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Comparision Of Seismic Behaviour Of A Typical Multi Storey Structure With Composite Columns And Rcc Columns

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Abstract: RCC-Concrete composite constructions are now a days very popular owing to their advantages over conventional concrete constructions. Concrete structures are bulky and impart more seismic weight and less deflection whereas steel structures impart more deflections and ductility to the structure, which is beneficial in resisting earthquake forces. Composite column is the combination of steel and concrete. The present work seeks to investigate the seismic behavior of a typical framed structure with composite columns and RCC columns and examine the key design issues involved. The present study deals with the comparative seismic behavior of a typical (G+15) multi-story structure through equivalent dynamic method of analysis for moderate seismic zone II using ETABS software.

Keywords: RCC-Concrete composite, Conventional Concrete constructions, (G+15) multi-story structure, Seismic zone II, ETABS software

1. INTRODUCTION

Now days, where we get to see a lot of structures, big and small, modern, and old, what catches our eyes the most are the modern skyscrapers, these structures are made from extraordinary attainments in science and engineering. nowadays, the focus has been shifted to constructing safe buildings keeping in mind the economic aspects of the project, as far as residential and commercial purpose is considered, generally, high-rise buildings, tall structures, towers, and blocks are constructed. They may also be known as vertical city. Consist of the ability to give more ground space and accommodating more people in less space. Hence giving us benefits such as a beautiful skyline, important landmarks, and optimum land use. Main reason behind these have achieved structure's stability, strength, and stiffness and for reached that purpose innovation came in to introduction. 'Composite construction.' Composite construction governs the non-residential high storey buildings sector. This has been the case for over twenty years. Its recognition is due to it has strength and stiffness that can be achieved, with minimum use of

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material the reason why composite construction is frequently so good can be expressed in one simple way - concrete is good in compression and steel is good in tension. By combining these two materials together structurally these strengths can be exploited to result in a highly efficient and light weight design. Composite systems also offer benefits in terms of time saving construction. The floor depth decreases that can be achieved using composite construction can also provide major benefits in terms of the costs of services

Columns were hardly used from the second world war till the initial 1970' s, research had started a long time before, at the 20th century. Combining of these materials had several motivations, steel columns were frequent encased in concrete to give resistance against the fire, and the other hand concrete columns used with steel as a rebar providing. 'til the 1950s. it was common to use a wet mix of less strength concrete and neglect the role of the good class concrete to the strength of the column. In 1956 Faber and Steven proved that it had good in savings could be made by using good-class concrete and use these columns like a composite part. Method was discovered by stages from initially design ways for steel columns. Not centred on ultimate research on composite columns. In the era of 1980, many buildings were built by using of composite column. Many developed countries like USA, Japan, Germany, Singapore, Australia, Canada, Belgium etc., adopt this kind of composite sections to facilitate speedy construction. Because of the increased use of composite columns, many experimental and theoretical research works been carried out to study the behaviour of the CFST columns.

Concrete infill steel column uses the benefit of both material steel as well as concrete. Generally steel hollow section of circular or rectangular fill with plain or reinforced concrete.it is mostly used in high-rise and multi-storey buildings as columns, and as beams in low-rise industrial buildings where a healthy and effective structural system is needed. there are several various advantages about which to such structural systems in both ways of structural performance and construction order. the innate buckling problem in thin-walled steel tubes is either banned or reduce because of the existence of the concrete core in. in addition that, the ability of the concrete in-fill is improved due to its confinement effect applied by the steel shell. Another factor like distribution of materials in the cross section helps them to whole system efficient in term of its structural performance. Because of the steel cover provided outer side it behaves most efficiently in tension and buckling. also gives the ultimate stiffness as the material lies furthest from the centroid. this, combined with the steel's high modulus of elasticity, gives the high impact to the moment of inertia. the concrete core gives the greater contribution to resisting axial compression.

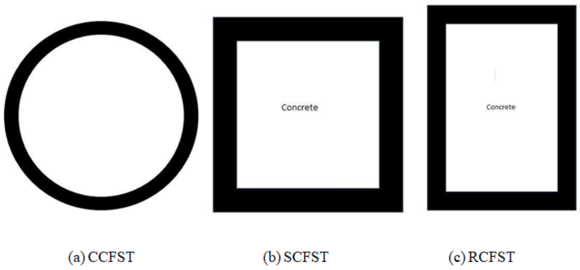

Fig 1: Concrete filled sections

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2. METHODOLOGY AND MODELLING

The inventive and progressive new ETABS is a definitive coordinated programming bundle for the auxiliary investigation and outline of structures. Joining 40 years of persistent innovative work, this most recent ETABS offers unmatched 3D protest based demonstrating and representation instruments, blazingly quick straight and nonlinear explanatory power, complex and extensive plan capacities for an extensive variety of materials, and realistic showcases, reports, and schematic illustrations that enable clients to translate and comprehend examination and configuration comes about rapidly and effortlessly. Outline of steel and solid edges (with mechanized improvement), composite bars, composite segments, steel joists, and cement and brick work shear dividers are incorporated, like the limit check for steel associations and base plates. Models might be practically rendered, and all outcomes can be indicated specifically on the structure. Extensive and adjustable reports are accessible for all examination and configuration yield, and schematic development illustrations of surrounding plans, timetables, subtle elements, and cross-areas might be created for cement and steel structures. ETABS gives an unequaled suite of instruments for basic architects planning structures, regardless of whether they are taking a shot at one-story mechanical structures or the tallest business elevated structures. Massively competent, yet simple to-utilize has been the sign of ETABS since its presentation decades back, and this most recent discharge proceeds with that custom by giving architects the innovatively progressed, yet instinctive, programming they require to be their generally beneficial.

2.1 Methods for analysis

- Modeling of Structural Systems
- In the present work, Structure was modeled for Composite columns and RCC columns for G+15 stories for seismic Zone-II by considering IS: 1893 2002 Code.
- Loading, Analysis
- By using this Code provisions verifying Models and Results
- The Results of Story drift, Displacement, Base reaction for Composite Columns and RCC Columns are compared.
- The analysis of the building has been carried out using ETABS 2016.
- The results from the models (Story drift, Displacement, Base reaction)

Table 1: Preliminary Data required for Composite and RCC models

Composite and RCC models		
S.No	**Parameter**	**Values**
1	No of Story	G+15
2	Each floor Height	3m
3	Height of Building	45m from GL

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4	Materials	Concrete –M30 grade Steel-HYSD 500
5	Beam Sizes	0.4m*0.6m
6	Support	Fixed
7	Slab thickness	0.15m
8	Column size	0.6m*0.6m
9	I- section(Composite)	ISMB500

Table 2: Load details

Load Details		
A	Dead Load	In ETABS the software itself calculates the dead loads by applying a self-weight multiplier factor of one which is taken by the structure and the rest load cases are kept zero. It is defined in load cases.
B	Live load on floors	3 kN/m2 as per IS 875-part 2
C	Floor finish on floors	1.5 kN/m2 as per IS 875-part 2

Table 3: Seismic Data analysis required for composite and RCC models

Seismic Data analysis required for composite and RCC models			
S.No	Parameter	Values as per IS 1893 2002-part 1	Reference
1.	Seismic Zone	II	Table 2 clause 6.4.2
2.	Zone Factor (Z)	0.1	Table 2 clause 6.4.2
3.	Type of soil	II(Medium)	Clause 6.4.2.1
4.	Damping	5%	Clause 7.2.4
5.	Response Spectra	As per 1893 2002	Figure 2, clause 6.4.6
6.	Load Combinations	1.5 (DL+LL), 1.2(DL+LL+EQ+X, 1.2(DL+LL+EQ-X), 1.2(DL+LL+EQ+Y) 1.2(DL+LL+EQY), 1.5(DL+EQ+X), 1.5(DL+EQ-X), 1.5(DL+EQ+Y), 1.5(DL+EQ-Y)	clause 6.3.1.2

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7.	Response reduction factor	5	Table 9 Clause 7.2.6
8.	Importance Factor	1	Table 6 clause 7.2.3

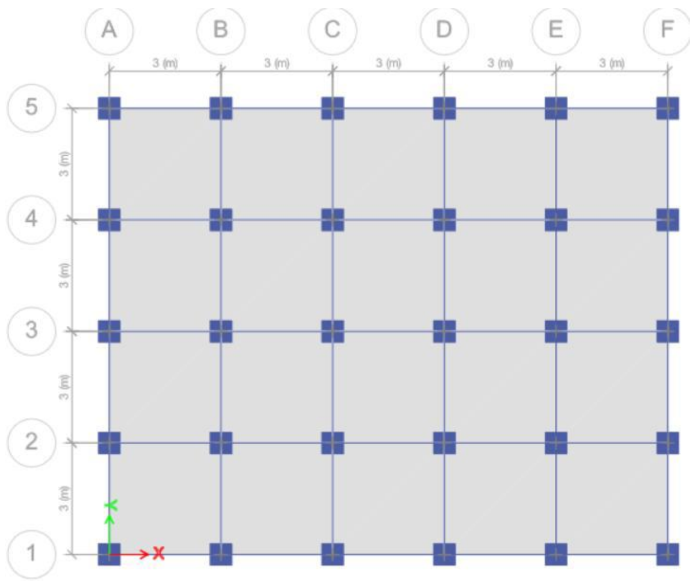

Fig 2: Etabs Plan view

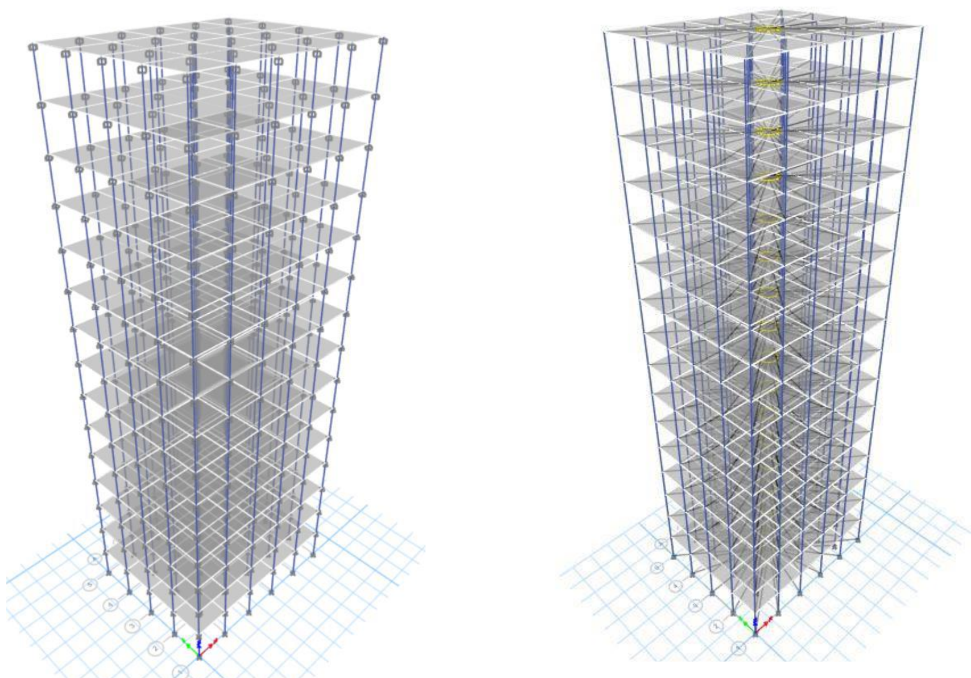

Fig 3: 3D view RCC and Composite

3. RESULTS AND DISCUSSIONS

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3.1 Shear force

The reduction in shear force observed in the composite structure is primarily attributed to its lower dead load and greater structural efficiency. Since earthquake forces are proportional to seismic weight, the lighter composite system generates smaller inertia forces. Furthermore, the higher stiffness of steel members enhances lateral load distribution and minimizes shear concentrations in individual members.

In contrast, the RCC structure attracts greater seismic forces because of its higher self-weight. Consequently, larger shear forces develop in beams and columns, especially at the lower storeys, necessitating additional shear reinforcement and careful detailing to prevent brittle failure.

- RCC structures develop higher base shear due to greater self-weight.
- Composite structures reduce shear demand because of lower mass and increased stiffness.
- Maximum shear forces occur at the lower storeys in both systems.
- Composite buildings distribute shear more uniformly, improving structural efficiency and seismic performance.
- ETABS results indicate that composite construction is advantageous for high-rise buildings subjected to lateral loads.

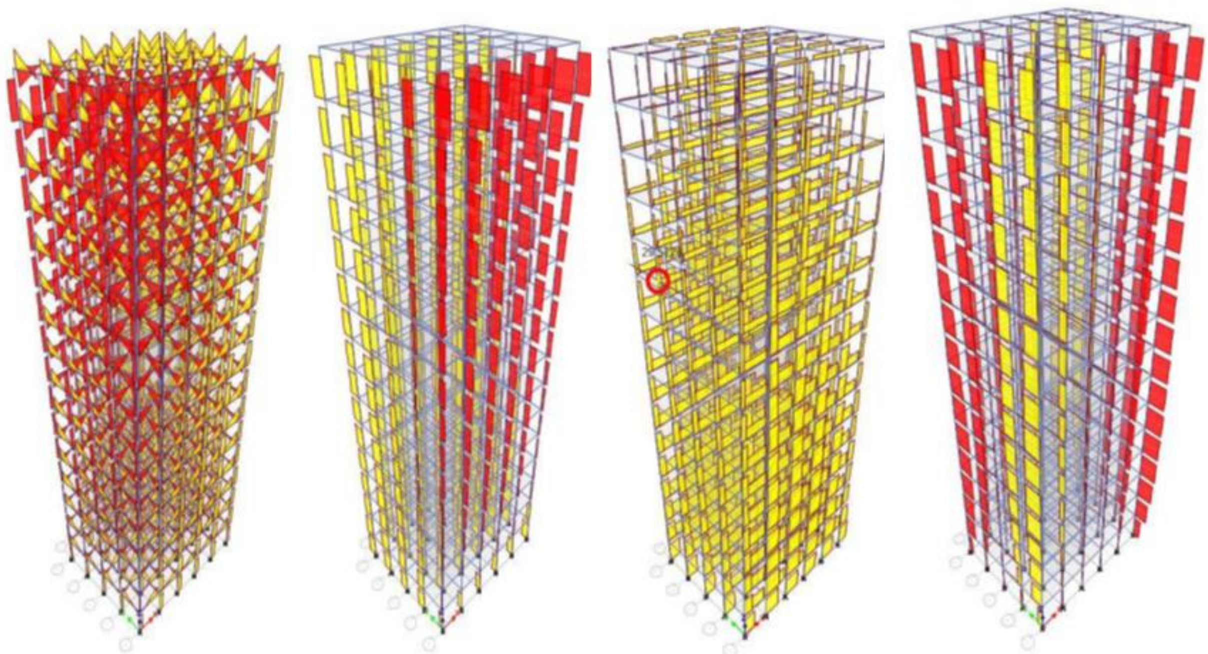

Fig 3: RCC & Composite Columns Shear forces

3.2 Bending moment

The RCC frame develops larger flexural moments because of its comparatively lower stiffness. Higher bending moments occur at the beam-column connections and lower-storey columns, where

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gravity and lateral loads accumulate. These larger moments require increased reinforcement and careful detailing to ensure ductile behaviour under seismic loading.

The composite column frame demonstrates improved structural efficiency due to the higher stiffness and strength of the steel–concrete composite sections. The bending moments are more evenly distributed, and the maximum moment values are reduced. Consequently, the structure experiences smaller lateral displacements, lower beam moments, and reduced seismic demand.

The reduced moment concentration in the composite frame indicates a more efficient load transfer mechanism and better utilisation of structural members.

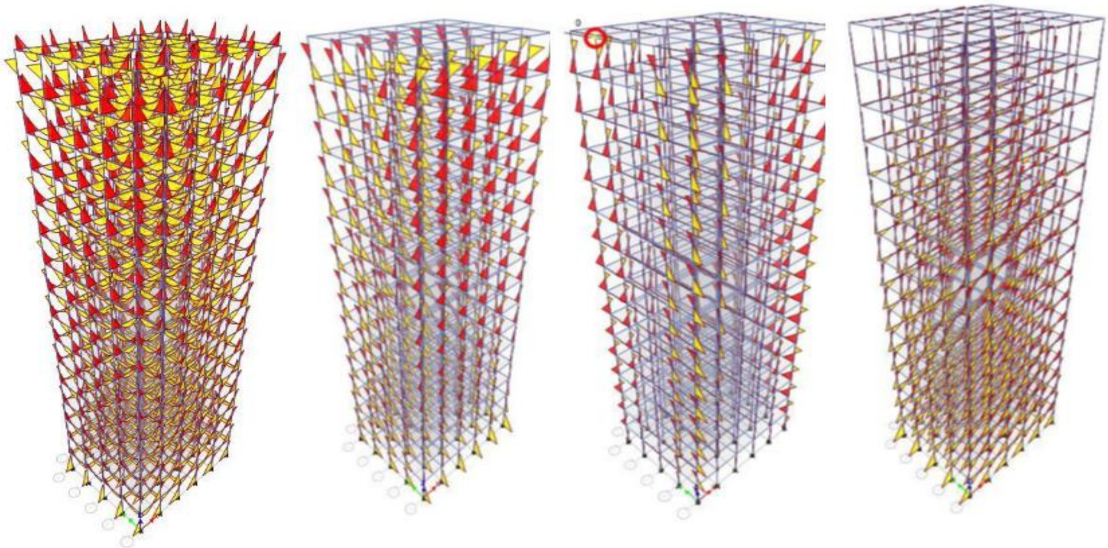

Fig 4: RCC & Composite Columns Bending Moment

3.3 Storey Displacement

The ETABS results clearly indicate that the composite column structure performs better than the RCC column structure in controlling lateral displacement under seismic loading. The maximum roof displacement decreases from 47.38 mm to 43.26 mm in the X-direction and from 52.47 mm to 49.95 mm in the Y-direction. This improvement confirms that composite columns provide greater lateral stiffness and superior seismic performance compared with conventional reinforced concrete columns.

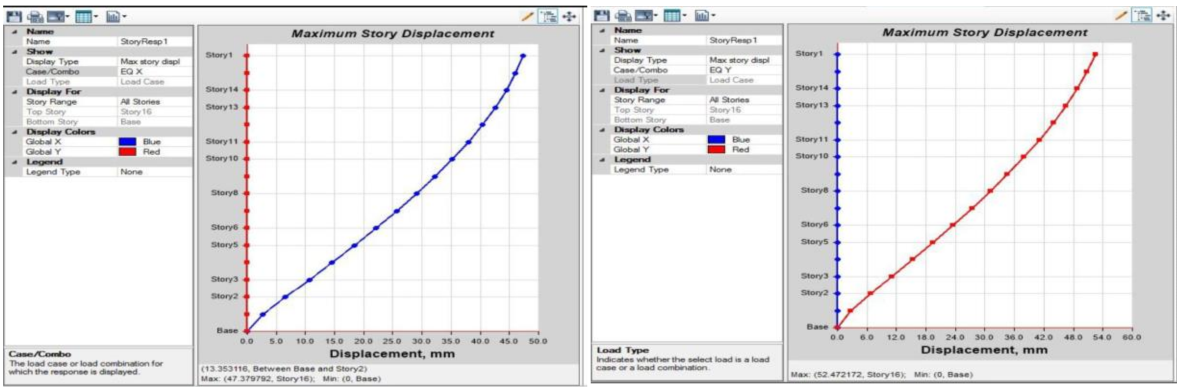

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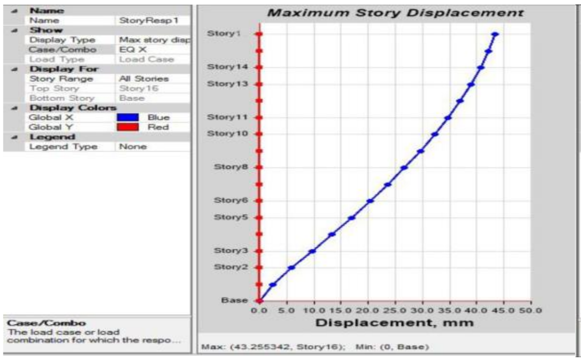
Fig 5: storey Displacement in RCC



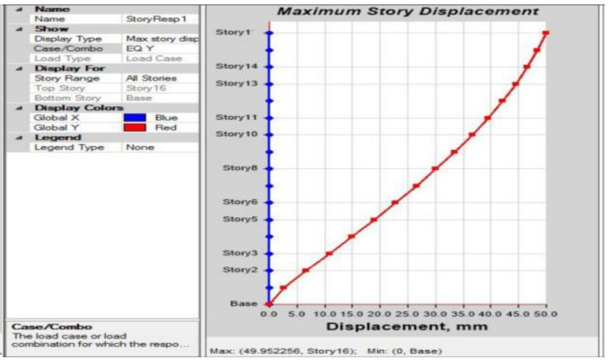


Fig 6: storey Displacement in Composite columns

3.4 Base Reactions

The base reaction analysis demonstrates that the composite column structure exhibits lower base shear and overturning moments compared with the RCC column structure, indicating a more efficient seismic response. Specifically, the X-direction base shear decreases by approximately 11.1%, while the X-direction overturning moment decreases by about 20.3%. The reported reductions in the Y-direction (FY = 671.50 kN and MX = 23147.98 kN-m) are exceptionally large and should be verified against the ETABS model before drawing final conclusions. If confirmed, these results indicate that the composite column system substantially reduces seismic forces transmitted to the foundation, thereby enhancing structural stability and reducing foundation design requirements.

Table 4: Base reactions

MODEL	LOAD CASE	FX (KN)	FY (KN)	MX (KN-m)	MY (KN-m)
RCC COLUMN	EQ X	-5672.20	0	0	-153143.9
	EQ Y	0	-5672.20	153143.9	0
COMOSITE COLUMN	EQ X	-5041.62			-122075.28
	EQ Y	0	-671.5	23147.98	0

3.5 Storey Drift

- Under EQ-X loading, the RCC column structure exhibits a storey drift of 0.000535 m, whereas the composite column structure records a lower drift of 0.000476 m, representing a reduction of approximately 11.0%.
- Under EQ-Y loading, the RCC structure has a storey drift of 0.000664 m, while the composite structure shows 0.000598 m, corresponding to a reduction of approximately 9.9%.

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- In both loading directions, the composite column structure experiences lower storey drift than the RCC structure, indicating greater lateral stiffness and improved resistance to earthquake-induced deformation.
- The reduced drift in the composite system helps minimise damage to structural and non-structural components, improves occupant safety, and enhances overall seismic performance.
- Furthermore, the storey drift values of both structural systems are well within the permissible limits specified by IS 1893 (Part 1): 2016, demonstrating satisfactory seismic behaviour.

Table 5: Storey drift

MODEL	**LOAD CASE**	**CASE TYPE**	**DIRECTION**	**DRIFT** (m)
RCC COLUMN (STORY 15)	EQ X	LinStatic	X	0.000535
	EQ Y	LinStatic	Y	0.000664
COMOSITE COLUMN (STORY 15)	EQ X	LinStatic	X	0.000476
	EQ Y	LinStatic	Y	0.000598

4. CONCLUSIONS

- Composite structure has less story drift and base shear when compared to RCC structure
- Max story displacement obtained for composite structure is less when compared to RCC columns.
- Story drift for RCC columns is 12.7% more when compared to composite columns
- Displacement when compared, RCC columns gets 9.3% more than Composite columns.
- Base reaction when compared, RCC columns are 12.52% more than Composite columns.

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