"A COMPARATIVE STUDY & ANALYSIS OF SEISMIC BEHAVIOUR OF COMPOSITE AND RCC STUCTURE USING E-TABS"

Ankit Mourya, Dr. J.N. vyas

[1]Student, Department of civil engineering Mahakal Institute of Technology and Management Ujjain
[2]Director, Mahakal Institute of Technology and Management Ujjain.

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Abstract -

Worldwide different types of RC and steel structures with various floor systems are being used. In few years construction technology has changed, firstly masonry structure were widely used, later steel structure system started for multistory. With the introduction of reinforced concrete, RC structural systems started for multistory building construction. With the invention of welding, it became practical to provide mechanical shear connectors to consider composite action. Due to failure of many multi-storied and low-rise RC and masonry buildings due to seismic behavior, structural engineers are looking for the alternative methods of construction. Use of composite or hybrid material is of particular interest.

Key Words: **RCC STRUCTURE, COMPOSITE STRUCTURE, TIME PERIOD, DEFLACTION COST ANALYSIS.**

1. INTRODUCTION

Steel and composite structures are majorly use these days. As a result, alternative structural systems are gradually developing in India to compete with RCC structural systems. The majority of the structures are RCC. In India, RCC structures are currently dominant, with steel structures gradually making their way into multistory building structures. As a result, a comparative analysis is required to determine the most effective structure.

Mainly reinforced concrete is used for construction. Because of its lower strength-to-weight ratio, reinforced concrete will become uneconomical as the number of floors increases. It will also take more time to execute as it needs curing.

1.1). Reinforced Concrete

Reinforced concrete **usually consisting of** Portland cement, water, **production** aggregate (coarse and fine), and **steel** reinforcing bars (rebar), concrete is **less expensive** in **comparison** to structural **steel.**

Concrete is a composite material with relatively high compressive strength properties, but lacking in tensile strength. This inherently makes concrete a useful material for carrying the weight of a structure. Concrete reinforced with steel rebar give the structure a stronger tensile capacity, as well as an increase in ductility and elasticity.

1.2). Combining steel and reinforced concrete

Material properties have a significant impact on seismic load. Because of the low strength-to-weight ratio of RC structures, lateral resisting members such as columns should be large in order to resist lateral forces. This will increase the base shear on the structure. Steel structures have higher ductility and elasticity than RC structures. Because the strength-to-weight ratio of a steel structure is high, the structure's weight is low. As a result, thin sections are used, which may be prone to buckling. Buckling is a major structural steel failure for large structures in seismic zones. It is critical to use a steel concrete composite structure in order to have both material properties. Concrete's high compressive strength prevents structural steel from buckling. Composite structures are stiffer than steel structures due to the use of concrete. When compared to RC structures, composite structures are much more ductile.

2. METHODOLOGY

The primary objective of this chapter is to perform analysis of a fifteen storied residential building as R.C.C and composite structure. Finally, comparison of structural behavior of the building required to evaluate better structural system. To achieve this objective, complete architectural design of a 2B+G+12 residential building has been used, gengtok, Sikkim located.

RCC structural systems have been formed. Again following same plan, composite structural systems have been formed. Then structural modeling and analysis have been performed by ETABS 2019 software for the selected two types of structural systems. Loads are assigned as per required for residential building. Load combinations are generated regarding. Comparisons of seismic structural behaviors have been prepared to evaluate better most effective structural system for the building used for this research.

2.1) Architectural Design

Complete architectural design of a 3B+G+12 stories residential building is chooses .To reduce torsion effect on the structure symmetric floor systems is used. Since the structure is symmetric.

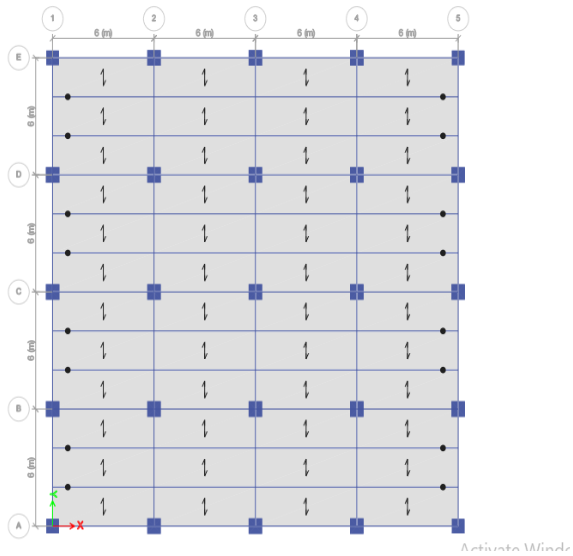

Figure 2.1 Typical Floor Plan

2.2) Structural System:

But in this analysis we used solid slab for a rigid diaphragm. But for composite structure reinforced concrete slab on corrugated steel deck is formed as composite is used.

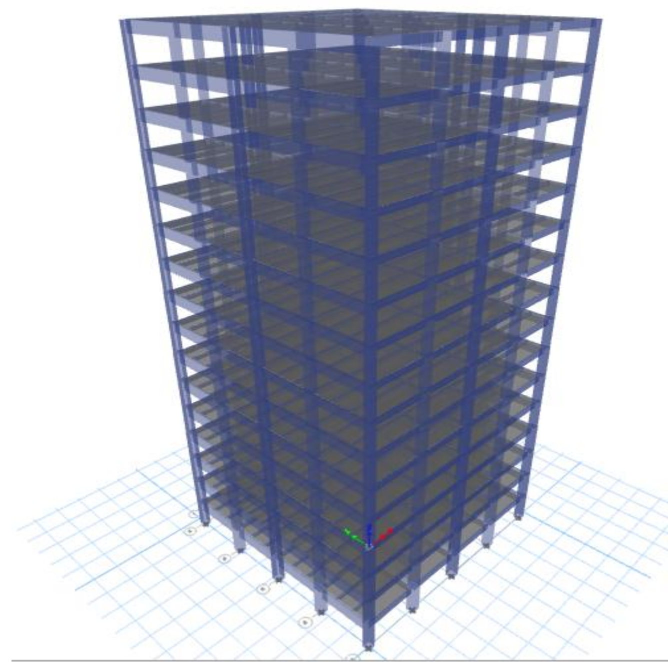

Figure 2.2 3D View of structural framing system

2.3) RCC Structure:

RC structural system is formed with beamsupported 12.5cm thick solid slab for the typical floor and also 12.5 cm solid slab for first basements and Ground floor. Structural is considered as intermediate moment resisting rigid frame Floor slab is assumed as rigid in plane which acts as diaphragm to transfer lateral load horizontally to shear walls and column. Design section for RC structure is shown in Appendix

2.4) Composite Structure

For the same floor plan as shown in plan, composite structure ismodeled as the same way as the R.C.C structure except Composite sections are used for column. System is used as. Design section for composite structure is shown.

Loading Criteria

Dead load- self weight of the structure.

Live load- as per IS- 875 part -2.

Lateral load calculation as per IS 1893-2016

2.5) Structural Modeling and Analysis:

This section deals with; structural modeling, assigning member properties, assigning basic loads, generation of load combinations and structural analysis of the two types of structures for the intended research work.

2.6_Properties of Structural Elements

The Following specifications of materials are used in designing of RCC and composite members and joints: Hot rolled section used for composite structure. Grade 500 steel with Fy = 500MPa and Fu = 545 MPa is used.). Concrete strength used is m30 for column and beams. For slab m30 is used.

3. RESULT AND DISCUSSION

3.1) Introduction

The objective of this study is to compare and discuss the design and construction of a single building using various data sources such as structural modeling, designing load calculation, and RCC and composite types of structural system.

The 3D building model is then analyzed using the software ETABS 2019. The different parameters such as base shear, and time period are then studied to determine the model's performance.

3.2) Model Time Period

Every building has its own natural frequency, which limits its resistance to external and internal effects, such as earthquakes and wind. The smallest natural frequency is referred to as the Fundamental Mode, while the largest natural period is the Fundamental Natural Period.

The time period is the period of time required for an object to complete one full cycle of motion. It is one of the most important facets in determining out how a structure will behave to ground shaking. We used 20 modes in the analysis, and each mode had its own time period. We see the time periods of the three structures

Table 3.1 - Time Period for all modes

Time Period(sec)		
Mode	Composite	RCC
Mode 1	2.814	3.35
Mode 2	1.731	2.103
Mode 3	2.45	2.976
Mode 4	1.18	1.361
Mode 5	1.1	1.318
Mode 6	1.23	1.453
Mode 7	0.65	0.803
Mode 8	0.62	0.78
Mode 9	0.59	0.722
Mode 10	0.442	0.551
Mode 11	0.45	0.539
Mode 12	0.396	0.499
Mode 13	0.321	0.427
Mode 14	0.35	0.417
Mode 15	0.3135	0.385
Mode 16	0.286	0.341
Mode 17	0.294	0.335
Mode 18	0.256	0.31
Mode 19	0.2198	0.273

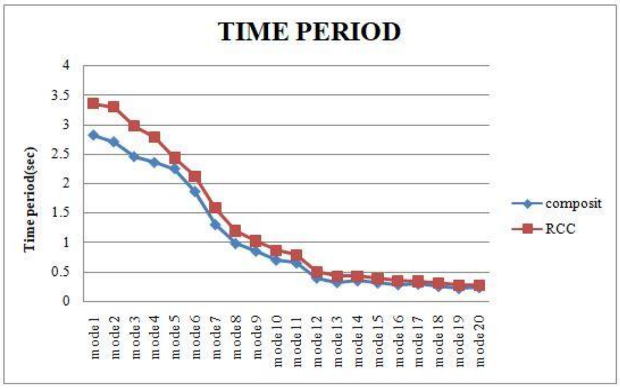

Fig. 3.1 model Time period of structural system

3.3) Deflection

Displacements, the extent to which a structural element moves or bends under pressure is the main serviceability concern in the structures.

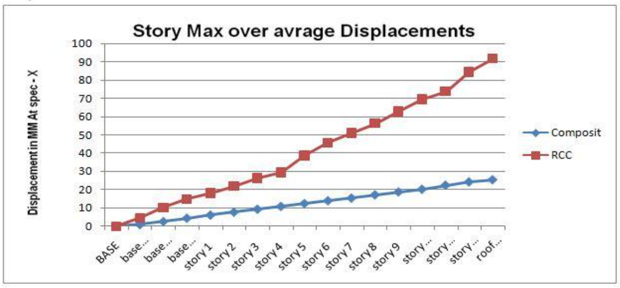

Fig. 3.2 comparison X-direction deflections

Table 4-2 X-direction deflection		
X-Direction Defection (mm)		
Location	Composite	RCC
Base	0	0
Basement 3	0.907	4.65
Basement 2	2.58	10.202
Basement 1	4.39	14.748
Story1	6.09	18.201
Story2	7.7	21.834
Story3	9.31	26.405
Story4	10.84	29.387
Story5	12.43	38.696
Story6	13.955	45.65
Story7	15.379	50.98
Story8	17.137	56.287
Story9	18.733	62.74
Story10	20.2	69.55
Story11	22.42	73.89
Story12	24.21	84.46
Roof top	25.425	91.76

Y-Direction Deflection

Y-Direction Deflection (mm)		
Location	Composite	RCC
Base	0	0
Basement 3	0.808	3.497
Basement 2	2.306	9.22
Basement 1	4.027	15.07
Story1	5.72	20.81
Story2	7.342	26.89
Story3	8.97	32.74
Story4	10.6	38.36
Story5	12.35	44.46
Story6	14.03	50.44
Story7	15.71	56.94
Story8	17.78	63.28

Story9	19.68	69.19
Story10	21.46	74.6
Story11	24	79.86
Story12	26.02	84.05
Roof Top	27.32	86.98

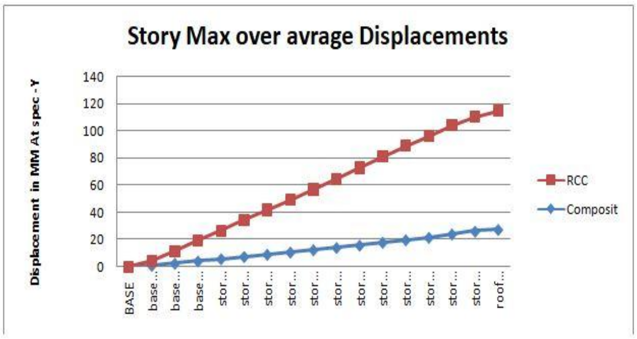

Fig. 3.3 comparison Y-direction deflections

3.4) Story Stiffness:

Story Stiffness in the X-Direction		
Story	Composite	**RC**
BASE	0	0
basement 1	71095.817	309324.33
basement 2	79393.376	335360.96
basement 3	84642.812	335075.72
story 1	155201.13	351616.79
story 2	169086.06	354913.52
story 3	174920.87	357946.44
story 4	240628.36	362220.46
story 5	247454.86	379805.97
story 6	255303.35	384167.24
story 7	284752.06	398980.82
story 8	287796.41	404263.58
story 9	305251.99	411720.2
story 10	306602.57	437701.01
story 11	305853.92	478533.86
story 12	345955.08	604251
roof top	652527.59	1350433.7

Story Stiffness in the Y-Direction		
Story	Composite	**RC**
BASE	70848.175	61508.805
basement 1	85644.776	73039.302
basement 2	102454.47	77101.674
basement 3	129838.32	90364.595
story 1	142037.11	93706.749
story 2	146645.95	96707.821
story 3	201807.98	102483.98
story 4	224263.74	121386.13
story 5	233372.68	128869.58
story 6	266834.29	152046.45
story 7	281636.04	158491.52
story 8	301745.27	164799.55
story 9	307293.75	186854.04
story 10	322231.64	193283.88
story 11	390675.39	204746.58
story 12	741943.79	338733.74
roof top	652527.59	1350433.7

4. CONCLUSIONS

RCC Structure

- When using RCC structure the fundamental period (First mode time period) of RCC structure is 16% higher compare to Composite structure.
- The maximum roof displacement for the X-direction for RCC structure 26% higher compare to Composite structure. The maximum roof displacement for the Y-direction for RCC structure is 31% higher than compare to Composite structure.
- The maximum Story stiffness for the X-direction for RCC structure is 11% lower than compare to composite structure.

Composite Structure

- When using RC structure the fundamental period (First mode time period) of Composite structure is about 16% lower than RCC structure.
- The maximum roof displacement for the X-direction for composite structure is 26% lower than compare to RCC structure. The maximum Roof displacement for the Y-direction for composite structure is 31% lower than RCC structure.
- The maximum Story stiffness for the X-direction for composite structure is 11% higher than compare to RC-C structure. The maximum Story stiffness for the Y-direction for composite structure is 19% higher than that of RCC structure.

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