Comparability of RCC and Steel – Concrete Composite Structures

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Abstract

In the building industry, composite structures are becoming increasingly common. Because of the confinement effect of steel with concrete and design adaptability, composite columns such as concrete filled steel tubes have high performance. In comparison to RCC and steel frame structures, composite structures have additional advantages. The primary requirement is for research on the behaviour and properties of composites in comparison to RCC and steel. Engineers are employing an effective structural system called Steel Concrete Composite Structure after noticing the problems and obstacles in the field of high-rise projects. For the sake of comparison, concrete composite with RCC and steel structural choices are studied in this study. The STAAD-Pro programme is used to analyse a multi-story commercial study in this publication. Modeling of composite, steel, and RCC structures is done using the equivalent static technique of analysis. In comparison to RCC and steel structures, composite structures are the greatest alternative for multi-story structures.

Keywords: ***S****tructure, Composite, Slab, Beam, Steel.*

I. INTRODUCTION

Steel and concrete are two elements that are extensively and inextricably employed as construction materials in today's modern period of innovation for projects ranging from skyscrapers to bridges. Despite the fact that these materials have varied qualities and features, they appear to be complementary in many respects. Steel has good tensile strength but a low weight-to-mass ratio, therefore thin pieces are employed, which may be prone to buckling. Concrete, on the other hand, has a high compressive strength. Steel may be utilised to increase ductility, which is a key characteristic for tall buildings, while concrete can provide corrosion protection and thermal insulation. Concrete may also be used to prevent steel from buckling. Composite construction is generally used in order to get the most out of both materials.

Steel concrete composite systems have grown in popularity in recent years as a result of their benefits over traditional building methods. Composite building combines the best qualities of both concrete and steel, resulting in a faster construction time. For beams and columns, composite members are made up of two distinct materials, such as steel and concrete. Steel and concrete constructions can be found in multi-story commercial buildings, industries, and bridges, among other places. Steel and concrete have about identical thermal expansion, however concrete is better at handling compression pressures whereas steel is more prone to tensile loads. Steel or entirely concrete constructions can be decreased with composite structures, which are becoming increasingly common. Initial construction loads will be carried out by steel frame sections, including self-weight during construction, and subsequently concrete will be cast around the section or poured within the tube section in composite construction. Deflections of members, size and material consumption of members in composite versus R.C.C., seismic pressures and behaviour of the building under seismic conditions in composite versus R.C.C., foundation requirements and type of foundation can be specified for the comparative research In terms of construction, a composite structure.

II. COMPOSITE STRUCTURES

Composite structures are ones that are made up of two separate materials that are so tightly linked together that they operate as a single structural unit. A composite member is generated when a steel component, such as a section beam, is joined to a concrete component, such as a deck slab, in such a way that forces and moments are transferred between them. Composite buildings are becoming more popular as a result of their quick construction time, low weight, big column-to-column spacing, and distinctive design.

2.1 Steel-concrete composite construction has a number of advantages.

a. The best possible use of steel and concrete is made.
b. Composite beams have less deflection than steel beams due to their higher stiffness.
c. Due to the usage of rolled steel, composite building was done on a fast-track basis.
d. Steel weight savings of 30% to 50% compared to non-composite structures.
e. It provides significant design, prefabrication, and construction schedule flexibility in crowded settings.

2.2 Composite Structure Elements

1. Composite slab: The composite action of steel beams and concrete or composite slab that form a structural floor is referred to as a composite slab. Concrete will mix structurally with profiled steel sheet to produce a composite part when it hardens. The behaviour of a composite slab is determined by factors such as the deck profile, steel sheet thickness, material qualities, span length, and construction details.

2. Shear Connector: It's a headed stud-like device that's projected on top of a steel beam's top flange to transmit shear between the composite slab and the steel girder. The primary function of the stud's head is to prevent uplift. Through-deck welding is the contemporary way of installing shear studs in composite constructions.

3. Composite beam: A composite beam is made up of a succession of T-beams that are parallel and have thin broad flanges. The steel beam is mostly under tension, while the concrete flange is in compression. Under stress, each component of the structure operates independently, with relative movement or slip happening at the interface. Composite beams are mostly prone to bending. Composite beams have less depth than non-composite beams and are frequently utilised in long-span constructions.

4. Composite column: A composite column is a compression type component made up of steel sections encased in concrete. There are mostly two types:

a) Steel-encased concrete portion; b) Steel-filled concrete tube section (CFST Column)

Standard I-section or H-section columns are commonly encased in a rectangular or square concrete section to make a solid composite section. Concrete filled columns are made out of hollow circular, square, and rectangular sections filled with concrete. It combines the benefits of steel and concrete. It's employed in a variety of structural applications, including high-rise building columns and bridge piers. Local buckling is delayed and compression stress and durability are improved by using infill concrete in steel tubes. Because this column is smaller, the amount of useable floor space is increased.

III. DETAILS OF THE BUILDING

The structure in question is a commercial structure. The plan is 63.20mx29.50m in size. Both R.C.C. and Composite construction are studied using the same building layout. Both types of buildings have the same fundamental loading.

3.1 Structural Data for R.C.C Building

Building Plan for R.C.C Structure:

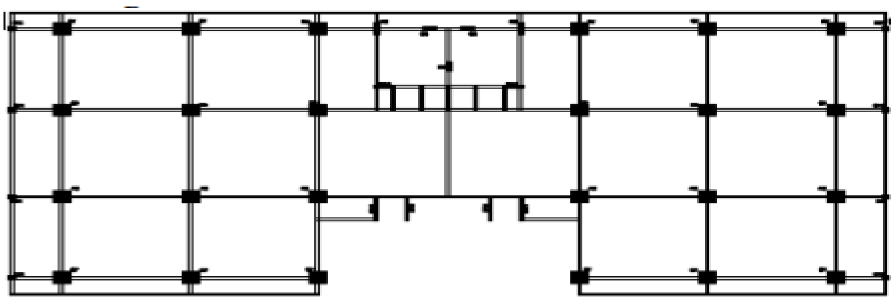

Figure 1: Plan showing typical floor of R.C.C

Table 1: Structural data of R.C.C. Structure

Plan dimension	63.20mx29.50m
Total height of building	46.8, 61.2, 75.6, 90 m.
Height of each storey	3.6m
Height of parapet	1.0m
Type of Beam	Size of Beams
B1	300mmx650mm
B2	230mmx300mm
B3	230mmx230mm
Type of columns	Size of columns
C6, C7	750mmx750mm
C11	450mmx450mm
C9	350mmx750mm
C8	350mmx600mm
Thickness of slab	200mm
Thickness of walls	230mm
Seismic zone	II
Wind speed	44 m/s
Soil condition	Medium soil
Importance factor	1
Zone factor	0.1
Floor finish	1.0 kN/m2
Live load at all floors	4.0 kN/m2
Grade of concrete	M30
Grade of reinforcing steel	Fe415
Density of concrete	25 kN/m3
Density of brick	20 kN/m3
Damping ratio	5%

3.2 Structural Data for Steel Concrete Composite Building

Building Plan for Steel Concrete Composite Structure:

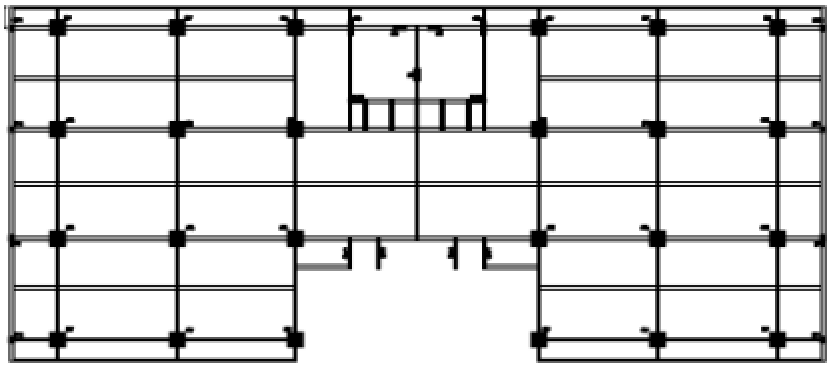

Figure 2: Plan showing typical floor of composite

Table 2: Data for Analysis of Composite Structure

Plan dimension	63.20mx29.50m
Total height of building	46.8, 61.2, 75.6, 90 m.
Height of each storey	3.6m
Height of parapet	1.0m
Type of Beam	Size of Beams
B1	ISMB450
B2	ISMB300
B3	ISMB200
Type of columns	Size of columns
C6, C7 (ISMB450)	500mmx500mm
C9(ISMB300)	350mmx400mm
C8(ISMB200)	300mmx300mm
Thickness of slab	200mm
Thickness of wall	230mm
Seismic zone	II
Wind speed	44 m/s
Soil condition	Medium soil
Importance factor	1.0
Zone factor	0.10
Floor finish	1.0 kn/m2
Live load at all floors	4.0 kn/m2
Grade of concrete	M30
Grade of reinforcing steel	Fe415
Density of concrete	25 kn/m3
Density of brick	20 kn/m3
Damping ratio	5%

IV. ANALYSIS

The Equivalent Static Method is used to analyse the explained 3D building model. The programme Staad Pro is then used to analyse the building models. The models are investigated for various parameters such as deflection, shear force, and bending moment. Seismic codes are specific to an area of the country. The major guideline that offers an outline for determining seismic design force in India is Indian standard criteria for earthquake resistant design of structures IS 1893 (PART-1): 2002. Code IS-875 (PART-3) & SP64 are used to determine wind forces.

V. CONCLUSION

The composite construction has a better reaction than the RCC structure. The displacement produced by a composite structure is reduced, and the structure is more resistant to structural stresses. In the case of high-rise buildings, composite structures are more cost-effective than RCC and steel structures. In comparison to RCC and steel structures, composite structures are a preferable choice for high-rise structures. Composite buildings have the advantage of being lighter and faster to build than standard concrete structures. As a result, the composite building takes less time to complete than an RCC construction. Steel-concrete composite structures perform better than R.C.C structures in earthquakes due to intrinsic ductility qualities.

VI. REFERENCES

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