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Effect of Floating Column in High Rise Building: A Review

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Abstract: ***The usage of floating columns for additional space is a recent trend that caters to functional needs. The architectural feature known as the floating column is prone to poor performance in earthquakes. As a result, it should be avoided in areas prone to earthquakes. Earthquakes primarily affect areas with weak structures; in modern buildings, apertures are often present for lifts, lighting, and other architectural features. This review displays the results of numerous research studies. Different researchers used various floating column locations across the structure. The primary goal of research conducted by multiple researchers is to compare structures with floating columns to those without floating columns. The evaluation is performed to determine whether the building is located on the safer side or if it is subjected to lateral effects. This review of floating columns examines the behaviour and impact on the structure, as well as possible mitigation measures.***

Keywords: ***Floating Column, Earthquakes, Architectural, Lateral Effects, Impact, Mitigation***

I. INTRODUCTION

1.1 General

Various multi-story buildings are currently being built with floating columns at varied locations for the attractive view, for gaining more space in the parking lot for mobility, and for the planning of various plans at various stories [1]. The vertical section, referred to as a floating column, is supported by a transfer beam but is not directly attached to the footings. Because their load transfer channel is blocked, they are known as the "Floating Columns." [2]. To fulfil their functional requirements, multi-story buildings must include column-free spaces in the bottom floor or first floor [3]. The main requirement for designing earthquake-resistant buildings or structures with floating columns is that the buildings must be able to withstand earthquakes of low intensity without causing significant property damage or loss of life, as well as moderate earthquakes without causing significant structural damage but causing some nonstructural damage [4]. The Floating Column is meticulously designed to ensure that the final product can withstand loads and remain durable and functional throughout its lifespan, capable of tolerating external loading.

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Traditional building constructions are made to meet specific stiffness and strength standards. Numerous projects have already made use of floating columns to increase the amount of space on the ground floor [5]. These open areas might be necessary for a parking lot or an assembly hall. The beam that supports the column is under a concentrated load from the column. In seismic regions, existing constructions created with these kinds of discontinuous parts are at risk. However, instead of demolishing those buildings, research can be conducted to strengthen them. To minimise lateral distortion, the rigidity of these columns can be increased retroactively or enhanced by bracing. Many high-rise buildings are planned and built using architectural complexity [7]. The case of seismic forces calls for ductility—the ductility and energy dissipation of a structure increase with its plastic deformability without collapse. As a result, the earthquake's actual forces are reduced. Due to space limitations, the idea of horizontal structure development is becoming obsolete. The era requires the adoption of vertical systems (tall buildings, floating column buildings, and retail malls. The behaviour of a structure during an earthquake is primarily governed by its general shape, scale, and geometry, as well as how seismic forces are transmitted to the ground. In framed structures, a column is typically built to distribute load from one column to another of a different story, then to the foundation, and eventually to the soil. With a floating column, there is no direct transmission of load. These columns will be positioned so that they hang from a base with no fixed supports, transferring the weight to the foundation. Poor building performance occurs when there is any variation or discontinuity in this load transfer path. Different structural systems like bracing [18], shear wall [7], triangular plate [3] can be used to minimize the effect from floating column.

1.2 Floating Column

A floating column is a vertical element that transfers load from one beam to another. They are a specific kind of column that is built over a beam or slab of any middle level of a building and is not supported by any footing. They are also known as hanging columns. They do not transfer the load to the foundation immediately. Instead, they serve as a point load by transferring the load to the beam or slab on which they are built [9]. When an underlying portion is upright but does not transmit the pile to the formation after unwinding on a pillar, a gliding segment is used. It acts like a light load on the Beam, transmitting mass to a vertical section beneath the surface via the base frame and the level part. The gliding phase can begin when lying on a bar on any floor or a standard floor. In any incident, the key aspect that differs from usual is where the coasting part rests on the shaft [10].

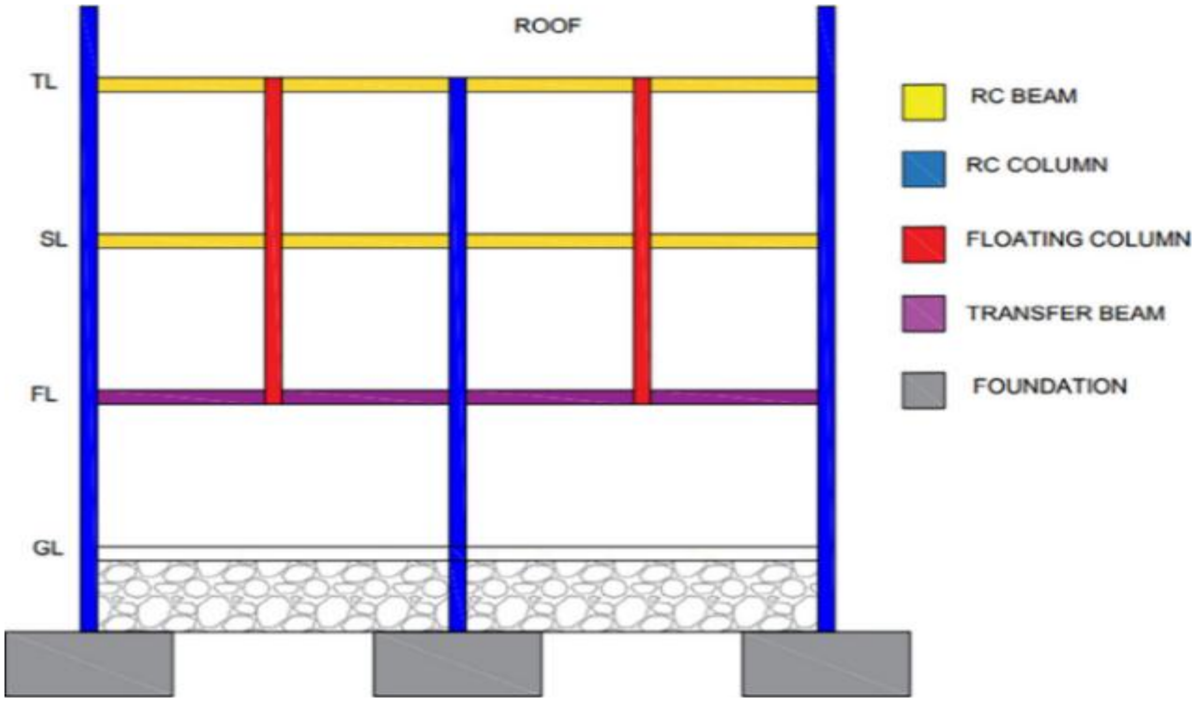

Fig 1: Floating Column [10]

II. ANALYSIS OF BUILDING A FLOATING COLUMN

The columns, beams, and slabs of a residential building with 6 and 12 stories are evaluated. Building bases were examined and created, both with and without edge columns. To compare an outcome, static load combinations and response spectrum analysis were performed. Results in various seismic parameters were compared [1]. The project, which involved conducting research into the framing of buildings with floating columns, has been completed using an existing residential building comprising G+10 structures. The software STAAD Pro 8Vi was used to create the aforementioned building models, and an equivalent static technique was used to analyze them [2]. The performance of 10-storey buildings with and without floating columns for different zones was studied and analysed. The software and the literature were validated, and further cases were investigated based on the validation results. For the medium soil location, various models have been constructed and analysed for both lower and higher seismic zones. Plots were made of the data for various seismic parameters [3]. Designs for multi-story structures with floating columns and without floating columns are built to perform comparative research of various structural parameters under seismic excitation, and this study examines the influence of floating columns on the structure [5]. A brief analysis of the building, both with and without a floating column, is carried out. Using the ETABS standard Finite element analysis program, floating columns are positioned at various story levels and locations throughout the structure for various seismic excitations. Comparisons are made between several seismic excitations for the final results, including maximum story displacement, maximum inter-story drift, story base shear, and overturning moment. The safest and most cost-effective way to lower the price of the floating column beam is proposed [6]. A conventional building and floating column buildings were analysed to highlight the performance of the latter under seismic loads. The response spectrum method has been used in a research study to conduct static and dynamic assessments for multi-story buildings with and without floating columns. By changing the floating column's placement and increasing the column size, several building instances have been examined [12]. Critical load combinations are discovered in this seismic analysis paper study. The building was modelled according to the design to study the effect of various loads in different earthquake zones, and floating columns are provided at multiple locations throughout the building. In the analysis, four examples are considered: the first without a floating column, the second with an internal floating column, the third with an external floating column, and the fourth with a floating column at a different floor level [13]. G+14 study is conducted on typical buildings without any floating columns and buildings with floating columns on each floor, with the floating columns provided on the inner and corners of each floor. The buildings in this area are designed to ensure safety while incorporating floating columns on each story. The size of the beams and columns varies and has been adjusted to ensure the building's safety while giving floating columns on each story [14]. G+3 structures with hanging columns were studied for their behavior. They examined how mass variations and infill walls impacted the behaviour of regular and floating column buildings. A fourth of a typical floor was given more mass than the other portions, and various building models with and without infill walls were investigated [15]. Symmetrical G+8 structures were analysed for structural irregularities caused by floating columns and to determine the best solution to reduce the risk of earthquake excitation. E Tabs finite element software was used for the analysis. The software was used to perform response spectrum analysis [16]. The nodal displacements are minimal, and the stresses are distributed evenly throughout all of the beams and columns in the framed construction without floating columns [17]. Introducing a Floating Column at an alternate level, internal part, and external edge, they used E-Tabs software to calculate forces, displacement, and moments.

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According to the study's findings, the presence of internal and external floating columns increased torsion values on all floors. The use of alternate floor floating columns reduced torsion values. There was an increase at the column's edge but a decrease at the intermediate column due to the inclusion of internal floating columns. The outcomes for the alternative floor, Floating Column, were opposed [19]. Static and dynamic analyses of a multi-story building with and without floating columns are carried out utilising the response spectrum approach. By adjusting the location of floating columns both vertically and within the floor, several construction scenarios are explored. It is explored how the building models respond structurally to different parameters [20]. Building models with and without floating columns for multistory buildings were developed to compare structural parameters under seismic excitation. Their research looks into the impact of floating columns in construction. Their primary goal is to examine the G+5 story building with floating columns at various locations, as well as to assess the seismic parameters of floating columns at these locations [22].

III. STRUCTURAL SYSTEM FOR STRENGTHENING OF FLOATING COLUMN

A. Shear Wall

A shear wall is a structure designed to withstand shear caused by lateral forces or seismic stresses. Shear walls are frequently present in tall structures [8]. It will start at the ground level and extend to the height of the building. Shear walls can range in thickness from 150 mm to 400 mm. Shear walls are positioned vertically like wide beams to withstand lateral stresses pushing down toward the base. Shear walls are typically provided by the width and length of the buildings. Shear walls are used when the difference between the building's centre of gravity and the load it carries exceeds 30%. As a result, concrete shear walls will serve as the supporting structures for the centre of gravity [7]. Shear walls often have a flat or flange area, while a centre wall is primarily made of C-sections. Additionally, they provide sufficient strength and control lateral displacements caused by stiffness. The plane and shape positions of the shear wall are mainly considered when determining how the design will be presented [11].

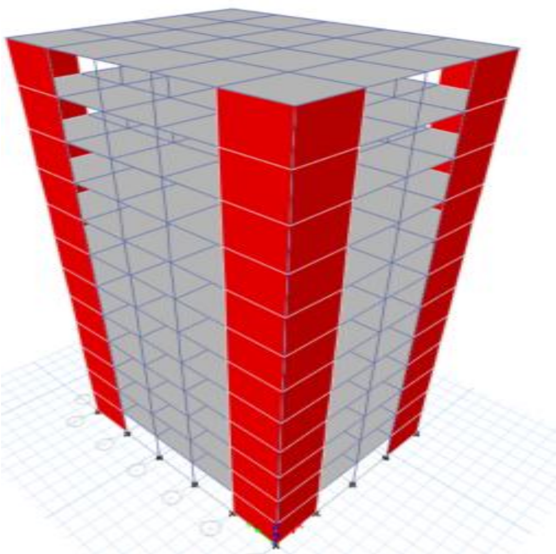

Fig 2: Shear Wall [10]

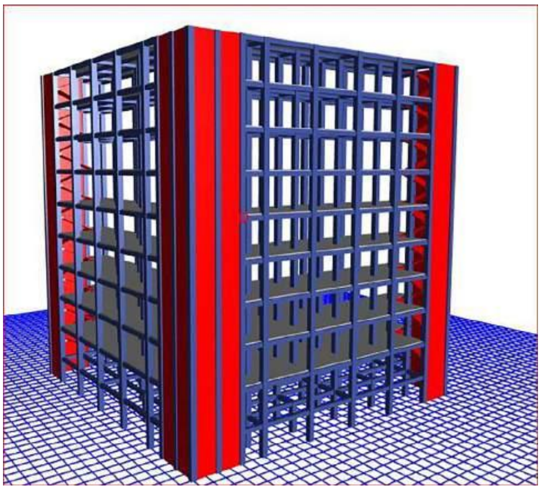

Fig 2.1: Shear Wall [11]

B. Triangular Plate

The use of triangular plates is beneficial in constructing floating columns. Compared to the Model with a standard building, the Model with a building that has a floating column given at a corner on the ground floor has a lower average value of displacement. Buildings with floating columns provided at corners on the ground level with triangular plates were found to have lower values of storey drift than models without floating columns at corners on the ground floor [3]

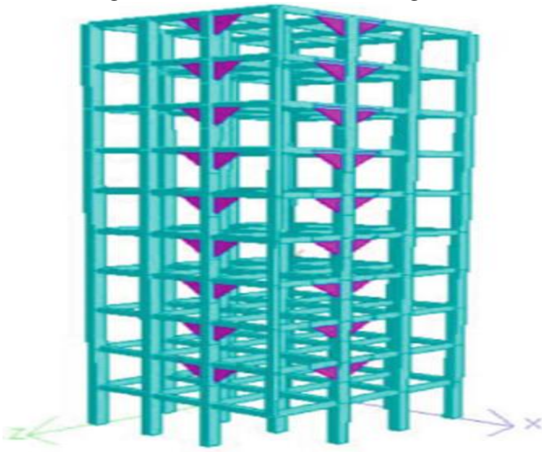

Fig 3: Building with a floating column at the ground floor's corner and a Triangular Plate. [3]

C. Bracing

The moments in columns tend to increase as the building parameters do, resulting in a reduction in building strength when floating columns are present. Focuses on identifying the presence of floating columns in multistory structures and how to lessen the risk factor of earthquake effects by strengthening the foundation of the building with bracing [18]. A strong emphasis has been placed on identifying floating columns in multistory structures and how to minimise the chance of seismic hazard by bracing structures with floating columns [21]. The effectiveness of various bracing configurations in strengthening or eliminating floating columns was investigated [22]. The impact of a floating column on different Inverted V-braced frame sections under earthquake excitation was investigated.

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To achieve their stated goal, linear static and dynamic analyses are performed for multi-story frames with floating columns to determine the reactions (effects) and considerations for a reliable and cost-effective structure design under various seismic excitations [23].

IV. RESULT AND CONCLUSION

The above study led to the following conclusions:

i. Buildings with floating columns experience larger displacements over time than regular buildings. As a result, floating column buildings are riskier than regular buildings.
ii. Following a building analysis, a comparison of the amounts of steel and concrete is computed. Thus, compared to a typical building, the floating column construction is not economically viable.
iii. The interior floating column placement lessens the seismic risk of the building compared to the exterior periphery of floating column placement.
iv. A building with a floating column experiences less base shear than a building without a floating column.
v. The model displacement values are increasing for floating column buildings, particularly corner floating column buildings. It is found that story displacement increases with increasing building height. As story displacement rises, so does story drift.
vi. A floating column placed in a different location alters the dynamic reaction. Structures with floating columns are more susceptible to earthquake damage than structures without floating columns. According to an analytical study, corner provisions floating columns on the ground floor are the worst-case provisions.
vii. Buildings with floating columns can be constructed more easily on complex soil types
viii. Because of the weight reduction from bottom to top floors, lower floors will experience greater story shear than higher floors.
ix. Story drift, time span, story shear, and removal were all significantly improved by up to 30% when using the shear wall to improve the seismic performance of a multi-story structure with various boundaries.
x. In frames with floating columns, it is discovered that bracing is very effective at imparting lateral stiffness and guaranteeing continuity of the load path. The increase in deflection due to the introduction of a floating column can be minimised by using bracing.
xi. The use of triangular plates helps to reduce the average value of displacement in floating column construction. When a triangular plate is used, story drift is also reduced.

DECLARATION

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Authors Contribution	All authors have equal participation in this article.

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