ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Design of a Structure Supported on a Single Column

K.Venkata Narasimhulu
Department of Civil Engineering,
Siddartha Educational Academy Group of Institutions -Integrated Campus,
C.Gollapalli, Chittoor Dist. A.P-517505, India.

Dr.K.Rajasekhar
Department of Civil Engineering,
Siddartha Educational Academy Group of Institutions -Integrated Campus,
C.Gollapalli, Chittoor Dist. A.P-517505, India.

ABSTRACT

The design and analysis of RCC structure supported on a single column is done in this project. Cost Comparison is done between RCC single column and RCC multi column structure. This paper presents structural modelling, stress, bending moment, shear force and displacement design considerations for a structure and it is analyzed using STAAD Pro. Various steps involved in designing of RCC structure supported on a single column using STAAD pro are Geometric Modelling, providing material properties and sectional Properties, fixing supports and boundary Conditions, providing loads & load combinations, Special Commands, Analysis Specification and Design Command. The influence of plan geometry has an important role in static analysis. Maximum values of stresses, bending moments, shear forces and displacements are presented. The acting loads considered in the present analysis were self weight, floor load, wind load and earthquake load. In these cases the floor load was applied perpendicular to the RCC structure. Comparison of RCC single column and RCC multi column is done.

INTRODUCTION

Structure supported on a single column provides better architectural view compared to structure supported on many columns. They save ground space as requires less area for providing foundation and provides more space for parking. They are also unique. Single column structure can be made either by using RCC or Steel. RCC structures are more common now days in India.

Reinforced concrete [1] as a structural material is widely used in many types of structures. It is competitive with steel if economically designed and executed. It has a relatively high compressive strength and better fire resistance than steel. It has long service life with low maintenance cost. It can be cast into any required shape.

Reinforced concrete is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength and ductility.

The modeling and analysis of structure supported on a single column is done by using STAAD Pro software [2]. STAAD Pro is a structural analysis and design computer program originally developed by Research Engineers International in Yorba Linda. Various ways of supporting a structure on one single column is shown in Fig. 1.1

Various steps involved in designing of reinforced concrete structure supported on a single column using STAAD pro-

- Geometric Modelling
- Material Properties
- Sectional Properties
- Supports
- Boundary Conditions
- Loads & Load combinations
- Special Commands
- Analysis Specification
- Design Command

Cite this article as: K.Venkata Narasimhulu & Dr.K.Rajasekhar, "Design of a Structure Supported on a Single Column", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 5 Issue 6, 2018, Page 174-178.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Fig.1.1: Structures supported on single column

GEOMETRIC MODELLING

SINGLE COLUMN BUILDING

The modelling of single column structure is done by using STAAD Pro software. The height of the structure is taken as 18 m. Structure is supported on a single column. It is a 4 storey building. Height of each storey is 3m. First storey starts at a height of 6m above ground level. Single column keeps the building at a height of 6m above ground level. Width and breadth of each storey is 12m. Column is provided at the centre of structure starting from ground level to a height of 18m above ground. Inclined beams are provided to support the structure at a height of 3m above ground level from centre column to four corners of building at a height of 6 m. After modelling of a single column structure [3] as in Fig.4.1which satisfies above dimensional requirements, three more similar single column structures are modelled and placed near it. All the four buildings are connected by providing a lift at centre as in Fig.4.2

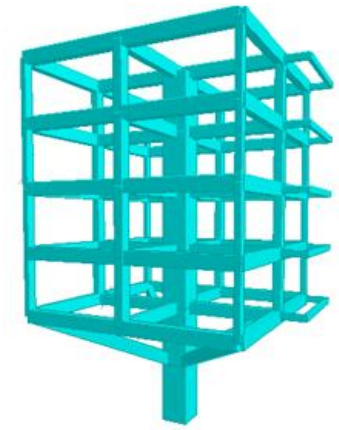


Fig.4.1: Single column structure

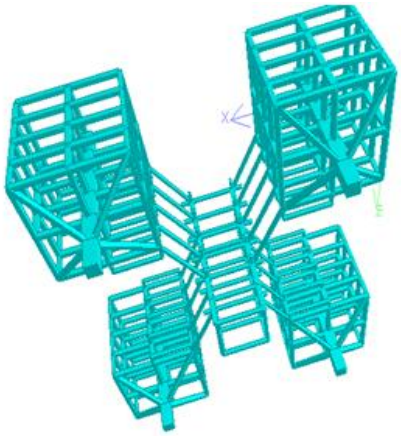


Fig.4.2: Four structures connected by a lift

MULTI COLUMN BUILDING

I have also done modelling of a structure which satisfies all the dimensional requirements as mentioned in Sec.4.1 but supported on multi columns [4] in place of single column and no inclined beams are provided as shown in Fig.4.3

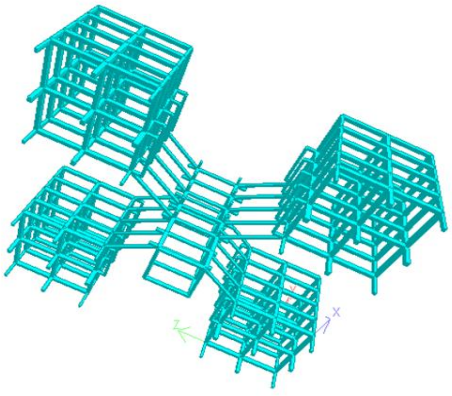


Fig.4.3: Multi column structures connected by a lift

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

DESIGN

Beam and Column reinforcement details are obtained in STAAD. Footing details are obtained on inputting various reactions and moments from STAAD into excel design sheets.

COLUMNS

All vertical elements of structure are called columns.

CENTRE COLUMN

Reinforcement details of Centre column (1.5 m x 1.5 m) whose length is 18 m are36 bars of 25 mm dia and 8 mm dia stirrups are provided at 250 mm c/c. All the centre columns of building are highlighted in Fig.7.1

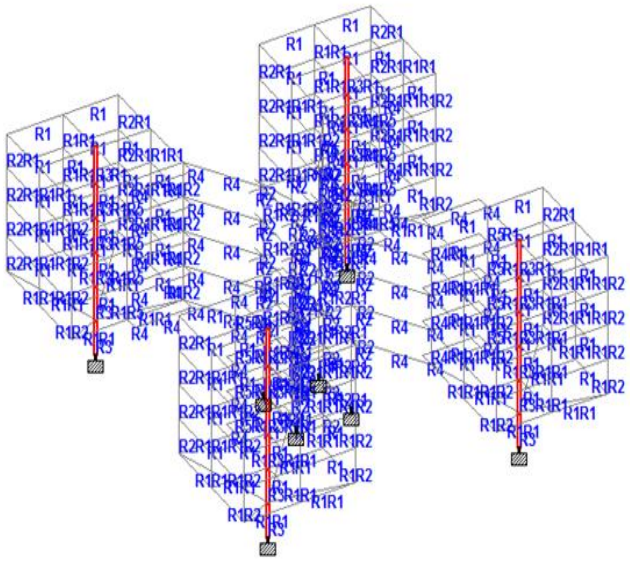


Fig 7.1: Centre columns of structure

BEAMS

Beams are generally placed horizontally or inclined in a structure but not vertically. If place vertically in a structure, it becomes column [5]. All the inclined beams of structure are highlighted in Fig.7.3.1

INCLINED BEAMS

Reinforcement details of inclined beams (0.45m x 0.60 m) in a structure whose length is 9m is Top – 5 bars of 25 mm dia are provided, Bottom- 5 bars of 20 mm dia are provided, 8 mm dia stirrups are provided at 200 mm c/c, 2 legged.

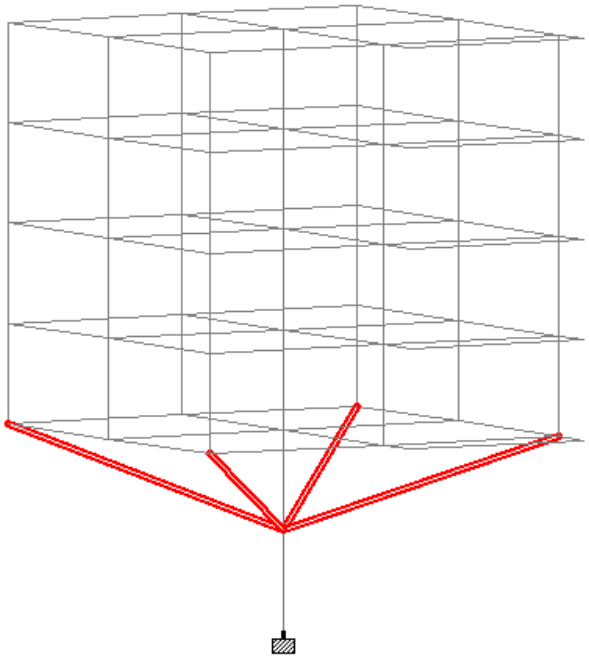


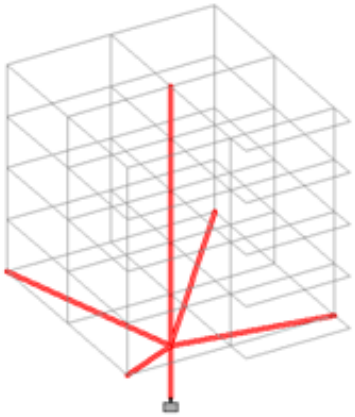
Fig.7.6: Inclined beams of structure

FOOTING

Footing size of centre column (1.5m x 1.5 m) is 9 m x 9 m and Footing depth is 2.26 m. Footing size of multi column (.60 m x.45 m) is 2.5 m x 2.5 m and Footing depth is 1.5 m. Footing size of multi column (0.45m x 0.30m) is 2 m x 2 m and Footing depth is 1.2 m

COST ESTIMATION

Both single column and multi column structure are designed in the same way; they only differ in column orientation and their sizes.



ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

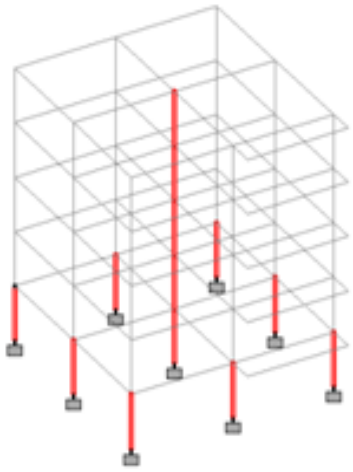


Fig. 8.1: Single column and Multi column structure.

Cost comparison of RCC single column and RCC multi column can be done by just comparing the cost of columns which are highlighted in above figure.

Volume of highlighted columns in single column structure is 5 times the volume of highlighted columns in multi column structure.

If cost of multicolumn structure is X + Y then Cost of single column structure is X + 5Y.

Where X = Cost of non highlighted part in structure which is same for both structures. and Y = Cost of highlighted part in multi column structure.

In general Construction cost of columns in a building is 10% of the total cost of building.

But in Fig. 5 (multi column structure) as we are considering columns only up to first floor (excluding centre column), Construction cost of highlighted columns would be 5% of the total cost of building.

If total cost of multi column structure is 100 i.e. X+Y = 100, Where X = 95 and Y = 5.

Then Cost of single column structure is X+5Y = 95+5(5) = 120

Therefore, Cost of single column structure is 20 % more than multi column structure.

RESULTS AND DISCUSSIONS

All the results related to analysis and design of structure supported on single column have been mentioned here.

DISPLACEMENT

Table 9.1: Maximum and minimum displacement

MAXIMUM DISPLACEMENT	70.295 mm
MINIMUM DISPLACEMENT	13.165 mm

SHAEAR FORCE

SHEAR FORCE/DIRCTION	X	Y	Z
MAXIMUM	471.87 kN	18956.15 kN	672.132 kN
MINIMUM	-467.6 kN	-30.25 kN	-672.50 kN

BENDING MOMENT

Table 9.3: Maximum and minimum bending moment

BENDINGMOMENT/DIRECTION	X	Y	Z
MAXIMUM	1939.3 kN-m	1123.13 kN-m	1973.5 kN-m
MINIMUM	-1808 kN-m	-1121.32 kN-m	-2568.4 kN-m

STRESS ANALYSIS

A stress analysis of structure is performed to determine the magnitude and distribution of stresses throughout the structure for static loading conditions and to investigate the structural adequacy of the substructure.

Table 9.2: Maximum and minimum stress

MAXIMUM STRESS	25.78 N/ mm^2
MINIMUM STRESS	0 N/ mm^2

DESIGN

Beam and Column reinforcement details are obtained in STAAD. Footing details are obtained on inputting various reactions and moments from STAAD into excel design sheets.

COLUMNS

- Reinforcement details of Centre column (1.5 m x 1.5 m) whose length is18 m is: 36 bars of 25 mm dia are provided, 8 mm dia stirrups are provided at 250 mm c/c.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

- Reinforcement details of exterior columns (0.45x 0.30) whose length is 12 m are: 8 bars of 16 mm dia are provided, 8 mm dia stirrups are provided at 200 mm c/c
- Reinforcement details of interior columns (0.60x 0.45) whose length is 12 m are: 6 bars of 25 mm dia are provided, 8 mm dia stirrups are provided at 200 mm c/c

BEAMS

- Reinforcement details of inclined beam (0.45m x 0.60 m) whose length is 9m are:Top – 5 bars of 25 mm dia. are provided.
- Bottom- 5 bars of 20 mm dia. are provided, 8 mm dia. stirrups are provided at 200 mm c/c, 2 legged.
- Reinforcement details of beams: Top -2 bars of 20 mm dia. Bottom- 2 bars of 25mm dia., 10 mm dia stirrups are provided at 200mm c/c
- Reinforcement details of beams in lift: Top – 2 bars of 12 dia. Bottom – 2 bars of 12 dia., 8 mm dia. stirrups are provided at 150mm c/c

FOOTING

- Footing size of centre column (1.5m x 1.5 m) is 9 m x 9 m and Footing depth is 2.26 m.
- Footing size of multi column (0.60m x 0.45 m) is 2.5 m x 2.5 m and footing depth is 1.5 m.
- Footing size of multi column (0.45m x 0.30m) is 2 m x 2 m and Footing depth is 1.2 m

COST COMPARISION

Cost of single column structure is only 20 % more than multi column structure.

CONCLUSION

1. Single column structure has been designed successfully to withstand all loads including earthquake and wind load.
2. Single column structure is 20 % more costly when compared with multi column structure.
3. Single column structure provides better architectural view and free ground space even though it costs bit more than multi column structure.

References

[1] International Journal of Engineering Sciences & Research Technology Design of Multistoried R.C.C. Buildings with and without Shear WallsM. S. Aainawala Dr. P. S. Pajgade Size of members like column can be reducedeconomically in case of structure with shearwall as compared to the same structurewithout shear wall.

[2] Yun, hyun-do, Choi, Chang-sik and Lee, lihyung, “Earthquake performance of highstrengthconcrete structural walls withboundary elements” 13th World Conferenceon Earthquake Engineering, Vancouver,B.C., Canada August 1-6, 2004.

[3] Anshuman. S, Dipendu Bhunia, BhavinRamjiyani, “Solution of Shear Wall Locationin Multi-Storey Building” internationaljournal of civil and structural engineering,volume 2, no 2, 2011.

[4] Varsha R. Harne, “Comparative study ofstrength of RC Shear wall at differentlocation on multistoried residential building” International Journal of CivilEngineering Research. ISSN 2278-3652Volume 5, Number 4 (2014), pp. 391-400

[5] Ashish S. Agrawal and S.D. Charkha, “Studyof Optimizing Configuration of Multi-StoreyBuilding Subjected to Lateral Loads