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Comparative Study Of Steel Structure And RCC Structure Of Flat Slab System Based On Column Span

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Abstract: These days, time is more valuable than money, and a lot of the construction approaches we use also have long construction timelines. The rapid way of erection of steel structural structures has made them a revolution in the modern era of construction. It is best to base your building type decision on the right conditions and functional needs in order to have a wise and efficient structure design. The study titled "Comparative study on design of Steel Structures and RCC frame Structures of flat slab system based on columns span" can assist us in selecting the construction method that best fits the given circumstances and architecture. The main goal of this study is focused on the crucial element, or column span, which can be just as important in determining a building's cost as its height when it comes to structural analysis and design. The design and analysis of steel structures with long and short column spans, as well as RCC structures with flat slab systems, are compared in this article. In this project, ETABS-2021 software is used for the design and analysis of the G + 10 RCC Structure of the flat slab system and the Steel Structure.

Index Terms **- Steel structure, RC structure of flat slab system, Comparison, ETABS.**

I. INTRODUCTION

Thanks to technical advancements brought about by new goods and services, people's quality of life has significantly increased. Therefore, the goal of any construction is to have as much usable area as possible, which meets the needs for a multipurpose structure that houses hotels, retail centers, and offices, among other things. Architects typically give a building plan with a high column span followed by a short column span in order to meet these functional needs. taking into account the seismic loads the building is subject to in order to withstand these pressures. As a result, it is crucial to select the kind of building that best fits the needs and is considerate of the location. As a result, it's important to carefully consider the kind of structure that best fits the needs and is appropriate for the location.

This project's goal is to compare the analysis of steel frame structures and RCC structure of flat slab system with lengthy column and beam spans and short column and beam spans. In this comparison, the building's height and dimensions were maintained while the columns were arranged in a grid pattern. The building's whole load applications, such as dead, imposed, and seismic loads, were studied in terms of analysis. ETABS-2021 software was used for both linear static and response spectrum analysis (dynamic analysis), which is a type of analysis.

1.1 Flat slab

Flat slabs system of construction is one in which the beams used in the conventional methods of constructions are done away with. The slab directly rests on the column and load from the slab is directly transferred to the columns and then to the foundation. To support heavy load's the thickness of slab near the support with the column is increased and these are called drops, or columns are generally provided with enlarged heads called column heads or capitals. Absence of beam gives a plain ceiling, thus giving better architectural appearance and also less vulnerability in case of fire than in usual cases where beams are used.

1.2 Steel structure

Structural steel is used to construct residential and commercial buildings, warehouses, aircraft hangers, hospitals and school buildings, metro stations, stadiums, bridges, etc Construction of these structures is done with the help of structural steel design components such as channels, beams, angles and plates

Now-a-days large span, super-high, over-weight, vibration, airtight, high-rise, and light- weight engineering structures are generally steel structures. One of these segments is industrial buildings where steel structures are widely witnessed. The reason being their added advantages over the concrete structures. Steel structures can take heavy loads despite of being light eight. Also, steel structures can be fabricated easily, hence consumes less time in construction and also has higher scrap value.

2. METHODOLOGY AND MODELLING.

Model Layouts for Steel and RCC Flat slab Structure in ETABS software are as shown in the below figures. The above shown structures are modeled for G + 10 storey height keeping the same plan dimension for both RCC and Steel Structures for short span and long span layouts. In both the models the columns were given fixed support at the bottom, which would depict the original foundation of the building. For Seismic analysis is done for building located in Zone III.

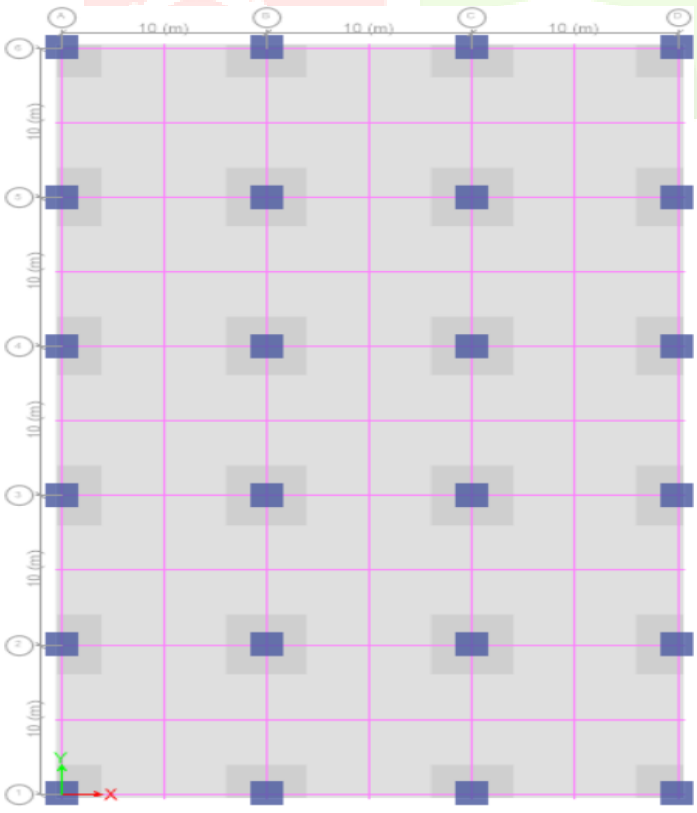

Fig.-1: 10m Spacing of Columns for RCC Flat slab structure

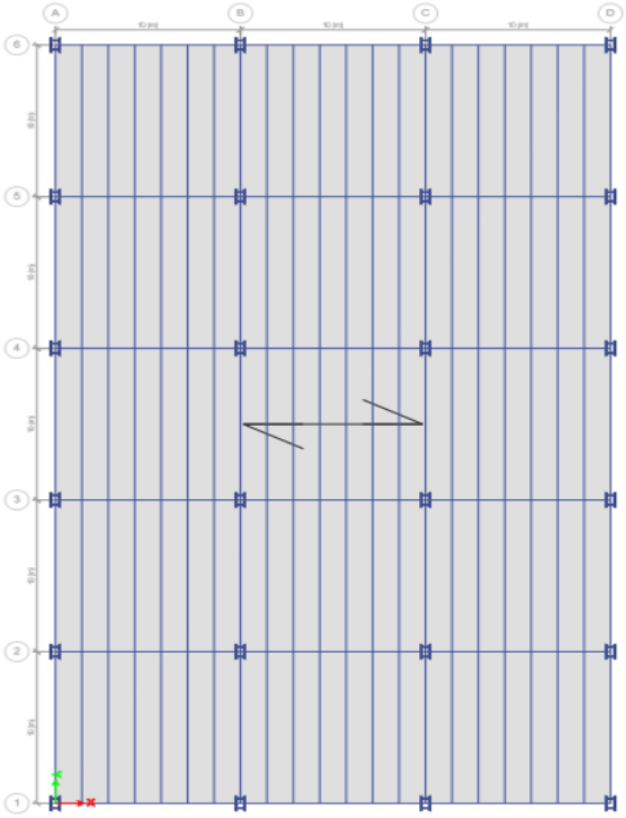

Fig-2: 10m Spacing of Columns for Steel Structure

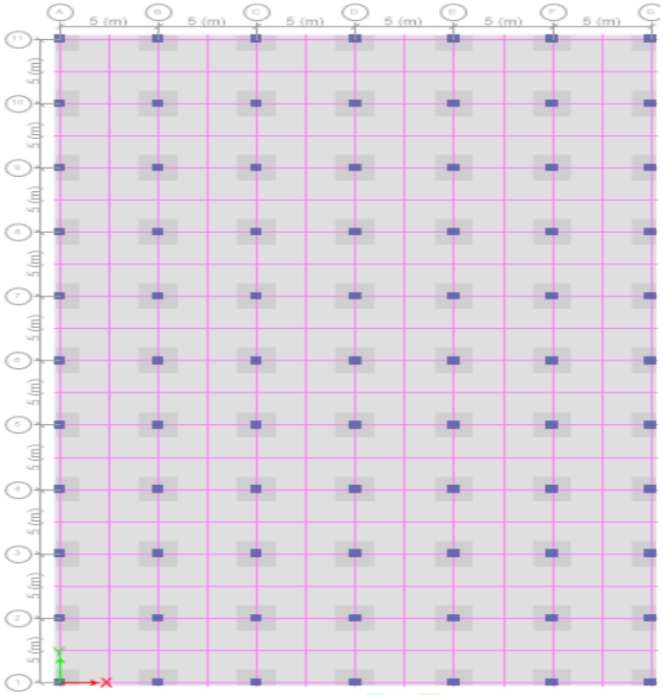

Fig.-3: 5m Spacing of Columns for RCC Flat slab

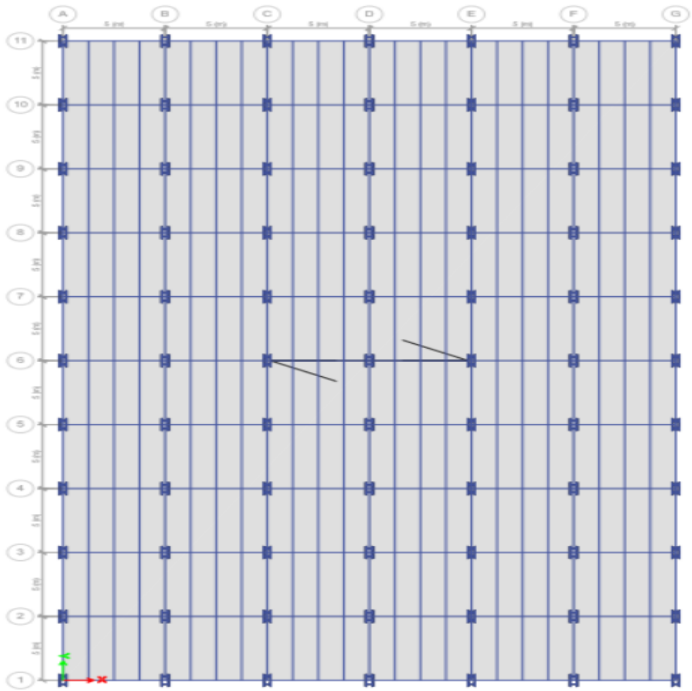

Fig.-4: 5m Spacing of Column for Steel Structure

Fig.1,2,3,4 represents the models which are considered for the analysis and the results of the following models is shown below.

TABLE: 1
SPECIFICATIONS OF THE 5m & 10m COLUMN SPACING RC FLAT SLAB STRUCTURE

Height of the Building	36.3m
Each storey height	3.30m
Plinth Height	2.10m
Grade of concrete	M30
Grade of steel	Fe415
Seismic Zone	Zone -III
Live load	$4kN/m^2$
Floor finish load	$1.5kN/m^2$
Soil condition	Medium stiff
Damping Ratio	5%

TABLE:2
SPECIFICATIONS OF THE 5m & 10m COLUMN SPACING STEEL STRUCTURE

Height of the Building	36.3m
Each storey height	3.30m
Plinth Height	2.10m
Grade of concrete	M30
Grade of steel	Fe345
Seismic Zone	Zone -III
Live load	$4kN/m^2$
Floor finish load	$1.5kN/m^2$
Soil condition	Medium stiff
Damping Ratio	5%

Table -3: Specifications provided for RC structure of flat slab structure of 5m column spacing

Size of the columns	900mm x 900mm
Depth of the slab	180mm
Depth of drop panel	100mm
Total Depth	280mm
Size of column strip and middle strip	3m x 3m

Table -4: Specifications provided for RC structure of flat slab structure of 10m column spacing

Size of the columns	1800mm x 1800mm
Depth of the slab	340mm
Depth of drop panel	100mm
Total Depth	440mm
Size of column strip and middle strip	5m x 5m

Table -5: Specifications provided for Steel structure of 5m column spacing

Size of the columns	2ISHB300 – 25mm THICK PLATE (Built-up column)
Size of Beams	ISMB500
Secondary Beams	ISLB200

Table -6: Specifications provided for Steel structure of 10m column spacing

Size of the columns	2ISHB450 – 20mm THICK PLATE (Built-up column)
Size of Beams	Top flange width = Bottom flange width = 500mm
	Flange thickness = 25mm
	Web thickness = 18mm
Secondary Beams	ISLB200

Table 1,2 represents the building description which is adopted and Table 3,4,5,6 represents the specifications which are provided for the considered models.

3. RESULTS AND DISCUSSIONS

The study of results has been described below of the above specified specifications of the structure

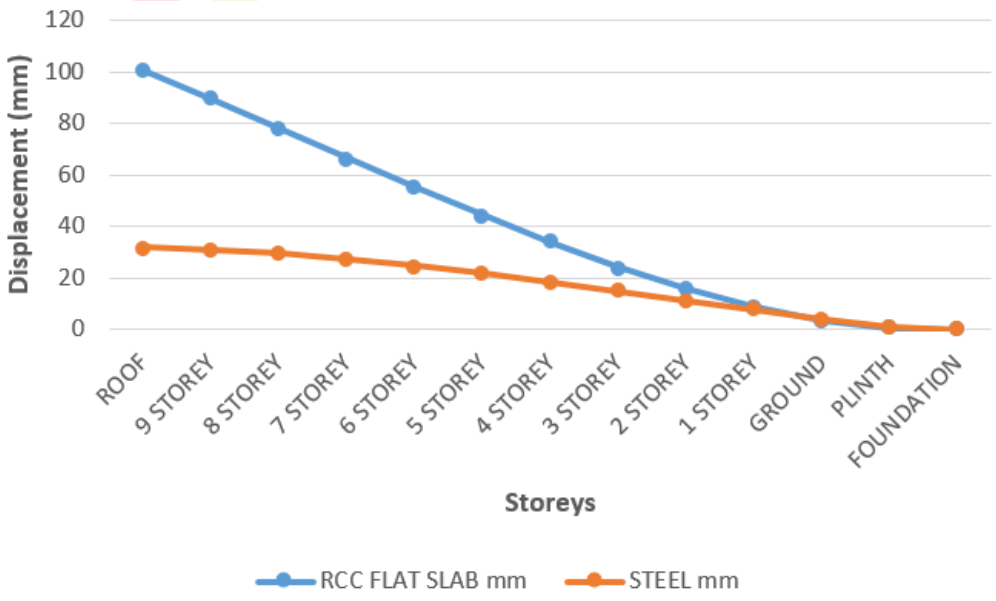

Fig.-5. Comparison of displacements for 10m column spacing RCC flat slab and steel structures

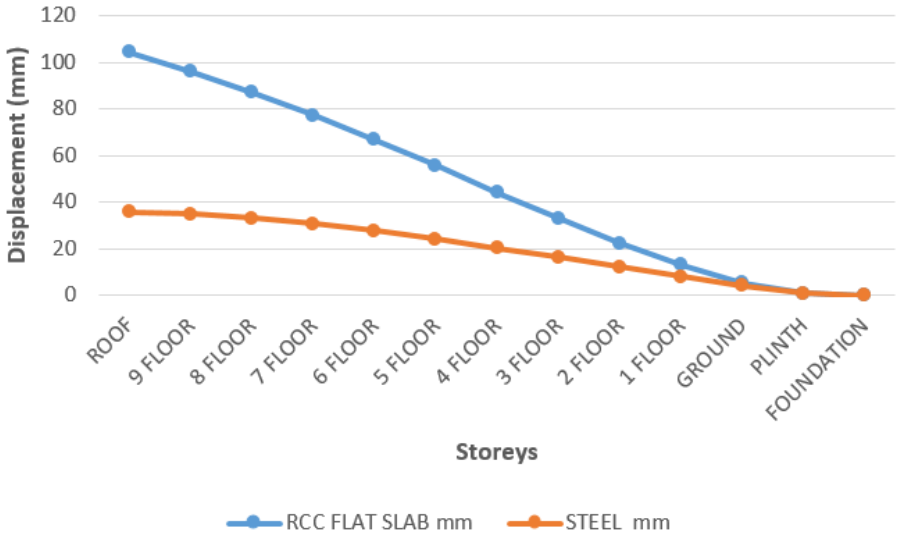

Fig.6. Comparison of displacements for 5m column spacing RCC flat slab and steel structures

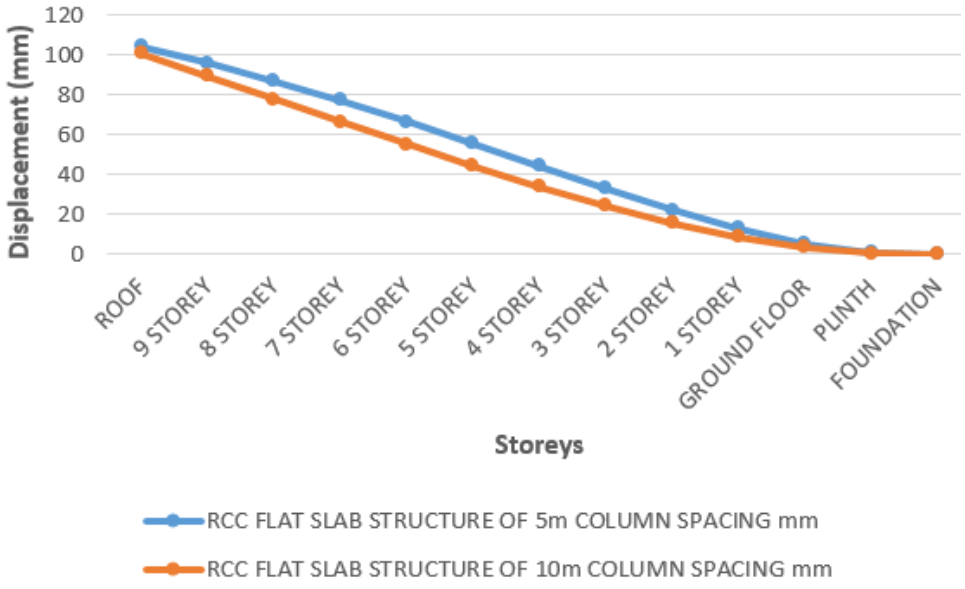

Fig.7. Comparison of displacements for 5m and 10m column spacing RCC flat slab structures.

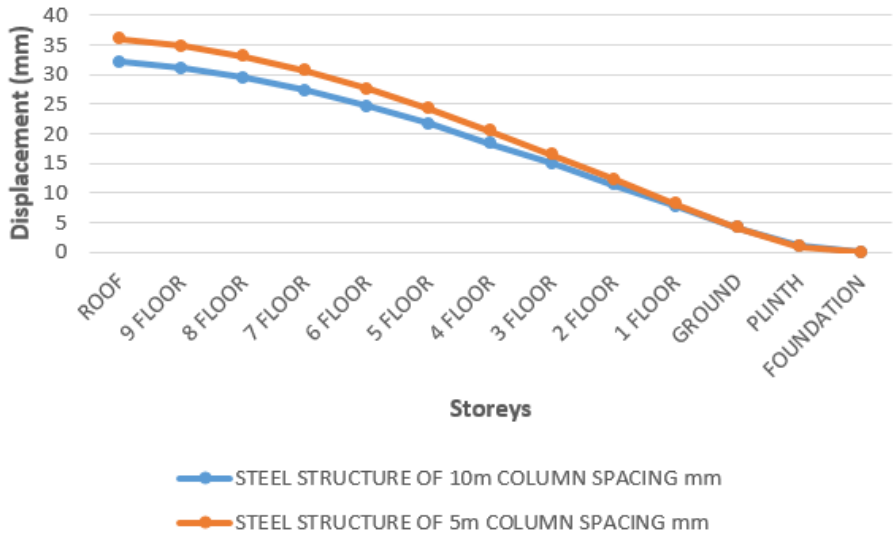

Fig.8. Comparison of displacements for 5m and 10m column spacing Steel structures.

In Fig.5, which represents the Comparison of displacements for 10m column spacing RCC flat slab and steel structures We can clearly see that there is increase of lateral displacement for RC structure of flat slab system compared to the steel structure for 10m spacing of columns. Compare to Steel structure, RC structure has more displacement. That displacement for the steel structure is reduced by 69%.

In Fig.6. which represents the Comparison of displacements for 5m column spacing RCC flat slab and steel structures We can see that there is increase of lateral displacement for RC structure of flat slab system compared to the steel structure for 5m spacing of columns. Compare to Steel structure, RC structure has more displacement. That displacement for the steel structure is reduced by 66%.

In Fig.7. which represents the Comparison of displacements for 5m and 10m column spacing RCC flat slab structures We can see that there is increase of lateral displacement for RC structure of flat slab system of 5m column spacing has more displacement compared to the flat slab structure of 10m spacing of columns. There is an increase of 3.2% of displacement for the 5m spacing of columns of flat slab structure compared to the flat slab of 10m spacing of columns structure.

In Fig.8**.** which represents the Comparison of displacements for 5m and 10m column spacing Steel structures We can clearly see that there is increase of lateral displacement for steel structure of 5m column spacing has more displacement compared to the steel structure of 10m spacing of columns. There is an increase of 11% of displacement for the 5m spacing of columns of steel structure compared to the steel structure of 10m spacing of columns structure.

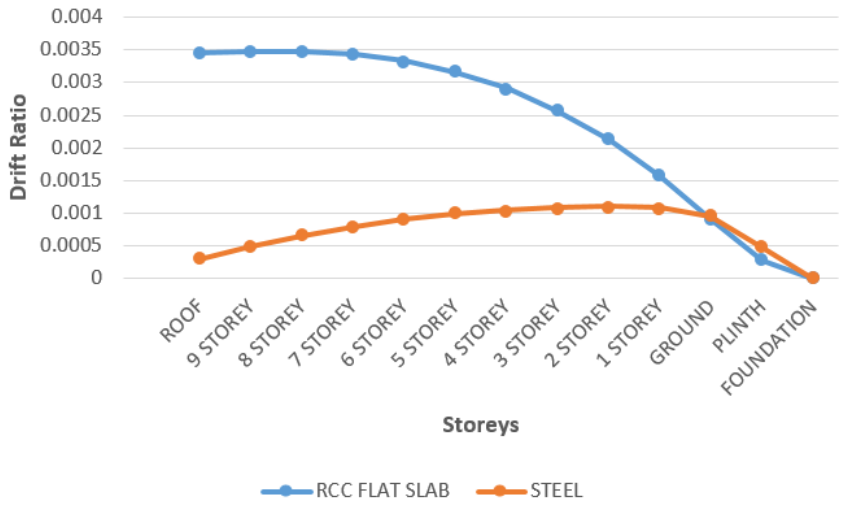

Fig.9. Comparison of drifts for 10m column spacing RCC flat slab and Steel structures

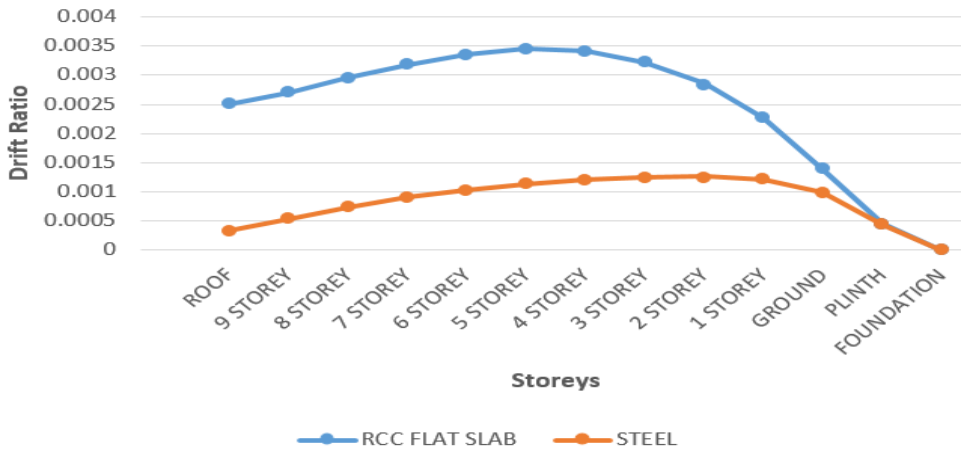

Fig.10. Comparison of drifts for 5m column spacing RCC flat slab and Steel structures

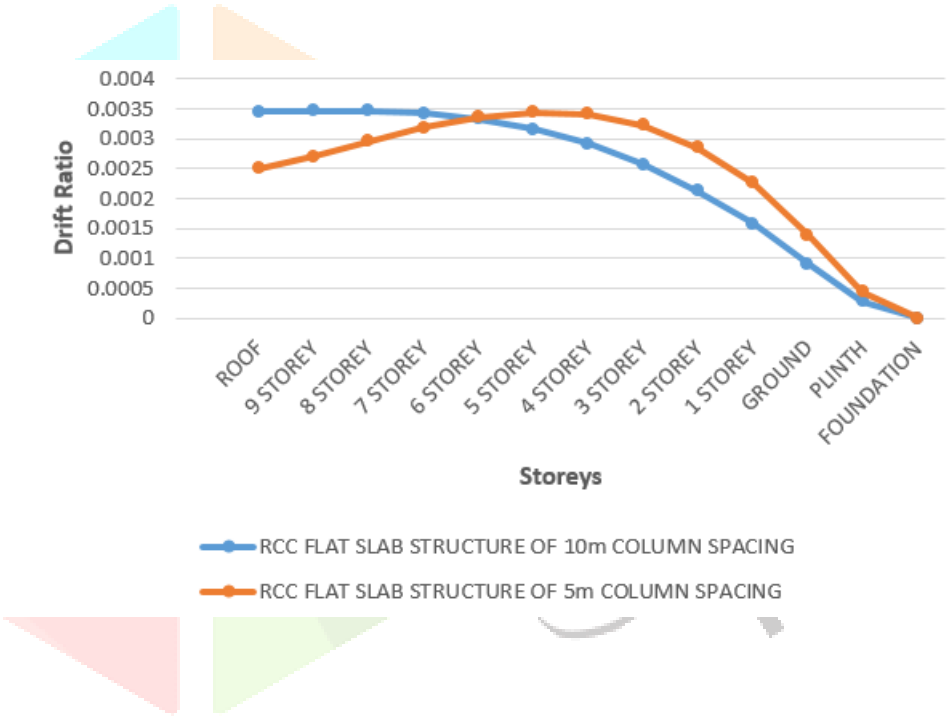

Fig.11. Comparison of drifts for 5m and 10m column spacing RCC flat slab structures

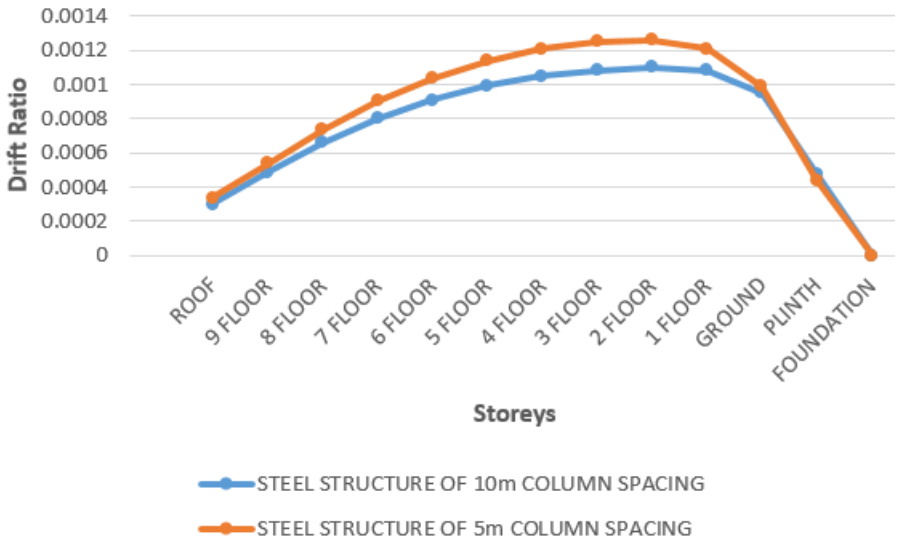

Fig.12. Comparison of drifts for 5m and 10m column spacing steel structures

In Fig.9. which represents the Comparison of drifts for 10m column spacing RCC flat slab and Steel structures We can observe that there is increase of drift for RC structure of flat slab system compared to the steel structure. Compare to Steel structure, RC structure has more drift. The maximum storey drift is observed at the 9th storey for the flat slab structure and for the steel structure at the 2nd storey and compared to both the structures steel structure has less drift. That drift for the steel structure is reduced by 68%. Comparatively steel structure has less drift compared to flat slab system of 10m column spacing structure.

In Fig.10. which represents the Comparison of drifts for 5m column spacing RCC flat slab and Steel structures We can observe that there is increase of drift for RC structure of flat slab system compared to the steel structure. Compare to Steel structure, RC structure has more drift. The maximum storey drift is observed at the 5th storey for the flat slab structure and for the steel structure at the 2nd storey and compared to both the structures steel structure has less drift. That drift for the steel structure is reduced by 63%. Comparatively steel structure has less drift compared to flat slab system of 10m column spacing structure.

In Fig.11. which represents Comparison of drifts for 5m and 10m column spacing RCC flat slab structures We can observe that there is increase of drift for RC structure of flat slab system of 10m columns. Compared to RC structure of flat slab system of 10m column spacing structure has more drift compared to 5m column spacing flat slab structure. We observe that maximum drift occurs at the 9th floor in 10m spacing of column flat slab structure and for 5m column spacing flat slab structure occurred at 5th floor. There is an increase in drift of 0.7% for 5m column spacing flat slab structure compared to 10m column spacing flat slab structure.

In Fig.12. which represents Comparison of drifts for 5m and 10m column spacing steel structures We can observe that there is increase of drift for 5m spacing of columns steel structure has more drift compared to the 10m column spacing steel structure.There is an increase of 12.83% compared to steel structure of 10m column spacing steel structure. Comparatively steel structure of 5m column spacing has more drift.

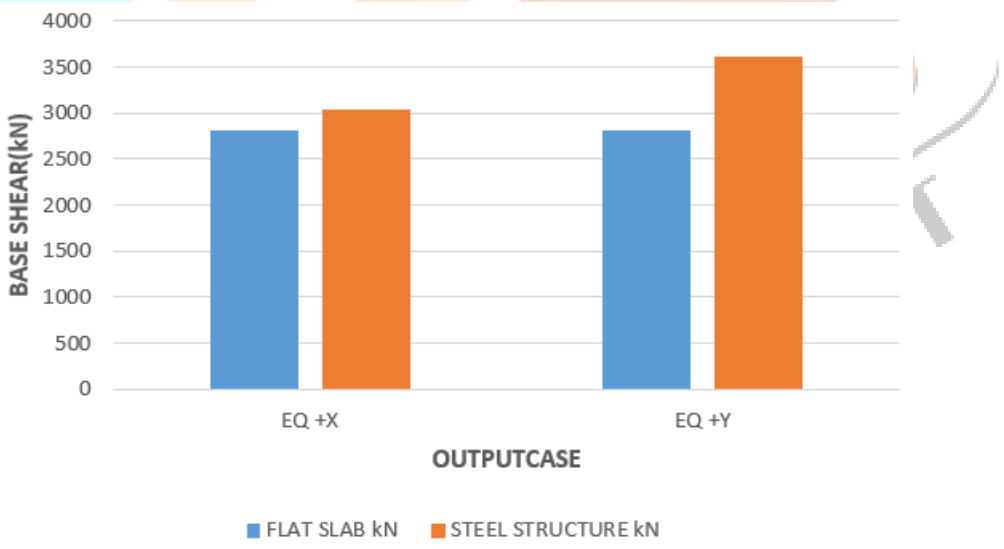

Fig.13. Comparison of Base shears for 10m column spacing RCC flat slab structure and Steel structures

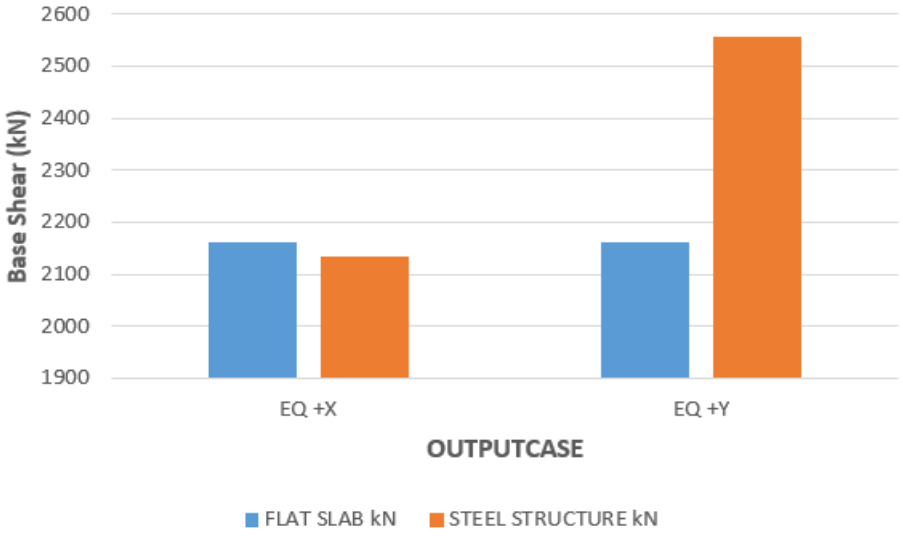

Fig.14. Comparison of Base shears for 5m column spacing RCC Flat slab structure and steel structures.

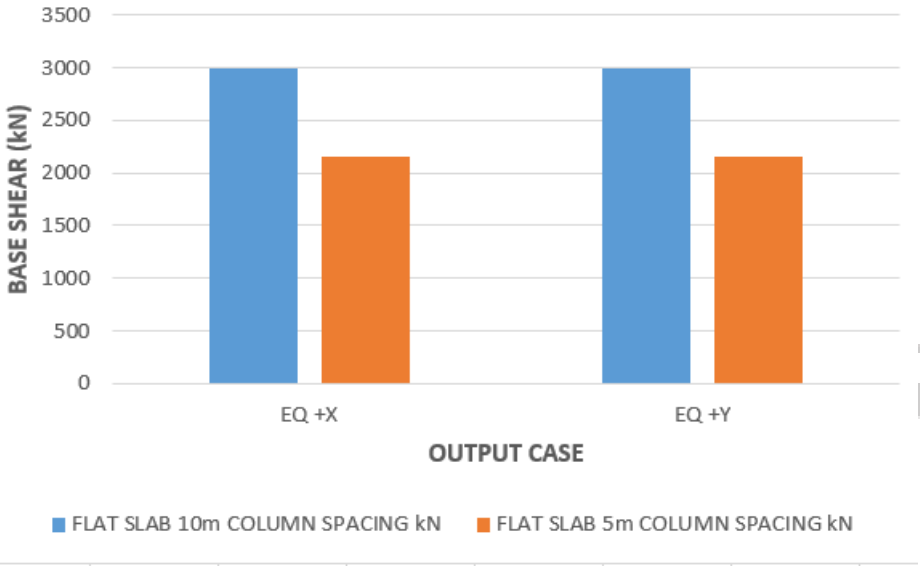

Fig.15. Comparison of Base shears for 5m and 10m column spacing RCC Flat slab structures.

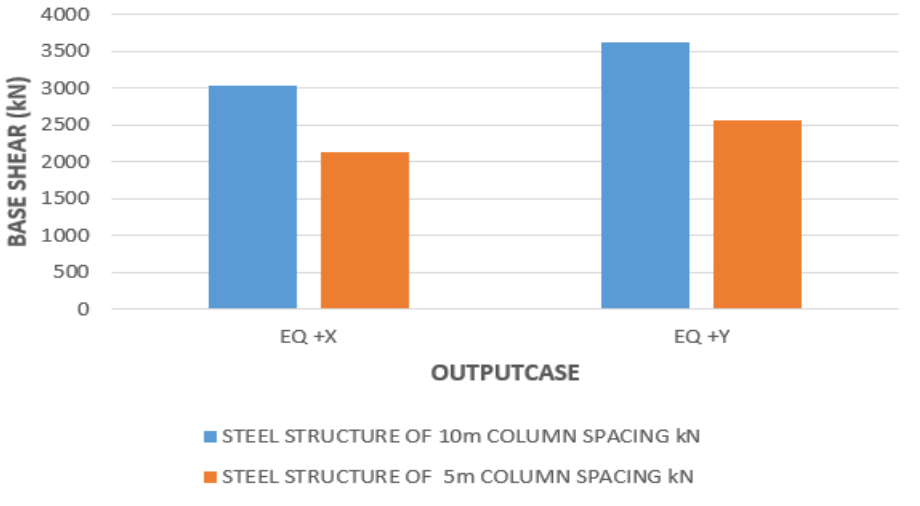

Fig.16. Comparison of Base shears for 5m and 10m column spacing steel structures.

In Fig.13. which represents Comparison of Base shears for 10m column spacing RCC flat slab structure and Steel structures Compared to Steel structure, RC structure has more base shear in X –direction and in Y-direction steel structure has more base shears. The maximum base shear is observed for the flat slab structure in X- direction and for the steel structure in the Y- direction and compared to both the structures steel structure has more base shear. That base shear for the steel structure is reduced by 1% in X- direction and 17% more in Y- direction compared to RCC Flat slab structure. Comparatively steel structure has less base shear in X-direction and has more in Y-direction compared to flat slab system of 10m column spacing structure.

In Fig.14. which represents Comparison of Base shears for 5m column spacing RCC Flat slab structure and steel structures Compared to Steel structure, RC structure has more base shear in X –direction and in Y-direction steel structure has more base shears. That base shear for the steel structure is reduced by 1% in X-direction and 15% more in Y- direction compared to RCC Flat slab structure. Comparatively steel structure has less base shear in X-direction and has more in Y-direction compared to flat slab system of 5m column spacing structure.

In Fig.15. which represents Comparison of Base shears for 5m and 10m column spacing RCC Flat slab structures Compare to flat slab structure of 5m column spacing, RC structure of flat slab system of 10m column spacing has more base shear in X –direction and in Y- direction. The maximum base shear is observed for the flat slab structure of 10m column spacing in X- direction and Y- direction and compared to both the structures flat slab structure of 10m column spacing structure has more base shear. That base shear for the flat slab structure of 5m column spacing is reduced by 28% in X- direction and Y- direction compared to RCC Flat slab structure of 10m column spacing.

In Fig.16. which represents Comparison of Base shears for 5m and 10m column spacing steel structures Compared to steel structure of 5m column spacing, steel structure of 10m column spacing has more base shear in X –direction and in Y- direction. That base shear for the steel structure of 10m column spacing is increased by 29.8% in X- direction and 29.39% Y- direction compared to steel structure of 5m column spacing.

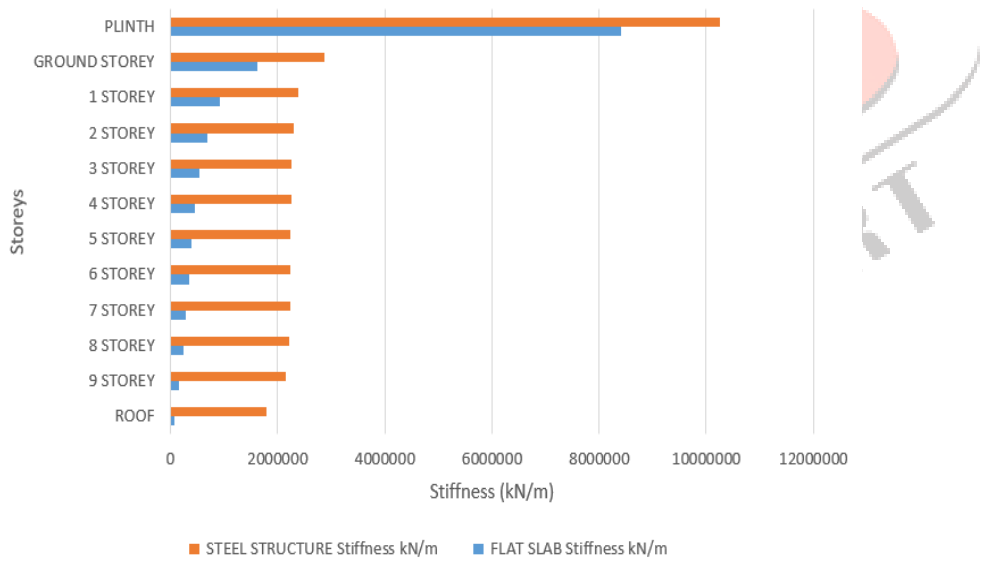

Fig.17. Comparison of Storey stiffness for 10m column spacing structures.

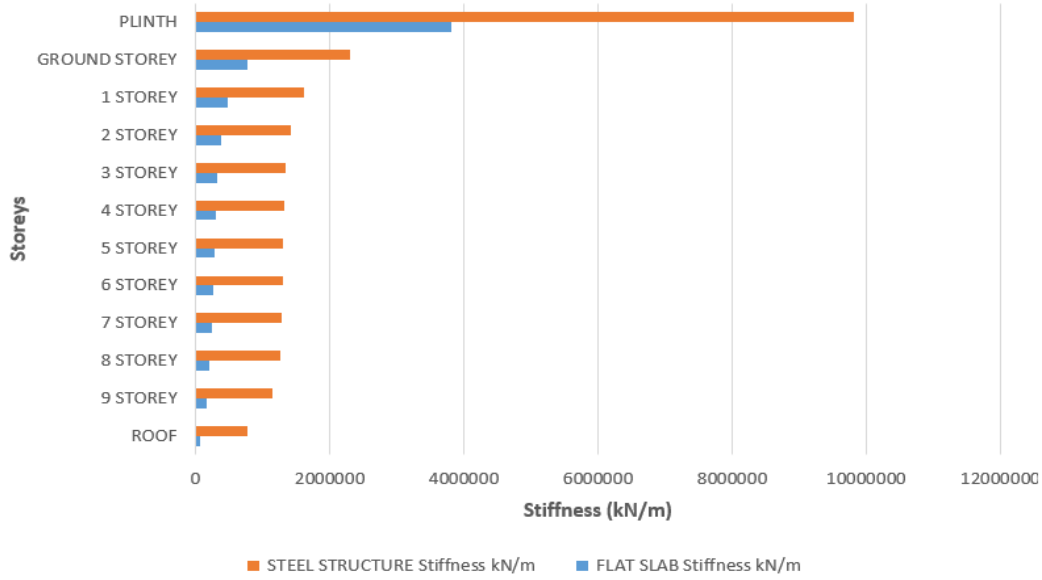

Fig.18. Comparison of Storey stiffness for 5m column spacing structures.

In Fig.17. which represents Comparison of Storey stiffness for 10m column spacing structures Compared to RC structure of flat slab system, steel structure has more storey stiffness. That storey stiffness for the steel structure is more by 61% compared to RCC Flat slab structure. Comparatively steel structure has more storey stiffness compared to flat slab system of 10m column spacing structure.
In Fig.18. which represents Comparison of Storey stiffness for 5m column spacing structures Compared to RC structure of flat slab system, steel structure has more storey stiffness. That storey stiffness for the steel structure is more by 18% compared to RCC Flat slab structure.

4. CONCLUSIONS.

1) The storey displacements are more for the RCC structure of flat slab system compared to steel structure in both the column spans (i.e, 5m & 10m).

2) The storey drift values are more for the RC structure of flat slab system compared to the steel structure in both the column spans (i.e, 5m & 10m).

3) While comparing the storey shear, the values are more for the steel structure in both the column spans (i.e, 5m & 10m). It is observed that there is a slight increase of storey shear value in X – direction in 5m column spacing RCC flat slab structure.

REFERENCES.

1. **Vinit, G., Kadia, N.&Samanta, K**. (2018) "Comparative Study of RCC and steel structures for different floor heights". International Journal of Innovative Research in Advanced Engineering, Vol.5, No.10, pp.324-328.
2. **Mahesh Suresh Kumawat, L.G. Kalurkar** "Static & Dynamic Analysis of Multistorey Building using Composite structures". : International Journal of Research in Engineering and Technology, Vol.3, No.7, pp.638-647.
3. **Jyothi DN (**2018**)** "Comparative Analysis of RCC and Steel structures". International Research Journal of Engineering and Technology, Vol.5, No.2, pp.345-347.

4. **D.R. Panchal and P. M. Marathe**, December (2011). "Comparative study of RCC, Steel and composite (G+30 storey) Building". International Conference 2 On Current Trends In Technology, Institute Of Technology, Nirma University, Ahmedabad – 382 481, pp 1-6, December, 2011
5. **Dr. S. K. Kulkarni, Vishwajeet Kadlag,** (2019) "Comparative study on Analysis and Design of RCC and Composite Structure". ; International Journal of Advance Research, Ideas and Innovations in Technology, Vol.5, No.3, pp.1082-1088.
6. **Zuqiang Liu, Xiaonan Wang, Zhiming Zhou, Jianyang Xue, Binglin Lai, Jinjun Xu** (2021) "Experimental and numerical study on seismic performance of steel reinforced concrete spatial frame with irregular section columns". Elsevier, Engineering Structures,
7. **Reidar Bjorhovde** (2003) "Development and Use of high performance steel". Elsevier, Journal of Constructional steel research. Volume 60, Issues 3–5, pp.393-400.
8. **S.V. Hoa, B.H. Joureneaux and L. Di. Lalla**. "Computer Aided Design for Composite Structures." Composite Structure, Volume 13 No.1 1989, pp 67-79.
9. **Shashikala. Koppad, Dr. S.V.Itti** (2013) "Comparative study of RCC and composite multistoreyed Buildings", International Journal of Engineering and Innovative Technology, p- 341-345, Volume 3, Issue 5.
10. **Sameh S. F. Mehanny and Gregory G. Deierlein**.(2001) "Seismic damage and collapse assessment of composite moment frames." Journal of Structural engineering, Vol. 127 No.9, pp 1045-1053.
11. **C.C. Weng.** "Shear strength of concrete encased composite structural members." Jornal of structural engineering, Vol 127, No. 10, Oct 2001, pp 1190-1197.
12. **Prof. Swapnil B. Cholekar, Basavalingappa S. M.,** "Comparative Analysis of Multistoried RCC and Composite Building due to Mass Irregularity", International Research Journal of Engineering and Technology, Volume: 02 Issue: 04, p- 603- 608.
13. **Prof. Prakarsh Sangave, Mr. Nikhil Madur, Mr. Sagar Waghmare, Mr. Rakesh Shete, Mr. Vinayak Mankondi, Mr. Vinayak Gundla,** (2015) "Comparative study of Analysis and design of R.C.C and Steel Structures", International Journal of Scientific & Engineering Research, Volume 6, Issue 2, pp- 256-267.
14. **Shunsuke sugano** "Seismic behavior of reinforced concrete columns which used ultrahigh strength concrete". Elsevier science, Eleventh world conference on Earthquake Engineering, Paper no.1383.
15. **Scott BD, Park R, Priestley MJN**. "Stress-strain behavior of concrete confined by overlapping hoops at low and high strain rates". ACI J 1982;79(1):13–27.
16. **Moehle JP**. "Displacement-based design of RC structures". In: 10th World conference on earthquake engineering, Madrid, Spain; 1992. p. 4297–302.
17. **L. Calado, L. Simoes da Silva and R. Simoes.** "Cyclic Behavior of Steel and Composite Beam-To-Column Joints." Department of Civil Engineering, Instituto Superior, Tecnico, Lisbon, Portugal and Universidade de Coimbra, Coimbra, Portugal, pp159-169.

18. **Mr. Nitish A. Mohite, Mr. P.K.Joshi, Dr. W. N. Deulkar**,(2015) "Comparative Analysis of RCC and Steel Concrete composite (B+G+11 storey) Building", International Journal of Scientific and Research Publications, Volume 5, Issue 10, p- 1-6,
19. **Nie JG, Cai CS**. "Steel–concrete composite beams considering shear slip effects". J Struct Eng 2003;129(4):495–506.
20. **Zou GP, Xia PX, Shen XH, Wang P**. "Investigation on the failure mechanism of steel concrete steel composite beam. Steel Compos Structure" 2016;20(6):1183–91.
21. **Ricles JM, Paboojian SD**. "Seismic Performance of steel-encased composite columns". J Struct Eng 1994;120(8):2474–94.
22. **Anish N. Shah, Dr. P. S. Pajgade** (2013) "Comparison of RCC and Composite Multi-storeyed Buildings", International Journal of Engineering Research and Application, Vol.3, Issue 2, March-April 2013, pp.534-539.
23. **IS 875 (Part 1): 1987**: Code of practice for design loads (other than earthquake) for buildings and structures.
24. **IS 875 (Part 2): 1987**: Code of practice for design loads (other than earthquake) for buildings and structures.
25. **IS 875 (Part 3): 1987**: Code of practice for design loads (other than earthquake) for buildings and structures.
26. **IS 1893 (Part 1): 2002**: Criteria for earthquake resistant design of structures part-1: General provisions and buildings.
27. **SP 6-1 (1964):** ISI Handbook for structural engineers- Part-1 Structural steel sections.
28. **IS 16700: 2023**: Criteria for Structural Safety Of Tall Concrete Buildings.
29. **IS 456: 2000**, "Code for practice of plain and reinforced concrete code of practice, Bureau of Indian Standards", New Delhi.
30. **IS 11384:2022**: Code of Practice for Design of Composite Structure, Bureau of Indian Standards, New Delhi, India, 1985