Identification of Seismic Damages in Reinforced Concrete Structures & There Recommendations

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Abstract

“Earthquake do not kill people, it is the structure made by them that do so”. In today’s world, we are heartrending towards globalization as a result of which the basic necessities of day to day life are bound to improve. Same practice is implementing through spectacular means of transportation of different places by providing flyovers, tunnels, subways etc. Because of urbanization, though these rudiments have become the necessity, we are going against nature. We are constantly disturbing the earth crust to facilitate these privileges. These facilities of today may cause some harmful defects to our coming generation by means of destruction through Earthquakes, Tsunami etc. Some measures should be taken in such a way that this progress should also not stop and simultaneously, the destructions should also not harm the lives. As an Architect, my aim of this paper is to enlighten the basic necessities and recommendations for framed structures which can hold a particular rector of earthquake without destruction. The following recommendations for a framed structure (Reinforced Concrete Structures) may avoid the loss of life and property.

Keywords: Earthquake, Floating Columns, Soft Story, Pounding, Separation Gap, Shear Walls

I. INTRODUCTION

An Earthquake occurs due to the traceable shaking of the surface of the earth due to sudden release of energy in the earth’s crust that creates seismic waves. The disturbed point under the earth crust is known as Hypocentre, through which vibrations are spread in all the directions and creates disturbance. Our earth crust is producing more than 10,000 earthquakes every year of minor and major intensities. Since these earthquakes are unpreventable, we should design earthquake resistant structures to avoid loss of property and life. Earthquakes are caused mainly of three different reasons i.e. Tectonic caused, volcanic causes and artificial disturbance (Man–made disturbance). Nuclear test and explosion, mining blast in mining areas, massive landslides along hill slope, large and deep excavations, vibrations due to heavy machinery used in industries are the main reasons of artificial or man-made causes of earthquakes. It is observed that 90 percent of total earthquakes are the reasons of tectonic causes. In India, destruction due to earthquake caused in Bhuj and Latur are the reasons of tectonic earthquakes.

Fig. 1: Indian Seismic Map

According to seismic zone map, India is divided into five different zones as per the proposed destruction due to earthquake. Fig.1 describes the different zones in which red coloured zone-V is considered as the most risky zone and all precautions should be taken before starting any construction to make a proper earthquake resistant building.
II. NEED OF STUDY

Presently, due to excessive growth in population, industrialization and globalization, modern techniques in every field are invented to fulfill the needs and demands of public. New inventions and ideas should be implemented taking into considerations that they will not harm the present working of the environment. Going against nature today or tomorrow is going to have worst effect on the society, which should be stopped abruptly. My focus through this paper is to highlight the general guidelines and recommendations which should be followed by Architects, Civil Engineers and general public to retain a RCC Building against an earthquake of high magnitude to stop the loss of life and property.

III. RESULT OF WEAKNESS IN RC FRAMED BUILDINGS

In these types of buildings reinforced concrete frames are provided in both principal directions to resist vertical loads and the vertical loads are transmitted to vertical framing system i.e. columns and Foundations. This type of system is effective in resisting both vertical & horizontal loads. The brick walls are to be regarded as non-load bearing filler walls only. This system is suitable for multi-storied building which is also effective in resisting horizontal loads due to earthquake. In this system the floor slabs, generally 10 0-150 mm thick with spans ranging from 3.0 m to 7.0 m. In certain earthquake prone areas, even single or double storey buildings are made framed structures for safety reasons. Also the single storey buildings of large storey heights (5.0m or more ) like electric substation etc. are made framed structure as brick walls of large heights are slender and load carrying capacity of such walls reduces due to slenderness.

Following are the main weakness in reinforced concrete framed buildings with their recommendations:-

A. Soft Storeys

A typical soft story is referred to that part of building of three or more stories having only columns with large openings on ground floor level such as parking garages or series of retail business centre. The damages are due to buckling of column of open storey and result in collapse of that structure. In these situations, to retain the structure from collapse, the three main recommendations suggested are as discussed and shown in fig.2.

Large openings at the stilt level should be filled with brick walls especially at the four corners of the structure.

Shear walls should be provided at all the four corners to strengthen the structure. These shear walls will start from the foundation till the top of the structure.

Cross RCC Bracing at the stilt level should be provided in such a way that the columns should be tied to each other at base and top of the column. These bracing of columns is recommended at the four corners of the structure.

B. Floating Columns

The floating column is a vertical member which rest on a beam and doesn’t have a foundation. Floating column acts as a point load on beam and its beam transfers the load to the column or vertical member below it. Cantilevers in the upper floor overhangs up to 1.2-1.5 meter beyond column of the ground floor. These floating columns are provided resting at the tip of overhanging cantilever beams. Because of less strength and unequal distribution of load of joints in between two adjoining floors, failure of beams and columns are likely to happen. Appropriate guidance from structural consultant is required before providing floating columns on the upper floor.
C. Damage due to Infill Walls

The infill wall is the supported wall that closes the perimeter of a building constructed with a three-dimensional framework structure (generally made of steel or reinforced concrete). Therefore, the structural frame ensures the bearing function, whereas the infill wall serves to separate inner and outer space, filling up the boxes of the outer frames. The infill wall has the unique static function to bear its own weight. The infill wall is an external vertical opaque type of closure. With respect to other categories of wall, the infill wall differs from the partition that serves to separate two interior spaces, yet also non-load bearing, and from the load bearing wall. The latter performs the same functions of the infill wall, hygro-thermically and acoustically, but performs static functions too.

At the time of earthquake, the reinforced concrete frames deforms first and cracks appears on the plaster along the contact of infill wall with frames. As cracks becomes larger, it penetrates into masonry and results into separation of infill walls.

D. Plan and Mass Irregularity

Complex shapes should be avoided as irregular shapes of the buildings causes discontinuity in the path of transfer of inertial forces. Plans with symmetry on both the axis is preferred an asymmetrical are subjected to twist or torsion during earthquake and causes more damage. Simple shapes like H, L, T, E, U etc. behaves better in earthquake than complex shapes. These simple shaped buildings can be broken into rectangular blocks with the help of separation gap or expansion joint. This joint provides freedom to the structure to balance at the time of earthquake and varies from 3-4 cm and starts from plinth level till the top of construction point. The gap is then further filled with rubber sealant.
E. Poor Quality of construction material and Corrosion of Reinforcement

Buildings materials used in the construction should be of approved quality and brand. In all types of buildings, whether they are load bearing, framed structures or composite, materials used in the construction plays a very vital role. Slackness in quality of building material will always have worst effect on building. Some of the main recommendations to be followed are: -

1) Inferior quality of steel and water will result in the corrosion of reinforced bars which further results in spilling of cement from the walls and roofs.
2) Poor quality of cement and bricks used should be avoided.
3) Inadequate proportion of cement, sand and aggregates in foundations, masonry, columns and slab results in poor and low-grade quality of construction.
4) Wrong placement of reinforcement bars should be avoided. The structure should neither be too heavily reinforced nor too light to resist against natural nor man made disturbances.

F. Pounding Damage

The occurrence of structural pounding in major cities is caused by insufficient gap between adjacent buildings. As a result, buildings will have larger deformation due to high amplitude of impact force. Pounding is a highly nonlinear phenomenon and a severe load condition that could result in high magnitude and short duration floor acceleration pulses in the form of short duration spikes, which in turn cause greater damage to building contents. Pounding is critical on the responses of the stiff system, especially when the system is highly out-of-phase. Essentially, in-phase systems exhibit displacement amplifications that are much closer to one, independent of model type. The pounding effect can be reduced in two ways:

1) By placing elastic materials between adjacent buildings or by reinforcing structural systems with cast-in-place reinforced concrete (RC) walls.
2) By providing a safe separation distance between adjacent.
The majority of reinforced concrete columns are subjected to primary stresses caused by flexure, axial force, and shear. Secondary stresses associated with deformations are usually very small in most columns used in practice. These columns are referred to as "short columns." Short columns are designed using the interaction diagrams presented in this chapter. The capacity of a short column is the same as the capacity of its section under primary stresses, irrespective of its length.

These short column arises when many closely spaced windows and masonry walls are built. At the time of earthquake, upper end undergoes displacement same as the regular column. The infill walls made up of bricks restricts horizontal movement of lower portion of short column.

**H. Damage of Overhead Water Tank and Parapet**

Overhead water tank provided at the roof level is many times not properly tied with the roots of RCC slab of the structure. This structural member experiences inertia forces due to heavy weight and heights which further results in the collapse at the time of shaking. The piers of the overhead water tanks should be of reinforced concrete cement (RCC), connected properly with the beams and bars of adjoining RCC slab as per the approved design by structural engineer.

**I. Damage to Staircase Block**

Stairs, in particular, are critical in the safe evacuation of buildings. In the case of major earthquakes, the stairs and ramps can be exposed to forces and displacements significantly more severe than those of everyday loads. During earthquakes the floors move horizontally, relative to each other, known as “inter storey drift”. Review of current and previous Loading Standards shows that inter storey drifts that stairs need to sustain are underestimated. This is clearly one of the reasons for the observed collapses. Inadequate assessment of inter-storey drift in earthquakes may result in either:

1) The stiffness of the buildings being locally increased by the stairs transferring forces between floors. The resultant interaction between the stairs and other structural elements may cause the building to deform in ways that were not envisaged by the designer. For example the added local strength and stiffness may introduced higher structural actions into elements causing a non-ductile failure to occur, or alternatively the change in stiffness may induce adverse torsional displacements, about the vertical axis of the building, which cause premature failure of columns due to the increased deformation imposed on them;
2) The structural actions induced in the stairs may cause the stairs to collapse or the forces transferred to the landings may cause these elements to fail;
3) The stairs may lose support and collapse.

In many buildings, failure of staircase is the major cause of damage at the time of earthquake. These staircase blocks are required to be tied with the adjacent slab, columns and beams in such a way that these should acts as an individual component. Two aspects are required to be covered in case of staircase design: - IS 13920:1993 & IS 1893(1):2002.

IV. CONCLUSION

In today’s era, innovation are appreciated and instigated with a very debauched rate. But their distresses are over looked which are resulting in many natural disasters like earthquake, tsunamis etc. which are disturbing the earth crust very often as compared to the older times. As far as the construction of buildings is concerned, as an Architect, it becomes our primary duty to highlight the general guidelines to be followed before starting any construction to our client. These references for RCC buildings, as mentioned in this paper, are required to be followed by Architects, Civil Engineers and Client to withstand their construction against seismic damages. These references will not only safeguard the building but also the life of the people living in.

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