iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VII **Month of publication:** July 2021

DOI: https://doi.org/10.22214/ijraset.2021.36935

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

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 VII July 2021- Available at www.ijraset.com

Seismic Analysis of Twin Tower Structures: A Review

Shruti Nagar[1], Dr. Savita Maru[2]
[1]*M.E. Student - Department of Civil Engineering, Ujjain Engineering College, Ujjain (M.P.), India*
[2]*Professer - Department of Civil Engineering, Ujjain Engineering College, Ujjain (M.P.), India*

Abstract: ***Since the world's most populous cities are experiencing a land shortage, it is more important to make high-rise buildings, skyscrapers, and twin towers safer and more secure for residence, commercial and other purposes. More research and study is required to make skyscrapers and twin tower high rise buildings safe and secure. New projects and ideas for twin towers and skyscrapers will help reduce the risk of disaster. More unique forms are in trend to show the rich connotation and vitality of buildings. Connected twin tower structures conform to these requirements, and many connected structures in different forms have been or are being built in recent years. It is observed that there are many types of high rise buildings in the world with different shape and sizes. These buildings are mostly designed and analyzed for seismic and wind loads. Therefore it is necessary to take new ideas of construction and research on that so that the chances of seismic and wind failure can be reduced. After reviewing various papers it is necessary to perform seismic analysis.***
Keyword: Twin tower structure, skyscrapers, seismic analysis, wind load.

I. INTRODUCTION

In today's world, new concepts for skyscraper construction are required to mitigate the negative effects of seismic and wind forces. It is more important to remember in different parts of the world due to the difference of seismic forces. Engineers and architects are making various efforts in this direction. Twin towers play an important role in addressing such issues because they give the system more stability, particularly in seismically active areas. Bridge is provided at a suitable height to balance the movement and to link two buildings. Due to the speedy increase in population and reduction in accessibility of land, vertical accommodation is obtaining a lot of preference which is resulting in vertical town development. The higher land costs, reduction in urban sprawl and for agricultural production, residential buildings are growing upward.

II. TWIN TOWER STRUCTURE

In architecture, the term "twin towers" refers to two tall buildings that are virtually identical in appearance and height, and are commonly built close together as part of a single complex. Recent days, Twin towers are vastly in demand due to its architectural and structural design, individual plan along with more space with same foundation support. To full the increasing demand of living space along with commercial space various efforts are made to fulfill the need of hour. Twin tower is the best example to rectify such kind of problem which not only comply the demand but also a mark of social and economic prosperity.

III. SEISMIC ANALYSIS

Seismic analysis is a branch of structural analysis that involves calculation of a building's (or non building's) earthquake response. In earthquake-prone areas, it is a part of the earthquake engineering, structural engineering and retrofit.

IV. LITERATURE REVIEW

A number of works have been presented on analysis of twin tower structures. In this review paper some literature in brief are presented by different scholars and researchers.

Petroski (1996) This is research paper on one of the tallest building of world The Petronas Twin Tower, 1482 feet in height, located in Kuala Lumpur, Malaysia. The design of any high rise structure or skyscraper , especially tallest one in the world cannot be developed only from architect's drawings, structural analysis is also most important part. It is very challenging to design the superstructure of the high rise building. Among the first decisions in front of structural professional Thornton and his acquaintances at Ranhill Persecute (Malaysia) was the selection between concrete and steel.

Wensheng LU (2000) The shaking table tests of several scaled multi-tower high-rise building models are summarised in this paper. The presumption of a rigid floor is clearly inappropriate for multi-tower building analysis. A new analytic model is proposed that takes into account the impact of a flexible transfer floor. The test results are compared to the theoretical dynamic action. This paper also discusses the link floors between towers at higher levels, as well as the contribution of foundation stiffness to structural dynamic action. A number of recommendations and conceptual guidelines are made. In the event of a moderate earthquake, the flexible connections between towers will greatly reduce the drift of multi-tower high-rise buildings, and they would be demolished and serve as energy dissipation members.

Kunayo (2001) In this research work structural analysis proceeded for the twin tower connected tall buildings, there are two kinds of method in dealing with the connection substructure. One method is to separate the towers and neglect the connection effect while in second method to treat the two tower floors and the connection floor as an entire floor with infinite stiffness. The first one cannot take the connection effect of the substructure into account, while the second may lead to considerable error as the connection is not so stiff. In this paper the substructure was treated as an elastic beam which can avoid the shortage of the simplified methods. Time history analysis was utilized to study the influence of the connection stiffness on the seismic response and the applicable premise of the simplified methods was discussed.

Lew (2004) This paper presents innovative features that were incorporated in the design of the WTC towers and how the towers were modeled for structural analysis. The objectives of this research paper were to determine why the World Trade Center Towers collapsed following impacts of the aircraft and subsequent fires; determine why the injuries were so high or low depending on location; determine what practices were used in the design, construction, operation, and maintenance of the buildings; and identify areas in current building and fire codes, standards, and practices that warrant revision. This paper presented design of the World Trade Center towers, and how the simplified structural models were developed to analyze the global behavior of the towers. These models were used to establish the structural capacity of the towers prior to the impact of aircrafts.

Willford (2008) The structural design of two identical 60-story towers in Manila was described in this paper using performance-based procedures for seismic and wind behaviour. St Francis Shangri-La Place in Manila is a construction of two identical 210m tall residential buildings with a plan area of 38m squared, situated in a typhoon-prone area and in UBC-97 seismic Zone 4. The Arup Damped Outrigger System is used in the structures, and the cost savings are addressed. High-rise buildings built using performance-based approaches not only perform better than those designed using traditional methods, but they also cost less to create. Studies conducted for the design of these structures reveal factors that are relevant to many high-rise structures. To begin with, incorporating a reliable non-tuned supplementary damping system will significantly reduce wind load effects, allowing for more cost-effective structural design and reducing the risks associated with uncertain intrinsic damping. Second, for such structures, performance-based seismic design is needed. Following ‘code' procedures blindly limits the design to unsuitable and uneconomic structural types that will not work well in strong earthquakes because the shear demand on the building could be underestimated, and the necessary flexural ductility at the core's base is unlikely to be achieved.

Zhu (2010) In this research paper there are parameters of connecting dampers between two adjacent structures and twin-tower structure with large podium are optimized through theoretical analysis. The connecting viscous fluid damper (VFD) is represented by the Maxwell model and the connecting visco-elastic damper (VED) is represented by the Kelvin model. Two optimization criteria are selected to minimize the vibration energy of the primary structure and to minimize the vibration energy of both structures. . It is concluded by comparison, that the results of parametric studies are consistent with the results of theoretical studies for the two types of dampers under the two optimization criteria. It is found that the effectiveness of VED and VFD in terms of the seismic response reduction of the neighboring structures. It is demonstrated in the numerical results that the seismic response and vibration energy of parallel structures are mitigated significantly. The explicit formula of VED and VFD can help engineers in application of coupled structure control strategies.

Sun (2011) In this research paper to minimize the seismic response of twin-tower building linked by a steel truss platform bridge, as well as to reduce temperature force in the steel truss, eight groups of combined isolation system, each consists of one pot-type bearings and four rubber bearing, were designed to connect the upper platform bridge to the lower supporting reinforced concrete towers. The features and working principles of the high-position isolation system were described. Then the seismic responses, including displacement, story drift and floor acceleration, of the structure with the isolation systems were calculated and compared with those of the structure with hinge joints in lieu of isolation. It is observed that both the structural seismic responses and the temperature forces in the large-span mega-truss structures can be minimize by the high-position isolation system.

Kumar (2011) Sky Towers consists of four high rises - Sky, Sky Forest (Twin Towers) and SKY Suites, 257 to 300+ meters height, under construction in Mumbai, India with area of about 8 million sq. ft. Flat PT slab was selected for speed of construction and economy. ACS (Automatic Climbing System) for core walls proceeding method is adopted to reduce the construction time. Climbing platform SCP and Automatic climbing formwork are used based on core geometry and predetermined construction sequence. Generic panel slab formwork with drop heads is used for flexibility to adopt different geometry, early stripping and crane independent faster construction. Guided climbing formwork is used for few peripheral walls. MEVA-ALUFIX panels are used for columns and other walls. High performance concrete and temperature control concrete is made available through in-house plants and other grades (M40, Lean concrete) are sourced from outside. Design mix keeps on changing during construction due to the variability in raw materials.

Haghollahi (2012) In this research work studies are carried out in 2 steel framed high rise building 20 & 25 storied high braced by outrigger and belt truss system. This investigation is done by response spectrum and non linear time history analysis by SAP software. The objective of this study is to find the optimum location of outrigger beams against lateral load within the building. It is shown in results that stories drift ratio is kept away from the outcomes of response spectrum analysis. It is concluded that outrigger and belt truss optimum location is at 10th and 14th story for 20 and 25 storied model respectively by response spectrum analysis on the other hand optimum location is 14th and 16th storey for 20 and 25 storied model respectively by time history analysis. Still the study claims that the optimum location is preferably upper levels for each specific case as per site condition.

Sheng (2014) This study based on a simplified 3-DOF model of twin-tower structure linked by a sky-bridge, the frequency response functions, the displacement power spectral density (PSD) functions, and the time-averaged total vibration energy were derived, by assuming the earthquake excitation.

The effects of connecting parameters, such as linking stiffness ratio and linking damping ratio, on the structural vibration responses were studied, and the optimal connecting parameters were obtained to minimize the vibration energy of either the independent monomer tower or the integral structure. The influences of sky-bridge elevation position on the optimal connecting parameters were also discussed.

It is concluded that the optimal connecting parameters derived from the simplified 3-DOF model are applicable for two multi-story structures linked by a sky-bridge with dampers. The seismic reduction effectiveness obtained varies from 0.3 to 1.0 with different sky-bridge mass ratio. The displacement responses of the structure considered are reduced by approximately 22% with sky-bridge connections.

Patil (2015) In this research paper, the earthquake response of symmetric multistoried building is carried out by manual calculation and with the help of ETABS 9.7.1 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The responses obtained by manual analysis as well as by software are compared. This research paper provides complete guide line for manual as well as software analysis of seismic coefficient method. It is concluded that base shear values obtained by manual analysis are slightly higher than software analysis.

Rajii (2016) In this research paper Computer aided design of a twin reinforced concrete multistorey tower is analyzed and it entails the use of Midas Gen software for modeling, analysis and design of a 25 storey twin tower and comparing the results with STAAD Pro software and manual design.

The structural elements of the 10th storey for the twin tower were analyzed and designed using manual computation to ascertain the results from the software packages. The moment distribution method of analysis and limit state design method were used to analyze and design the 25 storey twin tower by subjecting it to self-weight, dead load, live load, and wind load in accordance with BS 8110. From the compared resulst, it was observed that the results were similar and within the range. In conclusion, the use of Midas Gen for structural analysis and design give relatively accurate and reliable results.

Lavanya (2017) This research paper based on ETABS stands for Extended Three Dimensional Analysis of Building Systems software. The main purpose of this software is to design multi-storied building considering different parameters. This work presents multi-storied residential building analyzed and designed with lateral loading effect of earthquake using ETABS. This project is designed considering INDIAN CODES- IS 1893-part2:2002, IS 456:2000. In this analysis considered severe seismic zones and behaviour is assessed by taking type-II Soil condition. It is concluded that there is a gradual increase in the value of lateral forces from bottom floor to top floor in software analysis.

Chaurasiya (2018) This research paper examines different parameters like displacements in longitudinal and transverse direction. After this, storey drift is calculated in both X and Z direction. The most efficient case will be analyzed after all parameters. There are total 13 cases of twin tower multistoried building at medium soil condition under seismic forces for earthquake zone IV exist.

Abbood (2018) In this research paper effect of structural links on seismic responses for a linked building system has been investigated by using finite element modeling technique. The linked building system in this research work is represented by twin 40-story reinforced concrete frame-wall structures which are 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. By using 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 study concluded that the link was more effectual in strengthening the system and reducing the responses when installed at the last two floors.

Zhang (2018) In this research paper analysis and estimation method of multi balance synchronous test is established to study the wind effecst of a complex super high rise building with weak connection. First, the frequency domain method is applied to deduce the calculation process of the wind effect of the multi tower structure on the basis of the high frequency force balance (HFFB) technique. Then, the synchronous force test of HFFB is conducted on a twin-tower super high rise structure connected by a bridge. The wind-induced loads and response and the interference effect between the two towers are analyzed on the basis of wind tunnel test data. The displacement correlation between the towers and the relative displacement of the multi tower building are investigated. The channeling effect formed by the surrounding buildings is the main cause of the maximum cross-bridge displacement. The influence of the correlation in between the two towers can be avoid for the along-bridge relative displacement. The results of the HFFB and high-frequency pressure integral test agree with each other, thereby indicating the reliability and effectiveness of the proposed method.

Guo (2019) The asymmetrical high rise twin tower building analyzed in this research paper is composed of a 299.1- m-high tower and a 235.2-m-high tower, these towers are diagonally and rigidly connected by two steel truss systems with the maximum span of 65.43 m. With great structural irregularities and complexities, the structural seismic performance is necessary to be analyzed. A shaking table test of a 1/45 scaled model is performed in this study, by which the structural damage pattern and dynamic responses are analyzed. It is shown in results that the connecting trusses and rigid connection joints behave well during strong seismic excitations. The damages concentrated 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. Consequently, a three-dimensional finite element model of prototype structure is provided and validated by the experimental results. The analysis indicate that performance of the connecting trusses have the capability to coordinate translational and torsional deformation of the two towers and making them resistant to lateral seismic force together even subjected to maximum considered earthquakes. And this performance is still reliable although the high torsional modes are triggered.

Dhakad (2020) In this research paper, six tall structures are prepared using software approach, lessening the beam sizes with grade change in top floors, analyzed it and compared among them. Indian Standard code of practice 1893:2016 shows the seismic prone zones where the shakes are witnessed. On decreasing the load of the structure decreases the Base Shear on the foundation base without compromising the stiffness of the tall structures. After deep comparative analysis, it has been concluded out that Building with Base Shear reduction case F1(size of beam changes above G+13) emerges and hence proved to be the best Base Shear reduction case. Observing all the parameters, the main aim of this work has achieved with lessening the Base Shear parameter in both X and Z direction in Semi-Commercial (G+17) multistoried building under seismic loading. Building Case F1 (size of beam changes above G+13) observed and obtained as efficient case and should be recommended when this type of approach will be adopted in any earthquake zones.

Bhaviskar (2020) This research work deals with the analysis of G+40 storey buildings which are connected horizontally with the truss bridge at 21st and 31st storey with fixed base and shows the storey response curves of buildings connected with dampers and without dampers. The building frame type used is ordinary moment resisting frame (OMRF). The dampers used in this study are fluid viscous dampers (FVD) with force capacity of 500KN. The structure is analyzed using ETABS V16 software. It is concluded that by providing dampers overall displacement of buildings in each zone is considerably reduced.

Ma (2020) In this research paper, a high-rise frame-core tube structure with strengthened stories and high-position connections taken in consideration, which is a new landmark building in Wuhan, whose height is 238.6 m. Construction simulation analysis is carried out by the finite element analysis software ETABS which is used to studied the vertical deformation and deformation difference of vertical members under the gravity load, taking the influence of construction processes and shrinkage and creep of concrete into consideration. It is shown in results that there is a significant difference between the vertical deformation of the twin-tower model with connections and that of the single-tower model. Some engineering countermeasures are put forward to reduce the vertical deformation difference of the twin-tower connected structure.

Pastariya (2020) In this research work, it has been shown that the response of the triangular tower located at G+6 and G+10 storied building. Total 10 models were considered and analyzed for different parameters and most efficient model is selected which has least parametric values among all of them by utilizing Staad pro software. It is concluded that the best suitable location of tower by considering different result parameters it is found to be tower at center of short size of the building roof of both G+6 storey building and G+10 storey building.

Nishanth (2020) The principle this work is to analyze and design a commercial building with different slab arrangements, i.e., Conventional slab, Flat slab with drop panels, Grid/ Waffle slab, and building with load bearing wall. The effect of seismic and wind forces on buildings with different slab arrangements have been analyzed by using ETABS software. Analysis and design were done as per IS 456-2000 code book. M30 grade of concrete and Fe-500 steel is adopted. Load combinations are taken as per IS: 875-part 5 (2015) code book. Live loads are taken as per IS 875-part 1. Wind speed of 55 m/s and earthquake zone 5 is adopted for analysis. There are several aspects which affect the performance of structure from which storey drift, base shear and storey displacement play an important role in finding the behaviour of structure against the wind and seismic loads. It is concluded that storey displacement increased with storey height. It is shown in results that building with grid slab is stable and economical, in comparison of all other slab arrangements used in the building analysis against wind and seismic loads.

Penumatcha (2020) The objective of this research paper is to ensure the appropriate position of connecting beams in between twin tower structure subjected to lateral forces. For this, a three dimensional analysis was performed for the twin towers considered without connecting beams and with connecting beams between the two towers at different floor levels. Accordingly, eight alternatives were investigated including the one without connecting beams subjected to wind and earthquake. The wind analysis including P-D effect with a basic wind speed of 50 m/sec and earthquake analysis in Zone II were performed for both static and dynamic conditions. The study reveals that the 'lateral sway' at the top of structure against wind is within the permissible limit only in case of all floors joined with connecting beams. Similarly, the 'storey drift' is also satisfied as per the code requirements against earthquake.

Giri (2020) To analyze all parts of the building from story level to high level, we need to consider the gravity load, dead load, wind load or seismic forces, and drift forces. This research paper contains design of building against seismic forces using Response Spectrum Analysis. We have to consider better design to make a high rise building. In India data shows that 54% of the land is unsafe from earthquake point of view. Earthquakes effect design of any structure hazardously, since there are some techniques adopted as base isolation, dampers, wire and other methods to minimize seismic effects. Also works to better design to resist the seismic waves. We have to take better high quality materials and given better factor of safety in design process.

Pahadiya (2020) In this research paper different heights of twin towers shown. According to their requirement and ability they can also be different in the form of shape and sizes. For example : When finishing of World Trade Centre done the original tower was 1,368 feet (417 m) in height and the second tower was 1,362 feet (415.1 m) in height. The objective of this research work is to analyze different heights of twin towers in multistoried building under seismic zone as per Indian standards. The main factors considered here are : Displacement in transitional direction, Drift in both transitional direction, Base shear in both transitional direction, Maximum column- Axial forces Shear forces Moment forces Torsion forces, Maximum beam- Axial forces Shear forces Moment forces Torsion forces, Stresses in plate, Time period and mass participation factors. By reviewing and analyzing various research work for twin towers with different heights against seismic and wind loads. It is concluded that in the area of (displacement in both transitional directions, drift in both transitional direction, base shear in transitional direction, maximum column, maximum beam and stresses in plate, time period and mass participation factors) very few or zero number of research works has been done.

Bhanajibhai (2020) In this research paper, considering effects of influence parameters like the height of the tower, connection with basement and depth of basement with two parallel towers with a common basement. The main objective of this paper is the twin tower in linear dynamics earthquake analysis have been considering on the behaviour of structure G+20, G+25, and G+ 30 stories symmetrical twin tower without an underground basement, with 2, and 4 number of Basement. The seismic response of the superstructure was studied on the basis of variation of internal stress results such as base shear, storey displacement, storey drift, and storey shear. The analysis results obtained from Equivalent Static Force Method (ESFM), Response Spectrum Method (RSM), and Time History Analysis (THA).

The basement depth directly effect to the maximum base shear value. Because the basement and basement wall is supported by the twin tower tall structure. But it can reduce the story drift value. So, according to this paper on the basis of above consideration basements is more sustainability as compared to without basements.

Kumawat (2020) In the present world to counteract the poor results of seismic forces and wind forces, it requires new concepts of constructing high rise buildings. Twin tower plays a very important role in counteracting such issues it provides a lot of stability to the structure particularly within the extremely seismic zone. There may be completely different forms of twin towers like U shape, rectangular shape, inverted U shape building that have high resisting tendency. By reviewing and analyzing different research work, it's appear that in field of stability of twin towers against seismic and wind forces. It is necessary to observe that the structure with various possibilities of stability with its optimum location. On comparing simple shape building with non-uniform shapes such as U shape V shape it is concluded that non uniform shape building have high resisting tendency to seismic zone.

V. CONCLUSION

There are various work have been performed on seismic and wind analysis of twin tower structures considering various combinations of twin structure and methods of analysis. The shape of structure such as regular and irregular, type of structure on the basis of material, the position of bridge which links the tower, height of the building are most important parameters which affects the stability of building greatly that is why these factors need to be analyzed more with different kind of combinations.

REFERENCES

[1] Abbas Haghollahi, Mohsen Besharat Ferdous and Mehdi Kasiri (2012). "Optimization of outrigger locations in steel tall buildings subjected to earthquake loads", 15 WCEE LISBOA.
[2] Amitabh Kumar and Amit Singha (2011). "High Rise SKY Towers, Mumbai - Construction Challenges", CTBUH 2011 Seoul Conference. TS10-01, pp. 174-195.
[3] C. H. Lokesh Nishanth, Y. Sai Swaroop, Durga Chaitanya Kumar Jagrapu and Pawan Kumar Jogi (2020). "Analysis and design of commercial building with different slab arrangements using ETABS, ELSEVIER.. DOI: 10.1016/j.matpr.2020.05.823, Proceedings 33 (2020), pp. 700-704.
[4] C.V.S. Lavanya, Emily.P.Pailey and Md. Mansha Sabreen (2017). "ANALYSIS AND DESIGN OF G+4 RESIDENTIAL BUILDING USING ETABS", International Journal of Civil Engineering and Technology (IJCIET), Volume 8, Issue 4, April 2017, Article ID: IJCIET_08_04_210, ISSN Print: 0976-6308 and ISSN Online: 0976-6316, pp. 1845-1850.
[5] Fahim Sadek and H. S. Lew (2004). "WTC Towers: Innovative Design Features and Structural Modeling", CTBUH 2004 Seoul Conference.
[6] Henry Petroski (1996). "The Petronas Twin Towers", Sigma Xi, The Scientific Research Society. Vol. 84, No. 4 (JULY-AUGUST 1996), pp. 322-326.
[7] H.P. Zhu , D.D. Ge and X. Huang (2010). "Optimum connecting dampers to reduce the seismic responses of parallel structures", ELSEVIER. doi:10.1016/j.jsv.2010.11.016, Journal of Sound and Vibration 330 (2011), pp. 1931–1949.
[8] Huangsheng Sun, Linuo Chenb and Shihai Chen (2011). "Seismic Isolation Analysis on Long-span Platform Bridge Connecting Twin-tower Structures", Trans Tech Publications, Switzerland. Advanced Materials Research Vols 255-260 (2011), doi:10.4028/www.scientific.net/AMR.255-260.1225, pp. 1225-1229.
[9] Huang Kunyao, SUN Bingnan and LOU Wenjuan, (2001). "Influence of the Connection Stiffness on Seismic Response of the Double-tower Connected Tall Buildings", Journal of Building Structures, Vol. 03.
[10] Imad Shakir Abbood, Mahir Mahmood, Ammar N. Hanoon, Mohd Saleh Jaafar and Mohamed H. Musa (2018). "SEISMIC RESPONSE ANALYSIS OF LINKED TWIN TALL BUILDINGS WITH STRUCTURAL COUPLING", International Journal of Civil Engineering and Technology (IJCIET). ISSN Print: 0976-6308 and ISSN Online: 0976-6316, Volume 9, Issue 11, November 2018, Article ID: IJCIET_09_11_021, pp. 208-219.
[11] Jadav Bhavesh Bhanajibhai and N. B. Umravia (2020). "Dynamic Analysis of the Twin-Tower High-Rise Structure with Basement", International Advanced Research Journal in Science, Engineering and Technology. ISSN no 2293-8021, Vol. 7, Issue 5, DOI 10.17148/IARJSET.2020.7517, pp. 94-102.
[12] Krishnam Raju Penumatcha, Ravindra Vipparthy and Ambika Yadav (2020). "A Study on effect of Connecting Beams in a Twin Tower Structure", The Institution of Engineers (INDIA). https://doi.org/10.1007/s40030-020-00482-0, Vol. no. 13.
[13] Lele Zhang, Wentao Cheng and Zhuangning Xie (2018). "Wind effect of a twin-tower super high-rise building with weak connection", WILEY. DOI: 10.1002/tal.1503, pp. ZHANGetal 1-16.
[14] Lu Ma, Yabo Bai and Ji Zhang (2020). "Vertical deformation analysis of a high-rise building with high-position connections", WILEY. DOI : 10.1002/tal. 1787, pp. 1-25 MAetal.
[15] 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, Vol.10, No.1 (Jan/Feb 2020), DOI: https://doi.org/10.14741/ijcet/v.10.1.6, pp. 37-39.
[16] Mahesh N. Patil and Yogesh N. Sonawane (2015). "Seismic Analysis of Multistoried Building", International Journal of Engineering and Innovative Technology. ISSN: 2277-3754, Vol. no. 4, pp. 123-130.
[17] Markanday Giri, Sagar Jamle and Kundan Meshram (2020), "Response Spectrum Analysis", LAP LAMBERT Academic Publishing, Mauritius.
[18] Mayuri M. Baviskar and Prof. L.G.Kalurkar (2020). "Storey Response of G+40 Horizontally Connected Buildings with Dampers" International Research Journal of Engineering and Technology (IRJET). e-ISSN: 2395-0056, p-ISSN: 2395-0072, Vol. no. 07, pp. 754-766.
[19] M. R. Willford and R. J. Smith (2008). "Performance based seismic and wind engineering for 60 story twin towers in Manila", The 14th World Conference on Earthquake Engineering.
[20] Pankaj Kumar Dhakad and Sagar Jamle (2020). "Base Shear Reduction by Using Optimum Size of Beams in Top Floors with Different Grades in Multistoried Building at Different Levels", International Journal of Advanced Engineering Research and Science (IJAERS). [Vol-7, Issue-4, Apr- 2020] ISSN: 2349-6495(P) | 2456-1908(O), https://dx.doi.org/10.22161/ijaers.74.20, pp. 170-179.
[21] Raju Pahadiya and Ankit Pal (2020). "A Review on use of Different Heights of Twin Towers High Rise Building", International Journal of Current Engineering and technology. E-ISSN 2277 – 4106, P-ISSN 2347 – 5161, Vol.10, No.2 (March/April 2020), ; DOI: https://doi.org/10.14741/ijcet/v.10.2.7, pp. 233-236.

[22] 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, DOI: 10.33564/IJEAST.2020.v04i12.116, pp. 642-650.

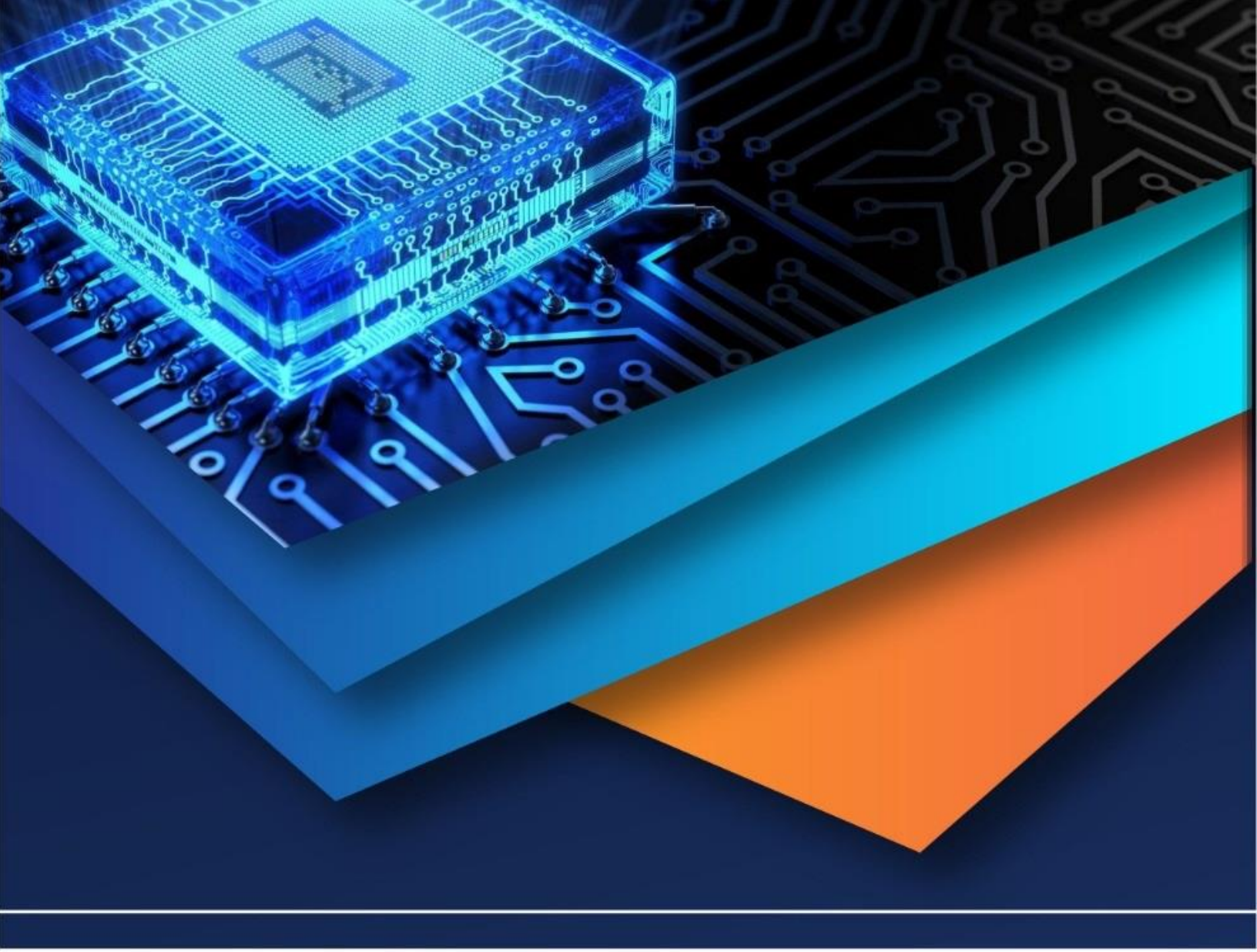
[23] S.A. Raji, O. F. Ajala and S. E Ayenigba (2016). "Computer Aided Design Of A Twin Reinforced Concrete Multi-Storey Tower", Journal of Multidisciplinary Engineering Science and Technology. ISSN no. 2458-9403, Vol. no. 3, JMESTN42351525, pp. 4584-4588.

[24] 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, , Vol.8, No.5, pp. 1200-1203.

[25] SUN Huang-sheng, LIU Mo-han and ZHU Hong-ping (2014). "Connecting parameters optimization on unsymmetrical twin-tower structure linked by sky-bridge", Springer. DOI: 10.1007/s11771-014-2200-4, J. Cent. South Univ. (2014) 21: 2460−2468, pp. 1-14.

[26] Wensheng LU and Xilin LU (2000). " SEISMIC MODEL TEST AND ANALYSIS OF MULTI-TOWER HIGH-RISE BUILDINGS", The 12th World Conference on Earthquake Engineering.

[27] Wei Guo, Zhipeng Zhai, Hanfeng Wang, Qiongxiang Liu, Kai Xu and Zhiwu Yu (2019). "Shaking table test and numerical analysis of an asymmetrical twin-tower super high-rise building connected with long-span steel truss", WILEY. DOI: 10.1002/tal.1630, pp. 1-27.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY