BUCKLING ANALYSIS OF RC-SIFCON COLUMN USING ANSYS SOFTWARE

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***Abstract*— Slurry infiltrated fibrous concrete (SIFCON) is an extremely improved version of conventional fibre reinforced concrete having high fibre content, a unique construction material having unique properties in the areas of strength, ductility, durability and toughness. SIFCON is relatively a new type of high performance fibre reinforced concrete in which formwork moulds are filled to its capacity with fibres and the resulting fibre network is infiltrated by cement based slurry. Infiltration is usually accomplished by gravity flow. Because of its high tensile strength, ductility, superior impact and abrasion resistant, it has excellent potential benefits in structural applications.**

This paper reports on the behavior of reinforced concrete with SIFCON column with varying percentage of SIFCON for different l/b ratios.

***Index Terms*— RC, SIFCON, Columns, ANSYS, Buckling analysis**

I. INTRODUCTION

In the construction of long span bridge, high rise building, offshore structures, and other mega structures requires materials, with increasingly improved properties, particular strength, stiffness, toughness, ductility, durability. In this view, simultaneous improvement in a combination of properties is needed. Such materials are called "High Performance Materials" or "Advanced Materials".

Due to the increase of civil infrastructure systems worldwide, the number of deteriorated buildings and structures also increases. Entire replacement will be increasing financial burden and might certainly be a waste of a natural resource if upgrading or strengthening is a possible alternative. A new method of resolving this difficulty is to selectively use advanced composites such as High Performance Fibre Reinforced Cementitious Composites (HPFRCCs). Usually two types of HPFRCCs obtainable in the market namely SIFCON and SIMCON. In a unique HPFRCC application termed Slurry Infiltrated Fibre Concrete (SIFCON), the steel fibres are placed inside a mould and then infiltrated by a high strength, cementitious slurry.

II. SIFCON

SIFCON is a high-strength, high-performance material containing a relatively high volume percentage of steel fibres when compared to SFRC. It is often referred as 'high-volume fibrous concrete'. Prof. Lankard carried out extensive experiments in his laboratory in Columbus, Ohio, USA in 1979 and he proved that, if the percentage of steel fibres in a cement matrix could be increased considerably, then a material of very high strength could be obtained, which he named as SIFCON and thus SIFCON originated

SIFCON is relatively a new type of high performance fibre reinforced concrete in which formwork moulds are filled to its capacity with fibres and the resulting fibre network is infiltrated by cement based slurry. Infiltration is usually accomplished by gravity flow. Because of its high tensile strength, ductility, superior impact and abrasion resistant, it has excellent potential benefits in structural applications.
SIFCON have the following properties:

- Excellent energy absorption capacity
- Highly ductile and greater Strength

III. SHORT COLUMN AND LONG COLUMN

A column is considered to be short when the ratio of its effective length to its least lateral dimension does not exceed 12. If the ratio of the effective length to its least lateral dimension exceeds12 the column is considered to be a long column.

IV. OBJECTIVES

- To study the effect of Reinforced concrete with the SIFCON in columns.
- To study the behaviour of RC with varying percentages of SIFCON (0%, 20%, 30%, 40%, 50% &100%) columns with different l/b ratios.
- To study the load deflection behaviour of RC-SIFCON columns when it is subjected to lateral and axial loading.
- To study of effect of structural size of RC-SIFCON columns having square cross section with different percentage of SIFCON on their buckling behavior

V. SOFTWARE USED FOR ANALYSIS

For the present study ANSYS software is used. For the nonlinear analysis ANSYS is an efficient nonlinear finite element package. ANSYS is a comprehensive general-purpose finite element computer program which contains over 100,000 lines of code. ANSYS has capability of performing static, dynamic, heat transfer, and fluid flow and electromagnetism analyses.

The origin of the modern finite element method may be traced back to the early 1900s, when some investigation approximated and modelled elastic continua using discrete equivalent elastic bars. However, Courant (1943) has been credited with being the first person to develop the finite element method. The next significant step in the utilization of finite element methods was taken by Boeing in the 1950s when Boeing, followed by others, used triangular stress elements to model airplane wings. Yet it was not until 1960 that Clough made the term "finite element" popular. During the 1960s, investigation began to apply the finite element method to the areas of engineering, such as heat transfer and seepage flow problems. In 1971, ANSYS was released for the first time.

VI. VALIDATION AND FE MODELING

Validation is done for RC column to the different percentages of SIFCON using FEM software ANSYS. Column dimension is taken as 3000mm length x 200mm breadth x 200mm depth.

VII. FE MODELING

3D modelling and 1D modelling of RC-SIFCON column is done. The element used in the analysis is SOLID185 for 3D modelling and BEAM188 for 1D modelling.

VIII. MATERIAL PROPERTIES

The modulus elasticity and Poisson's ratio details are shown below:

Table 1 Material properties

SI. No	RC (%)	SIFCON (%)	MODULUS OF ELASTICITY (N/mm^2)	POISSON'S RATIO
1	100	-	23158	0.15
2	-	100	20953	0.15
3	80	20	21349	0.15
4	70	30	32663	0.15
5	60	40	39067	0.15
6	50	50	28282	0.15

IX. BOUNDARY CONDITION FOR THE COLUMN

Boundary condition given for the column is one end fixed and the other end free.

X. CRITICAL OR BUCKLING LOAD

The value of critical or buckling load is calculated manually by using the below formula.

$$Pcr = \frac{\pi^2 EI}{4l^2} \quad \text{Equation 1}$$

Where,
Pcr= Critical or buckling load of the column, N
E= Modulus of elasticity, N/mm^2
I= Moment of inertia, mm
l= length of the column, mm

The manually calculated critical load and the critical load value got from ANSYS software for 1D and 3D model is tabulated as shown below:

Table 2 Critical load for column 200mmx200mmx300mm

Sl. no	Percentage of RC	Percentage of SIFCON	Manual buckling load (kN)	1D (kN)	3D (kN)	% of variation
1	100	-	846.490	845.205	842.456	0.48
2	-	100	765.898	764.728	762.242	0.15
3	80	20	780.373	764.728	776.648	0.47
4	70	30	1192.83	1190	1190	0.24
5	60	40	1428.02	1430	1420	0.56
6	50	50	1033.79	1030	1030	0.37

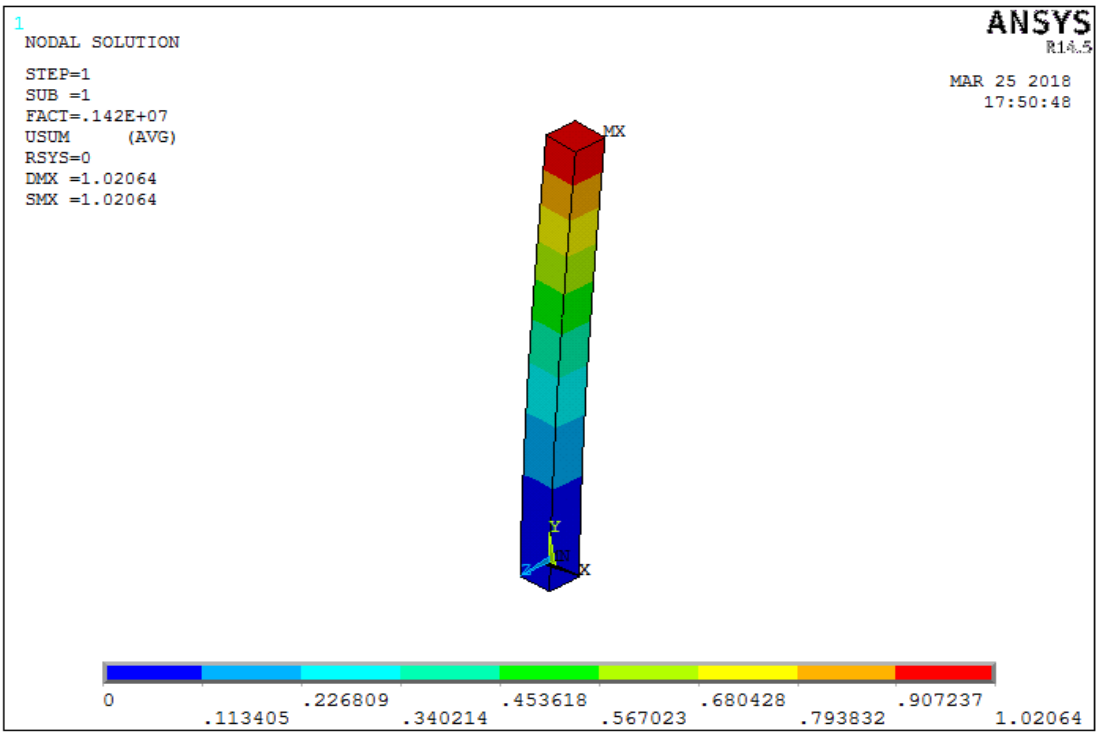


Fig 2 Critical load for 60% RC and 40% SIFCON column (3D)

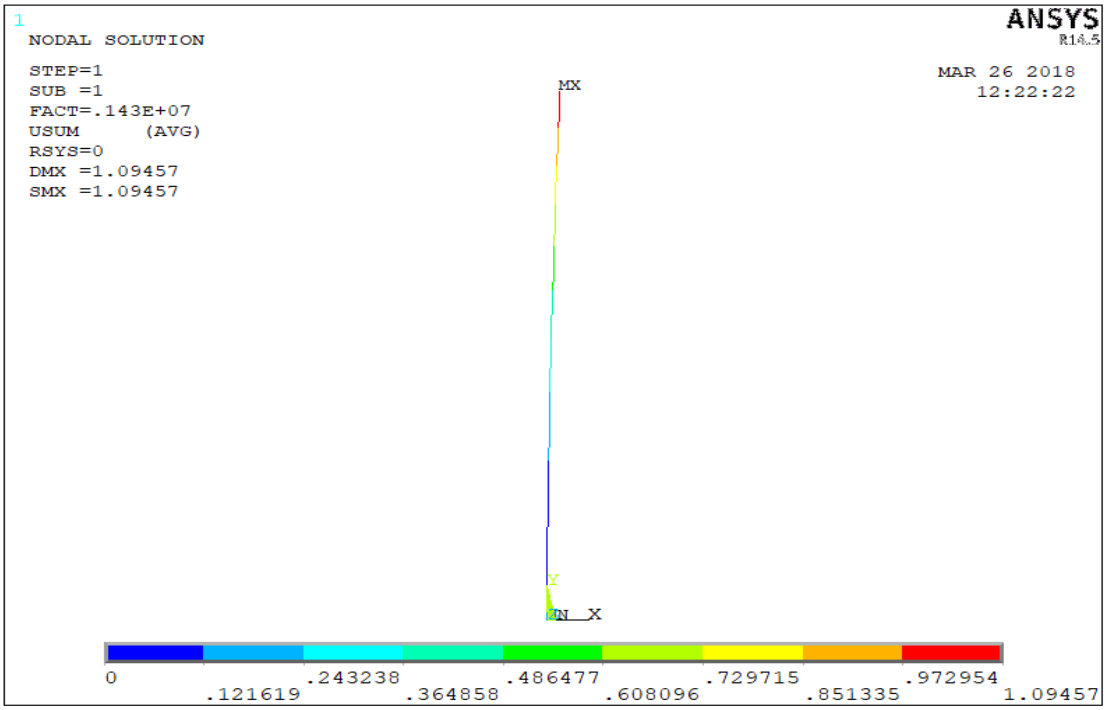
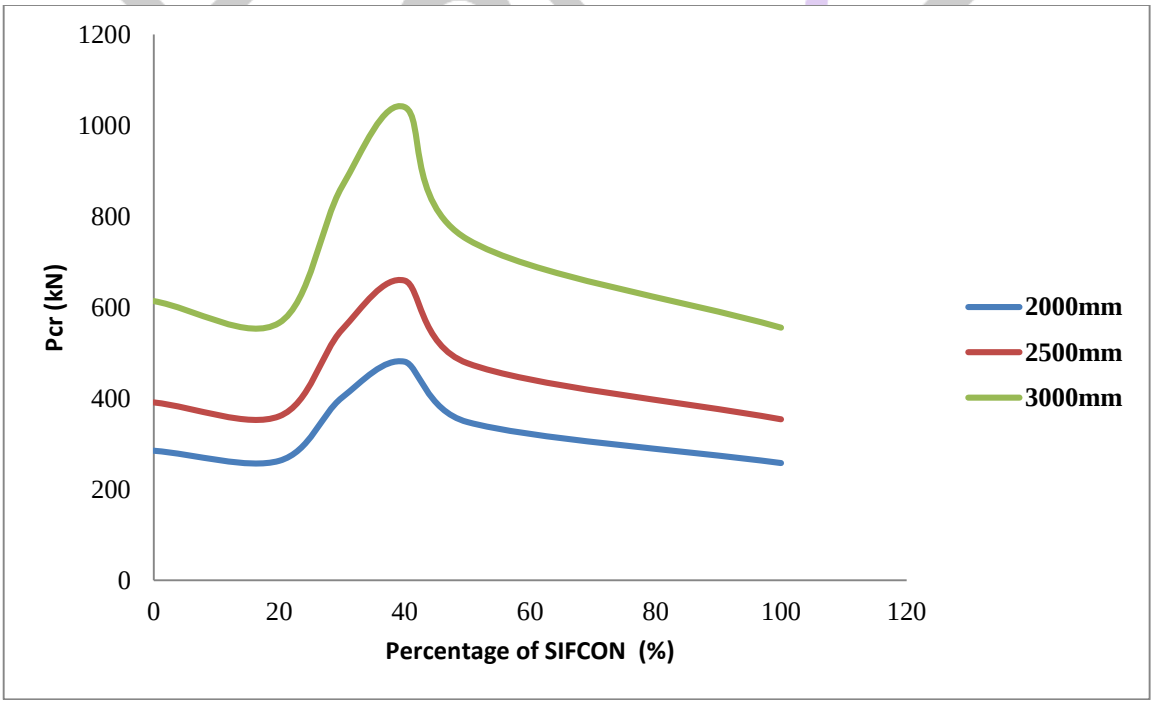


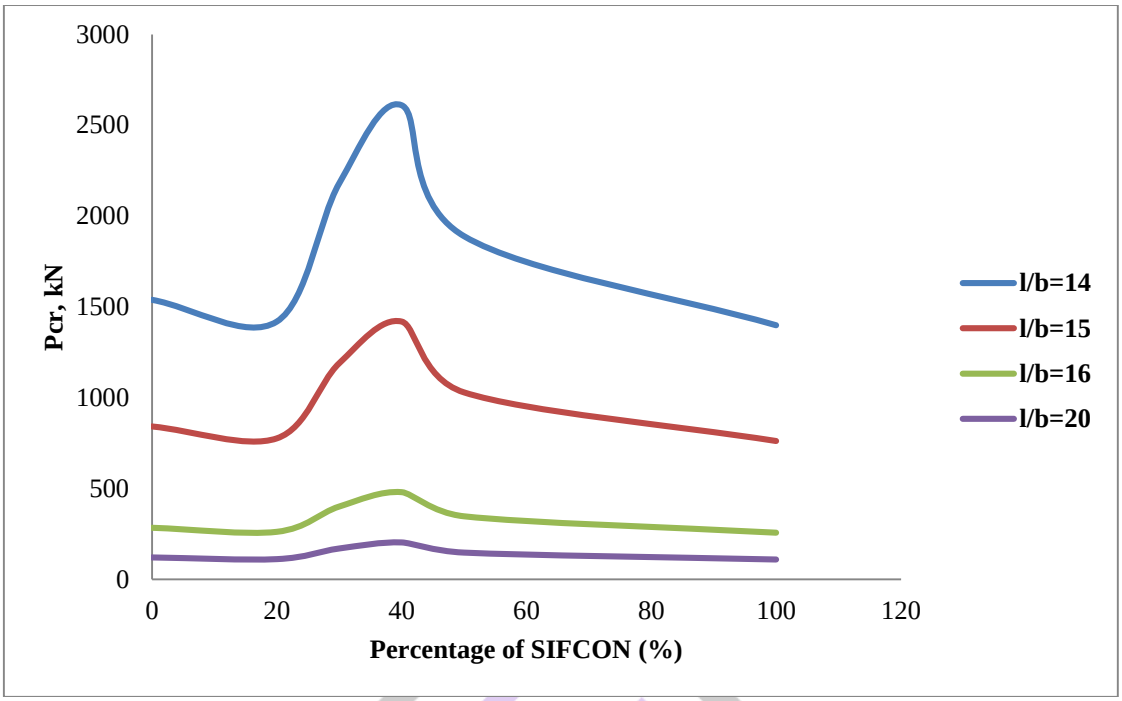
Fig 3 Critical load for 60% RC and 40% SIFCON column (1D)

XI. RESULTS AND DISCUSSIONS

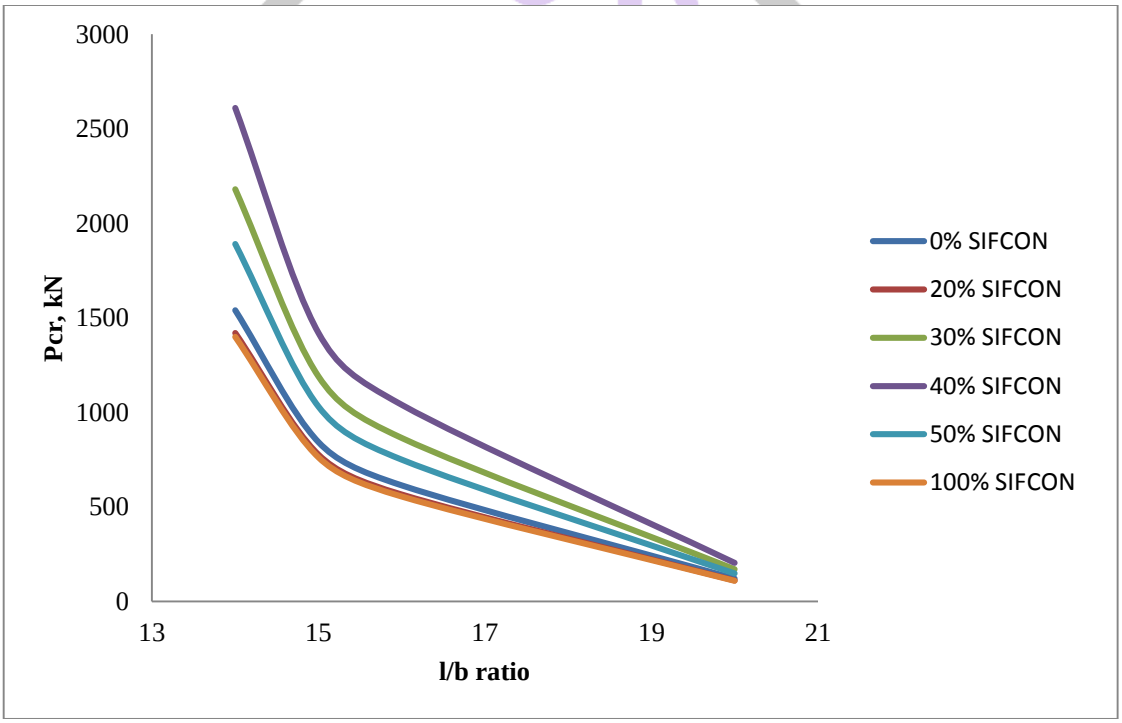
Inference drawn from the FE modelling of RC-SIFCON columns is shown by using graphs. These are the various graphs for the various parameters from the observations drawn after the FE modelling.



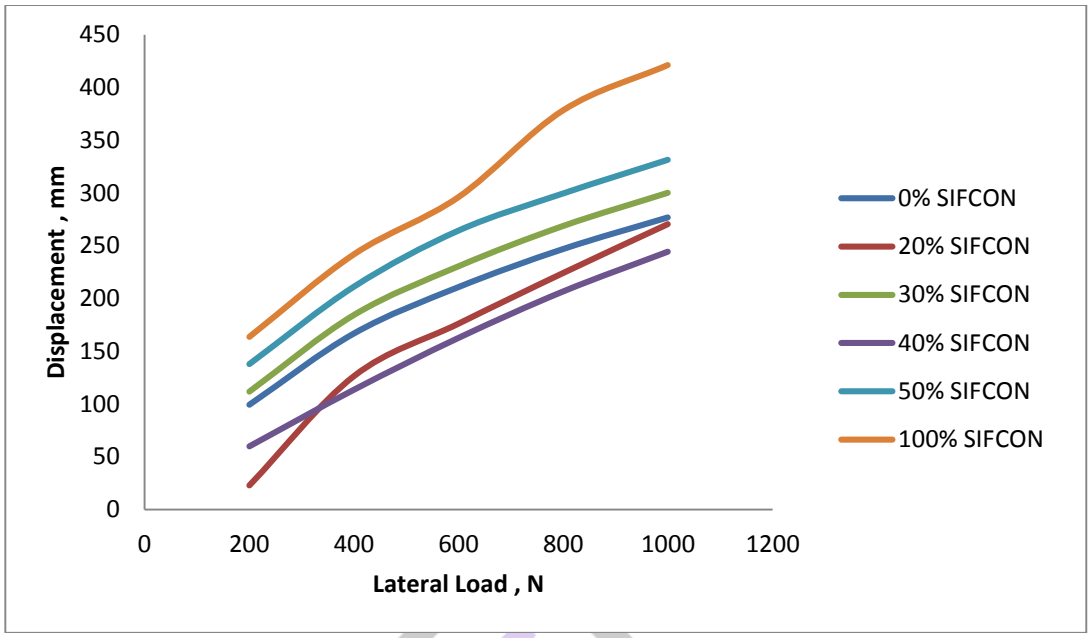
Graph 1 Critical load versus % SIFCON for constant l/b ratio



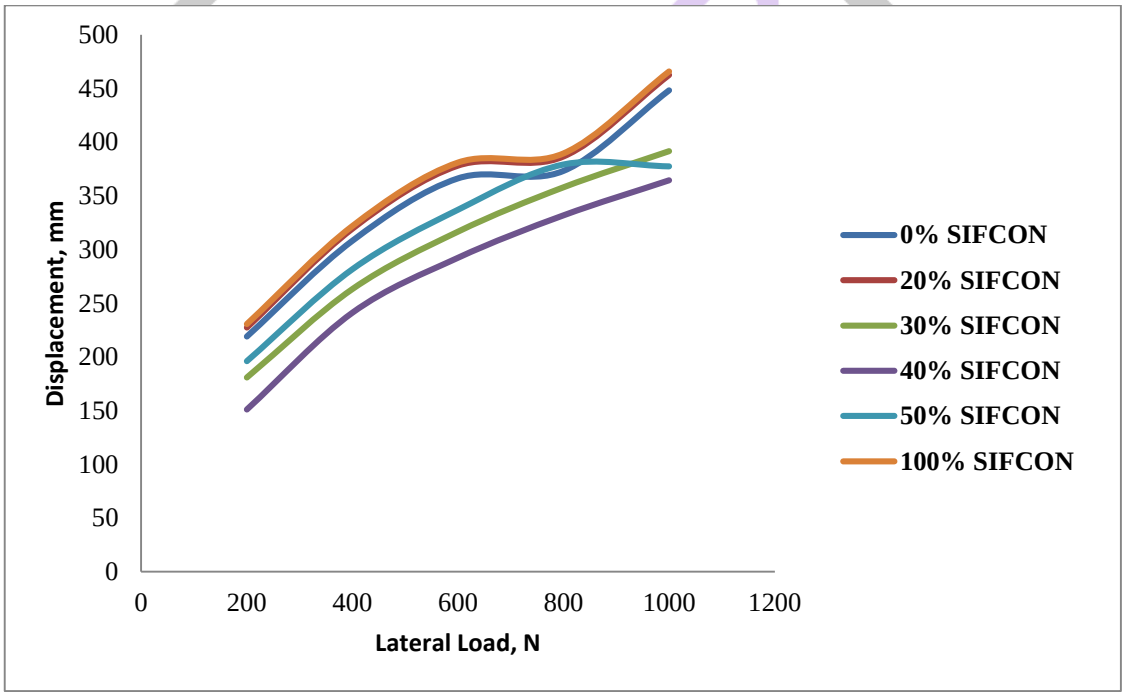
Graph 2 Critical load versus % SIFCON for varying l/b ratio



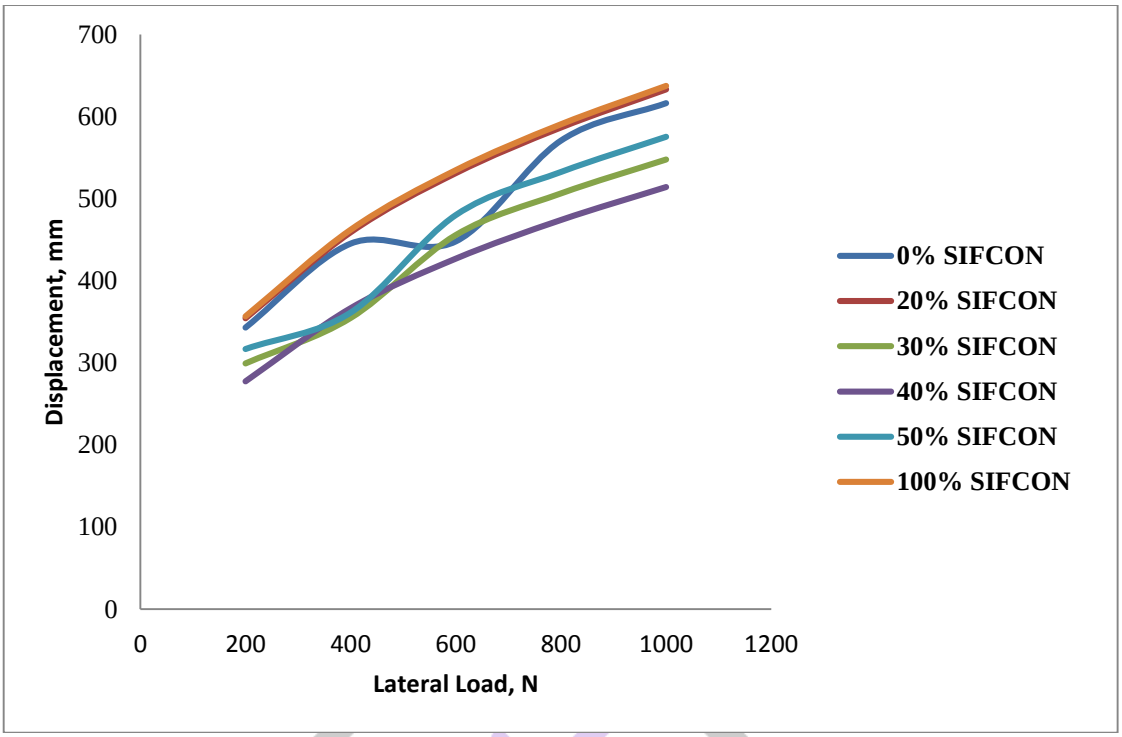
Graph 3 Critical load versus l/b ratio for different % of SIFCON



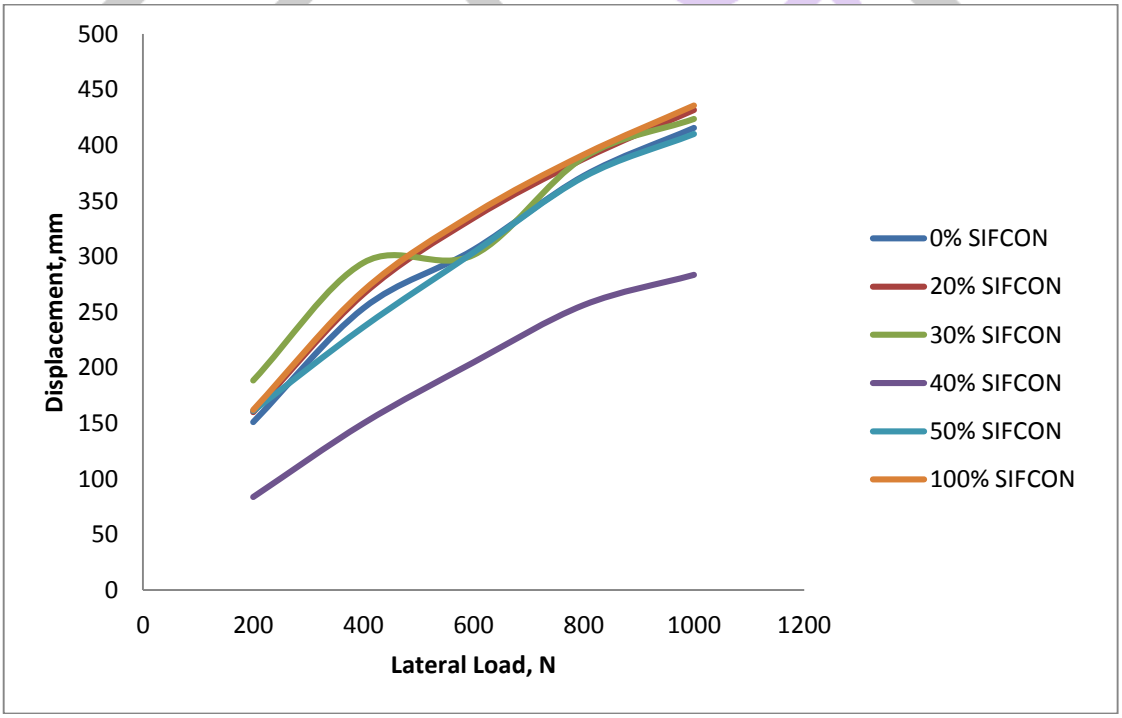
Graph 4 Displacement versus lateral load for l/b ratio= 14



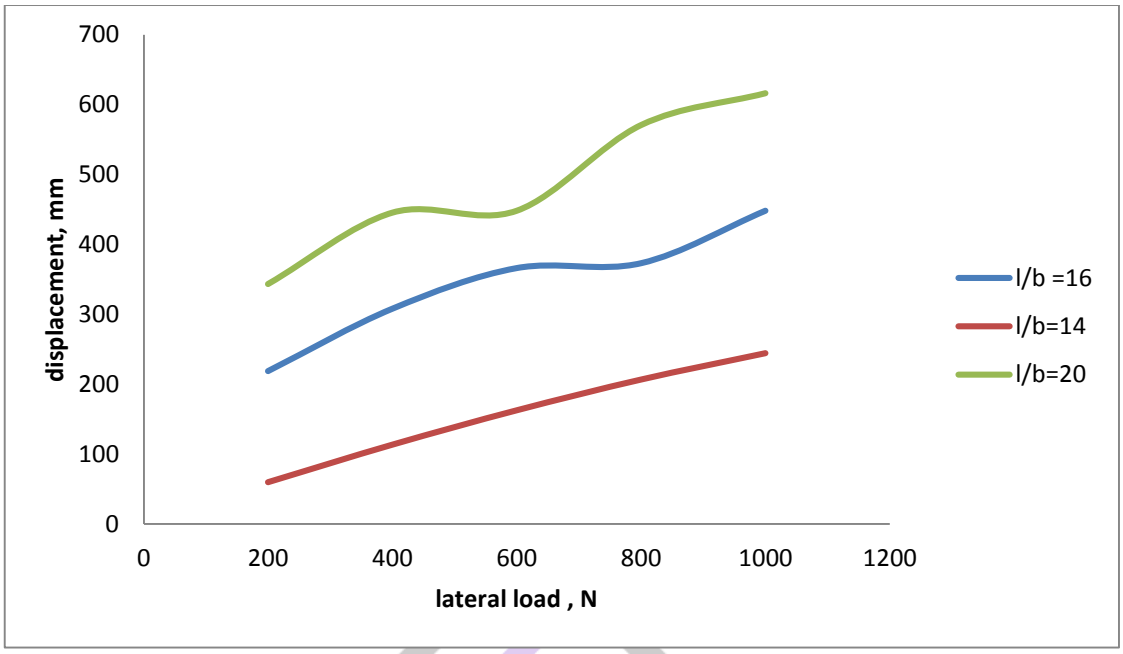
Graph 5 Displacement versus lateral load for l/b ratio= 16



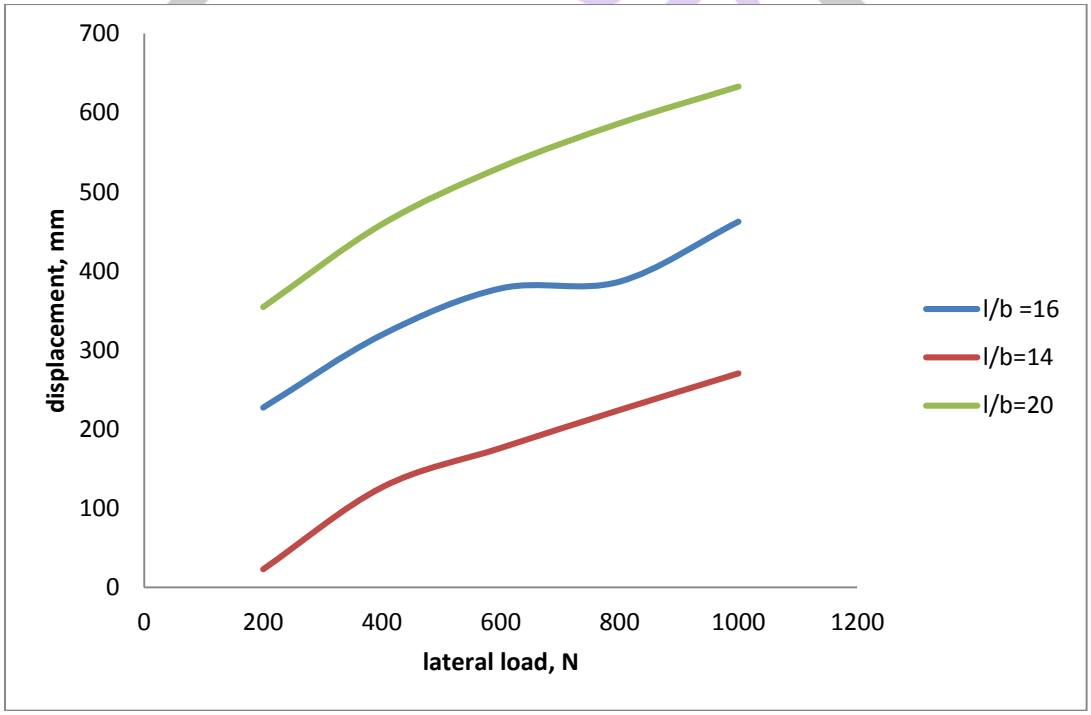
Graph 6 Displacement versus lateral load for l/b ratio= 20



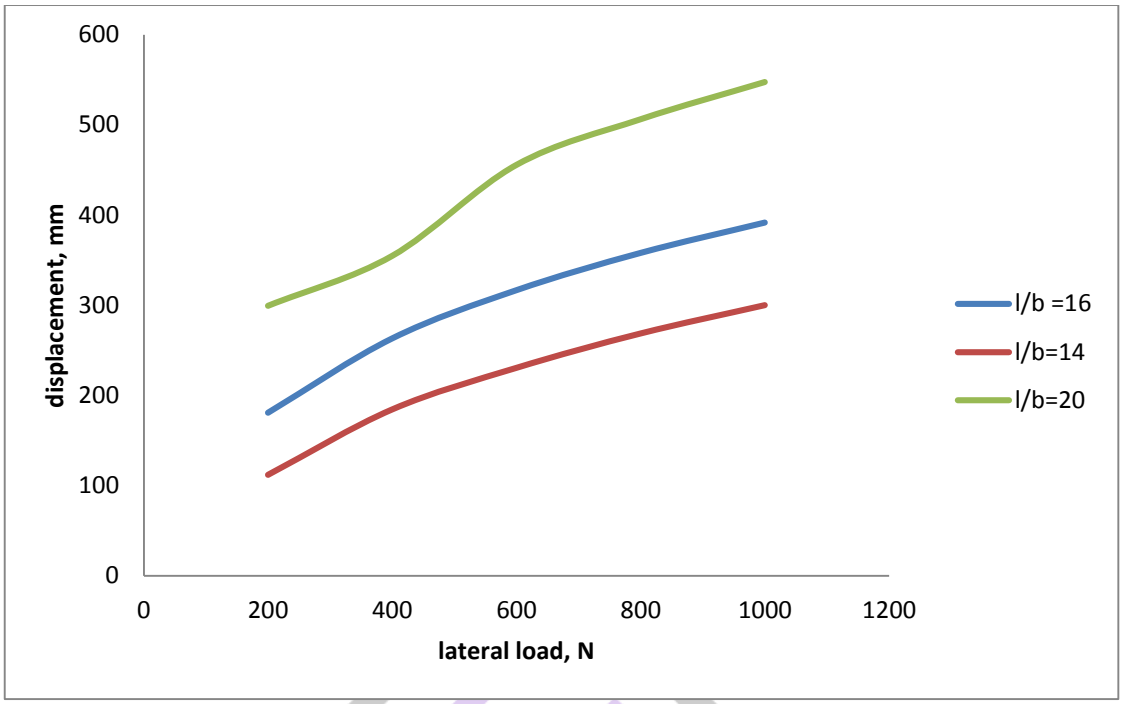
Graph 7 Displacement versus lateral load for l/b ratio= 15



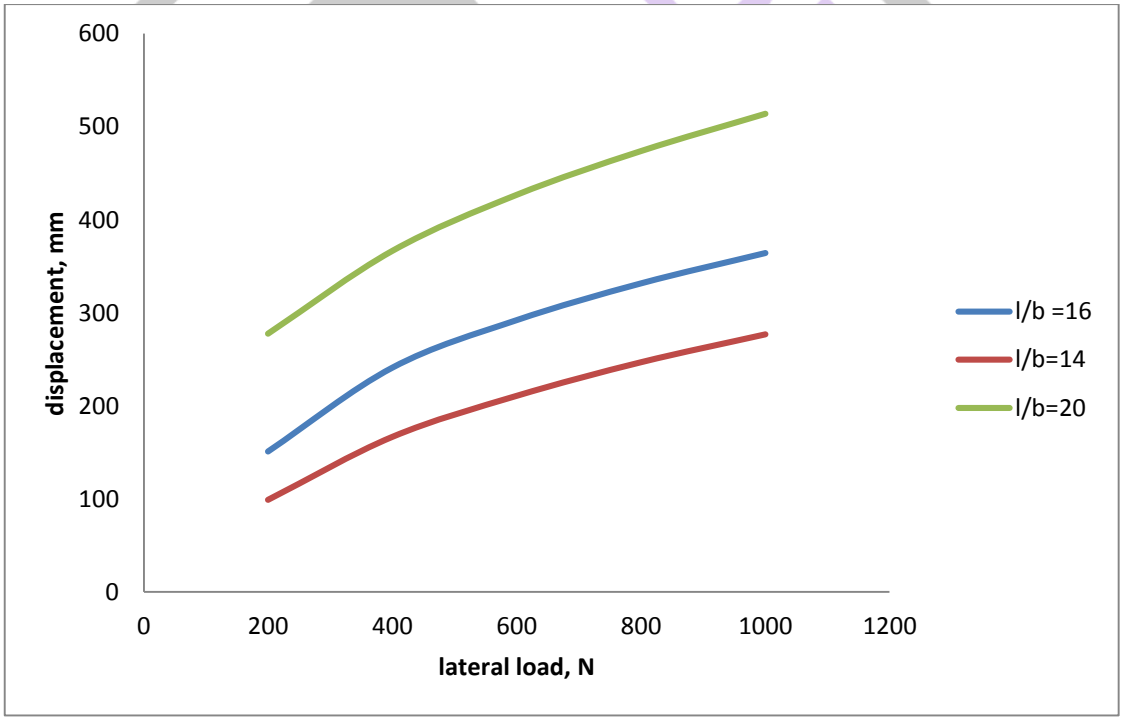
Graph 8 Displacement versus lateral load for 0% SIFCON column



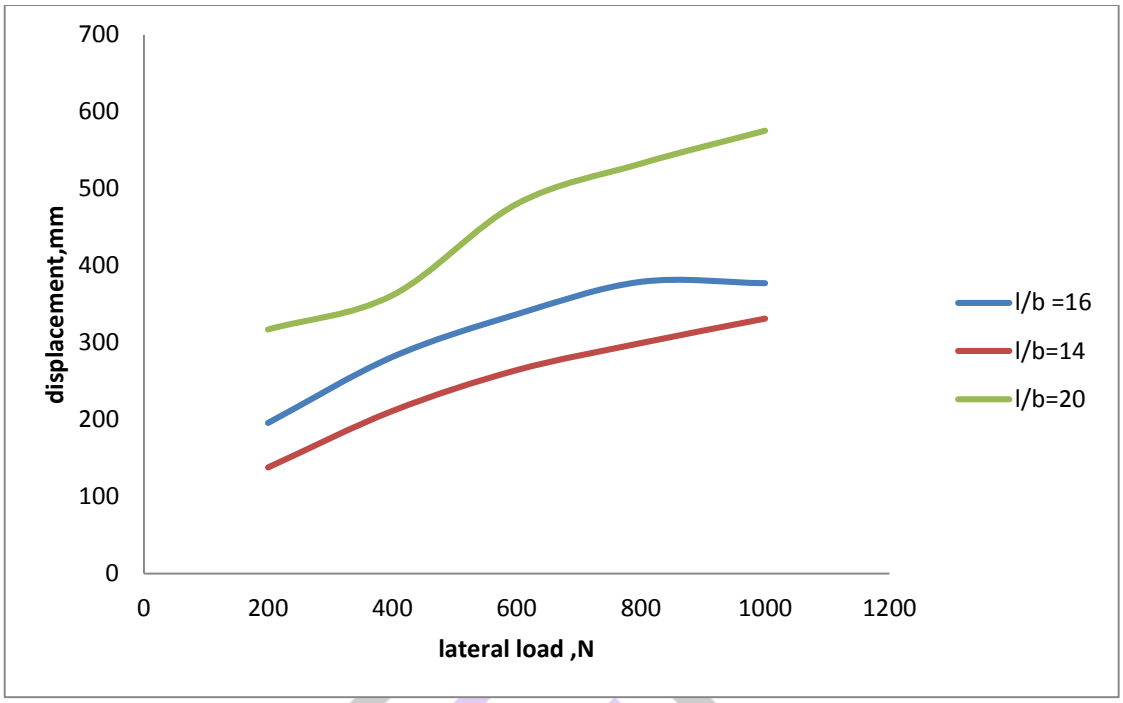
Graph 9 Displacement versus lateral load for 20% SIFCON column



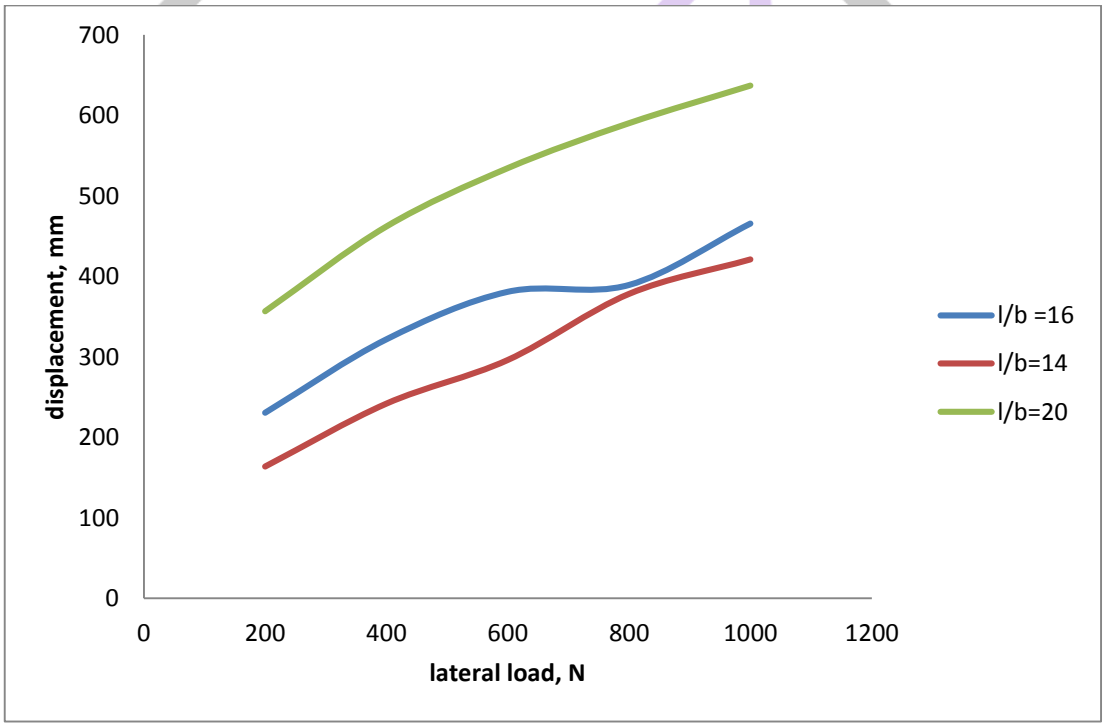
Graph 10 Displacement versus lateral load for 30% SIFCON column



Graph 11 Displacement versus lateral load for 40% SIFCON column



Graph 12 Displacement versus lateral load for 50% SIFCON column



Graph 13 Displacement versus lateral load for 100% SIFCON column

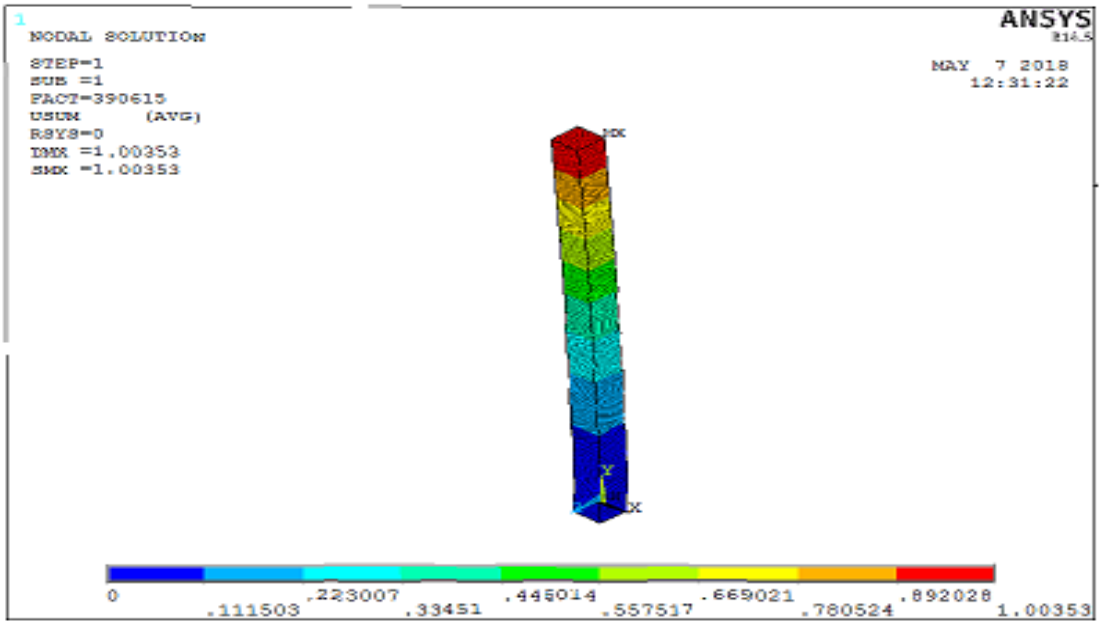


Fig 4 Critical load for constant l/b ratio=16 and 0% SIFCON

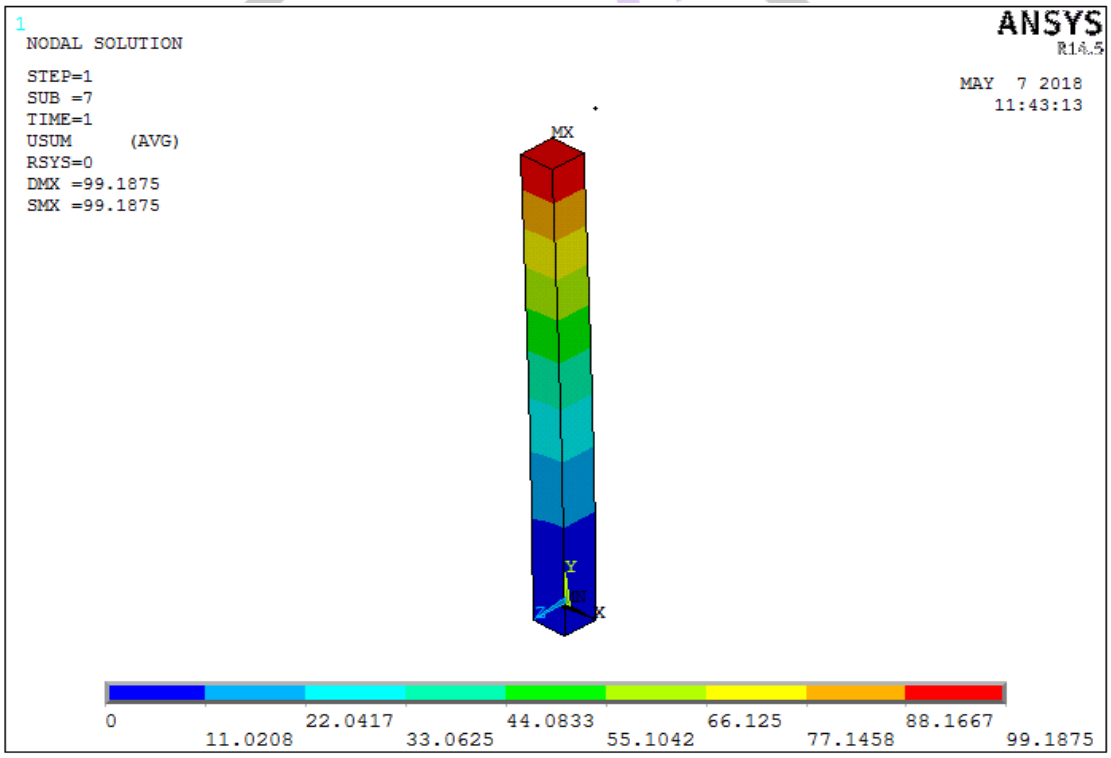


Fig 5 Displacement for 0% SIFCON and l/b ratio=14

XII. CONCLUSIONS

- When the percentage of SIFCON varies from 0 to 100%, critical buckling load is maximum for 40%SIFCON column for varying L/B ratio and was found maximum for the lesser L/B ratio.
- Keeping L/B ratio constant with varying length of the column, critical buckling load was maximum for the higher length of the column and for 40%SIFCON column for all the length of the column.
- As the load increased, deflection in the RC-SIFCON columns also increased. However, the deflection value is minimum for 40%SIFCON-60%RC column in all cases when compared to other percentages of SIFCON columns.

- 100%SIFCON column showed the maximum deflection for increase in the load when compared with the other percentages of the SIFCON column.
- When the percentage of SIFCON varies from 0 t0 100%, critical buckling load is maximum for 40%SIFCON column for increase in L/B ratio and was found minimum for 100%SIFCON column.
- While comparing the deflection of the RC-SIFCON columns for different L/B ratios, the deflection was maximum for the column having maximum L/B ratio and minimum for minimum L/B ratio as the buckling takes places in the slender column.
- Overall we can conclude that, the study on different type of columns with and without SIFCON shows the better results for 40% SIFCON -60% RC composite column and for l/b ratio=14.

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