PARAMETRIC STUDY OF RCC, STEEL AND COMPOSITE STRUCTURES UNDER SEISMIC LOADING

Dr. Ramakrishna Hegde[1], Mr. Bhavani shankar[2], Mohammed Farooq[3]
[1]Professor & HOD of civil engineering, Srinivas School of Engineering, Mangalore, India
[2]Assistant Professor, Department of Civil Engineering, Srinivas School of Engineering, Mangalore, India
[3]M.Tech Student, Department of Civil Engineering, Srinivas School of Engineering, Mangalore, India

---***---

***Abstract** - In this research work RCC, steel and composite structures comparison are taken into consideration in which same seismic conditions are applied to all the structures and analysis results have been compared to check the suitability of RCC, steel and composite buildings under seismic conditions. Here RCC, steel and composite buildings have been modelled and analysed on the same grid pattern and same external loads are applied on the all three structures. These three buildings are compared on the basis of uniform factor of safety between 2 to 3. The RCC Structure is no longer suitable because of increased dead load, span rejection and less stiffness .The structural engineers are trying to use different materials for most efficient design solution .There is great potential for increasing volume of steel in construction .The percentage of steel can be increased with the use of steel-concrete composite sections. The paper presents the effect of FEC (Fully Encased Composite) on a G+15 storey special moment frame. The building is analyzed and design for seismic loading by using ETAB software. Results are compared for the Base shear, Time period, Storey displacement and storey drift for all three structures. As the composite is having more lateral stiffness, the results of time period and storey displacement shows the significant variation. While analyzing for the performance point for the FEC is significantly much more as compared to the RCC model.*

Key Words: E-TABS, Seismic loads, Composite, Displacement, Storey drift, base shear, time period.

1. INTRODUCTION

In present days R.C.C structures &the steel-structures are mostly built, yet another type of structures known as Composite-structures additionally come into contemplations. It is very tough to realize that if there must arise an incidence of a low ascent buildings & high rise buildings which kind of structure will be more prudent & likewise provides significant quality. For the furthermost part tall structures are liked to be built as a steel structure & low ascent as R.C.C structures yet Composite-structures can make our structure more sparing & strong. In our exploration work, parametric investigation of Steel, R.C.C& Composite structure is made for elevated structure (G+15) story. For that some review & research papers are examined for the reference before determination of various segments for these three structures.

Utilizing the manual calculations, the pillar & column segments of Steel, R.C.C & the Composite buildings are chosen such that factor of safety can be normal.

ETABS is utilized for the parametric examination in which, low ascent (G+15) building is taken & then dead load, live load & super imposed load (dead) are connected alongside the seismic load. All the fundamental load combinations are framed. Here if there should be an existence of composite building, columns& beams are provided of composite CFST (Concrete filled steel tubes).& after the investigation, pillar forces, column forces, joint displacements, story accelerations, story drifts, story max displacements, story firmness & story shear are thought about.

2. BUILDING DESCRIPTION

Table -1: Description of structures

Description	RCC	Steel	Composite structure
No. of stories	16	16	16
Total floor height	3m	3m	3m
Dimension of structure	24mX24m	24mX24m	24mX24m

Table -2: Material Properties of Concrete and Steel

Property	RCC	Steel	Composite structure
Grade of steel (N/mm^2)	Fe 500	Fe 345	Fe 345
Grade of concrete (N/mm^2)	M25, M40	-	M25, M40
Poisson's ratio for concrete	0.2	-	0.2
Concrete density	25 kN/m^3	-	25 kN/m^3

Table -3: Geometric Parameters

Parameter	RCC	Steel	Composite structure
Plan	24mX24m	24mX24m	24mX24m
Beam (in mm)	300X600	ISMB350	ISMB350
Column (in mm)	650X650	650X300X 30	500X500 encased ISMB450
Slab thickness	200mm (2way slab)	100mm	100mm
Height of each storey	3m	3m	3m
Grade of concrete for beam	M25	-	-
Grade of concrete for Column	M40	-	M40
Grade of concrete for Slab	M25	-	M25

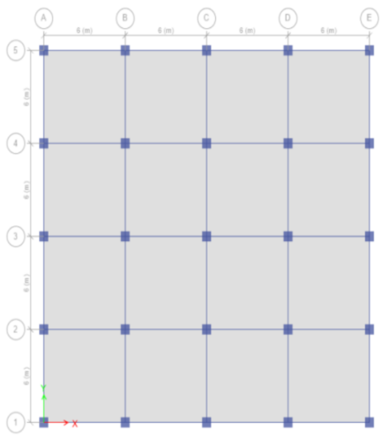


Fig -1 plan view

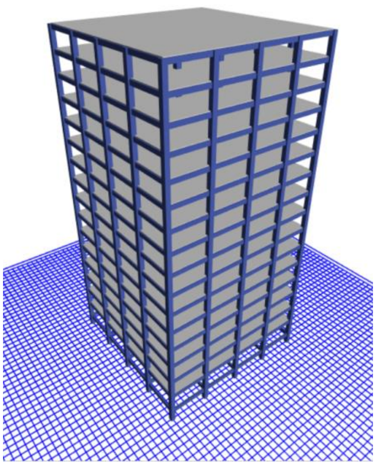
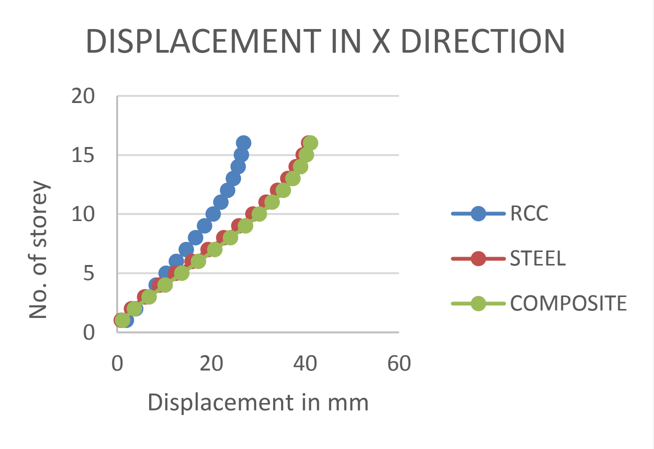


Fig 2 3-d view

3. RESULTS AND DISCUSSIONS

DISPLACEMENT IN X DIRECTION			
Storey	RCC in mm	Steel in mm	Composite in mm
16	26.972	40.835	41.219
15	26.489	39.642	40.332
14	25.766	38.17	39.099
13	24.778	36.36	37.462
12	23.542	34.205	35.427
11	22.089	31.728	33.032
10	20.45	28.963	30.324
9	18.656	25.956	27.352
8	16.737	22.753	24.167
7	14.717	19.404	20.815
6	12.623	15.967	17.345
5	10.476	12.505	13.807
4	8.298	9.106	10.268
3	6.116	5.891	6.826
2	3.974	3.055	3.664
1	1.977	0.913	1.141

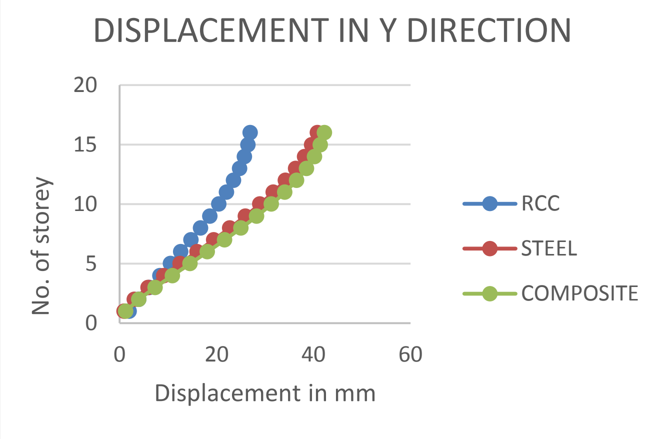
Table 4.1 Displacement of the structure in the X direction



Graph 4.1 Displacement of the structure in the X direction

DISPLACEMENT IN Y DIRECTION			
Storey	RCC in mm	Steel in mm	Composite in mm
16	26.972	40.835	42.257
15	26.489	39.642	41.422
14	25.766	38.17	40.21
13	24.778	36.36	38.565
12	23.542	34.205	36.505
11	22.089	31.728	34.073
10	20.45	28.963	31.321
9	18.656	25.956	28.302
8	16.737	22.753	25.066
7	14.717	19.404	21.659
6	12.623	15.967	18.128
5	10.476	12.505	14.519
4	8.298	9.106	10.888
3	6.116	5.891	7.324
2	3.974	3.055	3.996
1	1.977	0.913	1.273

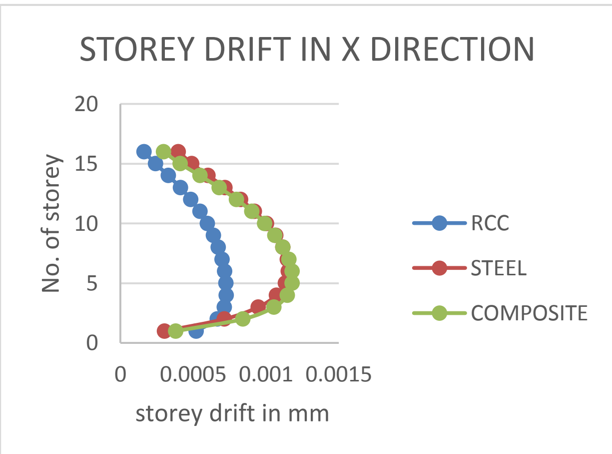
Table 4.2 Displacement of the structure in the Y direction



Graph 4.2 Displacement of the structure in the Y direction

STOREY DRIFT IN X DIRECTION			
Storey	RCC in mm	Steel in mm	Composite in mm
16	0.000162	0.000398	0.000296
15	0.000241	0.000491	0.000411
14	0.000329	0.000603	0.000546
13	0.000412	0.000718	0.000678
12	0.000484	0.000826	0.000798
11	0.000546	0.000921	0.000903
10	0.000598	0.001003	0.000991
9	0.00064	0.001068	0.001062
8	0.000673	0.001116	0.001117
7	0.000698	0.001146	0.001157
6	0.000716	0.001154	0.001179
5	0.000726	0.001133	0.00118
4	0.000727	0.001072	0.001147
3	0.000714	0.000946	0.001054
2	0.000666	0.000714	0.000841
1	0.000521	0.000304	0.00038

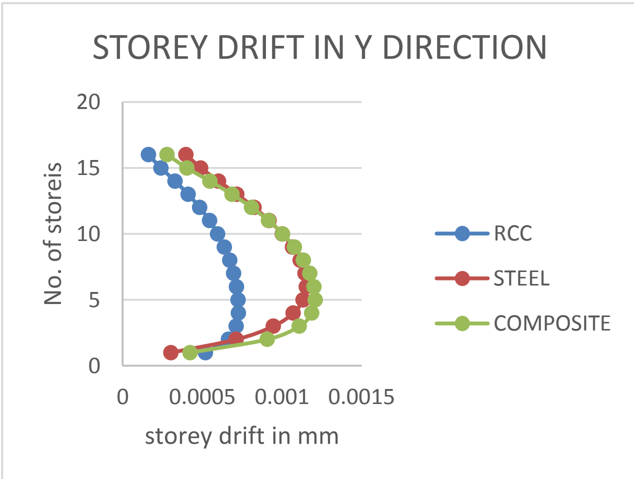
Table 4.3 Storey drift of the structure in x direction



Graph 4.3 Storey drift of the structure in x direction

STOREY DRIFT IN Y DIRECTION			
Storey	RCC in mm	Steel in mm	Composite in mm
16	0.000162	0.000398	0.000279
15	0.000241	0.000491	0.000404
14	0.000329	0.000603	0.000548
13	0.000412	0.000718	0.000687
12	0.000484	0.000826	0.000811
11	0.000546	0.000921	0.000917
10	0.000598	0.001003	0.001006
9	0.00064	0.001068	0.001079
8	0.000673	0.001116	0.001135
7	0.000698	0.001146	0.001177
6	0.000716	0.001154	0.001203
5	0.000726	0.001133	0.00121
4	0.000727	0.001072	0.001188
3	0.000714	0.000946	0.00111
2	0.000666	0.000714	0.000908
1	0.000521	0.000304	0.000424

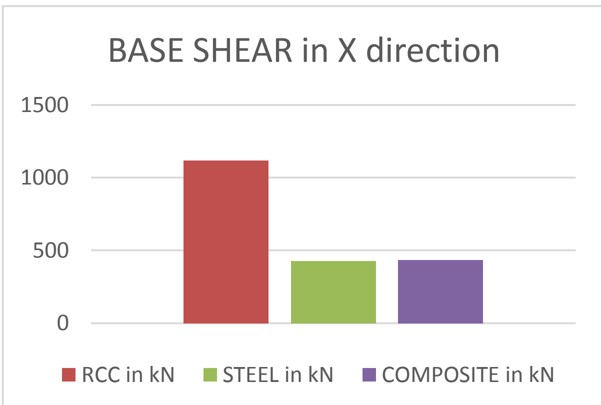
Table 4.4 Storey drift of the structure in y direction



Graph 4.4 Storey drift of the structure in y direction

BASE SHEAR in X direction	
R.C.C in kN	1119.299
STEEL in kN	429.2732
COMPOSITE in kN	432.1367

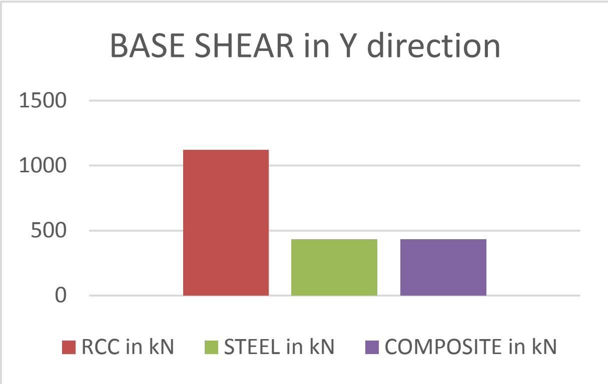
Table 4.5 Base shear of the structure in the X direction



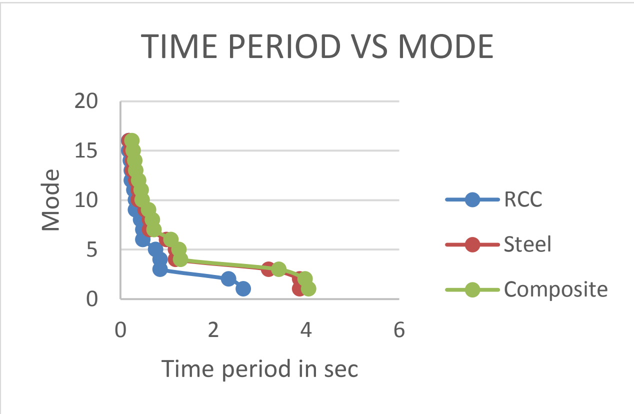
Graph 4.5 Base shear of thestructure in theX direction

BASE SHEAR in Y direction	
R.C.C in kN	1119.299
STEEL in kN	429.2718
COMPOSITE in kN	429.632

Table 4.6 Base shear of the structure in the Y direction



Graph 4.6 Base shear of the structure in theY direction



Graph 4.7 Time period v/s modes of a structure

TIME PERIOD VS MODES			
Storey	RCC (period in sec)	Steel (period in sec)	Composite (period in sec)
1	2.648	3.857	4.055
2	2.328	3.857	3.977
3	0.857	3.192	3.412
4	0.857	1.188	1.297
5	0.757	1.188	1.26
6	0.486	0.993	1.09
7	0.486	0.625	0.723
8	0.434	0.625	0.692
9	0.327	0.53	0.608
10	0.327	0.385	0.472
11	0.293	0.385	0.445
12	0.237	0.33	0.396
13	0.237	0.259	0.334
14	0.213	0.259	0.31
15	0.181	0.223	0.279
16	0.181	0.185	0.248

Table 4.7 Time period v/s modes of a structure

CONCLUSIONS

1. The Stiffness of composite building is discovered more noteworthy compared with &R.C.Cassembly.

2. Mass of the composite building is low when it is analogized with R.C.C. structure bringing about diminishment of establishment cost.

3. For tall rise assemblies, Composite-structures are observed to be finest method of development.

4.Storey drift for steel erection is more effectively analogized with R.C.C & composite structure.

5. Drift of all structures is within allowable limit.

6. The expanded solidness of R.C.C structures brings about expanded recurrence & reduction in the time period than Composite-structures

7. The greatest relocations are more in the Composite-structures yet inside breaking point. This is on grounds that Composite-structures are efficiently more adaptable when anogolized with R.C.C structures.

8. Because of more slender segment areas in Composite-structures the usable floor region increments

9. The shear power & twisting moment are decreased in the Composite-structures which brings actually about more slender areas in beams.

10. Due to light heaviness of the structure, Composite-structures are less vulnerable against the seismic forces acting on structure.

REFERENCES

1) Yongjian Shia, Xia Lib, Analysis of Ductility of Composite Steel-Concrete Structure Based on Computer simulation Technology, Department of Civil and Architecture Engineering, Dalian University, Dalian116622,China.
2) Mohd amir khan, Comparative Study of R.C.C & Structural Steel -Concrete Composite Frame for Linear and Non-Linear Analysis International Research Journal of Engineering and Technology p-ISSN: 2395-0072 , IRJET Page 2139 July -2017.
3) Bhavin H. Zaveri , Bhargav K.Panchotiya, Smit U. Patel, Parametric study of RCC, steel and composite structures under seismic loading, International Journal of Civil Engineering and Technology, pp. 127–147 July-August 2016.
4) Renavikar Aniket V.1, Suryawanshi Yogesh, Comparative Study on Analysis and Cost of R.C.C. and Steel-Composite Structure International Journal of Science and Research (IJSR) Volume 5 Issue 7, July 2016.
5) Manjari Blessing B, Gayathri S, Comparative Analysis of CFST and RCC Structures Subjected to Seismic Loading, International Journal of ChemTech Research Vol.10 No.8, pp 409-416, 2017.
6) Sattainathan.A, Nagarajan.N, Comparative study on the behavior of R.C.C., Steel and composite structure, International Journal on Applications in Civil and Environmental Engineering. 1(3), pp 21–26, March 2015.