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Comparative Study on Seismic Analysis of (G+10) R.C.C, Steel and Steel-Concrete Composite Building

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Abstract - *In India, reinforced concrete structures are in greater demands in construction because the construction becomes quite convenient and economical in nature. Steel-Concrete composite constructions are now a days very popular owing to their advantages over conventional concrete and steel constructions. Hence the aim of the present study is to compare seismic performance of a 3D (G+10) story RCC, Steel and Composite building frame situated in earthquake zone IV. All frames are designed for same gravity loadings. In RCC slab are used in all three types buildings. The sections of Beam and Column are made of either RCC, Steel or Steel-concrete composite sections. In a Seismic analysis Equivalent static method and Response Spectrum method are used. ETABS 2017 software is used and results are compared based on fundamental time period, displacements, story drift, base shear, story weight and story stiffness. Comparative study based on seismic analysis concludes that, RCC construction is best suited for low rise buildings among all the three types of constructions, but in a High rise building construction are Composite is a better options among the RCC and Steel Structures.*

Key Words: Seismic analysis, G+10 Building ETABS 2017, Response Spectrum Method, Comparative Performance.

1. INTRODUCTION

Most of the building structures in India fall under the category of low-rise buildings. So, for these structures RC members are used widely because the construction becomes convenient and economical in nature. But since the population in cities is growing exponentially and the land is limited, there is a need of vertical growth of buildings in these cities. So, for the fulfilment of this purpose a large number of medium to high rise buildings are coming up these days. Now a days for these high-rise buildings, it has been found out that use of steel-concrete composite members in construction is more economic and effective than using reinforced concrete members. The most popularity and now a days economic of steel-concrete composite construction in cities can be owed to its advantage over the conventional reinforced concrete construction.

RC frames are used in low rise buildings because loading is nominal. But in high-rise and medium buildings, the conventional reinforced concrete construction cannot be adopted as there is less stiffness and framework, increased dead load along with span restrictions, which is quite vulnerable to hazards.

1.1 Objective of Study

1. To determine the effect of earthquake various parameters like that Fundamental time period, story stiffness, drift, displacement, maximum story shear, weight of structures.
2. To reduce Story Drift and Displacement based on Seismic analysis.
3. To increase Base Shear of the Structures.
4. To comparative performance on Seismic analysis by response spectrum.
5. A construction Under the Effective solution of Structural element.

1.2 Method of Analysis

The analysis is conducted for IS 1893(Part 1), 2016 specified Equivalent static analysis and Response spectrum method.

a) Equivalent Static Analysis

This method is based on the assumption that whole of the seismic mass of the structure vibrates with a single time period. The structure is assumed to be in its fundamental mode of vibration. But this method provides satisfactory results only when the structure is low rise and there is no significant twisting on ground movement. As per the IS 1893: 2002, total design seismic base shear is found by the multiplication of seismic weight of the building and the design horizontal acceleration spectrum value.

This force is distributed horizontally in the proportion of mass and it should act at the vertical centre of mass of the structure.

Design Seismic Base shear

The total design lateral force or design seismic base shear (VB) along any principal
Direction of the building shall be determined by the following expression

$$VB = Ah \times W$$

Where,
Ah = Design horizontal seismic coefficient.
W = Seismic weight of the building

Design Seismic Weight of Structure

The seismic weight of each floor is its full dead load plus appropriate amount of imposed load as specified. While computing the seismic weight of each floor, the weight of columns and walls in any story shall be equally distributed to the floors above and below the story. The seismic weight of the whole building is the sum of the seismic weights of all the floors. Any weight supported in between the story shall be distributed to the floors above and below in inverse proportion to its distance from the floors.

Fundamental Natural Time Period-

The fundamental natural time period (Ta) calculates from the expression

Ta = 0.075h^0.75 [for RC frame building]
Ta = 0.080h^0.75 [for Composite frame building]
Ta = 0.085h^0.75 [for steel frame building]

If there is brick filling, then the fundamental natural period of vibration, may be taken as

$$Ta = \frac{0.09h}{\sqrt{d}}$$

b) Response Spectrum Analysis

Multiple modes of responses can be taken into account using this method of analysis. Except for very complex or simple structure, this approach is required in many building codes. The structure responds in a way that can be defined as a combination of many special modes. These modes are determined by dynamic analysis. In this we need to ascertain the force magnitudes in all directions i.e. X, Y & Z and afterwards see the consequences for the building. Different methods of combination are as follows:

1. Square root of the sum of squares(SRSS).
2. Complete quadratic combination(CQC).

In our present study we have used the SRSS method to combine the modes. The consequence of a response spectrum analysis utilizing the response spectrum from a ground motion is commonly not quite the same as which might be computed from a linear dynamic analysis utilizing the actual earthquake data.

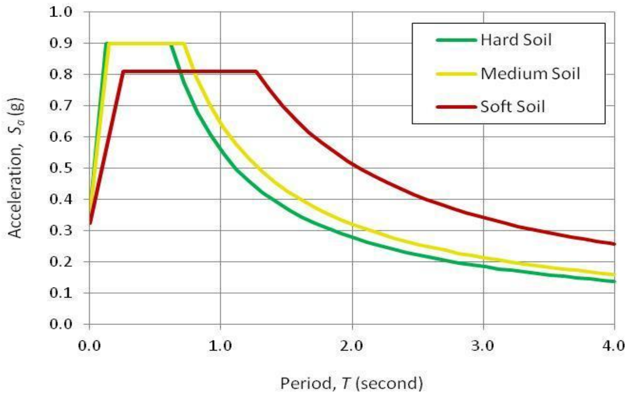


Fig -1: Acceleration based on soil

2. BUILDING CONFIGURATION

Table -1: Building Data

Descriptions	Parameter
No of Stories	(G+10)
Type of frame	Moment Resisting Frame
Total height of building	33.5 m
Height of each story	3.0 m
Foundation Depth	3.5 m
Plan of the building	25 m × 25 m
Floor Diaphragm	Rigid
Grade of Concrete	M25
Grade of reinforcing Steel	Fe500 for main steel Fe415 for distribution steel
Grade of structural steel	Fe345
Seismic Zone factor (Z)	0.24
Soil Type	Medium soil
Importance factor	1.5
Response reduction factor	5
Damping Ratio	0.05
Modal Combination Method	CQC
Combination Type	SRSS
Diaphragm Eccentricity	0.05 for all diaphragm
Frame load on floors	14 kN/m^2
Frame load on terrace	7 kN/m^2
Shell load on floors	4 kN/m^2
Shell load on terrace	2 kN/m^2

Table -2: Section Used in Structure

Member	Beam	Column	Slab/ Deck
RCC	300 x 450 mm	500 x 750 mm	150 mm slab
Steel	ISMB 400	ISWB 600-I	200 mm deck
Composite	ISMB 500	650 x 650 with ISMB 400	200 mm deck

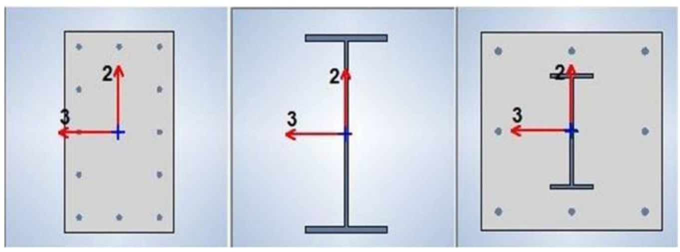


Fig -2: Structural Sections

In a Modeling R.C.C, Steel and Steel-Concrete Composite Structural element has been made and different Beam and Column sizes.

Codes used for analysis under the structures,
R.C.C design : IS 456 -2000
Steel Design : IS 800 – 2007
Composite design : IS 11384 - 1985

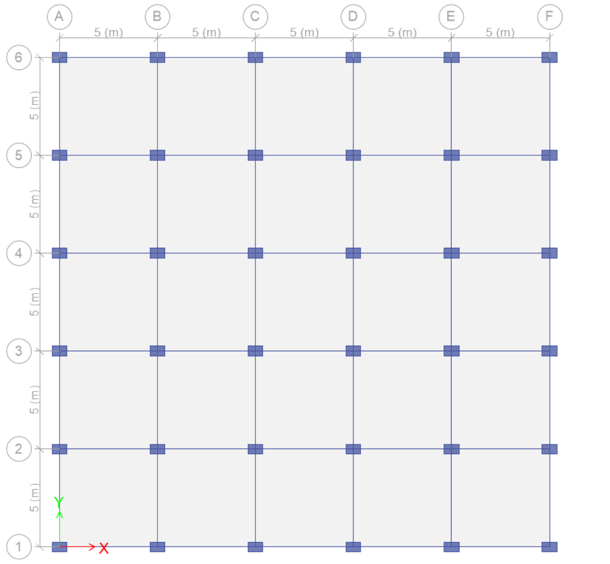


Fig -3: Plan of Building

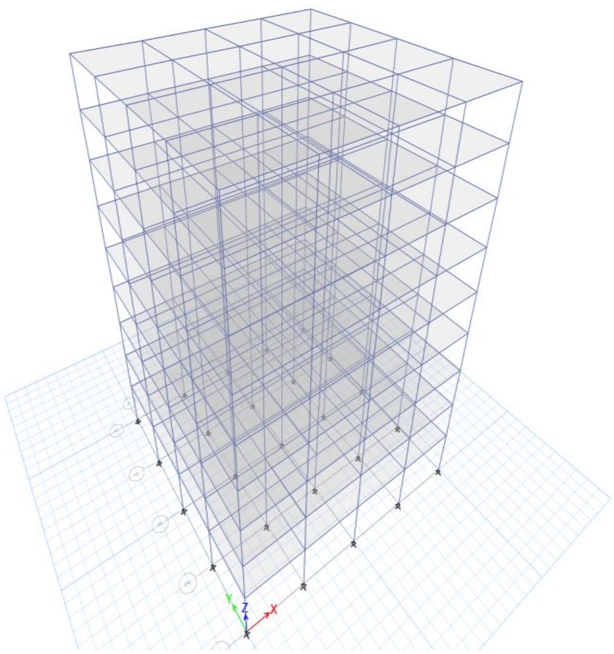


Fig -4: 3-D View of Building

3. RESULTS

The present study is to understand the seismic behavior of RCC, steel and steel concrete `composite buildings under the action of earthquake forces. Results are discussed in terms of base shear induced in the columns at foundation level, fundamental time periods, maximum top story displacements and story drifts compared within the considered configurations of buildings.

Table -3: Maximum Story Displacement (mm)

Story No.	R.C.C	Steel	Composite
10th	45.40	56.10	24.70
9th	43.90	53.20	23.90
8th	41.50	49.80	22.60
7th	38.30	45.70	20.80
6th	34.40	40.80	18.70
5th	29.90	35.20	16.30
4th	25.10	28.90	13.60
3rd	20.00	22.20	10.80
2nd	14.70	15.20	7.90
1st	9.40	8.50	5.00
G.F	4.20	3.00	2.20

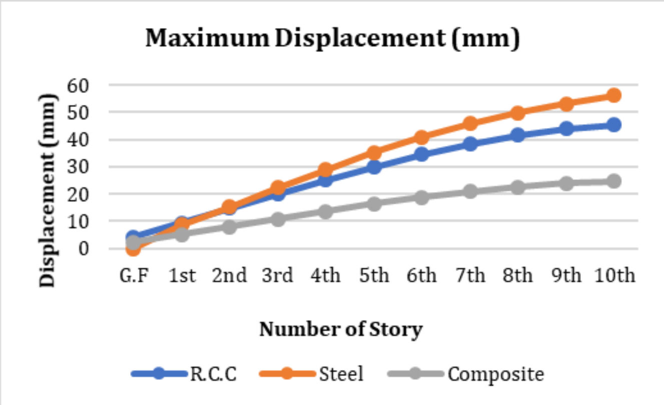


Chart -1: Displacement VS number of Story

Table -4: Maximum Story Drift

Story No.	R.C.C	Steel	Composite
10th	0.00050	0.00113	0.00027
9th	0.00080	0.00135	0.00044
8th	0.00107	0.00158	0.00059
7th	0.00130	0.00180	0.00071
6th	0.00148	0.00200	0.00081
5th	0.00161	0.00218	0.00088
4th	0.00170	0.00231	0.00093
3rd	0.00176	0.00235	0.00097
2nd	0.00178	0.00223	0.00097
1st	0.00173	0.00184	0.00093
G.F	0.00121	0.00865	0.00063

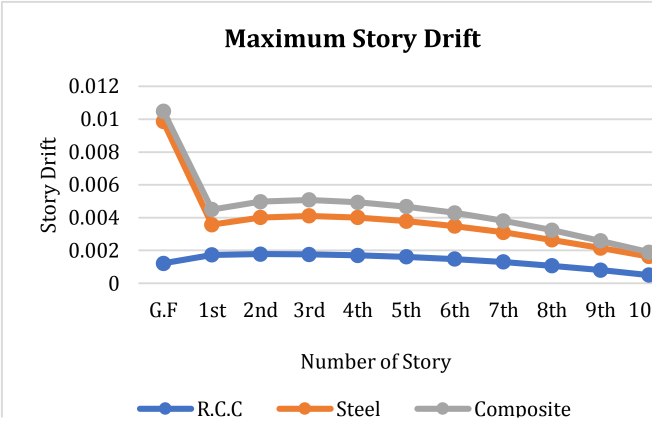


Chart -2: Drift VS number of Story

Table -5: Maximum Story Stiffness

Story No.	R.C.C	Steel	Composite
10th	0.00050	0.00113	0.00027
9th	0.00080	0.00135	0.00044
8th	0.00107	0.00158	0.00059
7th	0.00130	0.00180	0.00071
6th	0.00148	0.00200	0.00081
5th	0.00161	0.00218	0.00088
4th	0.00170	0.00231	0.00093
3rd	0.00176	0.00235	0.00097
2nd	0.00178	0.00223	0.00097
1st	0.00173	0.00184	0.00093
G.F	0.00121	0.00865	0.00063

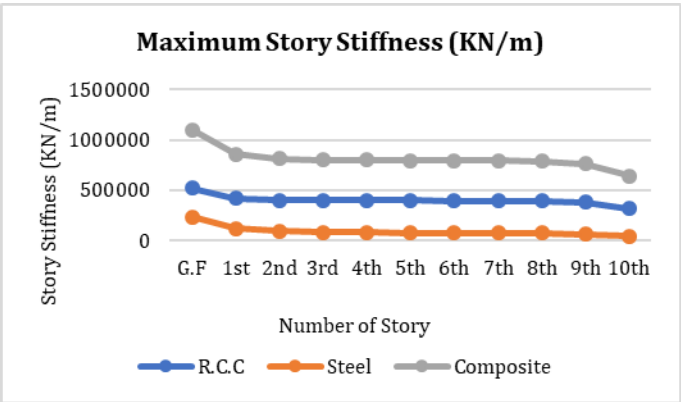


Chart -3: Stiffness VS number of Story

Table -6: Fundamental Time Period (S)

Mode	R.C.C	Steel	Composite
1	1.849	4.923	1.147
2	1.390	3.048	1.095
3	1.379	2.947	0.994
4	0.606	1.511	0.374
5	0.453	0.885	0.355
6	0.446	0.872	0.324
7	0.356	0.830	0.215
8	0.263	0.597	0.202
9	0.255	0.450	0.187
10	0.251	0.443	0.147
11	0.192	0.402	0.137
12	0.181	0.346	0.127

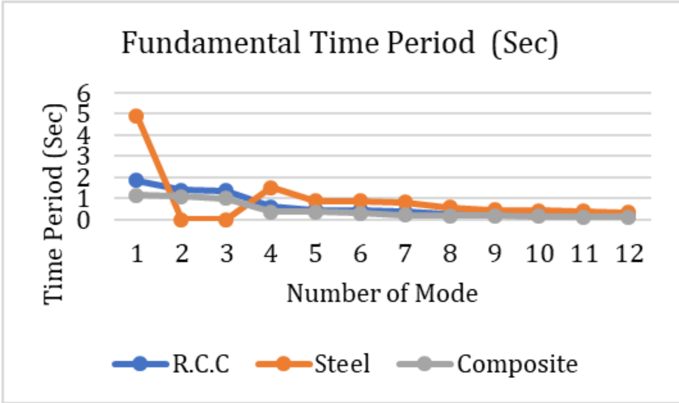


Chart -4: Time Period VS number of Mode

Table -7: Maximum Base Shear

R.C.C	Steel	Composite
1915.62	1831.56	2290.33

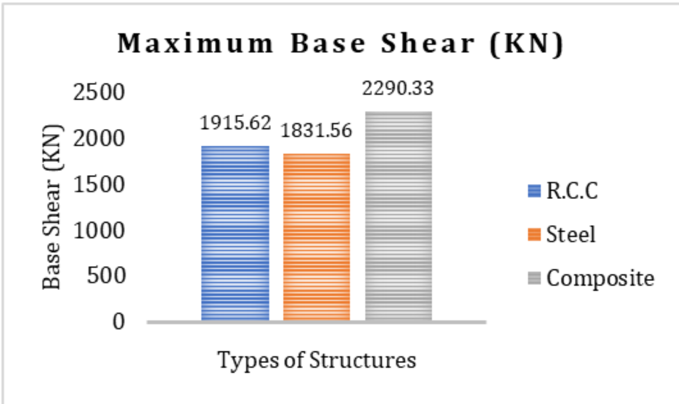
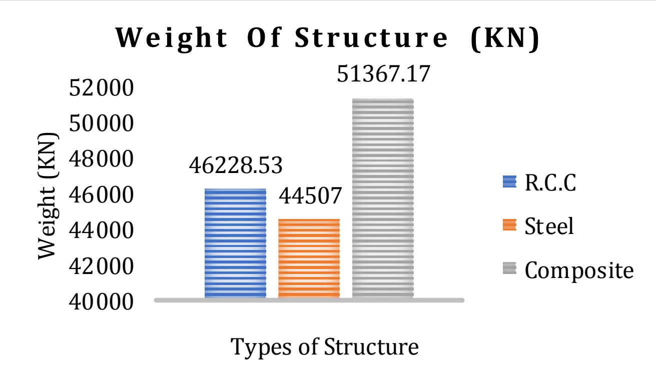


Chart -5: Base shear VS types of Structures

Table -8: Maximum Weight of Structures

R.C.C	Steel	Composite
46228.53	44507	51367.17



4. CONCLUSIONS

From the seismic analysis of different building configurations i.e. RCC, steel and steel concrete composite structures the following conclusions can be made:

The maximum displacement values are less in composite structures compared to RCC and steel structures hence it concludes that stiffness of composite structure is high compared to other buildings.

As the stiffness of composite members is high, the story drifts of composite structures are comparatively less than RCC and steel structures within permissible limits.

As the weight of the Steel concrete composite frame is more compared to RCC and Steel frame, it concludes that Steel concrete composite structure has maximum base shear value.

As it is already mentioned displacement values are less for composite structures so that time period required is also less for composite structures as compared to RCC and steel structure.

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REFERENCES

[1] Jadhav Gorakhnath S et.al (2017) "Comparative Analysis of RCC and steel-concrete Composite multistoried building, Journal of Information, Knowledge and Research in Civil Engineering, Volume 4, Issue 2, pp 398-404.

[2] Niles Kumar V. Ganwani and Dr. S. S. Jamkar (2016) "Comparative study of RCC and Steel-Concrete Composite building based on seismic analysis", International Journal of Engineering Research & Technology (IJERT), Volume 4, Issue 30, pp 1-4.

[3] Ketan Patel and Sonal Thakkar (2013) "Analysis of CFT, RCC and Steel building subjected to lateral loading", 3rd Nirma University International Conference on Engineering, Procedia Engineering 51, pp 259 – 265.

[4] IS 1893 Part 1:2016 Criteria for earthquake resistant design of structures (Sixth revision) Bureau of Indian standards, New Delhi.

[5] IS 456: 2000 "Plain and Reinforced Concrete- Code of Practice", Bureau of Indian standards, New Delhi.

[6] IS 800: 2007, "Indian Standard Code of practice for General Construction of Steel in India, Bureau of Indian Standards", New Delhi.

[7] IS 11384:1985, "Code of Practice for Design of Composite Structure, Bureau of Indian Standards", New Delhi.

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