Finite Element Analysis Of Column For Different Load Position With Axial Load And Uniaxial Moment

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Abstract

ANSYS is finite element software. In the present work finite element analysis of different types of column for different axial load and uniaxial moment position is being done. The study is based on the fact that the stress and strain variation depends primarily on load position on column cross section. The present study is aimed to know the variation of principal stress and principal strain i.e. the stress and strain at centroid of elements of column model. The objective of this work is to study the variation of principal stress, principal strain and Shortening of column for different load position.

Keywords *— Concrete column model, the element (top corner element), Reinforced Concrete, stress analysis, ANSYS.*

1. Introduction

Structural concrete member in compression are generally referred as columns and struts. The term column is associated with member transferring loads to ground. A column forms a very important component of a structure. Column supports beams which in turn support walls and slabs. It should be realized that the failure of a column results in the collapse of the structure. The design of a column should therefore receive importance. The columns in the structure are mainly subjected to axial compression. The columns carrying axial compression only are the internal columns with beams in all four directions or beams in one plane having same spans and same loading.

Columns along the sides of a building, which carry beams either in three orthogonal directions or a single beam in one direction are subjected predominantly to axial load and uniaxial bending due to un balanced moment transferred from a single beam on one side, while the moments from the other two beams in opposite directions balance each other provided their spans and loads on them are approximately equal.

2. Details of the Structure

A. Modelling and Analysis

The ANSYS is finite element analysis software. The finite element method is a general technique for constructing solutions to boundary value problems. This method involves dividing the domain of interest into a finite number of simple sub domains, the finite elements, and using various concepts to construct an approximation of the solution over the collection of finite elements. In the present work finite element analysis of column for different axial load position has being done. The element considered is Solid45, mapped meshing has been done.

The following types of columns are considered during analysis:

1. Rectangular column
2. Square column

In the present work a Reinforced concrete column has been analyzed. The analysis of top corner element of column has been carried out for four cases.

Case I: Constant load is applied at top one corner node.

Case II: Constant load is divided in to two equal parts and applied at top two corner node.

Case III: Constant load is divided in to three equal parts and applied at top three corner node.

Case IV: Constant load is divided in to four equal parts and applied at top four corner node.

B. Assumptions

The following are the assumptions made:
The model dimension of rectangular column is 300X750 mm and square column 500X500 mm is being taken. The value of Young's modulus, Density and Poisson's ratio are 22360 N/mm^2, $25kN/m^3$and 0.17 respectively.

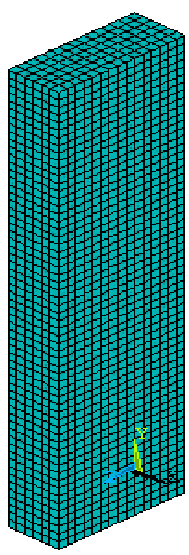

Figure 2.1 Rectangular Column Model

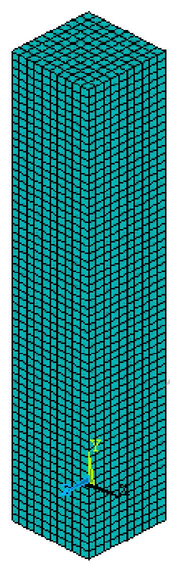

Figure 2.2 Square Column Model

3. Description for Loading

The load on the column is calculated for G+3 building. The actual load on column is obtained by calculating the loads on beams and their end shears. The total load acting on any column is the algebraic sum of the shear at the end of all beams meeting at the column, plus the axial load coming from the upper column and its self weight. The analysis of column is carried out for different loads with 200 kN increments and uniaxial moment 11.69kN-m.

The analysis is carried out for loads of

a. 1700 kN.
b. 1900 kN.
c. 2100 kN.
d. 2300 kN.
e. 2500 kN.

4. Results and Discussions

In the analysis variation of principal stress, the element has been studied. Similarly, variation of principal strain has been studied and the Shortening of column is also analyzed. In Rectangular column the value of load case IV is minimum to the remaining compared other three cases for principal stress, principal strain and shortening of column. For case I the value of principal stress, principal strain and shortening of column is maximum and for case II and case III the variation of parameters are nearly same. In Square column the value load case I is minimum compared to the remaining other three cases for Shortening of column. For case IV the value of principal stress and principal strain is minimum compared to the remaining other three cases. For case II the value of principal stress and principal strain is maximum and for case I and case III the variation of principal stress and principal strain are nearly same.

Table 4.1 Shortening of column (mm) in Rectangular Column with Axial Load and Uniaxial Moment for Different Load Cases

Load (kN) + Moment (kN-m)	Load Case 1	Load Case 2	Load Case 3	Load Case 4
1700 + 11.69	90.61	83.09	77.55	72.92
1900 + 11.69	93.20	84.24	78.11	72.80
2100 + 11.69	95.88	85.40	78.70	72.68
2300 + 11.69	98.63	86.571	79.30	72.56
2500 + 11.69	101.5	87.74	79.92	72.44

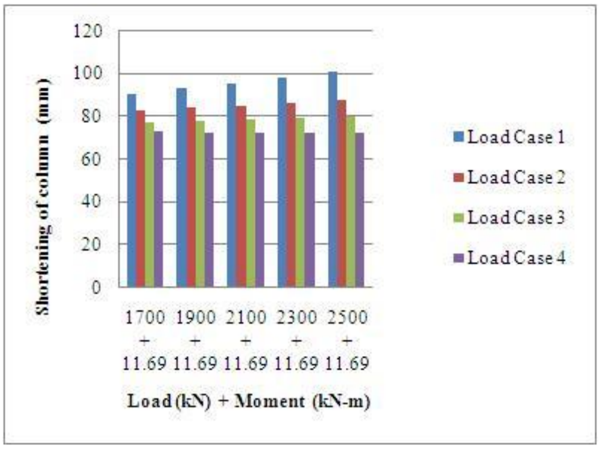

Figure 4.1 Variation of Shortening of column (mm) in Rectangular Column with Axial Load and Uniaxial Moment for Different Load Cases

Table 4.2 Shortening of column (mm) in Square Column with Axial Load and Uniaxial Moment for Different Load Cases

Load (kN) + Moment (kN-m)	Load Case 1	Load Case 2	Load Case 3	Load Case 4
1700 + 11.69	97.264	111.93	114.64	109.29
1900 + 11.69	95.078	111.65	115.13	109.23
2100 + 11.69	93.854	111.72	115.68	109.17
2300 + 11.69	92.889	111.95	116.26	109.11
2500 + 11.69	91.995	112.27	116.85	109.06

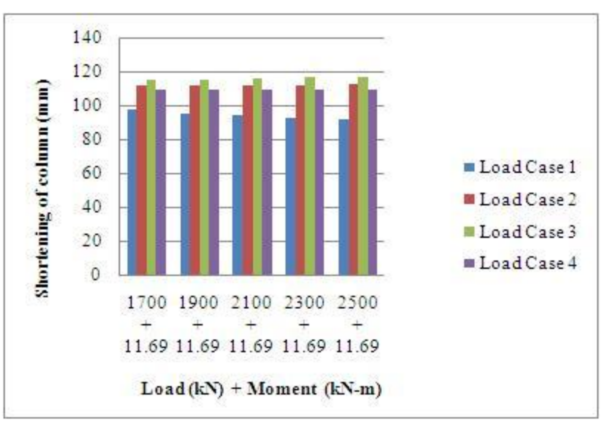

Figure 4.2 Variation of Shortening of column (mm) in Square Column with Axial Load and Uniaxial Moment for Different Load Cases

Table 4.3 Principal Stress (N/mm^2) in Rectangular Column with Axial Load and Uniaxial Moment for Different Load Cases

Load (kN) + Moment (kN-m)	Load Case 1	Load Case 2	Load Case 3	Load Case 4
1700 + 11.69	3902	1951	1301	1142
1900 + 11.69	4028	2014	1343	1141
2100 + 11.69	4158	2079	1387	1139
2300 + 11.69	4293	2147	1432	1138
2500 + 11.69	4431	2216	1477	1137

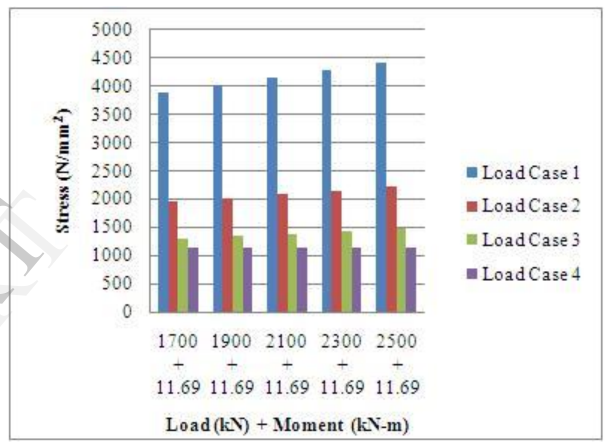

Figure 4.3 Variation of Principal stress (N/mm^2) in Rectangular Column with Axial Load and Uniaxial Moment for Different Load Cases

Table 4.4 Principal Stress (N/mm^2) in Square Column with Axial Load and Uniaxial Moment for Different Load Cases

Load (kN) + Moment (kN-m)	Load Case 1	Load Case 2	Load Case 3	Load Case 4
1700 + 11.69	1564	1952	1301	1194
1900 + 11.69	1683	2015	1343	1193
2100 + 11.69	1804	2080	1387	1192
2300 + 11.69	1926	2147	1432	1190
2500 + 11.69	2051	2216	1478	1189

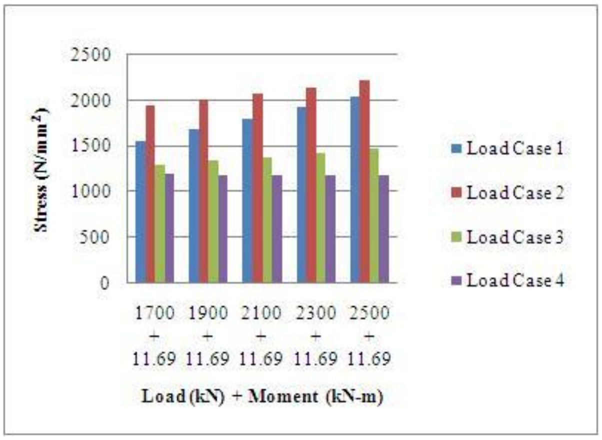

Figure 4.4 Variation of Principal stress (N/mm^2) in Square Column with Axial Load and Uniaxial Moment for Different Load Cases

Table 4.5 Principal Strain in Rectangular Column with Axial Load and Uniaxial Moment for Different Load Cases

Load (kN) + Moment (kN-m)	Load Case 1	Load Case 2	Load Case 3	Load Case 4
1700 + 11.69	0.2128	0.1063	0.0709	0.0531
1900 + 11.69	0.2226	0.1113	0.0742	0.0556
2100 + 11.69	0.2327	0.1163	0.0775	0.0581
2300 + 11.69	0.2430	0.1215	0.0810	0.0607
2500 + 11.69	0.2535	0.1267	0.0844	0.0633

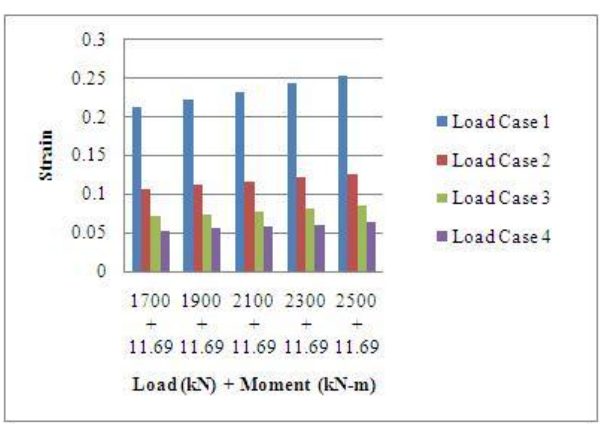

Figure 4.5 Variation of Principal strain in Rectangular Column with Axial Load and Uniaxial Moment for Different Load Cases

Table 4.6 Principal Strain in Square Column with Axial Load and Uniaxial Moment for Different Load Cases

Load (kN) + Moment (kN-m)	Load Case 1	Load Case 2	Load Case 3	Load Case 4
1700 + 11.69	0.08042	0.1064	0.07092	0.05319
1900 + 11.69	0.08804	0.11132	0.07421	0.05565
2100 + 11.69	0.0961	0.11637	0.07757	0.05818
2300 + 11.69	0.10471	0.12153	0.08101	0.0607
2500 + 11.69	0.11364	0.12677	0.08451	0.06338

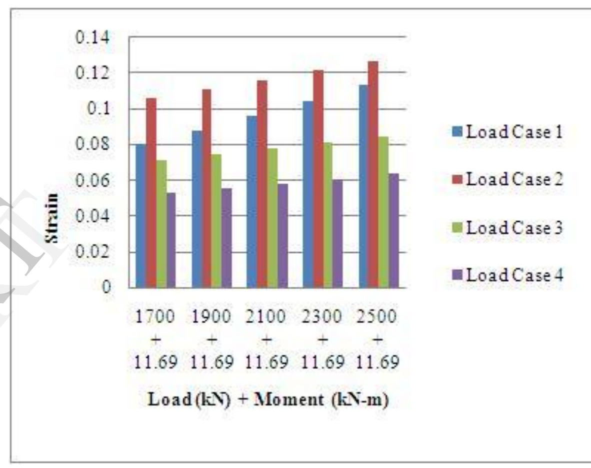

Figure 4.5 Variation of Principal strain in Square Column with Axial Load and Uniaxial Moment for Different Load Cases

5. Conclusions

On the basis of study carried out following conclusions can be drawn.

1. **Rectangular Column**
   a. The shortening of column is found to be lowest in the case IV of all the cases considered. The shortening of column increases in case III, II and I by 10.32%, 21.12% and 40.04% respectively.
   b. The principal stress is found to be lowest in the case IV of all the cases considered. The principal stress increases in case III, II and II by 29.90%, 94.89% and 289.70% respectively.

c. The principal strain is found to be lowest in the case IV of all the cases considered. The principal strain increases in case III, II and I by 33.34%, 100% and 300% respectively.

2. **Square Column**
   a. The shortening of column is found to be lowest in the case I of all the cases considered. The shortening of column increases in case II, III and IV by 22.04%, 27.02% and 18.55% respectively.
   b. The principal stress is found to be lowest in the case IV of all the cases considered. The principal stress increases in case III, II and I by 24.30%, 86.37% and 72.49% respectively.
   c. The principal strain is found to be lowest in the case IV of all the cases considered. The principal strain increases in case III, II and I by 33.33%, 100% and 79.30% respectively.

6. References

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