A Study on Seismic Vulnerability Assessment of a College Building in India

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ABSTRACT----*The greatest damage to human life and property are caused by earthquakes, they are nature's greatest hazards. Since earthquakes aren't preventable we need to design and construct structures that are earthquake resistant. Rehabilitation and mitigation measures are few of the primary measures adopted in many developed countries. In developed countries like Japan the damage caused due to moderate to severe earthquakes are minimal which implies that earth resistant construction techniques are implemented to curb any loss of life and property.*

In India there are about 80-90% of buildings which are non-engineered and are much vulnerable to damage due to earthquakes. In the state J&K presently the earthquake problem is the most important issue to be given serious consideration as it devastates societies. The Kashmir region has witnessed frequent earthquakes in the past. But the recent earthquakes demonstrated how extremely vulnerable the buildings in this region are. These earthquakes shook the confidence of many Kashmiri in local building materials and even in the techniques they had been using for centuries.

This paper presents the survey analysis that is the immediate reaction of the people towards frequent earthquakes in the state. There has been a strong desire to abandon traditional architecture and building systems and adopt cement and steel based construction, but still there are large number of people whose spine has not shaken yet and while construction they do not seem to be aware of threats posed by earthquake. During our interactions with the people we concluded that the main reasons behind their negligence is lack of proper seismic knowledge among skilled workers like masons, carpenters, bar binders and lack of attention shown by government officials. At times even the practicing engineers are not adequately familiar with details of seismic resistant construction.

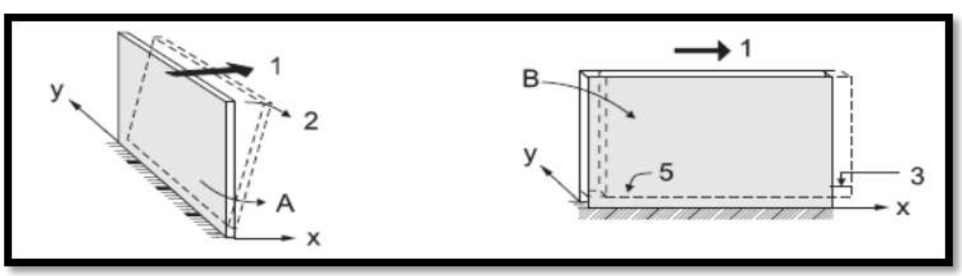
Key Words----*Damage, Engineered Buildings, Rehabilitation, Mitigation Measures, Seismic Vulnerability, Earthquake Resistant Construction.*

I. INTRODUCTION

The major earthquake which took place in October 2005 caused heavy losses in the state of Jammu and Kashmir due to the collapse of residential and industrial buildings. Implementation of earthquake resistant construction techniques in new buildings is possible but 90% of all structures that already exists cannot be redesigned there is a grave need for retrofitting of structures especially the structures of higher importance for example schools, hospitals etc., unsafe buildings cause loss of life and property and due to lack of proper shelter facilities in the freezing weather, life becomes miserably pathetic[1], [3] ,[9] & [10]. Hence the major concern isn't just designing seismically safe structures but also implementing new and improved retrofitting techniques to make the present buildings structurally safe in high earthquake prone areas[2].

II. BEHAVIOUR OF MASONRY BUILDINGS TO GROUND MOTION

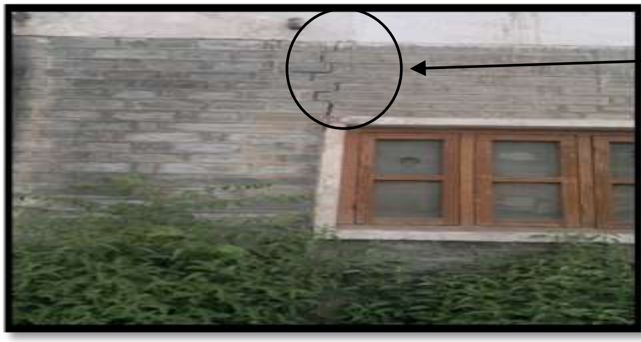
Ground vibrations during earthquakes cause inertia forces at locations of mass in the building. These forces travel through the roof and walls to the foundation. The main emphasis is on ensuring that these forces reach the ground without causing major damage or collapse. Of the three components of a masonry building (*roof*, *wall* and *foundation*) (Figure (a), the walls are most vulnerable to damage caused by horizontal forces due to earthquake. A wall topples down easily if pushed horizontally at the top in a direction perpendicular to its plane (termed *weak direction*), but offers much greater resistance if pushed along its length (termed *strong direction*) [Figure (b)][7].



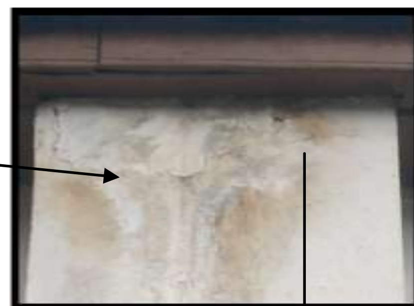
1 - Earthquake force
2 - Overturning
3 - Sliding

FIG. (a) Flexural wall FIG. (b) Shear wall

III. CATAGORISATION OF EARTHQUAKE DAMAGE STAGES IN LOAD BEARING MASONRY WALLS



Stage I of Earthquake. damage[1]

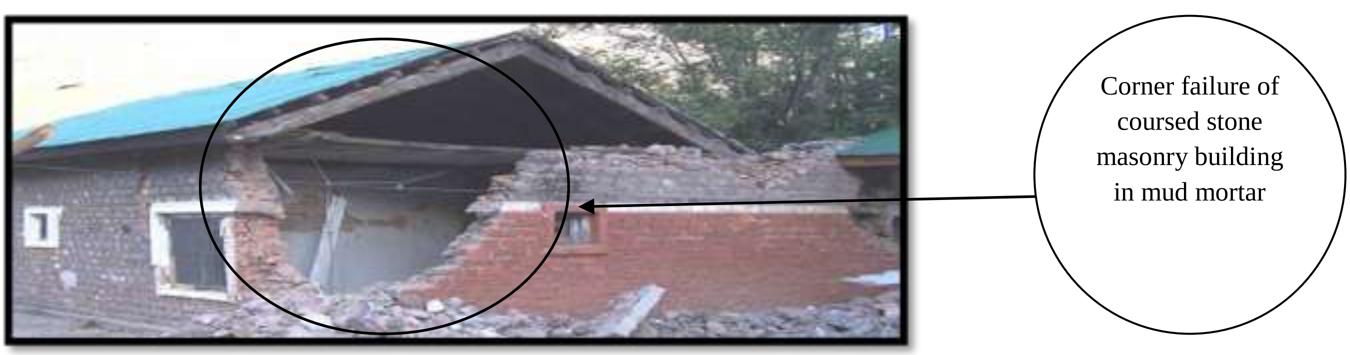


Stage I of Earthquake. Damage[1]

Stage II of Earthquake. Damage[1]

Stage II of Earthquake. Damage[1]

Stage III of Earthquake. Damage[1]



Stage III of Earthquake. Damage[1]

Total collapse

Stage IV of Earthquake. Damage[1]

IV. CASE STUDY

The importance of case studies are always evident because of the great amount of information they bring. The purpose is always learning from the implemented mistakes and renewal of old techniques in construction, it also brings relevant information into picture which is very important for rehabilitation of structures.The present case study involves a very important public building an eight class room building at science college Gogjebagh.

View the Class room Block

Some of the sailent features of this building are

- It is an important masonry building.
- It is a typical two storey building with eight class rooms. The construction of second storey is in progress.
- The construction of class rooms for Science College is going on under the supervision of JKPCC.

V. SALIENT FEATURES IN ACCORDANCE WITH CODES (IS 4326-1993, IS 13828-1993)

A. Lightness

Since the building is masonry, it cannot be that light in mass. However they have tried their level best to make the building as light as possible as well as consistent with structural safety and functional requirements. The upper storey wall is only one brick(250 mm) thick compared to ground storey wall which is one and a half brick (350 mm) thick.

B. *Projection And Suspended Parts*

Structural projecting parts are absent. Since it is a college building, there will not be much suspended parts after construction.

C. Building Configuration

The building is symmetrical in elevation. In plan it is not perfectly symmetrical. Besides the building is somewhat I shaped in plan which complicates the seismic behavior of the building and increases stress concentration by maximizing the torsion. The shape in the plan should have been changed into three rectangular blocks by the provision of separation section at appropriate places.

D. CONTINUITY OF CONSTRUCTION

All the parts of the building have been tied together and they will act as one unit during earthquake. However during construction, the various parts were not constructed as per codal recommendations as shown in Figure C as such there may be a lack of coherence between the parts during earthquakes.

E. Opening in Bearing Walls

Window openings are large in size which weakens walls from carrying inertial force in their own plane. Furthermore the total area of opening exceeds 40% of area of wall which is not in accordance with code.

F. Horizontal Bands

- Lintel band.

Lintel band has been provided on all the internal and external longitudinal as well as cross walls. The main reinforcement is 12 mm diameter 3 bars and the stirrups are of 10 mm diameter @ 175 mm C/C.

- Plinth band

It has been provided on top of foundation wall and will be effective during earthquakes as it is continuous.

- Sill band

Sill band has not been provided.

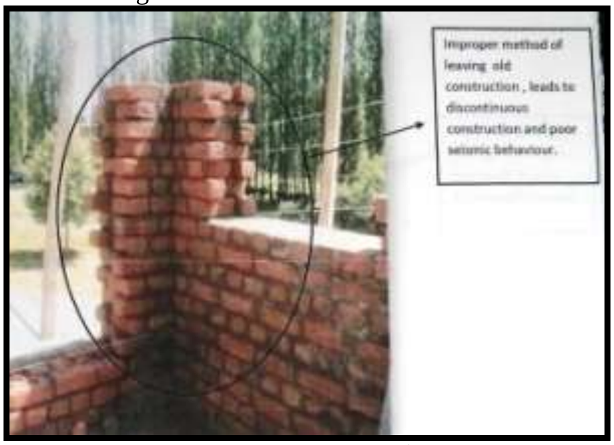


FIG C Construction of the corner joint

FIG D Misplaced vertical bar at the corner

G.Vertical Reinforcement

Vertical Reinforcement has been provided at the corners and the junctions of walls. One HSDB bar of 16 mm diameter has been used in the ground storey and 20 mm diameter has been used in the first storey which is not right as shown in Figure D. The vertical reinforcement has been embedded in the plinth wall of the foundation and slab passing through lintel band. Vertical Reinforcement is absent at the jambs of the windows and doors.

H. Workmanship

The quality of workmanship in brickwork is not so good, the structure being unengineered and also lack of proper planning has resulted in settlement of the building during 2005 earthquake which led to formation of cracks as shown in figure below. Lack of proper workmanship

I. Brick Nogged Timber Frame Construction

The wall construction does not consist of timber studs and corner posts framed into sills, top plates and wall plates.

VI. CONCLUSION

In all domains of civil engineering the most prominent aspect is always the safety as serviceability of the designed structure which is main feature of the Indian standard code. But as far as implementation of the codal provisions is concerned we are severely lagging behind. Hence importance and awareness of earthquake resistant construction techniques should be created also it should be made mandatory to implement techniques against seismic forces by the designers. Therefore to implement codal provisions and follow systematic guidelines and parallely optimize the construction cost is the need of the hour. Economy and financial feasibility is of equal importance in a developing nation like ours. Considering the case studies the above can be easily validated.

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