ISSN 2229-5518

Inelastic Analysis of RCC And Composite Structures

Dr.Sanjay kulkarni, Vishwajeet kadlag, Rakesh Abrol

Abstract— Composite structures made of steel and concrete are much admired owing to their compensation over RCC structures and steel structures. RCC constructions have more weight and larger cross sections for structural members. Steel structures have are ductile and have huge deflections in nature; this quality of steel structures is helpful in resisting earthquake loads. The acceptable properties of RCC and steel structures are combined in composite structures. In addition to that lesser cost, speedy construction, fire protection etc. are provided by them. In this comparative study RCC and composite structures are considered in seismic zone III. The seismic behavior of the study frames designed by the proposed methodology is evaluated by Response spectrum and nonlinear time-history analysis .ETABS software is used for modeling and analysis...

Index Terms— inelastic analysis , composite structures , performance curve , pushover analysis.

1 Introduction

THE majority of building structures are designed and constructed in reinforced concrete, mainly owing to the availability of the constituent materials and the low level of skill required in construction, as well as the practicality of the existing design codes. Now there is a practice of using steel and reinforced concrete together which are termed as composite structures. Such systems make use of each type of member in most efficient manner to maximize the structural and economic benefit. An additional benefit provided by composite columns is derived from their excellent fire-resistant properties. Traditionally, steel frames have been encased in concrete for fire protection purposes with some allowance being made for the structural properties of the encasement.

These essentially different materials thst is steel and concrete are completely compatible and complementary to each other; they have almost the same thermal expansion; they have an ideal combination of strengths with the concrete efficient in compression and the steel in tension; concrete also gives corrosion protection and thermal insulation to the steel at elevated temperatures and additionally can restrain slender steel sections from local or lateral-torsional buckling.

In conventional composite construction, concrete rests over steel beam, under load these two component acts independently and a relative slip occurs at the interface of concrete slab and steel beam, which can be eliminated by providing deliberate and appropriate connection between them. So that steel beam and slab act as composite beam and gives behavior same as that of Tee beam. In steel concrete composite columns both steel and concrete resists external loads and helps to limit sway of the building frame and such column occupies less floor area as compared to reinforced concrete. It should be added that the combination of concrete cores, steel frame and composite floor construction has become the standard construction method for multi-storey commercial buildings in several countries. The main reason for this preference is that the sections and members are best suited to resist repeated earthquake loadings, which require a high amount of resistance and ductility.

2 OBJECTIVE

The objectives of the study is to explain the concept of composite construction and to describe the elements comprised in steel concrete composite structures and to evaluate the performance of composite structures under earthquake loading and comparing it with conventional RCC structures. The parameters considered for comparisons are displacements, story drifts, and column axial forces, column bending moments and shear forces, beam shear forces and bending moments, time period of the structure and dead weight of the structure.

3 COMPOSITE CONSTRUCTION

A composite member is constructed by combining concrete member and steel member so that they act as a single unit. As we know that concrete is strong in compression and weak in tension on the other side steel is strong in tension and weak in compression. The strength of concrete in compression is complemented by strength of steel in tension which results in an efficient section. By the concept of this composite member the concrete and steel are utilized in a wellorganized manner.
The primary structural components use in composite construction consists of the following elements.

1. Composite slab

2. Composite beam

3. Composite column 4. Shear connector

4 COMPOSITE DECK SLAB

conventional steel-concrete floors consist of built-up structural steel beams and concrete floors connected together using shear connectors in such a manner that they would act monolithically .The principal merit of steel-concrete composite construction lies in the utilization of the compressive strength of concrete slabs in conjunction with steel beams, in order to en-

ISSN 2229-5518

hance the strength and stiffness of the steel girder. More recently, composite floors using deck slab have become very popular in the West for high rise office buildings. Composite deck slabs are particularly competitive where the concrete floor has to be completed quickly and where medium level of fire protection to steel work is sufficient. However, composite slabs with profiled deck slab is unsuitable when there is heavy concentrated loading or dynamic loading in structures such as bridges. The alternative composite floor in such cases consists of reinforced or pre-stressed slab over steel beams connected together to act monolithically. There is presently no Indian standard covering the design of composite floor system using profiled sheeting.

4 COMPOSITE BEAM

In general composite construction, concrete slabs rest over steel beams. Under load these two components act independently and a relative slip occurs at the interface if there is no connection between them. With the help of a deliberate and appropriate connection provided between them can be eliminated. In this case the steel beam and the slab act as a "composite beam" and their action is similar to that of a monolithic Tee beam. Though steel and concrete are the most commonly used materials for composite beams, other materials such as pre-stressed concrete and timber can also be used. Concrete is stronger in compression than in tension, and steel is susceptible to buckling in tension. By the composite action of these, we can utilize their respective advantage to the fullest extent. Generally in steel-concrete composite beams, steel beams are integrally connected to prefabricated or cast in situ reinforced concrete slabs.

5 COMPOSITE COLUMN

A compression member consisting of both steel and concrete elements can be termed as steel concrete composite columns. There are two types of composite columns

1. Concrete section with embedded steel section 2. A hallow steel section with concrete infill

Fig 3.2 types of composite columns

Friction and bond are the two parameters which makes both steel and concrete elements to act as a single unit in composite columns. The general process of construction of composite column includes erection of hallow steel section or I section which takes the initial construction loads then it is filled with concrete or concrete is casted around I beam. Lateral deflections and buckling of steel members are prevented by concrete member. In addition to that composite columns have less cross sectional area and light weight when compared with RCC columns. Due to this the usable floor area increases in composite structures and foundation cost is also decreased

6 SHEAR CONNECTOR

The total shear force at the interface between concrete slab and steel beam is approximately eight times the total load carried by the beam. Therefore, mechanical shear connectors are required at the steel-concrete interface. These connectors are designed to (a) transmit longitudinal shear along the interface, and (b) Prevent separation of steel beam and concrete slab at the interface.Shear connectors are essential for steel concrete composite construction as they integrate the compression capacity of supported concrete slab with supporting steel beams to improve the load carrying capacity as well as overall rigidity. The maximum shear force lies at the neutral axis. In case of composite beams the neutral axis of the section generally lies at the bottom of the concrete slab. This leads to separation of concrete slab from the steel beam. To avoid this there should be prefect bond between concrete and steel. This can he achieved by providing shear connectors at the interface of concrete and steel. Though steel to concrete bond may help shear transfer between the two to certain extent, yet it is neglected as per the codes because of its uncertainty. All codes therefore, specify positive connectors at the interface of steel and concrete. The shear connectors are designed to transmit longitudinal shear along the interface and horizontal shear between steel beam and concrete slab, ignoring the effect of any bond between the two. Shear connectors prevent separation of steel beam and concrete slab at the interface and also resist uplift force at the steel concrete interface. Commonly used types of shear connectors as per IS: 11384-1985. There are three main types of shear connectors; rigid shear connectors, flexible shear connectors and anchorage shear connectors.

Types of shear connectors:

Rigid type: As the name implies, these connectors are very stiff and they sustain only a small deformation while resisting the shear force. They derive their resistance from bearing pressure on the concrete, and fail due to crushing of concrete. Short bars, angles, T-sections are common examples of this type of connectors. Also anchorage devices like hoped bars are attached with these connectors to prevent vertical separation.

Flexible type: Headed studs, channels come under this category. These connectors are welded to the flange of the steel beam. They derive their stress resistance through bending and undergo large deformation before failure. The stud connectors are the types used extensively. The shank and the weld collar adjacent to steel beam resist the shear loads whereas the head resists the uplift.

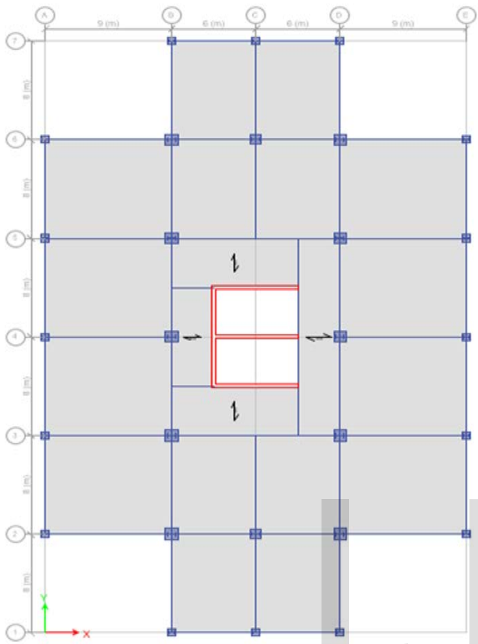
Bond or anchorage type: It is used to resist horizontal shear and to prevent separation of girder from the concrete slab at the interface through bond. These connectors derived from the resistance through bond and anchorage action.

7 MODELLING AND ANALYSIS

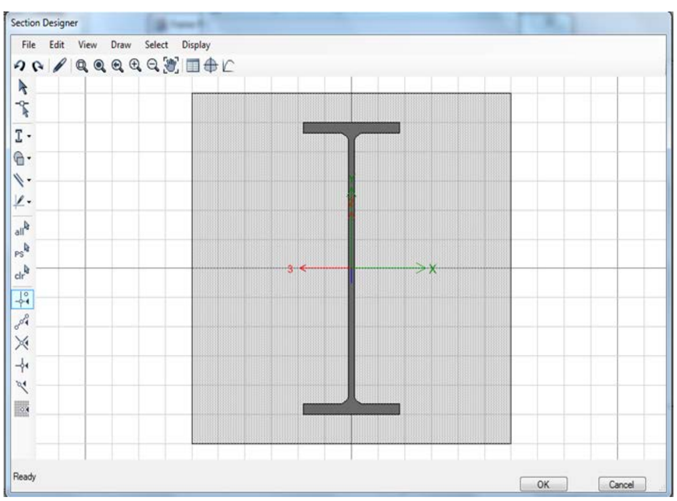
Inelastic analysis of both RCC & Composite frame building is carried out using Etabs.

• *Rakesh abrol is currently pursuing masters degree program in civil structural engineering in pune University, india PH-8493853548 E-mail:rakeshabrol16@gmail.com*

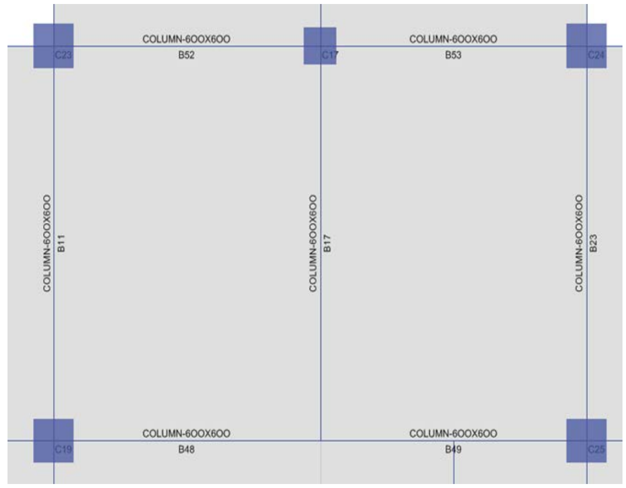
The outcome from the analysis is described in this chapter and analysis is discussed along with various parameters such as base shear, story drift, shear force, bending moment etc.



Plan of the building



Modelling of composite column (SRC)



Floor plan showing RCC section.

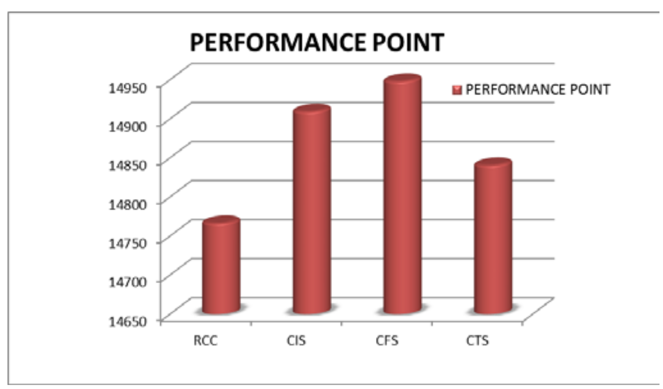
Elevation of building

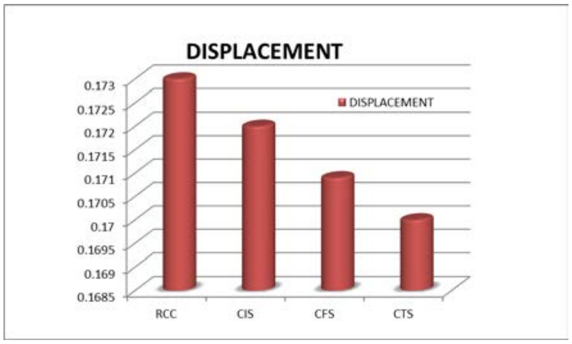
The sections considered for different models are given below

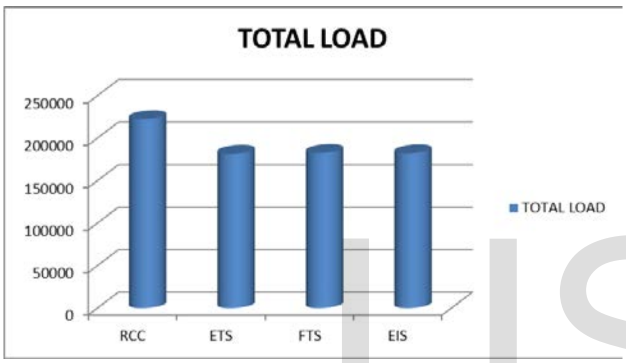
Particulars	RCC structure	Composite structure
Plan dimension	30mx48m	30mx48m
No of story	13	13
Height of each story	3.97m	3.97m
Total height	49.64m	49.64m
Depth of footing	2m	2m
Size of beam	300x750	300x750
Size of column	600mmx600mm	Encased I section (SRC)
	750mmx750mm	
	900mmx900mm	
Slab thickness	150	150
Dead load	2kn/m2	2kn/m2
Live load	4kn/m2	4kn/m2
Seismic zone	III	III
Soil condition	Medium	Medium
Response reduction factor	5	5
Importance factor	1	1
Zone factor	0.16	0.16
Grade of concrete	M30	M30
Grade of reinforcing steel	Fe500	Fe500

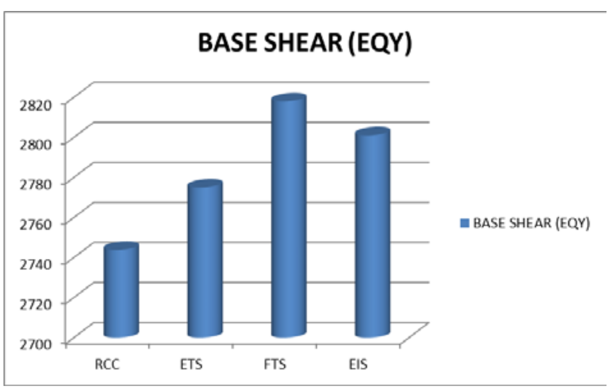
The basic parameters considered for the design are
Live load: 2 KN/sq.m
Floor finishes load: 1.25 KN/sq.m
Wall load: 10 KN/m (230 mm wall)
Earthquake parameters considered are Zone: IV
Soil type: Hard soil Importance factor : 1
Response reduction factor: 3
Earthquake loading as per IS 1893
Codes for analysis RCC design: IS 456:2000
Composite design: IS 11384
The above mentioned building models are analyzed using Response spectrum method. The building models are analyzed using ETABS software. The different parameters such as displacements, story drifts, column axial forces, column bending moments and shear forces, beam shear forces and bending moments, time period of the structure and dead weight of the structure are compared for composite and RCC structures.
Table: assessment of performance of composite with RCC

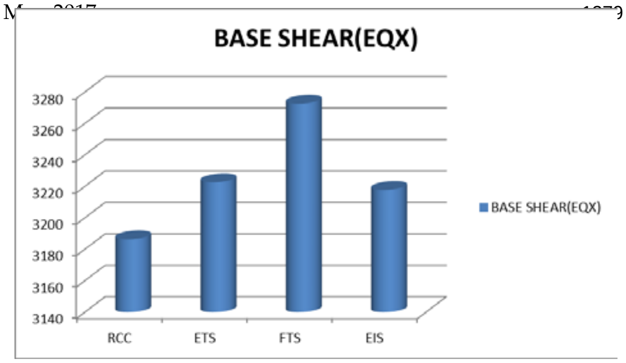
TYPES OF MODELS	PERFORMANCE POINT	DISPLACEMENT
RCC	14766.415	0.173
EIS	14909.314	0.172
ETS	14948.024	0.1709
CFTS	14840.435	0.17

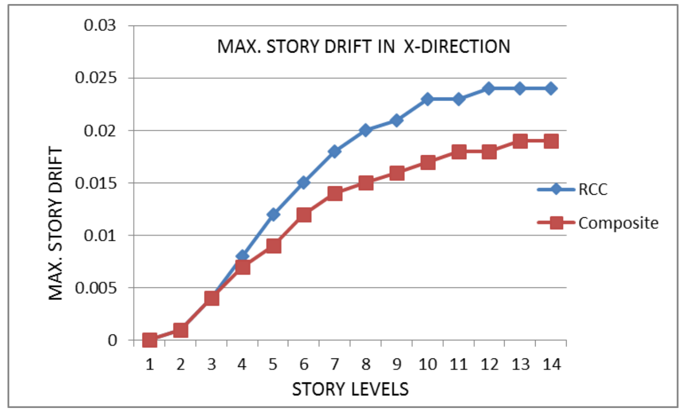


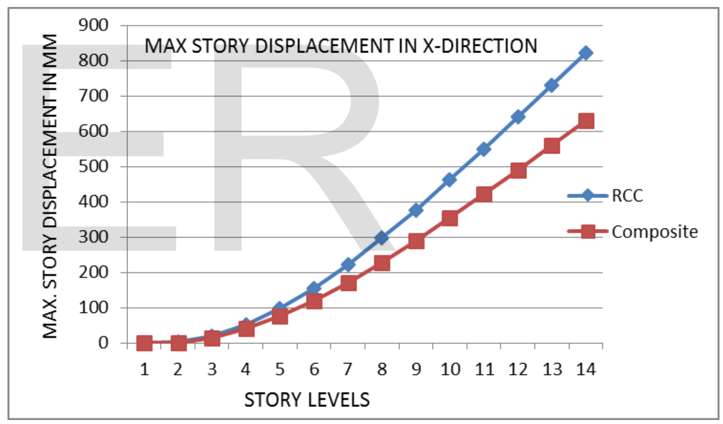












7 RESULTS AND DISCUSSIONS

1) It is seen that The self weight of the composite structure is less app. 30 % as compared with RCC.
2) The base shear of composite structure is maximum app. 20-50 % as compared to RCC.
3) From pushover analysis it is seen that story displacement of composite structure decreases near about 15-20 % as compare to RCC.
5) Also story drift of composite considerably reduced app. 5-10 % as compared to RCC.
6) The performance point curve shows that the performance of composite increases app. 15-20 % . As compared with RCC.
7) From the performance point it is seen that the displacement of composite structure are reduces as compared with RCC.
From the above results and discussion it is concluded that t
1) Composite model having more lateral load capacity (Performance point value) compare to RCC model.
2) The lateral displacement of the building is reduced for

composite model as compared with RCC

3) from the analysis of model it is seen that the hinges are formed in beam element first rather than column hence it is cuncluded that composite frame follows strong column weak beam concept or capacity based design concept.

8 REFERENCES

[1]. IS 11384:1985, "Code of practice for design of composite structures", Bureau of Indian Standards, New Delhi.

[2]. Comparative analysis of Seismic Behaviour of Multi-storey Composite Steel and Conventional Reinforced Concrete Framed Structures-by Ashiru Muhammad, Chhavi Gupta, Ibrahim B. Mahmoud- International Journal of Scientific & Engineering Research, Volume 6, Issue 10, October-2015 ISSN 2229-5518

[3]. D.R. Panchal, P.M. Marathe(2011), "Comparative study of RCC and composite (G+30) story building", Nirma University, Ahmedabad, India.

[4]. Composite Structures of Steel and Concrete (Beams, slabs, columns, and frames) for buildings
Third Edition by R.P. JOHNSON (2004)

[5]. Static &Dynamic Analysis Of Multistory Building Using Composite Structure-Mahesh Suresh Kumawat, L.G.Kalurkar-international Journal of Research in Engineering and Technology eISSN: 2319-1163