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Analysis of Tall Building by Various Types of Structural Forms under Earthquake Analysis: A Review

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ABSTRACT : In the present world scenario, construction of high-rise buildings is preferred due to the rapid rise in land value, scarcity of land and also to conserve land in rural areas for agricultural use. The construction of high-rise buildings primarily depends on wind and seismic loads. The operational characteristics of buildings depend on the structural configuration. The structural system of a high-rise building is designed to work with vertical gravity loads and mainly with lateral loads caused by wind and seismic activity. A structural system consists only of elements designed to transfer loads, all other elements that do not participate in the transfer of loads are called non-structural elements.

The article presents the review on the study of various researches on Analysis of Tall Building by Various Types of Structural Forms under Earthquake Analysis. The review concluded that it is required to analyze the behavior of Analysis of Tall Building by Various Types of Structural Forms under Earthquake Analysis under earthquake response to meet the growing demand for commercial and residential space. The structural form used are framed, shear wall, core, outrigger types of structural forms etc.

KEYWORDS: Tall Building, Framed, Shear Wall, Core, Outrigger, Structural Forms, Seismic Loads.

I. INTRODUCTION

Structural forms are also known as structural systems - it is a mechanism that ensures the structural stability of a building. Depending on the nature of the structure, one or more structural systems can be used for one high-rise building. The adequacy of the lateral load-bearing system should be decided by a structural engineer well verse in the structural analysis and design of high-rise buildings.

Structural Forms for Tall Buildings

High-rise buildings have become more popular as a word in development and it has become a trend to build a high-rise building. Due to the scarcity of land in closed environments, the simplest option is to build a high-rise building to accommodate all services. High-rise buildings are built as mixed-use developments, residential buildings, office work, and other important things that must be included when designing high-rise buildings. In addition, depending on the nature of the structure the structural engineer must choose the structure to proceed with the design. In addition, these structures discussed below can be identified as load-resisting systems. There are different types of bracing structures such as Braced frame structures, Rigid frame structures, Wall wall structures, Tube in Tube etc.

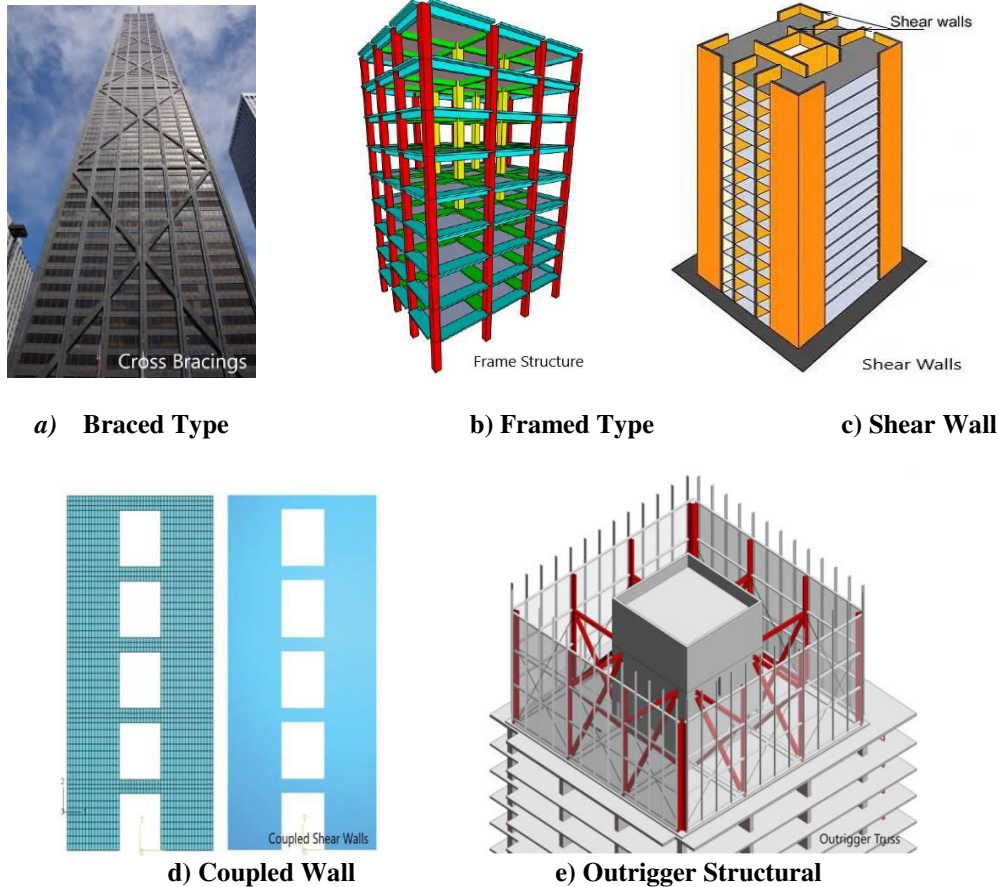


Fig. 1: Structural Forms (Ref. Taken: <https://www.structuralguide.com>)

II. REVIEW OF LITERATURE

The following research articles are review under the Analysis of Tall Building by Various Types of Structural Forms under Earthquake Analysis. The short summery are as follows:

M. Borah, S. Choudhury (2021) In this study, high-rise buildings were investigated under the influence of earthquake loads and different structures, namely, specific moments of resistance four frame, (framed building, (i outrigger system, braced model and hybrid model. The building models are as follows. located in Guwahati, Assam which is one of the most earthquake zones in India. A detailed analysis of the building system is done by modelling the geometry, component properties and boundary conditions. The components are deformed using the FE mesh using the software. "ETABS 2016". Appropriate limiting elements are provided in the beams and columns; the slab is modelled as a rigid diaphragm to simulate the dynamic behavior of high-rise buildings. in addition, seismic surveys were conducted to obtain performance standards and other responses.

The study concluded that the outrigger and hybrid models have shown good results in pushover tests. Although all the home models are in IO mode, these two models are less used compared to others. From the NLTHA, it has been noted that the shelter is better compared to other models. The outrigger and hybrid models are in an elastic state with no use.

S. Ramteke, P. Kale & et. al. (2021) The current project is focused on the study of the improvement of the location of the wall in uneven high-rise buildings. The shape of the barrier in the horizontal structure is a relevant consideration. In horizontal structures, the centre of gravity and the centre of gravity coincide, so that the walls are placed on the outer or inner edges (such as the box shape). Therefore, it is necessary to find a good and appropriate location of the walls installed in the same structure to reduce the impact of torsion. In this work a high building with different sections of shear walls is considered for analysis. The multi-storey building with G + 4 cases is analyzed for its removal, strength

and stability using the ETABS software. Analysis of seismic load design in Zone-V. A systematic review was conducted using qualitative and quantitative methods.

S. Abbood, M. A. Jasim & et.al. (2021) A brief description of the current policies found in the literature is presented to describe a specific case that has been widely reported, named, using an effective policy for combating back loading caused by wind and seismic. Therefore, an overview is presented that includes the behavior of different policies for different heights of high-rise buildings by performing a number of non-linear (pushover) and non-linear compression tests. (for wind and earthquake). Finally, a critical review of the available simplified model and the basic model of seismic energy is presented. too. This document is intended to help in the development and use of construction methods for high-rise buildings in the future.

Karthik A., Ankit Batra, Sakshi Gupta (2020)

The purpose of this paper is to review the structural design, wind and seismic behavior of tall buildings from a civil engineering perspective. First, the effect of construction type on aerodynamics is examined. It then discusses the loading, selection, and arrangement of key structural elements to resist load combinations including gravity, earthquake, and wind loads in heavy buildings. In addition, the new rules issued in TBEC-2018, the first national code with specific rules for tall buildings in Turkey, are reviewed.

Mr. Jaiprakash C, Ramya B V (2019) The articles Considering specific lateral loading along with vertical gravity loads due to wind or earthquake loads is important to find the behavior of tall buildings. As the height of the building increases, the amount of structural material required to resist lateral loads increases significantly. The design of tall buildings includes conceptual design, estimation, preliminary design and optimization for safe transfer of gravity and lateral loads. The design criteria are strength, serviceability and human comfort. The goal of a structural engineer is to achieve structural designs that meet the appropriate criteria. The present study describes a response spectrum method for analyzing a G+30-story reinforced concrete high-rise building under wind and seismic loads in accordance with IS codes of practice. Comparisons were made for shear, layer displacement, layer displacement, layer acceleration, layer forces and layer stiffness.

B. Mohammadzadeh, J. Kang (2019) One of the frequently used systems in the construction of seismic-resistant structures is steel-frame due to the high energy-dissipating, load bearing capacities. Irregularities of a building in plan and elevation, which results in the change in stiffness in different floors and regions inside the structure, highly affect the seismic performance and behavior of the structure. As a few studies can be found dealing with the stiffness irregularities in the structures, this study was about to investigate the seismic responses of high-rise steel-frame building of twelve stories with various stiffness irregularities. The building has five spans of 3200 mm distance in both X- and Y-directions. SAP2000 was used for the design purpose. It resulted in the various sections for different stories; one to three: 0.50m×0.50m×0.05m, four to seven: 0.45×0.45×0.05m, and eight to twelve: 0.40×0.40×0.05m. The FEM software ABAQUS was used for the time-history analysis of the buildings subject to real data recorded from Vrancea Earthquake in Romania.

S. Abbood, M. Mahmud & et. al. (2018) In this study is represented by twin 40-story reinforced concrete frame-wall structures 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. The linked building system is modelled as a rigid floor diaphragm for towers and as a beam for each link fixedly linked to the perimeter structural framework of the buildings. By employing 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 analysis outcomes indicated that the link could effectively change the structural responses of the linked building system. The structural responses have been decreased in some cases compared to the single tower, referring to the extra link stiffness as gathering the single tower to withstand seismic excitation. 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.

Pavan Kumar Reddy, Praveen Kumar (2017) After many functional reports, the application of lateral load resisting methods in the building configuration proved to significantly improve the earthquake performance of the structure using ETABS 9.7.4, the work was done for specific cases using shear walls and braces. the highest level is 93.5m for great heights and to win prizes. Modeling was completed to study the effect of specific cases along with specific elevations on seismic parameters such as base shear, lateral displacements, and lateral displacements. The study was carried out for soil II (medium soil) zone IV and zone V as targeted during IS 1893-2002.

Nicola Longarini, Luigi Cabras & et. al. (2017) To evaluate the effects of wind, wind tunnel testing and structural analysis were carried out, with two different methods: Pressure Integration Method, with finite element modelling, and High Frequency Force Balance method. The results from these two methods are compared to those obtained from Eurocode 1 and the Italian design codes, emphasizing the need to further deepen the understanding of the problems related to wind actions on such a type of structure with high geometrical slenderness. In order to reduce the effects caused by the wind, the design and damping solutions are defined and discussed in the comparative study. Those solutions include the reduction of height, steel belts, tuned mass damper, (viscous dampers, and orientation changes. Each solution is studied in detail, along with its advantages and limitations, and the reduction of the load adjustment and the change of behavior and speed are explained. This study shows the potential for improvement development in the building to stabilize vibrations and reduce design loads and thus provide a balanced balance between durability, serviceability, and development needs.

Bhalchandra p. Alone, Ganesh Awchat (2017) This paper deals with a case study on seismic analysis of high rise building system (Ground+ 3 Basements+50) storey RCC by STAAD pro v8i applying Indian standard provisions. One of the most terrible and destructive phenomena in nature is a strong earthquake and the terrible effect. It is very impossible to prevent earthquakes from happening, but damage to buildings can be controlled with proper design and detailing. Therefore, it is mandatory to perform seismic analysis and design of buildings against collapse. Designing a structure in such a way as to minimize damage during an earthquake makes the structure quite uneconomical, as an earthquake may or may not occur during its lifetime and is a rare occurrence. This study is mainly concerned with understanding the results from STAAD Pro v8i software under the gravity loads provision in IS 456:2000, The results shall satisfy the general criteria of not failing after analysis. Results for improvement Accuracy according to IS code 1893: 2002.

E. RaviKumar, P. Raghava, Dr.T.Suresh Babu (2017) In this paper, it is proposed to implement the Response Spectrum for irregular buildings greater than 90m in height in zones II, III, IV and V. In this case, the response spectrum analysis is done and the results are compared in four different zones with 7m 4 bay length. The results of the analyzes were obtained, in terms of lateral deformations, relative floors and shearing of the base, and conclusions were drawn.

Y.M. Abdlebasset, E.Y. Sayed-Ahmed & et. al. (2016) In many tall buildings, architectural requirements can result in a variable configuration for vertical structural elements between building floors. To accommodate the discontinuity of such vertical elements, a "transfer" floor must be introduced to transfer vertical and lateral loads between the upper and lower floors. The disadvantage of the transfer floor is the sudden change in the lateral stiffness of the building at its level: the structure becomes susceptible to the formation of a soft floor mechanism under moderate to strong earthquakes. These buildings generally showed normal elastic behavior for frequent earthquakes, but suffered large cracks near the transfer floors for rare earthquakes. This paper provides an overview of the latest publications dealing with the seismic behavior of high-rise buildings with a transfer floor.

Mr. Ashish A. Mohite (2015) The researcher analyzed the three-dimensional symmetrical moment resistance (MRF) model of the 10th, 12th, 14th, 16th, 18th and 21st floors with adjusted mass damper and without adjusted mass damper using ETABS software, moment resisting frames are columns. and the plane of the support frames with fixed or semi-rigid joints. They can be made of concrete, steel or composite materials. Moment-resisting frames may be sufficient for a building up to 20 stories high. A tuned mass damper (TMD) is placed on top of and through it to study its effects on the structural response through time history analysis with and without a tuned mass damper (TMD) in ETABS. The result obtained by the software analysis of the 10th, 12th, 14th, 16th, 18th and 21st floors of the building with and without the adjusted mass damper and compare the results with each other. It has been found that TMDs can be successfully used for structural vibration control.

Er. Nishant Rana¹, Siddhant Rana (2014) The paper reviews some of the major types of structural form systems employed for modern tall buildings structures. Since in the performance of tall building structures. Since, tall buildings enjoys rapid evolution and new innovations and with the development of increasingly taller buildings structures serviceability issues like lateral sway, floor vibration, and occupant comfort need to be given more attention. As the height of the building increases, lateral forces plays a dominant role. Therefore, certain provisions shall be made in order to resist these lateral forces so that building performance under the effect of lateral loads can be improved.

K. S. Vali, B. Ajitha (2014) In this paper, it is proposed to make an analytical study, on a multi-story building of 35 floors, which was done considering different seismic zones and the type of hard soil. The suitability and effectiveness of various commonly used lateral weight systems, as well as concrete fills, were tested. In these analytical models, different weighting systems are introduced, ie, X-prosthesis, V-prosthesis, inverted V or chevron-brackets and fillings. These building models were analyzed, using SAP 2000 software, for lateral forces using linear static and linear dynamic approaches as per IS 1893 (Part I): 2002.

F. Naeim, L. D. Carpenter & et. al. (2012) Building regulations aim to ensure safe buildings by prescribing loads and material properties, as well as structural details, generally apply to all types of buildings and structures. However, building regulations may not provide for the most economical, efficient and safe tall buildings because the regulations are general and prescriptive in nature. Tall buildings are truly a special class of buildings that have unique qualities and characteristics. It is recognized that tall buildings are designed with a different approach to meet safety and performance requirements, especially in regions with high seismic activity. To meet this need, the Los Angeles Tall Building Structural Design Council developed an alternative procedure for the seismic analysis and design of tall buildings in the Los Angeles region. The Council has been developing the alternative design procedure for eight years and recently published the third edition of the procedure.

III. CONCLUSIONS

After the summarized report on past research of dynamic analysis of tall building under various structural analysis are as follows:

- Various researcher are used the various types of structural forms such framed, outriggers, core & shear wall structure etc in which those have core types are find more resistance capacity.
- The dynamic analysis and lateral effects are analysed as per the earthquake and wind. The major area covers the earthquake analysis in it.
- Some researcher deals with the outrigger and hybrid models have shown better results in pushover analysis methods. & other researcher used the response spectrum analysis for seismic analysis.
- For controlling of vibration the tall building used the various dampers. In this It has been found that the TMDs can be successfully used to control vibration of the structure.
- The various results are taken by various researchers such as lateral deformations, respective storey drifts and base shears, Bending moment and shear force etc. are used to taken the earthquake analysis.

Over all it is concluded that it is important to analysis the tall buildings under various structural form to find out the optimised structure for specific region and location.

IV. FUTURE SCOPE

The list out topic or titled can be exculpated in future under the various types of various structural forms. The list is as follows:

- More research can be done with different forms of building models.
- Different seismic zone factors can be considered for the evaluation.
- Analysis can be performed for more height and changing the locations of the elements.
- Software analysis for the Madhya Pradesh region under the structural forms
- Wind analysis can be taken by various structural forms.
- Various country code study on high rise construction under Indian territory comparison analysis.

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