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# "Structural design analysis of vertical geometric irregularity flat slab system using Response spectrum"

**[1]Subhash Dharve, [2]Sankalp Sharan**
[1]MTech Scholar, [2]Professor (HOD)
[1] Department of Civil Engineering,
[1]Prashanti Institute of Technology and Science, Ujjain (MP), India

***Abstract:*** The increasing demand for architectural flexibility and large clear spans in modern urban construction has led to the widespread adoption of flat slab systems. However, vertical geometric irregularities in such structures can significantly impact their seismic performance. This study investigates the behavior of G+10 multi-story steel frame buildings with flat slabs, focusing on various degrees of vertical geometric irregularity (150%, 200%, 300%, and 600%) positioned at the center, left, and right edges. Using STAAD. Pro 2007 and Response Spectrum Analysis, the study evaluates critical parameters including shear stresses, bending moments, story drift, node displacement, and peak story shear. The results indicate that while flat slab systems offer architectural advantages, specific irregularity configurations—particularly 600% irregularity—induce drastic increases in stress and displacement, necessitating careful seismic design consideration.

***Index Terms*** **-Vertical Geometric, Flat slab system, Story drift, beamless slab, static lateral force, reinforced cement concrete (RCC)**

## I. INTRODUCTION

Steel structures are increasingly utilized in high-rise construction due to their strength and adaptability. Concurrently, flat slab systems—reinforced concrete slabs supported directly by columns without beams—have gained popularity for their aesthetic appeal, reduced construction time, and ability to provide greater clear height[1111]. However, the absence of deep beams makes flat slab systems more flexible under lateral loads compared to traditional frame systems, rendering them potentially vulnerable during seismic events.

Real-world structures often deviate from regular geometry due to architectural requirements, resulting in vertical geometric irregularities. A structure is considered vertically geometrically irregular when the horizontal dimension of the lateral force-resisting system in any story is more than 150% of that in an adjacent storey[3]. This study aims to assess the life and seismic behavior of such irregular flat slab systems using dynamic analysis methods mandated by IS 1893:2002.

## II. METHODOLOGY

The structural models of the analyzed buildings are prepared and analyzed by Staad pro-2007. Vertical irregularity is located in axes similar to the practice. Then, geometric vertical irregularity ratios (L2/L1) of the model buildings are changed to obtain different model. 12 different models for each number of stories having same floor dimensions up to the 5th floor but different from 6th to top floor, ratio is created for use in the analyses. Vertical geometric irregularity ratio is determined by dividing base width to the top width of two adjacent setbacks in one direction in the building. Vertical irregularity ratio changes from 150% to 600% percent in the models.

Story Drift

It is the displacement of one level relative to other level above or below. During an earthquake, large lateral forces can be imposed on structures; Lateral deflection and drift have three primary effects on a structure; the movement can affect the structural elements (such as beams and columns); the movements can affect non-structural elements (such as the windows and cladding); and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effect on structural elements.

As per IS 1893-2002. 7.11.1 Story drift limitation in any story due to the minimum specified design lateral force, with partial load factor of 1.0shall not exceed 0.004 times the story height.

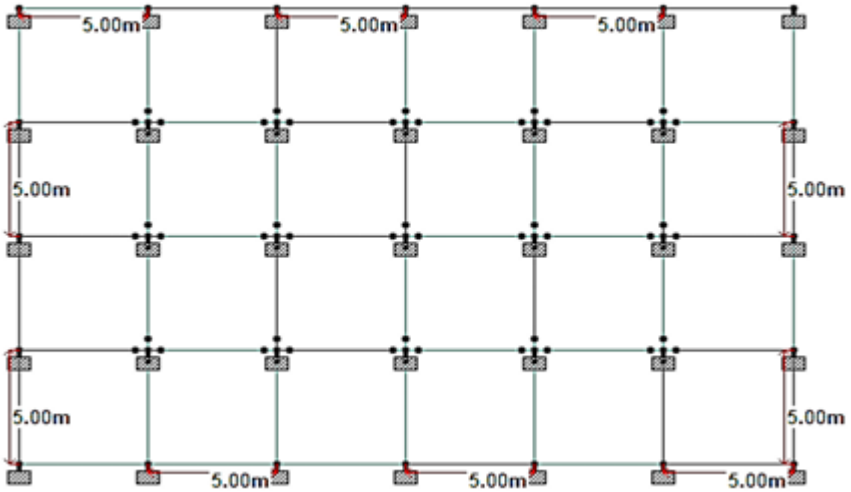



Fig. 1 Plan of Flat Slab 150%, 200 %, 300% & 600% Irregular

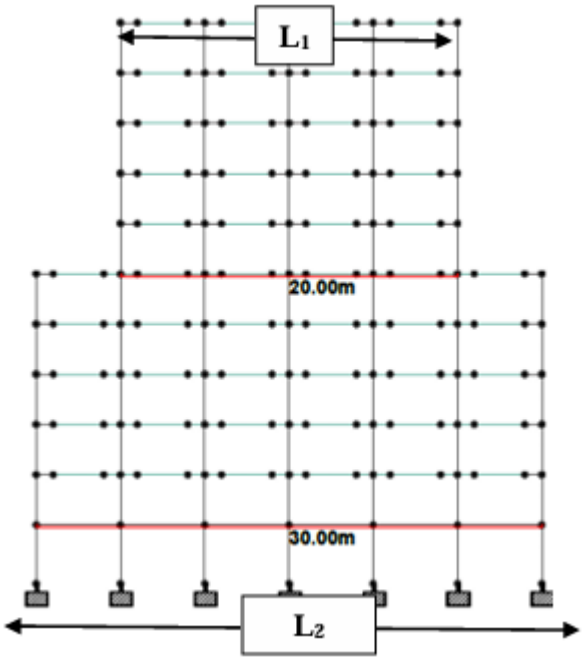



Fig. 2 Building with 150% Vertical Irregularity

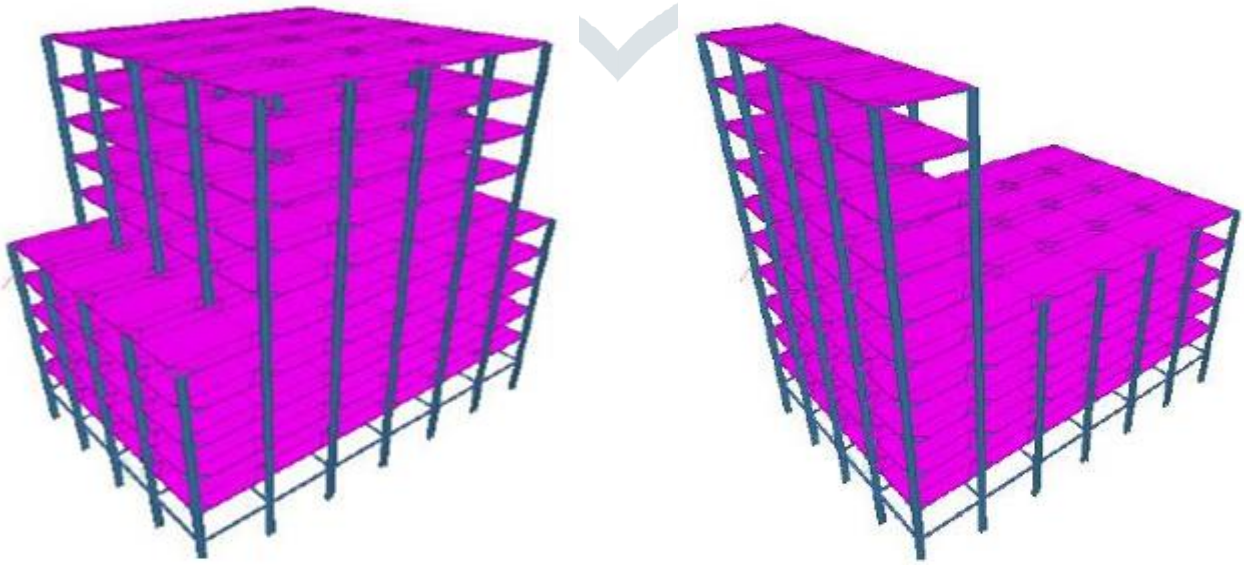


Fig. 3 3D View of 150% Irregular building with Center & left

## IV. RESULTS AND DISCUSSION

Center Shear Stresses

Table 1 Center Shear Stresses on Flat slab in 150% Irregular Building

| CENTER STRESSES SHEAR (KN/M2) | NOTATION | IR_150_C | IR_150_L | IR_150_R |
|---|---|---|---|---|
| | SQX | 442 | 411 | 426 |
| | SQY | 600 | 597 | 582 |

Table 2 Center Shear Stresses on Flat slab in 200% Irregular Building

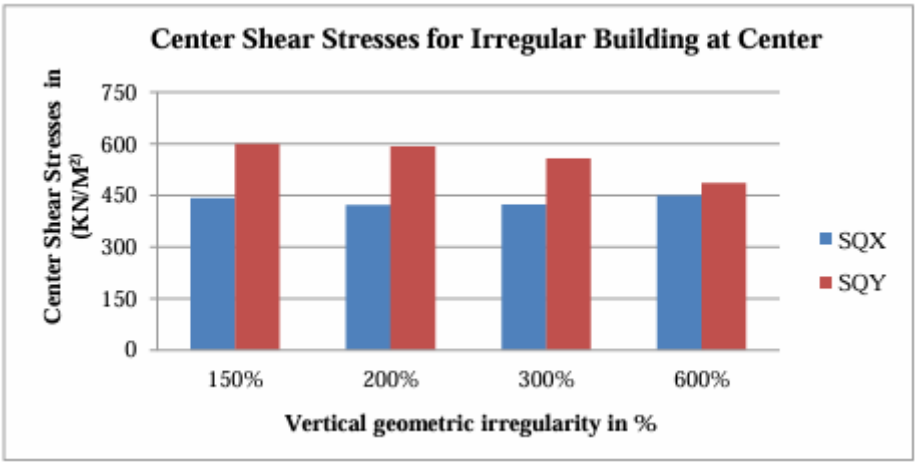
| CENTER STRESSES SHEAR (KN/M2) | NOTATION | IR_200_C | IR_200_L | IR_200_R |
|---|---|---|---|---|
| | SQX | 422 | 412 | 427 |
| | SQY | 592 | 577 | 565 |

Table 3 Center Shear Stresses on Flat slab in 300% Irregular Building

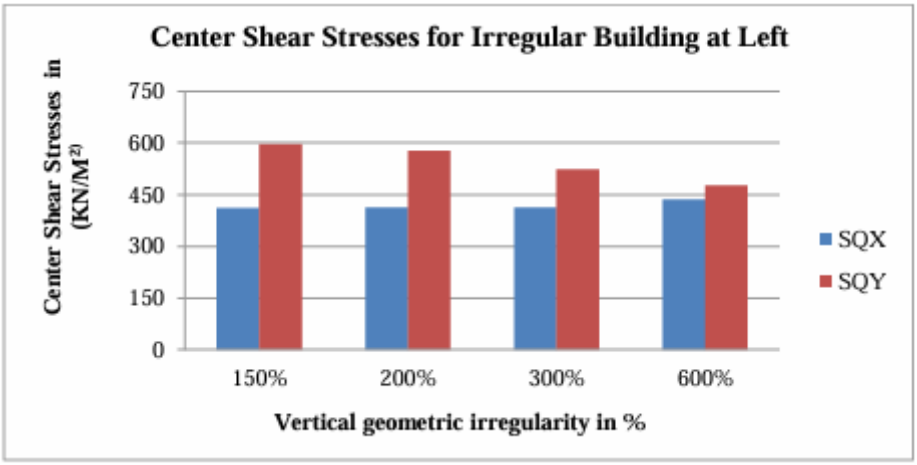
| CENTER STRESSES SHEAR (KN/M2) | NOTATION | IR_300_C | IR_300_L | IR_300_R |
|---|---|---|---|---|
| | SQX | 424 | 413 | 440 |
| | SQY | 557 | 523 | 511 |

Table 4 Center Shear Stresses on Flat slab in 600% Irregular Building

| CENTER STRESSES SHEAR (KN/M2) | NOTATION | IR_600_C | IR_600_L | IR_600_R |
|---|---|---|---|---|
| | SQX | 449 | 417 | 436 |
| | SQY | 486 | 484 | 476 |




Graph 1 Center shear stresses Vs Vertical geometric irregularity at center




Graph 2 Center shear stresses Vs Vertical geometric irregularity at left

**REFERENCES**

[1] Renuka Ramteke, "Parametric study of multistoried R.C.C. flat slab structure under seismic effect having different plan aspect ratio and slenderness ratio" International Journal of Trend in Scientific Research and Development, Vol. 1(4), pp. 210-220, 2017.

[2]. Prabesh Sharma., D.R Rajendra.S, Vanisree C.N., "Scrutinizing the Structural Response of Regular and Irregular Structure (With and Without Shear Wall) Subjected to Seismic and Wind Loading." International Journal on Recent and Innovation Trends in Computing and Communication, Vol.4(3), pp. 353 – 359, 2016.

[3]. Maikesh Chouhan., Ravi Kumar Makode,"Dynamic Analysis of Multi-Storeyed Frame-Shear Wall Building Considering SSI." Int. Journal of Engineering Research and Application, Vol.6(8) part-I, pp. 31-35, 2016.

[4]. Navjot Kaur Bhatia.,Tushar Golait, "Studying the Response of Flat Slabs & Grid Slabs Systems in Conventional RCC Buildings." International Journal of Trend in Research and Development, Vol. 3(3), pp. 334-337 ,2016.

[5]. Mohd Atif., Prof. Laxmikant Vairagade., Vikrant Nair, "Comparative Study on Seismic Analysis of Multistorey Building Stiffened with Bracing and Shear Wall." International Research Journal of Engineering and Technology (IRJET), Vol. 2(5), pp.1158-1170, 2015.

[6]. Akil Ahmed, "Dynamic Analysis of Multi-storey RCC Building Frames." International Conference on Inter Disciplinary Research in Engineering and Technology, Vol. 1, pp 89-94, 2015.

[7]. G.V. Sai Himaja., Ashwini .L.K., N. Jayaramappa., "Comparative Study on Non-Linear Analysis of Infilled Frames for Vertically Irregular Buildings." International Journal of Engineering Science Invention. Vol. 4(6), pp 42-51, 2015.

[8]. N. Janardhana Reddy., D. Gose Peera., T. Anil Kumar Reddy,"Seismic Analysis of Multi-Storied Building with Shear Walls Using ETABS-2013" International Journal of Science and Research (IJSR) ,Vol. 4(11), pp. 1030-1040, 2015.

[9]. Ali Koçak, Başak Zengin, Fethi Kadioğlu "Performance Assessment of Irregular RC Buildings with Shear Walls After Earthquake"

[10]. Anuja Walvekar, H.S.Jadhav , "Parametric Study of Flat Slab Building With And Without Shear Wall To Seismic Performance" International Journal of Research in Engineering and Technology. Vol. 4(4), pp. 601-607, 2015.

[11]. K. G. Patwari, L. G. Kalurkar (2016) "Comparative study of RC Flat Slab & Shear wall with Conventional Framed Structure in High Rise Building" International Journal of Engineering Research, Vol. 5(3), pp. 612-616, 2015.

[12]. Ravindra B N, Mallikarjun S. Bhandiwad, "Dynamic Analysis of Soft Storey Building with Flat Slab" International Research Journal of Engineering and Technology (IRJET), Vol. 2(4), pp. 1644-1648, 2015.

[13]. Ravikanth Chittiprolu, Ramancharla Pradeep Kumar, "Significance of Shear Wall in High-rise Irregular Buildings" International Journal of Education and applied research, Vol. 4(2), pp. 35-37, 2014.

[14]. Navyashree K, Sahana T.S, "Use of Flat Slabs in Multi-Storey Commercial Building Situated in High Seismic Zone" International Journal of Research in Engineering and Technology, Vol. 3(8), pp. 439-451,201