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EVALUATING ECONOMIC AND DYNAMIC EFFICIENCIES IN RCC, STEEL, AND COMPOSITE FRAMES FOR DIFFERENT BUILDING HEIGHTS

Md Ziyaullah Ansari[1], Afzal Khan[2]
[1,2]Millennium Institute Of Technology & Science Bhopal (M.P), India.

ABSTRACT

Reinforced Cement Concrete (RCC) is widely used for low and medium-rise buildings in India. However, for high-rise buildings, steel-concrete composite construction offers better performance due to its ductility and cost-effectiveness. This study compares RCC, steel, and composite frame structures for buildings of different heights under seismic conditions using ETABS. The analysis includes base shear, storey displacement, storey drift, modal frequency, and cost. The results indicate that composite structures offer superior seismic resistance and economic benefits for high-rise buildings.

1. INTRODUCTION

Background

The demand for high-rise buildings is increasing due to rapid urbanization and space constraints. RCC structures dominate low-rise construction, but composite structures, integrating steel and concrete, are gaining popularity for taller buildings due to their enhanced seismic performance and reduced construction time.

Objectives

- Compare RCC, steel, and composite structures for low, medium, and high-rise buildings.
- Analyze structural behavior using ETABS.
- Perform a cost comparison of beam and column members.

2. LITERATURE REVIEW

Studies indicate that composite structures perform better under seismic loads than RCC and steel structures. Composite frames exhibit reduced base shear and improved load distribution due to their hybrid nature. Prior research has demonstrated that composite structures have a higher stiffness-to-weight ratio, reducing storey drift and displacement.

3. METHODOLOGY

Structural Modeling

Buildings of 11, 21, and 31 storeys were modeled in ETABS. Each model was analyzed for seismic Zone IV conditions.

Load Considerations

- Dead Load: IS 875 (Part I)
- Live Load: IS 875 (Part II)
- Wind Load: IS 875 (Part III) with wind speed of 47m/s
- Earthquake Load: IS 1893

Cost Analysis

Cost estimation for beams and columns was performed using MS Excel.

4. RESULTS & DISCUSSION

Base Shear (kN)

Building Type	RCC	Steel	Composite
Low Rise	6394.42	5774.24	6103.41
Medium Rise	8024.73	6677.66	7535.81
High Rise	8797.92	6908.88	7613.33

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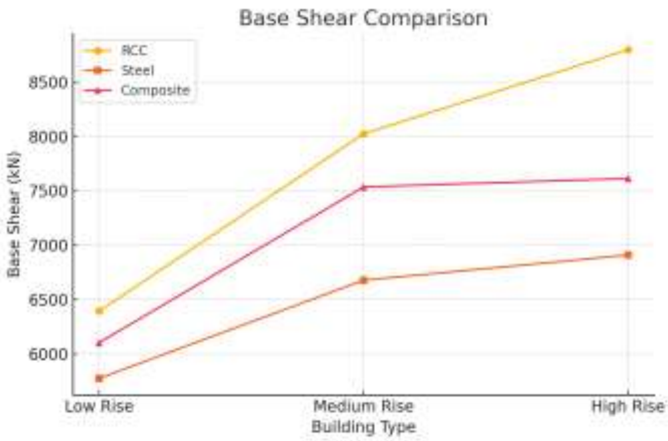
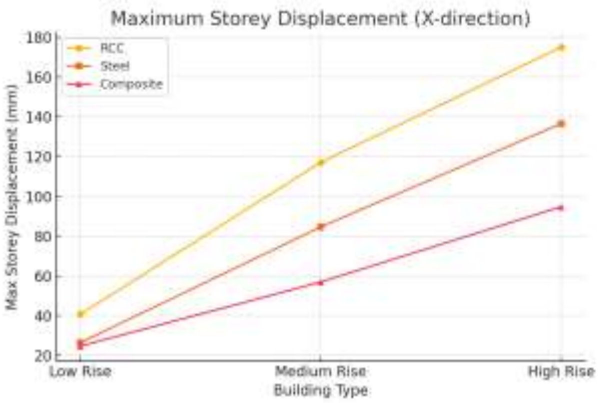


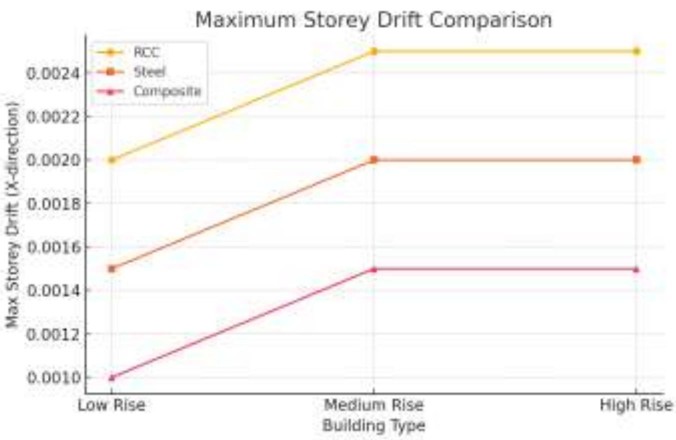
Maximum Storey Displacements (mm)

Building Type	RCC (X)	RCC (Y)	Steel (X)	Steel (Y)	Composite (X)	Composite (Y)
Low Rise	40.8	34.9	26.5	28	24.8	21.2
Medium Rise	117.1	90.4	84.7	81.4	57	47
High Rise	175	139.7	136.6	131.5	94.8	83.4



Maximum Storey Drift

Building Type	RCC (X)	RCC (Y)	Steel (X)	Steel (Y)	Composite (X)	Composite (Y)
Low Rise	0.002	0.0015	0.0015	0.001	0.001	0.0005
Medium Rise	0.0025	0.002	0.002	0.0018	0.0015	0.0012
High Rise	0.0025	0.002	0.002	0.0018	0.0015	0.0012

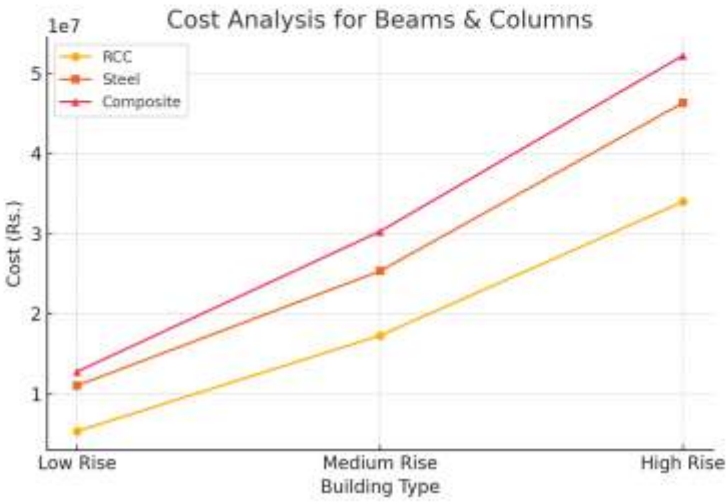


Modal Frequency Comparison (Hz)

Mode	RCC (Low)	Steel (Low)	Composite (Low)	RCC (Med)	Steel (Med)	Composite (Med)	RCC (High)	Steel (High)	Composite (High)
1	1.5	2.0	2.5	1.2	1.8	2.2	1.0	1.5	2.0
2	1.3	1.8	2.3	1.0	1.5	2.0	0.8	1.2	1.8

Cost Analysis (Rs.)

Building Type	RCC	Steel	Composite
Low Rise	5,368,167	11,047,420	12,798,120
Medium Rise	17,296,492	25,343,260	30,288,014
High Rise	33,975,040	46,296,200	52,202,020



5. CONCLUSION

1. Composite frames offer better seismic resistance and reduced storey drift.
2. RCC is ideal for low-rise buildings, while composite frames are recommended for medium and high-rise structures.
3. Composite structures reduce overall project duration, offsetting higher material costs.

6. FUTURE SCOPE

- Detailed cost analysis including slabs, footings, and connections.
- Consideration of irregular building shapes.
- Soil investigation and alternative seismic analysis methods.

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