INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 6.078
(Volume 6, Issue 5)
Available online at: www.ijariit.com

Design of soft storey in multi storey building with various combinations of beam and column using STADD Pro

Priyanka Chauhan
priyankachauhan6264@gmail.com
Lakshmi Narain College of Technology, Bhopal, Madhya Pradesh

Vikash Ku.Singh
vikashcivil07@gmail.com
Lakshmi Narain College of Technology, Bhopal, Madhya Pradesh

ABSTRACT

Nowadays, building has provided by soft storey or weak storey. This feature is not suitable for building situated earthquake prone reason. In this study effect of soft storey in different height, different section of beam and columns while keeping their area constant. The determinations of percentage stiffness, maximum bending moment, maximum Shear force. The analysis is carried out by STAAD. Pro V8i. Here the present works (problem taken) are on a G+9 storied regular building. These buildings have the plan area of 15 meter x 15 meter with a soft storey height of 2.1 meter & 2.5 meter at first floor, and 4 meter constant height above first floor in all models. Depth of foundation is 2.5 meter, and the overall height of chosen building including depth of foundation are 40.6 meter & 41 meter. The analysis has done on computer with the help of STAAD. Pro V8i software using the parameters for the design as per the IS-1893- 2002-Part-1[B] for the Bhopal area and the post processing result obtained has summarized. It is concluded that from this study that the column section 200 mm x 450 mm is more suitable than, square column whose section is 300 mm x 300 mm, and a circular column whose diameter 340 mm. This is finding out on the basis of their area constant with different section.

Keywords: *Soft Storey, Combination of Column, Combination of Beam, Seismic Analysis, Stiffness, Bending Moment, Shear Force.*

1. INTRODUCTION

1.1 Backgrounds And Motivation

Proper utilization of space has become a major concern in developing countries like India due to rapid urbanization and population growth. As a result, multi-storey housing buildings in urban areas are forced to have parking in the ground floor. In such framed buildings, the ground storey is generally built without any infill walls to allow easy movement of vehicles but the upper storey's are enclosed with infill walls. This type of framed building is known as 'open ground storey (OGS) building' in this study. It represents a typical Open ground storey building as shown in figure.

Fig. 1: Typical Open Ground Storey Building

While this type of open ground storey buildings has various functional advantages, they possess a potentially dangerous type of vertical irregularity. The rapid reduction in lateral stiffness and strength of the ground storey in OGS building results in large lateral displacements in ground storey level, which increases the curvature and force in the ground storey columns. The collapse of this type of buildings is mainly due to the formation of soft-storey mechanism in the ground storey columns. Past earthquakes have demonstrated the vulnerability of OGS buildings. A number of OGS framed buildings have experienced severe damage during the 2001 Bhuj earthquake.

Fig. 2: Failures of OGS building during 2001 Bhuj Earthquake

In usual design practice, the stiffness involvement of infill walls present in upper storey's of OGS framed buildings is ignored in the structural analysis ('bare frame' analysis). Design based on such analysis results in underestimation of the bending moments and shear forces in the ground storey columns and this is perhaps responsible for the failures of such buildings. To address this problem, Indian Standard IS 1893 (2002) recommend a factor to magnify the forces in ground storey columns. This factor is referred as 'multiplication factor (MF)' in this study. IS 1893 (2002) states: "The columns of the OGS (soft-storey) are to be designed for 2.5 times the storey shears and moments calculated under seismic loads of bare frame". ASCE/SEI 7 (2010) and NZS1170.5 (2004) do not recommend OGS buildings as they fall in the extreme soft/weak storey irregularity category. ICC IBC (2012) relies on ASCE/SEI 7 for its provisions related to structural design and earthquake loads. Different other international codes and published literature addressed this problem through MF in line with Indian code. A review of the MFs suggested by various international design codes is reported by Kaushik *et al*. (2006) and the corresponding expression/values of MF are shown in Table 2.3 (Chapter 2). This table shows that there is a wide disparity in the MF values suggested by international codes.

2. LITRETURE REVIEW

Esteva (1992) conducted a parametric study to show the influence of OGS on the nonlinear dynamic response of shear-beam systems representative of buildings characterised by different number of stories and time periods. The stiffness of each storey is represented by an elastoplastic shear element whereas all the masses are assumed to be concentrated at the floor level. P- effects are also considered in the analysis. This paper concludes that the response of soft ground storey buildings is very sensitive to the ratio of the mean over-strength factors at the upper storeys to that of the ground storey. The behaviour of RC framed buildings with OGS subjected to seismic loads was reported by Arlekar *et al*. (1997). A case study of four storeyed OGS building is presented using equivalent static and response spectrum analysis method to show the differences between the response of OGS frame, bare frame and fully infilled frame. This infill walls are modelled as panel elements for the linear elastic analyses carried out in this study. This paper shows that the stiffness of OGS can be less than 10% of the stiffness of the storey above (infilled) for both 220mm and 110mm thick brick wall. The drift and the strength demands in the first storey columns are reported to be very large for buildings with soft ground storeys. This paper concludes stating that it is difficult to provide such capacities in the columns of the first storey. Scarlet (1997) evaluated equivalent static forces to be taken into account in the design of lateral load resisting elements of soft stories in a soft storey building based on energy approach. It was based on interpolation between two extreme situations: uniform structures and rigid structures supported by a soft storey. This paper calculated the value of MFs for buildings up to 20 storeys subjected to two types of loading patterns: (a) inverted triangular load and (b) concentrated load at the top. It also showed the variation of MFs for varying support conditions (fixed and elastic support). This study also recommended the use of MF's in the columns of soft storey and adjacent storey.

3. MODELLING AND ANALYSIS

The study in this thesis is depends on NTHA of a family of structural models representing OGS framed buildings designed with different height and different section. Exact modelling of the nonlinear properties of different structural elements is very essential for nonlinear analysis. In the present study, frame elements are modelled using fibre elements with spread plasticity. The first part of this chapter presents a summary of different parameters defining the constitutive relations used for modelling reinforced concrete and infill wall elements. Ordinary Portland cement (OPC) from a unmarried lot turned into used during the direction of the investigation. The physical houses of the cement as determined from diverse tests conforming to Indian Standard IS: 1489-1991(Part-1). All the checks were achieved as in line with pointers of IS: 4031-1988. Cement turned into cautiously saved to prevent deterioration in its properties because of contact with the moisture. Fineness of cement is obtained as three%. Standard consistency is acquired to be 31%. Initial placing time is 65 minutes and final setting time is 315 minutes.

3.1 Structure Description

The plan layout of the special reinforced concrete moment resisting frame (SMRF) building with open first storey chosen for this study is shown in Figure 3.1. The building is by design kept symmetric in both x and z directions in plan to avoid torsional response under pure lateral forces.

The building is considered to be located in seismic zone II and intended for commercial use. The building is founded on Medium Soil. Elastic moduli of concrete and masonry are 22360.67 N/mm^2 and 6975 N/mm^2, respectively. Performance factor (K) has been taken as 1.0 (assuming ductile detailing). The unit weights of concrete and masonry are taken as 25 kN/m^3 and 20 kN/m^3 is considered. The other building parameters are as follows. There are two types of models are considered for the analysis purpose:

Model A: Ten storied (G+9) special Moment Resisting Frame with 2.1 Meter height at first floor and above ground floor, each floors having 4 meter height with Different column and beam sections. In This Model We Considered Beam And Column Having Constant Area.

Model B: Ten storied (G+9) special Moment Resisting Frame with 2.5 Meter height at first floor and above ground floor, each floors having 4 meter height with Different column and beam sections.

3.2 Model A

Geometry 15 m x15 m with five bay of 3 m each in x and z direction

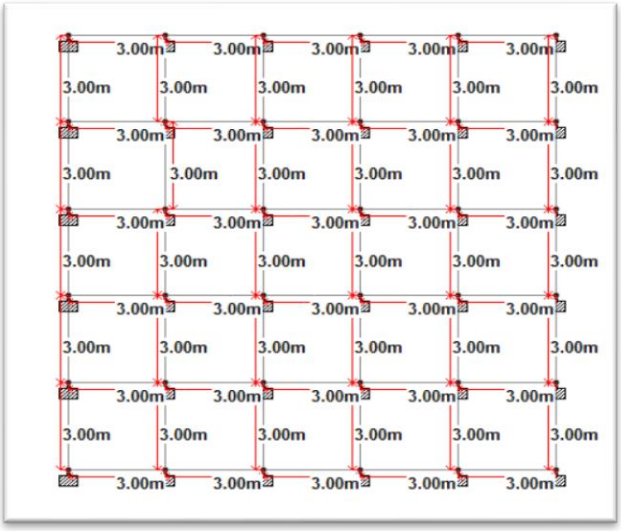

Fig. 1: Top View of Structural Model A

Model A is ten storey building (G+9) and has five bays in model A, Eighteen cases is considered.

- Case 1- There is an open ground storey; column section and beam section are 300 mm x 300 mm and 200 mm x 450 mm respectively.
- Case 2- There is an open ground storey; column section and beam section are 300 mm x 300 mm and 225 mm x 400 mm respectively.
- Case 3- There is an open ground storey; column section and beam section are 300 mm x 300 mm and 245 mm x 370 mm respectively.
- Case 4- There is an open ground storey; column section and beam section are 300 mm x 300 mm and 250 mm x 360 mm respectively.
- Case 5- There is an open ground storey; column section and beam section are 300 mm x 300 mm and 275 mm x 330 mm respectively.
- Case 6- There is an open ground storey; column section and beam section both are 300 mm x 300 mm.

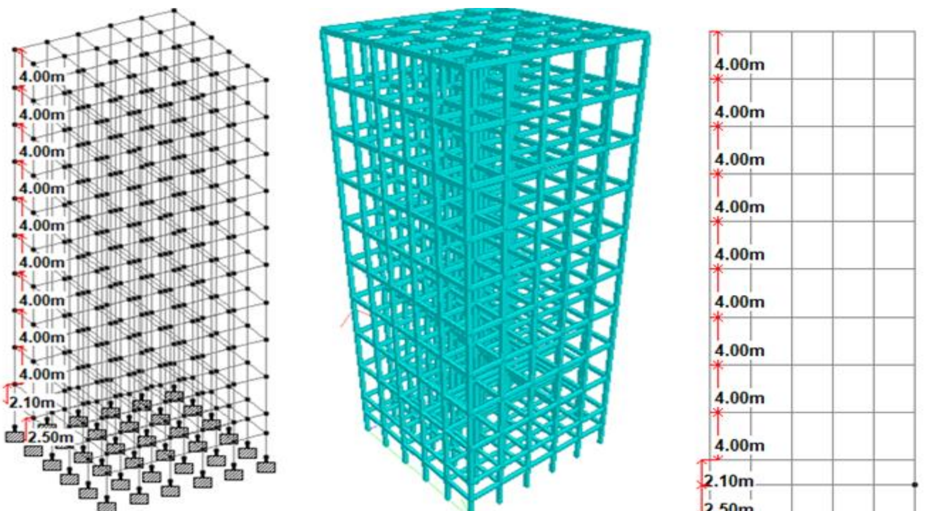

Fig. 4: Open Ground Storey, 2.1 m Height and Column Section are (300 x 300) mm

3.3 Structural Modelling

Modelling a building involves the modelling and grouping of its various load-carrying elements. The model must ideally represent the mass distribution, strength, stiffness and deformability. Modelling of structural elements and the material properties used in the present study is discussed below.

Table 1: Material properties of concrete, Steel & Brick Masonry

Properties of Material	
Grade of concrete	M 30
Modulus of elasticity (concrete)	2.7 $X10^7$ KN/m^2
Poisson ratio	0.22
Tensile strength of concrete	3 N/mm^2
Flexural strength	3.83 N/mm^2
Grade of Steel	Fe-415
Modulus of elasticity E(Steel)	2 $X10^7$ KN/m^2
Poisson ratio	0.3
Tensile strength of Steel	415 N/mm^2
Modulus of elasticity (Brick Masonry)	

4. RESULTS AND DISCUSSION

The performance of building frame with soft story is a studied for various condition in previous chapter different models for the present study with different cross section with constant area various method and strategy, code recommendation etc. have been described various model considered in the present study have been analyzed by a Staad.Pro V8i software .this chapter presents Calculation and results obtained for the duration of analysis.

4.1 Ten Storey (G+9) Building Model

Following section presents the result obtained from Staad.Pro v8i analysis building having soft storey due to opening of ground floor and uneven height.

- Stiffness
- Bending moment
- Shear force

4.2 Stiffness

The help of equivalent Diagonal strut method for infill wall calculates stiffness without opening and infill wall with opening. Stiffness of various column and beam section are shown in Table 2.

Table 2: Stiffness for various combinitions of column and beam section at 2.1meter height of soft storey

Stiffness of Various Column & Beam Section For H=2.1 M			
Different Beam Section	**Different Column Sections**		
	300mm x 300mm	**200mm x 450mm**	**340mm diameter**
200mm x 450mm	**41.58**	**74.27**	**40.72**
225mm x 400mm	**40.67**	**74.23**	**39.88**
245mm x 370mm	**40.57**	**73.05**	**39.68**
250mm x 360mm	**40.28**	**73.02**	**39.46**
275mm x 328mm	**38.09**	**72.52**	**39.41**
300mm x 300mm	**37.98**	**72.18**	**39.38**

The comparison of stiffness for various combinations of column and beam section 2.1 m height of soft storey graphically in figure 1.

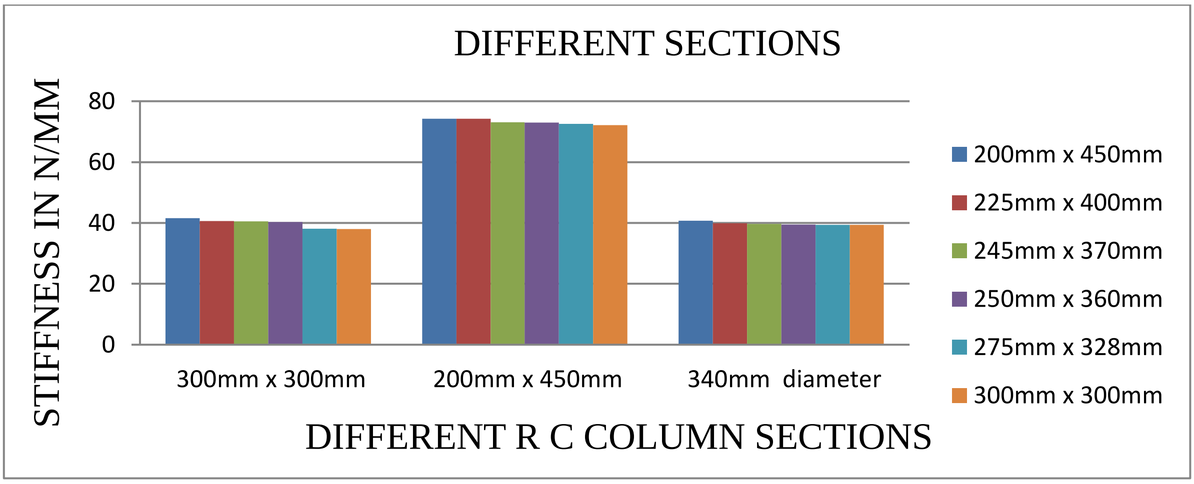

Fig. 1: Stiffness for various combinations of column and beam section

5. CONCLUSION

In this study, various structural parameters are calculated for different height, beam & column sections with constant area of soft storey. The different parameters include stiffness, bending moment and shear force.

5.1 Stiffness

- The value of percentage stiffness of soft storey is highest when the column section is rectangular (200 mm x 450 mm) for any height of soft storey. The value of percentage stiffness of soft storey is reduced to almost half (50%) as the column section is changed from rectangular to square or circular for any height of soft storey; keeping the area of column section constant.
- The value of percentage stiffness of soft storey increases when height of soft storey decreases. Maximum value of percentage stiffness was found 70.84% for a height 2.1 meter of soft storey; the minimum value was 3.78% for 4 meter height of soft storey.
- It can be concluded that the effect of soft storey can be eliminated or at best minimised by proper selection of column section and height of soft storey.
- Even without infill, the soft storey can be converted into a normal storey by providing rectangular column section and lesser height of soft storey (minimum 2.10 meter for head room).
- The value of percentage stiffness of soft storey remains almost constant for any variation in the beam section, keeping the area of beam section constant. The percentage variation of percentage stiffness varies from 0.72% to a maximum of 10.31% for various beam sections. It can be concluded that the variation in beam section doesn't affect much the percentage stiffness of soft storey provided the cross-sectional area of the beam is kept constant.
- The value of percentage stiffness is highest (70.84%), when column and beam sections are 200 mm x 450 mm and 200 mm x 450 mm respectively; for height of soft storey 2.10 metre.

5.2 Maximum Bending Moment

- Maximum bending moment increases when depth of beam decreases; for any height of soft storey.
- The value of maximum bending moment is highest when the beam section is 300 mm x 300 mm and column section is 200 mm x 450 mm; for any height of soft storey.
- The value of maximum bending moment is lowest when the beam section is 200 mm x 450 mm and column section is 340 mm diameter; for any height of soft storey

5.3 Maximum Shear Force

- The value of maximum shear force is lowest when the beam section is 200 mm x 450 mm and column section is 300 mm x 300 mm; for any height of soft storey.
- The value of maximum shear force is highest when the beam section is 300 mm x 300 mm and column section is 200 mm x 450 mm; for any height of soft storey.
- Maximum Shear force increases when depth of beam decreases; for any height of soft storey.

6. REFERENCES

[1] Pankaj agarwal and Manish Shrikhande (2009). A text book of earthquake resisting structure

[2] As per IS-1893 part 1 2002, ASCE/SEI 7 (2010), ICC IBC (2012), Euro code 8 (2003), NZS 1170.5 (2004), SI 413 (1995), NBC 201 (1994), FCEACR (1986)

[3] IS 456: 1978 and IS 456:2000 Code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi.]

[4] Liauw T.C "An approximate method of analysis for infilled frame with or without openins"Building science; 7:223-238 pergamon press;1972

[5] Armstrong; I.C "Capacity design of reinforced concrete frames for ductile earthquake performance" Bulletin of the newzeland society for earthquake engineering vol.5 No. 4 december 1974

[6] Dadi; V.V.S; surya Kumar "seismic evaluation of reinforced concrete building with soft storey" M.Tech dissertation ; department of earthquake engineering ; IIT roorkee June 2004

[7] ASTM E 447-84 Philadelphia PA 1984 American society of testing and materials "compressive strength of masonry assemblages" .

[8] IS-13920-1993 or SP 16 code of practice. Ductile detailing of RC structure subjected to seismic forces .

[9] (NZS 4230) New Zealand Code for length and width of diagonal strut of infill

[10] Hiten L. Kheni,and Anuj K. Chandiwala(2014), Seismic Response of RC Building with Soft Stories, International Journal of Engineering Trends and Technology (IJETT) – Volume 10 Number 12 - Apr 2014.

[11] Dhadde Santosh(2014), Evaluation and Strengthening of Soft Storey Building, International Journal of Ethics in Engineering & Management Education.

[12] Rakshith Gowda K.R and Bhavani Shankar(2014), Seismic Analysis Comparison of Regular and Vertically Irregular RC Building with Soft Storey at Different Level, International Journal of Emerging Technologies and Engineering (IJETE).

[13] Susanta Banerjee, Sanjaya K Patro and Praveena Rao(2014),Inelastic Seismic Analysis of Reinforced Concrete Frame Building with Soft Storey, International Journal of Civil Engineering Research. ISSN 2278-3652 Volume 5, Number 4 (2014),

[14] D. B. Karwar and Dr. R. S. Londhe(2014), Performance of RC Framed Structure by Using Pushover Analysis, International Journal of Emerging Technology and Advanced Engineering

