Vol 9, Issue 4, 2018
ISSN NO:0377-9254

SEISMIC ANALYSIS OF A BUILDING WITH FLOATING COLUMNS BY ETABS

[#1]NAGALAKSHMI D , M.TECH STUDENT
[#2]DR R BALAMURUGAN, PROFESSOR
[#1,2]DEPARTMENT OF CIVIL ENGINEERING
[#1,2]Khader Memorial College Of Engineering & Technology, Konda Bheemanapally(V), Devarakonda(M), Dist. Nalgonda – 508 248, T.S.

ABSTRACT:

Many building are planned and constructed with architectural complexities. The complexities include various types of Irregularities like floating columns at various levels and locations. Buildings are critically analyzed for the effect of earthquake. Earthquake load as specified in IS 1893 (part 1): 2002 are considered in the analysis of building. A G+6 storied building with different architectural complexities such as External Floating Columns, Internal floating columns and combination of Internal and External Floating columns is analyzed for various earthquake zones.

In overall study of seismic analysis, critical load combinations are found out. For these critical load combinations, Case wise variation in various parameters like displacements, moments and Forces on columns and Beams at Various floor level are compared and significant co-relationship between these values are established with Graphs. This Building is Design and analyze with the help of etabs Software.

I.INTRODUCTION

1.1 Introduction

Many urban multi-storey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height.

The behavior 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 setbacks (like the hotel buildings with a few storey 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.

1.2 What is floating column

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground.

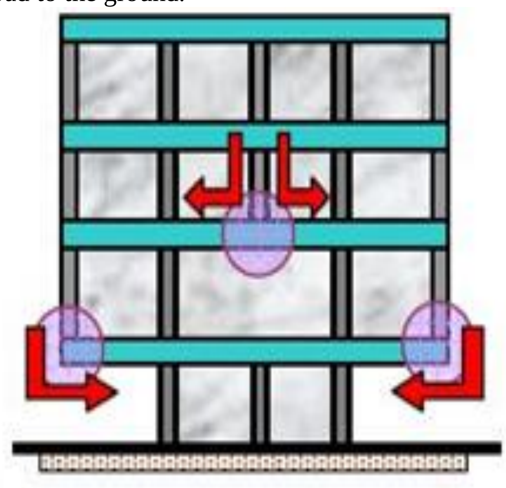

Fig1: hanging or floating columns

There are many projects in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available in the ground floor. These open spaces may be required for assembly hall or parking purpose. The transfer girders have to be designed and detailed properly, especially in earth quake zones. The column is a concentrated load on the beam which supports it. As far as analysis is concerned, the column is often assumed pinned at the base and is therefore taken as a point load on the transfer beam. STAAD Pro, ETABS and SAP2000 can be used to do the analysis of this type of structure. Floating columns are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection.

Looking ahead, of course, one will continue to make buildings interesting rather than monotonous. However, this need not be done at the cost of poor behavior and earthquake safety of buildings. Architectural features that are detrimental to earthquake response of buildings should be avoided. If not, they must be minimized. When irregular features 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.

II.REVIEW OF LITERATURES

Current literature survey includes earthquake response of multi storey building frames with usual columns. Some of the literatures emphasized on strengthening of the existing buildings in seismic prone regions.

Maison and Neuss [15], (1984), Members of ASCE have preformed the computer analysis of an existing forty four story steel frame high-rise Building to study the influence of various modeling aspects on the predicted dynamic properties and computed seismic response behaviours. The predicted dynamic properties are compared to the building's true properties as previously determined from experimental testing. The seismic response behaviours are computed using the response spectrum (Newmark and ATC spectra) and equivalent static load methods.

Also**, Maison and Ventura** [16], (1991), Members of ASCE computed dynamic properties and response behaviours OF THIRTEEN-STORY BUILDING and this result are compared to the true values as determined from the recorded motions in the building during two actual earthquakes and shown that state-of-practice design type analytical models can predict the actual dynamic properties.

Arlekar, Jain & **Murty** [2], (1997) said that such features were highly undesirable in buildings built in seismically active areas; this has been verified in numerous experiences of strong shaking during the past earthquakes. They highlighted the importance of explicitly recognizing the presence of the open first storey in the analysis of the building, involving stiffness balance of the open first storey and the storey above, were proposed to reduce the irregularity introduced by the open first storey.

Awkar and Lui [3], (1997) studied responses of multi-story flexibly connected frames subjected to earthquake excitations using a computer model. The model incorporates connection flexibility as well as geometrical and material nonlinearities in the analyses and concluded that the study indicates that connection flexibility tends to increase upper stories' inter-storey drifts but reduce base shears and base overturning moments for multi-story frames.

Balsamoa, Colombo, Manfredi, Negro & Prota [4] (2005) performed pseudodynamic tests on an RC structure repaired with CFRP laminates. The opportunities provided by the use of Carbon Fiber Reinforced Polymer (CFRP) composites for the seismic repair of reinforced concrete (RC) structures were assessed on a full-scale dual system subjected to pseudodynamic tests in the ELSA laboratory. The aim of the CFRP repair was to recover the structural properties that the frame had before the seismic actions by providing both columns and joints with more deformation capacity. The repair was characterized by a selection of different fiber textures depending on the main mechanism controlling each component. The driving principles in the design of the CFRP repair and the outcomes of the experimental tests are presented in the paper. Comparisons between original and repaired structures are discussed in terms of global and local performance. In addition to the validation of the proposed technique, the experimental results will represent a reference database for the development of design criteria for the seismic repair of RC frames using composite materials.

III.METHODOLOGY

ETABS:

ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS features an intuitive and powerful graphical interface coupled with unmatched modelling, analytical, and design procedures, all integrated using a common database. Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of geometrical nonlinear behaviours, making it the tool of choice for structural engineers in the building industry (Computers and structures Inc. 2003).

The accuracy of analytical modelling of complex Wall Systems has always been of concern to the Structural Engineer. The computer models of these systems are usually idealized as line elements instead of continuum elements. Single walls are modelled as cantilevers and walls with openings are modeled as pier and spandrel systems. For simple systems, where lines of stiffness can be defined, these models can give a reasonable result. However, it has always been recognized that a continuum model based upon the finite element method is more appropriate and desirable. Nevertheless this option has been impractical for the Structural Engineer to use in practice primarily because such models have traditionally been costly to create, but more importantly, they do not produce information that is directly useable by the Structural Engineer. However, new developments in ETABS using object based modeling of simple and complex wall systems, in an integrated single interface environment, has made it very practical for Structural Engineers to use finite element models routinely in their practice (Ashraf Habibullah, 2002).

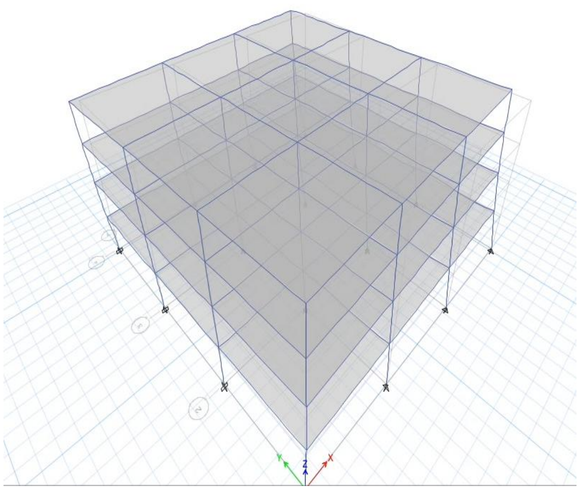

Fig2:Perform-3D Model

RUNNING ANALYSIS

Number of joints = 98
With restraints = 34
With mass = 18
Number of frame/cable/tendon elements = 158
Number of shell elements = 36
Number of constraints/welds = 4
Number of load patterns = 13
Number of acceleration loads = 6
Number of load cases = 4

ANALYSIS IN ETABS

The first step in ETABS is to set the grid dimensions. This includes setting number of lines in X direction, Y direction and the spacing between grid lines. Then the storey data is defined which includes setting the number of stories, height of typical and bottom storey. The type of slab is also mentioned in the grid data.

IV.RESULT AND DISCUSSION

The behaviour of building frame with and without floating column is studied under static load, free vibration and forced vibration condition. The finite element code has been developed in ETABS software.

4.1 Static analysis

A four storey two bay 2d frame with floating column are analyzed for static loading using the present FEM code and the commercial software *ETABS* .

Example 4.1

The following are the input data of the test specimen:
Size of beam – 0.1 X 0.15 m
Size of column – 0.1 X 0.125 m
Span of each bay – 3.0 m
Storey height – 3.0 m
Modulus of Elasticity, E = 206.84 X 10^6 kN/m^2
Support condition – Fixed
Loading type – Live (3.0 kN at 3^{rd} floor and 2 kN at 4^{th} floor)

Fig. 3& 4 shows the schematic view of the two frame without and with floating column respectively.

Fig. 3 2D Frame with usual columns
Fig4. 2D Frame with Floating column

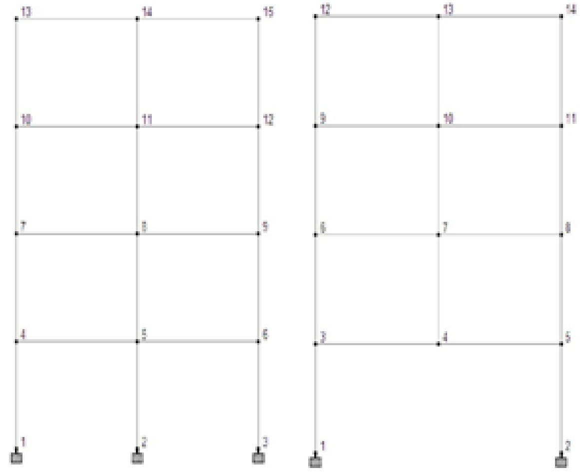

Fig: 3& 4

V.CONCLUSION

The study presented in the paper compares the difference between normal building and a building on floating column. The following conclusions were drawn based on the investigation

1) By the application of lateral loads in X and Y direction at each floor, the lateral displacements of floating column building in X and Y directions are more compared to that of a normal building. So the floating column building is unsafe for construction when compared to a normal building

2) By the calculation of storey drift at each floor for the buildings it is observed that floating column building will suffer extreme storey drift than normal building. The storey Drift is maximum at 3rd and 4th storey levels in both the cases.

3) The building with floating columns experienced more storey shear than that of the normal building. This is due to the use of more quantity of materials than a normal building. So the floating column building is uneconomical to that of a normal building

4) The final conclusion is that do not prefer to construct floating column in buildings unless there is a proper purpose and functional requirement for those. If they are to be provided then proper care should be taken while designing the structure

VI.REFERENCES

1. Agarwal Pankaj, Shrikhande Manish (2009), “Earthquake resistant design of structures”, PHI learning private limited, New Delhi.
2. Arlekar Jaswant N, Jain Sudhir K. and Murty C.V.R, (1997), “Seismic Response of RC Frame Buildings with Soft First Storeys”. Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi.

3. Awkar J. C. and Lui E.M, "Seismic analysis and response of multistory semirigid frames", Journal of Engineering Structures, Volume 21, Issue 5, Page no: 425-442, 1997.
4. Balsamoa A, Colombo A, Manfredi G, Negro P & Prota P (2005), "Seismic behavior of a full-scale RC frame repaired using CFRP laminates". Engineering Structures 27 (2005) 769– 780.
5. Bardakis V.G., Dritsos S.E. (2007), "Evaluating assumptions for seismic assessment of existing buildings ".Soil Dynamics and Earthquake Engineering 27 (2007) 223–233.
6. Brodericka B.M., Elghazouli A.Y. and Goggins J, "Earthquake testing and response analysis of concentrically-braced sub-frames", Journal of Constructional Steel Research ,Volume 64, Issue 9, Page no: 997-1007,2008.
7. Chopra, Anil k. (1995), "Dynamics of structures", Prentice Hall.
8. Daryl L. Logan (2007), "A First Course in the Finite Element Method", Thomson, USA
9. Fall H.G (2006), "Direct Stiffness Method For 2D Frames-Theory of structure".
10. Garcia Reyes, Hajirasouliha Iman, Pilakoutas Kypros, (2010),"Seismic behaviour of deficient RC frames strengthened with CFRP composites". Engineering Structures 32 (2010) 3075-3085.
11. Hartley Gilbert and Abdel-Akher Ahmed, "Analysis of building frames" Journal of Structural Engineering, Vol. 119, No. 2, Page no:468-483, 1993.
12. Kattan P I (2003), "MATLAB guide to Finite Element", Springer, Berlin & New York.
13. K. N. V. Prasada Rao, K. Seetharamulu, and S. Krishnamoorthy, "Frames with staggered panels: experimental study", Journal of Structural Engineering, VOL 110, No. 5, Page no: 1134-1148, 1984.
14. Krishnamoorthy CS, Finite element analysis, TMH Publications, 1987
15. Maison Bruce F. and Neuss Carl F., "Dynamic analysis of a forty four story building", Journal of Structural Engineering, Vol. 111, No. 7, Page No:1559- 572,July, 1985.
16. Maison Bruce F. and Ventura Carlos E., "DYNAMIC ANALYSIS OF THIRTEEN-STORY BUILDING", Journal of Structural Engineering, Vol. 117, No. 12, Page no:3783-3803,1991.