Structrual Analaysis of a Single Column Building Using ETABS

Manimegalai S U [1], Dr. S. Sundari[2],
[1]PG Student, Structural Engg, Government college of engineering, Salem
[2] Associate professor, Dept of Civil Engg, Government college of engineering, Salem

Abstract—**This study presents the structural analysis and design of a G+3 office building supported by a single circular reinforced concrete column. The proposed building has a 22 m diameter and an approximate floor area of 378.35 m², with a 3 m diameter central column supporting the floor system through ring beams and slabs. Structural analysis was carried out using ETABS to evaluate the behaviour of the building under the applied loading conditions. The analysis included structural modelling, material and member property assignment, load application, load combinations, diaphragm definition, and model verification. The major structural components, including the slab, ring beam, central column, shear wall, pile foundation, and staircase, were designed using the limit state method in accordance with relevant Indian Standard provisions. The critical forces obtained from ETABS were used for the design and reinforcement detailing of the structural members. The study demonstrates the feasibility of a mono-column structural system for office buildings, offering large column-free spaces, improved architectural flexibility, and efficient utilization of floor area. The findings emphasize that appropriate structural analysis, member design, reinforcement detailing, and foundation design are essential to ensure the strength, stability, and serviceability of single-column buildings.**

Index Terms—**Single-column building; Mono-column structure; ETABS; Structural analysis; Reinforced concrete; Circular building; Structural design; Pile foundation**

I. INTRODUCTION

The single column building is the structure supported on the single column which provides large serviceable area as compared to RCC and steel frame structure. Mono column or single column building supported on single column has more architectural view compares to the structure supported on many columns. Single column building requires less area for providing foundation and gives more space for parking. They are also unique single column structure can be made either by using RCC or steel. Single column structures are complicated one, compared with the other framed structures, single column supports entire structure, all other members will act as the cantilever and single column structure is the individual one. These structures provide more space for offices and parking. This structure provides maximum serviceability. This project describes planning, structural analysis, design and drawings with various components and approximate cost of the whole building. High strength deformed bars are used for the single column for reinforcement. Design of all structural members conforms to IS: 456- 2000. This requires the designer to make realistic estimates of the strengths of the materials composing the structure and the loading to which it may be subject during its design life. The primary aim of all structural design is to ensure that the structure will perform satisfactorily during its design life. Specifically, the designer must check that the structure is capable of carrying the loads safely and that it will not deform excessively due to the applied loads.

II. LITERATURE REVIEW

Dr Aled Alay Vashi, Prof. Hardik Solanki in 2021: "Analysis and Design of Mono Column structure". This study analyzes and designs a mono-column (single column) RCC building using ETABS/STAAD software as per IS codes (IS 456, IS 875, IS 1893:2016). The structure is compared with a conventional multi-column building under static and seismic loads in different seismic zones. Results show that storey displacement and drift increase with

building height and higher seismic zones, but remain within permissible limits. Mono-column systems provide large column-free space, better architectural appearance, and improved land utilization. Bracing systems such as X-type and V-type improve performance and reduce deflection. Although the mono-column structure is comparatively more expensive, it offers better space efficiency and satisfactory structural safety under earthquake conditions.

Basavaraju S N et. Al. in 2020: "Comparative analysis of multistorey single column". Comparative analysis of multistorey single column structures for different plan configuration with same plan area. Wind load and Seismic load play a crucial function in structural analysis. This research work carried out on analysis & design of single column structures, is used in defining loads. Being inspirit from the previous works on effect of seismic and wind load on single column structure, this paper presents effects of six different plan configurations such as Square, Circular, Pentagon, Triangular, Rectangular and Hexagon.

Dr. K. Baskar, P. Anand kumar et. Al in 2023:"Seismic Analysis & Design of Mono Column Structure Using ETABS". This project focuses on the seismic analysis and design of a mono-column reinforced concrete building using ETABS software according to IS codes, mainly IS 1893:2016 for earthquake resistance and IS 456 for concrete design. The building is a multi-storey structure supported on a single central column, where all other structural members act as cantilevers. The structure is analyzed for different seismic zones of India (Zone II to Zone V) using the response spectrum method. Important parameters such as storey displacement, storey drift, base shear, overturning moment, stiffness, bending moment, and shear force are evaluated. Results indicate that displacement and drift increase with building height and higher seismic zones, with Zone V showing maximum seismic effects, while all values remain within permissible limits as per IS 1893. The mono-column system provides large column-free space, better architectural appearance, improved land utilization, and efficient parking space. Proper bracing and structural detailing ensure safety, stability, and earthquake resistance, making the design reliable and suitable for construction.

Golu Dhakadb, Dr. Vivek Sonib in 2024:"To observe the behaviour of single column and Multi-Column building structure". This project analyses and compares single-column and multi-column RCC buildings using STAAD Pro under dead, live, wind, and seismic loads as per IS codes. The mono-column structure consists of a single central load-bearing column supporting the entire G+3 building, ensuring large open space and architectural uniqueness. Seismic analysis is performed for different zones to evaluate displacement, drift, shear force, and overturning moment. Results show that mono-column buildings have higher stiffness and lower displacement 16 compared to multi-column structures. Proper design ensures strength, stability, and safety. Foundation design and load combinations are checked to meet code requirements and structural performance standards.

Palaram Nikhil and Sanaka Vineela in 2018: "Analysis and design of a structure supported on a single column". The design and analysis of RCC high rise structure supported on a single column is done in this project. This paper presents structural modeling, stress, bending moment, shear force and displacement design considerations for a structure and it is analyzed using ETABS V9.7.2. Various steps involved in designing of RCC structure supported on a single column using ETABS V 9.7.2 are Geometric Modeling, providing material properties and sectional Properties, fixing supports and boundary Conditions, providing loads & load combinations, Special Commands, Analysis Specification and Design Command. The influence of plan geometry has an important role in response spectrum analysis. Maximum values of stresses, bending moments, shear forces and displacements are presented. The acting loads considered in the present analysis were self-weight, floor load, wind load and earthquake load under the different zones ZONE IV, ZONE V was compared. In these cases, the floor load was applied perpendicular to the RCC structure. Comparison of RCC single column and RCC multi column is done.

III. OBJECTIVES

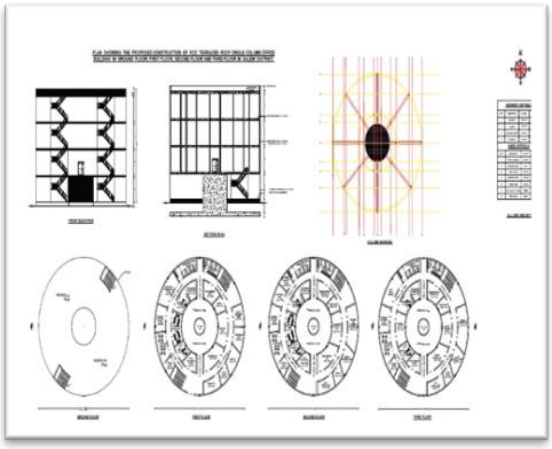
Rise in population have increases the demand of high-rise structures in cities. Multi-story buildings aim to increase the floor area of the building without

increasing the area of the land and saving money. These multi-story building, skyscrapers are built not just for economy of space they are considered icon of city's economic power and the city's identity. To study the performance of lateral displacement at different zones. To study the behavior of wind force on irregular structure under six zones. To study the maximum bending moments and shear force under six zones.

IV. METHODOLOGY

The methodology of the present study involves the structural modelling, analysis, and design of a single-column multistorey RCC building using ETABS software. Initially, the building plan, elevation, and section were prepared, followed by the definition of material and structural member properties. The structural model was developed by assigning appropriate slab, beam, column, wall, and foundation properties. Dead load, live load, wind load, and seismic load were considered based on relevant Indian Standard codes. Appropriate load patterns, load cases, and load combinations were applied to the structural model. The building was then analysed using ETABS to evaluate the structural response in terms of bending moment, shear force, axial force, torsion, story displacement, story drift, story shear, overturning moment, story stiffness, and modal characteristics. Based on the critical forces obtained from the analysis, the major structural members were designed and checked for safety and serviceability requirements.

V. AUTO CAD MODEL



VI. ANALYSIS

The The Analysis process is done by using ETABS software.

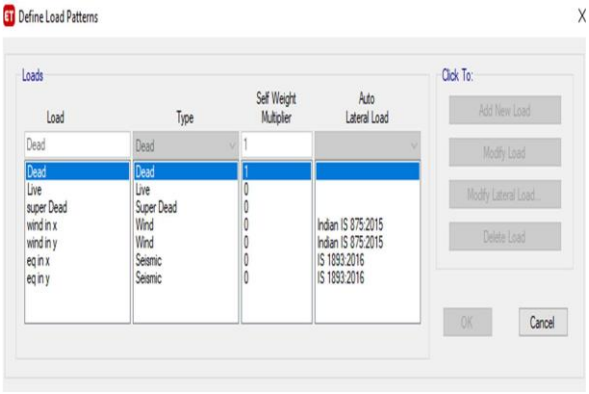


FIG 1: LOAD PATTERN

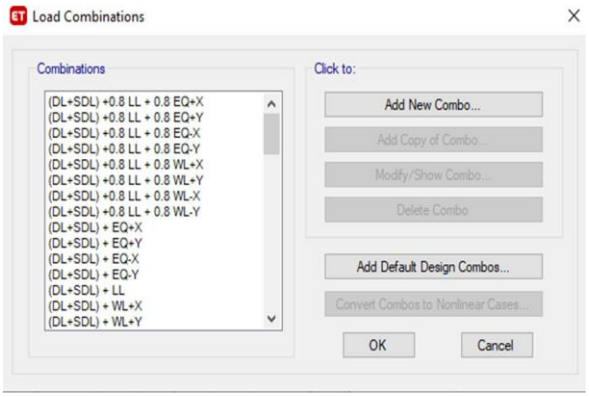


FIG 2: LOAD COMBINATIONS

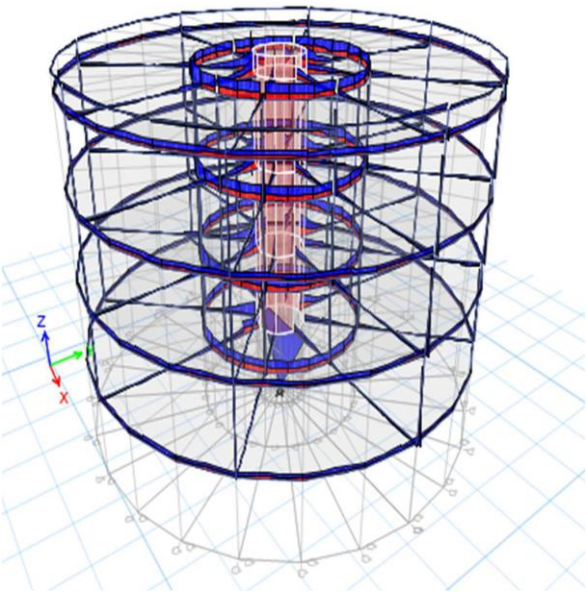


FIG 3: BENDING MOMENT

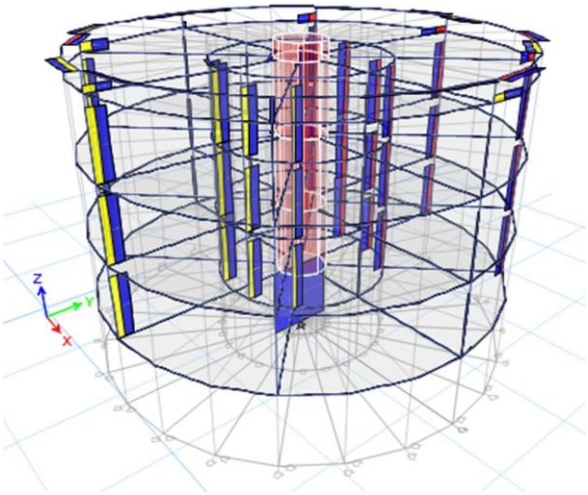


FIG 4: SHEAR FORCE

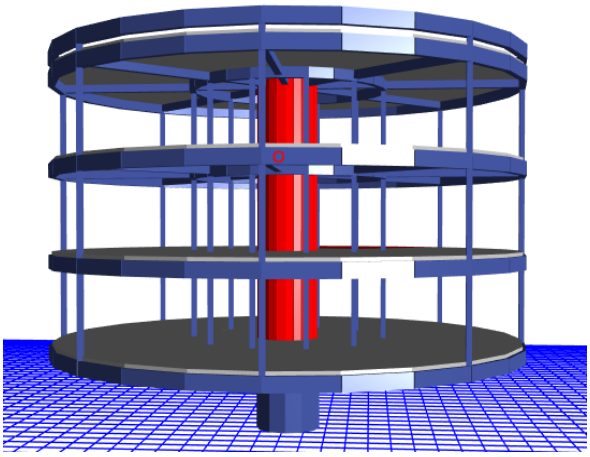


FIG 5: RENDERED DRAWING

VII. RESULTS

The report is from ETABS software.

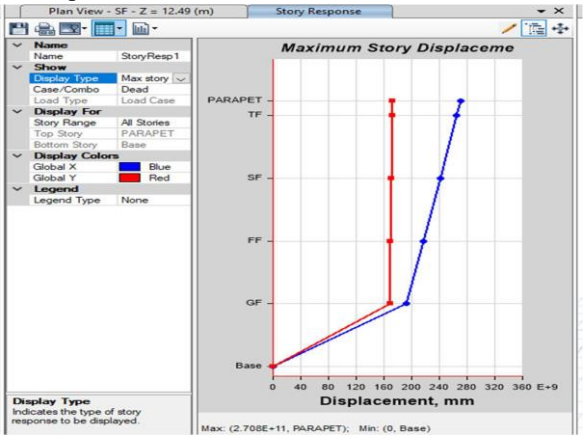


FIG 6: MAX STORY DISPLACEMENT

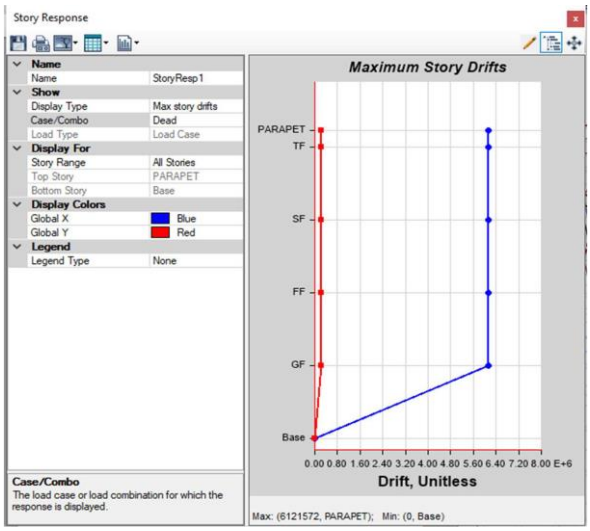


FIG 7: MAX STORY DRIFTS

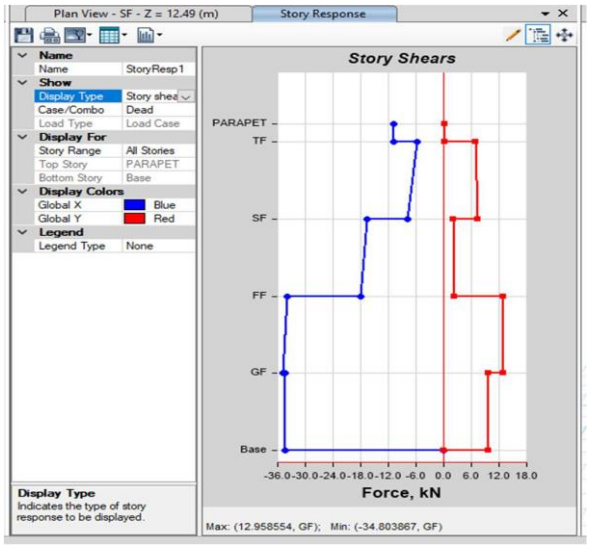


FIG 8: STORY SHEAR

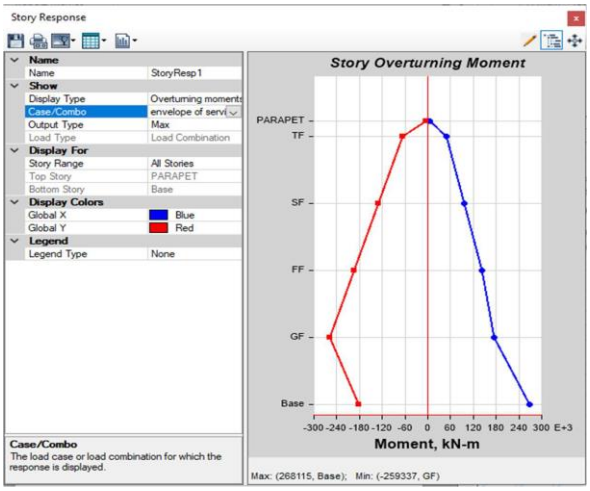


FIG 9: OVERTURNING MOMENT

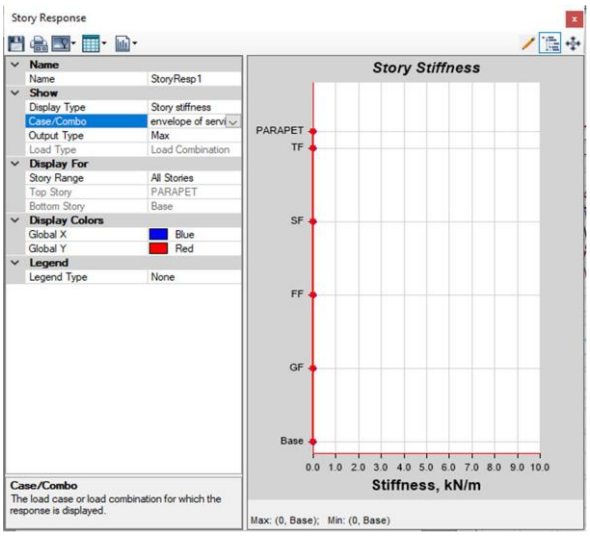


FIG 10: STORY STIFFNESS

MODAL RESULTS:

Modal Periods and Frequencies

Case	Mode	Period sec	Frequency cyc/sec	CircFreq rad/sec	Eigenvalue rad2/sec2
Modal	1	-46266775	0	0	0
Modal	2	18546757.893	0	0	0
Modal	3	-2002350.083	0	-3.138E-06	0
Modal	4	1482439.667	0	4.238E-06	0
Modal	5	-1134381.05	0	-5.539E-06	0
Modal	6	389167.969	0	1.615E-05	0
Modal	7	283181.08	0	2.219E-05	0
Modal	8	-46266775	0	0	0
Modal	9	-46266775	0	0	0
Modal	10	-46266775	0	0	0
Modal	11	-46266775	0	0	0
Modal	12	-46266775	0	0	0

Modal Participating Mass Ratios (Part 1 of 2)

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ	SumRX
Modal	1	-46266775	0	0.0006	0	0	0.0006	0	0.0001	0	0.0006	0.0001
Modal	2	18546757.893	0.0005	0	0	0.0005	0.0006	0	0	0.0002	0.0005	0.0001
Modal	3	-2002350.083	0.0003	0	0	0.0008	0.0006	0	0	0.0005	0.0003	0.0001
Modal	4	1482439.667	0	0.0002	0	0.0008	0.0008	0	0.0005	0	0.0002	0.0006
Modal	5	-1134381.05	0.2574	0.0021	0	0.2582	0.0029	0	0.0005	0.0617	0.6862	0.0012
Modal	6	389167.969	0.0699	0.7426	0	0.3281	0.7456	0	0.1783	0.0168	0.0186	0.1794
Modal	7	283181.08	0.5009	0.0834	0	0.829	0.829	0	0.0199	0.1203	0.2937	0.1994
Modal	8	-46266775	0.0004	0.0025	0	0.8294	0.8314	0	0.0113	0.0017	5.567E-07	0.2106
Modal	9	-46266775	0.0217	0.0092	0	0.8511	0.8406	0	0.042	0.1018	1.127E-06	0.2527
Modal	10	-46266775	0.0176	0.098	0	0.8687	0.9386	0	0.4621	0.0826	1.674E-06	0.7147
Modal	11	-46266775	0.0792	0.0033	0	0.9479	0.9419	0	0.0142	0.3706	1.075E-05	0.7289
Modal	12	-46266775	0.0228	0.0035	0	0.9707	0.9455	0	0.0244	0.1069	0.0002	0.7533

Modal Participating Mass Ratios (Part 2 of 2)

SumRY	SumRZ
0	0.0006
0.0002	0.001
0.0006	0.0013
0.0006	0.0015
0.0623	0.6877
0.0791	0.7063
0.1994	1
0.2011	1
0.303	1
0.3855	1
0.7561	1
0.8631	1.0003

Modal Load Participation Ratios

Case	ItemType	Item	Static %	Dynamic %
Modal	Acceleration	UX	-197.34	97.07
Modal	Acceleration	UY	-10.48	94.55
Modal	Acceleration	UZ	0	0

Modal Direction Factors

Case	Mode	Period sec	UX	UY	UZ	RZ
Modal	1	-46266775	0	1	0	0
Modal	2	18546757.893	1	0	0	0
Modal	3	-2002350.083	1	0	0	0
Modal	4	1482439.667	0	1	0	0
Modal	5	-1134381.05	0.311	0.003	0	0.687
Modal	6	389167.969	0.084	0.897	0	0.019
Modal	7	283181.08	0.605	0.101	0	0.294
Modal	8	-46266775	0.526	0.101	0	0.373
Modal	9	-46266775	0.201	0.09	0	0.709
Modal	10	-46266775	0.155	0.825	0	0.019
Modal	11	-46266775	0.56	0.025	0	0.415
Modal	12	-46266775	0.407	0.084	0	0.509

VIII.CONCLUSION

The present study investigated the structural behaviour of a single-column multistorey RCC building using ETABS under gravity, wind, and seismic loading conditions. The analysis results indicate that the proposed structural system can be effectively evaluated using ETABS by considering critical parameters such as bending moment, shear force, story displacement, story drift, story shear, overturning moment, story stiffness, and modal characteristics. The results demonstrate the importance of lateral load resistance and stability in the design of single-column structures. The obtained analytical responses provide useful information for assessing the structural safety and serviceability of the building. Overall, the study highlights the potential of ETABS-based structural

analysis for optimizing the design and improving the performance of innovative multistorey building systems.

We conclude our project with full satisfaction that we are designed the office building resting on single column by using of the AUTO CAD. The limit state method of design is adopted. We had done the design aspects of the structure manually and software. The analysis is done by ETABS software. In our project we also used the code provision of the SP 16 and SP 34 (the design aids for concrete and detailing). Finally, we learn detailing of various structural members by using SP 34 design aids. The knowledge gained from this project will help us to take up similar projects with courage and confidence in future course of actions.

REFERENCES

[1] Analysis and design of mono column structure by Alay Vashi, Prof. HardikSolanki, International Journal of Engineering Science Invention (IJESI). Volume:10, Issue12, Series I, December2021.

[2] Comparative analysis of multistorey single column by Basavaraju S N et. Al, First International Conference on Advances in Physical Sciences and Material (IOP Punlishing). Volume:1706, Issue01, 2020.

[3] Seismic analysis & design of mono column structure using ETABS by Dr. K. Baskar, P.Anand Kumar et. Al, International Journal For Advanced Research in Science & Technology (IJARST). Volume:13, Issue06, June2023.

[4] To observe the behaviour of single- column and Multi-column building structure by Golu Dhakadb, Dr. Vivek Sonib, International Journal of Research Publication and Reviews (IJRPR). Volume:05, Issue11, November2024.

[5] Analysis and design of a structure supported on a single column by Palaram Nikhil and sanaka Vineela, International Journal of Management Technology and Engineering (IRMTE). Volume:8, Issue X, October2018.

[6] Comparative analysis on behaviour of single column structure with waffle slab and flat slab by Raj Joshi, Gagan Patidar et. Al, International Journal of Creative Research Thoughts (IJCRT). Volume:8, Issue03, March2020.

[7] Design and analysis of single column multistorey building by Shubham Kumar Binjhwar, International Research Journal of Modernization in Engineering Technology and Science (IRJMETS). Volumn:5, Issue:04, April2023.

[8] Analysis and design of mono column building by Thejus Sreehari and Shilpa Valsakumar, International Journal of Engineering & Technology (IJERT). Volume:10, Issue06. 2022.

[9] IS 456 -2000. Bureau of Indian Standards. Plain and reinforced concrete – Code of Practice, New Delhi, India.

[10] IS 800:2007 General Construction Steel by Bureau of Indian Standards.

[11] 11 Handbook on code of practice for Design Dead Loads (Other than Earthquake) for Buildings and Structures (IS:875(Part 1) -1987, Bureau of Indian Standards. New Delhi.

[12] Handbook on code of practice for Design Live Loads (Other than Earthquake) for Buildings and Structures (IS:875(Part 2) -1987, Bureau of Indian Standards. New Delhi.

[13] Handbook on code of practice for Design Wind Loads (Other than Earthquake) for Buildings and Structures (IS:875(Part 3) -1987, Bureau of Indian Standards. New Delhi.

[14] Handbook on Criteria for Earthquake Resistant Design of Structures (IS 1893(Part 1)-2016.