iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** II **Month of publication:** February 2023

DOI: https://doi.org/10.22214/ijraset.2023.49188

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue II Feb 2023- Available at www.ijraset.com

Seismic Analysis of a Floating Column with Two Different Position of Building Using Software's

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Abstract: ***In present scenario buildings with floating columns is typical features in the modern multi-storey construction in urban India. Such features are highly undesirable in building built in seismically active areas. This study highlights the importance of explicitly recognising the presence of the first storey and the storey above, are proposed to reduce the irregularity introduced by the floating column. The behaviour of concrete structures is more vulnerable with the effect of floating columns resulted in failure of structures and severe damaged. The present project work is to the find the severity and effect of floating columns on the parameters of support reactions, axial forces, displacements, shear forces and twisting moments.***
In this paper using 3D finite element method & Matrix Displacement method seismic analysis of floating column With two different position is done for a multi-storey building. The structural response of the building models with respect to, base shear and storey displacements is investigated. The analysis is carried out using software ETABS & STAAD-PRO
Keywords: Floating column, Finite Element method, Matrix Displacement Method, Etabs, Staad-Pro

I. INTRODUCTION

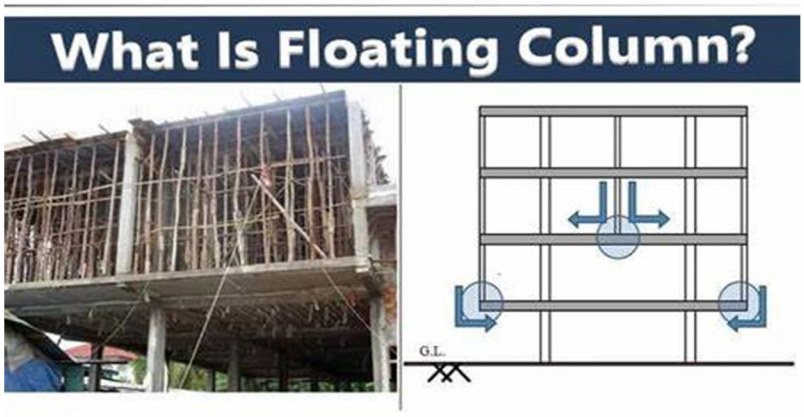
Due to space constraints, population growth, and other factors, multi-story structures in metropolitan areas must now feature column-free space. This is necessary for both functional and aesthetic reasons. At one or more floors, floating columns are given in buildings. In a building constructed in a seismically active area, these floating columns pose a significant risk. The shortest path must be used to carry the seismic forces that are generated at various floor levels in a building down to the ground. A building performs poorly if this load transfer path deviates from it or becomes interrupted. The way an earthquake's forces are transmitted to the ground, the building's general shape, scale, and geometry all affect how it moves during an earthquake. During the Gujarat earthquake of 2001, numerous structures with an open ground floor designed for parking collapsed or sustained damage. A column is a vertical building component that supports the foundation underneath it by bearing the weight of parallel beams attached to it. Floating Column: A floating column is a vertical element without a basis that sits on a beam. Many urban multi-storey buildings in India, today have open first storey as an unavoidable feature and primarily being adopted to provide lodgings for parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is reliant on its natural period, the seismic force distribution is dependent on the dissemination of stiffness and mass along the height.

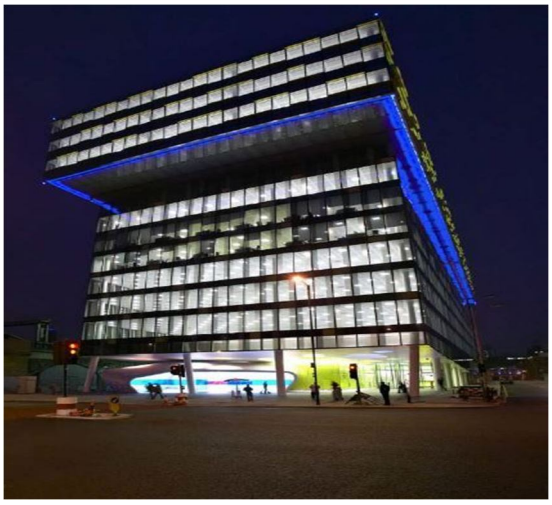
A building's behaviour during earthquakes can be significantly influenced by its overall design, scale, and geometry, as well as by how the earthquake forces are transmitted to the ground. Any deviation from this load transfer path or disconnection between it and the ground causes the building to perform poorly. Earthquake forces that occur at various floor levels in a building must be sent down along the height to the ground by the shortest way. Buildings with vertical setbacks, such as hotel towers that are a few storeys wider than the rest, create an abrupt increase in earthquake forces at the level of incoherence. Buildings with unusually tall storeys or those with a particular story that has few columns or walls are more likely to suffer damage or collapse. There are gaps in the load transfer path in structures with columns that sling or hover on beams at an intermediate floor rather than extending all the way to the foundation. In tall buildings, the ground floor and first floor columns are replaced to allow for a greater opening at ground level and to improve access to the public space at the base. Some Eastern European academics proposed the soft base level in the 1950s and 1960s in order to attain the huge apertures at the bottom level. In this type of structure, a frame is constructed at the base to support the top structure. Although it is believed that this type of structure performs better during earthquakes, it has been shown via recent experiences that this idea is false. Many of these structures shifted following the Romania earthquake in 1978. A column is defined as a vertical element that begins at the foundation and disperses the weight to the ground. Similar to a floating column, a floating column is a vertical component that ends at the ground level (termination level) of a structure. owing to an architectural need and its support by a beam. The columns below the beams take over the load in turn.

In actuality, the columns below the termination level, which is typically the stilt level, are not as carefully constructed and are more prone to failure. The employment of transfer girders to gather the vertical and lateral load from the high-rise building element and then distribute it to the widely spread column allows for a greater aperture at the ground floor level to be obtained at the moment. However, in the analysis of the transfer girder, taking into account the impact of interacting force demands thorough modeling in order to have a better grasp of the structural behaviour and examination. This is because it is outside the scope of simple and approximative formula development. In past, transfer girder was considered as RC member. But then past many year the transfer girder is designed as PC member as of its 2 advantages over the RC member. For floating columns, the transfer girder and columns supporting transfer girder desires exceptional attention. If load factor needs to be augmented for transfer girder and its columns to have additional safety of structure, shall be adopted. In the given system, floating columns must not be treated to carry any earthquake forces. Therefore earthquake forces are resisted by column/shear wall without considering contribution of floating column. In this manner, the entire system is given some seismic safety. However, floating columns are strong enough to support gravity loads, but transfer girders need to be of the right size and exhibit the least amount of deflection. Despite the fact that the floating column is only safe under lateral loading, they are used in many projects. Particularly in earthquake-prone areas, transfer girders need to be adequately designed and detailed. When there are no lateral loads, design and specification are not difficult. The 3-D study of the transfer girder is necessary to comprehend its appropriate behaviour, and extreme caution must be used at the connection where the floating column meets the transfer girder.

II. WHAT IS FLOATING COLUMN

A column is a vertical member which transfers the loads from beam to foundation whereas a floating column is a vertical member which transfers the load from beam to another beam. The load transfer in any building is usually from slab to beams to columns and then foundation. But a floating column, instead of transferring the load to foundation transfers the load on to the beam. The beam on which the floating column rests transfers the load to the columns below. The load is transferred in the form of a point load.





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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue II Feb 2023- Available at www.ijraset.com

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III. NEED OF FLOATING COLUMN

The lateral forces due to earthquake need to be transferred to the foundation through clear force transfer path. This force transfer path is disrupted in case of floating columns. These floating columns attract a lot of seismic force, which is unfavourable in the high seismic zone. The floating columns act well when only vertical forces are considered. But they are highly undesirable for lateral forces such as earthquake. It is highly discouraged to have floating columns in high seismic zone region. But even then, we see a lot of buildings be it residential, commercial or industrial using floating columns in their construction. And the only reason being the flexibility to alter the plan above or be w to suit the client requirement. This is where our knowledge and art of structural engineering comes into play. So , in this situation, it is the job of structural engineers like us to ensure that such buildings are not only analysed properly but the detailing of such buildings is also done properly. Detailing of the steel becomes a crucial part of floating column construction. Floating columns, though highly discouraged, are still an important part of the construction industry. It is in our hands to ensure correct analysis and design of this structural member. It is our responsibility to ensure that the detailing of this structural member and the girder beam supporting this floating column is done properly.

IV. NEED FOR THE PROPOSED WORK

Construction of multi-story buildings for residential, commercial, or industrial purposes is becoming a typical occurrence. These multi-story buildings require a lot of parking or open space at the ground level.

Some columns from the floors above cause issues in multi-story inhabited buildings that need to accommodate the number of parking spaces and the turning radius. These columns are created as floating columns in such circumstances. There may be a demand for a conference room or banquet hall on the lower floors of a commercial structure. For these reasons, we prefer a clear, unobstructed area than one with columns in between. Floating columns enter the picture in this situation. The ability to change the floor plans above is made possible via floating columns.

V. LITERATURE REVIEW

Literature based on the modelling of multi-storey building using floating column and transfer beam under seismic behaviour. From the detailed literature review, inference is studied.

Kishalay Maitra, N.H.M. Kamrujjaman Serker (2019) studies contemporary multi-tiered structures and floating columns are an inevitable feature of buildings Such features are highly undesirable in buildings constructed in seismic areas This study focuses on the performance of floating column structures and compares them with normal structures under seismic loads. In this study, static and dynamic analyzes were performed using the response spectrum method for tall buildings with and without floating columns Different cases of building were studied by changing the position of the floating columns and increasing the size of the columns. As a result, the floor displacement of the floating column method increased by 56.96% compared to the conventional method. Irregularities in torsion were observed when the floating column was inserted asymmetrically.

In addition, it was found that the foundation construction period at the time of floating column construction became longer, and the lateral rigidity at the time of floating column construction decreased. Floating column construction takes longer than normal construction. From the mode shapes, it is observed that the torsional modes are detected earlier when the floating column is designed asymmetrically compared to the normal symmetric structure of the floating column.

Gulchaman Khan, Prof Mayur Singi (2018) explained why he considers three times his high-rise homes of 8, 12 and 16 stories. All three instances were considered for hanging columns with and without sliding partitions, and for zone V the use of ETABS 2016 software was also analyzed. This observation indicates that as the building's FSI increases, the suspension column supply is good, but it is a volatile component, making the building more vulnerable. From his evaluation, Miles observed that the building's lateral shift and floor shift spiked from low to better zones. Using shear walls reduces these parameter values for all models. Floating column houses add floor float and displacement because mass is accelerated when columns are removed, which also increases drift and displacement. All four railroad crossings are reinforced with shear walls to ensure complete stability with respect to lateral displacement and floor movement. Resolved in terms of earthquakes.

Gulchaman Khan, Prof. Mayur Singi (2018) discussed the causes of three times of multi-storey houses are taken into consideration having 8 storeys, twelve storeys and sixteen storeys. All the 3 instances are taken into consideration having hanging columns furnished with and without shear partition, and moreover analyzed for zone V the usage of software ETABS 2016 .observation shows that the supply of hanging columns is nice in growing FSI of the building however is a volatile component and increases the vulnerability of the building. Its miles observed from the evaluation that lateral displacement and storey drift of the constructing will boom from decrease to better zones due to the fact the significance of depth might be more for higher zones. Through the usage of shear wall those parametric values reduce in all of the models. The storey float and displacement is extra for floating column homes due to the fact as the columns are eliminated the mass receives accelerated and therefore drift and displacement also will increase. As we have provided the shear walls at all the four junctions which makes it total stable in both the aspects lateral displacement as well as storey drift as we have provided shear walls at all the junctions which provides more strength up to 70% problem is solved for the seismic point of view.

Udhav B (2015) in their paper analysis of multi-storey building with floating column studied the behaviour of an existing structure which was a G+10 residential building. Various building models were created using STAAD Pro software and analysis was done using static method. The systematic building models comprises of all the modules which effect the mass, deformability, stiffness and finally the strength of structure. The structural building system consists of a column, block, wall, beam, elevator, staircase, slab, footing and retaining wall. The results shows that the column shear Changes in accordance with the condition and location of column, also the curvature at every single floor or storey rises and shear force gradually rises but it is almost equivalent at every floor for respective columns.

Sasidhar T (2017) performed the analysis of buildings using program ETABS. They considered a housing building G+5 and different cases of elimination of columns in dissimilar positions and in various floors of the housing building. Equivalent analysis is done on a mathematical model and results are related or compared with the existing building model. It was concluded that, the use of floating columns results in increased shear, increased bending moments and increased steel requirements of the buildings.

Ms. Waykule S.B (2016) in their study of performance of floating column for seismic analysis of multi-storey concrete building performed the analysis and evaluation of building with and without floating column in highly seismic prone zone v. 4-models were produced by changing the place of floating column. Linear static and time history analysis were performed on all the four models and the results were compared with each other. From time history analysis, response of all the 4-models were plotted. In this paper, they concluded that, the floating column at dissimilar position results into dissimilarity in dynamic response and building with floating column has much more storey drift in comparison with conventional one.

Priyanka D. Motghare (2019) this paper pertains of analytical studies carried out to evaluate the performance of RCC frame under different position of floating columns. Building with a column that hangs or floats on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transf

Mandwale S. et al. (2020) have done Response spectrum analysis of G+5 using ETABS 2016 software. The author has compared Normal Building and Building with FC. Columns were eliminated at outer edge on ground floor. Various Load combinations were taken as per Indian standard 456:2000.This Study concluded that the value of storey drift and time period were more in case of FC column building.

Pundir A et al. (2020) have modeled G+15 and G+20 Steel structures with eight different cases. He has introduced Mass irregularity on the alternate floor of different models and compared their results. After placing the heavy mass, there was 7% decrease in maximum displacement was observed on the 13th floor as compared to the building having no mass.

The bending moment was also increased by 15.8% on the 13th floor. He has also mentioned the increase in steel quantity due to the increment in mass. Similarly, he also calculated these parameters by placing heavy mass on the second and seventh floor. Hence this study concludes that an increase in the total weight of a building increases its lateral stability.

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Yamini et al. (2021) have done a literature survey on floating column buildings. Further Author concluded that FC affects the building parameter due to irregularity of structure. Maximum researchers in this Review have adopted shear walls to compensate for the effect of FC. It was also observed that Shear walls were effective below G+10 storey. She also concluded that FC creates more damage in ZONE IV& V. The effects were satisfactory in Zone III if extra techniques are used.

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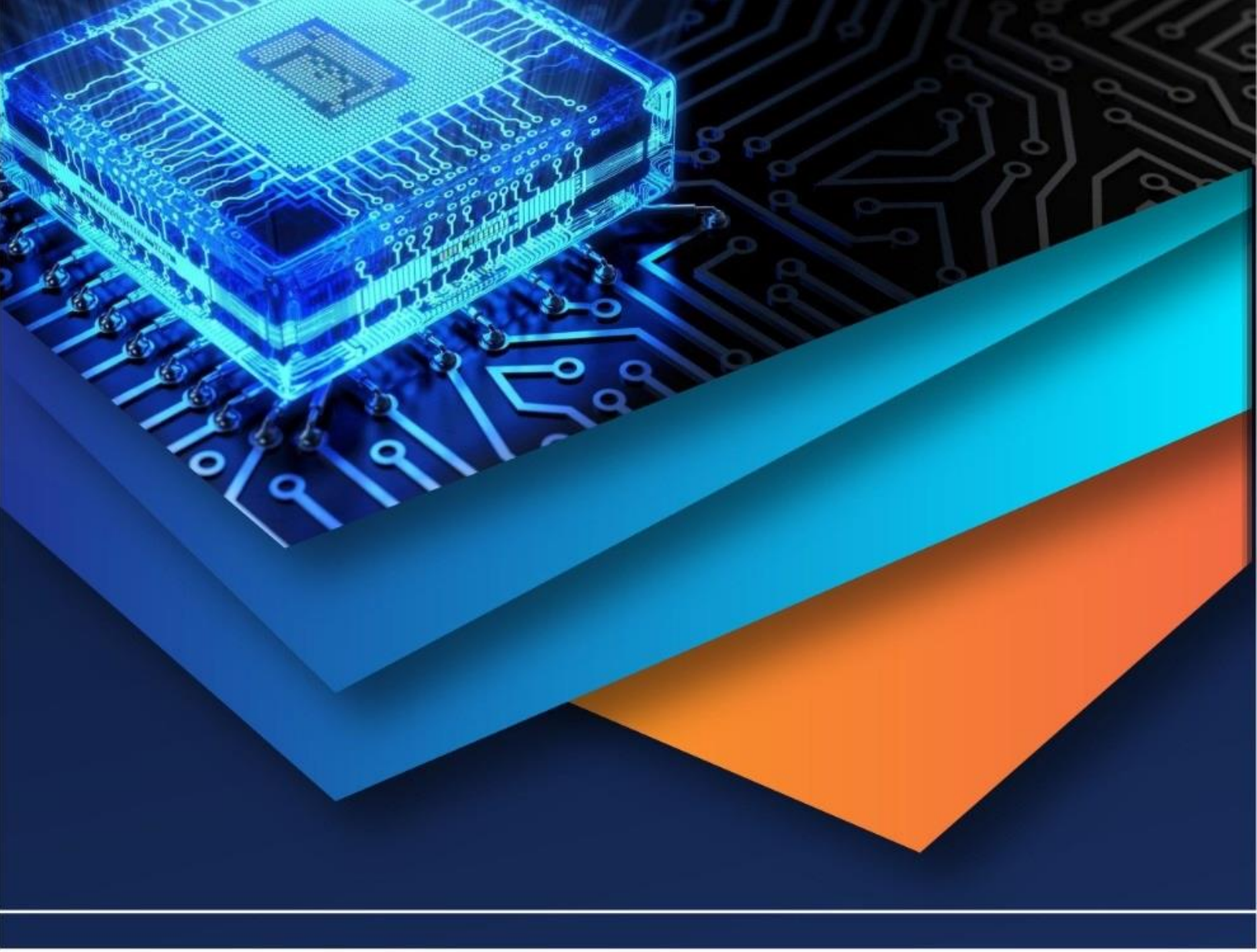

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