BEHAVIOR OF RCC BUILDING WITH SHEAR WALL WITH DIFFERENT CHARACTERISTIC AT SEISMIC ZONES II AND V

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Abstract:

Shear walls are incorporated in building to resist lateral Forces and support the gravity loads. RC shear wall has high in plane stiffness. Positioning of shear wall has influence on the overall behavior of the building. For effective and efficient performance of building it is essential to position shear wall in an ideal location. This paper presents the response of building with different positioning of shear wall using both Equivalent Static Method (Seismic Coefficient Method Zone II and V) and Response spectrum Analysis. Five different Model of RCC building, one with no shear wall and other four models with different position of shear wall which is subjected to earthquake load in zone V has been studied .This study also incorporates how the bending moment, shear force for beam and axial Force for column vary with change in positioning of RC shear wall. Building is modeled and analyzed using standard package staad pro.

KEYWORDS: Shear wall, Equivalent Static Method, Response spectrum Method, Storey Drift, Seismic Zone II and V

INTRODUCTION

Reinforced concrete building can adequately resist both horizontal and vertical load. Whenever there is requirement for a multistory building to resist higher value of seismic forces, lateral load resisting system such as shear wall should be introduced in a building. Vertical plate like RC wall introduced in building in addition to beam, column and slab are called shear wall. Shear wall can be provided both along the length and width of the building. Properly designed building with shear wall has shown good performance in past earthquake. Mark Finlet, a noted consulting engineer in USA stated that “We cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls.” Different positioning of shear wall in building produces varying response in the building during application of lateral force.

In many respects concrete is an ideal building material, combining economy, versatility of form and function, and noteworthy resistance to fire and the ravages of time. The raw materials are available in practically every country, and the manufacturing of cement is relatively simple. It is little wonder that in this century it has become a universal building material.

Tall buildings are the most complex built structures since there are many conflicting requirements and complex building systems to integrate. Today’s tall buildings are becoming more and more slender, leading to the possibility of more sway in comparison with earlier high-rise buildings. Thus the impact of wind and seismic forces acting on them becomes an important aspect of the design. Improving the structural systems of tall buildings can control their dynamic response.
With more appropriate structural forms such as shear walls and tube structures, and improved material properties, the maximum height of concrete buildings has soared in recent decades. Therefore; the time dependency of concrete has become another important factor that should be considered in analyses to have a more reasonable and economical design. In this paper, we introduce the highest reinforced concrete tower, located in high seismic zone. Having a general overview of the case, some especial aspects of the tower, and the assessment of its seismic load bearing system with considering some important factors will be discussed.

Vibrations which disturb the earth’s surface caused by waves generated inside the earth are termed as earthquakes. It is said that earthquakes will not kill the life of human but structures which are not constructed in considering the earthquake forces do. At present a major importance has given to earthquake resistant structures in India for human safety. India is a sub-continent which is having more than 60% area in earthquake prone zone. A majority of buildings constructed in India are designed based on consideration of permanent, semi-permanent, movable loads. But earthquake is an occasional load which leads to loss of human life but also disturbs social conditions of India. The extent to which the structural response changes the characteristics of earthquake motions observed at the foundation level depends on the relative mass and stiffness properties of the soil and the structure. Thus the physical property of the foundation medium is an important factor in the earthquake response of structures supported on it.

The estimation of earthquake motions at the site of structure is most important phase of design of the structure. It is assumed that the motion in foundation level of equal structure is to ground free field motion. This assumption is correct only for the structures constructed on rock or very stiff soil. For the structures constructed on soft soil, foundation motion is usually different from the free field motion and a rocking component caused by the support flexibility on horizontal motion of foundation is added.

RC Multi-Storey Buildings are adequate for resisting both the vertical and horizontal load. When such building is designed without shear wall, the beam and column sizes are quite heavy, steel quantity is also required in large amount thus there is lot of congestion at these joint and it is difficult to place and vibrate concrete at these places and displacement is quite heavy which induces heavy forces in member. Shear wall may become imperative from the point of view of economy and control of lateral deflection. In RC multi-storey building R.C.C. lift well or shear wall are usual requirement. Centre of mass and stiffness of the building must coincide. However, on many occasions the design has to be based on the off centre position of lift and stair case wall with respect to centre of mass which results into an excessive forces in most of the structural members, unwanted torsion moment and deflection. Generally shear wall can be defined as structural vertical member that is able to resist combination of shear, moment and axial load induced by lateral load and gravity load transfer to the wall from other structural member. Reinforced concrete walls, which include lift wells or shear walls, are the usual requirements of Multi Storey Buildings. Design by coinciding center of mass and stiffness of the building is the ideal for a Structure. Providing of shear wall represents a structurally efficient solution to stiffen a building structural system because the main function of a shear wall is to increase the rigidity...
for lateral load resistance. The use of shear wall structure has gained popularity in high rise building structure, especially in the construction of service apartment or office, commercial tower. It is very important to note that shear walls meant to resist earthquake should be designed for ductility.

LITERATURE REVIEW

• Significance of Shear Wall in High rise Buildings

• Static linear and nonlinear analysis procedures for determining structure responses under seismic forces

• Performance based analysis of structures.

Bozdogan K.B., Deierlein et.al., 2010 [1] discussed in detail the modeling issues, nonlinear behavior and analysis of the frame – shear wall structural system. An approximate method which is based on the continuum approach and one dimensional finite element method to be used for lateral static and dynamic analyses of wall-frame buildings is presented. Shaik Kamal

Mohammed Azam., 2013 [2] presented a study on seismic performance evaluation of multistoried rcframed buildings with shear wall. A comparison of structural behavior in terms of strength, stiffness and damping characteristics is done. The provision of shear wall has significant influence on lateral strength in taller buildings while it has less influence on lateral stiffness in taller buildings. The provision of shear wall has significant influence on lateral stiffness in buildings of shorter height while it has less influence on lateral strength. The influence of shear walls is significant in terms of the damping characteristics and period at the performance point for tall buildings. Provision of shear walls symmetrically in the outermost moment-resisting frames and preferably interconnected in mutually perpendicular direction forming the core will have better seismic performance in terms of strength and stiffness.

Shahabodin Zaregarizi; 2013 [4] presented a study on Comparative investigation on using shear wall and concrete infills to improve seismic performance of existing buildings in areas with high seismic potential. Results show that concrete fills have considerable strength than brick in fills, whereas the displacement acceptance of brick infills is higher than concrete infills. Masonry infills as lateral resisting elements have considerable strength which can prevent even collapse in moderate earthquakes. Performance of concrete infills is dependent on adjacent elements especially columns, so premature failure in columns due to strong axial forces must be considered. Misam Abidi,

Mangulkar Madhuri. N; 2012 [5] presented an assessment to understand the behavior of Reinforced Concrete framed structures by pushover analysis and the Comparative study was done for different models in terms of base shear, displacement, performance point. The inelastic behaviour of the example structures are examined by carrying out displacement controlled pushover analysis.

PHILOSOPHY FOR SEISMIC ANALYSIS

SHARE WALL

DESIGN NOTE FOR COMMERCIAL BUILDING

1. Foundation depth = 1.5
2. Supports = All are fixed Supports

3. Number of stores = G+9

4. Height of the each floor = 3m

5. Total height of the building = 27m

6. Cross section of the beam = 300 mm x 460 mm

7. Diameter of the column = 460 mm

8. Height of the parapet wall = 1.2 m

9. Thickness of the wall = 160 mm

10. Density of the brick = 20 KN/ m3

11. Density of the concrete in the members except walls = 25 KN/m3

12. Floor finish = 1 KN/m3

13. Slab thickness = 0.15 m

14. Number of beams = 1315

15. Number of columns = 994

16. Floor finish = 1 KN/m3

Basic wind speed zones are classified as six zones as per IS 875 part -3

DESIGN METHODOLOGY FOR SEISMIC ANALYSIS OF SHARE WALL

DESIGN BASE SHEAR:

From code IS: 1893-2002, as per the clause 7.5.3 design seismic base shear or total lateral force (VB) along any principle direction shall be determined by the following expression.

\[ VB = Ah \times W \]

Where,

\[ Ah = \text{Design horizontal acceleration spectrum value.} \]

\[ W = \text{Seismic weight of the building as per clause 7.4.2. IS: 1893 (Part-I) 2002.} \]

SEISMIC WEIGHT:

Seismic weights are calculated in a manner similar to gravity loads. The weight of the columns and walls in any storey shall be equally distributed to the floors above and below the 3rd storey 1st (plinth) storey. Following reduced live loads are used for DL+LL analysis. Zero on terrace and 50% in the floor walls [IS: 1893 (part I): 2002, clause 7.4] as the LL is > 3 KN/m2.

SEISMIC WEIGHT OF FLOORS:

The seismic weight of each floor is its full dead load plus appropriate amount of imposed load, as specified in clause 7.3.1. and 7.3.2 of IS: 1893 (Part-I) 2002. While computing the seismic weight of each floor, the weight of columns and in any storey shall be equally distributed to the floors above and below the storey.

The seismic weight of the whole building is the sum of the seismic weights of all the floors. Any weight supported in between stories shall be distributed to the floors above and below in inverse proportion to its distance from the floors.

The design horizontal seismic coefficient \( Ah \) for a structure shall be determined by the following expression.

\[ A_h = \left( \frac{Z}{2} \right) \times \frac{I}{R} \times \left( \frac{S_a}{g} \right) \]

Where,

\[ Z = \text{Zone factor.} \]
I = Importance factor.  
R = Response reduction factor  
Sa/g = Average response acceleration coefficient provided that any structure  
T< 0.1s,  
The value of Ah will not be taken less than Z/2 whatever be the value of I/R

**FACTOR (Z):**

The country is classified into four seismic zones as given below.

<table>
<thead>
<tr>
<th>Seismic Zone</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic intensity</td>
<td>Low</td>
<td>Moderate</td>
<td>Severe</td>
<td>Very Severe</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>0.1</td>
<td>0.16</td>
<td>0.34</td>
<td>0.36</td>
<td></td>
</tr>
</tbody>
</table>

**STRUCTURAL MODELLING SEISMIC ZONES II AND V SHARE WALL DESIGN & RESULT**

**GENERAL**

A building frame model involves the assemblage of structural elements viz., beams, columns, slabs, walls, footing etc to represent the structural aspects of a typical frame in a building and exhibit its behavior under external loading. An analytical model must ideally represent its mass distribution, strength, stiffness and deformability through a full range of local and global displacements. This chapter deals with the modeling of the RC plane frames of G+6 stories of octagonal building and G+2 story rectangular building of RC plane frames.

**MODELING ASPECTS**

RC plane frames of G+6 stories octagonal building containing with shape of rectangular building were modelled and analyzed by using STAAD pro. The numerical model represents all components that affect the strength, stiffness and the mass of the frame.

**MATERIALS**

The modulus of elasticity of reinforced concrete as per IS 456:2000 is given by

For the steel rebar, the necessary information is yield stress, modulus of elasticity and ultimate strength. High yield strength deformed bars (HYSD) having yield strength 415 N/mm² is widely used in design practice and is adopted for the present study.

**Share wall building first modeling design:**

![Fig: 1st plan](image)

All columns = 0.50 * 0.50 m  
All beams = 0.6 * 0.3 m  
All slabs = 0.10 m thick  
Terracing = 0.2 m thick avg.
Parapet = 0.10 m thick RCC

Fig: modeling

Fig: wind load

Fig: seismic load

Fig: concrete detailing beam

Fig: column detailing

Share wall building Second modeling design:
In this section, the details of the modeling adopted for various elements of the frame are given below.

**Share wall building 3rd modeling design:**

Column size : 350X550  
Beam size: 300X500, 300x600  
Slab Thickness – 140mm  
Grade Of Concrete - M 30  
Grade Of Steel Is - Fe 500  
Shear Wall Thickness - 200 mm  
Fck - 30 N/mm2  
Fy - 500 N/mm2  

Loading considerations for Design:-  
Design live load intensity is taken as -3kn/m2  
Seismic loads -IS: 1893-2002  
-IS: 1893-1984  
Dead loads -IS: 875 (PART -I)  
Live loads -IS: 875 (PART -II)  
Visakhapatnam region -zone factor is 0.1 (for Zone II)  
Importance Factor -I=1  
OMRF -Response Reduction Factor Is 3 SMRF  
 Response Reduction Factor Is 5
CONCLUSION

From above results it is clear that shear wall frame interaction systems are very effective in resisting lateral forces induced by earthquake zone II and V. For residential building shear walls can be used as a primary vertical load carrying element, thus serving the load and dividing space. The infilled frame type structural system become economical as compared to the Bare Frame structural system. The infilled frame is superior to the bare frame. When shear wall provided in the infilled frame storey drift drastically reduced than the bare frame. The axial force of the bare frame is maximum than the infilled frame. But when shear wall provided in bare frame and in infilled frame it will help to reduce axial force significantly in bare frame and infilled frame. When shear wall provided at corner on each side the structure gives better result than the all position.

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