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Analysis of a Tall Twin Tower Considering Lateral Load as Per I.S. 1893 : I : 2016 Using ETABS A Review

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ABSTRACT

In order to better comprehend the structure's dynamic properties and seismic performance, high-rise linked structures have recently gained popularity as a structural type. Earthquakes have historically resulted in extensive instability and structure devastation. Modern buildings are gradually subjected to more seismic force as their height and volume rise. Seismic design has grown to be a vital component of the structure's analysis and design in order to prevent severe damage and guarantee safety. In traditional seismic design, increasing stiffness of the building is usually adopted to reduce the structural response during an earthquake. This approach is usually costly, and the effect of practical application is not obvious, which could not fundamentally enhance the bearing capacity of the structure. Utilizing existing research, a theoretical and physical model of a symmetrical, joined twin tower has been created. Meanwhile, a practical design that makes use of damping vibration absorbers with energy-dissipating capabilities also makes use of the movement of additional weight to lower vibration amplitude of the main body structure. The analysis and verification of the model of a symmetrical, linked twin tower's

In this paper presenting review of literature and past publications.

Keywords - High-Rise Connected Structure, Dynamic Analysis, Response Spectrum Analysis, Finite Element Method, Seismic Performance.

I. INTRODUCTION

High-rise connected structure is a new type of structure that is developed in recent years. Through setting up the connection between buildings towers makes it to be common use of space, at the same time, connected building's distinctive shape can bring strong visual result, and can make building body to be characteristic. Although high-rise connected structures are frequently used in the nation, there is currently no consensus on the seismic behaviour of such structures domestically or abroad. In addition, the design of such structures lacks sufficient theoretical support, test data, and real-world experience in high seismic intensity areas. There is currently less research on the seismic behaviour of high-rise connected structures since they contain two different types of complicated structural systems, an increased base and a twin-tower.

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This study uses the compelling finite element programme ETABS to create a finite element model of a high-rise connected structure. It also calculates the seismic response of the connected structure using the dynamic response spectrum analysis method, analyses the results, and explains them. The study's findings can serve as a theoretical foundation for high-rise connected structure seismic design.

II. Literature Survey

Athul Sajeev Manikkoth and Emy Thomas (2021) The purpose of the research paper was to examine the placement of shear walls in a horizontally connected twin high-rise building (G+30) connected by a skybridge, as well as to examine the nature of the earthquake-exposed structure and evaluate the response of connected high-rise buildings in accordance with design-code standards. The effect of sky-bridge location on the induced structural responses was examined using ETABS. The building was analyzed for, base shear, maximum allowable displacement and stiffness.

Results stated that maximum displacement decreases on addition on shear walls. On addition of shear wall on one side displacement reduced both in X and Y direction and further on giving shear walls on both sides each, maximum displacement is further decreased. While moving on to the comparison based on the location of sky bridge, it is expected that providing a skybridge at the one fourth height or at least height will give the best performance. But on the combined effect of shear wall and sky bridge height there has been some variation to the expectation. In the case of displacement along X and Y direction, model with shear wall on both sides of each twin building and sky bridge at three fourth height gives the least displacement.

Jamal Ahmad Alomari (2021) The goal of the research paper was to examine the impact of connecting two nearby reinforced concrete structures with sky bridges made of the same material. Using SAP2000 software, three models of the two buildings connected by a sky bridge are developed and examined in relation to the El Centro seismic excitation and the IBC 2012 response spectrum. Three sky bridges are provided in one model at the levels of the fifth, eighth, and thirteenth floors. Two sky bridges are added at the levels of the 5th and 8th floors in a second model. One sky bridge at the level of the eighth story joins the two buildings in the third model.

The investigated twin buildings show slight decrease in the fundamental period of vibration, and slight increase in the value of base shear as the number of sky bridges increases from 1 to 2 to 3. The length of the first period of vibration of a twin tower connected by sky bridge/bridges is expected to have a value longer than that of the stiffer building and shorter than that of the more flexible one.

Rohit Shinde et.al (2021) objective of the research paper was to design and analyze G+25 steel Skywalk for the Twin Tower Building with using Stadd Pro Software for seismic analysis as per IS800 and determine the strength of the specified framework of the sky walk, using FEM Software ANSYS.

As per design manually staad replace members and give economic sky walk and for the purpose of checking the accuracy as per given analyses from staad pro prepare modeling in Ansys for Cross check for strength of the bridge and the strength and strain capacity of the bridge are economic as per given sizes in staad hence design are safe as given in staad.

Shruti Nagar and Dr. Savita Maru (2021) objective of the research paper was to analyze twin tower structure G+4 podium+25 floor building using linear dynamic earthquake analysis. Four models with different combinations of twin tower with podium were considered to achieve desirable results in terms

of story drift, displacement and base shear under seismic forces for seismic zone IV and medium type of soil using Response Spectrum Analysis with the help of ETABS v19 software. Four symmetrical R.C. Frame Structures were subjected to a nonlinear dynamic analysis: a Twin Tower joined by a podium, a Separate Twin Tower without a podium, a Separate Twin Tower with a podium, and a Single Tower with a full podium.

The analysis stated that the displacement and drift ratio of structure have greater value in the case of tower without a podium and the same have lesser value in the case of tower with podium. The value of displacement due to equivalent static lateral force method in X direction increased by 9.26%, 1.57% and decreased by 2.88% for model 2, model 3 and model 4 respectively with respect to model 1.The value of drift ratio due to equivalent static lateral force method in X direction increased by 1.12%, 0.07% and decreased by 0.14% for model 2, model 3 and model 4 respectively with respect to model 1.

Jadav Bhavesh Bhanajibhai and N. B. Umravia (2020) In a research study, the behaviour of structures with G+20, G+25, and G+30 stories of symmetrical twin towers without an underground basement, with 2, and with 4 basements, was taken into consideration. By observing the variations in internal stress findings, such as base shear, storeys displacement, storeys drift, and storeys shear, the seismic response of the superstructure was analysed. Different linear dynamic structure analysis techniques, including the Equivalent Static Force Method (ESFM), Response Spectrum Method (RSM), and Time History Analysis, were used to analyse the data from all models (THA).

Results stated that the basement depth is directly affected by 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. All dynamic analysis models under the slandered condition its result may be variable with the parametric changes such as basement wall thickness, soil saturation condition, soil saturation condition and pore water pressure soil saturation condition. It has been observed that when an analysis Structure with incremental 5 number of stories (16 m height) in both towers and 2 number (8 m depth) of common basement simultaneously. Its effect on the base shear has been increasing on average 12-14% and 18-20% respectively. It is a linear effect with the height of structure and depth of basement.

Pranamika R and Dr. M Senthil Pandian (2020) in the research paper, the twin tower and a single tower was designed using the ETABS software and analyzed to obtain the storey drift, storey shear, base reaction and the results obtained for single tower are compared with the results obtained for twin towers. The sky way bridge is provided at the 50 th storey. Both towers were designed for G+80 storey having total height as 400 m and each storey is of height 5m. The models were subjected to various load combinations and the obtained results are compared. Cross bracings are provided to resist lateral forces in skyway bridge.

In case of twin tower drift in x direction (EQ x) is 1.14% less at storey 80 in comparison to single storey. In case of twin tower drift in x direction (EQ y) is 0.79% less at storey 80 in comparison to single storey. In case of twin tower Stiffness in x direction (EQx) is 50.65% more at storey 80 in comparison to single storey. In case of twin tower Stiffness in x direction (EQz) is 70.19% more at storey 80 in comparison to single storey. It was concluded that twin tower has more shear and stiffness in comparison to single tower whereas drift is more in case of single tower.

B. Kiriparan et.al (2019) in the research paper, a fifty storied twin towers proposed in Colombo, connected with a skybridge at roof top was presented. The proposed skybridge was located 172 m above the ground and spanning 10 m from one end of a tower to another tower.

A dynamic time history analysis or power spectral analysis was used to analyse the linked tall buildings under the wind loading. Mean, Background and Resonance components of wind loading to be appropriately represented in the analysis, as the coupled tall buildings are more sensitive for dynamic response. Frictional resistance from the bearings and introduction of viscous dampers may cause significant structural coupling, which may lead to the alteration of internal forces in the tower's structural members.

Geetha and Kiran Kamath (2019) the effect of a podium structure of a single tower structure linked by a shared podium at the interface level under seismic load was the main topic of the study paper. The ETABs were used to generate the simulation model, which had different tower heights and podium heights, and it was examined using the equivalent static and response spectrum methods. In this study, it was seen how the equivalent static and response spectrum techniques of analysis affected the top displacement of the tower attached to the podium structure.

Results stated that the increase in the podium height of single tower- podium configuration the top displacement of the structure increases. In the case of response spectrum analysis the top displacement decreases after increment at a certain point and then remains independent to the height of the podium. The podium imposes the backstay effect at the podium –tower interface level. It is observed that with the increase in podium storeys the backstay forces at podium-tower interface increases. Analysis concluded that the structure must be designed for the results obtained from the response spectrum analysis rather than the results obtained by the equivalent static method of analysis which overestimates the results.

Maria E. Stavroulaki (2019) The goal of the research paper was to suggest a method for finite element analysis to simulate the interaction between buildings made of aggregated masonry. Since information on unknown geometry, dimensions, materials, and other factors makes it impossible to assess the stiffness of nearby structures, a parametric research was necessary to replicate the limits that were created. The natural frequencies of the real building complex are estimated by the finite element modeling of all the structures, which is then used for the dynamic identification of the simplified model.

Results concluded that the consideration of rigid restriction increases the dynamic eigenfrequencies, which means that the model simulates a structure with higher stiffness in comparison with the model of the real condition. This is critical to the decision of the intervention technique application. A flexible support could better simulate the real interaction, therefore, it is important to find the way to model this condition.

Imad Shakir Abbood et.al (2018) Using finite element modelling, a research report examined how structural linkages affected seismic responses for a system of linked buildings. The twin, 40-story reinforced concrete frame-wall components that made up the linked building system were joined horizontally by structural linkages. A rigid floor diaphragm for towers and a beam for each link that is fixedly connected to the perimeter structural framework of the buildings make up the model for the linked building system. The seismic responses of the twin towers were calculated at various places for the link using earthquake time history stimulation.

The analysis's results suggest that the link may significantly alter how the linked building system responded structurally. The increased link stiffness is referred to as gathering the single tower to endure seismic excitation, and in some circumstances the structural responses have been reduced when compared to the single tower. 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.

Surendra Chaurasiya and Sagar Jamle (2018) The twin tower multistory building located in seismic Zone-IV was the subject of a research paper that included a parametric comparison of the results for measures like displacement and storey drift. Seismic effects are acting on the structure under 13 different cases, and the Staad pro programme was used to analyse the data. The design of twin towers building subjected to seismic effects cannot be based on analytical results obtained from general multistoried structure. The displacement values for twin tower cases for the X direction steadily drop to a lower value of 39.059 mm, or Case M, as can be seen in the data. It appears that the percent drop is 20.37. Z-directional displacement values appear to have decreased by 18.12%. The building's layout, which divides the entire structure into two halves, appears to have a maximum Case value of M and a minimum Case value of F with a fall of 22.04%.

Xiaohan Wu et.al (2018) On the top floor, a lengthy sky corridor bridge connected a tall four-tower building. A passive control approach using a friction pendulum tuned mass damper (FPTMD) was used to lessen the earthquake reactions and member forces of the towers and sky corridor bridge. The mass of FPTMD was the sky corridor bridge. Friction pendulum bearings (FPBs) and viscous dampers were used in the flexible connections that connected the towers to the sky corridor bridge. The Perform-3D model was used to undertake an elastoplastic time-history analysis to examine its seismic behaviour under vigorous seismic excitation. The ideal design of the FPTMD was carried out, and the seismic behaviour of the structure was also explored, with varied friction coefficients and the radius of the friction pendulum bearing (FPB) under seismic excitations.

Results stated that compared with the friction pendulum, the viscous damper has less energy dissipation. However, the viscous damper can reduce the horizontal slip displacement of the friction pendulum and limit the slip displacement within the design value. The friction pendulum tuned mass damper (FPTMD) composed of friction pendulum bearing, viscous damper, and sky corridor bridge can effectively reduce the seismic response of the structure,including deformation of the structure and damage extent of the structure members.

Kai Chen et.al (2017) A specialised engineering of base isolation for the retrofitting of existing nearby frame structures was the subject of a study article. Comparatively speaking, connecting the isolation layer of nearby structures with a large floor reduces the relative displacement of top floors of superstructures more efficiently than employing building monolithic movement technology to widen the seismic junction. Seismic response was evaluated for the structures in different cases by time-history analysis. Parametric studies are performed in order to achieve the laws of top displacement difference of superstructures influenced by the change of dynamic characteristic of towers in the case of base-isolated multi-tower structure with a large floor.

The results of extensive numerical analysis verify the effectiveness of isolation with a large floor in minimizing the forces from earthquake and protecting the top story from crashing into each other, which has important reference value for application of retrofitting with isolation technology on adjacent reinforced concreted frames.

T N T Chik et.al (2016) The study compared the two systems' performance while examining the natural frequency and vibration mode of a multi-story office structure using a foundation system. The LUSAS finite element modelling (FEM) package software is used to analyse the building's vibrations. The foundation system is included in the structure model, and the building is simulated based on the original blueprint.

The FEM results indicated that the structure which modelled with rigid base have high natural frequency compare to the structure with foundation system. These maybe due to soil structure interaction and also the damping of the system which related to the amount of energy dissipated through the foundation soil.

Ji Dongyu and Li Xiaofen (2014) In order to create the finite element model of the connected high-rise structure for the research paper, big finite element software ANSYS was used. Dynamic time history analysis method and tianjin wave input were used during the calculation process in accordance with the established standards. The research selected the twenty-third floor and the third floor as the research object, and analyse the horizontal displacement time history curve and the horizontal acceleration time history curve of high-rise connected structure under earthquake action.

Conclusion stated,through seismic response calculation analysis of high-rise connected structure, this high-rise connected structure have good seismic behavior, is economic and reasonable, and can satisfy the engineering requirement.

Wensheng Lu And Xilin Lu (2013) Tests of various sized multi-tower high-rise building models on the shaking table were summarised in a research article. The analysis of multitower buildings is manifestly inappropriate for the rigid floor assumption. A fresh analytical model that takes the impact of flexible transfer floors into account is proposed. The contribution of the stiffness of the foundation to the structural dynamic behaviour was studied and contrasted with the test results and conjunction floors between towers at higher levels.

The report's conclusion noted that flexible connections between towers can considerably lessen the drift of multi-tower high-rise structures. However, after a mild earthquake, these structures will be demolished and serve as energy dissipation components. The answers are quite complex for multi-tower structures with asymmetrical shapes, like Shanghai Reception Center with its U-shape. The internal forces in the thin shape slab as well as the coupling activities between the towers have an impact on the building's safety. Strong earthquakes have the potential to cause serious damage to multi-tower buildings. However, if the building is properly designed and built, it will remain safe.

III.CONCLUSION

Here we reviewed various authors publication related to analysis of a tall structure using analysis tool.

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