International Journal of Scientific & Engineering Research, Volume 8, Issue 3, March-2017
ISSN 2229-5518

Relative Study of Dynamic Analysis of Multi-Storey Composite and Irregular Structure

Nilesh J. Jain[1], Sunil M. Rangari[2]

[1]P. G. Student, Department of Civil Engineering,
Saraswati College of Engineering, Navi-Mumbai,
University of Mumbai, Maharashtra, India.

[1]nilesh.jain108@gmail.com

[2]Professor, Department of Civil Engineering, Saraswati College of Engineering, Navi-Mumbai, University of Mumbai Maharashtra, India.

[2]sunilrangari@yahoo.co.in

Abstract— Several non-linear static and dynamic analysis of structure have been developed in recent years. This paper discusses and compare those measures that have been implemented for the dynamic analysis of composite and irregular structures. Steel-concrete composite arrangements for structures are designed by connecting the steel structural member to the concrete member.

In present study, a multi-storey composite and irregular structure for seismic analysis has been studied for various different software's like STAAD-PRO and ETABS for different seismic zones in India. Also studied the collapse simulation and analysis using the finite element based software named ANSYS. This study comprises of different irregularity responses due to plan and vertical irregularity. The comparative parameter studied, includes; base shear, storey drifts for the structure, shear forces and bending moments for column's and beams at different level.

Keywords— *Composite Structure; Geometric Irregularities; Mass Irregularities; Response Spectra Method; Fundamental Frequencies, Static Linear, Non Linear Static*.

I. INTRODUCTION

Structural design of buildings for Seismic loadings is predominantly concerned with structural safety during major ground motions. Seismic loading needs an understanding of the structural performance under huge in-elastic deformations. Many of the structures are evaluated for earthquake Forces and designed consequently. Several Research have been carried out to analyze the response of irregular structures. Work that has been already done relating to the seismic response of vertically irregular building frames. Structures with plan irregularities and those with elevation irregularities are common in the affected zone. The different kinds of irregularity given in the IS code 1893 (Part-I). Major failures happened Because of irregularities like soft storey Failure, Mass Irregularity Failure, Plan Irregularity Failure, Shear Failure.

The most detailed and specific description of the problem is obtaining by non-linear dynamic analysis, made by applying time-history records which, in the long term, signifies the precise development path. Yet, due to its complexity and high standards it goes beyond the edges of practical application and is appropriate only for the research and analysis of structures.

There are no commendations of how one can calculate the fundamental frequency simply by formula, and there are no provisions which permit the structural detailing by a pseudo-static design against a corresponding adjacent load, therefore, a rough study which provides basic dynamic data (i.e. Frequencies, peak values of base resultant forces) of a structures and also an overview of their response during an earthquake is a useful tool at the preliminary stage of a practical design.

Time history analysis is an analysis of the dynamic response of the structure at each increment of time, when its base is subjected to a specific ground motion time history.

Dynamic analysis may be performed either by the time history method or by the response spectrum method. However, in either method, the design base shear (V) shall be compared with a base shear (V_B) calculated using a fundamental period (T_a). Where (T_a) is the approximate fundamental natural period of vibration, in seconds. The base design shear V is less than V_B, and all the response quantities (for example member forces, storey displacements, storey forces, storey shears and base reactions) shall be multiplied by (V/V_B).

Time history method of analysis, when used, shall be based on an appropriate ground motion and shall be performed using accepted principles of dynamics IS-1893 (I), [12].

II. REVIEW OF LITERATURES

A. ***Panchal and Marathe (2011)*** compare the work of G+30 storey commercial building which is situated in seismic zone iv. The method adopted by them was equivalent static method of analysis. Etabs software is used for modeling of composite, steel and RCC Structures, and the results are compared. The issues obtain were high base overturning moment, high shear capacity requirement at base, high gravity stresses. For all these issues they compare the three types of model. And concluded that composite structure is found to be more economical [6].

B. ***Bagheri et al. (2012)*** Have modeled a multi-storey irregular buildings with 20 stories using software packages ETABS and SAP-2000-v.15 for seismic zone-v in india. Also deals with the effect of the variation of the building height on the structural response of the shear wall building. Dynamic responses of building under actual earthquakes, "el-centro 1949" and "chi-chi taiwan 1999" have been investigated by them this paper highlights the accuracy and exactness of time history analysis in comparison with the most commonly adopted response spectrum analysis and equivalent static analysis [1].

C. ***Mohite et al. (2015)*** Have studied construction of (B+G+11storey) commercial building, situated in kolhapur, with steel-concrete-composite and rcc and compared with each other. Using ETABS v.15 equivalent linear static method of analysis explained and results are compared for different parameters. Comparative parameter includes roof deflections, base shear, storey drifts, for the building and axial forces and bending moments for column's and beams at different level. They conclude that steel-concrete composite building is found to be more safe and economical and better option [3].

D. ***Mahajan and Kalurkar (2016)*** considered two different structures for the comparison under seismic analysis. "pushover analysis" are done for G+20 storey structure. The building is analyzed and design for seismic loading by using ETABS software. Results are compared for the base shear, modal time period, storey displacement and storey drift for both structures. As the composite is having more lateral stiffness, the results of time period and storey displacement shows the significant variation. While analyzing for "non-linear static analysis the performance point for the fec is significantly much more as compared to the rcc model [7].

E. ***YUAN jing et al. (2011)*** Have analysed seismic collapse process of a ten-storey rc frame structures from elastic stage to crack, then to collapse is simulated and analyzed using the finite element software named ANSYS/LS-DYNA. The simulation result is in good accordance with the actual seismic collapse process. The weaknesses of high-rise frame structures under seismic force are founded. The antiseismic capacity of high-rise frame structures' bottom layer is weak and crumbling of the concrete of beam-column joints caused by shear failure of the joints is the major reason for seismic collapse of frame structures [2].

F. ***Shaikh and Deshmukh (2013)*** have studied different irregularity response due to plan and vertical irregularity, and to analyze "geometric irregular"-shaped building while earthquake forces acts and to calculate the deflection in the columns. Additional increase in deflection has been considered because; the increase in deflection causes columns to collapse. So in design procedures this additional deflection has taken into account [4].

G. ***Gaur et al. (2014)*** Have analyzed horizontally irregular buildings for their stability. Multistory horizontally irregular buildings, as described in is 1893:2002, were modeled in program STAAD-PRO. Irregular plan like l-shape, h-shape and u-shape are considered for study. Each building is raised 20 storeys high. Assessment is done on the basis of lateral length ratio for each shape. Parameters like internal forces and roof displacement are used for the assessment. Results are plotted for internal forces of critical members and roof displacements versus lateral length ratios for different shapes [9].

III. Problem Defination

In the present paper a composite-irregular structure is to be considered for the study. The structure is going to be modeled and analyzed in a ANSYS software. The structure is a G+20 storey building, with geometric irregularity, mass irregularity and structural irregularity. The structure is a steel and concrete hybridized structure. The objective of the project is to carry out response spectrum analysis (RSA) and time history analysis (THA) of vertically and horizontally irregular composite building frames, with mass irregularity.

Horizontal structural irregularities exist in lateral load resisting system. Horizontally irregular building is analyzed for their stability. Structures with vertical offsets will fall under this category. Also, a building may have no apparent offset, but its lateral load carrying elements may have irregularity (for instance, shear wall length may suddenly reduce).

Mass irregularity will be induced by the presence of a heavy mass on a floor, say a swimming pool. The mass irregularity in is-1893 has been defined when weight of a floor exceeds twice the weight of the adjacent floor. NEHRP (national earthquake hazard reduction program) defines it when the weight exceeds 150% of that of the adjacent floor.

The mass irregularity can be induced by increasing the mass by 100% as that of the adjacent floor. The second last storey or the middle storey of the frame can be considered for inducing mass irregularity.

IV. Literature Appraisal

The analysis done by [6], is based on the equivalent static method. The equivalent static analysis work is appropriate for low to medium-rise buildings without significant coupled lateral-torsional modes, in which only the first mode in each direction is considered. Whereas the most preferable method to calculate the dynamic response of a particular structure is by adopting response spectrum method (RSM) o/r time history analysis (THA). Also the dynamic analysis would be more accurate if the finite element based software were preferred.

A multi-storey irregular building with G+20 stories using software packages ETABS and SAP 2000 v.15 was proposed by [1]. The results of two different software's were compared, but the software ETABS and SAP 2000, both of them have the same analysis engine at core. The only difference is that the sap 2000 is lot easier while dealing with geometry of the structure, whereas ETABS have all the necessary tools for building systems, as well as help in geometry formation of building systems. Henceforth the analyzed parameters should have compared with a finite element based software such as ANSYS to obtain a better result.

The analysis done by [2], is based on collapse simulation of a G+10 Storey RC Framed Structure, Using the Software ANSYS/LS-DYNA. The Modeled structure is a Symmetric in Plan as well as Elevation. Also no other irregularities were included. It has been found that the reinforced concrete member is damaged after reaching the ultimate strength or the deformation limit, hence such kind of flaws might have been over-come if the composite structure were preferred. Moreover, the limitation is that, the structure is symmetric, while the irregular structure is more prone to seismic loads.

Conclusions

It is proposed that buildings with irregularities are prone to earthquake damage, observed in many earthquake occurrences as compare to symmetric structures. Soft storey are more prone to seismic damages, hence it is more ideal to build masonry walls or RCC walls in ground storey to avoid such damages.

Earthquake produces significant deflection which is also serious factor leading to major damage or complete breakdown of structures. It is, therefore, necessary that irregular buildings should be carefully analyzed for deflection.

Overall response of composite structure is better than RCC structure i.e. composite structure produces less displacement, resist more structural forces. Earthquake response is more than wind load.

Irregular structures are commonly preferred by engineers from architectural point of view and hence such structure should be thoroughly analyzed for the seismic stability.

REFERENCES

[1] Bahador Bagheri, Ehsan Salimi Firoozabad, and Mohammadreza Yahyaei, "Comparative Study of the Static and Dynamic Analysis of Multi-Storey Irregular Building," International Scholarly and Scientific Research and Innovation Vol:6, No:11, 2012.

[2] YUAN jing, LIU hai-qing, CHEN zhen-xi, "Collapse Simulation Analysis of High-Rise Reinforced Concrete Frame structures under Seismic Force," 978-1-4577-0290-7/11 ©2011 IEEE.

[3] Mr. Nitish A. Mohite, Mr. P.K. Joshi, Dr. W.N. Deulkar, "Comparative Analysis of RCC and Steel-Concrete-Composite (B+G+11 Storey) Building," International Journal of Scientific and Research Publications, Volume 5, Issue 10, October 2015.

[4] Shaikh A. Aijaj, G.S. Deshmukh, "Seismic Analysis of Vertically Irregular Building," SRTMU's Res. J. Sci. 2013, 2(1), 101 - 111.

[5] D.R. Deshmukh, A.K. Yadav, S.N Supekar, A.B. Thakur, H.P Sonawane, I.M. Jain, "Analysis and Design of G+19 Storied Building Using Staad-Pro," ISSN: 2248-9622, Vol:6, Issue 7, (Part -1) July 2016.

[6] D.R. Panchal and P. M. Marathe, "Comparative Study of R.C.C, Steel and Composite (G+30 Storey) Building," International Conference On Current Trends In Technology, 'NUiCONE – 2011'.

[7] Abhishek Sanjay Mahajan, Laxman G. Kalurkar, "Performance Analysis Of Rcc And Steel Concrete Composite Structure Under Seismic Effect," IJRET Volume: 05 Issue: 04, Apr-2016 .

[8] Devesh P. Soni, Bharat B. Mistry, "Qualitative Review of Seismic Response of Vertically Irregular Building Frames," ISET: Vol: 43, No. 4, December 2006.

[9] Himanshu Gaur, R.K Goliya, Krishna Murari, Dr. A. K Mullick, "A Parametric Study Of Multy- Storey R/C Buildings With Horizontal Irregularity," IJRET: Volume: 03 Issue: 04 | Apr-2014.

[10] M. De Stefano, M. Tanganelli, S. Viti, "On the Variability of Concrete Strength as a Source of Irregularity in Elevation for Existing RC Building: a Case Study," Springer, Bull Earthquake Eng (2013), DOI 10.1007/s 10518-013-9463-2.

[11] George Georgoussisa, Achilleas Tsompanosa, Triantafyllos Makarios, "Approximate seismic analysis of multi-story buildings with mass and stiffness irregularities," ELSEVIER, Procedia Engineering 125 (2015).

[12] BIS (2002). ―IS 1893 (Part 1)-2002: Indian Standard Criteria for Earthquake Resistant Design of Structures, Part 1 – General Provisions and Buildings (Fifth Revision)‖, Bureau of Indian Standards, New Delhi.