



Use of Different Shapes of Twin Towers High Rise Building and Compare it with Simple type for Seismic Loading-A Review

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ABSTRACT

This study investigates the seismic response of buildings with non-traditional shapes (triangular, hexagonal, and curved) and compares them with conventional rectangular buildings. Nonlinear dynamic analysis was performed using STAAD PRO software to simulate seismic activity. The results show that buildings with non-traditional shapes exhibit reduced displacement, acceleration, and base shear forces compared to simple rectangular buildings. The triangular shape demonstrated the most significant improvement in seismic performance, followed by the hexagonal and curved shapes. The study highlights the potential benefits of using non-traditional shapes in seismic design, particularly in earthquake-prone regions. The result of this thesis research work will be beneficial for the development of the more numbers of highly improved sustainable building structure designs.

Keywords: seismic analysis, non-traditional shapes, building design, earthquake engineering, structural dynamic

INTRODUCTION

In this modern society high-rise buildings and skyscraper construction is normal. To make its construction effective, safe and economical it's necessary to apply some methods and analysis before construction of it. Modeling is the best way to find out its actual calculations and results. Wind load majorly affects skyscrapers and high rises therefore it is necessary to calculate wind load through modeling and analytics. Except from wind load there are several loads and its condition which affect the high rised buildings and they are-

- 1) Dead load
- 2) Live load
- 3) Seismic load
- 4) Snow load
- 5) Special loads

- 1) **Dead load-** Self weight of structure is known as dead load. it is its own weight of structure which can be high rise buildings or skyscrapers etc. Dead load is the first considered vertical load. Permanent load is the dead load which is acting through the whole life. Structural self weight is a dead load. Various load which act permanently throughout the life of the structure is called the dead load. Components of the building or any structure are consisting of dead load.
- 2) **Live load-** moving objects weight or moving living and non-living things weight are live load. Live load is the another load which is considered during the design of any structure. In fact live is a kind of movable load which is not stationary and is not permanent load . This load generally acting during a particular time of the day or any other schedule of time during the week, month, year or of any season.
- 3) **Seismic load-** when earthquake occurs it produces seismic waves which affect the structures. the load which is produced by seismic waves is known as seismic load. It can destroy the whole structure and can cause deaths of humans. Therefore it is necessary to conduct the code of seismic loads in seismic zones.
- 4) **Snow load-** when snow falls on structure its weight produces load which is known as snow load. It is necessary to take snow load as major factor in designing of any structure situated in such area.

$$S = \mu S_0$$

Where, S = Estimated snow load

μ = coefficient of shape

S_0 = snow load on ground.

5) **Special loads-** According to IS code of 456 – 2000, above loads are consider as well as the below mentioned loads are also taken in effect:

- (a) Movement of Foundation
- (b) shortening due to Elastic axial
- (c) fluid and soil pressure
- (d) shaking movement
- (e) Repeated no. of impact loading(Fatigue)

Need of the Study:

The very important purpose of the study is to analyse the Nature of the structure having double rise during the quaky drive in the zones of seismic forces considering its zone factor of the respected zone. Here, For the RC type frames vibrant analysis is prepared with allowing the various different parameters for analyzing result and the nature of building those building are going to connect with the one another . Therefore we can easily identify the importance of the need of the study this topic of twin tower posses..

METHODOLOGY

Methodology is a technique through which we can perform our work with a particular process in a proper manner to get the desired results. Here we are comparing the current results with the previous result on which the research had done. And if not getting the desired result then doing the same process with little modification up to desired number of times so to get the results. Problem formulation is a very significant initiative towards the overcoming of the problematic situation than to solve it in a different way. It is good to solve the problems but it is the best to destroy the problem before it originates

3.1 General:

As coming to the building design point of view, various factors are to be considered. One of the important factor is economic factor. Hence designing the building according to the load requirements makes it more economic. So designing the structure members accordingly. When it becomes important to consider the different grades of concrete mix in the different-different members of the building components. Then it is clearly observed that there is a great change in the magnitudes of the shear force and the bending moments and the other important factors which have to be considered.

Since a large numbers of research papers are available in this field, so we can get many research papers for the reference purpose. Also we have to complete our research with some assumptions and IS codes. As our topic plays a significant role in the construction field hence research is to be done. Now a days people are designing their houses by the well skilled architecture or the structure engineer but sometimes keeping in mind some exceptions are there, in such a situation this topic helps the people and the various innovators to do something new in this industry. This research should be done with considering economic factors as an important considerations.

3.2 Methodology approach & Modelling approach

Fundamentally thinking on this point, the very first step to analyse the structure is to be by software or by manual approach. Various constraints and factors are there to select the method for the analysing of the structure. Economic consideration is too taken while its selection. Availability of the resources is seen, lack of which it will be difficult to analyse the structure. There are various methods approaches are also recommended by the Indian standards. In this study various cases are study on the staddpro software which shows the variation of the results.

Contemplation of loads

1. Dead load- The intrinsic self-weight of any building or any kind of structure is termed as dead load in which all other loads like residents and goods are excluded. In the present case study software is used to take out the dead load of structure.

2. Live load- This is simply the amalgamation of all load bear by the structure or applied on the structure after eliminating dead loads. In this study IS 875(part-II) is taken as reference for taking live loads of various kinds of objects. In this study IS 875(part-II) is taken as reference for taking live loads of various kinds of objects.

3. Earthquake load- Seismic loads are developed in all three perpendicular directions due to movements of tectonic plates. In this study all seismic parameters are taken in accordance to IS1893(part I):2016.

3.4.1 Load combination taken for analysis of models

1. Seismic load in direction +x
2. Seismic load in direction -x
3. Seismic load in direction +z
4. Seismic load in direction -z
5. Permanent load
6. Movable load
7. Response spectrum in direction x
8. Response spectrum in direction z
9. Response spectrum in direction y
10. $1.2DL + 1.2LL + 1.2EQ_x + 0.36 EQ_z$
11. $1.2DL + 1.2LL + 1.2EQ_x - 0.36 EQ_z$
12. $1.2DL + 1.2LL - 1.2EQ_x + 0.36 EQ_z$
13. $1.2DL + 1.2LL - 1.2EQ_x - 0.36 EQ_z$
14. $1.2DL + 1.2LL + 1.2EQ_x + 0.36 EQ_z$
15. $1.2DL + 1.2LL + 1.2EQ_x - 0.36 EQ_z$
16. $1.2DL + 1.2LL - 1.2EQ_x + 0.36 EQ_z$
17. $1.2DL + 1.2LL - 1.2EQ_x - 0.36 EQ_z$
18. $1.5DL + 1.5EQ_x + 0.45EQ_z$
19. $1.5DL + 1.5EQ_x - 0.45EQ_z$
20. $1.5DL - 1.5EQ_x - 0.45EQ_z$
21. $1.5DL - 1.5EQ_x + 0.45EQ_z$
22. $1.5DL + 1.5EQ_z + 0.45EQ_x$
23. $1.5DL + 1.5EQ_z - 0.45EQ_x$
24. $1.5DL - 1.5EQ_z - 0.45EQ_x$
25. $1.5DL - 1.5EQ_z + 0.45EQ_x$
26. $0.9DL + 1.5 EQ_x + 0.45EQ_z$
27. $0.9DL + 1.5 EQ_x - 0.45EQ_z$
28. $0.9DL - 1.5 EQ_x + 0.45EQ_z$
29. $0.9DL - 1.5 EQ_x - 0.45EQ_z$
30. $0.9DL + 1.5 EQ_z + 0.45EQ_x$
31. $0.9DL + 1.5 EQ_z - 0.45EQ_x$
32. $0.9DL - 1.5 EQ_z + 0.45EQ_x$
33. $0.9DL - 1.5 EQ_z - 0.45EQ_x$

3.5 Parameters and different aspects of study-

For the analysis, here G+17 building is specially modelled in special way in different shapes so as to counteract or minimize the seismic parameters and also some other stability parameters. Various dimensions of the building elements are taken in the special consideration with the thought that it might reduce the effects of various magnitude of the various factors.

3.5.1 Maximum displacement values-

Maximum displacement values signify by which amount the nodes are dislocated with respect to their previous position while counteracting various loads that are applied on the structure. These values are examined and compared for various load cases modelled and analysed in accordance to IS1893(part-1):2016. This investigation will lead to conclude the status of node and so the structure whether the model is able to carry the desired load or it may fail and if so then the analysis is repeated again investigated for the same as per code. So the resultant displacement values are taken for consideration as it may be proved to be a very significant deciding parameter of objectives of the study and also safety of structure.

3.5.2 Story drift values

Story drift values are one of those seismic parameters which directly signify the structural safety of the structure in terms of fraction. Ratio of two consecutive floor levels within the multi-storey building or any skyscraper having different kinds of irregularity, is demarcated as story drift. As per IS for a given structure the limiting value must be a multiple of 0.004 times of single story height for load factor of 1 and not more than that otherwise the model is assumed failed and needed to be redesigned. Due to this limiting value structural stability is confirmed along with comfort to occupants in both residential as well as commercial building. Also the effect of story drift is not encountered and necessary for single storied buildings as per seismic code of India.

3.5.3 Maximum displacement values

Base shear values are the function of mass of structure, fundamental natural period of vibration of the structure and conforming mode shape relevant to that structure taken for analysis or consideration. Mathematically it was calculated by the summation of total horizontal force applied on the structure. While calculating for a multi-storey tower its value is calculated by assuming the full building height as a whole and afterwards its value is distributed along the building height with the help of some standard equation with regular distribution of mass and stiffness.

3.5.4 Frequency

Frequency implies to number of occurrence of a repeating event with respect to time. In structural analysis frequency entails the count of repetition of number of seconds required to vibrate back and forth in the building when subjected to lateral loads i.e. earthquake loads for this study.

3.5.5 Time period

Time period is also termed as "Fundamental natural period" in IS code 1893(1):2016 primarily the time period is inverse of the frequency which imply that time required by the rotation of vibration to pass from a single point taken at a time for study. In according to the seismic code of India. Fundamental natural period is a function of physical parameters of the building i.e. height and depth. Its value should vary from 0.05 to 2.00 sec in range.

3.7 Using STAAD PRO, Building analysis Steps are as follows-

1. Using STAADPRO software, firstly making new file.
2. Creating the structure by node & co-ordinates and other input members along with the column and the beam with specification make the new frame.
3. Now the members which are created label them with the dimensions & give them input properties.
4. Provide fixed or hinged support etc as per the structure type.
5. Specify and provide various forces combination with following forces- such as permanent load, movable load or seismic load etc on the structure.
6. Show the analysis type & also the behaviour of structure then to get various parameters such as storey drift, various stresses & the deflection values.
7. Now perform the analysis and run the analysis. In case if error occurs then we have to remove the error & further repeat the same process.
8. Now observe the result file & Note the various design parameters of structure parts such as column & beam etc. Also you can save the file for further use.

Objectives of the Study:

The various reviews were carried out and observed the result by comparing them with different results, which were taken as-

1. To calculate the maximum displacement in Z and X direction for all five selected cases.
2. To show the relation between base shear obtained in Z and X direction for various twin tower cases.
3. To cross check maximum forces at ground level in columns.
4. To obtain and investigate maximum forces or shear forces in columns along Y and Z directions.

5. To display the Bending moments which is maximum in columns for different different cases.
6. To investigate the shear forces which is maximum in beams along X and Z directions.

To examine the maximum Torsion moments in beams and columns along different axis

RESULT

As per the objectives, for earthquake analysis the Response Spectrum Observation is made on different staad pro shapes of twins tower consist of structure made up of G+17 storey building in Zone III, building made up of G+17 storey building in Zone III with three floor podium and after that twins tower starts These building model SHAPes are assumed to be situated in earthquake Zone III.

Since for the analysis of seismic effects, all the SHAPes of the structures have been analyzed for seismic vibrate for longitudinal along with transverse direction. Various loads along with load combinations applied on all the SHAPes and reflective result parameters have been analyzed with each other to determine the efficient SHAPE. Results are shown both in tabular form as well as graphical form. The analysis results obtained using Staad pro software is shown in tabular form along with various graphs with various parameters .

CONCLUSION

We studied about five different shapes and there are such case which gives the various result about each and every shape of building. On the basis of above parameters following results are obtained from this comparative study.

1. On comparing it has been concluded that the maximum displacement in X direction obtained for shape Z & Y with a minimum value respectively.
2. On comparing it has been concluded that the maximum displacement in Z direction obtained for shape Z & Y with a minimum value respectively again as well as X direction.
3. Comparing the Story drift for all shapes in X direction, shape V is observed as most efficient.
4. Comparing the Story drift for all cases in Z direction, shape Z is observed as most efficient.
5. As per comparative results, Case X for base shear forces in X direction values are efficient among all cases.
6. As per comparative results, Case X for base shear forces in Z direction values are efficient among all cases..
7. On analysing the mass participation factor for both direction for X direction in mass participation shape X is very efficient and direction for Z direction in mass participation shape Z is very efficient
8. As per comparative results in axial force, Case U is very effective than other cases.
9. Comparing the column shear force for all cases shape Z is the optimum than other cases.
10. As per comparative results in column bending moment, Case Z is very effective than other cases.
11. Comparing the beam shear force in X direction for all cases shape U is the optimum than other cases.
12. Comparing the beam shear force in Z direction for all cases shape U is the optimum than other cases.
13. As per comparative results in beam in X direction bending moment, Case Z is very effective than other cases.
14. As per comparative results in beam in Z direction bending moment, Case Z is very effective than other cases.
15. On analyzing the Torsional Moment in beams along X direction shape V is very efficient and direction for Z direction in Torsional Moment in beams shape U is very efficient

REFERENCES

1. B.G. Birajdar1, S.S. Nalawade2.(2004) "Seismic analysis of building resisting on sloping ground 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004 Paper No. 1472.
2. C.A. Deshpande. P. M. Mohite(2014) Effect of Sloping Ground on Step- Back And Setback Configurations of R.C.C.Frame Building International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERT V3IS100299 Vol. 3 Issue 10, pp. 379-382.
3. D.S Bhalchandra(2015) "Seismic Behavior of RC Buildings Constructed on Plain and Sloping Ground with Different Configuration of Shear Walls" ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 2, Number 10; pp. 59-65.
4. Jain and Rakesh (2017) " Analysis of building constructed on sloping ground for different types of soil", International Journal For Technological Research In Engineering Volume 4, Issue 12, August-2017 ISSN (Online): 2347 – 4718.

5. J. Joseph, (2017) "Seismic Analysis of Step back-Set back building on Sloping ground with Bracing systems", Imperial Journal of Interdisciplinary Research (IJIR), Vol-3, Issue-8, ISSN: 2454-1362, pp- 669-676.
6. J. Jyotsna Seismic Analysis of Step back-Set back building on Sloping ground with Bracing systems Imperial Journal of Interdisciplinary Research (IJIR) Vol-3, Issue-8, 2017 ISSN: 2454-1362.
7. K. Vgarg, (2014), "Effect of sloping ground on sloping ground on structural performance of RCC building under seismic load", ISSN: 2348-4098 Vol 2 ISSUE (v II) pp-1312-1321.
8. K. S Rathod (2015) Seismic Analysis of RCC Building Resting on Sloping Ground with varying Number of Bays and Hill Slopes" International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161.
9. K. Kumar, S. Gupta (2018), "DYNAMIC STUDY OF STEP BACK AND SET BACK BUILDING", International Journal of Civil Engineering and Technology (IJCIET) Volume 9, Issue 5, pp. 185–190, Article ID: IJCIET_09_05_021, ISSN Print: 0976-6308 and ISSN Online: 0976-6316 pp 185-190.
10. M. H. Shah (2016) "Seismic Analysis of Building on Sloping Ground Considering Bi-Directional Earthquake" April 2016 IJSDR | Volume 1, Issue 4 ISSN: 2455-2631 pp. 59-62.
11. N. S. Uttekar (2017) "Seismic Response of RC Building on Sloping Ground" IJRESTS vol:2 no.9.
12. P. S. kumar (2015) "Lateral stability of multi-storey building on sloping ground" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 02 Issue: 04 July-2015 p-ISSN: 2395-0072.
13. R. R. Sakalle (2017) "Analysis of a multi-storey building frame for lateral forces at sloping strata under the effect of seismic forces using staad pro" ISSN: 2277-9655 IJESRT vol: 3.00 pp-631-647.
14. Sagar Jamle M. A. Lahori (2019) "Response of Multistory Building Located on 200 and 300 Sloping Ground under Seismic Loading", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 06 Issue: 01 | Jan 2019 www.irjet.net p-ISSN: 2395-0072. Pp. 1603-1609.
15. S. B. Shashank (2013)- "Analysis And Design Of Multi-Storeyed Load Bearing Reinforced Masonry Structure And Framed Rc Structure", "International Journal of Advanced Technology in Civil Engineering", volume no:3, no of pages :92 to 97
16. T. N. Swarup "Study of seismic behaviour of multi-storied RCC buildings resting on sloping ground and bracing system" Vol-3 Issue-4 2017 IJAR IIE-ISSN (O)-2395-4396 pp. 172-178.
17. V. L. Shah (2015) - "Illustrated design of reinforced concrete building" International Journal of Engineering Research in Computer Science and Engineering, volume no: 3, no of pages: 487 to 493.
18. V. H. Shivanand (2014), "Design Of 3d RC Frame on Sloping Ground", International Journal of Research in Engineering and Technology, 19
19. W. K. Hammad Salahuddin & (2005)- "Comparison of design of a building using STAAD PRO", "International Journal of Scientific and Research Publications" volume no: 2 page no : 179 to 189
20. S. A. Raj & O. F. Ajala (2016)- "Computer Aided Design of A Twin Reinforced Concrete Multi-Storey Tower", "Journal of Multidisciplinary Engineering Science and Technology" volume no: