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A Review on to study the effect of location of horizontal walk by connected two high rise building (g+20) under seismic loading

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Abstract - *Now a days, adjacent tall buildings are being horizontally connected for different purposes. Structural Engineers are concerned with finding out the behavior of a structure when subjected to horizontal forces and adequate stiffness is required for the buildings which are high-rise in order to confront horizontal forces caused by winds and earthquakes. The main objective of this project is To study the effect of location of horizontal walk by connected two high rise building (G+20) under seismic loading using STAAD PRO software. The dead load, live load, and wind load are also applied and the design for beams, columns is obtained in STAAD Pro. The effect of sky-bridge structural responses is examined as well. The building is analyzed for, base shear and maximum allowable displacement. The analysis and modeling for the whole structure is done by using STAAD PRO software.*

Key Words: Staad-Pro, Baseshare, Base moment, Absolute, Bending moment, Connected Building etc.

1. INTRODUCTION

In this present increasing population and industrialization there is a huge demand for residential buildings in cities. In cities there is more population and less land area for their residential sector. This lead to development of high rise buildings in these respective areas. So considering all these aspects there is more demand for structural engineers. In order to compete in the ever-growing competent market it is very important for a structural engineer to save time. As a sequel to this an attempt is made to analyze and design a multistoried building by using a software package STAAD Pro. For analyzing a multi storied building one has to consider all the possible loadings and see that the structure is safe against all possible loading conditions.

A skyway is an elevated type of pedestrian way connecting two or more buildings in an urban area, or connecting elevated points within mountainous recreational zones. Skybridge that link near by structures combine them into a single structure system. In every aspect of human civilization, we needed structures to live. The structures should be built in an efficient manner so that it can serve people and save money. In simple words, the building means an empty surrounded by walls and roofs, in order to give shelter for human beings. In early times humans have lived in caves to protect themselves from wild animals, rain etc. Then, humans developed and built their homes using timbers and lived. Now a days the recent homes are developed into individual and multi-story buildings.

Buildings are the necessary indicator of social progress of the country. At current situation, many new techniques have been developed for constructions. So, that the buildings are built economically and quickly to fulfil the need of the people. A building frame is a three-dimensional structure which consist of column, beam and slab. Because of growing population, high rise building are coming into demand. The buildings should be constructed for human requirements and not for earning money. Buildings are built in different sizes, shapes and functions. With the immense increase in population, demand of land keep on mounting which in turn leads the responsibility of civil engineer to greater extent. Earlier horizontal system of construction was in use but now a day's vertical system of construction is preferred more due to a lesser amount of ground existing .

The main objective of this project is to study the effect of location of horizontal walk by connected two high rise building (G+20) under seismic loading.The dead load, live load, seismic load and wind load are applied and the design for beams, columns is obtained STAAD Pro. We conclude that STAAD Pro is very powerful tool which can save much time and is very accurate in Designs. Thus it is concluded that STAAD Pro is suitable for the design of a multistoried building.

Figure 1: Petronas Towers (Malesia)

Figure 2: Horizontally Connected High Rise Buildings

2. LITERATURE REVIEW

Literature Review for Paper [1] evaluated“ the response of a 10 storey building with seismic shear wall using STAAD”9.5. Main focus was to compare the change in response by changing the location of shear wall in the multi-storey building. Four models were studied one being a bare frame structural system and rest three were of dual type structural system. The results were excellent for shear wall in short span at corners. Larger dimension of shear wall was found to be ineffective in 10 or below 10 stories. Shear wall is an effective and economical option for high- rise structures. It was observed that changing positions of shear wall was found to attract forces, hence proper positioning of shear wall is vital. Major amount of horizontal forces were taken by shear wall when the dimension is large. It was also observed that shear walls at substantial locations reduced displacements due to earthquake.

The aim of paper [2] In this “study model of G+7 Structure is analyzed under seismic load by using STAAD.Pro software” in different seismic zones (II, III, IV, V) of India. Consideration is done for all the basic parameters of earthquake responsible to affect Multi- storey building and analyzed with Different Load combinations and try to fill the void of IS:1893-2002 doesn’t provide the variations in steel quantity from zone to zone. Result shows comparison of Base shear, Floor Displacements, support Reactions and variation of steel quantity by zone to zone. Result declare that Base shear, Displacements, support reactions and steel quantity are Depends on zone factor, so these values are more in zone-v, zone-V is critical for the G+7 structure. Support reactions zone-V as higher value as compare to zone-II, zone-III, zone-IV. 6. Steel quantity of seismic zone-V is higher than 53.84%, 13.89% and 8.31% as compared to zone II, zone-III and zone-IV.

Paper [3] In these research the “residential building of G+ 15 storey structure is analyzed for seismic load by using method of static and dynamic analysis” by considering ordinary moment resisting frame and special moment resisting frame in zone II. Equivalent static analysis and response spectrum analysis are the methods used in structural seismic analysis. The total structure were analyzed by using STAAD.PRO software. The result shows that response reduction of cases ordinary moment resisting frame and special moment resisting frame values with deflection diagrams in static and dynamic analysis. The special moment of resisting frame structured is good in resisting the seismic loads. Final result concludes that the results of static analysis in OMRF & SMRF values are low when comparing to that of dynamic analysis in OMRF & SMRF values. Hence the performance of dynamic analysis SMRF structure is quiet good in resisting the earthquake forces compared to that of the static analysis OMRF & SMRF.

In Paper [4] The present study deals with “seismic analysis of multistoried residential building G+7.” The dead load and live load applied and design for beam, column, slab and footing are obtained by analyzed Total structure by using STAAD.Pro software. the behavior of multistoried building by Equivalent Static Lateral Force Method is examined. The result shows the variation in calculation of base shear by manually and using STAAD.Pro Design Base Shear (Manually) = 2345.71 KN Design Base Shear (STAAD Pro)= 1634.43 KN . Finally, Conclude STADD. Pro is versatile software having the ability to determine the reinforcement required for any concrete section based on its loading and determine the nodal deflections against lateral forces and To consider Seismic forces and designed it as an earthquake resistant structure.

The objective of [5] has done comparative “study of static and dynamic seismic analysis of a tall building. A multi-storied framed structure of (G+9)”pattern has been selected. Seismic analysis linearlyhas been done for the tall building by static method (Seismic Coefficient Method) and dynamic method (Response Spectrum Method) using STAAD-Pro as per the IS-1893- 2002-Part-1. A comparison has been done between the static and dynamic analysis and the results such as Bending moment, Nodal Displacements, Mode shapes are computed, compared and summarized for Beams, Columns and Structure as a whole during both the analysis.

Paper [6] carried out research on different aspects of “analysis and design of tall buildings consisting of shear walls, connecting beams and coupling slabs.” An extensive programme of experimental study was chalked out. A few models of relatively large scale were cast and tested. The results of an RCC model which was tested by applying a point load at the top simulating an equivalent static lateral force due to wind and earthquake are presented here. Relatively large scaled models consisting of two planar walls solely connected by beams consisting of five storeys have been tested. Hydraulic jacks were used to apply the load. Load cells together with digital display system measured the intensity of load. Desired mode of failure was achieved. This was particularly due to failure of connecting beams. The above literature review indicates that the behaviour of shear wall under various types of loading, the provision of transverse and confining reinforcement, the role of stirrups in shear transfer at the joint and the detailing of the joints are the main issues. The review shows that additional cross inclined bars at the joint core introduce an additional new mechanism of shear transfer. However the review indicates insufficient information

regarding the interaction between the shear wall and the diaphragm. Hence in this investigation an attempt has been made to understand the behaviour of shear wall to diaphragm.

Paper [7] in this paper author perform research on four multistory tower interconnected on the top floor by a sky corridor bridge. In this analysis seismic action is controlled by tuned mass damper. Corridor is taken as friction pendulum tuned mass damper. The connecter bridge used to bake for path between four towers is connected by flexible links. Perform 3-D software is used to analyze the 3-D model of the framed multistoried connected tower developed by Nosa CAD, Elastoplastic time history analysis is used to analysis the model in Perform 3-D and the seismic parameters are haul out from software and compared against nonlinear response obtained in the result. The model is compose of 8 multi storey framed structure in which 6 storey is used for commercial purposes and bottom three storey is used for basement. All the building specifications are taken as per Chinese Code like C30 concrete is used in RCC members and C60 is used for core tube wall. The result of the study shows that the concept of frequency pendulum tuned mass damper is found successful which reduce not only seismic action and also deformation along with damage extent. When the tower and corridor are connected by rigid connections then the relative displacement developed in the tower is resisted by isolation devices.

Paper [8] "investigated the dynamic response of structurally connected twin tall buildings with a generic configuration." The structural system of the twin tall buildings and the connecting sky-bridge was replaced with a six-degree-of-freedom model at the level of the sky-bridge. The effects of sky-bridge axial and bending stiffness on the natural frequencies and modes of connected structures have been described by empirical formulas.

In paper [9] investigated a trio of structurally connected towers in Fukuoka City, Japan." The towers are connected at three different levels by aerial gardens, and contain various vibration control devices to assure their safety. The complex structural Fig. 1. Real structures with horizontal connection. 228 S. Mahmoud / Ain Shams Engineering Journal 10 (2019) 227–241 system that performs the seismic response analysis was replaced by a simplified lumped-mass model. Each of the connected towers was also represented by a lumped-mass model, with springs at each floor level for shearing and bending. The connecting sky-bridges were represented by rod elements.

Paper [10] "investigated the seismic response of a well-known high-rise building"(the Shanghai International Design Center), featuring two towers of different heights connected by trusses. They conducted shaking-table tests on a 1:15-scale structural model of the building under a suite of earthquake-ground motions. The structural system of the connected towers constitutes steel frame, reinforced concrete (RC) core walls and shear walls.

"introduced design guidelines and response evaluations for differently shaped high-rise buildings under wind excitations and earthquake loads." They constructed circular, triangular, square, and rectangular tall-building models. However, the above-cited studies considered only the dynamic load on isolated buildings with no sky-bridge connection to a surrounding building. The structural performance of such one-tower structural systems depends on that of the primary components, namely, the structural walls or moment- resistant frames. In reality, some tall buildings are linked to a surrounding structure which is normally similar to or even identical to the building. Because the sky-bridge can significantly interfere with the dynamic loadinduced responses of the linked structures, it should be considered when evaluating the overall structure response. The applied lateral loads and basics of design considerations have also been considered. Investigating the response under dynamic earthquake and wind loads become more complex for multi-tower connected structures.

This paper[10] an effort is made to analyses 23 storied high rise building" in which the bottom three floors are made for commercial housing and the rest of 20 floors are two symmetrical towers connected at 20th story by connecting plates. The study is carried out by finite element analysis in ANSYS software in which the aforesaid high rise twin tower is analyzed by time history analysis for seismic response. The building is connected by RCC plates and pile foundation is adopted at base. Building is analyzed for seismic intensity of 7degrees. Model is tested against various seismic parameter like horizontal displacement, horizontal acceleration, etc. in this analysis is focused on third floor and twenty third floor of the building to find the behavior of seismic parameters against seismic action. The results of the study shows the maximum horizontal displacement at twenty third floor is 0.078m at 2.26sand the horizontal acceleration for the same level is 1.90m/s2 at 1.64s. Similarly for third floor the maximum value recorded of horizontal displacement is 0.006m at 4.20s also horizontal acceleration is found 0.69m/s2 at 4.45s. These numerical value obtained by time history analysis in ANSYS suggest that the assumed connected structured model is safe for seismic action taken for consideration also economic and reasonable as per engineering practices.

3. OBJECTIVE OF RESEARCH WORK

1. The main objective of this project is to investigate seismic analysis of high rise building with horizontal walk and without horizontal walk as per code IS 1893-2002 part I criteria.
2. The present work is to investigate the performance of G+20 RCC base shear of building with 3 meter height of each story.
3. Comparisons of the story drift value of different types of building.
4. Compare acceleration of building with and without horizontal walk.
5. To study the result of various parameters such as displacement, torsion and deflection.
6. Design of the structural elements of a high rise building with horizontal walk including beams, columns.

4. PROBLEM STATEMENT

1. Buildings with plan and elevation eccentricities are developed for modelling and analysis. The basic building plan and properties were adopted from the validation journal, and a mirror copy of the same is created to provide a twin tower.

2. After remodeling a sky bridge is drawn connecting all the structure at respective stories require for modelling. The distance of 30 m is provided between both the structures. A total of 20 floor is provide. These cases are based on the height at which the sky bridge is provided. The sky bridges are provided at 16th, 12th,8th and 4th floors.

3. Investigate seismic analysis of high rise building with horizontal walk and without horizontal walk as per code IS 1893-2016 part I criteria with IV Zone.

4. Various loads are applied on building and then analysis is done on model. The behavior of structure is compared and the best configuration is discussed.

5. Various type of structural model consider for this study.
   i. Model 1- RCC G+20 story without walk
   ii. Model 1- RCC G+20 story with walk at 4thfloor
   iii. Model 1- RCC G+20 story with walk at 8th floor
   iv. Model 1- RCC G+30 story with walk at 12th floor
   v. Model 1- RCC G+30 story with walk at 16th floor

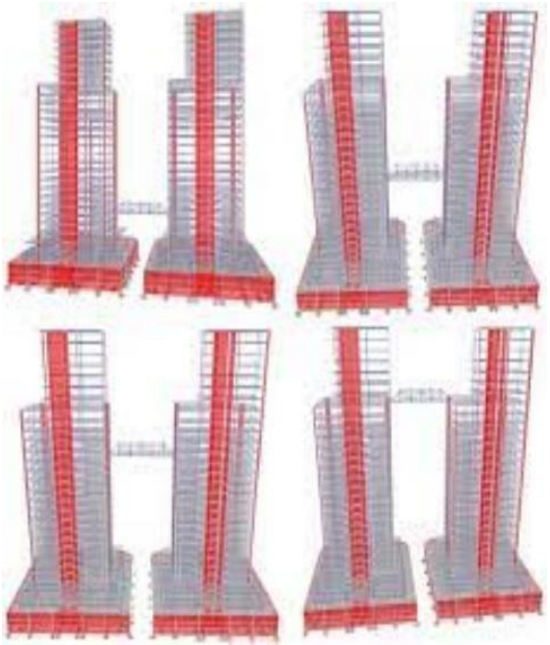

Figure 3: Horizontal Walk Connected Building

5. METHODOLOGY

1. Assumptions on geometric properties on the basis of preliminary calculations.
2. Creation of model of building in STAAD PRO
3. Modelling of building and assigning of Loads and their combination are decided as per IS 875 part I – part 5 and seismic load as per IS 1893-2002 part I in STAAD Pro.
4. Evolution of performance of RC frame building under seismic zone.
5. Analysis of building.
6. Design of building components.
7. Detailing.
8. Compare the results structure with horizontal walk and without horizontal walk.

MODELLING AND ANALYSIS PROCESS:

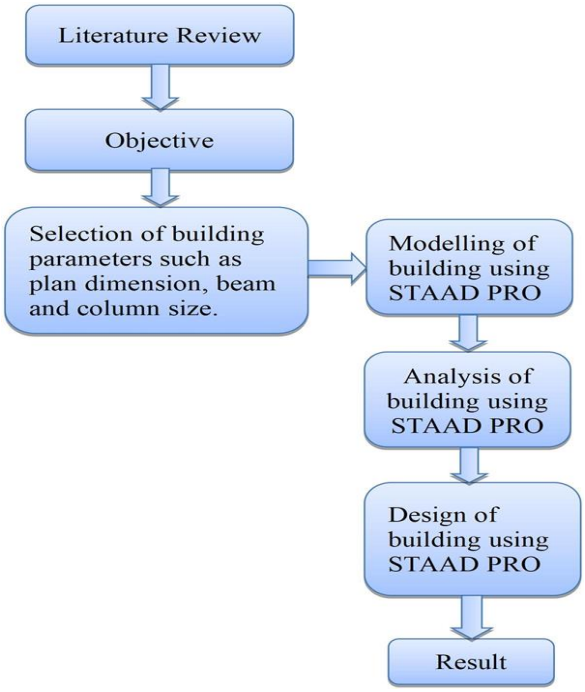

Figure 3: Modelling and Analysis Process

6. CONCLUSION

So far by reviewing and studying numerous research papers it has been analyzed that in the field of stability of multistoried twin tower against seismic and wind loads it is required to analyze the connected structure with various possibilities of structural stability by various means and its optimum location in the building. Here we come at conclusion drawn from studying the above review the position location of connector in the building is optimized so as to resist seismic loading.

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