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Analysis on Earthquake Resistant Properties of Rc Core Steel Composite Columns Using Ansys

KEYWORDS: ANSYS 12.0 V, Finite Element, Response Spectrum Analysis

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ABSTRACT *This study focuses on Eearthquake Resistant Properties Of RC Core Steel Composite Columns of different sections and different lengths. A model is proposed using ANSYS 12.0 V with proper Boundary conditions. The model is for RCC sections, Core Steel Circular Sections, Core Steel I-Section for a length of 800mm, 1600mm and 3200mm .The analysis has been carried out using 8-noded 185solid element and solid 65. Max Deflection, Max Principal Stress, Max Principal Strain, von Mises Stress and strains are obtained. Values of Deflections from the Modal Analysis(In case of static) it is evident that using Core Steel I Section Column is better than RC Columns and Steel Circular Core Column (Rrefer table no 4 and 5).It clearly evident that in case of Core Steel I Section Column values of Max.Principle reduces than RC and Core Circular Columns. von Mises Stress decreases as Column length increases for RC Column ,Circular Core and I Section Column*

1 Introduction

A large number of reinforced concrete (RC) buildings collapsed with storey failures by 1995Hyogoken-Nanbu earthquake in Japan[1]. Especially RC columns at the corner post on the failure storey collapsed in shear brittle under large compressive axial forces generated by large horizontal and vertical accelerations. In order to prevent happening brittle shear failure of RC columns and occurring the storey failure of building structures, it is necessary to make the ductility of columns larger. It can be thought using core steel composite columns is useful as one of the reinforcing RC columns. The purpose of this study to describe the elastic-plastic behavior of the core steel composite columns under large compressive axial load and earthquake horizontal load, and to show the composite columns have large better earthquake resistant performance than RC columns.

To increase ductility of column some reinforcing methods have been reported, such as covering RC columns by steel tubes or confining RC columns by arranging transverse reinforcement as hoop ties closely. On the other hand, the core steel composite is useful to resist large axial force. A large number of reinforced concrete (RC) buildings collapsed with storey failures by 1995 Hyogoken- Nanbu earthquake in Japan[1] Especially RC columns at the corner post on the failure story collapsed in shear brittly under large compressive axial forces generated by large horizontal and vertical accelerations. In order to prevent the storey failure, it is necessary to make the concrete strain less.

1.1Advantages of Core Steel Composite Columns

1. Encasing core steel makes the deformation capacity of RC columns to be large.
2. Effect of the ratio of acting axial force to compressive strength of encased core steel columns is large. The columns show large earthquake resistant properties.
3. Flexural strength of the composite columns with core steel is estimated conservatively by superposed strength using yield steel stress and 0.85 times of concrete compressive strength
4. Encased core steel with ns equal to 1.5 was the best suitable for composite columns to Make large earthquake resistant properties.
5. Using compact core steel is more suitable than H shaped steel, on the point of controlling shrinkage little

2.0 Finite Element Method

Introduction

The basic concept of finite element method is discritisation of a structure into finite number of elements, connected at finite number of points called nodes. The material properties and the governing relationships are considered over these elements and expressed in terms of nodal displacement at nodes. ANSYS is a general purpose finite element modelling package for numerically solving a wide variety of problems which include static/dynamic structural analysis (both linear and nonlinear), heat transfer and fluid problems, as well as acoustic and electro-magnetic problems. The mechanical and thermal buckling have been analyzed using a finite element (FE) model in ANSYS.

2.1 Advantages of FEM

1. FEM makes piecewise approximation i.e., it ensure the continuity at node points as well as along the side of the element.
2. FEM can handle ultimate number of boundary conditions.
3. FEM needs fewer nodes to get good results
4. FEM can consider the sloping boundaries exactly.If curved elements are used, even the curved boundaries can be handeled easily.
5. FE model can be altered easily and economically
6. Irregular shaped bodies can be easily modelled and. FEM can give values at any point.

2.2 ANSYS v.12.0

ANSYS V.12 is an integrated design analysis tool based on the FEM developed by ANSYS, Inc. It has its own tightly integrated pre and post-processor. The ANSYS product documentation is excellent and it includes commands reference; operations guide; modeling and meshing guide; basic analysis procedures guide; advanced

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analysis guide; element reference; theory reference; structural analysis guide; thermal analysis guide; electromagnetic fields analysis guide; fluid dynamics guide; and coupled field analysis guide.

ANSYS finite element analysis software enables engineers to perform the following tasks:

- Build computer models or transfer CAD models of structures, products, components, or systems.
- Apply operating loads or other design performance conditions.
- Study physical response, such as stress levels, temperature distributions or electromagnetic fields.
- Optimize a design early in the product development process to reduce production costs.

2.3 Stages To Solve Finite Element Analysis
1) Pre Processing
2) Solution Processor
3) Post Processing

2.4 Material Specifications
Steel
- Young's Modulus E= 200Gpa • Poison's ratio v=0.3 • Density p=7800kg/m^3.

Concrete
- Young's Modulus E=27836.8Mpa/25000Mpa • Poison's ratio v=0.16-0.3 • Density p=2400kg/m^3

2.5 Speciman Details

Description	R.C.C Column	Core Steel Circular Section Column	Core Steel I-Section Column
Column Size in (mm)	200 x 200	200 x 200	200 x 200
Length in (mm)	800, 1600, 3200	800, 1600, 3200	800, 1600, 3200
Reinforcement in (mm)	4 No 16mm	4 No 16mm	4 No 16mm
Core Steel in (mm)	-	41mm Dia	50 x 60 x 9 x 9
Axial Load in (KN)	467	606	616
Horizontal Load in(KN)	1	1	1

2.6 Earthquake Forces
The seismic analysis will be carried out in accordance with IS: 1893 by Modal Analysis of the Earthquake Analysis will be carried out by Response Spectrum Method. Earthquake analysis for the fill supporting structures (RCCframes) will be carried out by Response Spectrum Method. For the Calculation of the Design Spectrum, the following Factors were considered as per IS 1893 (part I) 2002.
Zone Factor: For Zone III = 0.16
Importance Factor (I) = 1.00
Response Reduction Factor (R) = 3.00
Average Response Acceleration Coefficient Sa/g = soil site condition.
The Design Horizontal Seismic Coefficient Ah for 0.1g, 0.2g & 0.3g of a structure

Static Analysis Results of Deflection (Table.no.1)

Specimen	R.C.C column			Circular Core Steel Column			Core Steel I-Section Column		
Length (mm)	800	1600	3200	800	1600	3200	800	1600	3200
Deflection (mm)	0.36116	0.687478	1.505	0.3387055	0.764159	1.518	0.385731	0.787278	2.091

Static Analysis Results of Max. Principle Stress (Table.no.2)

Specimen	R.C.C column			Circular Core Steel Column			Core Steel I-Section Column		
Length (mm)	800	1600	3200	800	1600	3200	800	1600	3200
Max.Principle tress(N/mm2)	30.541	14.64	10.506	19.851	16.335	13.366	21.628	19.662	15.675

Static Analysis Results of Max. von Mises Stress (Table.no.3)

Specimen	R.C.C column			Circular Core Steel Column			Core Steel I-Section Column		
Length (mm)	800	1600	3200	800	1600	3200	800	1600	3200
Von Mises Stress(N/mm2)	100.52	76.815	72.681	91.734	89.817	85.733	96.363	94.943	91.942

Modal Analysis Results of Deflection (Table.no.4)

Speciman	R.C.C column			Circular Core Steel Column			Core Steel I-Section Column		
Length(mm) modes	800	1600	3200	800	1600	3200	800	1600	3200
1	21.23	15.172	10.757	20.627	14.715	10.428	20.57	14.666	11.635
2	15.934	11.412	8.107	15.502	11.072	7.86	15.452	11.034	8.210
3	20.919	15.035	10.727	20.495	14.629	10.409	20.483	14.596	12.522

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Modal Analysis Results of Max. Principle Stress (Table.no.5)

Speciman	R.C.C column			Circular Core Steel Column			Core Steel I-Section Column		
Modes \ Length (mm)	800	1600	3200	800	1600	3200	800	1600	3200
1	1480	269.381	48.48	1404	260.484	47.042	1407	260.041	69.042
2	5167	1098	208.415	4776	1059	201.458	4807	1059	194.215
3	6680	1519	295.469	6122	1460	284.868	6204	1464	265.756

Modal Analysis Results of Max. Von Mises Stress (Table.no.6)

Speciman	R.C.C column			Circular Core Steel Column			Core Steel I-Section Column		
Modes \ Length (mm)	800	1600	3200	800	1600	3200	800	1600	3200
1	7605	237.25	41.562	1211	222.345	40.467	1212	221.951	50.436
2	4750	974.403	181.852	4453	934.888	176.006	4479	934.855	153.496
3	6307	1365	259.012	5906	1307	250.417	5957	1308	262.125

Spectrum Analysis Results of Deflection (Table.no.7)

Speciman	R.C.C column			Circular Core Steel Column			Core Steel I-Section Column		
spectrum \ Length (mm)	800	1600	3200	800	1600	3200	800	1600	3200
0.1g	15.322	10.788	8.13	25.585	11.128	7.879	25.465	11.094	7.23
0.2g	25.498	11.464	10.704	14.832	10.453	10.402	14.785	18.24	10.01
0.3g	16.188	18.313	7.618	15.806	18.319	7.383	15.801	10.416	7.33

Spectrum Analysis Results of Max. Principle Stress (Table.no.8)

Speciman	R.C.C column			Circular Core Steel Column			Core Steel I-section Column		
spectrum \ Length (mm)	800	1600	3200	800	1600	3200	800	1600	3200
0.1g	6327	2119	645.814	4931	2952	621.97	6822	2959	618.20
0.2g	5111	3062	786.46	5936	2067	756.783	5936	2426	742.85
0.3g	3045	1805	735.303	3018	1812	713.848	3145	2065	711.326

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Spectrum Analysis Results of Max. von Mises Stress (Table.no.9)

Speciman	R.C.C column			Circular Core Steel Column			Core Steel I-Section Column		
Length (mm) / spectrum	800	1600	3200	800	1600	3200	800	1600	3200
0.1g	5296	1771	577.908	6981	2747	556.16	11812	2743	542.92
0.2g	6613	2881	708.606	4973	1730	681.553	4980	4200	667.125
0.3g	1178	2623	612.786	1105	2630	595.372	1116	1730	589.995

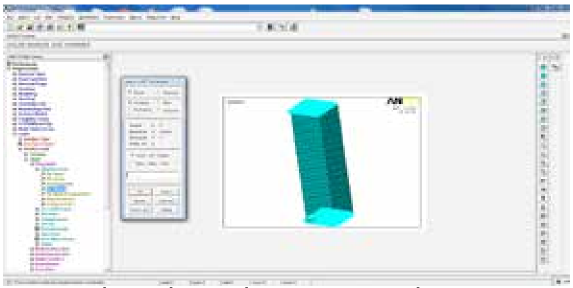


Fig.1 Applying The Displacement On Nodes

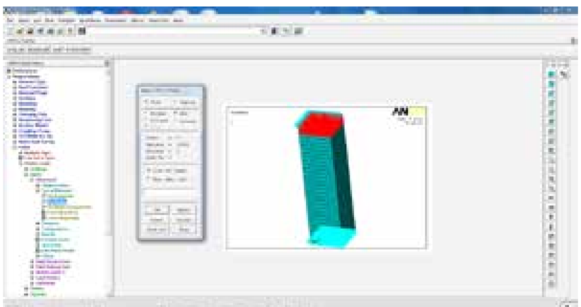
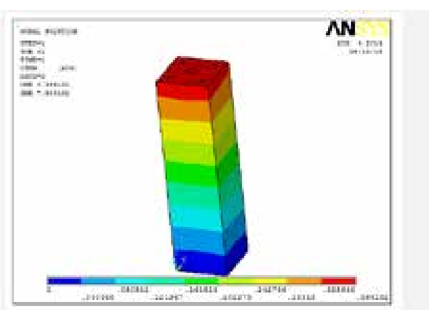
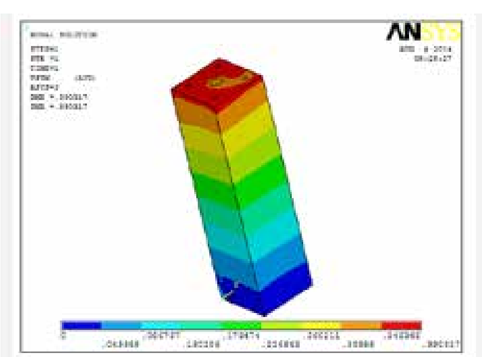


Fig.2 Applying The Force On Nodes





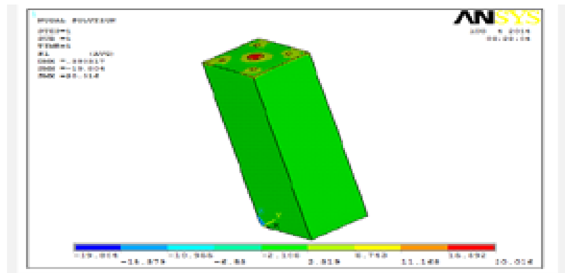
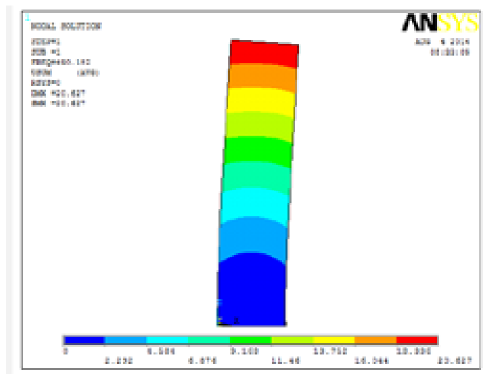
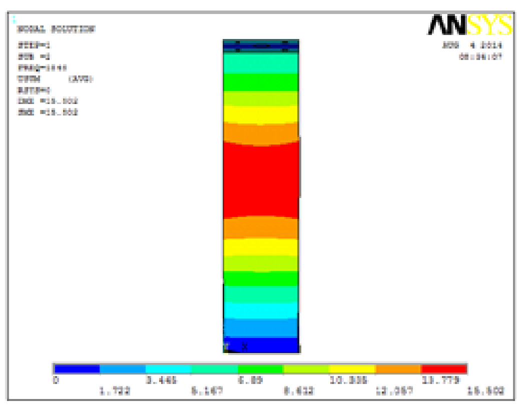


Fig.3 Different Modes Shapes Of Stastic Analysis





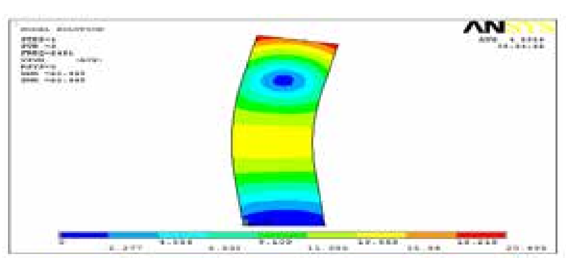


Fig.4 Different Mode Shapes of Modal Analysis

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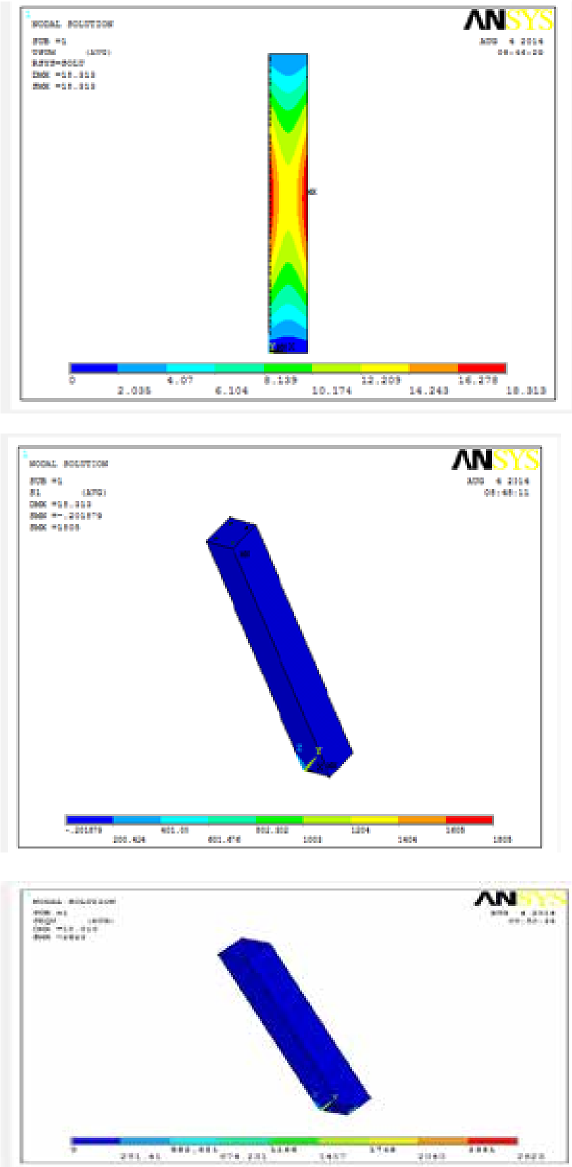
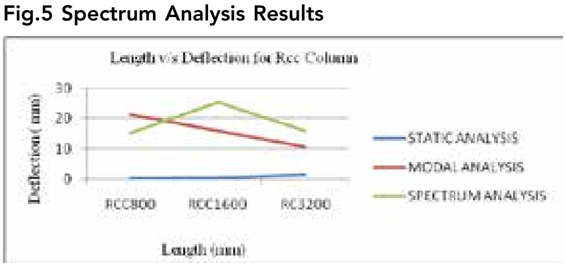
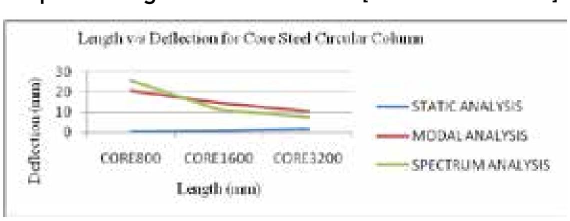


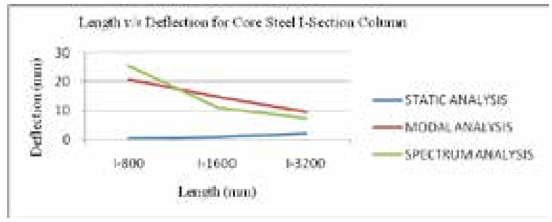
Fig.5 Spectrum Analysis Results



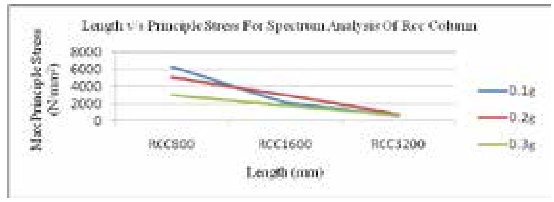
Graph1 : Length V/S Deflection [For RCC Column]



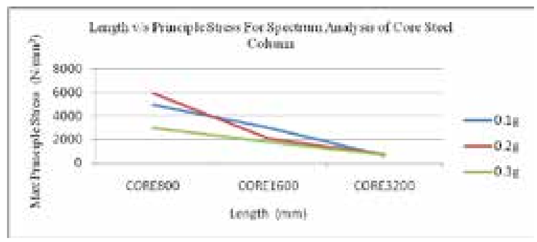
Graph 2 : Length V/S Deflection [For Core Steel Circular Column]



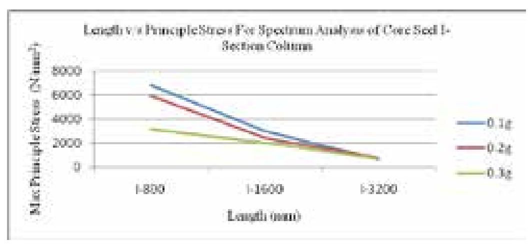
Graph 3 : Length V/S Deflection [For Core Steel I - Section]



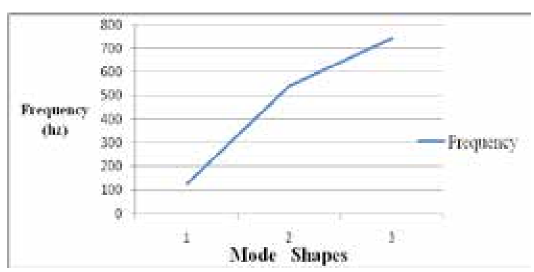
Graph 4 : Length V/S Principle Stress For RCC Column 0.1g,0.2g,0.3g Spectrum Analysis



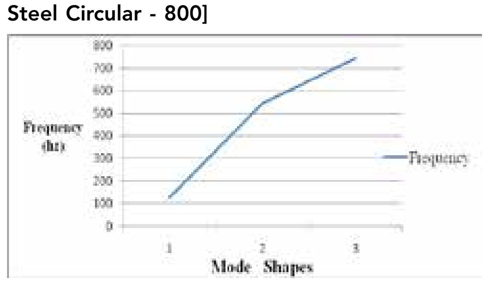
Graph 5 : Length V/S Principle Stress For Core Steel Circulr Column 0.1g,0.2g,0.3g Spectrum Analysis



Graph 6 : Length V/S Principle Stress For Core Steel I-Section Column 0.1g,0.2g,0.3g Spectrum Analysis



Graph 7 : Mode Shape v/s Frequency [For Core Steel Circular - 800]



Graph 8 : Mode Shape v/s Frequency [For-RCC-800]

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CONCLUSIONS:

1) From values of Deflections from the Modal Analysis(In case of static) it is evident that using Core Steel I - Section Column is better than RC and Circular Core Steel Column (Refer table no. 4 and 5).

2) From table no.5 it clearly evident that in case of Core Steel I- Section Column values of Max.Principle Stress reduces than RC Column and Core Circular Columns.

3) From table no.3 von Mises Stress decreases as column length increases for RC Column ,Circular Core and I-Section Column.

4) From table no.7 it is evident that it can concluded from table no.7 that for a constant Length of Column ,Deflection initially increases (Ex.15.3mm,25.5mm for 0.1gto 0.2g) initially but drastically decreases for 0.3g acceleration (Ex.7.3mm from 25.4mm of 0.2g refer tableno.7).

5) From table no.7 it is also evident that Core I- Section Columns are better to RC Column and Core Steel Column with respect to Spectrum Analysis

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