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Study of Behaviour of Seismic Evaluation of Multi-Storeyed Building with Floating Columns using STAAD Pro

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ABSTRACT: STAAD. Ro is a structural analysis and design computer program originally developed by Research Engineers International in Yorba Linda, CA. In late 2005, Research Engineer International was bought by Bentley Systems.

The collected data is analyzed and a 3-D model is generated using STAAD Pro. The various loads acting on the structure is calculated and the structure is analyzed for the various load combinations.

The ground vibration along with seismic tremors is the reason to the breakdown of structures. So as to spare loss of life and property; the structures should be planned against the powers originating from ground vibration. In this work A RCC encircled five-storied structure has-been broke down and intended to endure the quakes in which the Indian seismic zone IV is inclined to, the site of structure is in Jalandhar. Device utilized for calculations is STAAD-pro2000.

KEYWORDS: Load combinations, ,Floating columns, .Earthquake load, .Structural analysis., Multistoried buildings.

I. INTRODUCTION

The rapid urbanization and increasing land constraints in metropolitan areas have led to the evolution of architectural and structural designs that optimize space usage while fulfilling functional and aesthetic demands. One such widely adopted architectural feature is the floating column. A floating column is a vertical structural element that does not rest directly on the foundation but rather on a beam or slab at an intermediate level. While these columns enable flexible space planning—such as large open halls or parking areas on lower floors—they introduce significant discontinuities in the load transfer path of a building. In seismic-prone regions, the performance of structures with such vertical irregularities becomes a major concern. Floating columns disrupt the uniform distribution of lateral forces and may lead to stress concentrations and increased vulnerability during seismic events. These irregularities compromise the structural integrity and can result in disproportionate damage during earthquakes, as observed in past seismic failures.

Given the increasing use of floating columns in modern high-rise buildings, it is essential to conduct a detailed seismic evaluation of such structures to ensure their safety and resilience. This study aims to analyze the seismic behaviour of multistoried buildings with floating columns using STAAD Pro, a widely used structural analysis and design software. The research involves comparing the seismic response of buildings with and without floating columns under different seismic loading conditions, adhering to IS 1893 (Part 1): 2016 standards.

By assessing key response parameters such as base shear, storey displacement, storey drift, and mode shapes, the study provides insights into the impact of floating columns on the seismic performance of buildings. The results of this study are intended to contribute toward improved design practices and safer construction of irregular multistoried structures in seismically active zones.





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II. LITERATURE REVIEW

The presence of vertical irregularities, such as floating columns, in multistoried buildings has become increasingly common in modern architectural designs. However, their impact on structural behaviour under seismic loading has been a subject of extensive research in recent years. Numerous studies have highlighted the detrimental effects of such irregularities on the seismic performance of structures, prompting the need for careful analysis and design.

Pankaj Agarwal and Manish Shrikhande (2006), in their seminal work "Earthquake Resistant Design of Structures", emphasized the importance of understanding the dynamic response of buildings with irregular configurations. They pointed out that vertical discontinuities significantly affect load paths and can lead to sudden failures during seismic events.

Patel et al. (2013) conducted an analysis of multi-storeyed buildings with and without floating columns using STAAD Pro. Their study revealed that structures with floating columns exhibited higher storey drifts and displacements, making them more vulnerable during earthquakes. The results suggested that floating columns should be avoided in seismically active regions unless adequately designed.

M. N. Patel and K. J. Kinariwala (2014) examined the effect of vertical irregularities on multistoried buildings and concluded that floating columns led to increased base shear and inter-storey drift. They stressed the necessity of detailed dynamic analysis, particularly response spectrum and time history analysis, for such irregular structures.

Anshuman, Dipendu Bhunia, and Bhavin Ramjiyani (2011) studied the influence of floating columns on building performance and found that sudden load transfer at the column termination point caused stress concentration. They advocated the use of proper lateral load-resisting systems and suggested providing shear walls or bracing to enhance performance.

Pradeep M. and S. S. Jamkar (2015) analyzed G+5 and G+10 buildings with floating columns under seismic loading using STAAD Pro. Their research showed that the structural response in terms of base shear and natural frequency was significantly affected by the location and number of floating columns.

IS 1893 (Part 1): 2016, the Indian standard code for seismic design, highlights the importance of avoiding abrupt changes in stiffness and mass distribution. The code categorizes floating columns under vertical irregularities and recommends rigorous analysis methods to assess their impact.

From the review of existing literature, it is evident that buildings with floating columns require careful seismic evaluation due to their altered load transfer mechanisms and irregular structural behaviour. While modern software like STAAD Pro allows for detailed modelling and analysis, engineers must understand the implications of such design choices and implement necessary reinforcements or structural modifications to ensure safety and compliance

III. METHODOLOGY

The study involves the seismic evaluation of a G+5 multistoried RC building with and without floating columns using STAAD Pro. The building models are designed as per IS 456:2000 and analyzed for seismic loads following IS 1893 (Part 1):2016 provisions. Two building models are created—Model A (without floating columns) and Model B (with floating columns introduced at selected locations). Dead loads, live loads, and seismic loads are applied as per IS 875 and IS 1893 standards. The seismic zone, importance factor, and soil type are considered Linear static analysis is performed using STAAD Pro for both models. Key parameters like base shear, lateral displacement, storey drift, and member forces are compared. The results are interpreted to assess the impact of floating columns on the seismic behavior of the structure.





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IV. EXPERIMENTAL RESULTS



Fig-1: Proposed residential building plan

Illustrates the architectural layout of the proposed G+5 multistoried residential building located in seismic zone IV. The floor plan reflects the spatial arrangement of structural elements, including floating columns introduced to allow for unobstructed space on the lower levels (typically used for parking or lobbies). The layout is optimized for both functional use and structural analysis in STAAD Pro. The plan also serves as a foundational reference for modeling in subsequent seismic evaluations.

It presents the architectural floor plan of the proposed G+5 multistoried residential building designed for analysis in seismic zone IV, with the site located in Jalandhar, India. The building footprint includes a systematic arrangement of structural elements—columns, beams, and slabs—with particular focus on the integration of **floating columns**.

The plan is divided into functional zones, allowing open spaces on the ground floor for amenities like parking or lobbies, which is achieved by placing floating columns on transfer girders or beams above this level. These columns do not continue directly to the foundation but are supported by load-bearing beams or slabs at intermediate floors. This approach creates a **vertical discontinuity**, which is a critical concern in seismic design, especially under lateral loads during earthquakes.



Fig-2:View from Z-axis

This figure presents the elevation view of the building model as seen from the Z-axis, highlighting the vertical configuration of beams and columns. It emphasizes the presence of floating columns and other vertical discontinuities in the structure. This visual is crucial for understanding how loads may be transferred differently compared to conventional column systems, and it plays a significant role in detecting potential stress concentration zones.





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Fig-3: 3D View in STADD Pro

Figure 3 Shows the complete 3D structural model developed in STAAD Pro. This model incorporates real-time parameters like material properties, load cases (including seismic loads), and boundary conditions. The figure demonstrates the geometric integrity of the model, which includes the floating columns, slab thickness, and load paths. This visualization ensures the accuracy of input data and helps in identifying structural anomalies early in the design phase.

	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	27	15 GENERAT	3	1532.063	1.317	46.938	0.010	-92.013	1.623
Min Fx	27	2 EQ Z	3	-224.557	-0.090	-30.255	-0.007	60.063	-0.129
Max Fy	54	15 GENERAT	24	-0.827	115.808	-0.241	1.773	0.110	45.537
Min Fy	54	13 GENERAT	28	-0.434	- 114.9 23	0.260	-1.764	0.111	44.224
Max Fz	75	15 GENERAT	27	924.334	2.821	52.951	-0.006	-98.019	4.874
Min Fz	71	13 GENERAT	23	907.629	2.709	-53.985	0.008	99.733	4.665
Max Mx	239	13 GENERAT	110	1.259	33.398	-0.005	1.777	0.016	15.367
Min Mx	43	13 GENERAT	19	1.259	33.398	0.005	-1.777	-0.016	15.367
Max My	71	13 GENERAT	23	907.629	2.709	-53.985	0.008	99.733	4.665
Min My	75	15 GENERAT	27	924.334	2.821	52.951	-0.006	-98.019	4.874
Max Mz	71	12 GENERAT	23	966.209	60.597	-1.534	0.112	2.782	111.032
Min Mz	262	14 GENERAT	113	966.209	-60.597	-1.534	-0.112	2.782	-111.032

Table-1: Beam End Moment of Seismic Coefficient Method

Table 1 lists the beam end moments derived using the seismic coefficient method in STAAD Pro. The data includes maximum and minimum forces and moments (Fx, Fy, Fz, Mx, My, Mz) generated under earthquake load combinations. These values are essential for assessing how different structural members respond under dynamic loading. They offer insight into the behavior of critical structural elements during lateral loading and are used to validate whether the design satisfies the performance criteria of IS 1893:2016.





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	Project_A - Beam											
Geometry	Property	Loading	Shear Bending	Deflection	Concrete Des	sign						
Beam no. = 203 Design code : IS-456												
3#1	2 @ 364.0	0 0.00 To 2	033.33	3#12 @ 364.00 2033.33 To 3050.00								
	11 # 8 c/c	135.00		11 # 8 d/c 135.00								
at 0	0.000		at 15	25.000 at 3050.000								
Desig	Mz Mz	Dist. Met	Load		Fy(Mpa)	500						
18.4	8	1.5	14		Depth(ft)	1.312335977						
-24.	53	0	14		Width(ft)	0.820209973						
-32.	9	3	12		Length(ft)	10.00656230						

Fig 4-:Beam and column Design

Figure 4 showcases the reinforcement detailing and load-displacement behavior of key structural components such as beams and columns under seismic loads. The design is executed as per IS 456:2000 guidelines. It reflects the dimensional detailing, bar placement, moment-curvature relationships, and critical design values including ultimate moments and deflections. This figure supports the seismic resilience of the structure and validates that even with floating columns, the design meets the ductility and safety requirements for earthquake resistance.

V. CONCLUSION

The seismic analysis of multistoried buildings with floating columns using STAAD Pro reveals that such structural configurations significantly affect seismic performance. Buildings with floating columns show increased storey displacements, inter-storey drift, and base shear compared to regular buildings. These vertical irregularities lead to stress concentrations and reduced structural stability under seismic loading. Therefore, while floating columns may offer architectural advantages, they must be carefully designed with proper reinforcement and seismic considerations to ensure safety and compliance with IS 1893 standards.

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