"STUDY ON PERFORMANCE OF VERTICAL STRUCTURAL DISCONTINUITY OF A MULTISTOREY BUILDING USING TIME HISTORY ANALYSIS"

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Abstract - *In this modern era, as the technology improves the type of structures are also varying accordingly. Mainly floating columns are being as an unavoidable feature, so as to provide floor space index, parking and various other facilities. The present study investigates the effects of structure due to its column discontinuity and soil properties when subjected the seismic loads. In this study time history analysis method [THA] is carried out for a multi storied building with and without floating column along with and without soil structure interaction [SSI]. The structural response of the building is investigated with respect to maximum storey displacement, maximum storey drift, base shear and storey overturning moment. The analysis is carried out using ETABS v15 software. While considering soil structure interaction, the structure is safe for a permissible limit of drift and deflection, whereas the base shear is 5% lesser comparing to without soil structure interaction. Here the structure is found to be safe with floating column, because as the dimension of the structure is increased by 10% for the structure when the floating column is considered.*

Key Words: **floating columns, soil structure interaction, time history analysis, ETABSv15.**

1. INTRODUCTION

1.1 Floating column:

A vertical member which starts from foundation level and transfers all its loads safely to the ground is termed as column. Similarly if column at its lower level rests on horizontal member i.e., beam is termed as floating column. In turn these beams transfer loads coming on it from adjacent columns safely to the foundation.

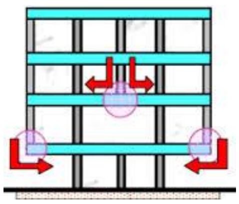


Fig 1.1: Example of floating column

Several projects are there in which floating columns are adopted to provide open space at the ground floor; these open spaces available are provided for function halls or to provide parking facility. In these cases at first floor transfer girders need to be provided for transfer of load in ease, moreover these transfer girders should be designed and detailed properly, it is more essential in earthquake zones. The beam in turn transfers load to the column below it, thus load transfer path in the discontinuous frame changes from vertical to horizontal. Thus floating column is also an often encountered construction practice, that it should be avoided because it leads to the overload of the beams. The joint between beam and floating column are considered as critical since their stability influence the overall stability of building and failure of beam-column joint in concrete moment resisting frame was identified as one of the leading causes of collapse of such structure. [1]

1.2 Soil Structure Interaction (SSI):

Definition:

The process in which the soil response influences the motion of the structure and the motion of the structure influences the soil response is called as SSI. In this case both structural displacements and the ground displacements are not dependent on each other.

Application:

- Traditional Structural Engineering methods disregard SSI effects, which is acceptable only for small structures on relatively stiffer soils.
- SSI effects become important and must be regarded for the structures in which P delta effects play a very important role structures for long way down seated foundations, fragile tall structures and structures rested on a cushiony soil such that the average velocity of shear should less than 100 m/s.

2. OBJECTIVES:

- The primary aim of this work is the comparative study of floating columns and non-floating columns with seismic behaviour.
- Determination of seismic response of both the models by using time history analysis in ETABS15 software.
- The comparative study will be done for various time history data's.
- Finding out effects on various parameters of RC building under seismic events due to presence of floating columns and without floating columns.
- Soil behaviour will be carried out by using soil structure interaction (SSI) & the same will be compared without.

3. METHODOLOGY:

- There are several analytic methods; both elastic and inelastic methods are used to detect the seismic behaviour of the buildings.
- A Time History Analysis method (THA) will be carried out using software ETABS15.
- The structure is modelled for both cases, i.e., with floating columns and without floating columns.
- The structure is implemented with the Soil Structure Interaction (SSI) for the footings.
- The structure will be subjected to Bhuj and Altadena earthquake.
- The output results will be expressed in terms of storey displacements, storey drift, base shear and overturning moment.

4. BUILDING MODEL:

Type of structure	[SMRF]
Seismic Zone	II
No. of stories	S+5
Floor height	3 m
Type of soil	Medium; Type II
Material	M35 & Fe 500
Columns	203 x 381, 203 x 457, 203 x 533, 203 x 610
Beams	203 x 457, 203 x 533, 203 x 610, 203 x 686
Slabs	102, 127, 152

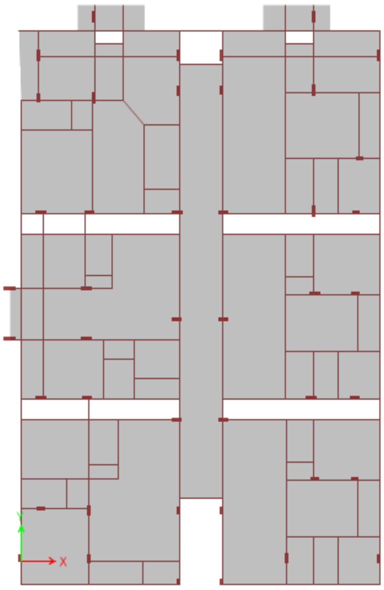
5. Time History Analysis:

This type of approach is bit accurate when the earthquake is occurred, the building response will be determined for every second of the ground motion. To come across such an analysis a representative earthquake time history is required for a structure being evaluated. Seismic response of a structure under dynamic loading is required to representative earthquake. [2]

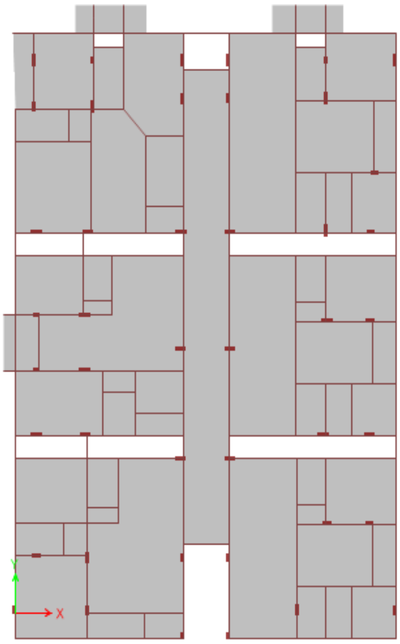
Data

- Input - BHUJ-Earthquake
- Peak ground acceleration v/s Time
- Location – January 26, 2001 at 08:46:42.9 I.S.T
- Magnitude- 7
- Duration – 90sec
- Acceleration time – 26706
- Number of steps – 8
- Step size – 0.005
- Time history type – Modal

Plans:



First Floor



Second Floor

Point spring data:

K_x	1905882 kN/m
K_y	1905882 kN/m
K_z	2334857 kN/m
K_{xx}	2081896 kN-m/rad
K_{yy}	2153685 kN-m/rad
K_{zz}	3380582 kN-m/rad

Base shear:

Direction	Distance m	T_a Sec	S_a/g	A_h	V_B kN
X	22.86	0.0188	1.282	0.01282	375.32
Y	32.004	0.0159	1.2385	0.12385	362.59

Check for deflection according to IS 1893:

$$\text{Deflection} = \frac{\text{height of the structure}}{250}$$

$$= \frac{15000}{250}$$

Deflection = 60mm

6. RESULTS AND DISCUSSIONS

A seismic time history analysis was carried out on the structure considered. An attempt has been made to compare the parameters considered such as maximum storey displacement, storey drifts, overturning moments and storey shear.

Maximum Storey Displacement

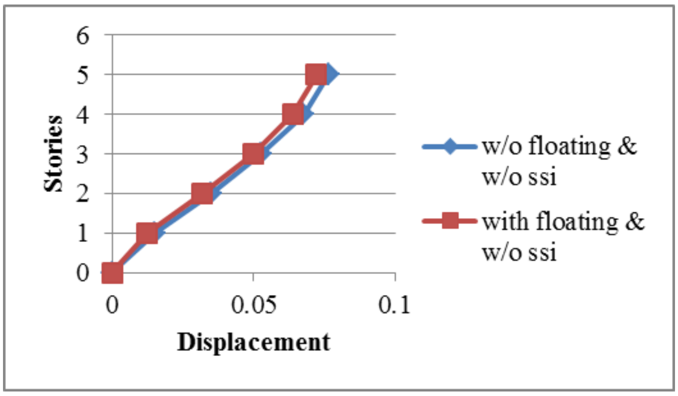


Fig 1: Maximum Storey Displacements for without SSI

In the above fig 1 shows that the comparison of respective stories for w/o SSI & w/o floating column and w/o SSI & with floating column. We get 6% lesser displacement when floating column & w/o SSI is taken into account comparative to w/o floating column & w/o SSI.

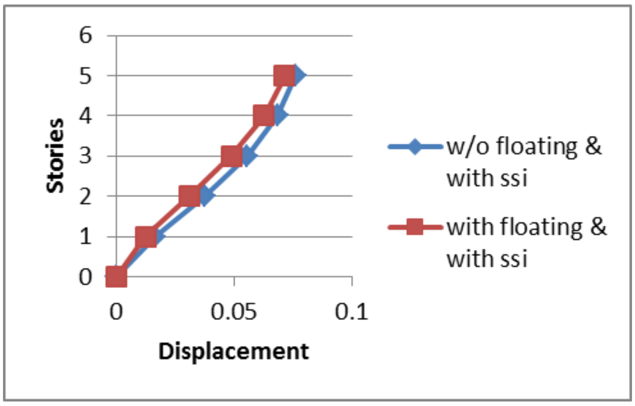


Fig 2: Maximum Storey Displacements for with SSI

In the above fig 2 shows that the comparison of respective stories for with SSI & w/o floating column and with SSI & with floating column in X direction. Here the storey displacement at top storey is 0.00446mm larger than with SSI & with floating column. We get 6.3% lesser displacement when floating column & with SSI is taken into account comparative to w/o floating column & with SSI.

Maximum Storey Drift

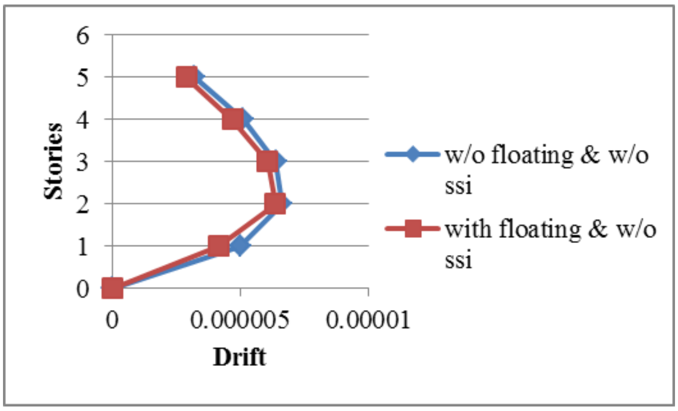


Fig 3: Maximum Storey Drifts for without SSI

In the above fig 3 shows that the comparison of respective stories for w/o SSI & w/o floating column and w/o SSI & with floating column in X direction. Here the storey drift at second storey is 0.25x10^{-6} larger than w/o SSI & with floating column. We get 3.9% lesser drift when floating column & w/o SSI is taken into account comparative to w/o floating column & w/o SSI.

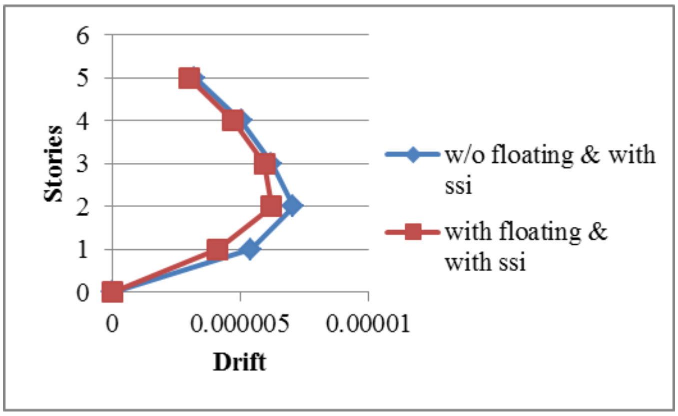


Fig 4: Maximum Storey Drifts for with SSI

In the above fig 4 shows that the comparison of respective stories for with SSI & w/o floating column and with SSI & with floating column in X direction. Here the storey drift at second storey is 0.86x10^{-6} larger than with SSI & with floating column. We get 13.9% lesser drift when floating column & with SSI is taken into account comparative to w/o floating column & with SSI.

Maximum Storey Shear

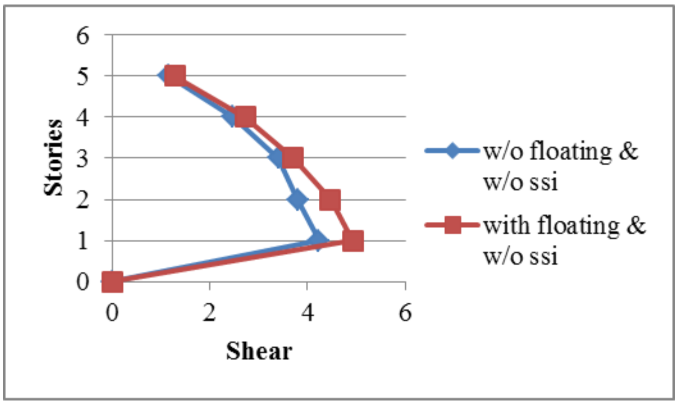


Fig 5: Maximum Storey Shear for without SSI

In the above fig 5 shows that the comparison of respective stories for w/o SSI & w/o floating column and w/o SSI & with floating column in X direction. Here the storey shear at first storey is 0.713kN larger than w/o SSI & w/o floating column. We get 16.89% larger shear when floating column & w/o SSI is taken into account comparative to w/o floating column & w/o SSI.

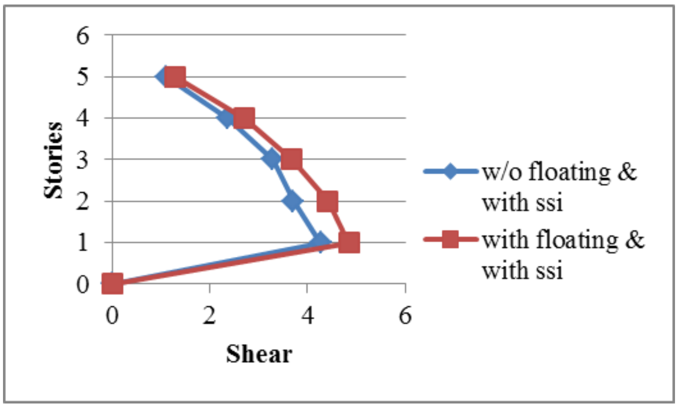


Fig 6: Maximum Storey Shear for with SSI

In the above fig 6 shows that the comparison of respective stories for with SSI & w/o floating column and with SSI & with floating column in X direction. Here the storey shear at first storey is 0.578kN larger than with SSI & w/o floating column. We get 13.5% larger shear when floating column & with SSI is taken into account comparative to w/o floating column & with SSI.

Maximum Over Turning Moment

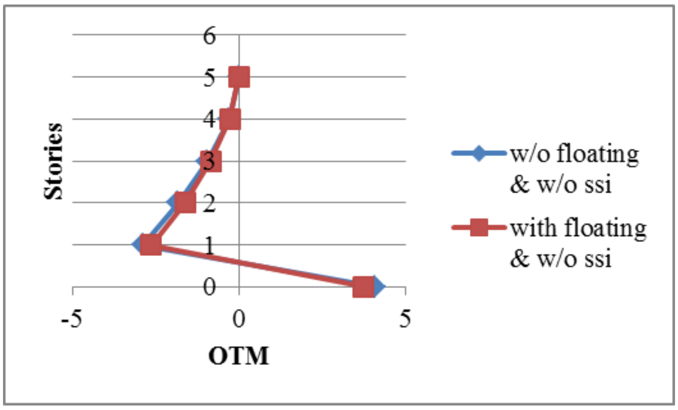


Fig 7: Maximum Over Turning Moment for without SSI

In the above fig 7 shows that the comparison of respective stories for w/o SSI & w/o floating column and w/o SSI & with floating column in X direction. Here the storey overturning moment at base is 0.332kN-m larger than w/o SSI & w/o floating column. We get 8.85% lesser overturning moment when floating column & w/o SSI is taken into account comparative to w/o floating column & w/o SSI.

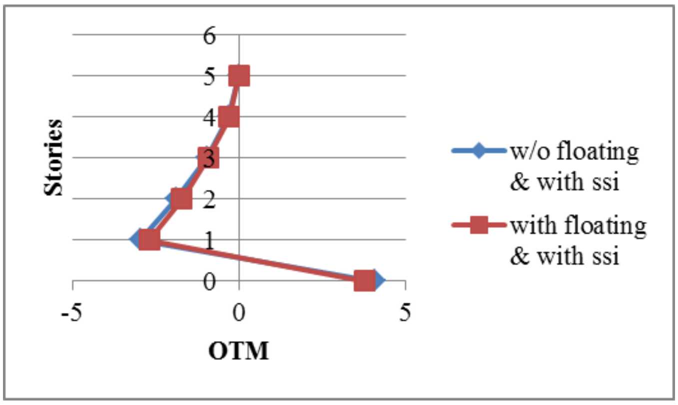


Fig 8: Maximum Over Turning Moment for with SSI

In the above fig 8 shows that the comparison of respective stories for with SSI & w/o floating column and with SSI & with floating column in X direction. Here the storey overturning moment at base is 0.298kN-m larger than with SSI & w/o floating column. We get 7.85% lesser overturning moment when floating column & with SSI is taken into account comparative to w/o floating column & with SSI.

7. CONCLUSIONS

- The model is safe for lateral loading while not considering soil structure interaction for the structure with floating column.
- While considering soil structure interaction, the structure is safe for a permissible limit of drift and deflection, whereas the base shear is 5% lesser comparing to without soil structure interaction.
- Here the structure is found to be safe with floating column, because as the dimension of the structure is increased by 10% for the structure when the floating column is considered.
- As the base shear due to the time history analysis are within the limits of the base shear due to static force.
- As the displacement due to the time history analysis is within the limits according to IS 1893.
- It is suggestible that dimensions of the structure with floating column are to be widened at the base level than the above limits.
- Hence floating column structure is suggested in Zone III areas

ACKNOWLEDGMENT

The authors would like to thank Dr. SRILAKSHMI G, HOD of civil engineering department, Sambhram institute of technology for their kind support and providing better environment. The authors are also grateful to Prof. KARTHICK N M, CMRIT for his encouragement and support.

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