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Comparative Study on Analysis and Cost Estimation of RC Structure and Steel Structure under the Normal Loading Conditions

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Abstract - *In India mostly we are using RCC structures, but in the recent trends steel structure is very much highlighted. India is a developing country and hence need for construction is more. So we need to find out the suitable material for construction. The material which we use in construction should be economical, safe and easy to handle. Before the existence of concrete we were using limestone, mud, and wood etc. but now there is a strong discussion between RCC structure and steel structure, that which one is better. Every material used for construction has its own pros and cons. RCC and steel are the materials that are mostly used in framing system for most of the building. Steel members have the advantages of high tensile strength and ductility while concrete members have the advantages of high compressive strength and stiffness.so in this study we will deal with comparison between RCC structure and Steel Structure for which the model will be same. The comparison like Shear force, bending moment, erection time and cost estimation will be done using software's like Etabs 2016, Staad.pro and spread sheets.*

***Key Words*:Bending moment, Shear force, Rcc structure, Steel structure, Erection time, Etabs, Stad.pro**

1. INTRODUCTION

An important and economic combination of construction materials is that of steel and concrete, with applications in medium to high-rise buildings as well as bridges. In India, reinforced concrete members are mostly used in the framing system for most of the buildings since this is the most convenient & economic system for low-rise buildings. However, for medium to high-rise buildings this type of structure is no longer economical because of increased dead load, less stiffness, span restriction and hazardous formwork. Steel-concrete composite frame system can provide an effective and economical solution to most of these problems in medium to high-rise buildings. The project proposed is a college building of G+1 storey, in Bhatkal Taluk, U.K. district, planning is done using AutoCad, analysed and design using Etabs and Staad. Pro. Keeping careful balance between economy and safety. For the design part first the plan of the particular building is done, which includes positioning of the particular rooms such that they serve their respective purpose and also suiting to the requirement the users. Thereby depending on the suitability, plan layout of beams and the position of columns are fixed. Thereafter, the loads are calculated namely the dead loads, which depend on the unit weight of the materials used and the live loads, which according to the code IS:456-2000 and IS:800-2007 and HYSD bars Fe-500 as per IS:1786-1985.

1.1 OBJECTIVES

- To prepare the plan for both composite as well as RCC structure with giving proper dimensions as per Indian Standard.
- To investigate the cost effectiveness of steel-concrete composite frames over traditional reinforced concrete frames for building structures.
- To compare the strength of the composite structure over RCC structure.
- Time required for the construction of composite structure and RCC structure.
- The results obtained from each of the model are compared with each other to determine the best construction material.

1.2 METHODOLOGY

Primary procedure is to prepare a plan by studying the location and surveying is carried out. And this plan is prepared as per requirements of Department of Pre-University Education Board, Karnataka. The design of RCC structural elements and Steel structure elements are carried by considering the minimum dimension of column, beam and slab. The dimensions of column and beams can be taken by trial and error method. Later the strength, failure criteria are checked by using ETABS. The dimension of RCC structure elements are designed using MS EXCEL (spread sheet) by considering the various loads such as live load and dead load. The design is carried as per the code, i.e IS: 456-2000. Similarly, same procedure is carried for steel structure as per code provision.

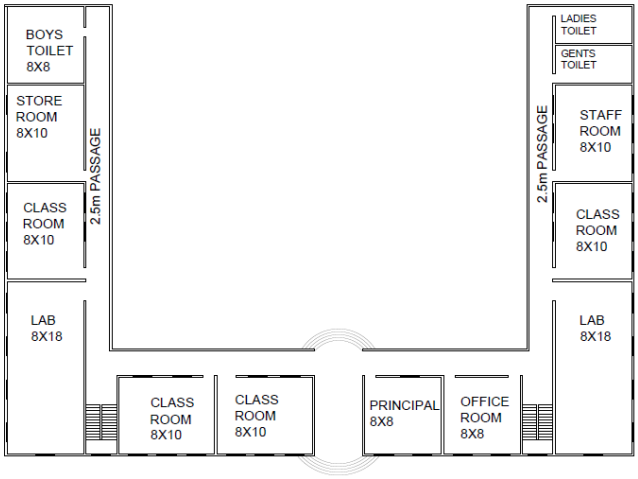

Fig -1: Typical floor plan

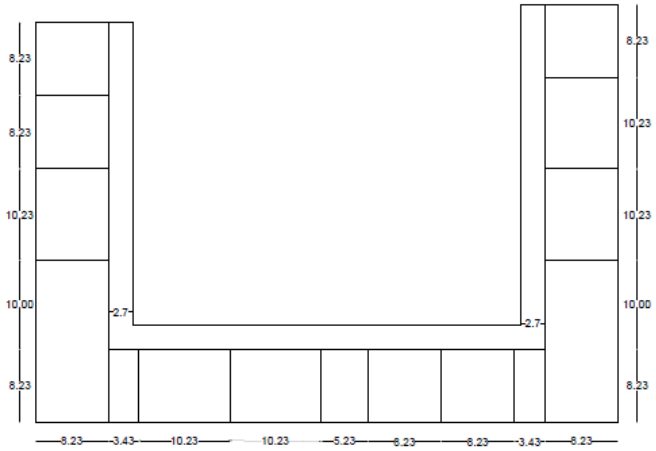

Fig -2: Centerline drawing

2. RCC STRUCTURE

The analysis and design of RCC structure is carried out on CSI ETABS. The center line drawing was imported in Etabs from AutoCAD for analysis under different loads like Dead loads, live loads and various load combinations. The wind load is not considered as the structure is only 2 storey. The sizes of slab, columns and beams are mentioned in the table below.

Table -1: Structural elements with properties

RCC Structures	Properties	
	Grade of concrete	Size (mm)
Column	M30	230 X 450
	M30	230 X 300
Beam	M25	230 X 300
	M25	230 X 450
Slab	M25	125

The sizes of the structural elements will be based on the loads acting on it. The below table shows the load calculated.

Table -2: LOADS CALCULATED

Loads	plinth	Ground floor	First floor
Wall load	13.34 kN/m	13.34 kN/m	-
Self-weight of slab	-	3.125 kN/m²	3.125 kN/m²
Floor finish	0.75kN/m² (if required)		
Live load (library)	-	6 kN/m²	2 kN/m²
Live load (other rooms)	-	4 kN/m²	2 kN/m²
Passage wall load	3.68 kN/m	3.68 kN/m	-
Stair case	8 kN/m	8 kN/m	4 kN/m

The load combination used are:

- 1.5(DL+LL)
- 1.2(DL+LL)
- 1.5 DL
- 0.9 DL

2.1 RESULTS

The maximum bending moment is 252.16 kN-m. And the maximum shear force was 764.4 kN.

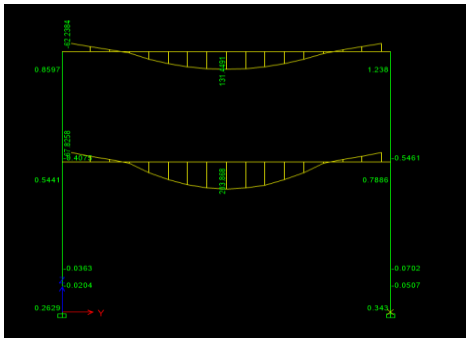

Fig -3: Max Bending moment for beam

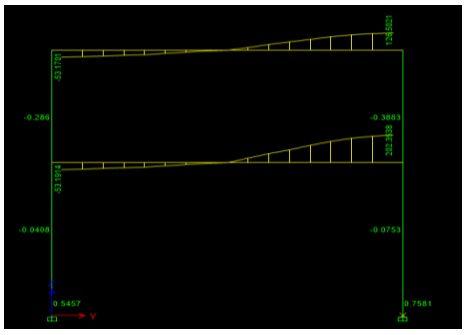

Fig -4: Max shear force for beam

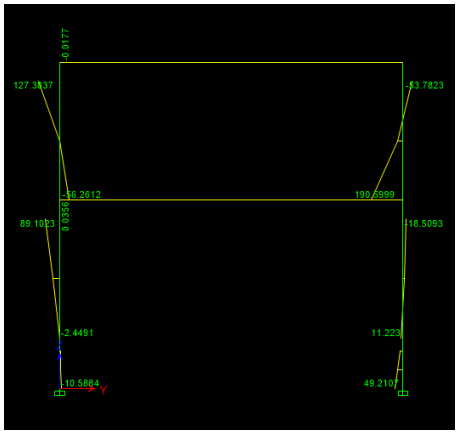

Fig -5: Max Bending moment for Column

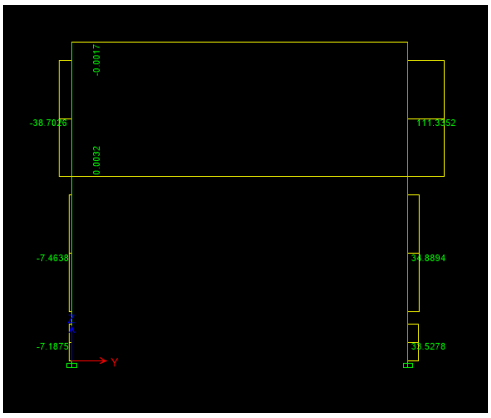

Fig -6: Max shear force for column

The reactions of the structure are shown below. Based on these reactions isolated footings are provided.The design of footing is done by grouping method; the max reaction was taken as 1100kN.

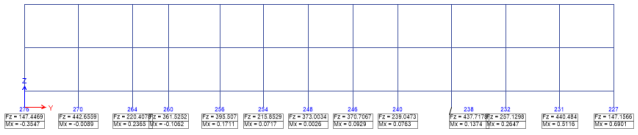

Fig -7: Reactions for footing

2.2 COST ESTIMATION

Table -3: ABSTRACT OF ESTIMATION

ITEM NO.	PARTICULAR	QUANTITY	UNIT	RATE (RS)	AMOUNT (RS)
1	Earthwork in excavation	508.91	cum	650	330791.5
2	PCC for foundation	89.81	cum	6120	549637.2
3	Rcc work for structure	859.6	cum	7500	6447000
4	Reinforcement including binding	209.435	Quintal	7025	1471280.875
5	Masonry work in super structure	490.127	cum	5048	2474161.096
6	Plastering for walls	5979.38	m^2	96	574020.48
7	Plastering for ceiling	2454.67	m^2	550	1350068.5
				TOTAL	13196959.65

The total amount estimated only for structural work, flooring work, painting, water tanks were excluded.

3. STEEL STRUCTURE

The analysis and design of steel structure is carried out on Stad.pro v8i. The center line drawing is imported in Stad.pro from AutoCAD for analysis under different loads like Dead loads, live loads and various load combinations. The wind load is not considered as the structure is only 2 storey. The sizes of slab, columns and beams are mentioned in the table below.

Table -4: Structural elements with properties

Steel Structures	Properties	
	Sections	Size (mm)
Column	ISHB	350
	ISHB	300
Beam	ISMB	300
	ISMB	350
	ISMB	400
	ISMB	500
Slab	Plates	50mm thick

The sizes of the structural elements will be based on the loads acting on it. The below table shows the load calculated.

Table -5: LOADS CALCULATED

Loads	plinth	Ground floor	First floor
Wall load	13.4 kN/m	13.4 kN/m	-
Self-weight of slab	-	0.934 kN/m^2	0.934 kN/m^2
Floor finish	0.75kN/m^2 (if required)		
Live load (library)	-	6 kN/m^2	2 kN/m^2
Live load (other rooms)	-	4 kN/m^2	2 kN/m^2
Passage wall load	3.68 kN/m	3.68 kN/m	-
Stair case	8 kN/m	8 kN/m	4 kN/m

The load combinations used are:

- 1.5(DL+LL)
- 1.2(DL+LL)
- 1.5 DL
- 0.9 DL

3.1 RESULTS

The maximum bending moment is 277.358 kN-m. And the maximum shear force was 235 kN.

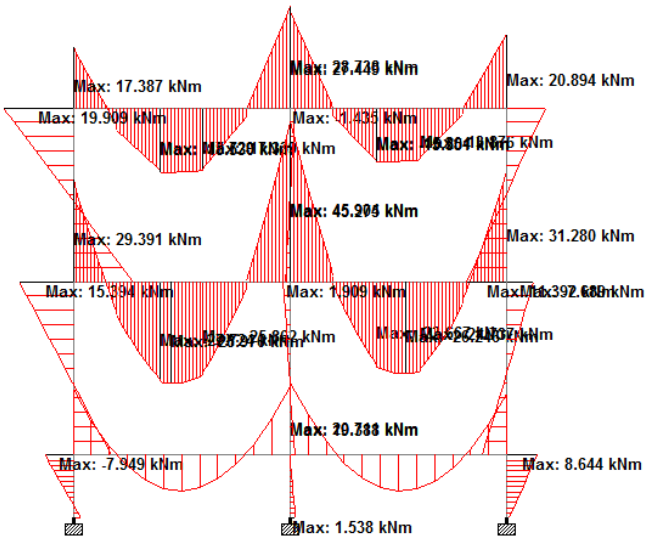

Fig -8: Max Bending moment

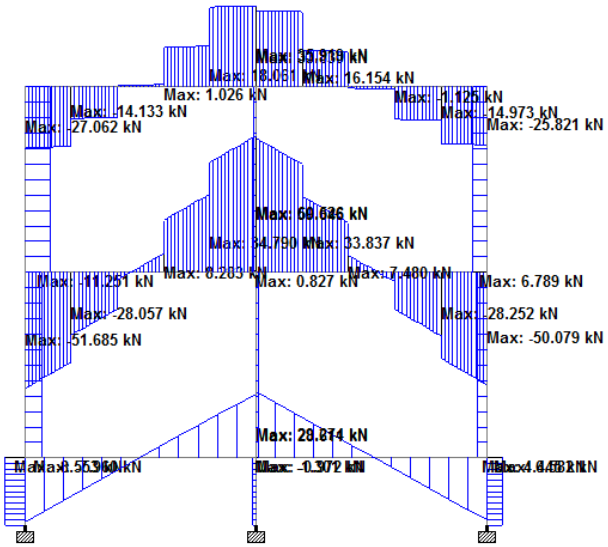

Fig -9: Max shear force

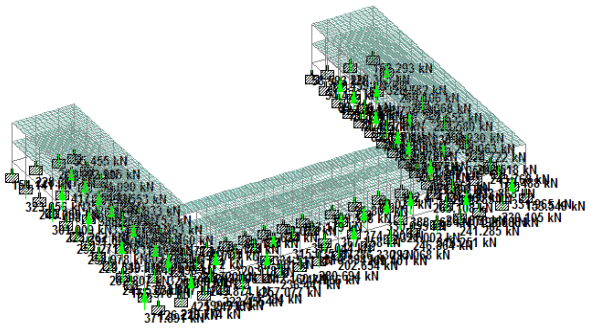

Fig -10: Reactions for footing

The reactions of the structure are shown below. Based on these reactions footing is provided with strong Rcc pedestrial. The max reaction was taken as 800kN.

3.2 COST ESTIMATION

Table -6: ABSTRACT OF ESTIMATION

ITEM NO.	PARTICULAR	QUANTITY	UNIT	RATE(RS)	AMOUNT(RS)
1	Excavation for foundation	400.87	cum	450	180391.5
2	PCC for foundation	70.74	cum	4000	282960
3	RCC work in foundation	282.98	cum	1800	509364
5	ISHB Steel section	130706.27	kg	36	4705425.72
6	ISMB Steel section	124552.31	kg	30	3736569.3
7	Plates	15180.933	m^2	32	485789.856
8	plastering for steel slab	73.176	cum	80	5854.08
9	Weld length	1511.3096	m	150	226696.44
10	Masonry wall	467.49	m^3	5048	2359889.52
11	Anchor bolts	516	no	15	7740
12	Plastering for walls	5979.387	m^2	96	574021.152
				TOTAL	13074701.57

4. COMPARISON AND CONCLUSION

4.1 COMPARISION

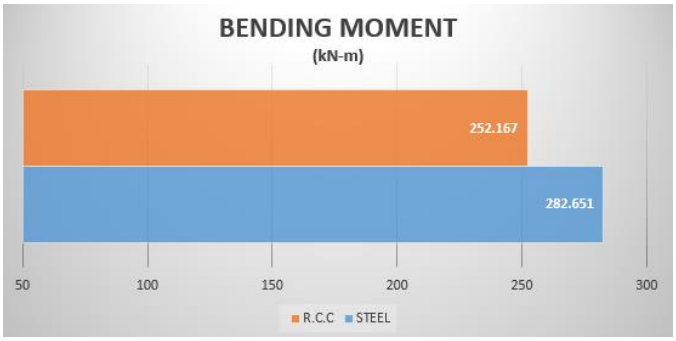

Chart -1: Comparison of max bending moment

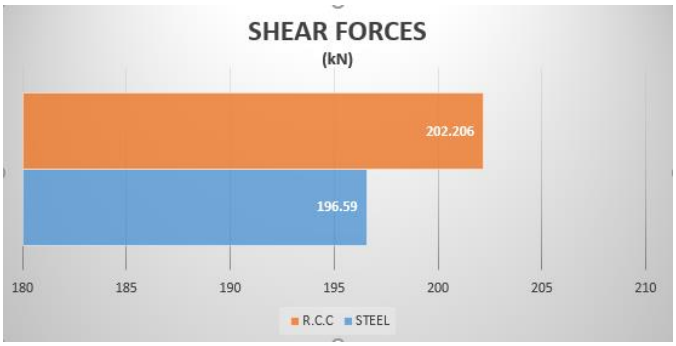

Chart -2: Comparison of max shear force

Chart -3:Comparison ofCost estimation

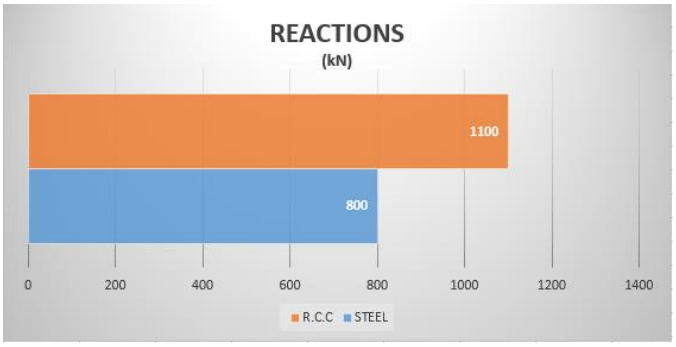

Chart -4:Comparison of Reactions

4.2 CONCLUSION

From the above it is concluded that steel structure is more suitable as compared to other structure up to 2 story. A building constructed using steel structures has less construction cost as determined in this work. The dead load on the steel structure is less compared to concrete structure. In steel structure we found more bending moment but less shear force compared to Rcc structure. The size of the steel structure elements is small. The standard steel sections are readily available so that the construction speed is higher and they may be kept ready by the time the site is ready and the structure erected as soon as the site is ready. Hence there is lot of saving in construction time. As the time is saved the construction cost will reduce.

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