behavior of engineered buildings, that have been designed and constructed according to codes, strongly depends on the technical level of the codes, which, in many cases, wasn't adequate. Many buildings in urban areas have different levels of seismic vulnerability and some of them show an inadequate behavior during earthquakes. For this reason, many recent studies in earthquake engineering are oriented to the development, validation and application of techniques to improve the seismic capacity of buildings, e.g. to reduce their vulnerability, enabling better decision making on seismic risk prevention and protection. To study the impact force between the adjacent buildings these buildings are connected with gap elements. Gap elements are used to connect the two adjacent buildings to model the contact between different elements. These gap elements which are connected at each adjacent buildings become active when two adjacent active buildings come towards eachother.

II. Objectives and Methodology

Objectives of this study are conducting pushover analysis and comparing its performance with reference to individual responses.For the purpose of analysis 3 buildings each of 5- storey are considered. The floor levels of each 5- storey buildings are kept at same level. Even though the heights are same the loadings on three buildings are different so the dynamic properties of three buildings are different.

III. Building Description

A. Building Geometry

The floor height of each buildings are 3.048m. Beam size are 0.23m *0.325m for building 1 and building 2 whereas that of building 2 is 0.3m *0.45m. Column size are 0.3m * 0.3m for all buildings with the slab thickness of 0.125m. The total height of each buildings is 18.288m. The properties are same for all buildings.

B. Material Properties

The concrete used is M20, steel used in Fe415 and the poisson's ratio is 0.2 for all buildings. The maximum separation between building 1 and building 2 is 0.3m and similar between building 2 and building

3. Buildings are modeled in Etabs 2016 and non linear static pushover analysis is performed to evaluate their seismic performance. Even all of these buildings have same height and are at same floor levels due to varying loading, these buildings have different dynamic properties (time period, frequency).If these buildings have same dynamic properties they never collide against eachother even there exists no gap because of in phase movement. As these buildings are connected by gap elements , gap elements transmit the impact force through these link when adjacent buildings come towards eachother.

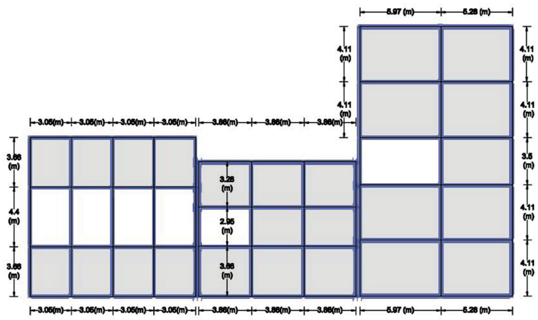

Fig. 1. Plan of study buildings

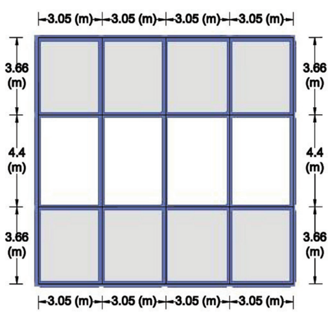

Fig. 2. Plan of study building 1

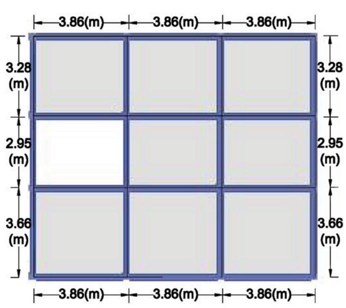

Fig. 3. Plan of study building 2

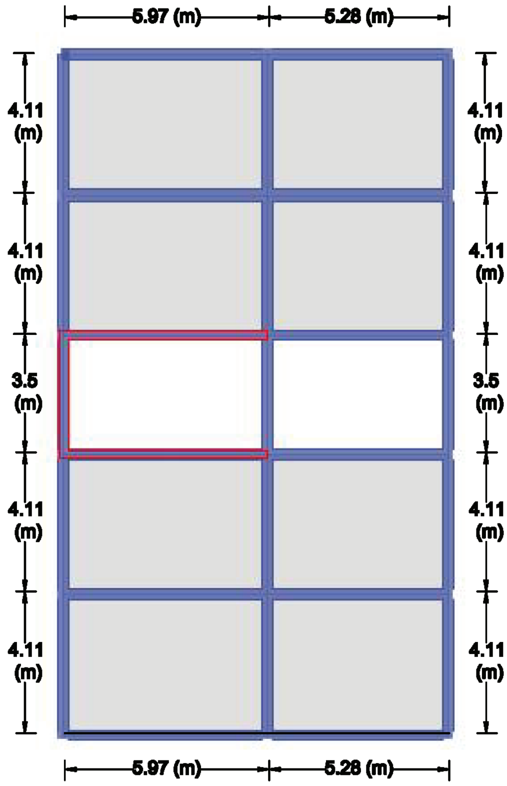

Fig. 4. Plan of study building 3

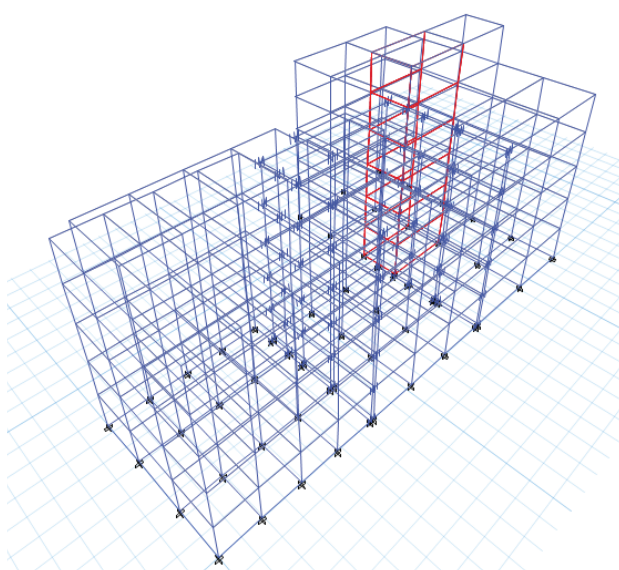

Fig. 5. 3D building model in ETABS 2016

IV. Analysis and Results

Nonlinear version of Etabs 2016 can model nonlinear behavior and perform pushover analysis directly to obtain capacity curve for three dimensional models of the structure. Displacement-controlled Pushover analysis is performed depending on the physical nature of the load and the behavior expected from the structure. After Pushover analysis hinges formation in each stage of a building are calculated, also from it is obvious that the demand curve tend to intersect the capacity curve near the event point, which means an elastic response and the security margin is greatly enhanced.

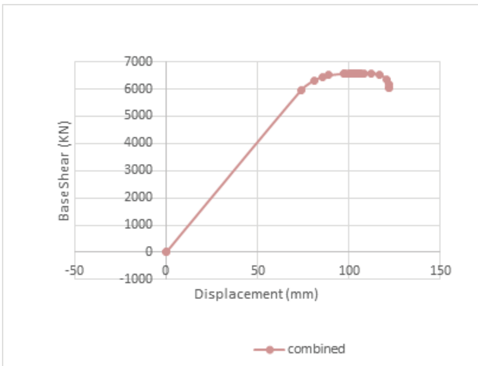

Fig. 6. Pushover curve for X-axis loading of block of all buildings

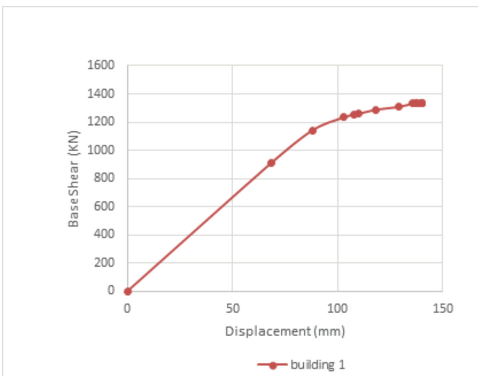

Fig. 7. Pushover curve for X-axis loading of building1

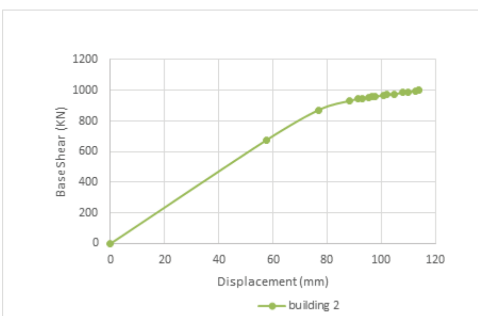

Fig. 8. Pushover curve for X-axis loading of building2

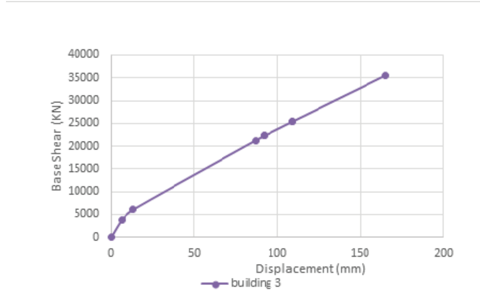

Fig. 9. Pushover curve for X-axis loading of building3

V. Results

Following conclusions are obtained from analysis.
a. After Pushover analysis of the structures both individually and combinedly, roof displacement at top is less in combined action.
b. Drift ratio is found to be very less in combined analysis in comparison to that of individual building.

References

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