International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-12 Issue-6, May 2023

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 responds poorly to earthquakes. As a result, it should be avoided in areas prone to earthquakes. Earthquakes affect mostly where there is a weak structure; in modern buildings, apertures are widespread 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 main goal of research conducted by various researchers is to compare structures with floating columns and without floating columns. The evaluation is done to see if the building is on the side that is safer or if it is subjected to lateral effects. This review on floating columns examines the behavior 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 story [1]. The vertical section termed as a floating column is supported by a transfer beam but is not 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] Floating Column is meticulously created to ensure that the final design can handle loads and will be durable and functional throughout its lifespan to tolerate external loading. Traditional building constructions are created using stiffness and strength standards.

Manuscript received on 26 April 2023 | Revised Manuscript received on 06 May 2023 | Manuscript Accepted on 15 May 2023 | Manuscript published on 30 May 2023.
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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 in risk. But instead of demolishing those buildings, research can be done to make them stronger. To lessen lateral distortion, the rigidity of these columns can be raised retroactively or given 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 deform ability 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 behavior of a structure during an earthquake is mostly governed by its general shape, scale, and geometry in addition to how the 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. While 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 from any variation or discontinuity in this load transfer path. Different structural system 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 start off when lying on a bar on any floor or on some other average floor. In any incident, the key aspect that differs from usual is where the coasting part rests on the shaft.[10]

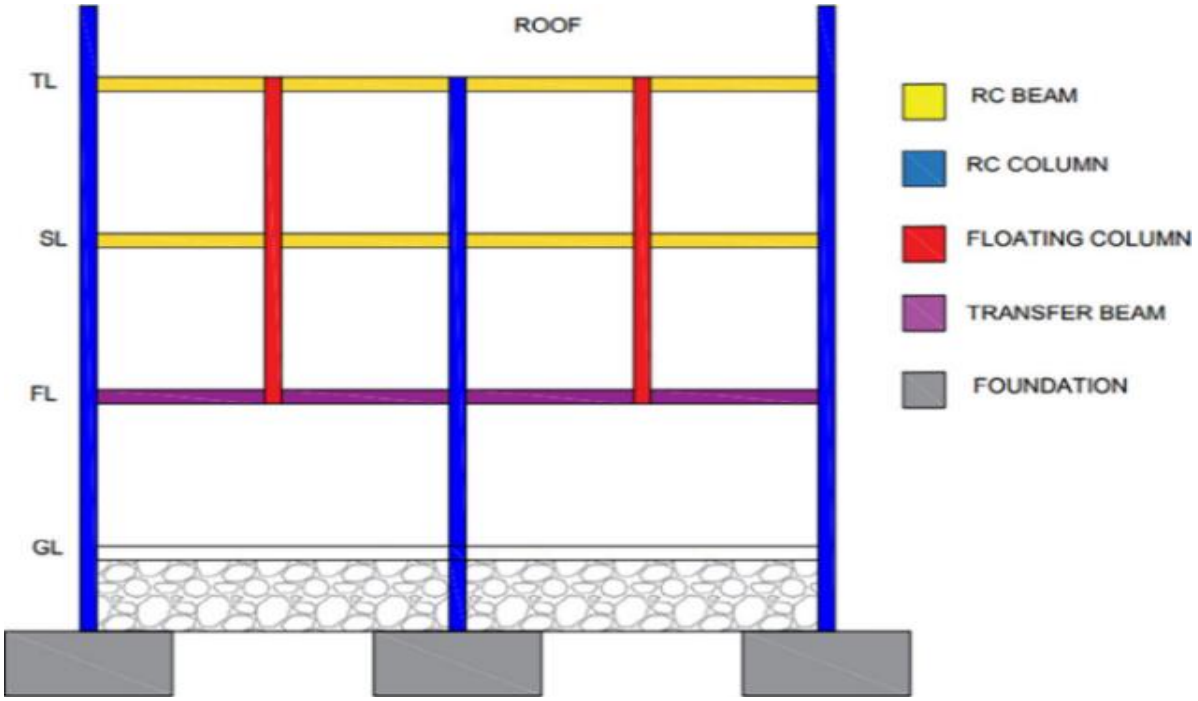

Fig 1: Floating Column [10]

II. ANALYSIS OF BUILDING FLOATING COLUMN

The column, beams, and slabs of a residential building of 6 and 12 story are evaluated. Building bases were examined and created both with edge column 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 work to conduct research into the framing of buildings with floating columns has been completed using an existing residential building made up of 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 column for different zones were study and analyze. The software and the literature were validated, and further cases were studied based on the validation results. For the location of medium soil, various models have been constructed and analyzed for the lower and higher seismic zones. Plots were made of the data for various seismic parameters.[3]. Designs for multi-story structures with floating column and without floating columns are built in order to perform comparative research of various structural parameters under seismic excitation, and this study examines the influence of floating columns in structure [5]. A brief analysis of the building both with and without floating column is carried out. Using the ETABS standard Finite element analysis programmed, floating columns are positioned at various story levels and locations throughout the structure for various seismic excitation. Comparisons between several seismic excitation are made for the final results for 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 to floating column buildings and highlights the performance of the latter under seismic load were analyzed. The response spectrum method has been used in 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 modeled as per design to study the effect of various loads in various Earthquake zones, and floating columns are provided at various 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 normal buildings without any floating columns and buildings with floating columns on each floor, with the floating columns provided on the inner and corner of each floor. The buildings in this area are structured in such a way that they are safe while also having floating columns on each story. The size of the beams and columns are 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 looked at how mass variations and infill walls affected the behavior 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]. A symmetrical G+8 structures were analyzed for the structural irregularities caused by floating columns and 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 Floating Column at an alternate level, internal part, and external edge Using E-Tabs software, they calculated forces, displacement, and moments.

Retrieval Number: 100.1/ijitee.F95570512623
DOI: 10.35940/ijitee.F9557.0512623
Journal Website: www.ijitee.org

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According to the findings of their study, internal and external floating column increased torsion values on all floors. Torsion values were reduced by the use of alternate floor Floating columns. 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 diametrically opposed [19]. Static and dynamic analysis of a multi-story building with and without floating columns are carried out utilizing the response spectrum approach. By adjusting the location of floating columns both floor-wise and inside the floor, several construction situations 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 in order 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 check the seismic parameters for floating columns at various 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 be started at the ground level and extended to the height of the building. Shear walls can range in thickness from 150mm to 400mm. 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 offered when there is a difference between the building's centre of gravity and the load it carries of greater than 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 flanges area, while a center wall is primarily made of C-sections. Additionally, they provide enough strength and control lateral displacements brought on by stiffness. Plane and shape positions of the shear wall are primarily taken into consideration when considering how the design will be shown.[11]

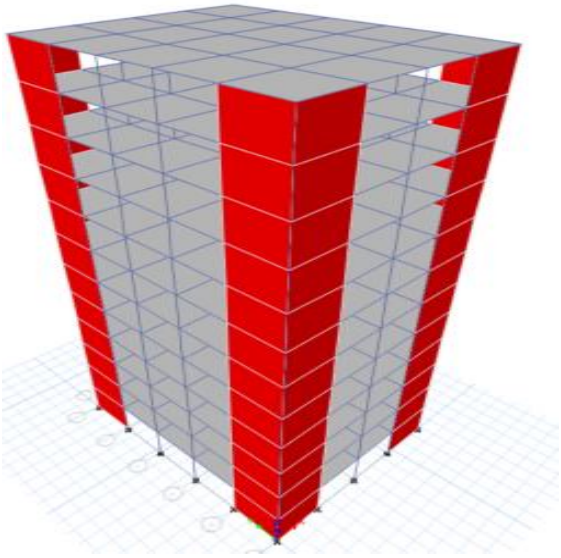

Fig 2: Shear Wall [10]

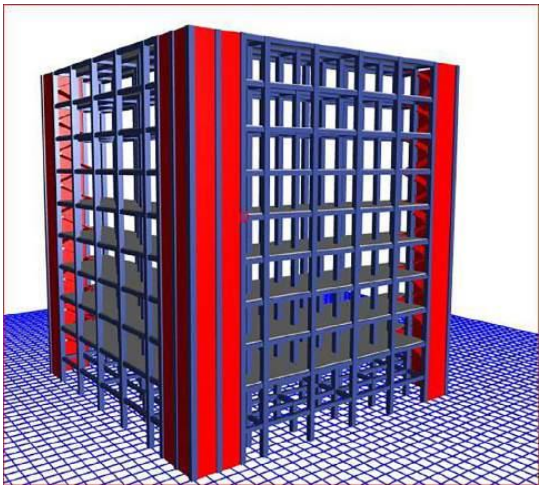

Fig 2.1: Shear Wall [11]

B. Triangular Plate

The use of triangular plates is beneficial in the construction of 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]

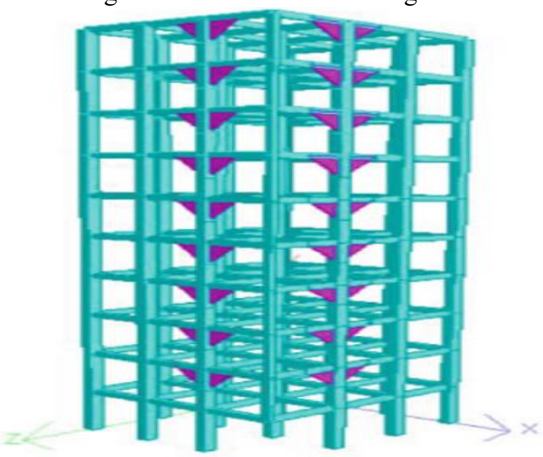

Fig 3: Building with a floating column at the ground floor's corner and a Triangular Plate. [3]

C. Bracing

The moments in columns, the building parameters tend to increase, resulting in a reduction in building strength with the present of floating column. Focuses on identifying the presence of floating columns in multistory structures and how to lessen the risk factor of earthquake effects by strengthening the floating columns building with bracing [18].A strong emphasis has studied on identifying floating columns in multistory structure and how to minimize the chance of seismic hazard by bracing structures with floating columns [21]. The effectiveness of various bracing configurations in strengthening or eliminating floating columns were investigate [22]. The impact of a floating column for different Inverted V Braced frame sections under earthquake excitation were investigate.

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To achieve their stated goal, linear static and dynamic analysis is performed for multi-story frames with floating columns to determine the reactions (effects) and considerations for reliable and cost-effective structure design under various seismic excitation. [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 normal building, the floating column construction is not economically viable.
iii. The interior floating column placement lessen the seismic risk of the building compared to 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 as building height increases. As story displacement increases, 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 hard 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 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 increased in deflection due to introduction of floating column can be minimized 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

Funding/Grants/ Financial support	No, I did not receive.
Conflicts of interest/ Competing interests	No conflicts of interest to the best of our knowledge.
Ethical approval and consent to participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of data and material/Data access statement	Not relevant.
Authors Contribution	All authors have equal participation in this article.

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