Evaluation of the Codal Provision for Asymmetric Building

Priyanshu Chandrakar[1], Kirti Sahu[2]
[1,2] *Civil Engineering, Kalinga University, Naya Raipur, Atal Nagar, Chhattisgarh*

***Abstract* - The research on asymmetric buildings has been extensive primarily focusing on the stability of a structure when subjected to earthquake. Based on them numerous guidelines are laid out for to make sure safety. I have during this paper tried to guage the effectiveness of the rules provided within the IS: 1893 (2000). Asymmetric buildings are more common now than they have ever been and their popularity has been growing primarily due to the functionality they provide. Due to the frequent earthquakes that India suffers being at the junction of two tectonic plates it has become increasingly important to review Indian buildings for seismic safety. The buildings are analyzed supported the effect of torsion which is that the main explanation for damage for Asymmetric Buildings.**

***Index Terms* - Asymmetric Building, Mass Eccentricity, Dynamic Analysis, Pushover analysis, Torsional Rigidity**

1.INTRODUCTION

The engineering challenges from major earthquakes in the Indian context cannot be overemphasized. More than about 60% of the acreage is taken into account susceptible to shaking of intensity VII and above (MMI scale). In fact, the whole Himalayan belt is taken into account susceptible to great earthquakes of magnitude exceeding 8.0, and during a short span of about 50 years, four such earthquakes (in Assam (1897), in Kangra (1905), in Bihar-Nepal (1934) and in Assam Tibet (1950)) have occurred (Jain and Nigam 2000). Although earthquake engineering applications started quite early in our country, extensive damage during several moderate earthquakes in recent years (Shekhar et al. 2004) indicate that earthquake risk in the country has been increasing alarmingly and that there is significant scope of improvement in our design codes.

In India, IS1893 (BIS 2002) is the main code outlining seismic design provisions. For low-rise structures (<40 m high) the code focuses the planning approach aboard shear and its distribution to varied floors of a building in the same static sense (either taking the primary mode of vibration of a cantilever column, or through a modal analysis taking into account the first few modes). An effort has been made in this paper to study the actual response of three low rise 2-D steel moment-resisting frame structures (designed to IS1893 and IS800 (BIS 2007) provisions) to two recent earthquake records (1991 Uttarkashi as captured from station Bhatwari and 2001 Bhuj as captured from station Ahmedabad), to find their yield and ultimate capacities through full dynamic analyses, and to match the results with the codal provisions.

2.METHODOLOGY

1. G+3 and G+8 Reinforced concrete framed structures were modelled in Etabs. Keeping this model as a standard, T and L shaped structures were modelled.
2. The structures were loaded as per IS 875: 1987 and analyzed as per IS 1893:2002.
3. Seismic analysis was performed using Seismic coefficient method as well as the response spectrum method.
4. The maximum storey displacement, storey shear and overturning moments were determined and compared.
5. Shear walls were added to the T- and L-shaped G+8 -buildings and analysed similarly as an attempt to reduce the seismic response parameters. The response parameters so obtained were compared to that of buildings without shear walls.

MODELLING

A G+3 and a G+8 reinforced concrete structure symmetric in plan model were generated in Etabs. With an equivalent floor area, L and T shaped models were also created. The size of the frame was determined by a preliminary design carried in the software.

The details of the model are as follows:

Grade of concrete	M25
Grade of steel	Fe415
Height of each storey	3.5M
Area of plan	350 m2
Size of columns for G+10 structure	450mmx450mm
Size of columns for G+4 structure	400mmx400mm
Size of beams	300mmx500mm
Thickness of staircase slab and landing	150mm
Depth of foundation for G+3 structure	1.5m
Depth of foundation for G+8 structure	2.5m

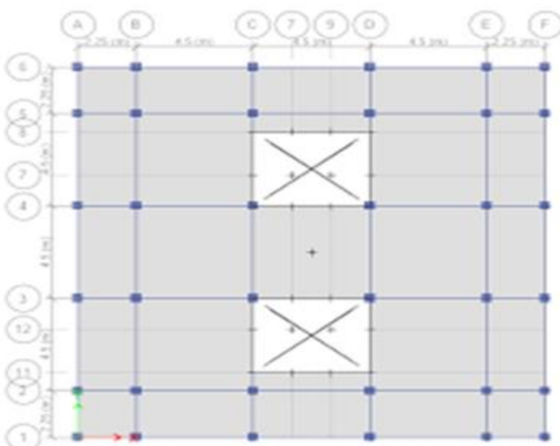

Fig. 1

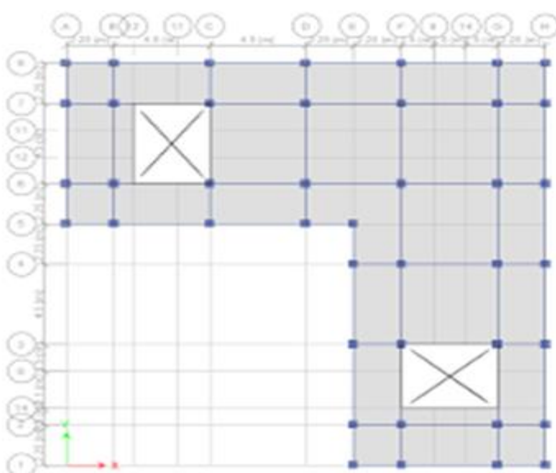

Fig. 2

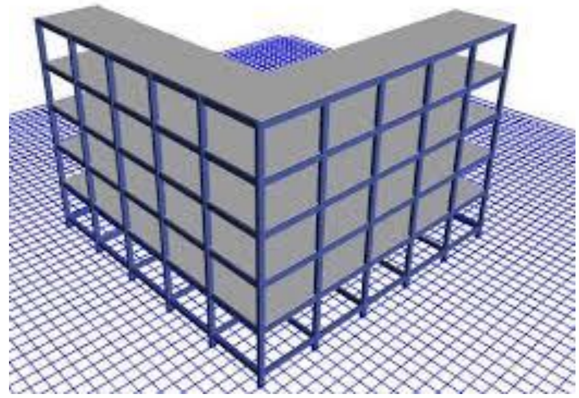

Fig. 3

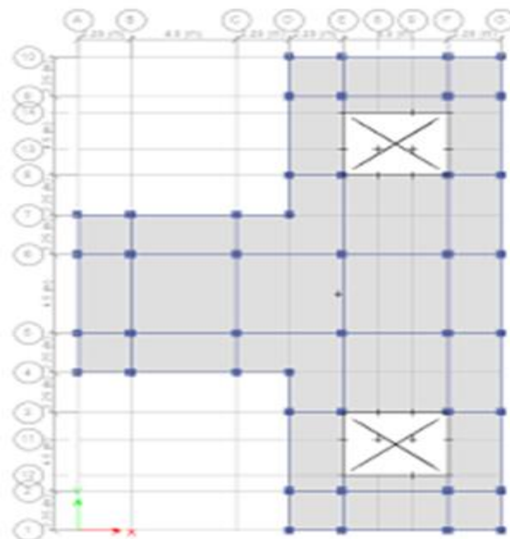

Fig. 4

2.1 Position of Shear Wall

In this current study, 2 locations of shear walls are in corporate with in the design method.

1.At First, shear walls formed within the extreme end position within the external frame of the building, the shear walls providing having L shape in the outer frame of the building, and additionally elevate well sortshear wall is providing at the centre frame of the building.

2.At second, shear walls providing within the interior frame of the building, equally L formed shear walls should be providing at the acute corners of the frame and additionally the centre position of structure is given with lift well.

ANALYSIS

The modeling for structure was done using SAP 2000 and the analysis is being conducted in ETABS building design and other analysis were also conducted with ETABS. There are two structures (models) which is taken one is of 8 storey with height 24.5m with 4 bays in the X direction of spans lengths of 5m at the 2 spans at the periphery and therefore the central span is about 4m long. The structure has 3 spans in the Y direction with the 2 spans at the periphery being 5m each and the central span is about 4m in length. The assumed materials are Concrete of grade M30 and therefore the Steel is Fe 415. The Beams are considered to possess a cross-section size of about 350x600m and therefore the columns are made from an equivalent cross section sizes with the longer side along the longer span. The Structure is loaded with a super load of about 3KN/m2 as per the super load requirements for a residential building as per IS 845 Part II. The load was applied to the center of mass at the first try for symmetric building. The center of mass (CM) was then applied at some extent 1.9m faraway from the centroid of the structure. The design of the structure was designed in ETABS as per IS: 456. The designed reinforcements were then taken imported into the SAP 2000 software and Pushover analysis was conducted on the structure. The Hinge used in the model was based on FEMA 356 for the respective columns and beams. The Degrees of Freedom for the Beams was M3 and for the Columns was P-M2-M3. The Pushover analysis is then conducted, and the occurrence of hinges is observed. Two Load Cases were constructed to conduct the analysis in both directions the force is applied as acceleration.

3.LITERATURE REVIEW

Saha (2016) In case of asymmetric buildings the center of stiffness and the center of mass does not coincide with each other. Therefore, torsional moments arise when the structure is subjected to dynamic earthquake loads. Therefore, it is not safe for buildings to be asymmetric in nature. The moments and all other forces are much higher in asymmetric buildings, as a result the design dimensions of the members are higher in case of asymmetric buildings.

Basu et al. (2004) A rigid floor diaphragm is a good assumption for seismic analysis of most buildings, several building configurations may exhibit significant flexibility in floor diaphragm. However, the issue of static seismic analysis of such buildings for torsional provisions of codes has not been addressed in the context. Apart from, the concept of center of rigidity needs to be formulated for buildings with flexible floor diaphragms. In this paper, the definition of center of rigidity for rigid floor diaphragm buildings has been extended to asymmetrical buildings with flexible floors. A superposition-based analysis procedure is proposed to implement code-specified torsional provisions for buildings with flexible floor diaphragms. The procedure recommends considering amplification of static and accidental eccentricity both. The approach is applicable to orthogonal as well as non-orthogonal asymmetrical buildings and account for all possible definitions of center of rigidity.

Peethambaram et al. (2008) Natural hazard like earthquake affects the stability of such structures which are restricted to expand vertically not horizontally. Performance of structures in different areas of Northern part of India, during the earthquakes, is reviewed. The behavior of a building during earthquakes depends critically on its overall shape, size and geometry. Nonlinear pushover analysis has been used to evaluate the seismic performance of three buildings with four different plans having same area and height. The results of effects of plan aspect ratio on seismic response of buildings have been presented in terms of displacement, base shear. Behaviour parameters of the analyzed moment resisting frames also calculated.

Ahmed Abrar et al.(2017) A set of ten different models are taken into account out of which the first model is with the regular structure, second-fifth with horizontal irregularities and the remaining sixth-tenth with both horizontal and vertical irregularities. He got the fundamental natural time period is observed to be the less for the model which is symmetry in shape as compared to asymmetry in shape, base shear yields low value in Response spectrum analysis when compared with the Equivalent static analysis.

4.CONCLUSION

It is often concluded that though the impact of the earthquake force is great on the 24.5m model the resultant effect of the eccentricity is little for the 8 storey model while the 24.5m model experiences a more significant change when the mass eccentricity is applied. Hence the useful for tall structures just like the 24.5m model but not so effective for the smaller 24.5m model. The change within the inner section of the building is little for the 24.5 and therefore the 30.5 model, while the difference increases as we approach the periphery hence it's proposed that to save lots of time the private columns are often designed for the column to the periphery and therefore the design is often applied to all or any the innermost columns because the variation is extremely small while the outer columns at the buildings periphery got to be designed separately.

The rise within the reinforcement required with the peak of the building makes it possible for an easier formula for calculation of the reinforcements of the structure thought the precise formulation of the formula would require study of more models and further study.

In seismic analysis of buildings, the ground slab is typically assumed to be rigid in its own plane. However, for several buildings that are long and narrow or have stiff end walls, floor diaphragm flexibility must be accounted for within the distribution of lateral load. Considerable research has been reported within the literature on the dynamics of flexible floor diaphragm buildings; however, the difficulty of seismic design of such buildings that takes into consideration torsional provisions of the codes has not yet been addressed. during this paper we developed a framework for analysis of such buildings following usual codal requirements for torsion. The building is assumed to possess one wing only, i.e., buildings with multiple wings ~e.g., L, V, Y, etc. shaped! are not considered.

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