Journal of Civil Engineering and Environmental Technology
Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 2, Number 5; April-June, 2015 pp. 387-389

http://www.krishisanskriti.org/jceet.html

Open Ground Storey Buildings under Seismic Loading in Chandigarh - A Case Study

Monika Sharma[1] and Abhishek Thakur[2]

[1]Chitkara University Baddi, H. P.
[2]P.G Student Jaypee University of Information & Technology Solan, H.P.
E-mail: [1]monika.sharma@chitkarauniversity.edu.in, [2]abhishekthakur91@gmail.com

Abstract—*According to the physiographical and tectonical study, india can be divided into three broad categories: peninsular india, indo-gangetic plains and the extra-peninsular india (himalayas). The extra-peninsular india or the himalayas have recently observed faulting in the himalayan foothills and chandigarh being situated at the seismic zone iv have to soon be planned to design the economical and seismic safe buildings.*

With the six convulsions which has shaked the region in the last few months it is now indicating that the region is soon being categorized as the second most prone to quakes regions. After the bhuj earthquake took place, the is 1893 code was revised in 2002, incorporating new design recommendations to address OGS framed buildings. There are numerous ways to improve the seismic performance of the buildings by properly following the building codes.

due to the fast growing urban environment in a developing country like India, there has been observed an expansive need of providing buildings with open ground storey as it facilitates the parking requirements as the columns in the ground storey do not have the partition walls.

The cost of construction of these open ground storey buildings is even lesser than the buildings with the basement parking. According to the past surveys it was observed that this type of buildings is the most unsafe one. These buildings disintegrate on seismic loading due to the behavior of the soft-storey in the ground storey of the building.

This case study comprises of the behavior of different open ground storey buildings under seismic loading, the behavior of columns, irregularities and some of the preventive measures which can be applied during the construction and execution processes.

Keywords: *soft – storey, irregularities, seismic loading, OGS.*

1. INTRODUCTION

Earthquakes are sudden release of energy accumulated in deformed rocks causing the ground to tremble or shake. Earthquakes in simple terms are a sudden trembling or shaking movement of the earth surface. A/c to IS 1893, clause 7.1, to perform well in an earthquake, a building should possess four main attributes, namely simple and regular configuration, adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation, suffer much less damage than buildings with irregular configurations.

2. SEISMIC HISTORY

From beginning of 20th century, more than 700 earthquakes of magnitude 5 or more are recorded in India. The Seismicity of India can be divided into 4 groups, namely Himalayan Region, Andaman Nicobar, Kutch Region and Peninsular India.A massive earthquake of magnitude 6.9 (on Richter scale) occurred on 26th January, 2001 in Bhuj, Gujrat. Some of these occurred in populated and urbanized areas and hence caused great damage. Many went unnoticed, as they occurred deep under the Earth's surface or in relatively un-inhabited places. Most earthquakes occur along the Himalayan plate boundary (Fig. 1). Some of the earthquakes that occurred in the Himalayan region has been shown in Fig. 2.

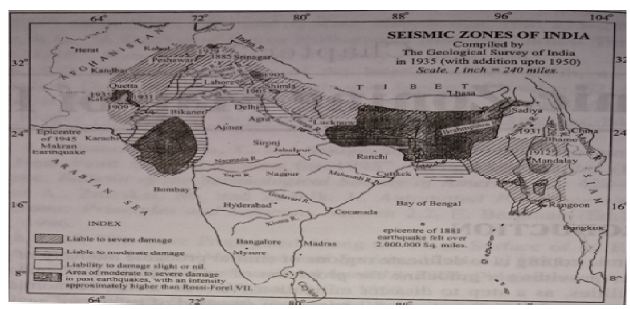

Fig. 1: Showing seismic zones in India

S. No.	Name	Location	Year	Magnitude/ Intensity	Death
		Himalayan Region			
1.	Kashmir Earthquake	Srinagar, J. & K.	1885	—	3,000
2.	Shillong Earthquake	Shillong, Plateau	1897	8.7	1,600
3.	Kangra Earthquake	Kangra, H.P.	1905	8.5	20,000
4.	Bihar-Nepal Earthquake	Bihar-Nepal border region	1934	8.3	10,000
5.	Assam Earthquake	Assam	1950	8.5	1,526
6.	Bihar-Nepal Earthquake	Bihar-Nepal border region	1988	6.5	1,000
7.	Indo-Burma Earthquake	India-Burma Border	1988	7.3	—
8.	Uttarkashi Earthquake	Uttarkashi, Uttaranchal	1991	7.0	768
9.	Chamoli Earthquake	Chamoli, Uttaranchal	1999	6.8	103
		Andaman Nicobar			
1.	Andaman-Nicobar Earthquake	Andaman-Nicobar Trench	1941	8.1	—
		Kutch Region			
1.	Samaji Earthquake	Samaji, Delta of Indus	1668	X	—
2.	Kutch Earthquake	Kutch, Gujarat	1819	8.0	2,000
3.	Anjar Earthquake	Anjar, Gujarat	1956	6.1	115
4.	Bhuj Earthquake	Bachau, Gujarat	2001	6.9	20,000
		Peninsular India			
1.	Bombay-Surat Earthquake	Bombay-Surat	1856	VII	—
2.	Son Valley Earthquake	Son Valley	1927	6.5	—
3.	Satpura Earthquake	Satpura	1938	6.3	—
4.	Balaghat Earthquake	Balaghat, M.P.	1957	5.5	—
5.	Koyna Earthquake	Koyna	1967	6.0	177
6.	Ongole Earthquake	Ongole, Bhadrachalam	1967	5.4	—
7.	Broach Earthquake	Broach	1970	5.4	26
8.	Latur Earthquake	Latur, Maharashtra	1993	6.2	10,000
9.	Jabalpur Earthquake	Jabalpur, M.P.	1997	6.0	54

Fig. 2: Some damaging earthquakes which have occurred in Himalayan region

3. STRUCTURAL ASPECTS

3.1. Soft Storey

The recurrent increase in open ground storey in urban India for the high parking demand has led to these types of structures to be seismically stable for the future. The lateral stiffness in soft storey is less than 70% of the stories immediately above or less than 80% of the combined stiffness of the three stories above. The part of the building which is structurally soft is the soft storey. These can be especially dangerous in earthquakes, because they cannot cope with the lateral forces caused by the undulation of the building during a quake. As a result, the soft story may collapse, causing what is known as a soft story collapse. Parking garages, for example, are often soft stories, as are large retail spaces or floors with a lot of windows. While the unobstructed space of the soft story might be aesthetically or commercially desirable, it also means that there are less opportunities to install shear walls, specialized walls which are designed to distribute lateral forces so that a building can cope with the swaying characteristic of an earthquake.

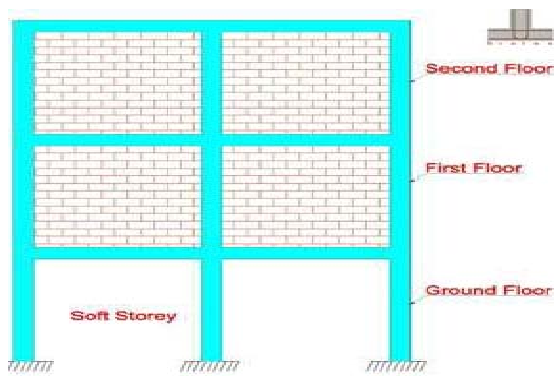

Fig. 3. Soft storey

3.2. Behavior of Column

3.2.1. Design Strategy

Designing a column involves selection of materials to be used (i.e., grades of concrete and steel bars), choosing shape and size of the cross-section, and calculating amount and distribution of steel reinforcement. The first two aspects are part of the overall design strategy of the whole building. The Indian Ductile Detailing Code IS: 13920-1993 requires columns to be at least 300mm wide. A column width of up to 200mm is allowed if unsupported length is less than 4m and beam length is less than 5m. Columns that are required to resist earthquake forces must be designed to prevent shear failure by a skillful selection of reinforcement.

3.2.2. Floating Columns

The balconies are not counted in the Floor Space Index (FSI), thus buildings have overhanging boundaries in upper storey. The perimeter columns of the ground storey are discontinued in the upper stories and floating columns are provided along the overhanging perimeter of the building. (see Fig. 1)

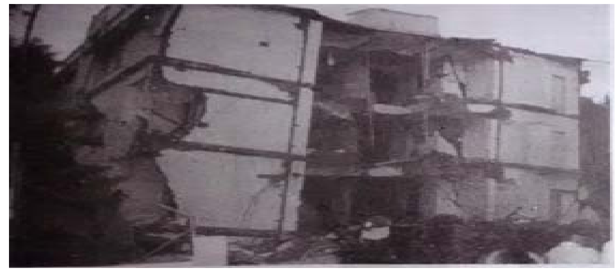

Fig. 4: Failure of reinforced concrete columns with floating columns

Fig. 5: Failure of the reinforced concrete building

4. IRREGULARITIES

During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having these discontinuities are termed as Irregular structures. Size of the building: In tall buildings with large height-to-base size ratio, the horizontal movement of the floors during ground shaking is large. In short but very long buildings, the damaging effects during earthquake shaking are many. And, in buildings with large plan area like warehouses, the horizontal seismic forces can be excessive to be carried by columns and walls. Buildings with simple geometry in plan have performed well during strong earthquakes. Buildings with re-entrant corners, like those U, V, H and + shaped in plan have sustained significant damage.

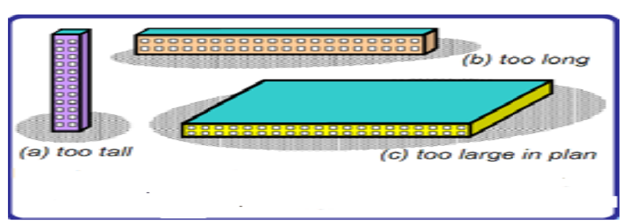

Fig. 5: Building with one of their overall sizes much larger or much smaller than the other two, do not perform well during earthquake"

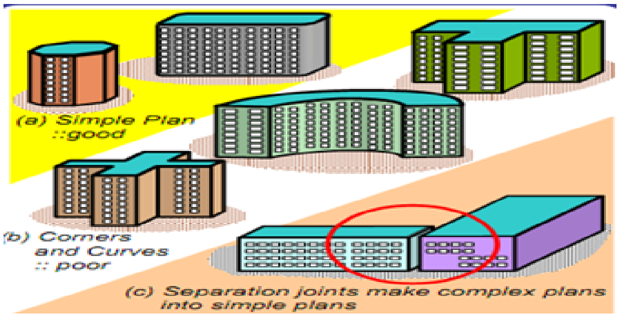

Fig. 6: Simple plan shaped buildings do well during earthquake

5. POOR QUALITY OF CONSTRUCTION MATERIAL AND CORROSION OF REINFORCEMENT

The faulty construction practices and lack of quality control contribute to the damage of buildings. It was observed that the ratio of sand was high. The recycled steel was used as reinforcement. The corrosion of reinforcement bars occurred due to: (a) insufficient concrete cover, (b) poor concrete placement, and (c) porous concrete.

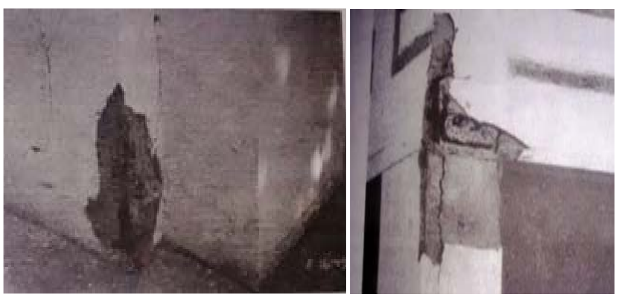

Fig. 7: Damage due to corrosion of steel at column force and at beam column joint

6. CONCLUSIONS

It has been observed that the construction of these buildings in Chandigarh, Himachal Pradesh is increasing considerably and since these areas lies in seismic zone IV and zone V, there is a vast need of the improvement of the construction of these buildings as well as the care while undergoing the execution so that the risk of earthquake damage can be minimized.

1. For RCC framed buildings more than three stories, IS 1893 and IS 13920 must be used.
2. Building shear walls between the open ground storey columns.
3. More care should be given at time of planning. Building with strong-column and weak beam can be achieved at planning stage.
4. Two basic technologies are used to protect buildings from damaging earthquake effects. These are base isolation and seismic dampers.
5. For the masonry buildings, use of lintel band, as suggested by the Bureau of Indian Standards (IS 13828:1993) proves to be a good option [2]. This seems to suggest that additional horizontal bands, possibly at the sill level and at plinth level, are needed [3] this can be explained more clearly with Fig. 8.

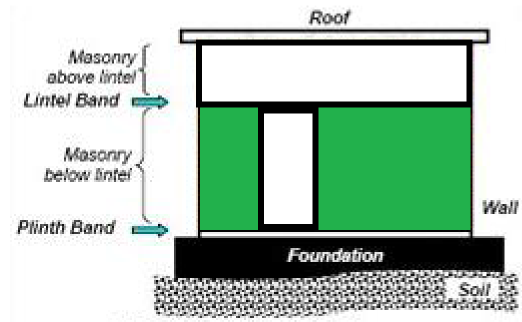

Fig. 8: Building with flat roof

REFERENCES

[1] Murty CVR –*Earthquake Tips*-Indian institute of Technology, Kanpur.
[2] K S Jagadish, S Raghunath and K S Nanjunda Rao- *Behaviour of masonry structures during the Bhuj earthquake of January 2001*.
[3] Jag Mohan Humar, David Lau, and Jean-Robert Pierre- *Performance of buildings during the 2001 Bhuj earthquake.*
[4] Jaswant N. Arlekar, Sudhir K. Jain and C.V.R. Murty(1997), Seismic Response of RC Frame Buildings with Soft First Storeys, Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi