DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURE AND ITS COMPARISION WITH RCC STRUCTURE

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Abstract - *Steel Concrete Composite Structures are becoming popular in India in current trends of changing construction scenario whereby the general discussion on technical aspects are far behind being new in Indian industry at wide scale. Steel-concrete composite structure is the steel section encased in concrete for columns and the concrete slab or profiled deck slab is connected to the steel beam with the help of mechanical shear connectors so that they act as a single unit. Steel-concrete composite with Reinforced cement concrete options are considered for comparative study of G+4 storey residential building which is situated in earthquake zone III and for earthquake loading, the provisions of IS:1893(Part1)-2002 is considered by Equivalent Static Method of Analysis. For modeling of Composite & R.C.C. structures ETABS is used*

Key Words:

1. INTRODUCTION

In India reinforced concrete members are mostly used in the framing system for most of the buildings since this is the most convenient & economic system for low-rise buildings. However, for medium to high-rise buildings this type of structure is no longer economic because of increased dead load, less stiffness, span restriction and hazardous formwork. Steel concrete composite frame system can provide an effective and economic solution to most of these problems in medium to high-rise buildings. This paper includes the Comparative study of R.C.C. with Composite (G+4) Storey building which further includes the details of time period, storey drift,deflections, bending moments in x & y direction, axial force and shear force in columns & beams. The main objectives of the study are

- To provide a brief description to various components of steel concrete framing system for buildings.
- To investigate major parameters like, time, seismic response of steel-concrete composite frames over traditional reinforced concrete frames and steel frames for building structures.

1.1 Elements of composite construction

1. Composite beam, slab & shear connectors

A steel concrete composite beam consists of a steel beam, over which a reinforced concrete slab is cast with shear connectors. The composite action reduces the beam depth. Rolled steel sections themselves are found adequate frequently for buildings and built up girders are generally unnecessary. The composite beam can also be constructed with profiled sheeting with concrete topping or with cast in place or precast reinforced concrete slab.

2. Composite Column

A steel – concrete composite column is conventionally a compression member in which the steel element is a structural steel section. There are three types of composite columns used in practice which are Concrete Encased, Concrete filled, Battered Section.

3. Shear Connectors

Shear connections are essential for steel concrete construction as they integrate the compression capacity of supported concrete slab with supporting steel beams / girders to improve the load carrying capacity as well as overall rigidity. Therefore, mechanical shear connectors are required at the steel-concrete interface. These connectors are designed to

(a) Transmit longitudinal shear along the interface

(b) Prevent separation of steel beam and concrete slab at the interface.

2. MODELING AND ANALYSIS

The building considered here is a commercial building. The plan dimension is 30m x 24m. The study is carried out on the same building plan for both R.C.C and Composite construction. The floor plans were divided into five by six bays in such a way that center to center distance between two grids is 6 meters by 4 meters respectively as shown in Figure 2. The basic loading on both types of structures are kept same.

Table -1: Data for analysis for RCC structure and Composite structure

Structural Details	
Type of Structure	Multi-Storey Rigid Jointed RC Frame Structucture
No. of Storey	G+3 Storey
Floor to Floor Height	3.25 meter

Plinth Level	1.25 meter above Ground Level
Surrounding Location of Structure	Plain Terrain
Type of Soil on which Structure is rest	Medium Soil (Poorly Graded Sand: Stiff Soil)
Safe Bearing Capacity of Soil	400 kN/m2

Checklist of process used in detailed design of composite structure is guided as per the INSDAG Resource and general design of building principles.

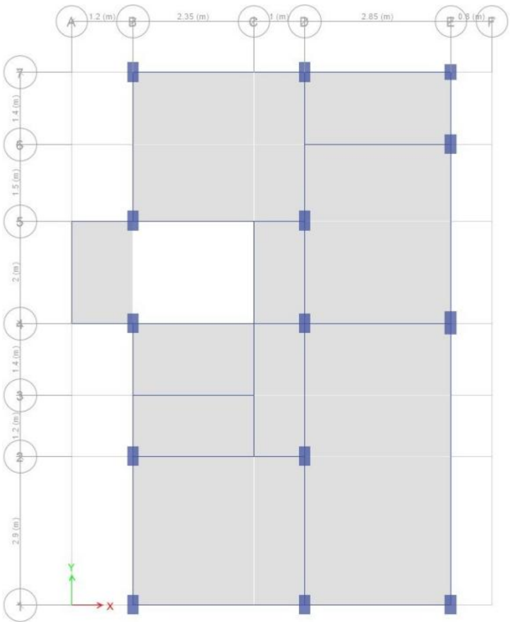


Fig1: Typical Floor Plan

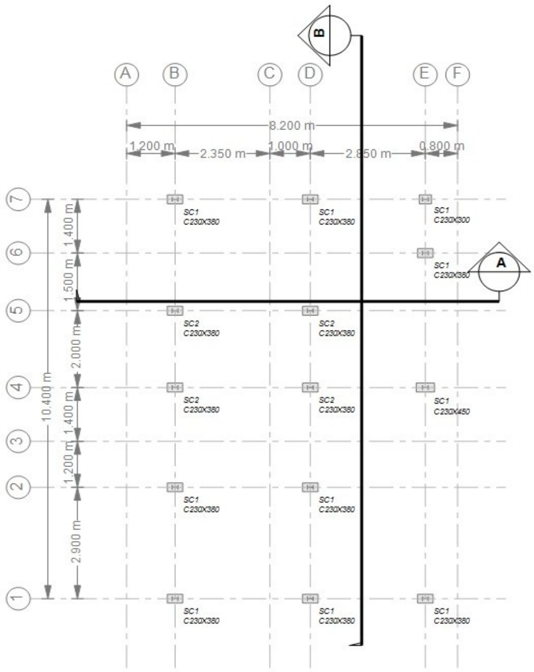


Fig1: Composite Column Center Plan

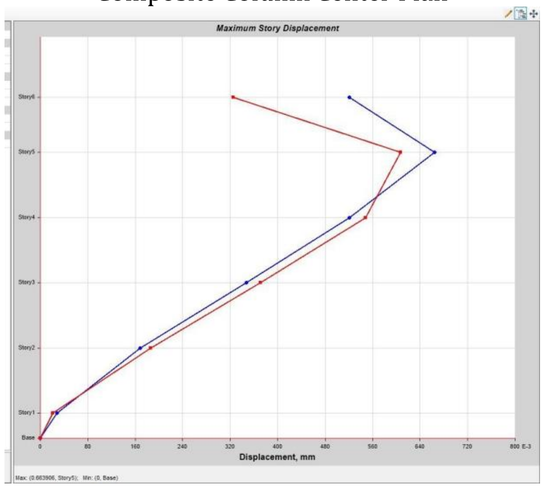


Fig -3: Story Displacement RCC

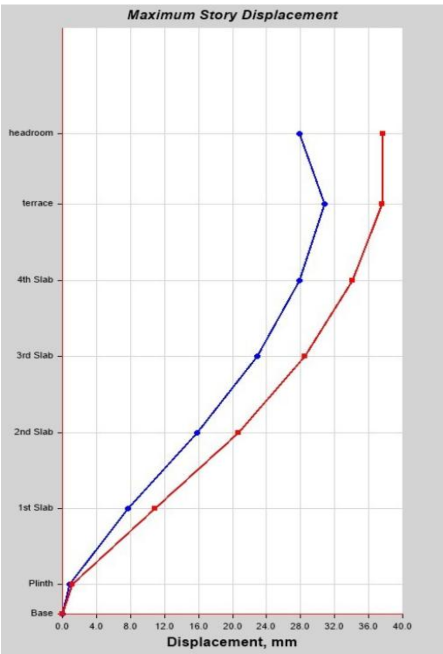
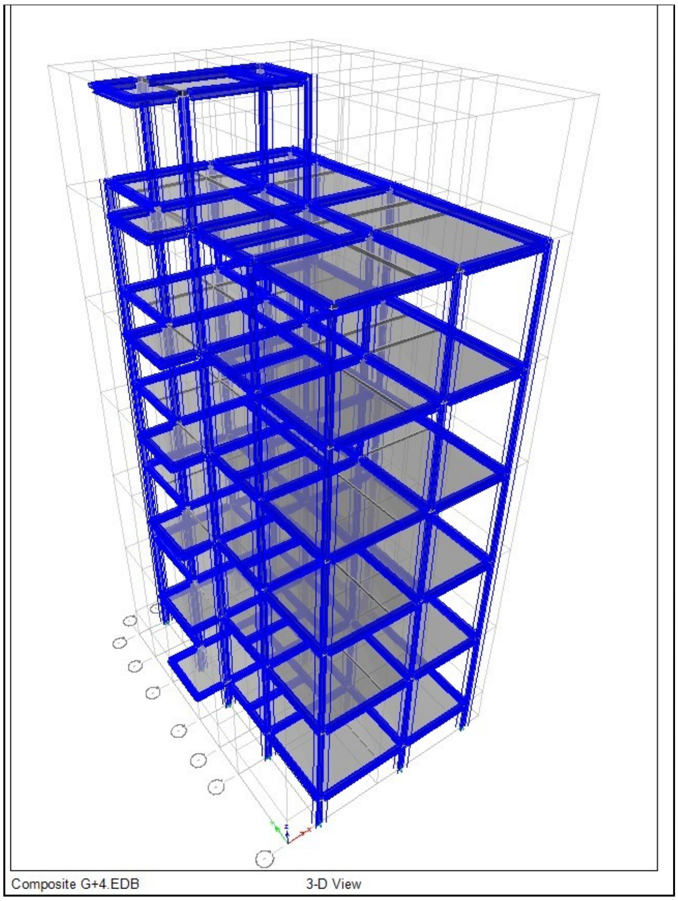


Fig -4: Story Displacement composite

Table -2: Data for analysis for RCC structure and Composite structure

Structural Details	
Seismic Zone	III
Zone Factor (Z)	0.16
Site Type	II for Medium Soil as per Table 4 of IS 1893 (Part 1): 2016
Importance Factor (I)	1.2 as per Cl.7.2.3 and Table 8 of IS 1893 (Part 1): 2016
System	SMRF (Special Moment Resisting Frame)
Response Reduction Factor (R)	5 as per Cl.7.2.6 and Table 9 of IS 1893 (Part 1): 2016
Percentage of Imposed Load to be Considered in Seismic Weight	25% for LL is up to 3 kN/m2 as per Cl.7.3.1 and Table 10 of IS 1893 (Part 1): 2016



Checklist	
Step 1:	**Enter Basic Input Data; Define Grid and Story Data**
	Set Design Codes
	Define Grid Data
	Define Story Data
	Set Units of Length, Force and Acceleration
	Save the File
Step 2:	**Define Material Properties**
	Define Concrete Properties as per Grade of Concrete
	Define Rebar Properties as per Grade of Steel
	Define Reinforcement Bar Sizes as per requirements

Step 3:	**Define Section Properties**
	Define Beams Define Columns Define Slabs ***Note:*** *Enter correct properties of materials, cover, modifiers w.r.t. type of section*
Step 4:	**Define Diaphragms**
	Define Diaphragm for all Floors
Step 5:	**Check Snap Options**
	Draw > Snap Options > Select required Snap Options
Step 6:	**Draw the Structure**
	Draw Columns Draw Beams Draw Slabs Draw Staircase
Step 7:	**Assign Conditions to Model**
	Assign Support Conditions Assign Releases to Beams Assign Diaphragms
Step 8:	**Check Model for any Modeling Error**
	Analyze > Check Model ***Note:*** *Fix the Error, if Any*
Step 9:	**Define Load Pattern for Load Cases and Mass Source for Seismic Weight**
	Define Dead for DL Define Super Dead for SIDL Define Live for LL Define Wind in X-Direction for WLX Define Wind in Y-Direction for WLY Define Seismic along X-Direction for ELX Define Seismic along X-Direction + 0.05 Eccentricty for ELX+0.05e Define Seismic along X-Direction - 0.05 Eccentricity for ELX-0.05e Define Seismic along Y-Direction Define Seismic along Y-Direction + 0.05 Eccentricity for ELY+0.05e Define Seismic along Y-Direction - 0.05 Eccentricity for ELY-0.05e Define Mass Source for Seismic Weight Calculations
Step 10:	**Set Load Cases**
	Check the Load Cases as per Load Pattern
Step 11:	**Assign Super-Imposed Dead Loads**
	Assign SIDL
Step 12:	**Assign Live Loads**
	Assign LL Set Live Load Reduction Factors
Step 13:	**Define Load Combinations and Envelope**
	Define Load Combinations as per Codal Provisions Define Envelope for Design Load Combination and Service Load Combination
Step 14:	**Define Analysis Options**
	Assign Meshing Check Model Again Auto Relabel All Check Active Degree of Freedom Set Load Cases to Run Set Advanced SAPfire options
Step 15:	**Analyse the Structure and Check the Behaviour**
	Analyse the Model by Run Analysis

	Check Analysis Run Log to check that Model does not run into Instaility Check Storey Drift Limitation as per Cl.7.11.1.1 of IS 1893 (Part 1) : 2016 Check Torsional Irregularity as per Cl.7.1 and Table 5 of IS 1893 (Part 1) : 2016 Check for Lateral Sway as per Cl.20.5 of IS 456 : 2000 ***Note:*** *If checks are not compliant with codal provisions then go to Step 2, 3 and 6*
Step 16:	**Design the Structure**
	Revise the Preference Select Design Combinations Perform Design Check for all members by Verify all members Passed Verify Analysis vs Design Section ***Note:*** *If any member is failing in Design, Try changing Design Section* *Unlock Model > Changed Section Size > Repeat Step 14 and 15*

The explained 3D building model is analyzed using Equivalent Static Method. The buildings models are analyzed by using ETABS software. In composite structure the beam is modeled as composite beam element and column is modeled as RCC beam element and shear wall is modeled as RCC plate element. In RCC structure the beam and column is modeled as RCC beam element and shear wall is modeled as RCC plate element. The different parameters such as node displacement, maximum shear force, axial force and maximum bending moment, Time period were studied for the models. The dead load and live load are considered as per IS-875(part 1 &2) and wind load is considered as per IS-875(part 3).For earthquake loading IS: 1893 (Part1) is used.

3. CONCLUSIONS

Although the standard codal provisions are absent but still using EURO Codes as referance and resources primarily by INSDAG and effort of Buick davison on development of Steel Design Manual. An successful attept to analysis of steel concrete composite structure is being made and using softwares to establish its validity and reliability to the process is being described. Efforts have been made to cover the codal provisions at most possible

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