Expected Seismic Performance Of Buildings Located In Waknaghat And Kandaghat Area Of Solan, District

Ankur Thakur[1], Dipali Sharma[1], Parveen Kumar[1], Nikita Gupta[1], Poonam Dhiman[2]

ABSTRACT— The Himalayan belt of India lies near the fault separating Indo-Australian and Eurasian plate. It is but natural that this area is seismically active and lies in zone IV. Despite this fact, most of non-engineered buildings in Himachal Pradesh have poor configurations and construction quality. In this paper, an effort is made to study structural irregularities and construction defects of buildings situated in Waknaghat and Kandaghat (district Solan, HP). Some of the factors which were included in the survey are : offsets, cantilever slab loaded above, setbacks, soft storey, unequal heights of the column , honeycombing, cantilevered slabs loaded above, open ground storey etc. Along with above mentioned defects, other factors like segregation, exposed bars, verticality of columns, poor bricks quality were also acknowledged. An effort has also been made to suggest some remedies for the above mentioned irregularities and defects.

Keywords— Irregularities, Configurations, Exposed bars, Irregularities, Offsets, Soft storey.

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1. INTRODUCTION

IN this paper, an effort is made to study structural irregularities and construction defects of buildings situated in Waknaghat and Kandaghat (district Solan, HP). A building that lacks symmetry and discontinuity in geometry, mass, or load resisting elements is called as irregular building. The purpose of the paper is to enhance our knowledge regarding earthquake resistant buildings, ill effects of irregularities on seismic performance and to suggest possible remedial measures or precautions to be taken at planning or construction stage of buildings.

2. SEISMIC HISTORY

2.1 Soil Type

Fig.1 shows accurance of past earthquakes in the area under study. It shows an intricate mosaic of high mountain ranges, hills and valleys with altitude ranging from 300 to 3000 m above MSL. The altitude of the hill ranges is higher in northern parts whereas south-western part of the district is represented by low denuded hill ranges of Siwalik [1] The soils of the State can broadly be divided into nine groups. These are: (i) Alluvial Soils (ii) Brown Hill Soil, (iii) Brown Earth (iv) Brown Forests Soils (v) Grey Wooded Orpodzolic Soils (vi) Grey Brown Podzolic Soils (vii) Planosolic Soils (viii) Humusand Iron Podzols (ix) Alpine Humus Mountain Speletal Soils. The Soil Found In The Districts Of Mandi, Kangra, Bilaspur, Una, Solan, Hamirpur And Sirmaur Is Generally Brown, Alluvial And Grey Brown Podzolic, Kullu And Shimla Have Grey Wooded Podzolic Soils, While Kinnaur, Lahaul And Spiti And Some Parts Of Chamba District Have Humus Mountain Speletal Soils.

2.2 Past Earthquakes

Large earthquakes (Fig. 1) have occurred in all parts of Himachal Pradesh, the biggest was the Kangra Earthquake of 1905. The Himalayan Frontal Thrust, the Main boundary Thrust, the Krol, the Giri, Jutogh and Nahan thrusts lie in this region. Besides that there are scores of smaller faults, like the Kaurik Fault which triggered the 1975 earthquake.

Largest Instrumented Earthquake in Himachal Pradesh:
(i) 4 April 1905 - Kangra (Himachal Pradesh), Mw 7.833.00 N, 76.00 E, OT=00:50. At least 28,000 people were killed in the Kangra Dharamsala region of

1.ankurthakur1234@gmail.com,dipalisharma373@gmail.com,parveenbarwal123@gmail.com,nikitagupta.714@gmail.com PG students, deptt. Of civil engineering, Jaypee University Waknaghat Solan (H.P)

2. (poonam.dhimanjuit@gmail.com) Jaypee University Waknaghat Solan(HP)

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Himachal Pradesh. Damage and casualties also occurred in adjoining parts of Punjab including in the cities of Amritsar, Lahore, Jalandhar, Ludhiana and Sialkot.

(ii) 28 February 1906 - Near Kullu (Himachal Pradesh), Mw 6.4 32.00N, 77.00E. Damage and casualties in the Bashahr-Shimla hills states.

(iii)11 May 1930 - East of Sultanpur (Himachal Pradesh), 6.0 (TS) 11:30:36 UTC, 31.70N, 77.00E.

(iv) 22 June 1945 - Near Padua, Kathua District, J&K (H.P.-J&K Border region), 6.0 (TS) 18:00:51 UTC, 32.599N, 75.90E

(v) 10 July 1947 - Near Padua, Kathwad District, J&K (H.P.-J&K Border region), 6.0 (TS)
10:19:20 UTC, 32.599N, 75.90E

(vi) 12 August 1950 - Near Padua, Kathwad District, J&K (H.P.-J&K Border region), 6.0 (TS) 03:59:06 UTC, 32.599N, 75.90E

(vii) 12 September 1951 - Chamba-Udhampur Districts (H.P.--J&K Border region), 6.0 (TS)
20:41:48UTC, 33.30N, 76.50E

(viii)17 June 1955 - Lahual-Spiti District (Himachal Pradesh), 6.0 (TS) 10:14:09UTC, 32.50N,78.60E

(ix) 17 June 1962 - Chamba-Udhampur Districts (Himacahl Pradesh-J&K Border region), 6.0 (TS) 04:39:26, 60 UTC, 33.30N, 76.20E

(x) 19 January 1975 - SW of Dutung, Himachal Pradesh (Indo-China Borderegion), Ms 6.8 08:02:02.50,32.455N, 78.430N, 33kms depth.This earthquake struck in the early afternoon of January 19, 1975. It caused havoc in parts of the Kinnaur, Lahaul and Spiti regions of India. 60 people were killed in this sparsely populated region

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(xi) 21 October 1991 - Near Pilang (Uttarkashi District), Uttaranchal, Mw 6.8, 21:23:14 UTC, 30.78N, 78.77EBetween 750 to 2000people killed in the Gharwa l region. It was also felt very strongly in Uttar Pradesh,

Chandigarh, Delhi, Haryana and Punjab. Fatalities were also reported from Himachal Pradesh. Some minor damage was reported in Chandigarh and New Delhi.

(xii) 29th March 1999 - Near Gopeshwar (Chamoli District), Uttaranchal, Mw 6.519:05:11,UTC,30.492N,79.288E 115 people killed in the Gharwal region. The quake was felt very strongly in Uttar Pradesh, Chandigarh, Delhi and Haryana.

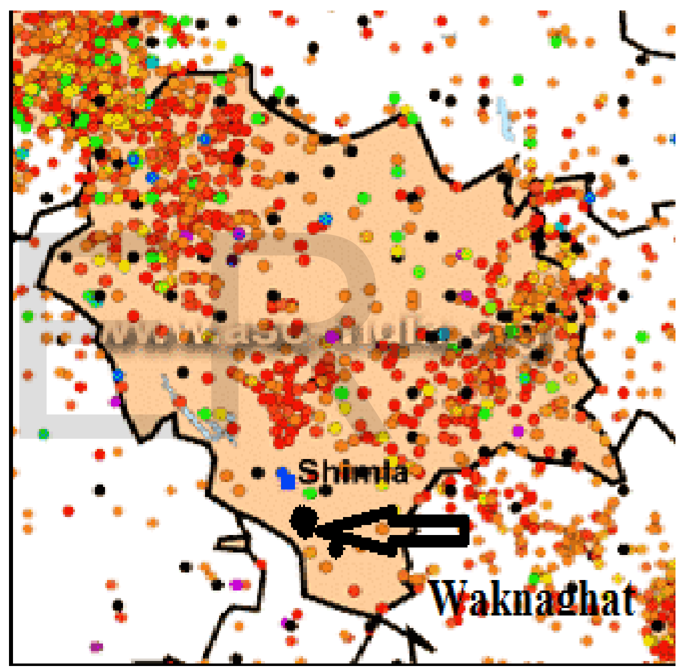

Fig.1. Past Earthquakes in H.P, India

(xiii) 11 November 2004 -Bharmour, Kangra region, Mb 5.1, 32.442 N, 76.512 E, D=34 kms, OT=02:13:45UTC. A moderate earthquake struck the Kangra Valley and the Dhauladhar Mountains on 11 November 2004 at 07:43 AM local time. It was felt strongly in the Kangra-Dharamsala region and event caused minor damage to buildings in the region. Abbreviations used:

D=depth, OT= origin time, Mw = moment magnitude, Ms= surface wave magnitude, Mb= body wave magnitude, Ml= local magnitude.

3. STRUCTURAL IRREGULARITIES

3.1 Offsets

Fig. 2. Offsets

The building shown Fig. 2 is located in waknaghat and is under construction. This buildings has four stories and is made of RCC with brick infill panels. The column under construction has offsets in them. Due to the misalignment of the reinforcing bars in the two columns, during an earthquake, there are chances of sudden failure of this joint. So, at the time of construction, utmost care must be taken to get true vertical line in columns.

3.2 Cantilever Slab Loaded Above

The cantilever portion of the building must be used as free spaces like balconies with less loads. Fig. 8 shows a commercial building located in the marketplace of Kandaghat. It has a cantilever slab that is loaded heavily. Fig. 3 (a),(b) shows a residential house situated in the market of Kandaghat in which the cantilever portion has been used as the living room. The extra weight loaded above proves to be detrimental during an earthquake. In order to correct this defect, in Fig. 8, columns must be provided at the cantilever ends as shown by black circles so that load is distributed uniformly. Whereas, in Fig. 9 the bottom portion of the cantilever must be either provided with one more column or must be covered with walls on the two sides.

Fig.3 (a) Cantilever Slab Loaded Above

Fig. 3. (b)

3.3 Short Column Effect

Buildings on slopy ground have unequal height of the columns (Fig. 4) along the slope, which causes ill effects like twisting and damage in shorter columns

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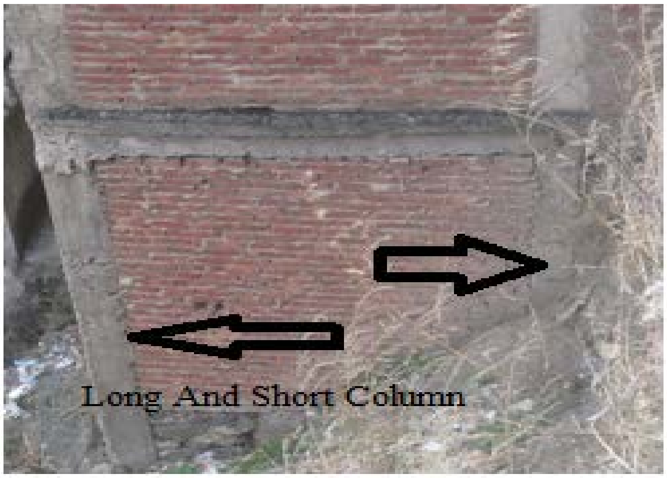

Fig.4. Short column Effect

3.4 Soft Storey

Fig. 5. Soft Storey

A soft storey as in Fig. 5. is one in which the lateral stiffness is less than 70% of that in the storey immediately above, or less than 80% of the combined stiffness of the three stories above. Many buildings with an open ground storey (soft storey) were observed. The essential characteristic of a weak storey consists of a discontinuity of stiffness, which occurs at the second storey connections. This is caused by lesser strength or increased flexibility and also the structure results in excessive deformations in the first storey of the structure, which in turn results in concentration of forces at the second storey level. These stories are more likely to get collapsed or were severely damaged during earthquake.

3.5 Hanging and Floating Columns

Buildings with columns that are hanging or floating on beams of an intermediate storey and not attached to the Foundation so this building have discontinuities in the load transfer Path. Fig. 6 clearly show that the column do not continues up to the foundation and in the middle storey there is hanging column. Due to this, Shear and overturning forces are induced that can leads to the failure of the building.

Fig . 6. Floating Columns

3.6 Set Backs

According to IS 1893 (part 1): 2002, plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15% of its plan dimension in the given direction. Buildings with vertical Setbacks cause two types of problems:

(i) Sudden jump in earthquake forces at the level of discontinuity

(ii) Torsion

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Fig. 7. Setbacks (Re-entrant corner)

5. CONCLUSIONS

There are numerous buildings that are constructed in these locations with a number of structural irregularities in them. Since H.P lies in zone IV and zone V, these areas are more prone to earthquake damage.

Thus, various remedies are suggested to come up with these defects.

1.IS 1893 (Part 1):2002 must be followed strictly in order to sustain earthquake damage.

2. Ductile detailing using IS13920 should be mandatory.

3.The general solution for a structure with setback is that the building must be divided into different blocks with a separation joint at the junction.

4.More care is necessary at the time of planning for reducing these irregularities.

5.The torsional effects ina building can be minimized by proper location of vertical resisting elements and mass distribution.

6.Shear walls must be properly employed for increasing the stiffness where ever necessary and must be uniformly distributed.

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