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AN EVALUATION OF THE SEISMIC AND WIND PERFORMANCE OF A G+9 REINFORCED CONCRETE STRUCTURE WITH AND WITHOUT SHEAR WALLS UTILIZING STAAD PLUS

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Abstract - Designing high-rise reinforced concrete (RC) structures with adequate lateral stability is essential, especially in areas prone to earthquakes and strong winds. A G+9 RC framed structure was examined in this research with and without shear walls, utilizing STAAD as a tool for comparison.The PRO CONNECT Version. Model A is a standard reinforced concrete moment-resisting frame, while Model B is an improved version of Model A with three shear wall components positioned in the middle to increase lateral stiffness. For Seismic Zone II circumstances, both models were tested under dead load, live load, wind load, and seismic load according to IS 1893 (Part 1):2016. Displacements at nodes, forms deflected, stress distribution on plates, and bending moment behavior of frame elements were used to assess the structural reaction. Through altering the distribution of seismic and wind forces and minimizing horizontal displacements, the comparison study demonstrated that the addition of shear walls substantially increased the building's lateral stiffness. When compared to the bare frame model, the shear wall system lowered the bending moments in the columns by absorbing most of the lateral load. A lack of change in the gravity load response, including vertical displacement and slab stress behavior, suggests that shear walls mainly affected lateral performance and had no negative effect on gravity load behavior. The research shows that medium-rise RC structures with shear walls have better drift control, lower member demands, and better structural performance overall, and that they resist lateral loads efficiently. Buildings vulnerable to seismic and wind forces should use wall-frame dual systems, according to the results.

Important Terms - Shear wall, reinforced concrete building, STAAD.Pro, structural performance, lateral displacement, seismic analysis, wind load, and storey drift.

I. INTRODUCTION

Modern construction practices prioritize structural safety against lateral loads due to the ever-increasing demand for high-rise structures and the fast-paced urban population increase. The strength, longevity, and simplicity of construction of moment-resisting frames made of reinforced concrete (RC) make them a popular choice for medium- and high-rise structures. Taller buildings are subject to more lateral stresses from wind and earthquakes, which means higher displacement, storey drift, and bending loads on structural parts. One of the main goals of structural design in seismic areas is to limit lateral deformation. During powerful earthquakes, excessive storey drift may severely damage both structural and non-structural components, reducing their serviceability and even causing the structure to collapse. In spite of moment-resisting frames' considerable resistance to gravity loads, their lateral stiffness may not be enough for constructions that are much higher. To enhance stiffness and seismic performance, it is usual practice to install extra lateral load-resisting devices, including shear walls. The great in-plane stiffness and strength of reinforced concrete shear walls make them effective as vertical cantilever elements that withstand lateral forces. The walls mainly resist lateral loads when they are combined with moment-resisting frames, creating a dual structural system. The frame adds to both the gravity resistance and the lateral resistance. Redistribution of bending forces from columns to shear walls, improvement of storey drift behavior, and substantial reduction of lateral displacement are all results of this interaction.

This research looks at how shear walls affect the structural response of a G+9 reinforced concrete structure that is loaded with wind and seismic forces. Model A is a standard RC frame devoid of shear walls; Model B is an identical RC frame with three shear wall components integrated into the center bay. Both models are examined analytically. The two models are created and evaluated with the help of STAAD.When calculating the dead and live loads, the PRO CONNECT Edition takes into account the seismic load according to IS 1893 (Part 1):2016 and the wind load according to IS 875 (Part 3). We compare the two models' performance by looking at their responses to bending moments, plate stress distribution, deflected shape, and nodal displacement. Incorporating shear walls improves compliance with seismic design standards, decreases structural demand, and increases lateral

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stiffness; the goal is to measure this improvement and understand its impact.

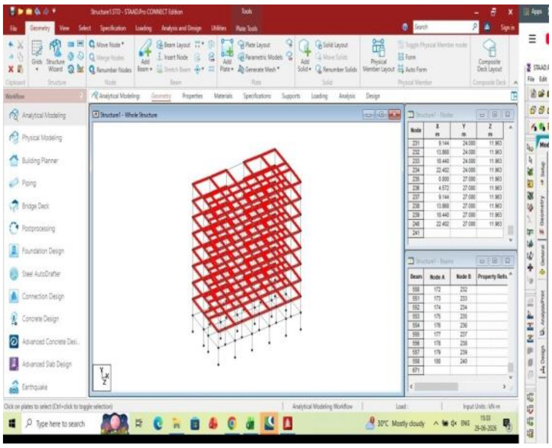

Fig. 1: A STAAD for the G+9 building.Modeling environment for the Pro CONNECT Edition

As a realistic evaluation of shear walls' performance in high-rise RC buildings, the research shows how important they are as a method for efficiently resisting lateral loads in structures that are vulnerable to earthquakes and winds.

II. REVIEW OF LITERATURE

The significance of managing lateral deformation and guaranteeing structural safety has led to substantial research on the behavior of reinforced concrete structures when exposed to wind and seismic stresses. Shear walls have been the subject of much study as a means to enhance the seismic performance of tall buildings. Research shows that shear walls greatly increase lateral stiffness, decrease displacement response, and make structures more stable when subjected to high loads. Structural systems must be strong, rigid, and ductile enough to resist lateral stresses, according to earthquake-resistant design principles. According to Chopra, the distribution of mass, stiffness, and damping properties are the three most important factors determining a structure's dynamic reaction during an earthquake. When it comes to managing seismic reaction, shear walls are a great option since structural systems with increased lateral stiffness often encounter lower deformation demands.

Reinforced concrete structures, especially in areas prone to seismic activity, should include shear walls, as pointed out by Paulay and Priestley. Their findings showed that well-designed shear walls may reduce the load on beams and columns and handle most of the lateral forces caused by earthquakes. In order to ensure steady energy dissipation during significant earthquakes, they also stressed the need of ductile detailing of shear walls.

The effect of shear wall configurations has been investigated numerically in a number of studies using structural analysis software based on finite elements. Due to low lateral stiffness, researchers have found that structures without shear walls often display significant roof displacement and storey drift. Due to the extra load route provided by shear walls in resisting lateral pressures, the displacement response is significantly reduced upon their introduction. Research using STAAD database.The placement, thickness, and arrangement of shear walls have a substantial impact on a building's performance, according to Pro and comparable structural analysis systems. In order to minimize torsional effects and maximize control over lateral displacement, walls should be centrally and symmetrically placed. Shear walls, if not positioned correctly, may cause an eccentricity to form between the mass and rigidity centers, which in turn can increase the torsional response. Limits on inter-storey drift are specified in Indian seismic design regulations established in IS 1893 (Part 1):2016 to minimize excessive damage during earthquakes. While wall-frame dual systems are better able to meet drift criteria, earlier research indicated that higher bare reinforced concrete frames could encounter larger drift values. Therefore, shear walls are a practical way to enhance the seismic performance of medium- and high-rise structures. Adding shear walls alters the distribution of internal stresses inside the structural system, according to research investigations. Columns in traditional moment-resisting frames are designed to withstand substantial lateral bending forces. Less bending moments in columns are a consequence of shear walls attracting a substantial amount of overturning and lateral shear moments in wall-frame systems. Seismic resistance is concentrated in meticulously designed wall components, and this redistribution permits more cost-effective construction of frame sections.

In most cases, shear walls do not significantly alter the behavior of gravity loads. According to earlier research, the presence of shear walls has little effect on the reactions of the dead and live loads, such as the vertical displacement and slab stresses. That shear walls mainly improve lateral stiffness and not gravity load bearing capability is shown by this. Shear walls provide substantial structural benefits for reinforced concrete high-rises, according to the results of earlier studies. On the other hand, design specifications, loading circumstances, building geometry, and wall arrangement all affect how effective it is. This is why this research uses

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STAAD to compare a G+9 RC structure with and without shear walls.To assess their impact on wind and seismic performance, use Pro.

III. STUDY DESIGN

In order to assess how shear walls impact the structural behavior of a reinforced concrete high-rise structure, this research follows a comparative analytical methodology. We use STAAD to create and evaluate two 3D structural models of a G+9 building.The PRO CONNECT Version. Both models depict standard moment-resisting frames made of reinforced concrete; however, one model adds shear walls to the same structural design, making it a dual lateral load-resisting system, whereas the other model does not. To make sure we're comparing apples to apples, we kept both models' geometry, materials, loading, and support conditions the same. Model B differs from Model A just in that it incorporates shear wall components. By using this route, we can pinpoint the effect of shear walls on the shift in structural reaction.

A. Modeling of Structures

This analysis takes into account a ten-story building that is a G+9 reinforced concrete construction. Elements such as slabs, columns, and reinforced concrete beams make up the structural system. We used the STAAD.Pro beam and plate components to create a three-dimensional model of the building's framework. To simulate the slab system's response to gravity loads and in-plane diaphragm action during lateral loading, shell elements are used. As an example of a standard moment-resisting frame system, Model A is comprised only of reinforced concrete beams and columns. Three reinforced concrete shear wall components are located in the middle bay of Model B, the second model. The shear walls are represented by plate components, which capture their stiffness and load-carrying behavior; they run the length of the structure. Supports are supplied at the basic level for both models. The comparison is limited to the influence of the shear wall addition and not to changes in structural constraint since the boundary conditions are same.

B. Design Considerations and Material Characteristics

In accordance with Indian design guidelines, the structural elements are modeled utilizing reinforced concrete characteristics. The standards of IS 456:2000 are followed for assigning concrete and reinforcement characteristics. The structural analysis takes into account the material's elastic behavior to ascertain the building's reaction to various combinations of loads. Optimal lateral stiffness and practical construction feasibility are achieved by carefully selecting the shear wall dimensions and thickness. Three 120 mm thick walls positioned in the middle of the construction design make up the shear wall arrangement that was chosen.

C. Problems with Loading

The study takes into account the primary lateral and gravitational loads that are operating on the structure. In accordance with the requirements of IS 875, both dead load and live load are applied. The self-weight of building components and other permanent loads are considered dead load, but the loads imposed by occupants and activities are known as live load. In accordance with IS 1893 (Part 1):2016, the comparable static technique is used to assess seismic loading. Based on the given characteristics, such as the zone factor, importance factor, response reduction factor, and soil conditions, it is presumed that the building is situated in Seismic Zone II. The building's reaction is tested by applying earthquake loads in both main horizontal directions. In accordance with IS 875 (Part 3):1987, wind loading is applied. To investigate how wind pressure affects the building's reaction, wind forces are taken into account in both the X and Z planes. For this investigation,

we used the following load cases:

- Geomagnetism in the X-direction (EQX)
- Seismic force in the Z-direction (EQZ)
- The X-direction wind load (WX)
- Work zone wind speed (WZ)
- Discharge (DL)
- Live load

D. Analysis Procedure

The phases of modeling, loading, solution, and post-processing make up the whole analysis process. Both models are examined in STAAD.Pro CONNECT Edition once the geometry, material characteristics, and loading conditions have been defined. In the post-processing environment, the analytical results are retrieved. When doing comparisons, the following response factors are taken into account:

- To what extent may nodes be moved by earthquake and wind forces?
- The building's deflected contour behavior.
- Distributed stress on plates in shear walls and slabs.
- Alteration in bending moment in frame components.

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- The impact of shear walls on the distribution of lateral loads.

We compare the retrieved data from Model A and Model B to find out how much better it is with shear walls. This approach systematically compares the structural performance of a wall-frame dual system to that of a plain reinforced concrete frame.

IV. FINDINGS AND ANALYSIS

By comparing the G+9 models of reinforced concrete buildings, we can see that shear walls significantly affect how structures react to seismic and wind loads. The findings from STAAD.We measure the effects of pro post-processing on bending moment response, plate stress distribution, deflected forms, and lateral displacement. Model B's inclusion of shear walls (compared to Model A, which does not have them) elucidates the benefit of adding lateral rigidity.

A. Displacement Behavior at Nodes

Under lateral loading circumstances, the findings of the nodal displacement show that the two structural models vary significantly. Because the moment-resisting frame is responsible for providing all lateral resistance in Model A, larger horizontal displacements occur due to the lack of shear walls. The displacement grows steadily with the height of the structure and reaches its highest point on top. When earthquake and wind forces cause the columns and beams of a flexible frame system to bend significantly, as seen in Model A's displacement profile, the system often behaves as expected. The deformation caused by the cumulative impact of lateral loads is greatest towards the top of the structure, which means that the higher floors undergo bigger motions.

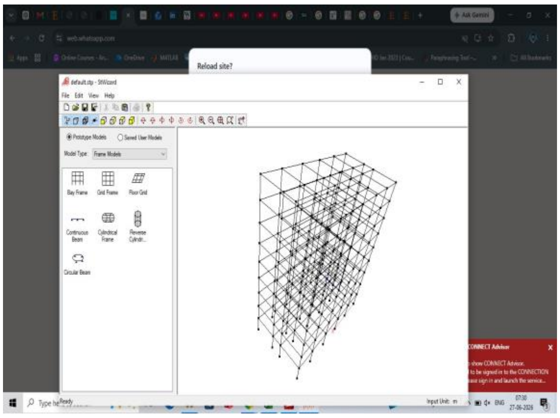

Figure 2 shows a summary of nodal displacements for all load situations in Model A (without shear walls).

When shear walls are included into Model B, the lateral displacement is considerably reduced under earthquake and wind load scenarios. By reducing the deformation demand on beams and columns, the shear walls serve as vertical cantilever elements that are rigid enough to withstand most of the lateral forces. The displacement profile is reduced and made more consistent as compared to the bare frame model.

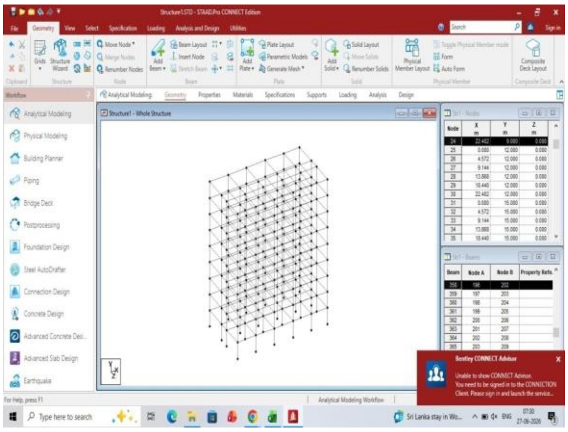

Figure 3 shows a summary of nodal displacements for all load situations in Model B (with shear walls).

A decrease in lateral displacement verifies that the shear walls improve the building's overall stiffness. For tall buildings, where undue lateral movement might compromise structural integrity and operational reliability, this upgrade is crucial.

B. Response to Storey Drif

One of the most crucial metrics for assessing earthquake resistance is inter-story drift. Limits imposed by IS 1893 (Part 1):2016 address the danger of excessive drift, which may harm both structural and non-structural parts. Since the moment-resisting system in the bare frame model is less stiff along the sides, it exhibits greater drift values. Because of the high cumulative storey shear, the lower and middle stories experience the most drift. This kind of behavior suggests that taller structures may need more stiffness than what a standard frame can provide in order to effectively manage seismic forces. The shear wall model performs better in terms of drift. By distributing the lateral load and preventing the frame from moving too much, the walls lessen the deformation of the storeys. The likelihood of meeting the permitted limit of 0.004 times the storey height, as set forth by IS1893, is enhanced by the decrease in drift.

C. Comparison of Deflected Shapes

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Those distorted forms that came out of STAAD.The structural behavior under applied loads may be visually shown by Pro. Both models exhibit comparable vertical deformation patterns when subjected to gravity loading, since the shear walls do not significantly impact the transmission of gravity loads. Nevertheless, significant variations are seen when subjected to seismic and wind loads. Model A's lateral wobble is more pronounced because of its flexible structure, and the roof level experiences the most deformation. Model B's deflected form is noticeably more rigid because to the shear walls' prohibition of lateral movement over the whole building height. Model B's enhanced deflected form verifies that the wall-frame interaction mechanism is functional. Shear walls limit the structure's total flexibility while providing resistance to overturning effects.

D. Distributed Stress on Plates

The results of the study reveal how stresses have developed in the slab and shear wall components via the plate stress contours. The stress patterns in both models are identical under both dead and live loads due to the fact that the transmission of gravity force is almost unaffected by the presence of shear walls. When subjected to seismic and wind loads, disparities stand up more. Model A places a greater strain on its frame elements due to the fact that lateral forces are mostly transmitted via the beam-column system. Model B's shear walls receive lateral forces transferred by the floor slabs, which function as diaphragms.

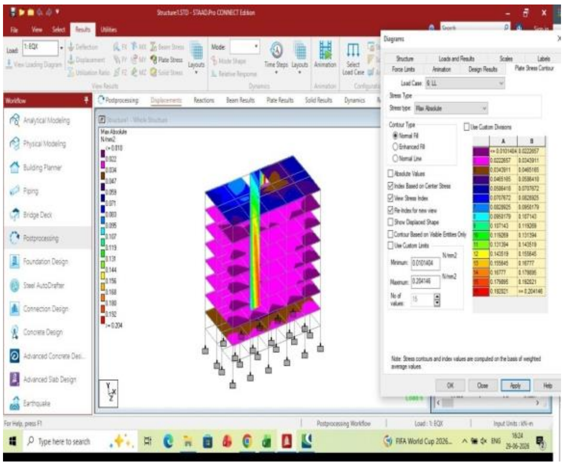
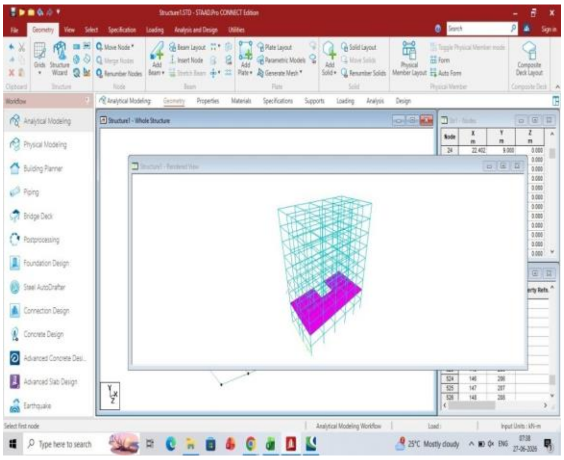


Figure 4: The live load case's maximum absolute plate stress

Elevated in-plane stresses act against the shear wall components, especially in the vicinity of the base, when shear forces and overturning moment are at their peak. The cantilever walls are successfully resisting lateral loads, as seen by this stress distribution, which is typical of such a structure.

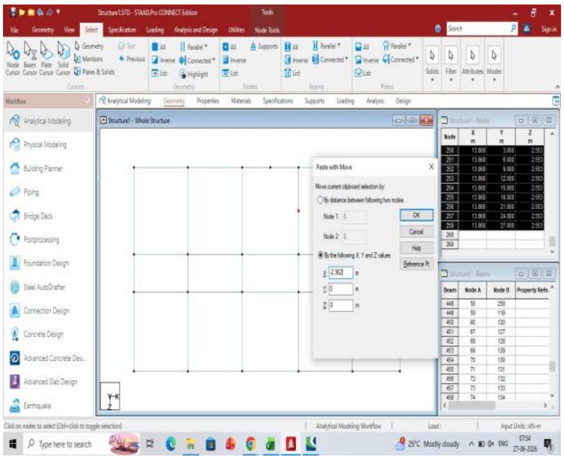
E. The Response to a Bending Moment

After shear walls are included, there is a noticeable redistribution of lateral forces, as seen by comparing the bending moments of the two models. Because the frame is the principal lateral resisting system in Model A, columns are responsible for resisting a significant amount of the bending moments caused by earthquakes and wind.



Model A (no shear walls) bending moment diagram subjected to seismic combination (Fig. 5).

Column bending moments are decreased in Model B because the shear walls absorb a large portion of the lateral strain. Structural efficiency is improved and more inexpensive design of frame members is made possible by reducing the requirement for column moments.



Under seismic combination, Model B (with shear walls) bending moment diagram (Fig. 6)

As the overturning effects from each story add up, the shear wall experiences its greatest bending moment close to its base. Theoretically, a vertical

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cantilever experiencing lateral forces might react in this way.

F. Performance Evaluation as a Whole

When looking at the G+9 building as a whole, it is clear that the structural performance is much improved with the installation of shear walls. Key points to note are:

- Seismic and wind loads considerably decrease lateral displacement.
- Improved storey drift performance brings it closer to the maximum allowed by IS 1893.
- The wall-frame system's improved lateral rigidity is shown by deflected forms.
- The redistribution of lateral pressures results in a reduction in column bending moments.
- The addition of shear walls has little effect on the behavior of gravity loads.
- Seismic and wind-induced lateral loads may be efficiently attracted to and resisted by shear barriers.

The findings show that high-rise reinforced concrete structures may be made safer, stiffer, and more seismically resistant by using shear walls.

V. CONCLUSION

This research looked at how shear walls affected the structural performance of a G+9 reinforced concrete structure that was storm, earthquake, wind, and live load tested. A two-dimensional STAAD was compared with the other.Model B incorporates three parts of reinforced concrete shear walls in the center bay, whereas Model A represents a normal reinforced concrete moment-resisting frame without shear walls. Adding shear walls greatly enhances the building's lateral performance, according to the analytical findings. The following are the main takeaways from the comparison:

The structural models were created and analyzed with the help of STAAD.Pro CONNECT Edition. Verification of the constructed numerical models and applied boundary conditions was confirmed by the error-free completion of the study. Shear walls significantly lessen the building's lateral displacement when subjected to earthquake and wind loads. The shear wall model shows a much stiffer reaction when compared to the bare frame model. This is because the walls give an improved ability to withstand lateral loads. Because of the shear wall, the reaction of the storey drift is much better. By minimizing distortion between stories, shear walls increase the likelihood of meeting the drift limits outlined in IS 1893 (Part 1):2016, which in turn improves seismic performance and damage monitoring. Shear barriers are efficient in regulating lateral movement, as shown by the deflected shape comparison. A more stable and regulated deformation pattern is shown by the wall-frame dual system, in contrast to the bare frame, which suffers increased lateral sway. Once shear walls are introduced, there is a marked shift in the distribution of bending moments in structural parts. The walls mitigate the bending moment demand on columns and enhance the structural system's overall efficiency by absorbing most of the lateral forces caused by earthquakes and wind. The shear walls actively contribute to the lateral load resistance, as seen by the plate stress findings. Under seismic and wind loading, the concentration of shear force and overturning moment causes higher stresses around the wall base. This behavior is in line with what is expected of a wall. After shear walls are added, the building's reaction to gravity loads is essentially unaffected. The same behavior of vertical displacements and slab stress patterns under dead and live loads in both models suggests that shear walls mainly increase lateral resistance rather than gravity load bearing capability. When compared to a traditional moment-resisting frame, the comparative analysis shows that high-rise structures exposed to lateral loads perform better when using a reinforced concrete wall-frame dual system.

The results indicate that Model B's shear wall arrangement is the best option for the G+9 building's structural needs. Medium- and high-rise reinforced concrete buildings benefit greatly from shear walls due to their increased stiffness, less displacement, decreased column moment requirement, and better seismic behavior. To further assess the overall seismic behavior of the building, further research may include response spectra, nonlinear analyses, optimization of shear wall placement and thickness, and comprehensive design of shear wall reinforcement in accordance with IS 13920:2016.

REFERENCES

[1] Bureau of Indian Standards, IS 456:2000 - Plain and Reinforced Concrete - Code of Practice (Fourth Revision), New Delhi, India.

[2] Bureau of Indian Standards, IS 875 (Part 1):1987 - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures: Dead Loads, New Delhi, India.

International Journal of
AI ELECTRICAL CIVIL AND MECHANICAL ENGINEERING
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0434 www.zesterapublications.com Original Research Paper

[3] Bureau of Indian Standards, IS 875 (Part 2):1987 - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures: Imposed Loads, New Delhi, India.

[4] Bureau of Indian Standards, IS 875 (Part 3):1987 - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures: Wind Loads, New Delhi, India.

[5] Bureau of Indian Standards, IS 1893 (Part 1):2016 - Criteria for Earthquake Resistant Design of Structures: General Provisions and Buildings (Sixth Revision), New Delhi, India.

[6] Bureau of Indian Standards, IS 13920:2016 - Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces (Second Revision), New Delhi, India.

[7] Bureau of Indian Standards, SP 16:1980 - Design Aids for Reinforced Concrete to IS 456:1978, New Delhi, India.

[8] Bentley Systems, STAAD.Pro CONNECT Edition - Technical Reference Manual, Bentley Systems Incorporated.

[9] A. K. Chopra, Dynamics of Structures: Theory and Applications to Earthquake Engineering, 4th Edition, Prentice Hall, New Jersey.

[10] T. Paulay and M. J. N. Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons, New York.

[11] R. Park and T. Paulay, Reinforced Concrete Structures, John Wiley & Sons, New York.

[12] S. U. Pillai and D. Menon, Reinforced Concrete Design, 3rd Edition, Tata mcgraw-Hill, New Delhi.

[13] N. Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi.

[14] P. Agarwal and M. Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall of India, New Delhi.

[15] S. K. Duggal, Earthquake Resistant Design of Structures, Oxford University Press, New Delhi.

[16] B. C. Punmia, A. K. Jain and A. K. Jain, Reinforced Concrete Structures (Volumes I & II), Laxmi Publications, New Delhi.

[17] N. Krishna Raju, Advanced Reinforced Concrete Design (IS 456:2000), CBS Publishers, New Delhi.

[18] S. S. Bhavikatti, Structural Analysis (Volumes I & II), Vikas Publishing House, New Delhi.

[19] C. V. R. Murty, Earthquake Tips - Learning Earthquake Design and Construction, National Information Centre of Earthquake Engineering (NICEE), IIT Kanpur.

[20] Federal Emergency Management Agency (FEMA), FEMA 450 - NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, Washington, D.C., USA.

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