Steel Composite- An alternative to conventional RCC structures

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1. Abstract

Steel has for some time been utilized for the development projects yet the utilization was restricted to a specific tallness on account of the bending and twisting gets over limit after a specific stature. The RCC structure after broad use and exploration end up being substantially more affordable and concrete as a development material covered the entire metropolitan wilderness as we witness today. The hustle for the advancement of the development business especially to give the economy, productivity and speed in development has constrained the specialists to investigate new techniques for development where they can use the ideal strength of the steel and RCC structure. The innovative progression in the business presently encourage the examination of the designs and furthermore the experimentation with respect to new material and procedures and their blend to utilize the best option in contrast to the advantage of the infrastructure business. The current paper is such an endeavor to look at the seismic reaction of steel versus RCC building and the results are compared.

***Keywords**: Composite, RCC, Seismic, Dynamic Response, Steel Structure*

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2. Introduction

The urbanization has had a profound job of the development business in molding the manner in which the urban areas of our country and the world resemble. The expense of land has risen dramatically in the last not many decades[1]. The work of the structural engineers have dramatically become more complex to provide self sustained constructions alongside giving economy and security. The research and development in new materials and their mix experimentation utilizing current techniques have prompted new ideas in the construction business to give the best options that give the strength and simultaneously are savvy. The speed of the construction likewise assumes a significant part in choosing the materials or construction since now a days, the structure is sold even before the footing is laid on the land[2]. The designers are in a race against time as the builders are anxious to procure their property. In such cases the steel as a construction material aides in quick erection of the structure yet the simple fast development can't be the main consideration as it hampers the economy considerably[3]. Then again, the RCC structures are most economical however the speed of construction is less in RCC structure along with bulky rcc sections which leads to non-optimum use of space. [4]. Consequently, to give the most best of both worlds the designers have concocted a choice to give composite segment to the construction industry in which the hot rolled steel sections are encased in a RCC setting. This sort of development assists with furnishing quick erection of the structure with the economy advantage of utilizing concrete as a material[5]. In the current investigation a RCC outline is contrasted with a composite casing bearing a similar steel core section setup. The areas anyway are diverse regarding size and material.

3.System Development

Two models are created using the analysis and design software ETABS and the beam column arrangement and other planning data is kept identical with the same site conditions as well. The sections however are changed with respect to the materials being steel and composite. The two models are named traditional and composite models. The traditional model and the composite models are created in accordance with IS code 1893:2002 for the seismic excitations and IS code 875 Part 1 and Part 2 are utilized for the loading on the frame and shell components. The composite construction is made along a similar grid lines and the columns are created as rectangular concrete sections encasing Indian standard hot rolled I sections. The columns are planned by AISC 360-10 American code. The slab consists of a solid deck connected to the beam underneath by use of shear connectors. The shear connectors are considered in accordance by the code and meets the base necessity. Both the structures are thought to be situated in zone 5 and the soil condition is taken to be medium. The models are examined for static and dynamic earthquake excitations. The data assumed for both the models and plan information are given in the table 1 underneath.

Table 1: *Structural specifications and Design data*

Variable considered	Value
Dead load on beams	5.5 kN/m
Live load on beams and slab	2.5 kN/m
Zone	V
Zone factor according to IS code	0.36
Soil conditions	Medium
Response reduction factor	5.0
Importance factor considered	1.2
Grade of concrete	M30
Floor height	3 m
Slab thickness	150 mm
Footing	Fixed type
Slab designed as	Membrane thin

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The conventional and composite models were designed independently and the design data differed as per the structural demand the parametric details for conventional and composite structure are given in *table 2* and *table 3* respectively.

Table 2: *Parametric design data for conventional RCC model*

Interior Column size	450*1200 mm
Exterior Column size	450*850 mm
Beam sizes all	230*750 mm
Slab thickness	150 mm
RCC design code	IS 1893:2002
Steel grade	Fe 500

For the composite model the beam sections were designed as hot rolled Indian standard I sections and were connected to the deck by shear connectors. The composite columns were designed by encasing I section in RCC setting. The parameters taken are given in *Table 3* below.

Table 3: Parametric design data for Composite model

Column size internal	450*900 RCC encased with mm ISWB-600
Column size Corners	350*750 RCC encased with ISWB-500
Perimeter Beam size	ISWB-600
Interior Beam sizes	ISWB-450
Slab thickness	150 mm
Shear connectors diameter	20 mm
Shear connector length	100 mm
Composite design code	AISC 360-10
Steel grade	Fe 345

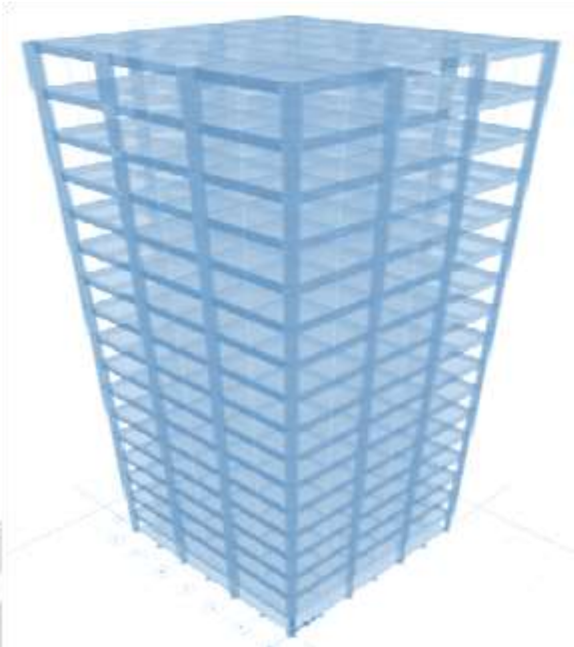

Fig: 1 Extruded rendered 3-d view

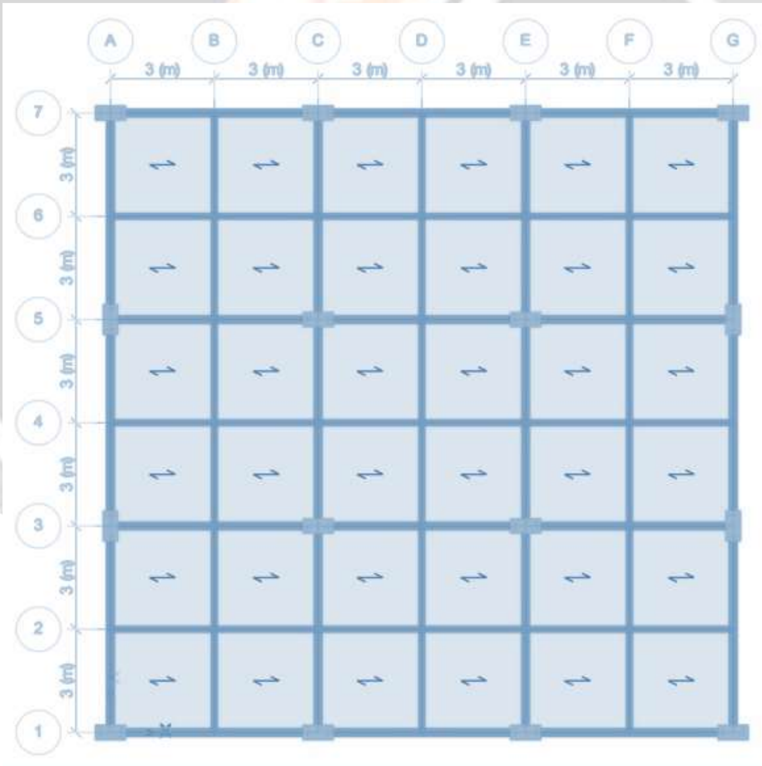

Fig: 2 Top view of the models

4. Results and Discussion:

The two models were analyzed by using response spectrum method and equivalent static method to evaluate critical design parameters such as inter storey drift, Base shear, displacements and time periods of the structures. These parameters were calculated and compared between the two structures.

1. Storey displacement: The storey displacement is the measure of the movement of the individual storeys with respect to the base of the structure. The storey displacement of the models are studied and were within the permissible limits. The storey displacements are shown in *table 4*.

Table 4: Storey Displacements comparison

Parameters	For RCC model	For Composite model
Displacement as per Static Method in X direction	35.03 mm	25.27 mm
Displacement as per Static Method in Y direction	50.10 mm	35.99 mm
Displacement as per Response Spectrum in X direction	36.80 mm	27.48 mm
Displacement as per Response Spectrum in Y direction	51.79 mm	38.73 mm

2. Storey Drift: Storey displacement is specially considered during seismic loading as it becomes quite crucial. This analysis is done by ETABS on the mathematical models as per the Indian standard code norms. It is a ratio hence unitless quantity. The calculated drift of both the models are compared in table below

Table 5: Inter Storey Drift comparison

Parameters	For RCC model	For Composite model
Drift as per Static Method in X direction	0.000939	0.00071
Drift as per Static Method in Y direction	0.001219	0.00089
Drift as per Response Spectrum method in X direction	0.001007	0.00079
Drift as per Response Spectrum method in Y direction	0.001236	0.00095

3. Storey Shear: Critical are storey drifts when these are calculated for any building having considerable height. The inter storey shear is very important parameter that influences design. The inter storey shears are measured and tabulated in *table 6* below.

Table 6: Storey shear comparison

Parameters	For RCC model	For Composite model
Storey shear as per Static Method in X direction	897.47kN	877.11kN
Storey shear as per Static Method in Y direction	1004.51kN	1004.10kN
Storey shear as per Response Spectrum method in X direction	861.26kN	821.85kN
Storey shear as per Response Spectrum method in Y direction	951.48kN	918.16kN

Modal time period: Modal time period is found out by using the Eigen Vectors and analyzing the mode shapes from both the ends of the oscillations that the structure shows during an excitation. The time period is measured and tabulated in *table 7* below.

Table 7: Modal time period

Mode	For RCC model	For Composite model
1	2.226	1.682
2	2.109	1.538
3	1.526	1.244

Conclusion: Analysis of the traditional RCC and Steel composite structures have generated the following conclusions. The observed data is summarized below.

a. The storey displacement declines when the composite structure is compared to the conventional RCC structure. The composite structure has considerably lower displacements than conventional RCC structure.

b. The steel composite structure excels in performance as compared to the RCC structure in inter storey drift with lower drift values in all static and response spectrum cases.

c. The base shear comparison reveals a marginal difference between the two models with Composite structure being at the lower side for the storey shear.

d. There was a considerable reduction in time period values for composite structure as compared to traditional RCC structure.

e. Apart from above factors the composite structures are superior for economical and quick constructions.

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