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A Comparative Study on Analysis of a Conventional Multi-Storey Building & a Monocolumn Building

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Abstract: ***The comparative study on analysis of RCC Frame structure supported on a single column and multi-column is done in this project. Cost comparison , Ground space comparison is done between RCC single column and RCC multi column structure .This paper presents structural modelling, stress, bending moment, shear force and displacement, deflection design considerations for a structure and it is analysed using STAAD-Pro. Various steps involved in designing of RCC Frame structure supported on a single column and multi-column by using software are Geometric Modelling, providing material properties and sectional Properties, fixing supports and boundary Conditions, providing loads & load combinations, Special Commands, Analysis Specification , Design Command and Report. The influence of plan geometry has an important role in static analysis. Maximum values of stresses, bending moments, shear forces and displacements and deflection are presented. The acting loads considered in the present analysis were dead load, Live load, floor load, and wind load. The project is to planning & analysis by using software for a multi storied building and single column building of G+3, G+7, G+15 floors. The design is done by taking in to account the requirements and standards recommended by IS code and national building rules.***

Keywords: Multi-storeyed building, mono column building, Planning, STAAD-Pro, Modelling, Analysis…

I. INTRODUCTION

Due to urbanization and scarceness of land multi-storey structures has been constructed using modern construction technology. Stability of structural system depends upon loading and supporting conditions. Due to the requirement of large service spaces, mono column structural system has been gained popularity. Structural system will be more stable when all the components balance static and dynamic loads. Fulfilling the criteria of stability conditions for a mono column will be a complicated.

Structure supported only on single column is known as mono column structural system. Mono column structures are the complicated one, compared with the structures supporting in all the sides depends upon their configuration, since mono column is supporting whole structure, all other members will act as cantilevers and mono column structure is a critical one. Eccentric loading will cause the structure to twist in any direction and may cause failure of structure is very critical condition.

This structure supported on a mono column provides large unobstructed serviceable floor space compared to structure supported on many columns. They save ground space as requires less area for providing foundation and provides more space for parking. Maximum space utilization is considered will serve its maximum serviceability. This building consists of mono column i.e. Single column structural system (each floor in whole structure is supported independently by mono column at the center). Design of all structural members conforms to IS: 456-2000, IS: 800-2007 & IS: 11384-1985.

Primary aim of all structural design is to ensure that the structure will perform satisfactorily during its design life. Specifically, the designer must check that the structure is capable of carrying the loads safely and that it will not deform excessively due to the applied loads. This requires the designer to make realistic estimates of the strengths of the materials composing the structure and the loading to which it may be subject during its design life.

A. Mono Column Building

The modelling of single column structure is done by using STTAD PRO software. The height of the structure is taken as 12 ,24.5, 48 m resp. for G+3, G+7, G+15. Structure is supported on a single column. Height of each storey is 3 m. First storey starts at a height of 3m, 3.05m, 3m resp. for G+3, G+7, G+15 above ground level. Hence Single column keeps the building at a height of 3m, 3.05m, 3m resp. for G+3, G+7, G+15 above ground level. Width and breadth of each storey is 12 m, 12m and 16m resp for G+3, G+7, G+15.Column is provided at the center of structure starting from ground level to a height of 12, 24.5, 48 m resp. for G+3, G+7, G+15.

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B. Objectives of the Project

Following specific objectives has been made for the present study-

1) To know if Mono column structure can withstand the different types of loads.
2) To know the effect of lateral loads on the Mono column structure.
3) To know the Cost to build the Mono Column structure comparing it to Multi-Column structure.
4) To know about the aesthetic view and ground space that can be provided.
5) To know the effect of Shear force, Moment and Support Reaction on Structure.

II. METHODOLOGY

A. General

A Model of G+3, G+7, G+15 storied is created, investigated and configured by utilizing STAAD-Pro programming software.

1) Problem Statement

Following particulars are given to the structure:

TABLE I
STRUCTURAL DETAILS

STRUCTURE DETAILS		
Description	Details	Unit
No. of Storeys	3 7 15	
Dimension in x-direction	G+3 = 12 G+7 = 12 G+15 = 16	m m m
Dimension in z-direction	G+3 = 12 G+7 = 12 G+15 = 16	m m m
Storey Height	3	m
Live Load (typical)	3	kN/sq.m
Live Load (terrace)	1.5	kN/sq.m
Floor Finish	1.5	kN/sq.m
Type of Soil	MEDIUM (TYPE II)	
Slab Thickness	G+3 – 120 G+7 – 120 G+15 – 150	mm mm mm
Wall thickness External	230	mm
Wall thickness Internal	150	mm
Wall loads External	12.42	kN/m
Wall load Internal	8.1	kN/m
Parapet Wall (1m Height)	3	kN/m

TABLE II
MONOCOLUMN SIZES

	Mono Column Size
G+3 MONOCOLUMN STRUCTURE	2500 X 2500 mm
G+7 MONOCOLUMN STRUCTURE	2500 X 2500 mm
G+15 MONOCOLUMN STRUCTURE	3000 X 3000 mm

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TABLE IIII
COLUMN SIZES

Model	Gravity Load Building	
	Beam	Column
G+3 RCC Structure	400 X 400 mm	600 X 600 mm
G+3 Monocolumn Structure	400 X 400 mm	600 X 600 mm
G+7 RCC Structure	400 X 400 mm	600 X 600 mm
G+7 Monocolumn Structure	400 X 400 mm	600 X 600 mm
G+15 RCC Structure	450 X 450 mm	500 X 500 mm
G+15 Monocolumn Structure	450 X 450 mm	500 X 500 mm

2) Material Properties

Grade of concrete	M30 (fck = 30 N/mm^2)
Modulus of Elasticity	$5000\sqrt{fck}$ = 27386.12788 N/mm^2
Grade of Steel	Fe 550 (fy = 550 N/mm^2)
Density of concrete	25 kN/m^3

B. Types of Loads Acting on the Structure

The structures are analysed for following loads:

1) Dead loads
2) Live loads
3) Wind loads

In this Load Combinations considered are:-

- 1.2(D.L.+ L.L.+ W.L. x)
- 1.2(D.L.+ L.L.+ W.L. z)

C. Plan Modelling and Elevation

The general plotting represents the plan and elevation of G+3, G+7, G+15, for mono column and multi column building. All the stories have similar room arrangement. The entire plan area is about 144 sq.m for G+3, G+7, and 256 sq.m for G+15 . There is some space left around the building for parking of cars.

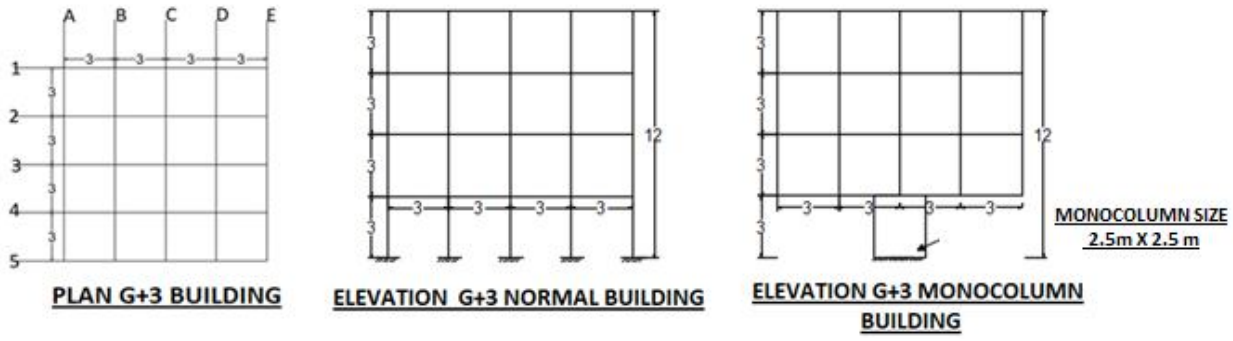

Fig. 2.1 Plan and Elevation of Low rise Normal and Monocolumn Building frame

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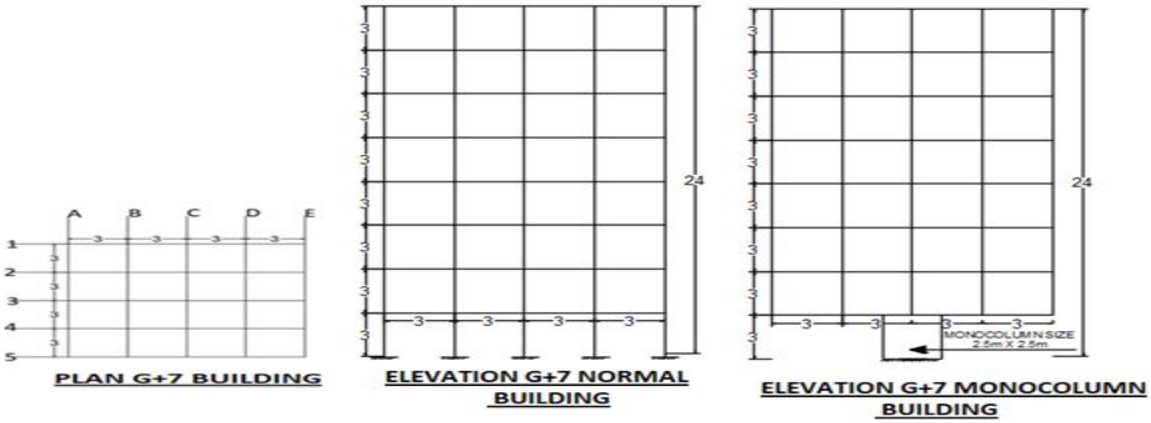


Fig. 2.2 Plan and Elevation of Mid-rise Normal and Monocolumn Building frame

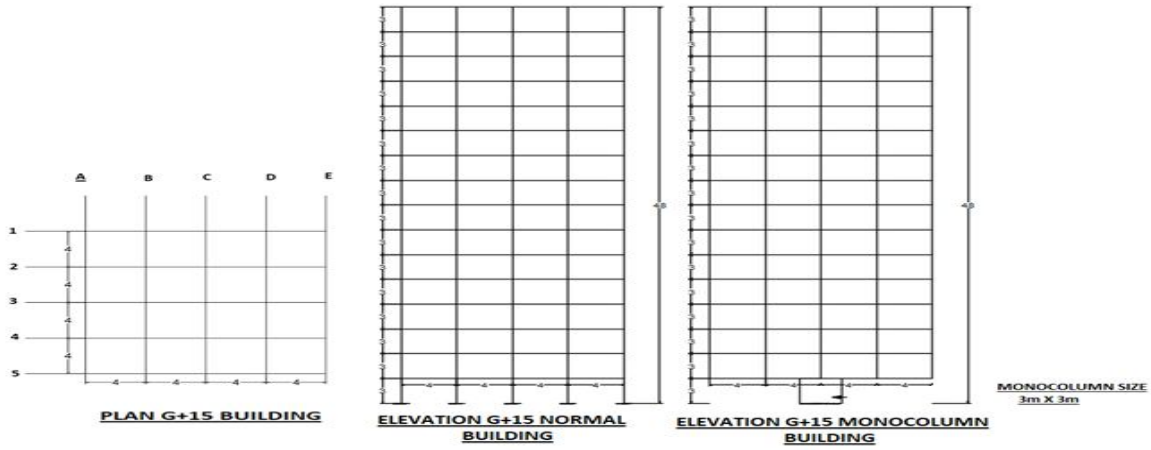
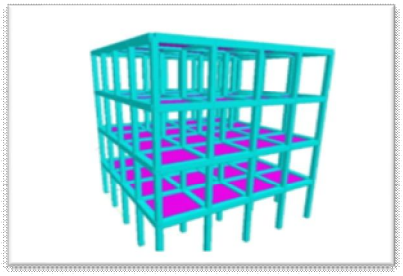


Fig. 2.3 Plan and Elevation of High-rise Normal and Monocolumn Building frame

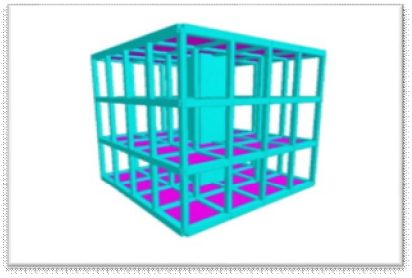
D. Modelling in STAAD Pro

The whole process of the analysis and design are given below:

1) *Inputting The Job Information:* Firstly, the information of the project is written after opening the STAAD Pro.
2) *Generating the 3D Model Geometry:* Using the command file also called "Run Structure Wizard". The model of the framed structure is generated in STAAD by Snap Node/Beam dialog box which appears when we select the grid from the top menu bar. Then the nodes and beams are created.
3) *Assigning The Material:* As after creating the beams and columns we will assign material to them as we require. Our design is concrete design hence we have assigned the concrete material to the beams and columns.
4) *Specifying Member Properties:* The properties of the beams and columns is their size (width, depth of cross-section). So, with the help of this command we have inputted the different properties (as circular, rectangular, square) and assign these properties to specified members.



(a) Multicolumnl Building G+3



(b) Monocolumn Building G+3

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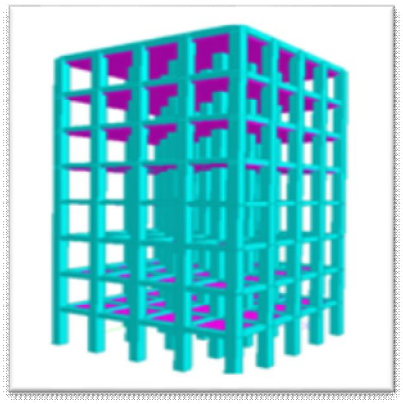
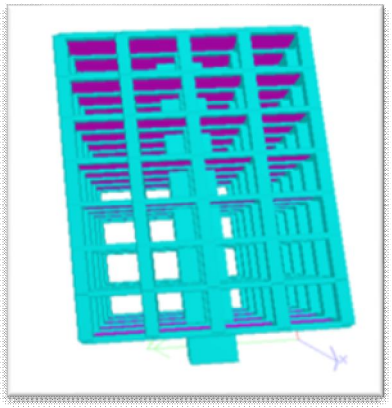
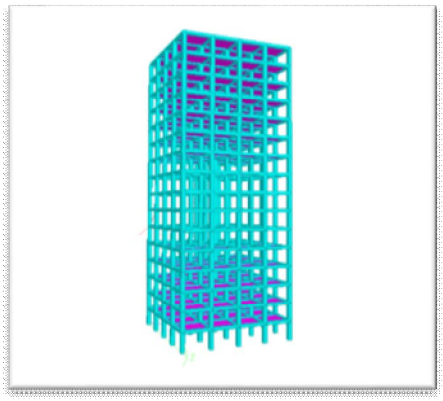


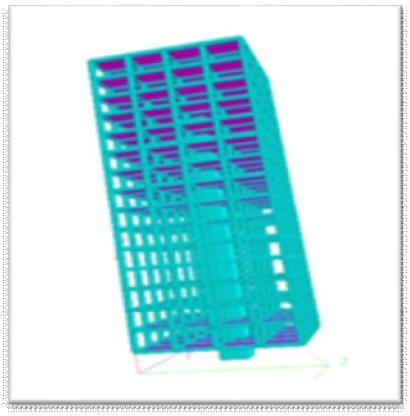
(c) Multicolumnl Building G+7



(d) Monocolumn Building G+7



(e) Multicolumnl Building G+15



(f) Monocolumn Building G+15

Fig. 2.4 Rendered Models of the Buildings after specifying and assigning the Properties

5) *Specifying Material Constants:* As we assigned the concrete material so by default, we have the constants of concrete and We don't need to use this command separately. Or if we need to change the constants we can do so by this command.

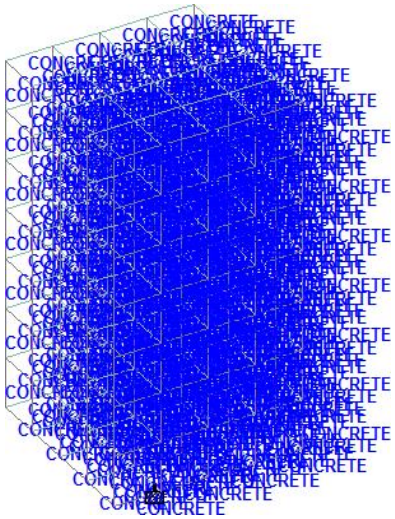


Fig. 2.5 Assigning Concrete Material to the Multi-Storey Building

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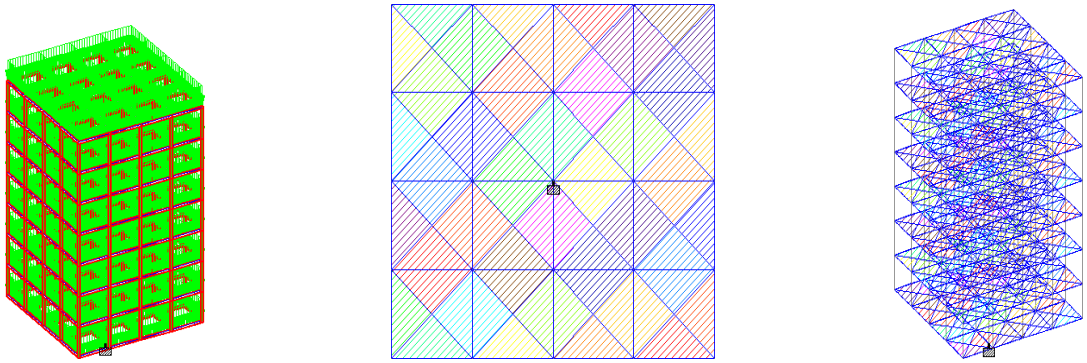
6) *Specifying Member Offset:* As default in the STAAD design of model and after assigning properties, the STAAD takes the beams and columns center to center and if we want to have beams end to end over the columns then we use Beam offset command.
7) *Printing Member Information:* As if we would like to get a report consisting of information about all the members including start and end joint numbers, members length in STAAD output file then we use this command as by going to Commands Pre-Analysis Print Member information from top menu bar.
8) *Specifying Supports:* The supports are first created (as we created fixed supports) and then these are assigned to all the lowermost nodes of structure where we are going to design the foundation.
9) *Specifying Loads:* This is done in following steps:
a) Firstly creating all the load cases.
b) Then assigning them to respective members and nodes.
10) *Specifying The Analysis Type:* Before doing the analysis for the loads we require specifying analysis command which we need is linear static type. Choosing statics check, we will add this command.

E. Loads Acting on the Structure



(a) (b) (c)

Fig. 2.6 Types of Loads (a)Dead Load (b)Live Load (c) Floor Load

1) *Dead load*: A constant load in a structure that is due to the weight of the members, the supported structure, and permanent attachments or accessories.
2) *Live load*: The second vertical load that is considered in plan of a structure is forced loads or live loads. Live loads are either portable or moving burdens with no quickening or effect. These heaps are thought to be delivered by the planned utilize or inhabitance of the building including weights of versatile parcels or furniture and so forth. Live load continues changing now and again. These heaps are to be reasonably expected by the planner. It is one of the significant loads in the plan. The base estimations of live loads to be expected are given in IS 875 (section 2) – 1987. It relies on the expected utilization of the building.
3) *Floor load*: The load that a floor (as of a building) may be expected to carry safely if uniformly distributed, usually calculated in KN per square meter of area.
4) *Wind load*: Wind is a mass of air that moves in a mostly horizontal direction from an area of high pressure to an area with low pressure. The wind load is defined as the load on a structure due to the action of wind. High winds can be very destructive because they generate pressure against the surface of a structure. The effect of the wind is dependent upon the size and shape of the structure. Calculating wind load is necessary for the design and construction of safer, more wind-resistant buildings and placement of objects such as antennas on top of buildings.

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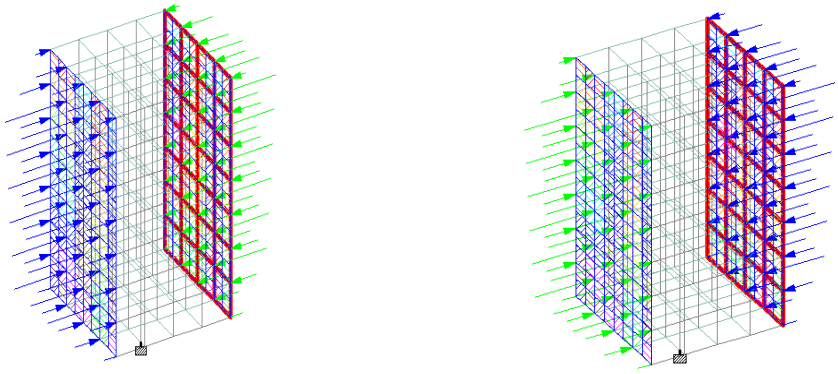

(a) (b)

Fig. 2.7 Wind Loads (a) in 'X' direction (b) in '–X' direction

III.RESULTS

A. Comparison between Monocolumn and Conventinal Muti-column Building:

Comparison is done for mono-column building and a general column in multicolumn building for a common load combination case of 1.2(DL+LL+WL).

1) Low Rise Building (G+3)

Table IV
Comparison Of Results

Description	Normal column	Mono column
Support reaction Fy (for columns)	10404.8 KN (416.192 KN for each col.)	6034.126 KN
Bending Moment	0.172 KN-m	1.718 KN-m
Displacement (y- axis)	1.811 mm	56.894 mm
Stress	0.006 N/mm^2	0.064 N/mm^2
Beam Moments (Mz)	18.647 KN-m	486.28 KN-m
Axial Forces Fx (Beam)	416.192 KN	6034.192 KN
Area of steel required (In Ground Floor and Foundation)	16116 mm^2	3608 mm^2

2) Medium Rise Building (G+7)

Table V
Comparison Of Results

Description	Normal column	Mono Column
Support reaction Fy (for columns)	23528.5 KN (941.14 KN for each col.)	14815.629 KN
Bending Moment	0.023 KN-m	0.175 KN-m
Displacement (y- axis)	1.547 mm	34.074 mm
Stress	0.008 N/mm^2	0.104 N/mm^2
Beam Moments (Mz)	25.014 KN-m	557.129 KN-m
Axial Forces Fx (Beam)	941.14 KN	14815.629 KN
Area of steel required (In Ground Floor and Foundation)	68480 mm^2	8858 ^{2}

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3) High Rise Building (G+15)

Table VI
Comparison Of Results

Description	Normal column	Mono Column
Support reaction Fy (for columns)	69702.875 KN (2788.115 KN for each col.)	43230.832 KN
Bending Moment	0.46 KN-m	1.07 KN-m
Displacement (y- axis)	11.848 mm	87.355 mm
Stress	0.057 N/mm^2	0.147 N/mm^2
Beam Moments (Mz)	131.716 KN-m	1152.369 KN-m
Axial Forces Fx (Beam)	2788.115 KN	43230.832 KN
Area of steel required (In Ground Floor and Foundation)	48668 mm^2	25525 mm^2

IV. CONCLUSIONS

This project has been selected with utmost enthusiasm and keen interest by us and has been successfully completed. For the analysis of the multi-storey mono column structure we have used the software STAAD Pro V8i.

From the above analysis the following conclusions were made:

1) Mono column structure has been designed successfully to withstand load combination including wind load.
2) From cost analysis it can be concluded that:
a) From Economic point of view mono column building is uneconomical when compared to the multi column building.
b) Mono column building is 61.03 % more costly when compared to multi-column building for low rise building (G+3).
c) Mono column building is 26.33 % more costly when compared to multi-column building for midrise building (G+7).
d) Mono column building is 46.4 % more costly when compared to multi-column building for high rise building (G+15).
e) It is be better to construct midrise building when compared to low and high rise building due to less %cost difference.
3) Single column structure provides better architectural view and free ground space even though it costs a bit more.
4) Mono column save ground space as requires less area for providing a foundation and provides more space for parking.
5) In Mono column Structure, Steel required for Ground floor and foundation is far more less than that required in Multi Column structure.
6) The Shear force, Moment and Support Reaction on Structure of Mono column Structure is more than Normal Building.
7) Staad Pro advanced software which provides a fast, efficient, easy to use and accurate platform for analyzing and designing structure.

A. Space Availability

1) The structure supported on a mono column provides large serviceable floor space compared to structure supported on many columns.
2) They save ground space as requires less area for providing foundation and provides more space for parking.
3) Maximum space utilization is considered will serve its maximum serviceability.
4) For our design problem mono column provide more 2.03 % space which is unobstructed by any mean for
5) Low rise and Mid-rise building than normal multicolumn building.
6) For High rise for given problem statement, it is observed that normal multicolumn building provide1.1 % more space than mono column building, which un satisfy our objective.

(But in mono column, area is not obstructed by column)

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REFERENCES

[1] A Review on Mono Column Multi-Storey Structural System Using Composite Material by Ankur Pandey1, Vaibhav Singh2 and Gaurav Awasthi3
[2] Analysis and Design of a Structure Supported on A Single Column by Palaram Nikhil1 and Sanaka Vineela2
[3] Design And Analysis Of Mono Column Building By Using STAAD Pro by T.Subramani1, S.Priyanka2 , E.Sahul Hameeth3 , P. Shanmuga Subramani4 , K.R. Shuresh5
[4] DESIGN OF MULTI STOREY BUILDING RESTING ON SINGLE COLUMN by Madireddy Satyanarayana.
[5] Analysis of Mono Column Multi-Storey Structure Subjected to Different Wind Intensities by Priyanka Rajeev1, Suji P2
[6] A Comparative Study on Analysis of a Conventional Multi-Storey Building & A Single Column Building by Mr. Jayant S. Ramteke 1, Mr. M. R. Nikhar 2, Mr. G. D. Dhawale 3, Mr. S. G. Makarande
[7] K Venu Manikanta and Dr. Dumpa Venkateswarlu (2016), Comparative Study on Design Results of a Multi-Storied Building Using STAAD Pro and ETABS For Regular and Irregular Plan Configuration, International Journal of Research Sciences and Advanced Engineering, Volume 2, Issue 15, Pages 204 – 215.
[8] Ashok kumar N, Navaneethan M, Naviya B and Gopalakrishnan D (2017), Planning, Analysis & Design of Hospital Building Using Staad Prov8i, International Journal of Scientific & Engineering Research, Volume 8, Issue 4, Pages 1624 - 1628.
[9] IS: 456-2000," Code of Practice for Plain and Reinforced Concrete", New Delhi, Bureau of Indian Standards.
[10] IS: 11384-1985, "Code of practice for composite construction in structural steel and concrete", Bureau of Indian Standards, New Delhi.
[11] https://youtu.be/JQuqI8LQsYM G+8 storey building design in terrain category IV by Staad Pro V8i Software

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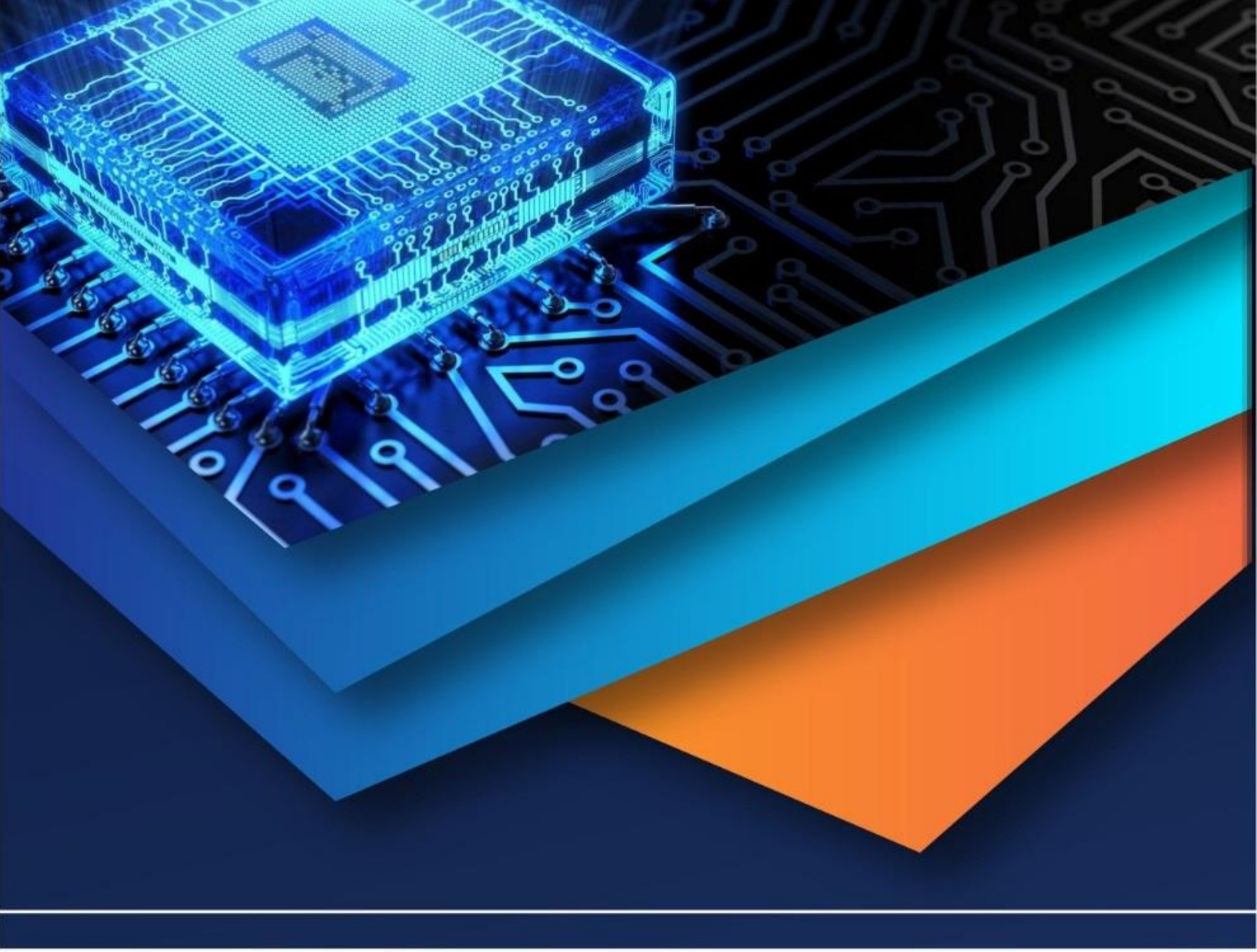

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