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COMPARATIVE STUDY OF RCC AND STEEL STRUCTURES FOR DIFFERENT FLOOR HEIGHTS

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Abstract: As our country (India) is the fastest growing country across the globe and need of shelter with higher land cost in major cities like Mumbai, Delhi, Ahmedabad, Vadodara where further horizontal expansion is not much possible due to space shortage, we are left with the solution of vertical expansion. In India reinforced concrete structures are mostly used since this is the most convenient & economic system for low-rise buildings. However, after a certain height of structure for medium to high-rise buildings this type of structure is no longer economic because of increased dead load, less stiffness, span restriction, low natural frequency and hazardous formwork. So, the Structural engineers are facing the challenge of striving for the most efficient and economical design solution while ensuring that the final design of a building must be serviceable for its intended function, habitable for its occupants and safe over its design life-time. Steel and concrete composite structures are becoming a more and more common solution for buildings, since its structural efficiency and fast erection methods make its use economically competitive. Use of composite material is of particular interest, due to its significant potential in improving the overall performance through rather modest changes in manufacturing and constructional technologies. The results of this work show that the Steel Structures are the best solution for high rise structure as compared to R.C.C structure as shown in literature is for commercial buildings having large span. Comparative study includes deflection, axial force and shear force, bending moment in column and beam, cost. In this project study of various multi-storeyed residential buildings like G+7, G+14, G+21 are analysed by using STAAD-Pro software.

Keywords: Steel; RCC; Structures; STAAD; Pro; design; economy; etc.

I. INTRODUCTION

This paper involves analysis and design of multi-storeyed [G+7, G + 14 and G+21] using a very popular designing software STAAD Pro. The principle objective of this project is to analyse and design a multi-storeyed building [G+7, G + 14 and G+21 (3-dimensional frame)] using STAAD Pro for RCC frame and Steel frame and comparing with each other. The design involves load calculations manually and analysing the whole structure by STAAD Pro.

The design methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard Code of Practice.

LOADS CONSIDERED: Dead Loads, Imposed Loads, Seismic Loads

II. DESIGN OF RCC AND STEEL STRUCTURE

2.1 Design Approach for RCC

The architectural plan was analysed for possible placement of column. The aesthetical considerations were kept in mind during finalization of column placement. Main beams were placed connecting columns. Moreover, wherever dimmed necessary secondary beams were provided to reduce the slab spanning.

The Geometrical layout was prepared in Staad.PRO. Due to the structure being a typical residential building, standard size of beam was applied viz. 300 x 450 mm, it was later released during analysis that the provided beam size was adequate and economical. The column sizes were decided considering the axial reactions at the bottom node of each column. For columns having higher reactions specifically for higher storeys, larger sizes were required. It has been kept in mind that percentage of steel does not exceed 4% in column design. The thickness of the slab was kept 125mm throughout the floor area.

2.1.1 Sizing of RCC Columns

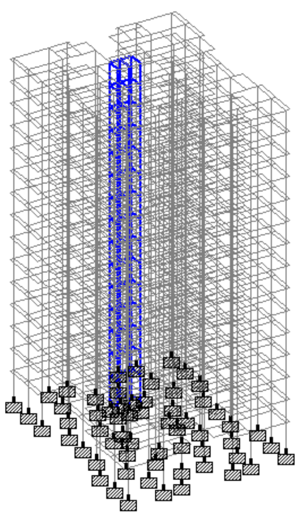
The sizes of the members in different model have been taken as per strength as well as displacement requirements.

	G+7	G+14	G+21
Column	500 x 400	800 x 400 , 750 x 400	900 x 400 , 900 x 600
Beam	450 x 300	450 x 300	400 x 300 , 650 x 300
Slab Thickness	150	150	150.

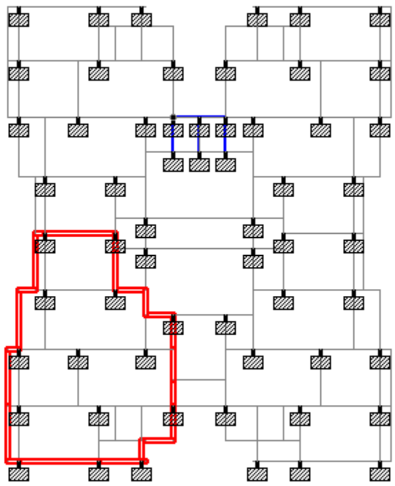
2.2 Design Approach for Steel

For the justification to the comparative study carried here the layout has been kept same for design of steel structure. ISMB sections are used beams in the steel design as, it provides thick webs that can effectively carry the moments from the slab. While wide flanged sections are used in column design as they provide excellent sectional performance, with high bending and buckling resistance due to H-shaped arrangement of flanges and the web.

III. MODELLING OF ARCHITECTURAL PLAN IN STAAD.PRO



The above given structure is initially modelled for G+14 storey height keeping the same plan dimension. All the Columns were given fixed support at the bottom, which would depict the original foundation in the Building and keep the structure stable. The entire beam ends as fixed as well which would portray the actual condition. For the same structural configuration, modelling of G+7 G+14 and G+21 was performed in both steel and R.C.C.



IV. COMPARATIVE RESULT ANALYSIS BETWEEN RCC AND STEEL STRUCTURE

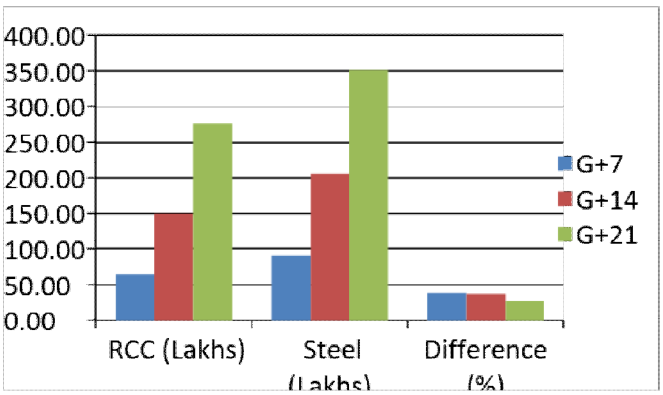
4.1 Quantitative Analysis:

The quantity of reinforcement and concrete required in RCC structure and steel quantity in steel structure are tabulated below:

Qty Comparison			
Storey	Qty of Concrete Structure (m^3)	Reinforcement (Kg)	Qty of Steel Structure (Kg)
G+7	726.60	53,372.38	257,437.51
G+14	1634.90	125,866.16	586,253.52
G+21	3082.40	222,287.97	1,004,194.39

Weight of Steel structure is quite low as whereas compared to RCC structure and that will results into higher axial forces in RCC structures. The cost of RCC and Steel structures and the difference for both the structure for same floor height are tabulated below:

Storey	Cost of Concrete Structure (Lakhs)	Cost of Steel Structure (Lakhs)	Difference (%)
G+7	50.31	90.10	37.77
G+14	115.11	205.19	37.12
G+21	212.06	351.47	27.49



From the statistical results it is obtained that Steel structures are costlier than RCC structures. But it can be seen that as the number of storey increases, the difference between the cost of RCC and steel structures decreases.

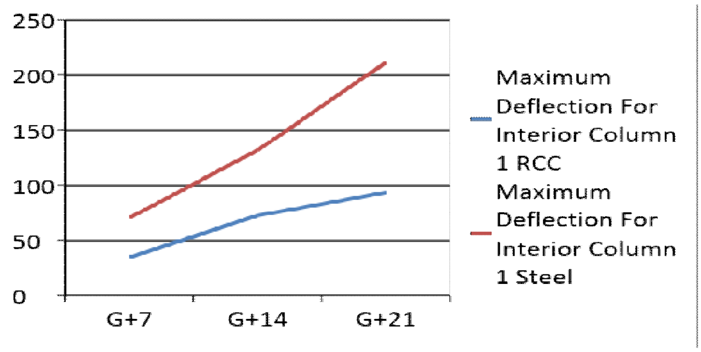
4.2 Deflection

Maximum Deflection is under for the columns considered in the below shown table:

Maximum Deflection for an Interior Column				
	RCC		Steel	
	Floor No.	Displacement (mm)	Floor No.	Displacement (mm)
G+7	7	35.351	7	71.268
G+14	14	73.164	14	131.587
	7	45.463	7	64.933
G+21	21	94.177	21	211.627
	14	61.036	14	137.965
	7	27.165	7	60.86

From the above results steel is definitely lighter and more flexible. To help counter this inherent flexibility, designers often couple the frame with concrete or masonry infill panels. Usually this works out well because most codes require some fire separation at the stairwell and block or solid concrete does the job nicely. Concrete frames really shine in super-slender structures because they can produce a very stiff system even within a small profile.

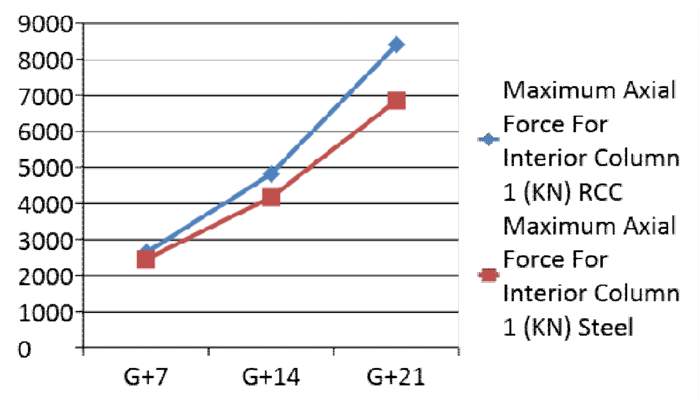
Carnegie Hall Tower is such an example where the tower is 50' wide in the upper portion. Designers rejected a steel frame only because they could not get it to develop sufficient lateral stiffness. The extra mass of concrete structures also produces better damping, meaning that it adsorbs energy quicker and produces better dynamic performance. This is advantageous when controlling any movements - whether seismic or wind induced.



4.3 Axial Force

Maximum Axial forces for Interior Column 1 are tabulated below:

Maximum Axial Force for Interior Column 1 (KN)		
	RCC	Steel
G+7	2638.48	2460.791
G+14	4820.19	4174.329
G+21	8410.82	6855.089



From the above statistical result, it can be concluded that axial force in RCC is much higher than Steel structures. Due to weight of Steel structure is quite low as whereas compared to RCC structure and that will result into higher axial forces in RCC structures.

V. CONCLUSION

It has been observed that the cost of Steel Structure for the residential building is more than RCC structures. However speedy erection may make Steel structure economically viable. Further, Steel structures are expected to show superior performance under earthquake due to high ductility than the conventional R.C.C. structure.

- Axial forces are lower in Steel structures due to the lower Weight of Steel structure compared to RCC structure.
- As the number of storey increases, the gap between the cost of RCC and steel structures decreases.
- Composite structures are more economical than that of R.C.C. structure as shown in literature for commercial buildings having large spans.
- According to the results, the deflection of the Steel structure is quite higher than RCC as Steel is a ductile material and allows a larger deflection.
- Speedy construction facilitates quicker return on the invested capital & benefit.

REFERENCE

1. Reinforced Concrete Vol. II by Dr. H.J. Shah
2. Design of Steel Structures by N. Subramaniam
3. Video Tutorials of STAAD.Pro from Youtube.com
4. Document NO. :: IITK-GSDMA- EQ26-V3.0 by Dr. H J Shah and Dr. Sudhir K Jain.
5. IS 1893-1 (2002): Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings
6. IS 456:2000 PLAIN AND REINFORCED CONCRETE - CODE OF PRACTICE
7. Technical guide for STAAD.Pro IN Bentley forums