International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 09 | Sept - 2021 ISSN: 2582-3930

REVIEW ON ANALYSIS OF IRREGULAR CONNECTED TWIN BUILDINGS SUBJECTED TO SEISMIC LOADING

Sadhana Surendra Ugare[1], Prof. N.P. Phadtare

[1] *Sadhana Surendra Ugare, Civil Enginerring, Padmabhooshan Vasantraodada Patil Institute of Technology, Budhgaon*

[2]*Prof. Prof. N.P. Phadtare, Enginerring, Padmabhooshan Vasantraodada Patil Institute of Technology, Budhgaon*

Abstract - Dynamic analysis of structures is broadly used in research in all fields of earthquake analysis studies including universities. Until recently, it has not been reported to be used in practical seismic design of building or evaluations of buildings. However, recent updates of building codes all over the world recommend the use of the dynamic analysis method in the seismic design of buildings located in regions which are highly vulnerable to the seismic actions. Conventional methods of earthquake analysis are dependent upon static analysis. But to understanding the behaviour of building on dynamic forces, dynamic analysis plays a vital role in it. Hence it is important that an earthquake analysis of structure with dynamic approach is carried out. Such a dynamic approach is possible with using Response spectrum Method.

Response-spectrum analysis (RSA) is a linear-dynamic statistical analysis method which measures the contribution from each natural mode of vibration to indicate the likely maximum seismic response of an essentially elastic structure. Response-spectrum analysis provides insight into dynamic behaviour by measuring pseudo-spectral acceleration, velocity, or displacement as a function of structural period for a given time history and level of damping. It is practical to envelope response spectra such that a smooth curve represents the peak response for each realization of structural period.

The recent advancement of high rise structure analysis and design follow IS 1893:2002 to perform dynamic analysis. Response-spectrum analysis is useful for design decision-making because it relates structural type-selection to dynamic performance. Structures of shorter period experience greater acceleration, whereas those of longer period experience greater displacement. Structural performance objectives should be taken into account during preliminary design and response-spectrum analysis.

***Key Words*:** response spectrum method, Story response, Etabs

1. INTRODUCTION

The use of high rise buildings made the structural engineer to analyze and design as per drastic earthquake effects. Now days, Twin buildings are highly in demand due to its arch-structural design, individual plan along with more space with same foundation support. For that, we should know the efficient point parameters such as story drifts, story responses, accelaration, and base base reactions when these kinds of structures under seismic loading.

2. OBJECTIVE

This study examines different parameters such as story drifts, lateral displacements, bending moments, axial forces and base shear when twin buildings connected with each other at different elevation come in contact with seismic loading where building is situated at Zone V. The most efficient case will be analyzed after all parameters.

3. METHODOLOGY

The space frame will model in ETABS software. The descriptions of the twin buildings are listed in Table 1.Various connecting locations will be studied up to 12 floors. The performance of the building will evaluate in terms of story drifts, lateral displacements, bending moments, axial forces and base shear.

Table 1 Details of building

Building configuration	G + 12 (C shaped)
No. of bays in X direction	4
No. of bays in Y direction	5
Height of building	39 m
Dimensions of building	15 m x 12 m

4. REVIEW OF LITERATURE

1) S. Boopathi Raja V. Preetha

The study summarizes the different types of structural irregularities i.e. Plan and vertical irregularities in RC building along with their performance during earthquake.

2) Vedantee Prasad Shukla Shukla, Sayali Pradeep Rote, Manoj Bharat Kamble

In this paper static analysis is performed for R.C.C frame regular and irregular building up to G+ 15 storeys by using "Response Spectrum Method". The problems introduced due to discontinuity in stiffness, mass and geometry of structure. Irregular building is compared in all four zones. The designing has been carried out in ETABS software

3) Shehata E. Abdel Raheem[1'2] Momen M. M. Ahmed[2]

The focus of this study is to investigate structural seismic response demands for the class of L-shaped buildings through evaluating the plan configuration irregularity of re-entrant corners and lateral–torsion coupling effects on measured seismic response demands. The measured responses include story drift, inter-story drift, story shear force, overturning moment, torsion moment at the base and over building height, and torsional irregularity ratio.

4) Bharat Khanal, Hemchandra Chaulagain

In this context, the present study evaluates the effect of plan configuration irregularity when subjected to the varying angle of the input response spectrum. For this, one regular and six different L-shaped RC building frames were modelled for numerical analysis. The analysis was done through an equivalent static lateral force method and response spectrum analysis (dynamic analysis). The structural responses were measured in terms of story displacement, inter-story drift ratio, torsion irregularity ratio, torsion diaphragm rotation, normalized base shear force, and overturning moment. The results indicate that buildings with plan configuration irregularity are more sensitive to the varying angle of the input response spectrum as compared to the symmetrical building model. The significant increase in seismic response demand was observed when the finite element models were subjected to a 135ºangle as compared to the 0º angle of seismic incidence.

5) Rohan Chavan[1], Prachi Sohoni[2]

In proposed problem G+11 story irregular RC buildings are analysed with and without cross bracing system, which is one of the best of concentric bracing systems. Non-linear time history analysis is carried out in order to find out response of structure for various ground motions. ETABS 2016 software is used for analysis purpose. The performance of the building is evaluated in terms of story drifts, lateral displacements, bending moments, axial forces and base shear.

6) Dr. K.B. Parikh[1], Jayant Shaligram[2]

In this paper, plan irregular open ground storey setback buildings resting on plain and 45 degree sloping ground have been analyzed using nonlinear time history analysis with and without replacing open ground storey columns by reinforced concrete filled steel tube columns. RCCOL model and RCFSTC are considered. Performance of both the models has been evaluated in terms of storey displacement, storey drift, base shear. It is observed that storey displacement, storey drift and torsional response are decreased by greater extent. Thus, RCFST columns provided in open ground storey alleviate the devastating effects due to presence of irregularities in the building during strong earthquake ground motion.

7) Mohamed Safeer Kodappana*1, Priyanka Dilip P*2

In this paper, an attempt is made to discovering the behaviour of shear wall with a different pattern of openings under earthquake loads. Many buildings now a days have irregular arrangements, both in plan and elevation. That courses the structures with undesirable distributions in their stiffness of the building. These unpremeditated changes in structural stiffness cause bad impact to the buildings. The reason behind the lack of the seismic behaviour of the structure is the plan irregularity or vertical irregularity present in it. The shear walls are the best and simple methods to sustain these lateral forces. And they provide required strength against seismic forces. Sometimes a shear wall may include openings due to the functional needs such as doors and windows. This study is carried out on plan irregular structures with shear wall contain staggered and regular openings. Analysis has been done to estimate the behaviour of plan irregular structures when introducing the different pattern of openings in shear walls, at an advantageous position. The parameters considered are storey displacement, storey drift, storey shear and stress distributions that concern with the pattern of the openings. The dynamic analysis is carried out with the help of ETABS v 15 by using response spectrum method.

8) Jayant Shaligram[1] Dr. K.B Parikh[2]

This study investigates the performance of the setback building with open ground storey using nonlinear static pushover analysis. Such type of building possesses vertical geometric and mass irregularity as well as stiffness irregularity. In this paper, plan irregular setback building with open ground storey resting on plain and sloping ground which makes the building so weak to survive during earthquake. An attempt has made to alleviate effects of these irregularities during earthquake by replacing OGS columns by Reinforced concrete filled steel tube columns. RCFST columns increase the stiffness of the OGS which offset the soft storey effect as well as reduce storey displacement, drift and torsional response significantly. From hinges results, it can be observed that performance of the building is improved significantly.
Ref. Emerging Research and Innovations in Civil Engineering

9) More Amol R.[1], Prof. Dr. Kale R.S.[2]

This paper is concerned with the effects of various Mass and column stiffness Irregularity on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) of vertically Mass and column stiffness Irregular RC building frames. Comparison of the results of analysis of irregular structures with regular structure will be done. Comparison of mass irregular buildings having different column stiffness will also be done. The scope of the project also includes the evaluation of response of structures for axial force, base shear, time period, bending moments, storey drift and storey displacement.

10) Mohammed Mohi uddin[1],Hashim Mohiuddin[2]

In the present work, an analytical study is performed to evaluate the effect of plan irregularity on the seismic behaviour of the conventional RC framed building. Six models of G+14 storey building with one regular and remaining irregular plan (Hexagonal, Circular, Elliptical, Sector and Y-shape) have been taken. The Plan area for each structure is same. The performance of these building models under Seismic loading is examined by carrying out Response Spectrum analysis using structural analysis software ETABS 2016 v16.2.1. The comparison is made between the regular model and irregular model for various parameters.

11) Shaikh Abdul Aijaj Abdul Rahman[1], and Ansari Ubaidurrahman Salik[2]

In this paper the proportional distribution of lateral forces evolved through seismic action in each storey level due to changes in mass and stiffness of frame on vertically irregular structures. The effect of mass and stiffness irregularity of G + 10-storeyed vertical geometric irregular building is studied using finite element method-based software. Two methods of analysis, namely linear static and linear dynamic analysis are used to evaluate response of the structure in the form of storey shear, storey displacement and storey drift. Responses are plotted and compared, and conclusions have been made from the results.

12) Surendra Chaurasiya1, Sagar Jamle2

Also a lot of twin towers are under construction not only across the world but also in India too. Such structures are made possible by bridging the gap between these two towers by various means like making the bridge or by RCC frame, steel connections, etc. In this paper various papers are studied to comprehend the concept and optimize the need. The study on various research papers along with existing towers help in deciding the objectives of the study and so the optimizing parameters.

13) Ying Zhou, Xilin Lu*,†, Wensheng Lu and Jiang Qian

Many reinforced concrete or steel reinforced concrete single-tower buildings have been built in China. The structural performance of such one-tower structural systems depends on that of the primary components that are structural walls or moment-resistant frames. For multi-tower connected structures, problems become more complex. A multi-tower connected building, with large floor slab openings in plan and long-span truss in elevation, was thus studied because of its structural complexity and irregularity. First, a 1/25 scaled model structure was tested on the shake table under minor, moderate, and major earthquake levels. Then, the dynamic responses of the model structure were interpreted to those of the prototype structure according to the similitude laws. The experimental results were also compared with the numerical analysis of a three dimensional finite element model for the irregular structure. Both experimental and analytical results demonstrate that, despite of the structural complexity, the overall responses of the building meet the requirements of the Chinese design code and the torsion of the structure is not remarkable. It is suggested that the strength and stiffness of the long-span connecting truss should be improved due to the potentially large vertical acceleration under strong earthquakes.

14) M.R. Willford[1]and R.J. Smith[2]

This paper describes the structural design of two similar 60 storey towers in Manila using performance based procedures for seismic and wind actions. High-rise buildings designed by performance based methods not only perform better than conventionally designed ones, but are also less expensive to construct. The buildings incorporate the Arup Damped Outrigger System, and the savings realized by this are discussed.

15) Imad Shakir Abbood * ahir Mahmod Ammar N. Hanoon Mohd Saleh Jaafar Mohamed H. Mussa

Effect of structural links on seismic responses for a linked building system has been investigated in this paper by using finite element modelling technique. The linked building system in this study is represented by twin 40-story reinforced concrete frame-wall structures horizontally coupled by structural links. It is assumed that the two adjacent buildings were similar in this linked building system, so the two adjacent stories could be linked at the same height by an inter-building link. The linked building system is modelled as a rigid floor diaphragm for towers and as a beam for each link fixedly linked to the perimeter structural framework of the buildings. By employing earthquake time history excitation, the seismic responses of the twin towers were computed at different locations for the link. The responses of structures were evaluated and compared. The analysis outcomes indicated that the link could effectively change the structural responses of the linked building system. The structural responses have been decreased in some cases compared to the single tower, referring to the extra link stiffness as gathering the single tower to withstand seismic excitation while the responses have been increased in other cases, attributing to the additional mass of link. Thus, in the design of seismic-resistant linked building systems, care must be taken, particularly regarding properties of the link, specifically mass, stiffness, and location, as well as the link resistance with respect to the strength of the link and/or the structural elements composing the link to obviate undesired structural responses.

3. CONCLUSIONS

So far by reviewing and studying numerous research papers it has been analyzed stability of multi-storeyed irregular linked twin building against seismic loading is less as compared to symmetric multi storied building and it is required to analyze the connected structure with various possibilities of structural stability by various means and its optimum location in the building. Here we come at conclusion that studying the above literature the position of connector in the building is optimized so as to resist seismic loading. Also below points have been observed.

1. The plan configurations of structure have significant impact on the seismic response of structure in terms of displacement, story drift, story shear.
2. The storey shear force was found maximum for the first storey and it decreased to a minimum in the top storey in all cases.
3. Large displacement was observed in the T shape building. It indicates that building with severe irregularity shows maximum displacement and storey drift.
4. It was found that mass irregular building frames experience larger base shear than similar regular building frames.
5. The stiffness irregular building experienced lesser base shear and has larger inter storey drifts.

REFERENCES

1. Surendra Chaurasiya1, Sagar Jamle2, "Twin Tower High Rise Building Subjected To Seismic Loading: A Review." International Journal of Advanced Engineering Research and Science (IJAERS) [Vol-6, Issue-4, Apr- 2019] ISSN: 2349-6495(P) | 2456-1908(O)
2. Ying Zhou, Xilin Lu, Wensheng Lu and Jiang Qian, "Study on the seismic performance of a multi-tower connected structure" Ref. published online 16 September 2009 in Wiley Online Library (wileyonlinelibrary.com/journal/tal). DOI: 10.1002/tal.533
3. M.R. Willford and R.J. Smith "performance based seismic and wind engineering for 60 story twin towers in manila" The 14th World Conference on Earthquake EngineeringOctober 12-17, 2008, Beijing, China.
4. Imad Shakir Abbood * ahir Mahmod Ammar N. Hanoon Mohd Saleh Jaafar Mohamed H. Mussa "seismic response analysis of Linked twin tall buildings with Structural coupling International Journal of Civil Engineering and Technology (IJCIET) Volume 9, Issue 11, November 2018
5. Bharat Khanal, Hemchandra Chaulagain "Seismic elastic performance of L-shaped building frames through plan Irregularities" Published by Elsevier Ltd on behalf of Institution of Structural Engineers.
6. Abdel Raheem, Ahmed, Ahmed and Abdel-Shafy "Seismic performance of L-shaped multi-storey buildings with moment-resisting frames" [University of New South Wales] on [26/10/17]. Copyright © ICE Publishing, all rights reserved.
7. Vedantee Prasad Shukla, "Comparative Analysis & Design of Irregular Building & its Behaviour at Different by Using Etabs & Rcdc Software International Journal of Trend in Scientific Research and Development (IJTSRD) ISSN: 2456-6470
8. Rohan Chavan1, Prachi Sohoni2 "Seismic Analysis of Irregular RC Structure with Cross-Bracing System" © 2018 IJSRSET | Volume 4 | Issue 8 | Print ISSN: 2395-1990 | Online ISSN: 2394-4099.
9. Shaikh Abdul Aijaj Abdul Rahman "Seismic analysis of vertically irregular Buildings" CURRENT SCIENCE, VOL. 111, NO. 10, 25 NOVEMBER 2016
10. Jayant Shaligram 2Dr. K. B. Parikh "Seismic Performance Evaluation of Setback Building with Open Ground Storey" Emerging Research and Innovations in Civil Engineering (ERICE - 2019) | February 2019 e-ISSN: 2455-5703
11. S. Boopathi Raja "Studies on Effect of Structural Irregularities on Seismic Performance of Reinforced Concrete Building" ISSN No: 2456 - 6470 | www.ijtsrd.com | Volume - 1 | Issue – 6
12. More Amol R, Prof. Dr. Kale R.S "Study of seismic responses of multi-storied RCC building with mass irregularity & column stiffness variation" International Journal of Engineering and Techniques - Volume 3, Issue 6, Nov-Dec 2017
13. Mohamed Safeer Kodappana, Priyanka Dilip P "Study on Dynamic Behaviour of Shear walls with Staggered Openings in Irregular R.C. Framed Structures" © 2017 IJSRSET | Volume 3 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099 Themed Section: Engineering and Technology
14. Imad Shakir Abbood "Effect of structural links on seismic responses for a linked building" Volume 9, Issue 11, November 2018, pp. 208–219, Article ID: IJCIET_09_11_021
15. Jayant Shaligram 2Dr. K. B. Parikh "Seismic Performance Evaluation of Setback Building with Open Ground Storey" Emerging Research and Innovations in Civil Engineering