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Analytical Study on RCC Core Steel Composite Column Using FEA

Lakshmy G Das[1], Preetha Prabhakaran[2] and Nivya John[3]

[1] M.tech Scholar, Department of Civil Engineering, Indira Gandhi Institute of Engineering and Technology for women, Ernakulam, Kerala, India

[2] Associate Professor, Department of Civil Engineering, Sree Narayana Gurukulam College of engineering, Ernakulam, Kerala, India

[3] Assistant Professor, Department of Civil Engineering, Indira Gandhi Institute of Engineering and Technology for women, Ernakulam, Kerala, India

Abstract

The study focuses on response of composite column to time dependant loading conditions. For this purpose spectrum analysis was carried out on the RCC core steel composite column of different sections and different length. 3D model is generated using ANSYS 14.5. Different sections selected as RC conventional column, circular core steel column, and core steel I section column for 900mm, 1800mm, 3600mm. The response analysis is carried out by selecting suitable accelerations and frequencies. Maximum Principle stress, Von Mises stress and deflection are obtained. The deflection values are increases as length of column increases. It is also evident that maximum principle stress and Von Mises stress is decreased as length increases and core steel I section column is better than RCC column and circular core steel composite column.

Keywords: *Finite element analysis, spectrum analysis, maximum principle stress.*

1. Introduction

Now a day's number of reinforced concrete buildings collapsed with storey failures by earthquakes. Therefore to prevent the storey failures of building structures, it is necessary to make the ductility of column larger. It can be achieved by using core steel composite columns is useful as one of the reinforcing RC columns. The steel-concrete composite column is a compression member. It comprises either a concrete encased steel section or a concrete filled hollow section of steel. It is generally used as a load-bearing member in a composite framed structure. Higher strength and stiffness compared with RC columns of the same materials properties. In composite columns the strength of the concrete is increased due to the confining effect provided by the steel. It is very cost effective when compared to steel structure because of composite effect (steel and concrete). The purpose of this study focuses earthquake resistant properties of composite columns. This analysis is carried out using finite element analysis method - ANSYS 14.5. Response spectrum analysis is carried out in this study to determine the response of structures. The spectrum analysis is one in which the results of a modal analysis are used with a known spectrum to calculate displacements and stresses in the model.

2. Scope

The scope of present studies is to compare RCC core steel composite column of different sections with conventional RC column and identified the advantages of RC core steel composite column. Use of core steel column in construction offers several major economic advantages over rain forced concrete columns. It resists bending moments and shear forces and restricts the concrete thereby increasing ductility. Innovative composite materials influence the properties of RC composite column.

3. Analytical investigations

Prepare 3D Models of composite column sections of different length using ANSYS 14.5 software. Specimen details of different column sections, element type and material properties are provided for each column. Specimen details of different column sections are shown in table 1.

Table 1: Specimen details of column sections

Description	***RCC Column***	***Core Steel Circular Column***	***Core Steel I – Section Column***
Colum size in (mm)	200x200		
Length in (mm)	900, 1800, 3600		
Reinforcement in (mm)	4 No. 16mm		
Core Steel in (mm)		41mm dia	50x60x9x9

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3.1 Element type

Solid 65 element was used to model the concrete. This element has eight nodes with three degrees of freedom at each nodes. A link 180 element was used for steel reinforcement provided in column. Solid modeling and automatic meshing is not useful for line element models.

3.2 Material specifications

3.2.1 For concrete

Young's Modulus E=25000Mpa
Poison's ratio v = 0.3
Density p = 2400kg/ m^3

3.2.2 For Steel

Young's Modulus E = 200Gpa
Poison's ratio v = 0.3
Density p = 7800kg/ m^3

3.3 Spectrum analysis

In this study spectrum analysis was carried out to calculate displacements and stresses in the model. The analysis is mainly used to determine the response of structures to time-dependent loading conditions (earthquakes loads).There are different types of spectra are available for a spectrum analysis. Here Response Spectrum analysis is done in each column. Selecting, zone factor - zone III, soil type as soft soil- Type III and Damping ratio - 0.05 according to IS 1893 part 1.

4. Result and discussions

Response spectrum analysis has been carried out on RC conventional column, circular core steel column, and core steel I section column for 900mm, 1800mm, 3600mm. The results of different sections are shown in tables below.

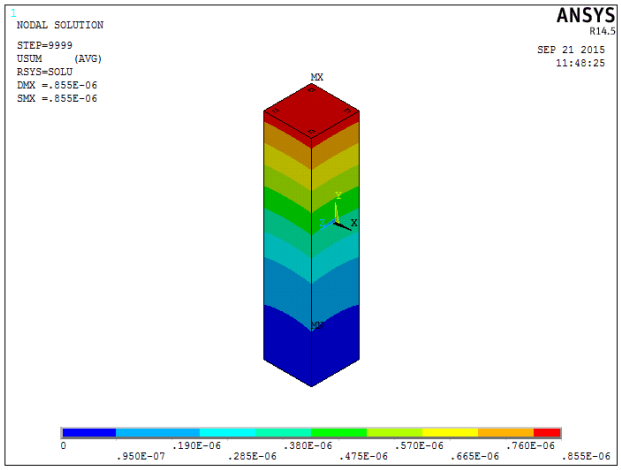

Fig 1: Deflection in 0.1g spectrum of RCC column 900 mm length

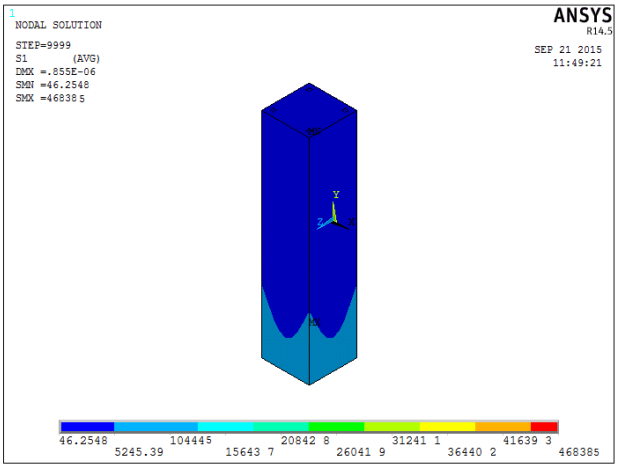

Fig 2: Max .Principle stress in 0.1g spectrum of RCC column 900 mm length

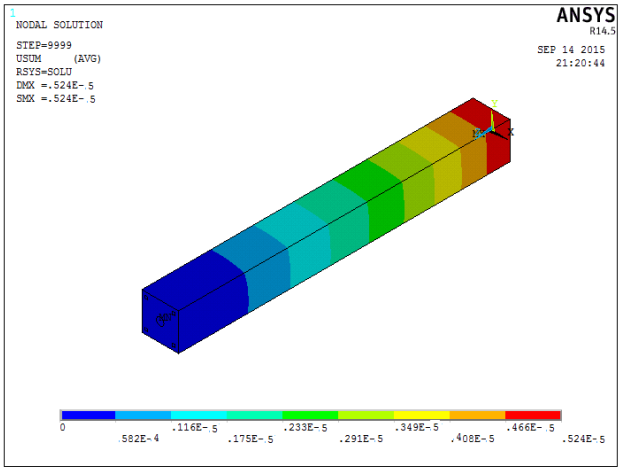

Fig 3: Deflection in 0.2g spectrum of circular core steel

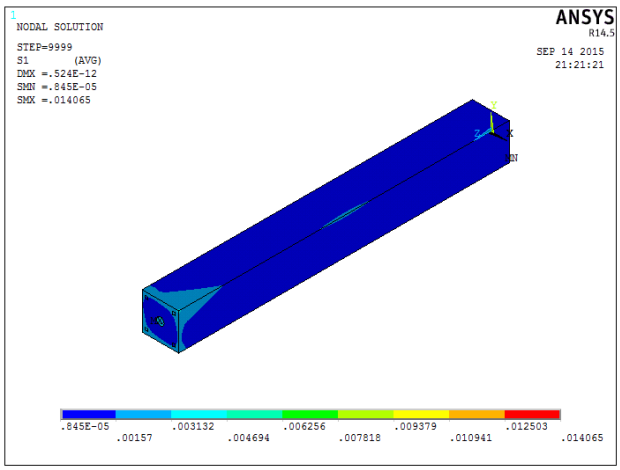

Fig 4: Von mises stress in 0.2g spectrum of circular core steel

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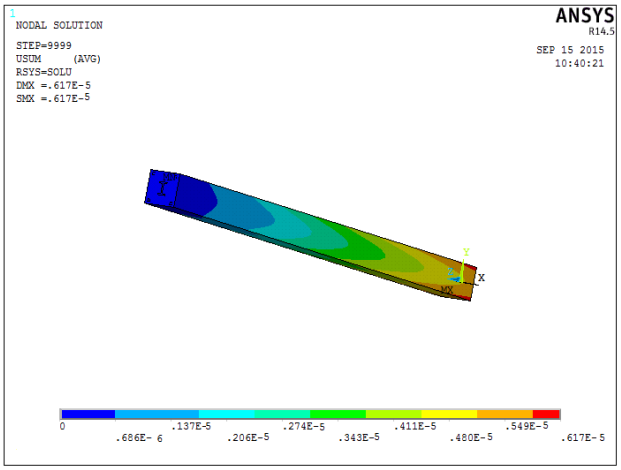

Fig 5: Deflection in 0.3g spectrum of core steel I section

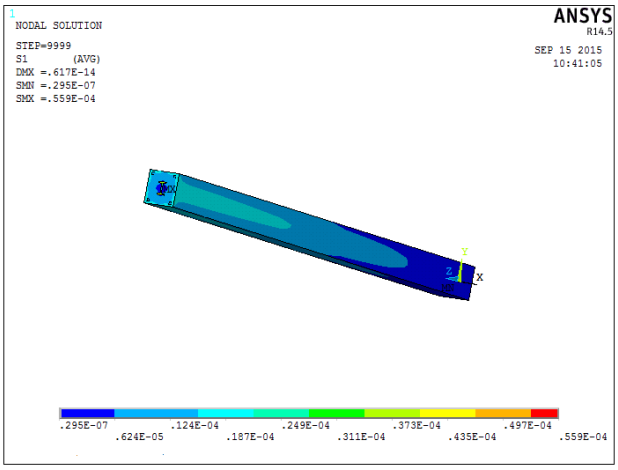

Fig 6: Max. Principle stress in 0.3g spectrum of core steel I section

Table 2: Spectrum analysis results of R.C.C Column

Specimen length (mm)	Spectrum	900	1800	3600
Deflection (mm)	0.1g	0.000855	0.013	0.206
	0.2g	0.00171	0.026	0.411
	0.3g	0.00256	0.039	0.617
Max. Principle stress (N/mm^2)	0.1g	468.385	1964.7	980.764
	0.2g	936.769	3932.94	196.00
	0.3g	140.515	5899.41	294.00
Von mises stress (N/mm^2)	0.1g	468.385	1964.7	980.764
	0.2g	936.769	3932.94	196.00
	0.3g	140.515	5899.41	294.00

Table 3: Spectrum analysis results of circular core steel column

Specimen length (mm)	Spectrum	900	1800	3600
Deflection (mm)	0.1g	0.663	0.864	0.115
	0.2g	0.506	0.524	0.231
	0.3g	0.759	0.346	0.176
Max. Principle stress (N/mm^2)	0.1g	2430	776	665.7
	0.2g	4860	1406.5	1331.4
	0.3g	7290	1940	1997.1
Von mises stress (N/mm^2)	0.1g	2430	2260	665.7
	0.2g	4860	1406.5	1331.4
	0.3g	7290	2880	1997.1

Table 4: Spectrum analysis results of core steel I section column

Specimen length (mm)	Spectrum	900	1800	3600
Deflection (mm)	0.1g	0.194	0.416	0.206
	0.2g	0.224	0.747	0.411
	0.3g	0.336	0.950	0.617
Max. Principle stress (N/mm^2)	0.1g	1430	667	186
	0.2g	2860	1350	373
	0.3g	4290	2030	559
Von mises stress (N/mm^2)	0.1g	1430	933	258
	0.2g	2860	1870	516
	0.3g	4290	2800	774

4. Conclusions

Response spectrum analysis was carried out in different sections to identify the behavior of composite column section. From Spectrum analysis results, deflection is increases as length of column increases. Maximum principle stress is decreases as length of column increases. Von mises stress is decreases as length increases. Deflection and stresses are increases as the spectrum value increase from 0.1g to 0.3g. For a constant length of column, deflection increases continuously in Spectrum analysis.

From the analysis Core I- Section Columns are better than RC Column and Core Steel Column.

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