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Lessons From Jan, 26, 2001 Gujrat (India) Earthquake

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SUMMARY

Authors have done extensive post earthquake survey of Jan 26, 2001, Bhuj earthquake. Based on the post earthquake survey, important points are highlighted.
In this paper both types of buildings i.e. a) Load bearing & b) Framed structure are considered.

a) **Load bearing buildings**: - Importance of provision of various bands for load bearing building, such as band at sill level, lintel level etc. are explained with the help of actual field problem. Reasons for failure of various buildings are explained, with the help of photographs. Some buildings in the epicentral area were found to be in the intact condition. The salient features of these buildings are highlighted, so that these points can be kept in mind for future construction.

b) **Framed structures**: - Wide spread destruction of framed structures was observed. Framed structures collapsed even at locations 250 to 300 kms away from epicenter.
It was observed that wherever there was violation of codal provision, large-scale damage or collapse was observed .Several cases are explained with the help of photographs & figures.
Important reasons behind the failures are 1) Short column effect 2) Flexible ground floor (soft story) 3) Lack of proper detailing 4) Poor Workmanship 5) Ponding effect 6) Appendage effect.

INTRODUCTION

During visit at Anjar,Bachau, Kandla, Bhuj, Madhaapur and other places it is prominently seen that the collapse of the major buildings is on account of lack of knowledge of relevant codes and or ignorance. The various cases are highlighted with the help of field examples and classified as load bearing structures and framed structures. “Kutch” is in zone V of earthquake map of India as per IS 1893. There is a possibility of major earthquake in this area. IS code has recommended various measures for load bearing and framed structures.

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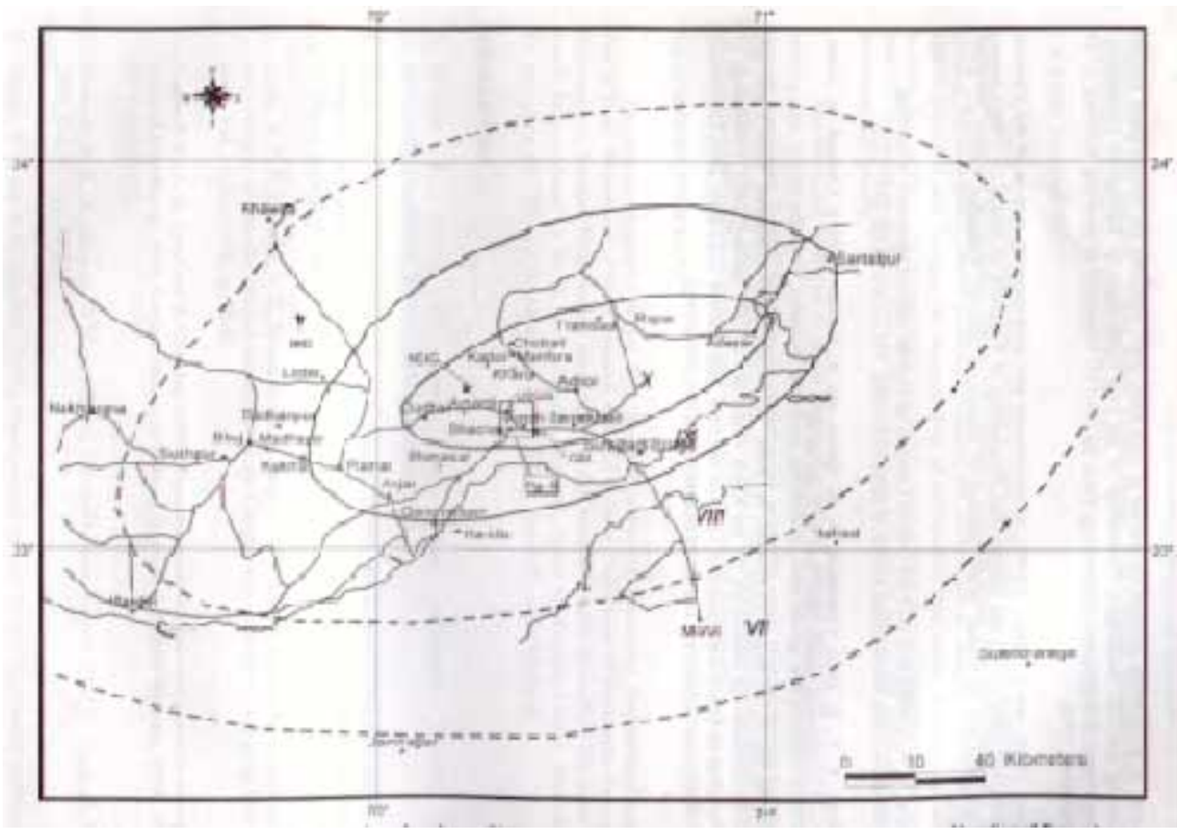

Fig. 1 Isoseimal Map Of Bhuj Earthquake (4)

LOAD BEARING STRUCTURE –

The load bearing structure consists of coursed or uncoursed rubble masonary, plinth, superstructure of brick walls / stonewall and roof in the form of slab. In earlier days Teakwood beams with teak planks with clay layer at its top were provided in place of slab. As far as code is concerned, it is mentioned that these elements should be properly tied at the various levels so that the building must act as one unit. The response of load bearing structure is explained with the help of photographs.

Photo No. 1 : Total Collapse at Bachau 18 Km. From Epicenter.

The reasons for failure are given below:-

a) The masonry wall, mainly in mud morter.

b) Absence of connecting band.

c) No through stone were provided.

d) Heavy mass concentration at roof level.

e) Buildings were close to each other.

f) Unsymmetric buildings, due to full opening at its front resulting into torsional moment on the buildings

Photo No. 2 : Intact Two Storied Load Bearing Structure At Madhapur.

Photo no.3: Intact Single Storied Load Bearing Structure of Railway quarters At Aundh, 20 km from epicenter

Above buildings are perfectly alright without any damage. The reasons are listed as follows –

a) Symmetric building.

b) Structure with bands at sill level, lintel level.

c) Appropriate size and location of the openings.

d) Quality workmanship

FRAMED STRUCTURE

Considering earthquake forces as per codes, correct analysis, design and detailing of the frames are required to make frame structure earthquake resistant. It is seen that in the megacity of Ahmedabad and Bhuj, major failures are occured due to violation and or ignorance of codal provisions. Important reasons for the failure are (1) Short column effect (2) Flexible ground floor (Soft storey) (3) Lack of proper detailing (4) poor workmanship (5) Ponding effect (6) Appendage effect

Photo No. 4 : Total Collapse Of Framed Structure At Bachau

In case of shopping complex, large corridor is always provided .To some extent this converts the corridor portion in soft storey. In this structure, front beams are provided at 2.4 meter height.(Floor height. is 3.60 meter). The column is converted in to a short column, thereby attracting large earthquake forces. Due to unsymmetrical distribution of partition walls, torsional moments are developed. Combined effects as mentioned above result into a total collapse as seen in photo no.4.

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Photo No. 5 : Total Collapse Of Framed Structure At Ahmedabad (Mansi Tower)

Ahmedabad is located at 250 km away from the epicentre. Photograph shows Mansi tower which consist of four blocks and one of the block is totally collapsed. It is seen that on this block a swimming pool was constructed at its top, which resulted into unsysmmetry and heavy mass concentration at the top of the structure. Large mass at the top means large inertia forces developed at the top level. This resulted into the failure of particular block of Mansi tower.

Photo No. 6 : Total Collapse Of Framed Structure At Ahmedabad (Shikhar tower)

Photo No. 7: Exposed footing and column of framed Structure At Ahmedabad (Shikhar tower)

Shikhar Tower is 10 storied structure whose foundations rest on yellow soil. One of the 4 wings of the tower has literally come down with a death toll of 98. The reasons for the failure are as follows –

a) Building was not properly designed. Size of column and reinforcement are not adequate even for gravity loads.

b) Looking at the photograph 7, it is clear that the size of footing is insufficient for the strata available. From this failure, one is confused whether the structure was designed or not.

Photo No. 8 : The First Floor Looks Like Ground Floor (Hostel At Kandala Port)

Phot No. 9 : Circular column for parking (Ground floor) after failure

Parking is generally provided on the ground floor. Being meant for parking, no partition walls are provided thereby lacking an inherited stiffness due to the infilled walls. Large moments are developed due to earthquake forces at the ground floor. Due to this, plastic hinges are formed at beam columns joint in the column , at the plinth and floor level because of this, the ground storey column are crushed. It can be seen in photo No. 8 & 9 . In epicentral area, most of the RCC framed structures with parking have faced this problem. To avoid this type of failure, special analysis given in code must be adopted .

Photo No. 10 : Improper Detailing At Beam Column Joint.

Detailing plays important role in earthquake resistant design. If detaling is not proper then brittle failure is prossible. Photo no. 10 shows beam column Joint for the building at Bachau. The reasons can be as follows

(a) Discontinuous bars.

(b) Insufficient lap length provided for bars in column and beams.

(c) No lateral ties and stirrups are available at junction where there is large demand of confining steel.

(d) Over lap to all column bars are provided at critical point.

(e) Poor workmanship

Photo No. 11 : Perfect RCC Framed Structure At Bhuj.

Photo shows five-storied RCC framed building, which remains in intact condition even after severe earthquake of magnitude 7.3. The possible reasons are as follows.

a) Symmetric structure.

b) Proper structural design.

c) Proper detailing.

d) Codal provisions strictly followed.

CONCLUSION

By and large it is seen that the buildings, where earthquake resistant principles were followed, have suffered no damages or very little damages.

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