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Analysis and Design of Tall Building - A Critical Review

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***Abstract:** High-rise building is trending nowadays as there is a rapid growth of the urban population. The factors such as cost of land, preservation of agricultural land and desire to avoid urbanization boosted up the need for high-rise buildings. Gravity and lateral loads govern the structural design of high-rise buildings. Lateral load resistance is offered by interior structural systems like core structure, outriggers, etc. or exterior structural system like rigid frame, wall frame, etc. Structure Systems should be such that it should fulfill all the specified requirements. A Shear wall structure resists the lateral load entirely by shear walls. Shear wall maybe a part of core or partition between accommodations. Shear walls are components which are built from foundation to the tip of the building, the length and thickness may vary. Shear wall behaves as vertical cantilevers. A Rigid frame structure comprises parallel or orthogonal bends consisting of columns and girders with moment resisting joints. Rigid frame is simple and is convenient due to its rectangular form. Lateral load resistance is provided by bending resistance of columns, girders and joints. Gravity load is resisted by continuity of the frame by reducing the moments in the girders.*
***Keywords:** Tall building, gravity load, lateral load, shear wall, concrete structure, Reinforced concrete.*

I. INTRODUCTION

High-rise building are trending nowadays as there is a rapid growth of the urban population. The factors such as cost of land, preservation of agricultural land and desire to avoid urbanization boosted up the need for high-rise buildings. Gravity and lateral loads govern the structural design of high-rise buildings. Lateral load resistance is offered by interior structural systems like core structure, outriggers, etc. or exterior structural system like rigid frame, wall frame, etc. Structure Systems should be such that it should fulfill all the specified requirements. The aim of our study is to review literature available on the design and analysis of tall building.

Need of Tall Buildings

Rapid growth of urban population

Increased cost of land

Demands of business activities to be as close to each other as possible

Need to preserve important agricultural resources.

Development of prestige building / landmark for corporate organizations in the city.

II. LITERATURE REVIEW

Ali Sherif R. Rizk, (2014), mentioned that concrete can be used for building up to 400m. Although concrete can be lifted up to 600m and it is preferred up to 400m and above 400m, the use of composite concrete steel construction helps in reducing gravity loads on columns and walls of lower floors. Increase in number of floors between 20 to 80 floors & in steel buildings necessitates 370% increase in needed weight of steel. The increase in number of floors for concrete structures has necessitates only 70% increase in needed weight of reinforced concrete. [1]

Zhong F., Kai Y.and Xiaohu M., (2014), mentioned that in structural design of high-rise Building, the main effect of steel reinforced concrete shear wall is to enhance the seismic performance of the structure & reduce the section size of members & increase the lateral stiffness of the structure. Compared with pure steel structure, the steel covered by concrete has the advantage of fire-proof, heat preservation & sound insulation. Arrangement of the shear wall must be in such a way that there can be optimum reduction in size of columns. [7]

O. Esmaili S,(2008), Study of Structural RC Shear Wall System in a 56-Story RC Tall Building in which shear wall system are used with irregular opening under both lateral and gravity loads and may result in some special issue in behavior of the structural element like shear walls, coupling beams etc. A lot of non-linear analyses were performed with the most prevalent retrofitting guidelines like FEMA 356, to check the seismic evaluation of tower. After his study, he concluded that not only main walls are assumed to

carry the seismic load but it will also bear some percentage of gravity loads. Increasing axial load level which decreases R factor, so design base shear will be increased and moment of inertia of the section should be increased. Similarly lesser the axial load, more will be the crossectional area. By considering both sequence loading and time dependency of concrete simultaneously in analysis, the critical demand would be found to occur somewhere in the middle height of the structure (here somewhere is in between 25-30 storey).[6]

Mohit Sharma, (2014), in his study take (G+30) storey regular building for analysis. The building have the plan area of 25m*45m, depth of foundation is 2.4m, storey height is 3.6m each and total height of building is 114m. The static and dynamic analysis of building is done using STAAD PRO. Software as per IS-1893-2002 part1 for zone2 and zone3.Torsion will develop, if the building is unsymmetrical in nature and it will important parameter for analysis. Torsional failures are seen to occur where the symmetry is not planned in the location of the lateral structural elements as for example providing the lift cores at one end of the building or at one corner of the building or unsymmetrically planned buildings in L shape at the street corners. Large torsional shears are caused in the building columns causing there torsional shear failures. [5]

Mayuri D. Bhagwat et.al, (2014), studied dynamic analysis of G+12 multistoried practiced RCC building considering for Koyna and Bhuj earthquake is carried out. The time history analysis, response spectrum analysis and seismic responses of such building are comparatively studied. The modeling is done with help of Etabs Software. Two time histories (i.e. Koyna and Bhuj) have been used to develop different acceptable criteria (base shear, storey displacement, storey drifts). [3]K Rama Raju,(2013), used the limit state method of analysis and design of G+40 RCC high rise building under seismic and wind load as per IS codes. The tall building design involves preliminary design, conceptual design, approximate analysis and optimization to safely carry lateral and gravity load. After his observation, he found that analysis in beam and column using STAAD PRO are much higher than the result reported by INSDAG report because load cases considering for analysis are not mentioned in INSDAG report. While designing some some of beam and column member, the limit of maximum percentage of reinforcement in member exceeded. To satisfy this limit, the crossection of beam and column are to be increased and also suggested to increase the grade of concrete from M35 to M60. [2]Mir M. Ali & Moon K. S., (2007), mentioned that rigid frame systems are not efficient for the bending of columns & girders causes the building to sway excessively. On the other hand, vertical steel shear trusses or concrete shear walls alone may provide resistance for buildings up to about 10 or 35 stories, respectively, depending on the height-to-width ratio of the system. When shear trusses or shear walls are combined with MRFs, a shear truss (or shear wall)-frame interaction system results. The approx. linear shear-type deflected profile of the MRF, when combined with the parabolic cantilever sway mode of the shear truss or shear walls results in a common shape of the structure, when the two systems are forced to deflect in the same way by the rigid floor diaphragm. The upper part of the truss is restrained by the frame, whereas at the lower part, the shear wall or truss restrains the frame. This effect produces increases lateral rigidity of the building. [4]

III. CONCLUSION

A. After reviewing the paper, it has been concluded that:

1) Shear wall for both gravity and bracing system is unacceptable neither conceptually nor economically. Not only main walls are assumed to carry seismic load but also they are going to bear significant percentage of gravity loads [6].

2) Response spectrum method gives 50% mores results than time history analysis and it is recommended that time history analysis should be performed as it predicts the structural response more accurately than the response spectrum analysis [3].

3) Application of steel concrete shear wall, steel plate composite shear wall and steel plate shear wall with vertical stiffener and with opening, greatly improve the seismic performance and efficiency of structure, also effectively increase the usable space [7].

4) Analysis in beam and column using STAAD PRO are much higher than the result reported by INDSAG report because load cases considering for analysis is not mentioned in INDSAG report [2].

5) In high rise building, the use of composite concrete steel construction helps in reducing the gravity load on columns and walls of lower floor [1].

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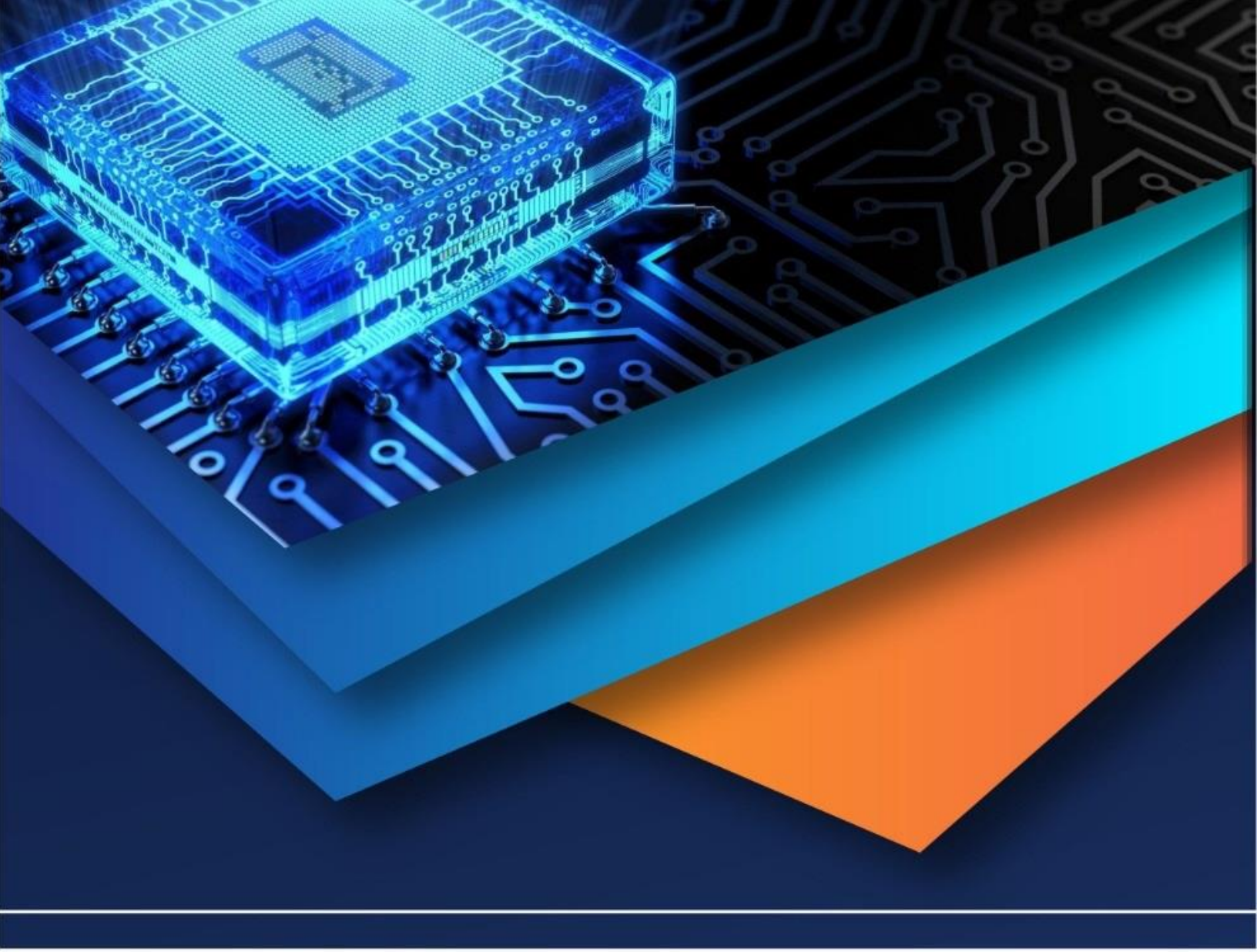

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