A Comparison of Structural System for Regular and Irregular Buildings

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Abstract - In this work a comparison of Moment Resisting RC Frames for Regular and Irregular buildings in all the four seismic zones is carried out. The different moment resisting frames considered are Ordinary Moment Resisting Frame (OMRF) and Special Moment Resisting Frame (SMRF).Comparisons are made for the behavior of building frames considering different elevation irregularity and response reduction factor under earthquake forces. For this purpose, the three buildings of different configurations considered are a regular bare-frame block structure, an irregular stepped structure and an irregular plaza structure. For the same plan area and same height a comparison is done for different buildings. The base area is 15m x 15m of G+8 storey buildings. The results show a close competition between regular bare-frame and irregular stepped frame, though irregular plaza frame showed higher values. OMRF showed higher values as compared to SMRF.

Keywords- Moment resisting frames, SMRF, OMRF, Seismic behavior, Response reduction factor, Regular building, Irregular building, Staad.pro.

I. INTRODUCTION

The selection of a particular type of framing system depends upon two important parameters i.e., seismic risk of the zone and the budget [1]. The lateral forces acting on any structure are distributed according to the flexural rigidity of individual components. Indian Codes divide the entire country into four seismic zones (II, III, IV & V) depending on the seismic risks. OMRF is probably the most commonly adopted type of frame in lower seismic zones [2]. However with increase in the seismic risks, it becomes insufficient and SMRF frames need to be adopted [4]. Moment-resisting frames are rectilinear assemblages of beams and columns, with the beams rigidly connected to shear, amount of reinforcement etc. Moment frames have been widely used for seismic resisting systems due to their superior deformation and energy dissipation capacities. The components of a moment frame should resist both gravity and lateral load. Lateral forces are distributed according to the flexural rigidity of each component [3].

II. MATERIALS AND METHODS

The use of seismic analysis both in research and practice has increased substantially in recent years due to the proliferation of verified and user-friendly software and the availability of fast computers. The methods can be grouped into static or dynamic methods, which are applied in elastic and inelastic response analysis.

2.1 Method Adopted In the Analysis Work

The following procedure is adopted in the thesis work.

1. We reviewed various the methods that are used in seismic analysis.
   (i) Dynamic Analysis method
   (ii) Static Analysis method
2. We prepared a problem of G+8 storey building.
3. We analyze the building through equivalent static analysis using simplified code method.
4. The following steps were followed in analysing the structures through simplified code method –
   (i) Selection of building geometry, bays and storey (3 geometries).
   (ii) Selection of response reduction factor (OMRF and SMRF) models as per Table 7 of IS 1893 (PART 1):2002.
   (iii) Selection of 4 seismic zones (II, III, IV and V) as per Table 2 of IS 1893 (PART 1):2002.
   (iv) Selection of Importance factor as per Table 6 of IS 1893 (PART 1):2002.
   (v) Consider thirteen load combinations as per IS 456:2000 and IS 1893 (PART 1):2002.

2.2 Formation of the problem

A G+8 storey reinforced concrete buildings of different configuration in medium soil has a base plan 15m x 15m and its height is 27m. The different configurations considered are a regular bare-frame block structure and an irregular plaza and an irregular stepped structure. The grade of concrete is M20 and that of steel is Fe 415. The column size is of 0.35m x 0.45m and the beam size is 0.23m x 0.45m. Unit weight of R.C.C: 25kN/m^3 as per Table 1, IS 875 (PART 1):1987. Unit weight of Masonry: 20kN/m^3 as per Table 1(page 8), IS 875 (PART 1):1987.

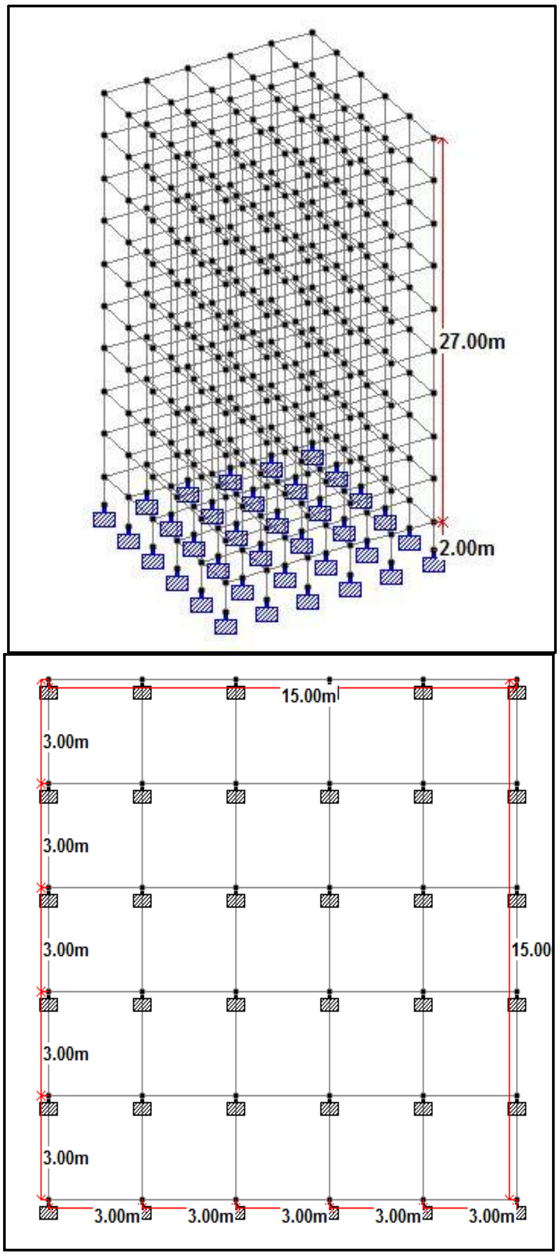

Figure1. Isometric View of Regular Bare-Frame Block Structure

III. ANALYSIS

(i) Dead Loads: As per IS 875 (PART 1): 1987

(a) Self weight of slab

(b) Slab = 0.15 m x 25kN/m^3 = 3.75kN/m^2 (slab thickness 0.15 m assumed)

Finishing load = 1kN/m^2

Total slab load = 3.75 + 1 = 4.75kN/m^2

(c) Masonry wall Load = 0.25 m x 2.55 m x 20kN/m^3 = 12.75kN/m

(d) Parapet wall load = 0.25 m x 1 m x 20kN/m^3 = 5kN/m

(ii) Live Loads: As per IS 875 (PART 2): 1987

Live Load = 3kN/m^2

Live Load on earthquake calculation = 0.75kN/m^2 as per Table 8 of IS 1893 (PART 1):2002.

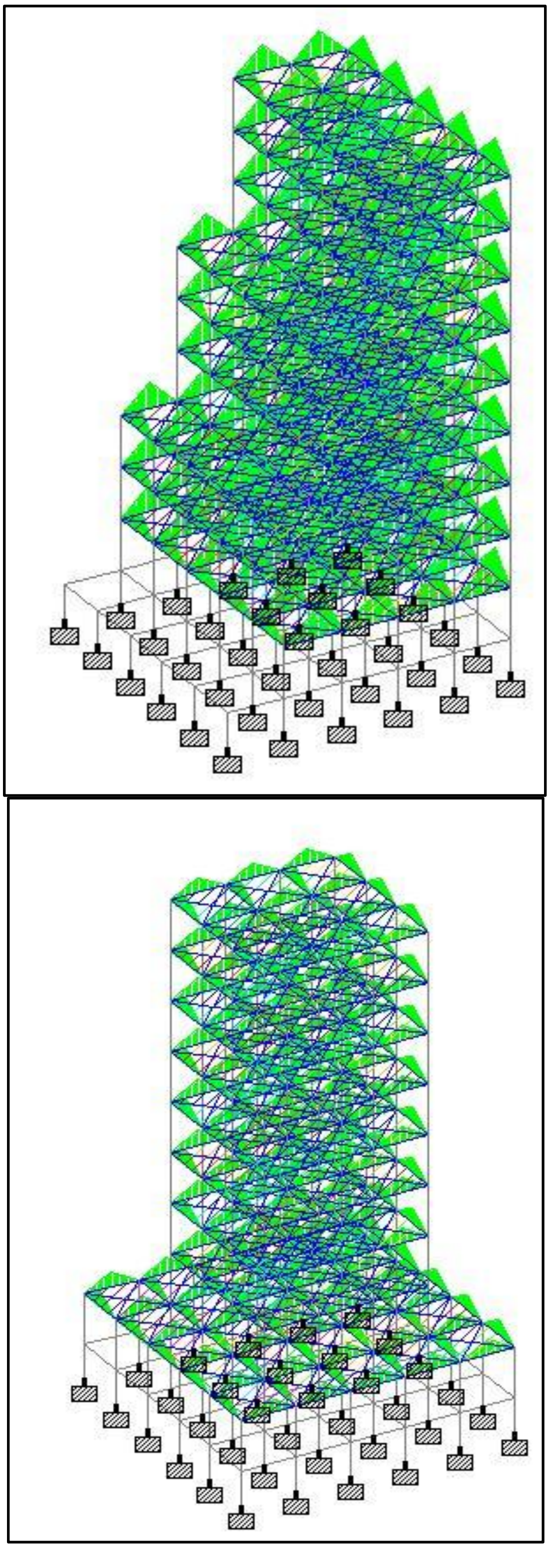

Figure 2. Live Load Diagrams for Irregular, Plaza and Stepped Structures

IV. RESULTS AND DISCUSSION

Maximum bending moment (kNm) in Zone II is shown in Table 4.1 and Fig.4.1.

Table 1: Maximum Bending Moment (kNm) In Zone II

MAXIMUM BENDING MOMENT (kNm) IN ZONE II			
RF	TYPE OF STRUCTURE		
	BARE FRAME	STEPPED	PLAZA
OMRF	156.494	173.165	189.493
SMRF	101.692	116.136	121.919

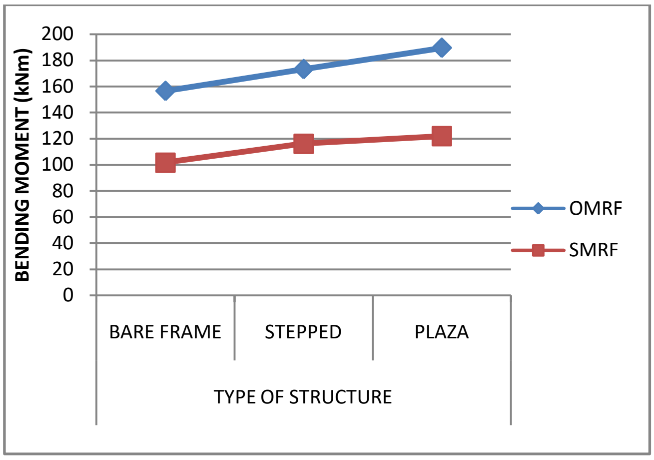

Figure 3. Maximum Bending Moment (kNm) in Zone II

V. CONCLUSION

Here in this work OMRF (ordinary moment resisting frame) and SMRF (special moment resisting frame) is analyzed with all seismic zones considering various regular and irregular structures. The conclusion of the work is as follows.

Bending Moment

- The maximum bending moment is observed in irregular plaza building and minimum in regular bare frame building.
- The moments of regular bare-frame and irregular stepped building were close, irrespective of the type of frames. Though plaza building showed greater moments in every case.
- The special moment resisting frame is more efficient than ordinary moment resisting frame and SMRF reduces moments means reduces area of steel so it is more economical to OMRF.
- The rate of bending moment increases as the seismic zone intensity increases.
- While observing, nature of graph is same in all seismic zone, it is clear that bare frame is best, stepped is second best and plaza building is critical.

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