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To Study The Behavior Of Gate Type Twin Tower Structure Under Seismic Load: A Review

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Abstract: Nowadays, new concepts for high-rise and twin towers construction are needed to resist the effects of seismic and wind forces. The main reason is the need for space, both residential and commercial, in urban areas. Globally, more or less about 10 million people move to urban areas each month. Some very large cities don't have much space available to build buildings.

Tall buildings are susceptible to lateral movement, or drift, due to wind or earthquake forces. Therefore it is very important to design such types of structures so that they withstand wind or earthquake forces. This research work analyzes the seismic behavior of a gate-type twin tower G+10 floor building with the top three floors connected using linear dynamic earthquake analysis. We have considered a model of a gate-type twin tower structure to achieve desirable results in terms of storey drift, displacement, absolute moment, and temperature variation with temperature stresses under seismic forces for seismic zone III and medium type of soil using STAAD Pro. Software.

Key Words: Gate type twin tower structure, storey drift, displacement, seismic forces, STAAD PRO software.

1. INTRODUCTION

The gate-type twin tower building is a distinguished architectural design characterized by two towers connected by a top element like a gate. This type of structure combines aesthetic appeal with symbolic and functional elements. The gate deals with both as a visual focal point and a functional component, often communal spaces, housing entranceways, or architectural features. From a structural point of view, structural engineers face unique challenges in analysing and designing gate-type twin tower buildings. The seismic performance of gate-type twin-tower structures is a crucial aspect of structural engineering, especially in locations which subjected to wind and earthquake forces. These buildings, characterized by their gate-like architecture and paired tower's structural design, demand a comprehensive understanding of how they respond to seismic forces. This introduction deals with the different considerations and unique challenges which are associated with the structural dynamics, and seismic performance of such buildings, exploring design principles, and different strategies to increase their resilience against wind and seismic forces.

In architecture, the term "twin towers" means two tall buildings which are identical in appearance and height, and are commonly built close together as part of a single complex. In recent days, Twin towers have been vastly in demand due to structural and architectural design, individual plans along more space with the same foundation support. Wind forces load distribution, and earthquake considerations are crucial factors that require careful attention to ensure the safety and stability of such buildings, especially in locations that are subjected to earthquake and wind forces.

Fig -1: Real Gate type structure (The DIFC Gate building, Dubai)

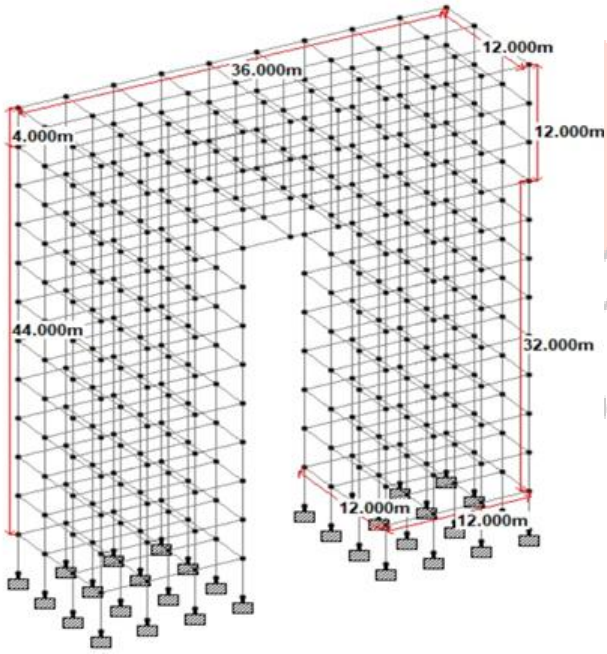

Fig -2 Model of gate-type building

2. OBJECTIVE OF STUDY

The main objectives of the project are as follows:

1. To determine the deflection and displacement of gate-type twin tower structures subjected to seismic forces.
2. To calculate the absolute moment due to earthquake forces.
3. To find drift due to seismic load.
4. To calculate temperature stresses due to temperature variation.

3. LITRATURE REVIEW

[1] Shruti Nagar, Dr. Savita Maru (2021) : The current study examines the effects of influencing factors such as the tower's height, connection to the podium, and podium depth with two parallel towers (Twin-Tower). This study's primary goal is to apply linear dynamic earthquake studies to the twin tower construction G+4 podium+25 floor building. Using Response Spectrum Analysis and the ETABS v19 software, we have examined four models with various configurations of twin towers and podiums to get the desired outcomes for storey drift, displacement, and base shear under seismic forces for seismic zone IV and medium type of soil. The current study examines the effects of influencing factors such as the tower's height, connection to the podium, and podium depth with two parallel towers (Twin-Tower). This study's primary goal is to apply linear dynamic earthquake studies to the twin tower construction G+4 podium+25 floor building. Using Response Spectrum Analysis and the ETABS v19 software, we have examined four models with various configurations of twin towers and podiums to get the desired outcomes for storey drift, displacement, and base shear under seismic forces for seismic zone IV and medium type of soil.

[2] Surendra Chaurasiya and Sagar Jamle (2018) : The twin tower multistory building located in seismic Zone-IV is the subject of this study's parametric comparison of results, including displacement and storey drift. Seismic impacts operating on the structure under 13 different situations are analysed with the aid of the Staad pro programme. The researcher came to the following conclusions in this paper: 1) Analytical results from generic multistory structures cannot be used as the basis for the design of twin tower buildings vulnerable to seismic effects. The displacement values for twin tower situations for the X direction progressively drop to a lower value of 39.059 mm, as can be seen in the data. 2) It appears that the Z direction displacement values have decreased by 18.12%.. 3) When storey take part in drift, for X direction, maximum case will be Case A while comparing with minimum case i.e. Case M, it seems to be downfall of 20.37%.

[3] Imad Shakir Abbood, Mahir Mahmod, Ammar N. Hanoon (2018) : The 40-story reinforced concrete frame-wall twin buildings that are connected horizontally by structural linkages serve as the study's representation. An inter-building link might connect the two neighbouring storeys at the same height since it is presumed that the two buildings were identical in this linked building system. The linked building system is modelled as a beam for each link that is fixedly attached to the buildings' perimeter structural framework, and as a rigid floor diaphragm for towers. The seismic responses of the twin towers were calculated at various places for the link using earthquake time history stimulation. Based on a numerical examination of the link's characteristics, the results showed that the link might significantly alter the linked building system's structural reaction.

[4] Lekkala Harish Kumar, V. Siva Rajasekhar Reddy, (2021) : In this investigation, A building's frame is made up of its storey and number of bays. A multi-story building with multiple panels is a complex intermediate construction from a statically speaking. An R.C. building with a G+15 story frame is designed and implemented. The structure in the plan (30 m x 20 m) is made up of monolithic columns that are connected to form a network. Staad-Pro, a programme for structural analysis design, is used to create the design. The structure was subjected to both horizontal and vertical loads. According to IS 456-2000, the building is designed as a two-dimensional vertical frame, and the maximum and minimum bending moments and shear forces are determined by trial and error techniques. With the use of several software programmes, numerous research were conducted on the planning, designing, and analysis of a structure. In this investigation, A building's frame is made up of its storey and number of bays. A multi-story building with multiple panels is a complex intermediate construction from a statically speaking. An R.C. building with a G+15 story frame is designed and implemented. The structure in the plan (30 m x 20 m) is made up of monolithic columns that are connected to form a network. Staad-Pro, a programme for structural analysis design, is used to create the design. The structure was subjected to both horizontal and vertical loads. According to IS 456-2000, the building is designed as a two-dimensional vertical frame, and the maximum

and minimum bending moments and shear forces are determined by trial and error techniques. With the use of several software programmes, numerous research were conducted on the planning, designing, and analysis of a structure.

[5] Mahendra Kumawat, Ankit Pal and Mayank Choudhary (2020): Every study mentioned above recommends implementing): According to this study, there are many different kinds of tall buildings with a variety of shapes and sizes in the world. The primary loads for these structures are seismic and wind. Thus, in order to lower the likelihood of wind and seismic failure, new construction concepts and research are needed. It is vital to examine the various twin tower shapes in multistory buildings under seismic zones in accordance with Indian standards after reading through a number of papers.

[6] Raju Pahadiya,(2020): This study analyses the different parameters like base shear, shear force, bending moment displacements in longitudinal and transverse direction. After this, storey drift is calculated in both X as well as Z direction. The most efficient twins' tower height combination will be analyzed after all parameters. There is total 11 height combinations of twin tower multistoried building at medium soil condition under seismic forces for earthquake zone III exist. The design of twin towers height combination of building subjected to seismic effects the analytical results obtained from 11 combination of twins tower multistoried structure. As seen in results the minimum displacement in X direction height case B and Z direction height case B, minimum base shear in height case I and K in respectively X and Z direction, minimum axial force in height case B, minimum column shear force in height case B in both direction, minimum column bending moment height case B in both direction, beam shear force height case B is optimum as well result same for torsional force. That means height case B is a very efficient case for twin towers in height cases.

[7] Wei Guo, Zhipeng Zhai, Hanfeng Wang, Qiongxiang Liu, Kai Xu, Zhiwu Yu (2019), The asymmetrical high-rise building investigated in this paper is composed of a 299.1-m-high tower and a 235.2-m-high tower, which are diagonally and rigidly connected by two steel truss systems with the maximum span of 65.43 m. Given the great structural irregularities and complexities, the structural seismic performance is necessary to be investigated. A shaking table test of a 1/45 scaled model is conducted in this study, by which the structural damage pattern and dynamic responses are analyzed. The results show that the connecting trusses and rigid connection joints behave well during strong seismic excitations. The damages concentrate on the connecting floors, and the whole structural damage is slight. Most of the lateral resistance components remain elastic. The structure presents high seismic resistance against strong ground motions. The structure presents high seismic resistance against strong ground motions.

[8] Wei Guo, Longlong Guo, Zhipeng Zhai, Shu Li (2021), In this paper, a novel rotational friction negative stiffness damper (RFNSD) composed of negative stiffness device (NSD) and rotational friction dampers (RFDs) is proposed to develop flexible connection for improving the seismic performance of an asymmetrical super high-rise twin-tower connected structure. The prototype structure is rigidly connected by long-span steel truss, and shaking table test has shown that the rigid connection between the towers and the truss corridor generally cause buckling of steel truss members and structural damage on the connected floors. To mitigate seismic responses of the truss corridor and the towers, the rigid connection is replaced by flexible ones using the proposed RFNSD and lead rubber bearing (LRB). The results show that the developed flexible connection can obviously mitigate the dynamic responses and structural damages. As the stiffness of the pre-tensioned spring in NSD increase, the dynamic response of the steel truss connection corridor would be further decreased. The RFDs can effectively control the increased deformation of the flexible connection caused by the NSD, and promote the energy dissipation capacity. The model with the flexible connections presents good seismic performance, indicating the effectiveness of the proposed RFNSD.

[9] Wei-feng Qin, Jun-yang Shi , Xiaoyue Yang, Jiming Xie, Steve Zuo (2021): To compare the aerodynamic and structural dynamic properties of twin towers to those of an isolated single tower, a TA study was carried out. It was discovered that the reciprocal aerodynamic interference between two towers might be advantageous in that it could prevent regular vortex shedding and result in a significantly smaller across-wind oscillation for the twin towers than for the single tower. Additionally, it is discovered that a significant amount of out-of-phase wind forces, which act on the two towers in opposing directions, may be

applied to the twin towers. The resulting structural response can be effectively controlled by structural links between the two towers.

[10] Fantao Meng , Xingqun Ruan , Jianfeng Zhao, Jiangrui Qiu , Lei Meng , Peng Hou (2022), In this paper, the researchers work with two towers: the Lower Tower (S2) is equivalent to a single particle one-degree-of-freedom system, and the Higher Tower (S1) is equivalent to a two-particle two-degree-of-freedom system in the unequal height twin towers with a maximum height of 60 m. Then, using a simplified structural dynamics method, the variation law of their first-order natural vibration periods in the parallel conjoined direction was analysed. A vertically conjoined three-degree-of-freedom system was set up to study the coupling of frequencies and changing law of mode shapes. An engineering practise further validated the simplified structural dynamics models after they were compared to the finite element simulation. The simplified structural dynamics methods can be used to control and optimise the design scheme to find a reasonable position for the connecting body within the tower height by examining engineering examples and comparing them to numerical simulations.

[11] Thakor Vishal kumar Sureshbhai, Jenil Thakkar (2023): The research on Twin Tower-type structures is summarised in this paper, even though very few researchers have published a detailed analysis. The parameters such as storey displacement, storey shear, and storey drift under seismic and wind conditions have been compiled here to help with the precise location of bridging the connection between towers. According to the study, the link was more successful in fortifying the system and lowering responses when it was used on the final floor. A longitudinal and transverse investigation and analysis were conducted to ascertain the influence of beam connections at varying heights on the induced dynamic responses of twin connected tall buildings.

[12] Thakor Vishal Kumar Sureshbhai, Aakash R. Suthar, (2023): The high rise and medium rise twin towers G+28 (85.98 m) and G+24 (75 m), connected at different heights and spans, are analysed in this work. This study aims to guarantee optimal positioning and efficient use of connecting beams in twin tower structures subjected to lateral loads. This building, which is located in Ahmedabad Zone III, will have its static and dynamic conditions examined in the model. The ETABS software's study parameters include storey displacement, drift, and base shear. At the connections, which are offered at 0.8 H + 5% distance (where H is the building's height), the economy and maximum durability were calculated.

13] Vinesh N. Bhinde, Pratik A. Parekh, Narendra R. Pokar, (2020): This analysis pertains to symmetric structures with 40 and 50 stories, where links of varying sizes are provided at the most practical location. In this case, lateral loading conditions will be considered when analysing the building and its connecting structures. The structure had been modelled using the ETABS Software. The response spectrum for zones IV and V as well as the time history analysis for the Bhuj earthquake in medium soil will be used to analyse the model. The variables that need to be researched for lateral loading include base shear and storey displacement.

[14] Sayed Mahmoud, (2019): The author of this research thoroughly evaluates, in accordance with design code requirements, how linked high-rise buildings would react to earthquake loads. Additionally, the impact of the sky-bridge's location on the induced responses is looked at. A collection of ground motion records with varying peak ground accelerations stimulated the building configurations. The responses to the two orthogonal directions (the sky-bridge and perpendicular directions) in which the lateral dynamic earthquake loads were applied separately were examined. In certain scenarios, the location of the connecting bridge had a minor impact on the building structures' predicted responses to dynamic loads, while in another, it had a significant impact.

[15] Rishabh Sisodia, N. Tej kiran2, K. Sai Sekhar Reddy (2019): In this analysis, a G+30 symmetric office block connected at various levels by a single steel bridge is taken into consideration in order to determine how seismic loads affect the structure using E-tabs. The outcome demonstrates how these connections act as a "Stiffener" for both towers when seismic and wind forces are applied to the structure. It gives the multi-tower greater durability and a longer lifespan by reducing the storey displacements of the towers.

4. CONCLUSION

❖ **After reviewing and studying various research papers it has been concluded that:**

- ❑ By connecting them, high-rise twin tower buildings become more stable against wind and seismic loads.
- ❑ When wind and seismic forces act on the twin tower structure, the connection gives both towers stiffness.
- ❑ When located at the top, the connection lessens the towers' storey displacements.
- ❑ A structure's ability to withstand earthquakes is somewhat dependent on its shape.
- ❑ Other factors that impact the stability of the structure against wind and seismic forces include the building's height, material composition, and connection location.
- ❑ The tall building's seismic response is decreased when links are installed at the highest levels.

5. REFRENCES

1. Shruti Nagar, Dr. Savita Maru, Department of Civil Engineering, Ujjain Engineering College, Ujjain (M.P.), "Seismic Analysis of Twin Tower Structures", International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429 Volume 9 Issue X Oct 2021- Available at www.ijraset.com
2. Surendra Chaurasiya and Sagar Jamle (2018) "Determination of Efficient Twin Tower High Rise Building Subjected to Seismic Loading" International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161©2018
3. Imad Shakir Abbood, Mahir Mahmod, Ammar N. Hanoon (2018), "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,
4. Lekkala Harish Kumar, V.Siva Rajasekhar Reddy,(2021), "Seismic analysis and design of a multi-storied building of (g+15) by using staad pro" The International Journal of analytical and experimental modal analysis Volume XIII, Issue XII, December/2021 ISSN NO:0886-9367.
5. Mahendra Kumawat, Ankit Pal, and Mayank Choudhary (2020), "A Review Study-Use of Different Shapes of Twin Towers High Rise Building under Seismic Loading", International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161 ©2020.
6. Raju Pahadiya, Ankit pal,(2020)**,**"Determination of Efficient Height Combination of Twin Tower under Seismic Loading", International Journal of Advanced Engineering Research and Science (IJAERS) [Vol-7, Issue-5, May- 2020] ISSN: 2349-6495(P) | 2456-1908(O)
7. Wei Guo, Longlong Guo, Zhipeng Zhai, Shu Li,(2022), "Seismic performance assessment of a super high-rise twin-tower structure connected with rotational friction negative stiffness damper and lead rubber bearing" Soil Dynamics and Earthquake Engineering, Publisher: Elsevier
8. Wei-feng Qin, Jun-yang Shi, Xiaoyue Yang, Jiming Xie, "Characteristics of wind loads on Twin-Tower structure in comparison with single tower" Engineering Structures Volume 251, Part A, 15 January 2022, 112780.
9. Siddharth Pastariya (2020). "Analysis of triangular tower on building subjected to seismic loads with different positions", International Journal of Engineering Applied Sciences and Technology. Vol. 4, Issue 12, ISSN No. 2455-2143.
10. K. Rama Raju, M.I. Shereef, Nagesh R Iyer, S. Gopalakrishnan (2013). "Analysis of tall building subjected to wind and seismic loads", National Conference on Emerging Technologies in Civil Engineering,https:// www.researchgate.net/publication/269252967.

11. Jack p. Moehle (2006). “seismic analysis, design, and review for tall buildings”, the structural design of tall and special buildings, Struct. Design Tall Spec. Build. 15, 495–513 (2006), Published online in Wiley Interscience (www.interscience.wiley.com).
12. Kulkarni, T., Kulkarni, S., Algur, A., Kolhar, M. H., (2016). Analysis and Design of High-Rise Building Frame using STAAD PRO, International Journal of Research in engineering and Technology.
13. Wei Guo, Zhipeng Zhai, Hanfeng Wang, Qiongxiang Liu, Kai Xu, Zhiwu Yu (2019) “Shaking table test and numerical analysis of an asymmetrical twin-tower super high-rise building connected with long-span steel truss”
14. ,Fantao Meng,Xingqun Ruan, Jianfeng Zhao, Jiangrui Qiu , Lei Meng , Peng Hou (2022)“Analysis of horizontal vibration characteristics of unequal height twin towers of rigid connected structure”.
15. Thakor Vishalkumar Sureshbhai, Jenil Thakkar (2023),“Behaviour of multi-story twin structure connection of the beams at different level” International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 10 Issue: 03 | Mar 2023.
16. Thakor Vishal Kumar Sureshbhai, Aakash r. Suthar. “A parametric evaluation of twin tower structure having horizontal and vertical connection variations”(2023). International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 10 Issue: 06 | Jun 2023.
17. Vinesh N. Bhinde, Pratik A. Parekh, Narendra R. Pokar, Dynamic Analysis of Regular Twin Tall RCC Structure with Various Sizes of Links at Most Effective Location .2020 JETIR June 2020, Volume 7, Issue 6 (ISSN-2349-5162).
18. “Horizontally connected high-rise buildings under earthquake loadings”,(2019),Sayed Mahmoud,Ain Shams Engineering Journal, Volume 10, Issue 1, March 2019.
19. Rishabh Sisodia, N. Tej Kiran, K. Sai Sekhar Reddy (2019), “Analysis of a Multi-Tower Frame Structure connected at different levels using ETABS”, International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Volume: 06 Issue: 03 | Mar 2019 www.irjet.net.
20. T. Jayakrishna et al., seismic analysis of regular and irregular multi-story buildings by using staad-pro. International Journal of Civil Engineering and Technology (IJCIET)Volume 9, Issue 1, January 2018.