Review Paper on Comparative Analysis of Infilled RC Building Frame with Fixed Base and Flexible Base by Considering SSI for Seismic Load

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Abstract— In conventional approach of analysis and design of structure, the structural engineer consider the base of R.C. building as fixed and avoid the compressible nature of soil. Compressible nature of soil causes decrease in the overall lateral stiffness of R.C. building. This may increase the natural time periods of the structural system. Such increase in lateral natural period, considerably effect the seismic behaviour of R.C. building frame. In this study a G+7 infill masonry RC building is analysed considering effect of infill stiffness using modelling approach given by Hendry for fixed Base and flexible Base. Equivalent static analysis of these two building models is carried out to compare the performance of infill masonry building resting on Raft foundation with fixed base and flexible base by considering Soil Structure Interaction for seismic loading seismic on the basis of Story shear, Floor displacement, Story drift, Time period and Settlement of Raft. Results shows that maximum increases in story shear for flexible base infill frame models compare to fix base infill frame model, displacement for flexible base infill frame is considerably increase compare to fixed base infill frame, story drift is increasing inflexible base infill frames compare to fixed base infill frame. This study also reveals that time period and settlement of raft foundation also increases in case of building with flexible base. This study shows that considering the Soil structure interaction in dynamic analysis of RC building frame the settlement is increased. The effects of soil structure interaction on total and differential settlement is critical factor for soft soil.

Keywords: Structural Designing, Analysis, Soil Structure Interaction, Stadd.Pro, Seismic Analysis

I. INTRODUCTION

In conventional approach of analysis and design of structure, the structural engineer consider the base of R.C. building as fixed and avoid the compressible nature of soil. But in reality it has been seen that the supporting soil system allow the deformation upto some extent due to its compressibility. This compressible nature of soil causes decrease in the overall lateral stiffness of R.C. building. This may increase the natural time periods of the structural system. Such increase in lateral natural period, considerably effect the seismic behaviour of R.C. building frame resting over raft foundation.In general the effect of masonry infill wall is ignored in design and analysis of R.C. structures which may cause unsafe design. In analysis if the effect of infill is taken then the weight of the R.C. building got increased. The earthquake movement generates inertial forces and these forces are proportional to the weight of the structure, although, infill will increase the strength and stiffness of the R.C. building and reduces natural period. Hence for safe design, the effect of infill masonry wall should be considered

II. LITERATURE REVIEW

Several investigators performed the various type of studies considering the effects of soil compressibility which broadly falls in the area of soil-structure interaction studies.

A. Malviya et al (2017) tried to consider the impact of soil compressibility in investigation and outline of structure. A (G+7) 4 straights X 4 bayous RC structure upheld on sandy soil and arranged in seismic zone V according to May be: 1983 (section 1)- 2002 was dissected utilizing STAAD PRO programming. They at first dissected considered building outline by tradition approach i.e. taling settled base condition and bolster responses were processed for various load mixes and the sizes of establishment for various backings were figured by utilizing STAAD FOUNDATION programming. At that point they supplanted the settled help by a spring of proportional establishment solidness to perform adaptable base examination and computed the most extreme aggregate settlement and differential settlement between footings. In light of results, they presumed that dirt compressibility causes settlements of establishments, change the help responses, redistribution of powers in pillar and segment and furthermore influences the prerequisite of fortification for plan.

B. Gaonkar et al (2016) tried to introduce the concept of structure-soil-structure interaction by conducting a literature review in the area of study. They done three case studies on dynamic structure-soil-structure interaction analysis that considers adjacent tall buildings modelled by computer programs as a reference and concluded that the taller building increased the response of a shorter building adjacent to it and a shorter building decreased the response of a taller adjacent building when the distance between the adjacent buildings are varied and the base shear in taller buildings is higher as compared to shorter adjacent building. They also observed that the effects of structure-soil-structure increases time period, base shear and displacement when the distance between adjacent buildings are varied.

C. Badry et al (2016**)** made an attempt to reduce the computational cost by using equivalent pier method for deep foundation system and found their approach to be effective in optimising the computational efficiency. They used it in the analysis of L-shaped eleven storey building resting on pile foundation with homogenous soil conditions under dynamic loading.

D. Mohod et al (2014) studied a 3 bay three-storey regular RCC space frame supported on isolated footing resting on homogeneous soil mass and subjected to gravity loading using finite element method. They considered the three cases for analysis as fixed base analysis, elastic analysis and elastoplastic analysis. It was investigated that during non-interaction analysis displacement is purely a deflection of beams and during elastic analysis displacement is due to settlement as well as deflection, whereas in case of elastoplastic analysis displacement is majorly due to settlement and very small due to deflection and an increase in displacement was found with the increase in number of storeys.

E. Jamkar et al., (2013) conducted the investigation for RC frame with the different arrangement of infill masonary work boards subjected to dynamic seismic loading. In his investigation he compared the results for different cases and made conclusion in aspect of IS 1893(2002) code. In their paper he concluded that by considering stiffness of infill wall beneath plinth the response of the structure for earthquake motion can be enhanced as compared to the soft basement.

III. Conclusion

The effect of Soil Structure Interaction on the analysis results are considered and compared with Fixed base frame model. Story shear, Floor displacement, Story drift, Time period and Settlement of Raft between Fixed base and Flexible base infill frame models are compared between.

A. Story shear

Maximum increases in story shear for flexible base infill frame models compare to fix base infill frame model. The increase in story shear is found 1.23 time of fixed base infill frame model. The design value of story shear is underestimated in conventional approach.

B. Floor displacement

Displacement for flexible base infill frame is considerably increase compare to fixed base infill frame. The increase in displacement is found 4.03 to 5.04 times of fixed base infill frame.

C. Story Drift

Story drift is increasing inflexible base infill frames compare to fixed base infill frame. This increase in story drift is found to be 1.26 to 4.86 compare to fixed base infill frame.

3.4. Time Period

Time period for flexible base infill frame is considerably increases compare to fixed base infill frame. The time period increase is found 1.7 time of fixed base infill frame model. This ratio shows that considering the Soil structure interaction in dynamic analysis of RC building frame the time period is increased. Hence ignoring effect of SSI may leads to Seismic vulnerability.

D. Settlement of Raft

Settlement for flexible base infill frame is considerably increases compare to fixed base infill frame. The value of settlement for flexible base model 62.07 mm more than fixed base infill frame model. Differential settlement between center and corner of raft with magnitude of 5.28 mm occurs with non-uniform pattern. This shows that considering the Soil structure interaction in dynamic analysis of RC building frame the settlement is increased. The effects of soil structure interaction on total and differential settlement is critical factor for soft soil.

References

[1] Abou Elfath H. , "Rehabilitation of a reinforced concrete frame using eccentric steel bracing", Eng. Struct., 23, 745-755, 2001.

[2] IS 1893(Part-I): 2002 "Criteria for Earthquake Resistant Design of Structures" Part-I General Provision and Buildings (Fifth Revision). Bureau of Indian Standards, New Delhi, 2002.

[3] Joao Luis Domingues Costa, "Standard Methods for Seismic Analyses" Report BYG.DTU R-064, 2003.

[4] Shan-Hau Xu & Di-Tao Niu , "Seismic Behavior of R.C. Braced Frames", ACI Structural journal, No.1, 100, Jan –Feb-2003.

[5] T.EI Amoury, A. Ghobarah, "Retrofit of RC Frames using FRP Jacketing or steel bracing" , IJSEE: Vol. 7, No. 2, 2005.

[6] Ravi kumar G. and Kalyanaraman,-"Earthquake design and retrofit of RC multi-storied buildings with steel bracing", National Program on Earthquake Engineering Education, 2005.

[7] Youssefa M.A & Ghaffar zadehb H., Nehdi M., "Seismic performance of RC frames with concentric internal steel bracing" Department of Civil and Environmental Engineering, Shiraz University, Iran, 23 October 2006.

[8] Ferraioli M., Avossa, "Performance based assessment of R.C. buildings strengthened with steel braces", Proceedings of the 2nd International Congress Naples, Italy, 2006.

[9] Ghaffarzadeh H. and Maheri M.R.,-"Cyclic tests on the internally braced RC frames", Dept. of Civil Engineering, Shiraz University, Shiraz, Iran, 2006.

[10] Rahai and m. Lashgari, "Seismic strengthening of nine-storey RC building using Concentric and buckling-restrained bracing", 31st Conference on our world in concrete and structures, 16 - 17 august, 2006.

[11] Tapia-Hernandez E. & Tena-Colunga A., "Behavior of moment resisting concentrically braced frames (MRCBFs) of regular buildings in seismic zones" 14th World Conference on Earthquake Engineering, Beijing, China, October 2008.

[12] A.R. Khaloo and M. Mahdi Moseni "Nonlinear Seismic Behavior of RC Frames With RC Braced", Asian Journal of Civil Engineering (Building & Housing) Vol. 9 , No. 6, 2008.

[13] M.R. Maheri and H. Ghaffarzadeh, "Earthquake design basis for internally braced frame", The 14 Th World Conference on Earthquake Engineering, Beijing, China, October 12-17, 2008.

[14] Mahmood Hosseini, Peyman Shadman Heidari and Mojtaba Heravi, "Analytical and Experimental Study of the Effect of Bracing Pattern In The Lateral Load Bearing Capacity Of Concentrically Braced Steel Frames", The 14th World Conference on Earthquake Engineering, Beijing, China, October 12-17, 2008.

[15] L. Di Sarnoa, A.S. Elnashaib, "Bracing systems for earthquake retrofitting of steel frames" Journal of Constructional Steel Research 65, 15 February 2009.

[16] Viswanath K.G., Prakash K.B. and Anant Desai, "Seismic analysis of steel braced RC frame"

International Journal of Civil and Structural Engineering Volume 1, No 1, and 2010.
[17] Duggal S.K "Earthquake Resistant Design of Structures." Oxford University Press YMCA Library Building, Jai Singh Road, New Delhi, 2010.
[18] Bhunia S.A & Ramjiyani A.D , "Solution of shear wall location in multi-storey building" ,International Journal of civil and structural Engineering, Volume 2, No 2, 2011.
[19] Pankaj Agarwal, Manish Shrikhande, "Earthquake Resistant Design of Structures" PHI Learning Private Limited, 2011