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Comparative Analysis of Design and Schedule of Reinforced Concrete and Prefabricated Steel Structure

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Abstract - *In India, concrete is very popular material of construction especially in case of medium and low rise buildings. In case of high rise buildings steel is generally used and Steel Tube is not such popular. This project deals with the comparison between the RCC and steel structures in accordance to their structural behaviour, Cost and other factors which help in deciding the best suitable materials for construction. In this project a G+3 Residential building is considered for analysis. The different types of models are RCC, and Steel structures. These models are analysed for shear forces and bending moments using "STAAD Pro" software. The results obtained from each of the model are compared with each other to determine the best construction material. The scheduling of construction of reinforcement concrete structure and steel structure is done by "Primavera P6" software and compared to both structure to know the duration of time for each activity. The comparison of cost estimation for both structures is performed to conclude and prefer the economic type of structure.*

Key Words: **RCC (Reinforced Cement Concrete), G+3 (One Ground and Three Upper Floor), RCC and Steel Structure (Comparison), G+3 Building drawings (AutoCAD), Designing and analysing (STAAD Pro), Scheduling (Primavera P6), Cost Comparison.**

1. INTRODUCTION

An ideal and modern construction material will aim to maintain structural strength while reducing its impact on the environment. Reinforced concrete is one of the most widely used modern building materials because of its durability and compatibility. Moreover concrete can be moulds in any shape which make it a very useful. Adding thin steel bars to concrete can increase the strength of the concrete, making it better to use in variety of application. Steel industry is growing rapidly in almost all parts of the world. Time is most important parameter from the construction point of view and steel structure is built in a short period. The steel which is used for the manufacture of rolled steel structural, fastenings and other elements for use in structural steel works is called structural steel. Steel structure are widely used in high-rise, residential high-rise steel structures are very common in the developed countries. In present work, comparative study of design, scheduling and embodied energy of RC and Steel structure (G+3 Residential building) is included.

1.1 Structural Details

A typical plan of building is selected for comparative study of RCC and steel structure having plan dimensions 12.20m X 19.80m.

Table -1: Structural Details

Foundation	1.5m below GL
Depth	G.L.
No of Floors	G + 3
No of Flats in each floor	2
Storey height	3.5m
Wall Thickness	230mm (External) 180mm (Internal)
Slab depth	150mm
Beam	230mm X 450mm 230mm X 400mm
Column	230mm X 500mm 230mm X 450mm

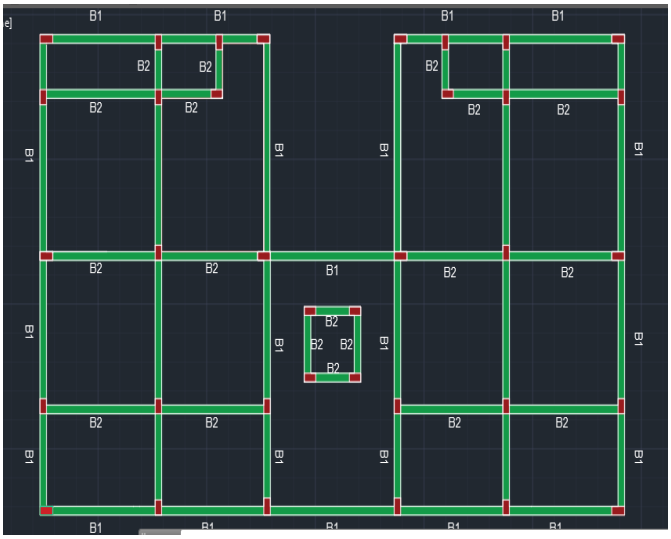


Fig -1: Plan of Building

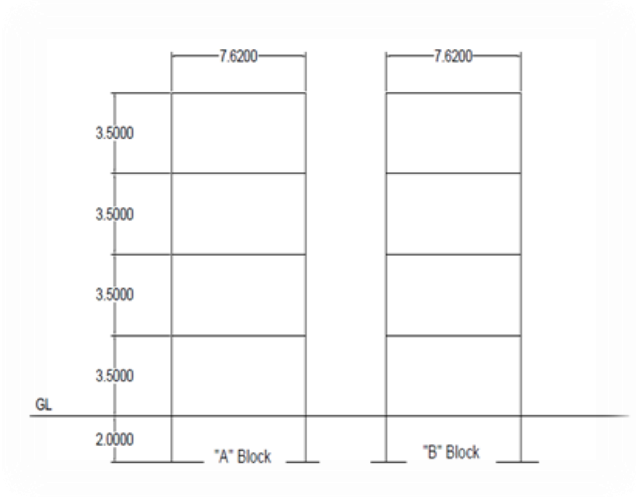


Fig -2: Elevation of Building

2. METHODOLOGY

2.1 Modeling and Analysis in "STAAD Pro"

3-D model has prepared and analyzed to compare shear strength and bending moment of Reinforced concrete structure and prefabricated steel structure in "STAAD Pro". Following basic parameters are used for the analysis and design of structures:

Table -2: Material Properties

Unit weight of RCC	25 KN/m^3
Unit weight of Steel	78 KN/m^3
Grade of Concrete	M25 for RCC and Steel Structure
Grade of Reinforced Steel	Fe 415 for HYSD bars
Grade of Structural steel	Fe 250
Dead Load	Self-weight of structural elements
Wall loads External, Internal parapet wall	16.1 KN/m^2 12.6 KN/m^2 4.6 KN/m^2
Live load	1.5 KN/m^2
Floor Finish	1 KN/m^2

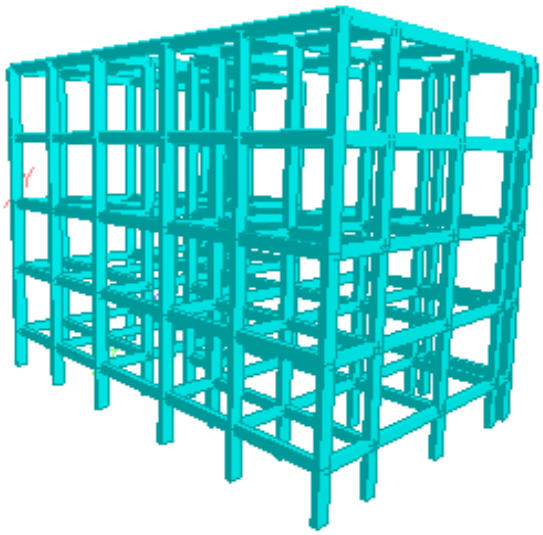


Fig -3: 3D view of RC structure in "STAAD Pro"

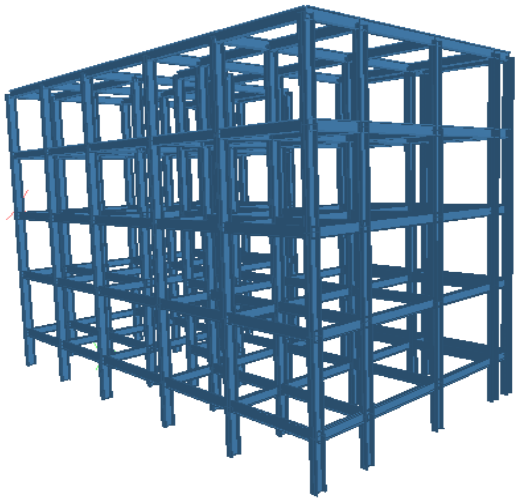
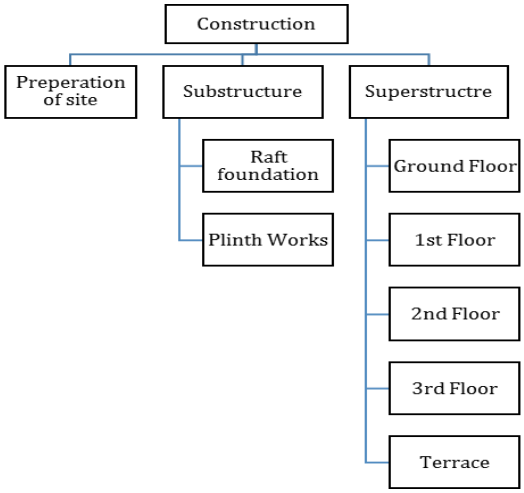


Fig -4: 3D view of Steel structure in "STAAD Pro"

2.2 Scheduling of Structure in "Primavera P6"

Scheduling process has been performed for both structures by using "Primavera P6" to conclude the duration of construction of each activity of a structure. Many activities are carried out in the Scheduling process which are listing of tasks, activities, milestones with a planned start and finish date. The work break down structure is carried out based on deliverable of structure. Here the WBS are taken;



Here are the list of activities are taken: Lineout, excavation, preparation of PCC, shuttering of footing, concreting of footing, shuttering of plinth beam, concreting of plinth beam, screed concrete, shuttering of columns, concreting of columns, shuttering of beams and slab, concreting of beams and slab, Masonry works, flooring works, plastering works, painting works. The duration and resources are assigned to each activities to conclude the time and cost of project.

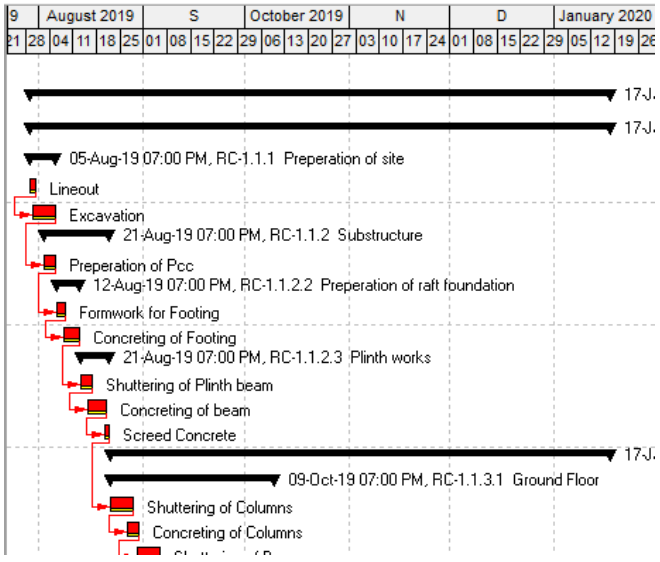


Chart -1: Scheduling of RC Structure

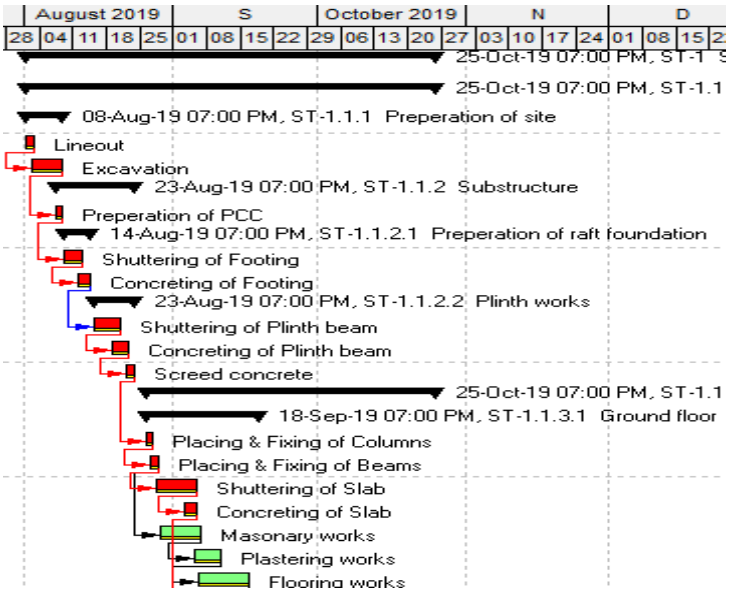


Chart -2: Scheduling of Steel Structure

3. RESULTS AND DISCUSSION

3.1 Comparison of Shear Force, Bending Moment & Cost Estimation

The results are obtained from "STAD Pro" software which shows in the way of comparison of RC and Steel structure.

Table -3: Comparison of Shear Force

Storey No	RCC (kN/m³)	Steel (kN/m³)
Ground	66.80	49.21
1st	67.14	49.86
2nd	67.98	50.47
3rd	**68.45**	**51.18**
Terrace	37.48	25.61

Table -4: Comparison of Bending Moment

Storey No	RCC (Kn-m)	Steel (Kn-m)
Ground	64.14	39.92
1st	61.75	41.56
2nd	63.90	42.10
3rd	**65.538**	**43.603**
Terrace	35.18	19.73

Table -5: Comparison of Cost Estimation

DESCRIPTION	RCC COST (INR)	STEEL COST (INR)
Excavation	2,59,854	2,59,854
Formwork	17,91,308	11,29,069
Concreting	21,45,090	13,62,960
Steel	-	35,16,600
Plastering	8,38,616	4,06,584
Reinforcement	4,60,425	2,49,648
Total	**54,95,293**	**69,24,715**

3.2 Comparison of Scheduling of Construction:

Total duration required for construction of **RC Structure is 125 days and for Steel structure is 62 days.**

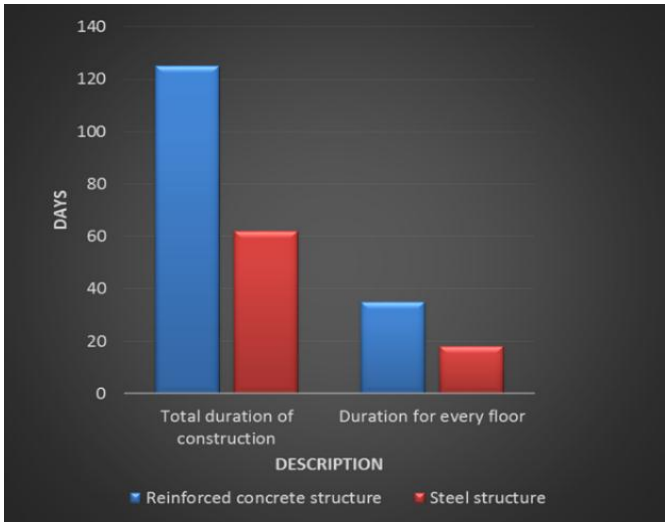
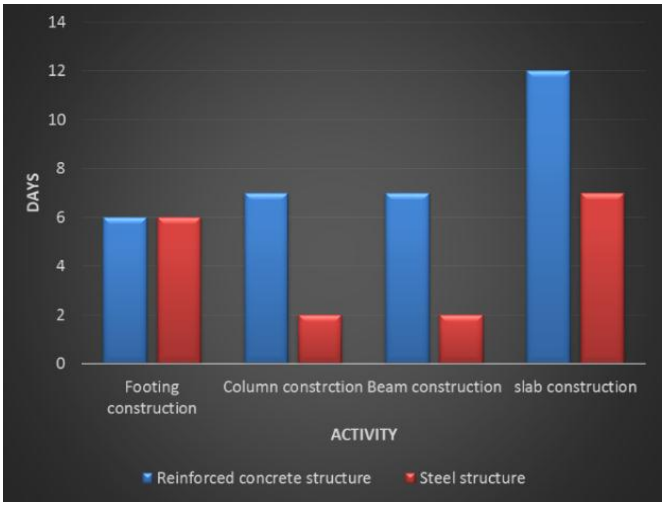


Chart -3: Graphical representation of total duration of construction varying RC and Steel structure

Reinforced Concrete structure:
Total duration of construction- **125 days**
Duration for every floor – **35 days**

Prefabricated Steel Structure:
Total duration of construction- **62 days**
Duration for every floor – **17 days**



Reinforced Concrete structure:
Total duration for
Footing construction- **6 days**
Column construction- **7 days**
Beam construction – **7 days**
Slab construction – **12 days**

Prefabricated Steel structure:
Total duration for
Footing construction- **6 days**
Column construction- **2 days**
Beam construction – **2 days**
Slab construction – **7 days**

4. CONCLUSIONS

- From the above result we can observe that the total shear force in Reinforced Concrete structure is 12.77 % more than the Prefabricated Steel structure. Where, the maximum shear force observed at 3rd floor of both structure.
- The total bending moment in Reinforced Concrete structure has increased by 9.80 % compared to the prefabricated steel structure.
- From the above it is conclude that steel structure is more resist as compared to the normal concrete structure. A building constructed using steel has less dead load on it, even the bending moment and shear forces acting are less as determined in this work. It has high strength per unit mass.
- The cost of formwork, concreting, plastering and reinforcement is quite less in the steel structure where steel member doesn't require it. But the excavation cost is remain same.
- We can observe that, the steel members/elements have not used in RC structure, so the quantity and cost of steel structure is more than the RC structure. Where, the cost of steel material is much more than concrete per cubic meter.

- The total construction cost of steel structure is 20.64 % more than the RC structure.
- The duration of beam and slab construction is twice faster in steel structure compared to RC structure which makes big difference. The duration of construction of footing is remain same in both structures.
- From the result, we can observe that the total duration of construction of RC structure is 125 days, where steel structure is 62 days. So, the construction for prefabricated steel structure takes 50% less time when compared to RC structure.

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BIOGRAPHY

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