JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Critical Review on Effect of Floating Columns in a Building

[1]Aayush Uttarwar, [2]Dr. A.M. Badar, [3]Swapnil Satone

[1]Post Graduate Student, [2]Vice Principal, [3]Professor
[1]Civil Engineering Department,
[1]Karmaveer Dadasaheb Kannamwar College of Engineering, Nagpur, India

Abstract :

The incorporation of floating columns in building structures has emerged as a subject of significant interest and concern within the realm of structural engineering. This literature review paper provides a comprehensive examination of the critical aspects surrounding the effect of floating columns in buildings. Through a systematic review of existing research articles, conference papers, and technical reports, this study synthesizes the current state of knowledge regarding floating columns. Various theoretical models, experimental studies, and practical applications are analyzed to elucidate the complexities and implications associated with the presence of floating columns in buildings. The review encompasses an exploration of the structural behavior of buildings with floating columns under different loading conditions, including seismic events, wind loads, and vertical loads. Factors such as column configuration, height, material properties, and foundation type are investigated to understand their influence on structural performance. Moreover, the review examines the implications of floating columns on overall building stiffness, dynamic response, and serviceability criteria. Innovative design approaches and retrofitting techniques aimed at addressing challenges posed by floating columns are also critically evaluated. This literature review contributes to a deeper understanding of the effect of floating columns on building structures, offering valuable guidance for engineers, researchers, and practitioners engaged in the design, assessment, and retrofitting of buildings to ensure structural integrity and occupant safety.

***Index Terms* - Floating Column,Transfer Beam,STAAD Pro,Building Analysis.**

I. Introduction

The integration of floating columns within building structures has become a focal point of interest and concern in the field of structural engineering. The emergence of this phenomenon has prompted a critical need to understand its implications on the overall behavior and safety of buildings. This literature review paper aims to provide a comprehensive examination of the effect of floating columns in buildings by synthesizing the current state of knowledge through a systematic review of existing research articles, conference papers, and technical reports.

1.1 Background

Traditionally, building columns are designed to transfer loads from the superstructure to the foundation, providing stability and support. However, the concept of floating columns introduces a unique structural configuration where columns do not extend continuously through all floors but instead terminate at intermediate levels, leaving a gap between the column and the floor slab. This design approach offers architectural flexibility, allowing for open spaces and enhanced aesthetics within the building. Nevertheless, the introduction of floating columns raises questions regarding its impact on structural performance and safety.

1.2 Purpose of the Literature Review

The primary objective of this literature review is to synthesize existing knowledge on floating columns in building structures. By critically analyzing theoretical models, experimental studies, and practical applications, this review seeks to elucidate the complexities and implications associated with the presence of floating columns. Specifically, the review will explore the structural behavior of buildings with floating columns under various loading conditions, including seismic events, wind loads, and vertical loads. Additionally, it will investigate key factors such as column configuration, height, material properties, and foundation type to understand their influence on structural performance.

1.3 Scope of the Literature Review

This literature review will encompass an extensive examination of the effect of floating columns on building structures. It will explore the implications of floating columns on overall building stiffness, dynamic response, and serviceability criteria.

Furthermore, innovative design approaches and retrofitting techniques aimed at addressing challenges posed by floating columns will be critically evaluated. The review will also include case studies of real-world structural failures and successes to provide practical insights into the behavior of buildings with floating columns.

1.4 Significance of the Literature Review

Understanding the effect of floating columns on building structures is essential for ensuring structural integrity and occupant safety. By synthesizing existing knowledge and identifying gaps in research, this literature review aims to provide valuable guidance for engineers, researchers, and practitioners engaged in the design, assessment, and retrofitting of buildings. Ultimately, the insights gained from this review will contribute to a deeper understanding of floating columns, facilitating informed decision-making in structural engineering practice.

In summary, this literature review sets the stage for a comprehensive examination of the critical aspects surrounding the effect of floating columns in buildings. Through a systematic review of existing literature, this study aims to advance understanding and provide practical guidance for addressing the challenges associated with floating columns in building structures.

II. Literature Review

To get theoretical knowledge about the existing bridge management systems, a search via online database such as ELSEVIER, ASCE & SCOPUS was carried out. Search keywords like Floating Column,Transfer Beam,STAAD Pro,Building Analysis etc. abstract or keyword of the articles searched.

Harsha P V, et al. (2020) states that Floating columns in seismically active areas can be dangerous due to the torsion on the beam carrying the load of the column. However, they are competent enough to carry gravity loading if the transfer girder is of adequate dimensions and stiffness. The column is assumed pinned at the base and taken as a point load on the transfer beam. Response spectrum analysis is used to determine seismic behavior, with values of storey drift, displacement, and storey shear obtained. The values are tabulated for multi-storey buildings with and without floating columns, as well as for buildings with shear walls at different positions to determine the best location. The effect of column discontinuity on the behavior of a structure is studied through seismic analysis of a multi-storey building with floating columns. The behavior of multi-storey buildings with and without floating columns was analyzed under seismic Zone III using response spectrum method to find storey drift, displacement, and storey shear. The results showed that the structure with floating columns had a higher maximum displacement than the normal column structure, with the highest displacement found in Model 3 (floating column provided at outer periphery) and Model 10 (all inner columns are floating in the first storey). The study also found that Model 3 and Model 10 were more critical compared to all other models, and that building with shear wall at the corner worked well compared to other models. Overall, the study provides valuable insights into the seismic analysis of multi-storey buildings with floating columns.

N Lingeshwaran, et al. (2021); The purpose of the study is to analyze the seismic responses of high-rise buildings with and without floating columns and shear walls in order to design earthquake-resistant buildings. The study aims to investigate the benefits of providing floating columns and shear walls, as well as to compare the results of different models obtained in software. The advantages of using floating columns and shear walls include increased seismic resistance and improved structural stability. However, the disadvantages include increased construction costs and potential difficulties in construction. The study also involved designing a high-rise building with floating columns and shear walls using E-TABS software. The characteristics of buildings with floating columns and shear walls include increased stiffness and strength, while the similarities and differences between different models depend on the specific design parameters and seismic effects. The study considers three different cases: Case 1 is a high-rise building without floating columns, Case 2 is a high-rise building with floating columns, and Case 3 is a high-rise building with both floating columns and shear walls. The design parameters evaluated include the number of stories, beam and column sizes, slab sizes, live and dead loads, density of concrete, seismic zones, site type, importance factor, response reduction factor, damping ratio, structure class, and earthquake design code. These parameters are important for determining the seismic resistance and stability of the building, as well as for ensuring that the building meets the relevant design codes and standards. The study also evaluates the effects of different design parameters on the seismic responses of the building, such as maximum story displacement and maximum story drift, in order to optimize the design and improve the earthquake resistance of the building. The study suggests several future scope areas for upgrading the performance of seismic vibration of multi-storey RC buildings. These include the adaptation of motion dampers throughout the height of the building, providing base isolation for the RC building, providing braced frames, and considering the soil-structure interaction in weak soil zones. These measures can help improve the resilience and earthquake resistance of the building, and are likely to become more important in the future as the demand for earthquake-resistant buildings increases. For example, in earthquake-prone areas such as Japan, many buildings are designed with base isolation systems to reduce the effects of seismic waves on the building. Similarly, in areas with weak soil zones, soil-structure interaction analysis is often used to optimize the design of the building and improve its seismic resistance.

Siva Naveen E, et al. (2018) states that the design of irregular structures is important for improving their utility and aesthetics, especially in seismic zones. The type, degree, and location of irregularities should be carefully considered to ensure the structure's performance under lateral loads. The structural configuration of a building depends on several factors such as geometry, shape, and size of the building. The vertical members such as columns and shear walls resist the horizontal inertia forces and the resultant of these forces gets concentrated at a point called center of stiffness. When the center of mass doesn't coincide with the center of stiffness, eccentricity develops in the structure. Eccentricity occurs due to the irregular arrangement of structural configuration which in turn induces torsion in the structure. Location and size of structural elements have a significant effect on torsional coupling which results in damage of structures. Regular structures have no significant discontinuities in plan or in vertical configurations. Irregular structures have certain physical discontinuities either in plan or in elevation or both which affect the performance of the structure subjected to lateral loads. Different structural irregularities affect the seismic response of structures in different ways. The judicious choice of these parameters in the design of structures improves the performance of the structure. The study found that irregularities in stiffness, such as in models SI-2 and SI-10, can increase displacement response by up to 71.7%. These models also showed maximum storey drift compared to other irregular models. The paper presents a study on the seismic response of irregular structures under earthquake loads. The study focuses on the effect of different types of irregularities, such as mass, stiffness, and geometric irregularities, on the seismic response of structures. The results show that different types of irregularities affect the seismic response of structures in different ways. The choice of type, degree, and location of irregularities in the design of structures is important as it helps in improving the utility as well as aesthetics of structures. The study concludes that the design of structures should consider the effect of irregularities on the seismic response of structures to ensure the safety and stability of the structures during earthquakes.

Nakul A Patil, et al. (2015), The study compares the response of RC frame buildings with and without floating columns under earthquake and normal loading. It found that the deflection in the case with floating columns is more than the case with floating columns and struts. The primary aim of the study is to compare the response of RC frame buildings with and without floating columns under earthquake loading and under normal loading. The study aims to determine the seismic response of both models, study the effect of internal and external floating columns on the building under earthquake loading for different seismic zones, and evaluate the cost of both models if designed as earthquake resistant. The study also aims to find out the effects on various parameters of RC building under seismic events due to the presence of floating columns and to determine which structure is superior to another in higher earthquake zones. From the literature review, it is suggested that floating columns may increase storey drift and storey displacement, while decreasing storey shear. However, the specific advantages, disadvantages, characteristics, similarities, and differences of floating and non-floating columns in RC frame buildings may vary depending on the specific design and seismic zone. The study aims to compare the seismic response of RC frame buildings with and without floating columns under earthquake loading and under normal loading. The study uses two software programs for the analysis and design of the structures: ETABS 15 and STAAD-Pro v 8i. The study finds that the deflection in a floating column without struts is more than the deflection in a floating column with struts. The study also finds that the probability of failure of a building with floating columns is higher than that of a building without floating columns. The study concludes that provision of floating columns at different locations affects the performance of building during earthquake and different parameters such as storey drift, storey shear, and displacement increases. It is also observed that buildings with floating columns are not economical if designed as earthquake resistant. Ultimately, the choice between floating and non-floating columns depends on the specific requirements, constraints, and preferences of the project.

Meghana B .S., et al. (2016); The objective of the study on composite structures is to analyze the behavior of composite multistory buildings of various heights and different zones with floating columns in different positions in the plan area. The study also aims to find the critical position of the floating column in composite structures. In simpler terms, the study aims to understand how composite structures perform in different scenarios and identify the best position for the floating column. The parameters compared in the results obtained from linear static analysis of the G+15 storey composite building with and without floating column are displacement, storey drift, and storey shear. The study aims to compare the behavior of composite structures with and without floating columns in different zones and find the critical position of the floating column. Floating columns are disadvantageous in seismically active areas due to stiffness irregularity, discontinuous load transfer path, and increase in values of parameters such as storey drift displacement when compared to regular RC structure without floating column. However, composite structures are stiffer than RC and are economical with speedy construction. The study found that the floating column provided in the edges of the outer face of the building is more critical in composite buildings. The floating column showed higher displacement and drift values, which can affect the overall seismic behavior of the building. The paper concludes that the behavior of composite structures with floating columns varies depending on the position of the floating column and the zone in which it is located. The study found that the critical position of the floating column in composite structures is at the center of the building. The study also found that floating columns are disadvantageous in seismically active areas due to stiffness irregularity, discontinuous load transfer path, and increase in values of parameters such as storey drift displacement when compared to regular RC structure without floating column. However, composite structures are stiffer than RC and are economical with speedy construction. The study recommends further research to investigate the behavior of composite structures with floating columns in different scenarios.

Akshay Gujar, et al. (2019); The objective of the study conducted by Akshay Gujar and H.S. Jadhav is to evaluate the effect of vertical irregularities, such as floating columns, in multi-story buildings. They compared the effect of construction sequence analysis and regular analysis on the performance of a G+10 story building in zone IV. The study aimed to determine the variations in deformations and design forces between sequential analysis and conventional analysis. They found that the deformation in corner floating columns is more in construction sequence analysis compared to linear static analysis. The location of vertical irregularity such as floating column affects more in case of sequential analysis.The study investigates the impact of vertical irregularities, specifically floating columns, on multi-story buildings. The effect of sequential loading differs from actual analysis. The building being analyzed has 10 stories and is comprised of 4 bays x 4 bays of 3.5m. It includes one floating column and a transfer beam. Deformation, bending moment, and shear force are being considered. The conclusion of the research paper is that there are significant variations in deformations and design forces between sequential analysis and conventional analysis in multi-story buildings with floating columns. The study found that the deformation in corner floating columns is more in construction sequence analysis compared to linear static analysis. The location of vertical irregularity such as floating column affects more in case of sequential analysis. The study suggests that special structures with floating columns require construction sequence analysis. The research paper provides valuable insights for designers and engineers in the construction industry to improve the seismic performance of multi-story buildings with floating columns. For example, they can use construction sequence analysis to accurately predict the behavior of the building during construction and design the structure accordingly.

M Sowmya, et al. (2019); The study focuses on the seismic response of G+5 and G+10 buildings with floating columns in different zones. This study states that ductility is one of the most important factors influencing the building performance in earthquake-resistant design. It refers to the ability of a material to deform under stress without breaking. In the context of earthquake-resistant design, ductility is achieved by predetermining the locations where damage takes place and then providing good detailing at these places to ensure pliable behavior of the building. This means that the building is designed to withstand the forces of an earthquake by allowing certain parts of the building to deform or bend without collapsing. For example, reinforced concrete shear walls can be designed to be ductile by providing appropriate reinforcement and connection with other components in the structure. Based on the study, it is observed that the seismic performance of buildings on slopes can be significantly improved by providing shear walls with different configurations. The provision of shear walls reduces storey displacement, storey drifts, and bending moments in the building. The study also found that the time period of vibration for a building with shear walls located towards the shorter column is the least compared to any other location. Additionally, the displacements in linear static analysis are relatively higher compared to the displacements in response spectrum analysis. The study concludes that earthquake-resistant design is concerned with ensuring that the damage in buildings during earthquakes is of the appropriate range and that they occur at the right places and in the correct amounts. The seismic codes are specific to a certain region or nation, and in India, IS 1893(Part 1):2002 is the primary code that provides guidance for calculating seismic design pressure.

Neha Pawar, et al. (2021); This study focuses on analyzing the behavior of a building with floating columns when subjected to seismic forces. The study aims to compare the behavior of different models with stiffness irregularities with floating columns. The study uses response spectrum analysis to evaluate the participation of each natural mode of vibration for indicating the maximum seismic response of an elastic structure. The study also compares the maximum storey displacement, storey drifts, base shear, and overturning moments of all the cases analyzed. The study uses a G+8 high rise structure with a special moment resisting frame and various configurations of the building are analyzed using FEM based software ETabs. The structural response of all configurations is compared to validate the results. According to this study Stiffness irregularity refers to the vertical irregularity in a structure's stiffness. If the lateral stiffness is less than 70% compared to the above storey or less than 80% of the average stiffness up to three storeys, the structure is said to have a soft storey. Floating columns are one of the elements that cause stiffness irregularity in a structure. Stiffness irregularity affects the seismic performance of a building by subjecting it to non-uniform earthquake forces. This can cause sudden failure at the level of discontinuity, especially in structures with vertical setbacks. To compensate for the effects of floating columns, many researchers have adopted shear walls, which are effective below G+10 storeys. For example, in a study analyzing a G+5 storey building, the second floor was found to be the optimum location to provide floating columns. The conclusion of this research paper is that the behavior of a building with floating columns can be improved by incorporating seismic strengthening techniques. The study found that the use of floating columns can cause stiffness irregularities in a structure, which can lead to non-uniform earthquake forces and sudden failure at the level of discontinuity. However, the study also found that the use of bracings and composite structures can help compensate for the effects of floating columns and improve the seismic performance of the building. The study also highlights the importance of response spectrum analysis in evaluating the seismic response of an elastic structure. Overall, the study provides valuable insights into the behavior of buildings with floating columns and the measures that can be taken to improve their seismic performance.

H.M. Veerash, et al. (2016); This study is about the performance-based evaluation of a building with floating columns using elastic analysis. The study analyzes the behavior of structures with and without floating columns under seismic and gravity conditions. The seismic parameters such as lateral displacement, base shear, fundamental time period, and interstorey drift are studied and compared between the regular structure and the structure with floating columns. The study concludes that floating columns should be avoided, especially in seismic-prone areas. According to IS 1893(Part1):2002, the load combinations considered for building analysis are as follows: gravity analysis with load factors of 1.5(DL+LL), equivalent static analysis with load factors of 1.2(DL+LL+EQY) and 1.2(DL+LL+EQX), and response spectrum analysis with load factors of 1.2(DL+LL+SPY) and 1.2(DL+LL+SPX). The lateral displacement profile for building models is obtained from the equivalent static and response spectrum methods by analyzing the behavior of the building under seismic conditions. The equivalent static method assumes that the building is subjected to a static force that is equivalent to the maximum seismic force that the building is expected to experience. The response spectrum method, on the other hand, takes into account the dynamic characteristics of the building and the ground motion. The lateral displacement profile is a graph that shows the displacement of each floor of the building in response to the seismic forces. The profile is obtained by analyzing the lateral displacement of the building at different points in time and plotting the results on a graph. The lateral displacement profile is an important parameter in the seismic analysis of buildings as it helps to determine the structural integrity of the building under seismic conditions. The material and member properties considered for the building model in the study are as follows: the grade of concrete is M20 and M30 for the cantilever beam, the grade of steel is Fe 415, the Young's modulus of M20 and M30 concrete is 22.32 x 10^6 Kn/m2 and 27.38 x 10^6 Kn/m2, respectively, the density of concrete is 25 Kn/m2, the Young's modulus of brick masonry is 2100 x 10^3 Kn/m2, the density of brick masonry is 20 Kn/m3, the thickness of the slab is 0.120 m, the wall thickness is 0.25 m, the roof finishes is 2.0 KN/m2, the floor finishes is 1.0 Kn/m2, the live load intensities for the roof and floor are 1.5 Kn/m2 and 3.0 Kn/m2, respectively, and the earthquake live load on slab as per clause 7.3.1 and 7.3.2 of IS 1893(part I)-2002 for the floor and roof are 0.75 KN/m2 and 0 KN/m2, respectively. The conclusion of this study is that the performance of a floating column building can be evaluated using elastic analysis. The study found that the base shear and lateral displacement of the building can be calculated using the equivalent static and response spectrum methods. The study also found that the floating column building performed well under seismic conditions and met the safety requirements specified in the Indian Standard Code of Practice for earthquake resistant design of structures. However, the study recommends further research to investigate the behavior of floating column buildings under different seismic conditions and to develop more accurate analytical models for these types of structures.

Sreadha A.R., et al. (2020); The study focuses on the seismic behavior of a multi storey building with a floating column introduced at the 5th floor in the outer section of the plan. The floating column is intended to improve the building's seismic performance by reducing the torsional effects and increasing the lateral stiffness. The material properties and seismic parameters of the building model are detailed in Table IV, including the geometry of the considered model. The study aims to determine the drift, over-turning moment, and P-delta effect of the building under seismic loads. The presence of a floating column in a multi-storey building affects its seismic behavior in several ways. In seismic-prone areas, buildings with floating columns exhibit higher storey drift and storey displacement compared to buildings without floating columns. The maximum displacement is higher in structures with floating columns, and with an increase in the number of storeys, the displacement also increases. When the floating column is shifted towards a higher storey, the lateral displacement increases. The structure without a floating column shows minimum storey drift, while the structure with a floating column shows maximum storey drift. The structure without a floating column shows minimum base shear, while the structure with a floating column shows maximum base shear. Therefore, it can be concluded that floating columns at higher floors must be avoided in high-rise building design.In the seismic analysis of multi-storey buildings with and without floating columns, various parameters are studied, such as maximum displacement, effect on the number of storeys on drift, and base shear. The seismic behavior of the structure is also analyzed using equivalent static analysis and response spectrum analysis. The material properties and section properties are considered for analysis. The seismic parameters considered as per IS code are also taken into account. In terms of advantages, floating columns offer more open spaces within the ground floor, which can be used for auditorium or parking intention. However, structures with floating columns are not preferred in tectonic areas due to the discontinuity of load transfer path. In terms of disadvantages, structures with floating columns are not designed for earthquake loads and exhibit higher storey drift and storey displacement compared to buildings without floating columns in seismic-prone areas. The characteristics of structures with floating columns include the transfer of load from vertical to horizontal within the intermittent frame. The similarities between structures with and without floating columns include the use of columns to support the building. The differences between structures with and without floating columns include the load transfer path and seismic behavior. For example, the whole earthquake load on the structure is shared by the shear walls without any loads on the floating columns in structures with floating columns.

III. CONCLUSION

Based on the findings of the literature survey, it is evident that structural modeling software stands out as the predominant and most effective tool for analyzing complex structural behaviors. Various modeling approaches are employed to suit diverse structural conditions, facilitated by specialized software. Notably, Normal Columns Buildings consistently yield safer results across various angles of analysis compared to structures featuring Floating Columns. Nevertheless, considerable research attention has been directed towards mitigating the risks associated with Floating Columns. This review underscores several strategies aimed at enhancing the seismic resilience of such structures. Implementing strategically positioned Shear walls in soft stories enhances the strength of Floating Column structures, while the integration of Composite Beams beneath Floating Columns reduces deflection compared to traditional Reinforced Concrete Beams. Increasing ground floor column sizes bolsters storey stiffness in Floating Column buildings, addressing torsional irregularities stemming from asymmetrical Floating Column placement. Utilizing Wall Infill between Floating Columns not only strengthens the structure but also enhances its seismic response. Moreover, positioning Floating Columns symmetrically, particularly at the outer periphery, reduces the probability of failure and influences Shear Force distribution. Future research avenues may explore the impacts of stiffness and torsional irregularities, as well as the influence of flexible floor diaphragms, a facet often overlooked in existing literature. Additionally, analyzing the efficacy of Fiber Reinforced Polymer in enhancing the structural response of Floating Column buildings presents another promising area for investigation.

IV. ACKNOWLEDGEMENT

I express my heartfelt gratitude to my Thesis Guide, **Dr. A.M. Badar**, and Co-Guide, **Dr. Swapnil Satone**, for their unwavering encouragement and support, which played a pivotal role in bringing the project to fruition and contributing to its success. Additionally, I extend my appreciation to the Head and all the faculty and staff of the Civil and Environmental Engineering Department at KDKCE for their invaluable assistance in the development of my project titled "Critical Review on Effect of Floating Columns in a Building."

REFERENCES

[1] Akshay Gujar, H.S. Jadhav, 2019 – “Performance of Multi-story RCC structure with Floating Column”, International Research Journal of Engineering and Technology (IRJET) Volume: 06, Issue: 03

[2] M Sowmya, K Kiran Kumar, 2019 – “Study On Seismic Response With Floating Column For G+5 And G+10 With Different Zones”, INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH, Volume 07, Issue 05

[3] Harsha PV, Shilpa Valsakumar, 2020 – “SEISMIC ANALYSIS OF MULTI STOREY BUILDING WITH FLOATING COLUMNS USING ETABS”, International Research Journal of Engineering and Technology (IRJET) Volume: 07, Issue: 07

[4] N. Lingeshwar et al, 2021 - “A study on seismic analysis of high-rise building with and without floating columns and shear wall”, Elsevier

[5] Meghana B .S., T.H. Sadashiva Murthy, 2016 – "EFFECT OF FLOATING COLUMN ON THE BEHAVIOUR OF COMPOSITE MULTISTORIED BUILDING SUBJECTED TO SEISMIC LOAD", International Research Journal of Engineering and Technology (IRJET) Volume: 03, Issue: 06

[6] Sreadha A R, et al., 2020 - "Seismic Study of Multistorey Building using Floating Column", International Journal of Emerging Science and Engineering (IJESE) ISSN: 2319–6378 (Online), Volume-6 Issue-9

[7] Siva Naveen, et al., 2018 - "Analysis of Irregular Structures under Earthquake Loads", 2nd International Conference on Structural Integrity and Exhibition.

[8] Nakul A Patil, et al., 2015 - "Comparative Study of Floating and Non-Floating Columns with and Without Seismic Behaviour- A Review", International Journal of Research in Engineering, Science and Technologies (IJRESTs) Vol:01 No.:08

[9] Neha Pawar, et al., 2021 - "Effect of floating columns on buildings subjected to seismic forces", International Conference on Advances in Civil Engineering (ICACE 2021) doi:10.1088/1757-899X/1197/1/012018

[10] H.M. Veeresh, et al., 2016 - "Performance Based Evaluation of Floating Column Building by Elastic Analysis", Bonfring International Journal of Man Machine Interface, Vol. 4, Special Issue, July 2016

[11] Neha Pawar, et al., 2021 - "Review on "Effect of Floating Columns on Building subjected to seismic Forces"", International Conference on Advances in Civil Engineering (ICACE 2021) doi:10.1088/1755-1315/822/1/012045

JETIR