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NON LINEAR BUCKLING ANALYSIS OF REINFORCED CONCRETE WALL BY USING DIFFERENT PARAMETERS

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ABSTRACT

Structural walls are used worldwide to resist gravity and earthquake loads. Buckling of longitudinal bars is one of the types of damage in reinforced concrete (RC) structures subjected to axial compressive loading. The aim is to study non linear buckling behavior of reinforced concrete wall by using finite element model. G+20 storey residential building is analysed by response spectrum method and secondly, the ground structure shear wall is to be analyzed which having maximum axial load for buckling behaviour. This paper investigates effect of several parameters which is affecting to the behavior of wall. These parameters includes; slenderness ratio, percentage of reinforcement. The RCC wall is analyzed by taking different percentage of reinforcement with constant slenderness ratio for varying axial compressive loading and lateral loading. Finite element modeling was performed in ANSYS software.

KEYWORDS: ANSYS, Buckling analysis, FEM, Non-Linear, RCC wall

INTRODUCTION

Failure due to crushing is basically material failure where as failure due to buckling is geometry instability. Buckling is failure of compression member at much lower stress than yield value. Buckling is also called as elastic instability.The compression members as like shear wall or column, under vertical load increases, they buckled and fails. This all happens while stresses in material are much less than their yield value, hence material is not fully utilized. Wall buckling is a phenomenon that has generally been related with wall slenderness

Buckling of longitudinal bars is a common form of damage in reinforced concrete (RC) structures subjected to earthquakes. When parts of a wall section are subjected to compressive strains, the possibility of lateral instability arises. Although global wall buckling occurs when the wall boundary is in compression, buckling can be strongly influenced by the magnitude of the tensile strain experienced by the wall for prior loading in the opposite direction. Basically buckling tendency is assumed to depend mostly on the wall clear height to thickness ratio *hu/b* and loading history.

BACKGROUND

The author had studied four large-scale shear walls, one reinforced with steel bars and three totally reinforced with GFRP bars were constructed and tested for lateral and axial loading.[1] The Maule Chile Earthquake of 27 February 2010 caused damage to several mid-rise and high-rise concrete wall buildings**.** A magnitude 8.8 earthquake struck south central Chile**.** In Chile, it is to find rectangular wall edges having thickness of 150 to 200 mm so that floor-to-floor slenderness ratios getting *hu/b* = 16 or greater. Such walls can be buckled out of the plane of the wall. Fig.1 and 2 shows buckling of wall after Chile earthquake. [2]

The non linear buckling analysis had studied to develop a simple and reliable model for reinforcing steel bars. In the first set of simulations, individual bars with varying length to cross-sectional diameter (L/D) ratios were considered while in the second phase full column models with varying longitudinal and transverse reinforcement were simulated. [5]

From the literature review, it is clear that many issues related to the prediction of buckling behavior of bars in reinforced concrete wall remain unresolved due to lack of sufficient data and reliable models. Additional work is needed on the parameters influencing buckling response of bars in reinforced concrete wall, such as effective buckling length, interactions between longitudinal bars, loading pattern.

Figure 1.Buckling of longitudinal reinforcement

Figure 2.First storey buckling in Chile earthquake [2]

OBJECTIVE

Non linear buckling analysis by using finite element method is going to performed for particular RCC wall on the basis of seismic behavior of structure. The effect of several parameters which is affecting to behavior of wall is to study in this paper. These parameters includes; slenderness ratio, percentage of reinforcement.

DETAILS OF RCC WALL

General

The length of wall is 1450mm and height of wall is 4500mm. Hence Slenderness ratio (height/width) is 19.56. The multiple axial force and lateral force is applied to the wall to find stress and starin values. The compressive strength of concrete is used for analysis is 40N/mm2 and yield stress is Fe415. Poisson's ratio is assumed 0.3. In first case, the thickness of wall will be kept constant which is 230mm for varying percentage of reinforcement and in second case thickness of wall is 300mm for same percentage of reinforcement as like 230mm.

Material properties

Young modulus of elasticity (E) = 31.622GPA
Poisson Ratio (ν) = 0.3
Density of concrete (γ) = 0.250 x 10^2 KN / m^3

General Requirementsof RCC wall

As per ductile detailing code (IS13920:1993) following are requirements for RCC wall.

- Reinforcement shall be provided in two curtains, if thickness of wall more than 200mm, each having bars running in the longitudinal and transverse directions in the plane of the wall.
- Minimum reinforcement of wall should be 0.25% of gross area in each direction.
- The maximum spacing of reinforcement in either direction should not exceed the smaller of Lw/5 3tw or 450mm.

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METHODOLOGY

Nowadays, RCC walls are provided in most of high rise structures rather than columns for a resistance of lateral loads and gravity loads. In his project work, G+20 residential building were analyzed in ETAB software. According to slenderness ratio, the ground structure wall was selected for finite element buckling analysis which is having maximum axial loading. The wall has to evaluate for different parameters. The wall is study for following cases.

The RCC wall is analyzed by varying percentage of reinforcement such as 0.84%, 0.994% and 1.34% for constant slenderness ratio 13.04 (which means thickness of wall is not changed) and spacing of transverse reinforcement. In this case, thickness is 230 mm.

Second one is, slenderness ratio is varying for above same reinforcement. The thickness is assumed in this case is 300mm. The comparison between the buckling behaviors for certain increment of loads is to study.

Validation

The axial force is calculated manually which coming in wall no. 19 and it is compared with ETAB results. Axial force applied to RC wall from ETAB is 7000KN and from manual calculation is 6722.13KN. It shows that manual and software results are 96% accurate.

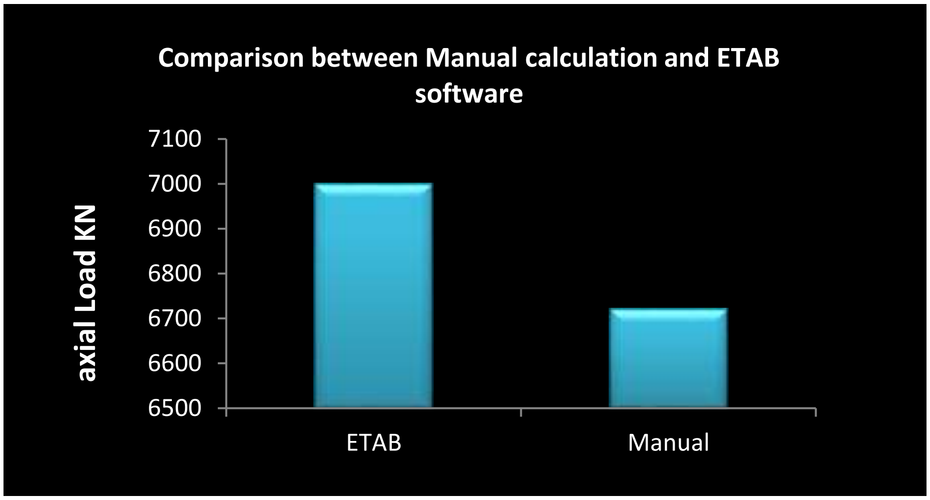

Figure3 Comparison between Manual calculation and ETAB software

Modelling in ANSYS 16

- Creation of geometry of RC wall structure in the UNIGRAPHICS software and then it was imported in ANSYS WORKBENCH 16 software.
- Providing the material properties for the RC wall as per design.
- Providing concrete material properties with specifying Young's modulus, Poisson ratio and density of concrete
- Giving optimum finite element model generation i.e. element meshing as per geometry of the wall
- Provision of boundary conditions is fixed based for buckling analysis as per model specification
- Applied lateral and axial force on the top of the wall which are summation of all forces which is acting from top of the building to the ground floor wall.
- Meshing is created differently for concrete and steel.
- Extraction of solution for different parameters like total deformation, directional deformation etc.

Meshing for reinforcement and concrete

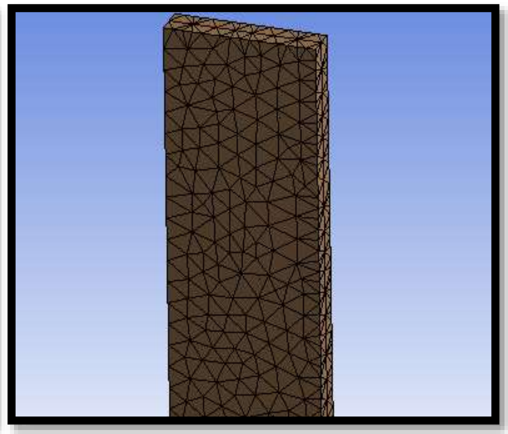

Figure 4 . Meshing of reinforcement 6mm

Figure 5. Meshing of concrete 100mm

Total deformation of reinforce concrete wall

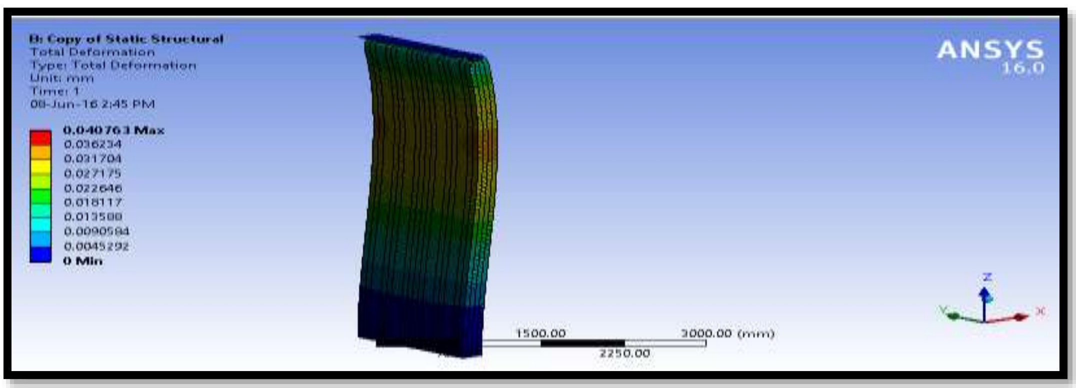

Figure 6 Total deformations for 230mm thickness wall for 0.84% of reinforcement in Eigen buckling analysis

RESULTS

Following results are for 230mm thickness of reinforced concrete wall which is having various percentage of steel

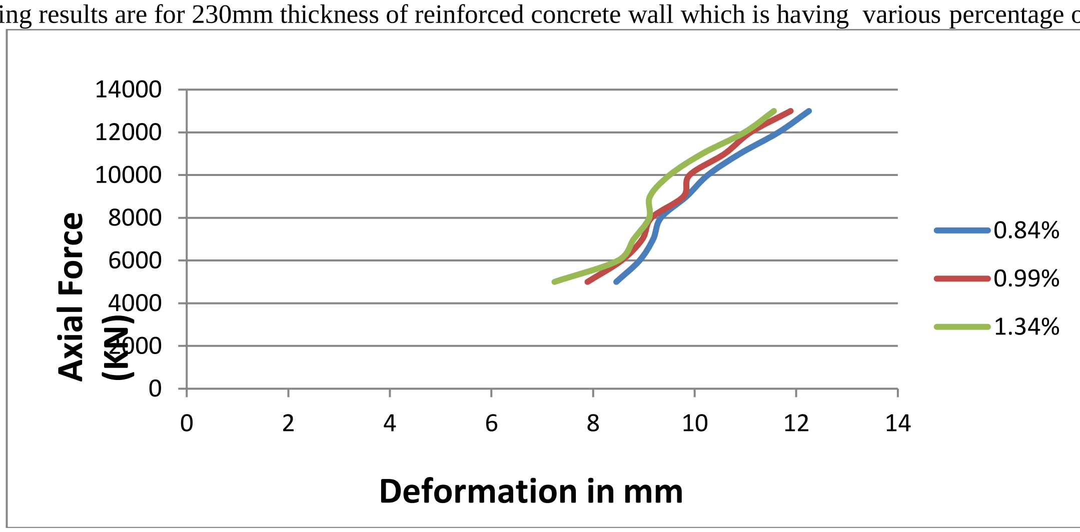

Figure 7 Deformation for various increment of loading for 230 mm thickness of wall

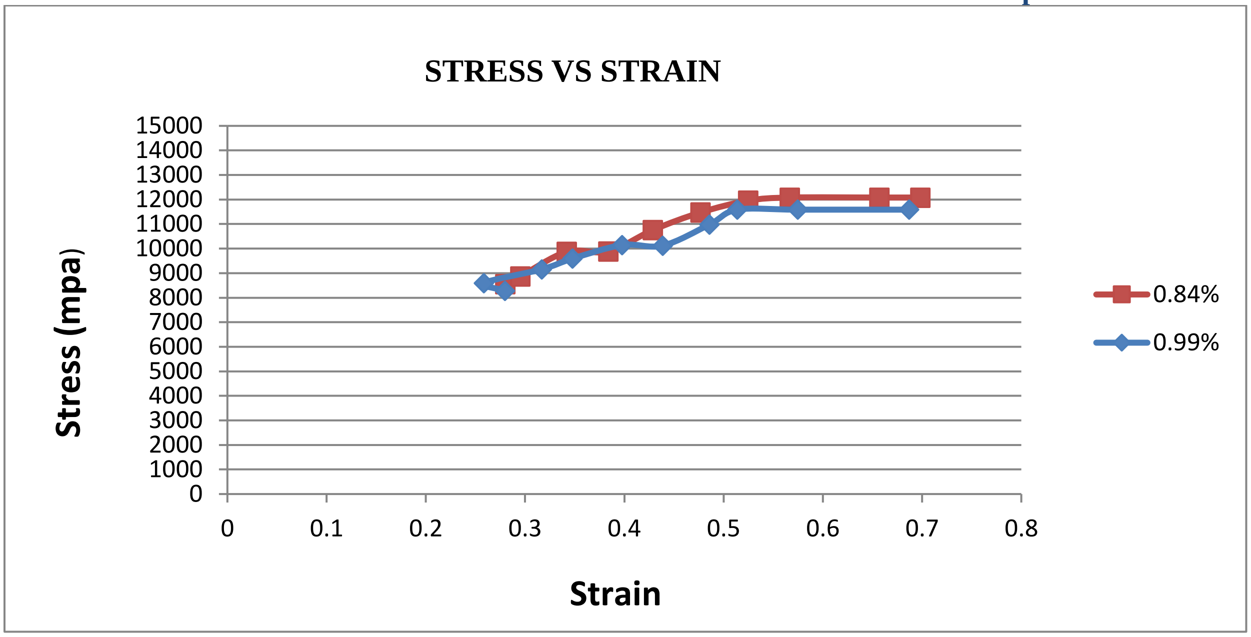

Figure 8 Stress vs strain behaviour for two percentage of steel

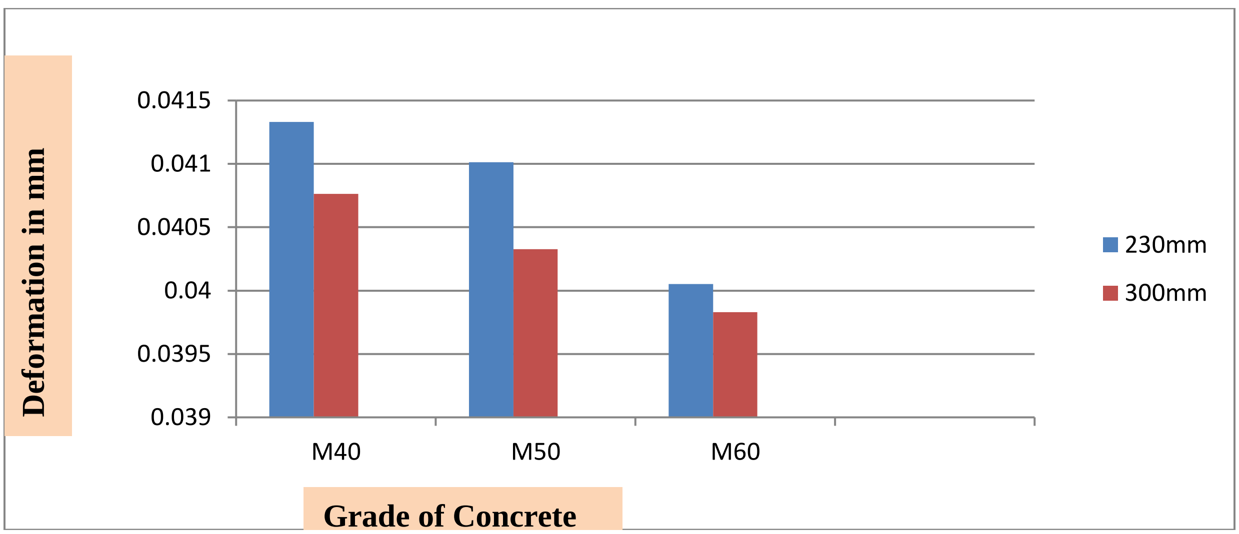

Figure 9- for 0.72% of Reinforcement & for slenderness ratio 22.5

CONCLUSION

1. The stress and increases at the level of 12000mpa value of stress. After that the material is goes to plastic stage. It means that reinforced concrete wall completely collapse after the load of 10000KN.
2. 3D finite element models were developed in ANSYS WORKBENCH 16 to study bucking of wall. The effects of several significant parameters, such as slenderness ratio (Leff/B), percentage of reinforcement, material strength and were investigated to determinate the average stress vs. strain relations.
3. According to analyze, the results will be compared as per buckling behavior of RCC wall under increment of loading condition which is axial and lateral loading on that particular wall.
4. The expected conclusion will be thickness of 230mm will be buckled more as compared to thickness of 300mm as per slenderness ratio.
5. Safe load carrying capacity affects the wall. It may be decreases due to slenderness ratio.

FUTURE SCOPE

Various parameters are affecting the behavior of RCC wall such as spacing of transverse reinforcement, Grade of concrete, grade of steel etc.

In the future scope of this study, further researchers may do their work by keeping slenderness ratio and percentage of reinforcement constant with changing spacing of transverse reinforcement. This may get results more buckling behavior of wall. Although, it is possible to analysis by varying compressive strength of concrete (fck) and varying characteristic yield stress (fy) with becomes constant other parameters for various types of loading.

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