



Performance analysis of RCC building using floating column with different soils

¹ Amit Jay Daksh, ² Dharmendra Singh ³ Dr. Sharad Kumar Soni

¹ M.Tech (Scholar), ² Asst. Prof. Civil Engineering,
³ HOD, Civil Engineering Department
Rabindranath Tagore University, Bhopal, India

Abstract: Now a day's lots of multi-story buildings are constructed with floating column for aesthetic point of view and for getting more space at parking areas for movement. But such building are highly get damaged during earthquake in highly seismic zone as compared to normal building. Floating columns are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection. This study highlights the importance of explicitly recognizing the presence of the floating column in the analysis of building. The study is carried out to analyse the building with floating columns and to find out its comparison with the building without floating column with different soil in terms of storey drift, base shear and time period frequency using Staad Pro V8i (SS4) software.

Keywords: Floating column, RCC building, performance, Staad pro

1. Introduction

In present time the shortage of space is a growing issue in urban cities due to increase in population. For this there is a need of having column free space, and also for aesthetic and other functional requirements. This new concept leads to pause of columns that are floating columns. Buildings with floating columns are of typical feature in the modern multi storey construction practices in whole world and also in our urban India. When irregular features such as floating columns are included in buildings, a considerably higher level of engineering effort is required in the structural design and yet the building may not be as good as one with simple architectural features. Many multi-storey buildings also have open first storey as an irregular feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. The behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building. Buildings with vertical obstacles (like the hotel buildings with a few storeys wider than the rest) cause a

sudden jump in earthquake forces at the level of discontinuity. Buildings that have fewer columns or walls in a particular storey or with unusually tall storey tend to damage or collapse which is initiated in that storey. Many buildings with an open ground storey intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path.

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground, and the term “Floating Column” is also a vertical element which at its lower level rests on a beam which is a horizontal member.

A common form of discontinuity in load path in moment frames arises with a floating columns, i.e., when a column coming from top of the building is discontinued at a lower level, usually at the ground storey. In such cases, loads from the overhanging portions take a roundabout way and travel to the nearest column that is continuous till the foundation. This leads to increased demand on the columns in the ground storey and can cause failure of these columns.

In this study, the behaviour of the multi-storey buildings with floating columns at higher seismic zones using STAAD Pro are modelled and analysed.

2 Objectives of Study

1. To study the effect of positioning of floating column on seismic performance of buildings resting on plain and sloping ground.
2. To perform the response seismic analysis of building using Staad pro ss4.
3. To compare the performance of building on plain and slopping ground.
4. To study the effect of floating on building on plain and slopping ground.
5. To compare the building on plain and slopping ground with or without floating column.

3. Research Methodology

Now a day's lots of multi-story buildings are constructed with floating column for aesthetic point of view and for getting more space at parking areas for movement. But such building are highly get damaged during earthquake in highly seismic zone as compared to normal building. Floating columns are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection. This study highlights the importance of explicitly recognizing the presence of the floating column in the analysis of building. The study is carried out to analyse the building with floating columns and to find out its comparison with the building without floating column in terms of storey drift, base shear and time period frequency using Staad Pro V8i (SS4) software.

Generation of the Structure

The structure may be generated from the input file or mentioning the coordinates in the GUI. The figure below shows the GUI generation method.

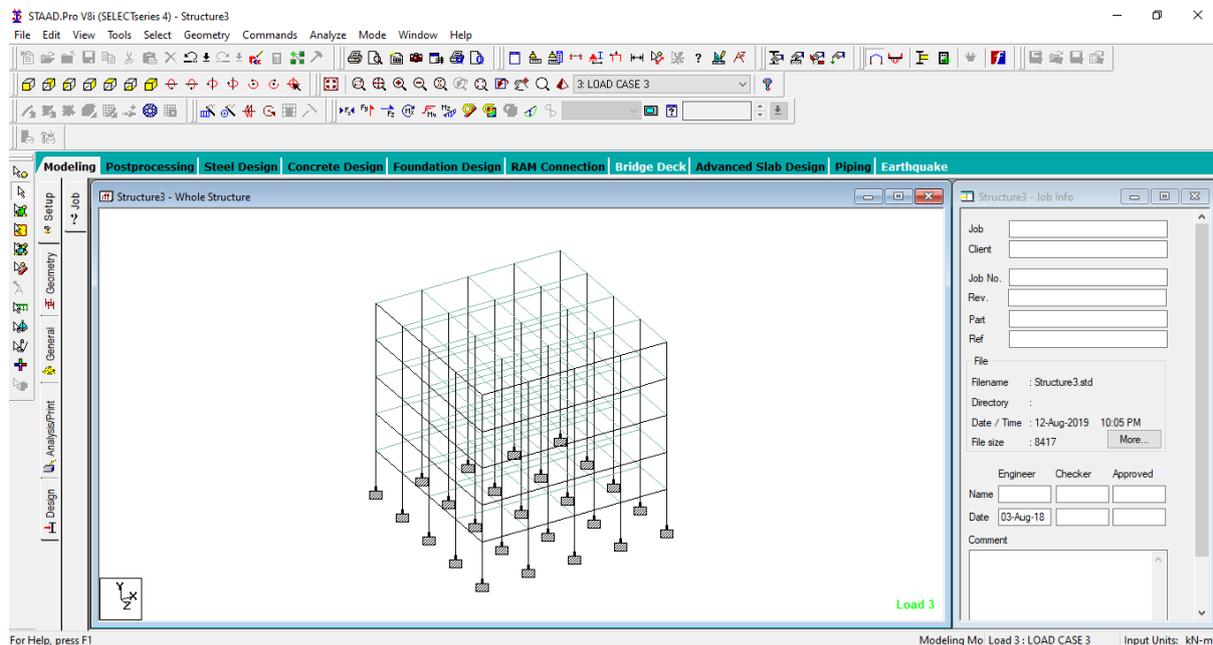


Fig. 1: Generation of structure

Supports

We can provide different end conditions for example supports such as fix, pin etc. When we talk about pinned support translational and rotational movement are not allowed. In other words we can say that this type of support will have reactions for all forces but will resist no moments. A fixed support has zero degree of freedom. Other supports such as translational and rotational can also be utilised. The springs are characterized with respect to spring constants. When a force displaced a joint whatever it may be we can call as translational support.

Design Loads for Residential Buildings

Loads are a design parameter for building design process as it is associated with the definition magnitude of hazards associated with external forces criteria while building must resist providing a rational performance (i.e., safety and serviceability) during the structure's valuable life. As these design loads are considered in design phase due to various reasons such as occupancy, building size and shape also affect expected load generated and site location according to their climate be considered. Hence by considering design loads we will find various information regarding structure such concrete take off, steel take off etc. Hence for optimization of design we have to predict loads accurately so that building life is increase and perform same function which they built.

Building Description

Model consists of G+4 storey RCC building having four bays in each direction with width of bay as 3.2m. The story height for each floor and plinth height is kept as 3.2 respectively. The RCC frame consists of beam and column of sizes 0.23m x 0.4m and 0.4m x 0.237m respectively. Slab thickness is taken as 120mm. The models are analysed on levelled as well as sloping ground. The frames on levelled and sloping ground under consideration for present study is as shown in Fig. 2 and Fig. 3. The concrete of grade M20 and steel of grade Fe 415 are used.

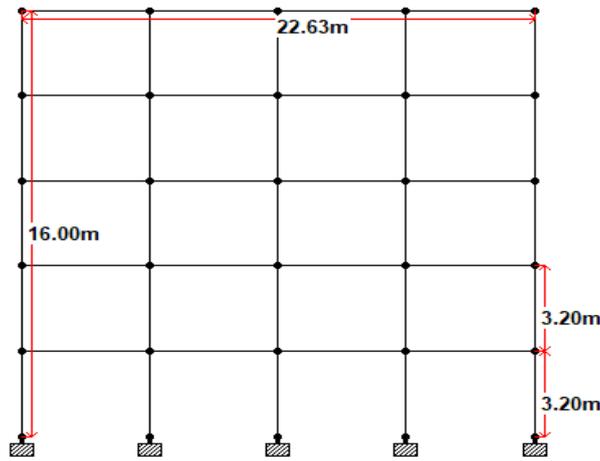


Fig. 2: Building frame on levelled ground

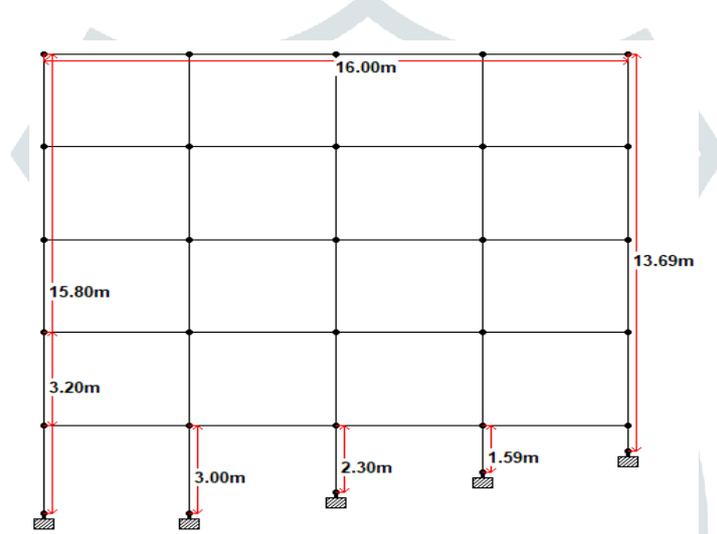


Fig. 3: Building frame on slopping ground

Table 1: Building description

S.no	Specification	Plain	Slopping
1	Plain dimensions	16 x 16 m	16 x 16 m
2	Length in x- direction	16 m	16 m
3	Length in z- direction	16 m	16 m
4	Floor to floor height	3.2 m	3.2 m
5	No. of stories	4	4
6	Plinth level	3.2 m	3.2 m
7	Soil type	Hard	Hard
8	Seismic zone	4	4

4. Results and Discussion

In present study, comparison of seismic response parameter such as time period, base shear, storey displacement, storey drift and dynamic response are done by varying the location of floating column floor wise by using linear static analysis. Result are compared in tabular and graphically for the analysis of building with and without floating column.

Natural Frequency, (Hz)

In our study after decreasing length of FC on ground conditions, stiffness decreases (or flexibility increases) and mass also decreases but due to dominant effect of stiffness, natural frequency decreases. At low natural frequencies, the structure can resonate (chances of matching the external frequency (By EQ or other loads) with natural frequency of building) easier which is susceptible condition for collapse of building. In our study, when floating column lies up to 3rd floor from top is most severe condition due to minimum natural frequency on both ground condition (normal and slopping).

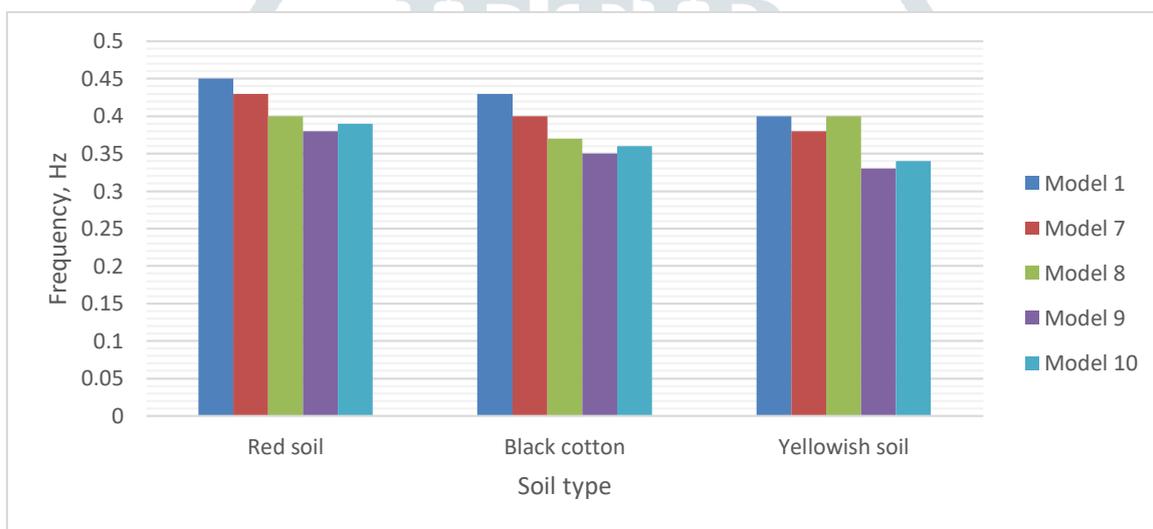


Fig. 4: Variation of frequency vs model for plain ground

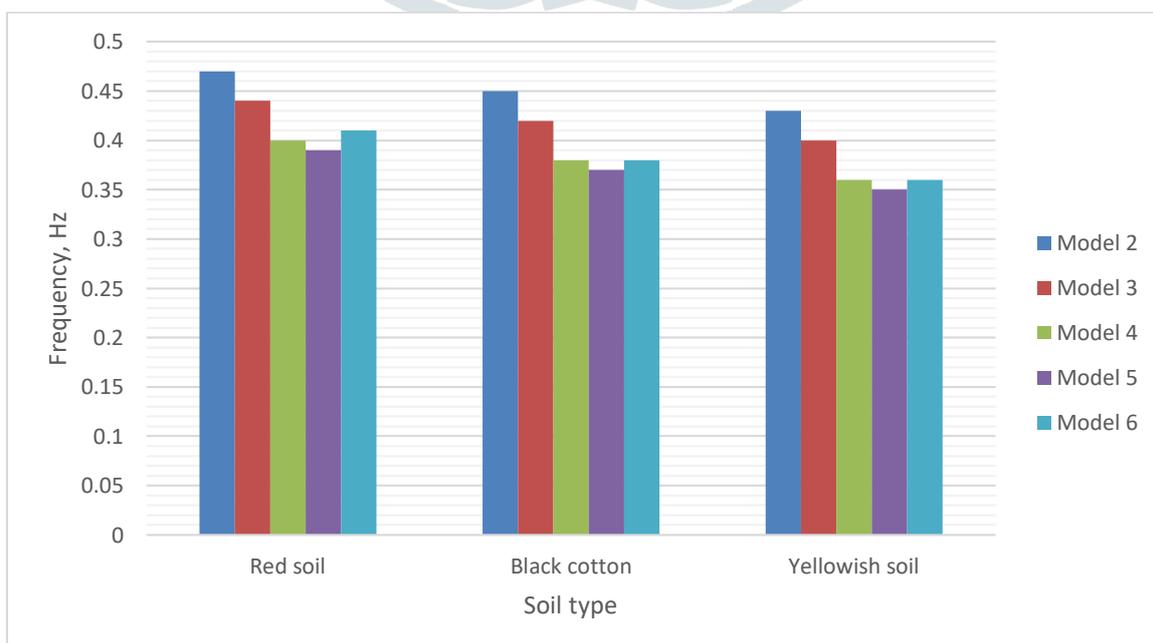


Fig. 5: Variation of frequency vs model for slopping ground

Magnitude of frequency for various models has been plotted. It can be seen in graph, on normal building maximum frequency in model 1 and minimum frequency in model 9 and in slopping building maximum frequency in model 2 and minimum frequency in model 5.

Peak Storey Shear

Peak storey shear is estimation of maximum expected lateral forces at different storey that will occur due to seismic ground motion. In general, peak story shear increases continuously from top story to bottom story and bottom storey shear is also called as base shear. In our study, in both ground (normal and slopping) condition peak storey shear decreases with decrease in length of floating column due to decrease in weight of building and minimum length of floating column is most critical for resistance against seismic forces.

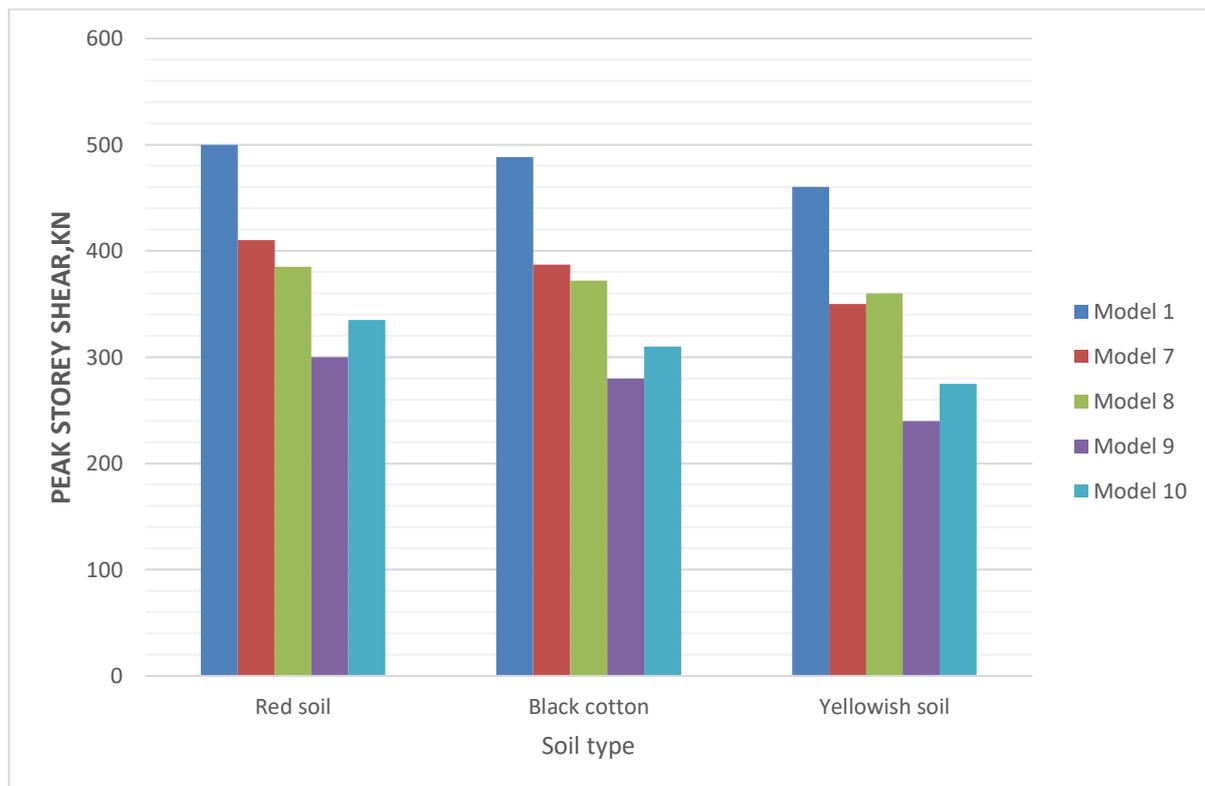


Fig. 6: Variation of peak shear vs model for normal ground

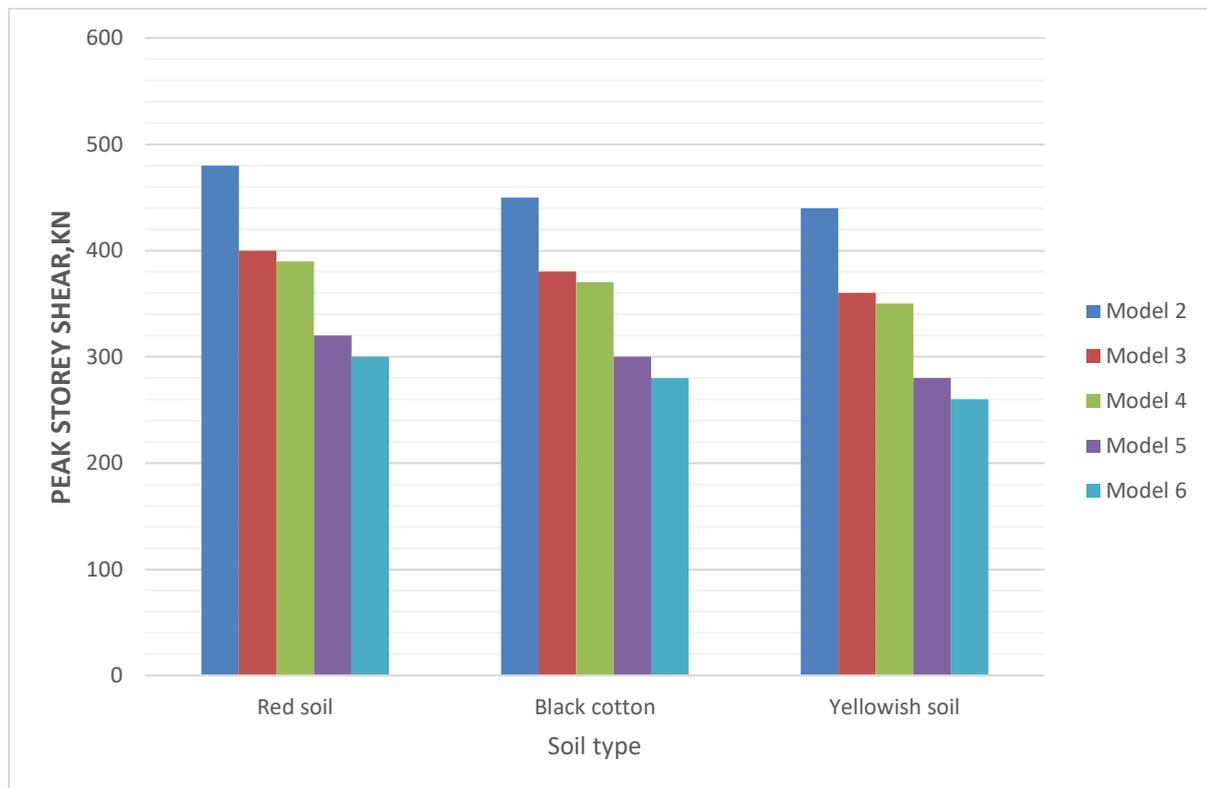


Fig. 7: Variation of peak storey shear vs model for slopping ground

Magnitude of peak storey shear for various models has been plotted. It can be seen in graph a peak story shear is decreases continuously from bottom story to top story and also decreases according to decrease in length of floating column on both normal and slopping condition.

5. Conclusion

After analysis of models based on decrease in length of floating column according to the various parameters, there are following conclusion can be drawn: -

1. In our study, when a structure having floating column lies up to 3rd floor from top is most severe case in both ground condition (normal and slopping) due to minimum natural frequency, maximum value of time period, minimum peak story shear in each floor, maximum displacement of nodes, maximum value of storey drift and after analysing these parameters this structure give least stability against earthquake on yellowish soil.
2. In our study, if we design all beams according to that a beam having maximum value of axial force, shear force and bending moment and lies in a structure in which FC lies up to 1st floor from top, then whole structures will be safe on red soil.
3. After locating building on slopping ground (In our study slope of 10° to be provided), for that much amount of slope the structure will not give too much variation on basis of each parameters except natural frequency and time period which tends to more stability on red soil as compared to normal building.

References

- [1] Anusha, Rao (2021). Seismic Behaviour Of R.C.C Building with and Without Floating Columns, JournalNX- A Multidisciplinary Peer Reviewed Journal, 3(11), 1-6.
- [2] Saleem Akhtar, Geeta Batham (2021). Seismic Response Evaluation of RC frame building with Floating Column considering different Soil Conditions, International Journal of Current Engineering and Technology, 4(1), 132-138.
- [3] Parveen Hamza, Gokul Raveendran K, Dr.C.Justine Jose (2020). Seismic Performance & Structural Stability Analysis of Floating Column Building. International Journal of Scientific & Engineering Research, 11(10), 91-98.
- [4] Sukumar Behera (2012) "Seismic Analysis of Multistorey Building with Floating Column" Department of Civil Engineering, National Institute of Technology Rourkela.
- [5] Shivam Tyagi, B.S Tyagi (2018), Seismic Analysis of Multi-storey Building with Floating Column, International Research Journal of Engineering and Technology, 5(5), 3479-3483.
- [6] Arpit Shrivastav, Aditi Patidar (2018), Seismic Analysis of Multistorey Buildings having Floating Columns, SSRG International Journal of Civil Engineering, 5(5), 1-6.
- [7] Karishma I. Patel, Hitesh K. Dhameliya, Krutarth S. Patel (2017), A Review on Seismic Analysis of Multistorey Building with Floating Column, International Journal of Advance Engineering and Research Development, 4(11), 485-487.
- [8] Z. M. Mustafa (2017), Seismic Analysis of a Multistorey Building with Floating Column: A Review, International Journal for Research in Applied Science & Engineering Technology, 5(12), 1733- 1735.
- [9] Pradeep D (2017), Seismic Analysis of Multi-Storey Building with Floating Columns using Etabs, International Journal of Scientific Development and Research, 3(5), 110-116.
- [10] Waykule. S.B (2016), Review on Study of Behaviour of Floating Column for Seismic Analysis of Multi-storey Building, International Journal of Engineering Applied Sciences and Technology, 1(11), 39-42.
- [11] Gaurav Kumar, Megha Kalra (2016), Review Paper on Seismic Analysis of RCC Frame Structures with Floating Columns, International Journal of Advanced Technology in Engineering and Science, 1(11), 39-42.
- [12] S.B. Waykule (2016), Study of Behaviour of Floating Column for Seismic Analysis of Multi-storey Building, International Journal of Civil Engineering and Technology, 7(6), 676-685.
- [13] Gangadari Vishal Kumar (2016), Seismic Analysis of Multi-storey Building with Floating Column, International Journal of Innovative Research in Technology, 3(6), 6-10.
- [14] Bhavya B S, Jisha P (2016), Seismic Evaluation of RC Unsymmetrical Building with Floating Columns & Soft storey Considering Different Configuration, International Journal of Innovative Research in Science, Engineering and Technology, 5(8), 15456-15465.
- [15] Joshi Shridhar D (2016), Seismic Response of Multi-Storey Building with Vermicular Irregularity as Floating Columns, International Journal for Innovative Research in Science & Technology, 2(11), 570-577.

- [16] Sabari S, Praveen J.V (2015), Seismic Analysis of Multistorey Building with Floating Column, International Journal of Civil and Structural Engineering Research, 2(2), 12-23.
- [17] Isha Rohilla (2015), Seismic Response of Multi-Storey Irregular Building with Floating Column, International Journal of Research in Engineering and Technology, 4(3), 506-518.
- [18] A.P. Mundada (2014), Comparative Seismic Analysis of Multistorey Building with and without Floating Column, International Journal of Current Engineering and Technology, 4(5), 110-118.
- [19] Criteria for Earthquake Resistant design of structures, Part1: General provisions and buildings, IS 1893:2002, Bureau of Indian Standards, New Delhi.

