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Comparative Study of Design of a Multi-Storey Commercial Building by Manual and STAAD.Pro Software

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Abstract: In this technological world, many number of application softwares are available to do the complex and large structural work in easier manner by saving time and manpower. In Civil Engineering field, analysis and design of structure is subjected to multiple types of loading which is calculated by some application softwares. For this purpose of civil engineering STAAD Pro software is selected for analysis and design of multi-storey building as well as to find out how the values obtained from STAAD Pro software are differ from manual calculated values. For analysis and design of multi-storey building (G+6), proper techniques are used for creating geometry, cross sections for column, beam, slab and footing. Also by assuming the location of Commercial building in Vadodara, Gujrat, some developing specifications, support conditions and seismic loading conditions are obtained manually as well as on STAAD Pro software. Lastly comparison of results obtained from manual calculated values and STAAD Pro software values are done. Also some percentage difference obtained.
Keywords: Seismic Loading, Analysis, Design, Multi-storey Building, Manual, STAAD Pro Software

I. INTRODUCTION

India is highly populated country and majority of population lives in cities. Therefore, more population in India was the motivation behind the widespread building construction activities in last few decades. Also in many states of India moderate to severe earthquake occurs near crowded areas may cause severe damage if the high rise buildings are not designed properly. Also the multistorey cost is expressively increased if this structures are design using some seismic procedures. In this project commercial building assumed which is located in Vadodara city of Gujrat. Due to earthquake (zone III) area, seismic loading is consider in RCC frame structure of building with G+6 number of storey. All structural components were analyzed and designed manually. Detailing is done on Auto CAD software. The analysis and design were done as per standard specifications using STAAD Pro for static and dynamic loads. All the dimensions of building members are specified also load combinations such as dead load, live load, floor load and earthquake load are applied as per IS codes. STAAD Pro software can solve typical problem like seismic analysis using various load combinations to confirm Indian Standard codes like IS 456: 2000, IS 1893: 2002, IS 875: 1987, etc. Also it is compulsory to have sufficient information and knowledge regarding the STAAD Pro software used in analysis and design of structure for checking difference between manual methods values and STAAD Pro software values.

II. OBJECTIVE

Objective of this paper is to analyse and design commercial building with RCC framed structure on STAAD Pro software. The structure is analysed for dead load, live load, floor load and earthquake load. To get practical knowledge of plan and complete the projection earthquake resistant framed structural multistorey building. Also to provide a structure which will be safe, serviceable, economical and aesthetically pleasant as well as understand the basic principles of structure by using IS codes. To understand the parameter of design of slab, beams, columns, footings and other structural components by manually and also on STAAD Pro software with three dimensional model of the structure

III. METHODOLOGY

A. Statement of Project

1) Type of building: Commercial complex
2) No. of storeys: G+6
3) Live load: 4.0kN/m^2 at typical floor and 1.50kN/m^2 on terrace
4) Floor finish: 1.0kN/m^2

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5) Water proofing: 2.0 kN/m^2
6) Terrace finish: 1.0 kN/m^2
7) Location: Vadodara city
8) Earthquake load: As per IS 1893(Part 1) – 2002
9) Depth of foundation below ground: 2.5m
10) Type of soil: Type II, medium as per IS: 1893
11) Allowable bearing pressure: 200 kN/m^2
12) Average thickness of footing: 2.5m, assume isolated footings
13) Storey height: Typical floor: 5m, ground floor: 4.1m
14) Floors: Ground floor + 5 upper floors
15) Ground beams: To be provided at 100 mm below ground level
16) Plinth level: 0.6m
17) Walls: 230 mm thick brick masonry walls only at periphery
18) Steel grade: Fe 415
19) Concrete grade: M25

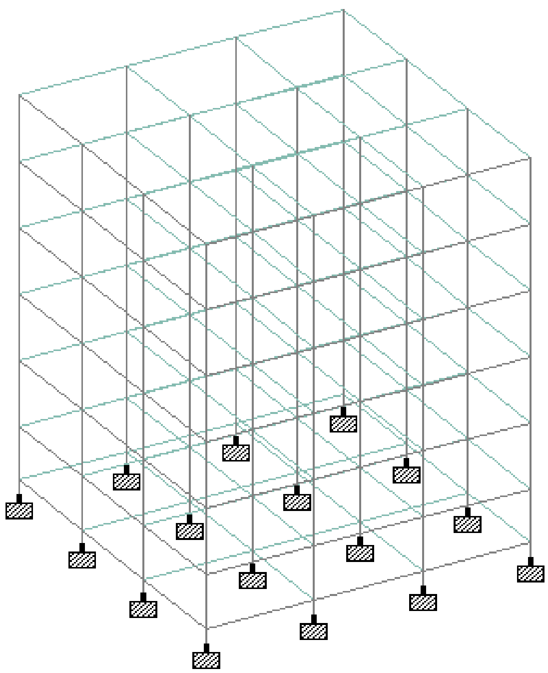


Fig.1 Skeletal diagram

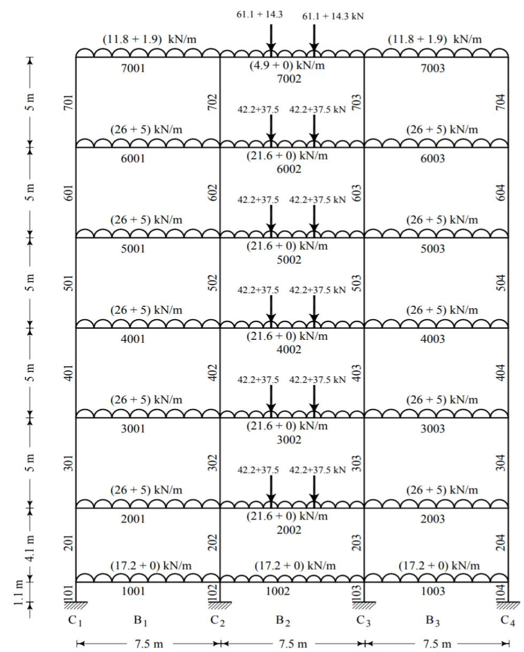


Fig.2 Gravity load diagram

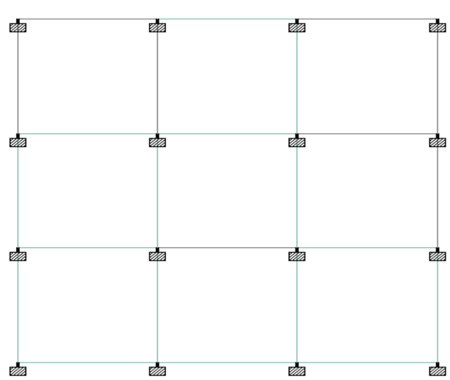


Fig.3 Centre line plan

B. Load condition and structural response system:

This concepts presented in this project provide an overview of building loads and their effect on the structure. Building loads can be divided into two types based on the orientation of structural action: vertical and horizontal loads.

Design loads for commercial building are as follows

1) *B.1. Dead Load:* In STAAD Pro assignment of dead load is automatically done by giving the property of the member. In load case, we have option called self-weight which automatically calculates weights using the properties of material i.e., density and after assignment of dead load the skeletal structure looks red in colour as shown in fig.4. Dead load= unit weight of material* cross section area= 25*b*d
2) B.2. Live Load: In STAAD, we assign live load in terms of U.D.L. we has to create a load case for live load and select all the beams to carry such load. After the assignment of live load the structure appears as shown in fig.5. For our structure live load for all floors are taken as $4kN/m^2$ and for terrace level, it is taken as $1.5kN/m^2$
3) *B.3. Floor Load:* Floor load is calculated based on the load on the slabs. Assignment of floor load is done by creating a load case for floor load. After the assignment of floor load the structure looks as shown in fig.6. The intensity of the floor load is taken as $2.5kN/m^2$ Negative sign indicates that floor load is acting downwards.
4) *B.4. Earthquake Load:* For earthquake loads design we should have to consider multiple factors into account as follows:

Response reduction factors 2. Structural response factor 3. Overall cost of project

Earthquake load acts on the beam, column, joints and footings of the structure.

These load acts on the Centre of mass of structure. But for design considerations the total base shear is distributed to the vertical elements of lateral force resisting system.

The base shear is maximum on the top floor and minimum on the bottom floor.

Load calculation methods used in the analysis:

a) For gravity loads: 1. Moment distribution method 2. Slope deflection method
b) For earthquake loads: Portal frame method

In manual method of design three load combinations are used:

- 1.5 (DL + LL)
- 1.5 (DL + EL)
- 1.2 (DL + LL + EL)

TABLE 1. Factored end moments of three combinations

Sr. No.	combination	B2001		B2002		B2003	
		Left	Right	Left	Right	Left	Right
1.	1.5(DL+LL)	-174.2	305.44	-305.44	305.4	-305.4	174.2
2.	1.5(DL+EL)	-263.5	363.00	-363.00	363.0	-363.0	263.5
3.	1.2(DL+LL+EL)	-242.2	354.29	-354.29	354.2	-354.2	242.2

TABLE 2. Factored end shear for three combinations

Sr. No.	combination	B2001		B2002		B2003	
		Left	Right	Left	Right	Left	Right
1.	1.5(DL+LL)	344.36	379.36	240.48	240.48	379.36	344.36
2.	1.5(DL+LL)	193.398	123.102	221	221	123.10	193.39
3.	1.2(DL+LL+EL)	134.16	164.04	221.64	221.64	164.04	134.16

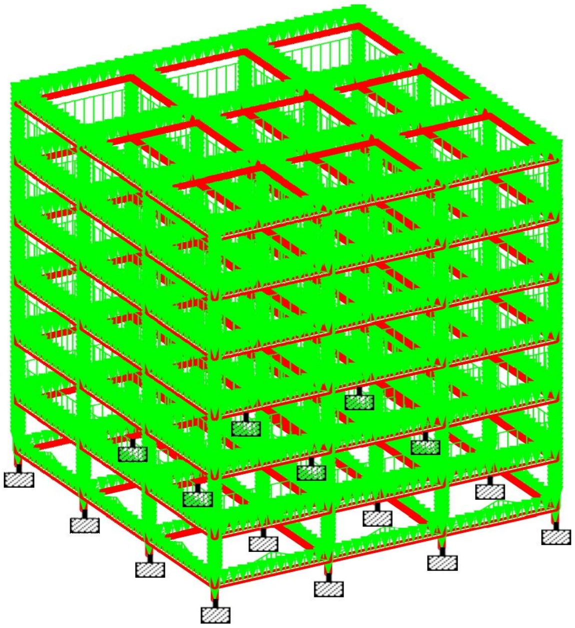


Fig.4 dead load diagram

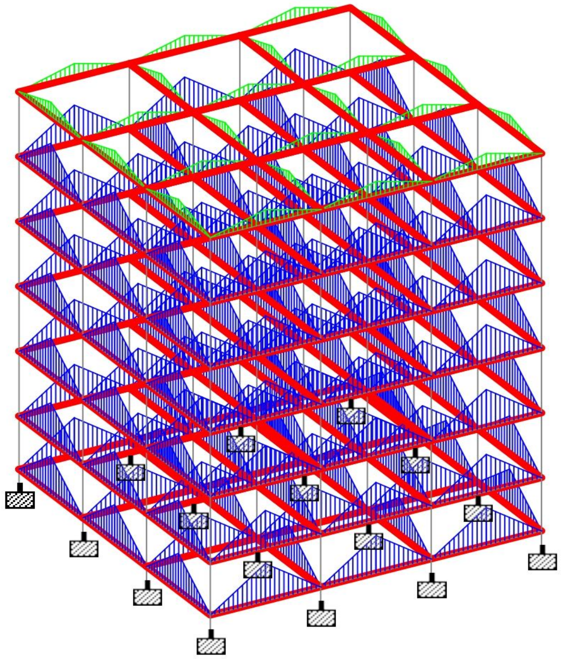


Fig.5 Live load diagram

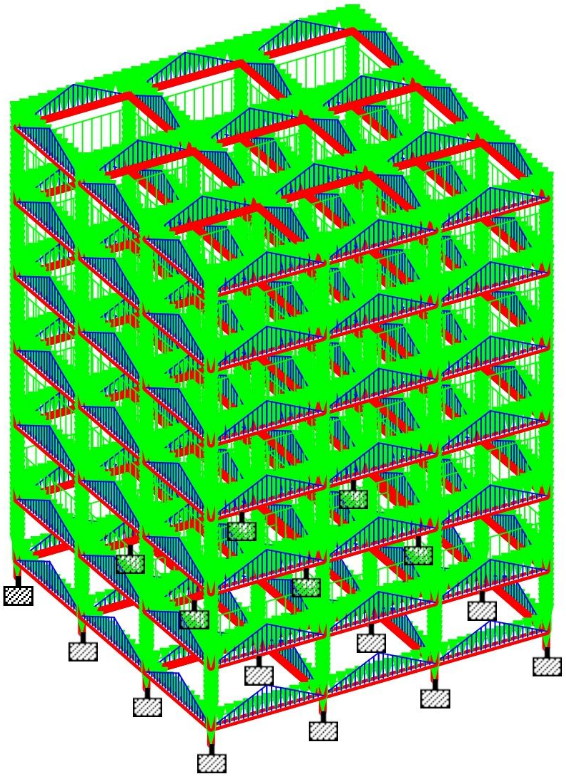


Fig.6 Floor load

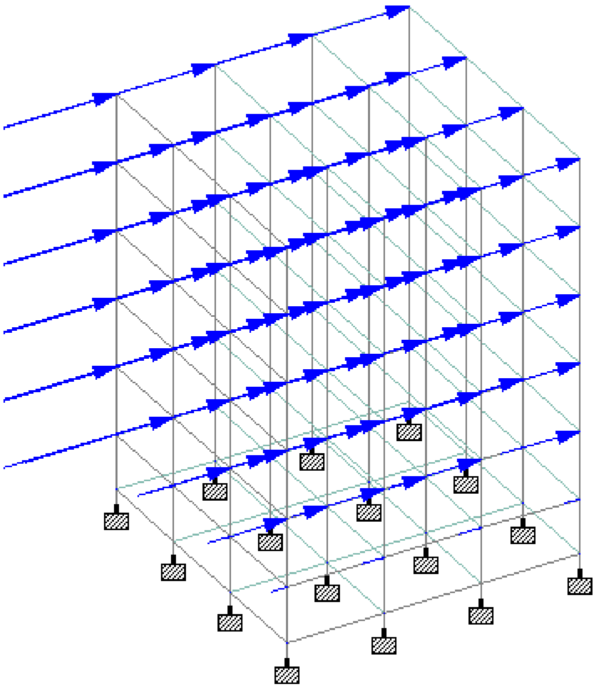


Fig.7 Earthquake load

C. Design of Slab

The ratio of longer span to shorter span of all slabs is less than 2, so all the slab are two way slabs.
Design of two way slab
Evaluation steps:

1) Depth calculation
2) Effective span calculation
3) Bending moment
4) Main middle strip reinforcement (along both span)
5) Edge strip reinforcement
6) Torsional reinforcement
7) Check for shear and deflection

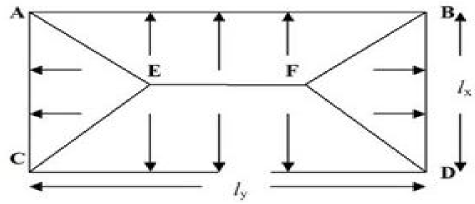


Fig.8 Two way slab

TABLE 3. Design summery of slab

slab	D(mm)	d(mm)	r/f at middle strip	r/f in edge	Torsional r/f
S1	320	290	12mmϕ@185mmc/c	1 bar in each strips	12mmϕ@185mmc/c
S2	320	290	12mmϕ@176mmc/c	1 bar in each strips	12mmϕ@176mmc/c
S3	320	290	12mmϕ@185mmc/c	1 bar in each strips	12mmϕ@185mmc/c
S4	320	290	12mmϕ@176mmc/c	1 bar in each strips	12mmϕ@176mmc/c
S5	320	290	12mmϕ@50mmc/c	4 bars in each strips	12mmϕ@70mmc/c
S6	320	290	12mmϕ@176mmc/c	1 bar in each strips	12mmϕ@176mmc/c
S7	320	290	12mmϕ@185mmc/c	1 bar in each strips	12mmϕ@185mmc/c
S8	320	290	12mmϕ@176mmc/c	1 bar in each strips	12mmϕ@176mmc/c
S9	320	290	12mmϕ@185mmc/c	1 bar in each strips	12mmϕ@185mmc/c

D. Design of beam

Design of beam is done by using moment distribution method.
End moment and moment shear are calculated by using MDM
Span moments for each span is calculated.
Span moments are the maximum moment in span.
Then design for each span and support have been done.

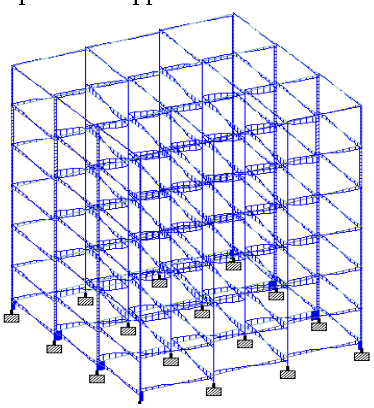


Fig.9 Shear force diagram

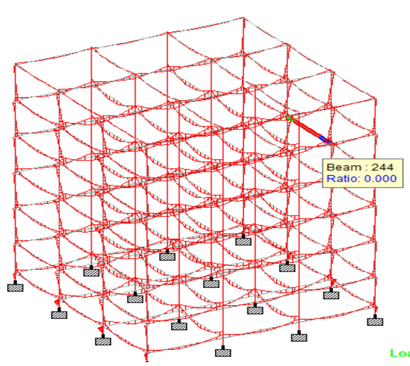
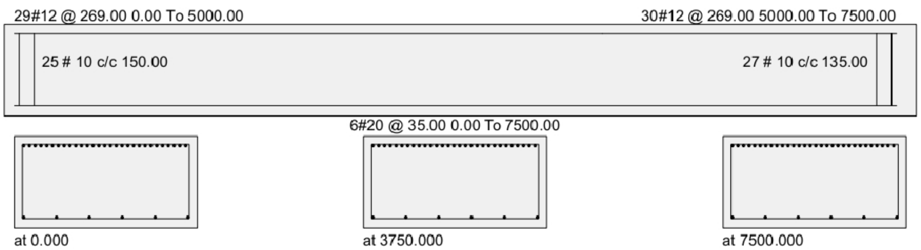


Fig.10 Bending moment diagram

STAAD.Pro Query Concrete Design

Beam no. 151

Design Code: IS-456



Design Load

Mz(Kn Met)	Dist.et	Load
143.309998	3.800000	5
-248.429993	0.000000	5
-259.989990	7.500000	5

Design Parameter

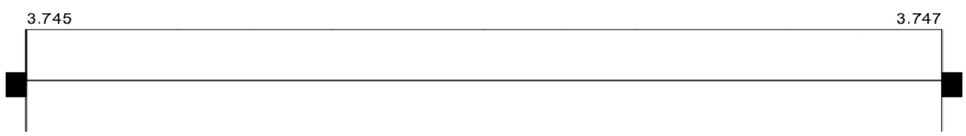
Fy(Mpa)	415.000000
Fc(Mpa)	25.000000
Depth(m)	0.300000
Width(m)	0.600000
Length(m)	7.500000

Fig.11 Reinforcement details of beam

STAAD.Pro Query Deflection Result

Beam no. 151

Deflection in Global X axis. Load case 1.



Dist.m	X(mm)	Y(mm)	Z(mm)
0.000000	3.7453	0.0465	-0.0016
0.625000	3.7454	-0.5197	-0.0011
1.250000	3.7456	-0.7924	-0.0008
1.875000	3.7457	-0.8291	-0.0005
2.500000	3.7459	-0.6870	-0.0003
3.125000	3.7460	-0.4236	-0.0001
3.750000	3.7462	-0.0963	0.0000
4.375000	3.7463	0.2376	0.0001
5.000000	3.7465	0.5208	0.0001
5.625000	3.7466	0.6958	0.0001
6.250000	3.7468	0.7052	0.0001
6.875000	3.7469	0.4918	0.0001
7.500000	3.7471	-0.0019	0.0000

Fig.12 Deflection of beam

Output for beam: Beam 151 (2001)
Beam No. 151 Design Results
M25 Fe415 (Main) Fe415 (Sec.)
Length: 7500.0 mm SIZE: 600.0 mm X 300.0 mm Cover: 25.0 mm

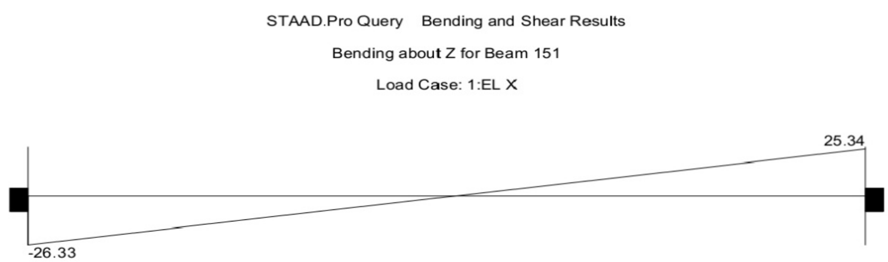
TABLE 4. Summary of Reinforcement Area (mm^2)

Section (mm)	0.0	1875.0	3750.0	5625.0	7500.0
Top reinforcement (mm^2)	3234.69	330.58	0.00	330.58	3389.05
Bottom reinforcement (mm^2)	1438.76	531.33	1879.81	462.26	1605.32

TABLE 5. Summary of provided Reinforcement Area (mm^2)

Section (mm)	0.0	1875.0	3750.0	5625.0	7500.0
Top reinforcement (mm^2)	29-12ϕ (2 layers)	4-12ϕ (1 layer)	3-12ϕ (1 layer)	4-12ϕ (1 layer)	30-12ϕ (2 layers)
Bottom reinforcement (mm^2)	5-20ϕ (1 layer)	4-20ϕ (1 layer)	6-20ϕ (1 layer)	4-20ϕ (1 layer)	6-20ϕ (1 layer)
Shear reinforcement	2-10mmϕ@ 150mmc/c	2-10mmϕ@ 150mmc/c	2-10mmϕ@ 150mmc/c	2-10mmϕ@ 150mmc/c	2-10mmϕ@ 150mmc/c

Shear design results at distance d (effective depth) from face of the support
Shear design results at 506.0 mm away from start support
VY = 171.49; MX = 1.75; LD= 5
Provide 2 Legged 10ϕ @ 190 mm c/c
Shear design results at 505.5 mm away from end support
VY = 157.14; MX = 1.75; LD = 5
Provide 2 Legged 12ϕ @ 140 mm c/c



Dist.m	Fy(kN)	Mz(kNm)
0.000000	-6.8901	-26.3324
0.625000	-6.8901	-22.0261
1.250000	-6.8901	-17.7198
1.875000	-6.8901	-13.4135
2.500000	-6.8901	-9.1072
3.125000	-6.8901	-4.8008
3.750000	-6.8901	-0.4945
4.375000	-6.8901	3.8118
5.000000	-6.8901	8.1181
5.625000	-6.8901	12.4244
6.250000	-6.8901	16.7307
6.875000	-6.8901	21.0370
7.500000	-6.8901	25.3434

Fig.13 Bending and shear results of beam 1

TABLE 6. Design of singly reinforced beam

Support	A		B		C		D
Span		AB		BC		CD	
Length		7.5		7.5		7.5	
B (mm)		300		300		300	
d (mm)		550		550		550	
D (mm)		600		600		600	
Span moments		179.5		106.06		179.5	
Support moments	263.59		363		363		263.5
Xu min.		264		264		264	
Mu lim.	573	573	573	573	573	573	573
Pt. support	0.9568		1.46		1.46		0.9568
Pt. span		0.6099		0.3434		0.6099	

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TABLE 7. Summary of beam design

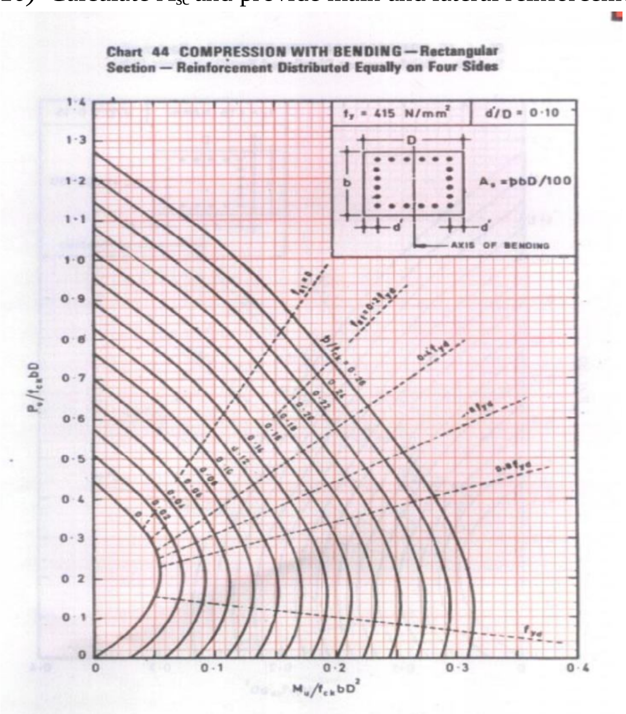
	Pt. max %	Ast req.(mm)	Bar diameter(mm)	No.of bars provided	Ast	Ast pro.
Span	0.609	1006.4	25	3 bottom	490	1472
Support	1.46	2416.3	25	5 top	490	2454

E. Design of Column

Design of bi-axially loaded column

Steps

1) Assume percentage of reinforcement (P)
2) Assume effective cover and calculate d'/D and d'/e
3) Calculate $\frac{Pu}{fck*b*d}$
4) Choose graph from SP-16 and find $\frac{Mux1}{fck*b*D*D}$………………. (From Fig.14)
5) Choose graph from SP-16 and find $\frac{Muy1}{fck*D*b*b}$
6) Calculate Puz……………………………………………….……… (from Fig.15)
7) Find $\frac{Pu}{Puz}$, $\frac{Mux}{Mux1}$ and $\frac{Muy}{Muy1}$
8) Find $\frac{Mux}{Mux1}$ permissible……………………………….…………… (from Fig.16)
9) Check $\frac{Mux}{Mux1}$ permissible > $\frac{Mux}{Mux1}$
10) Calculate A_{sc} and provide main and lateral reinforcement of the column.



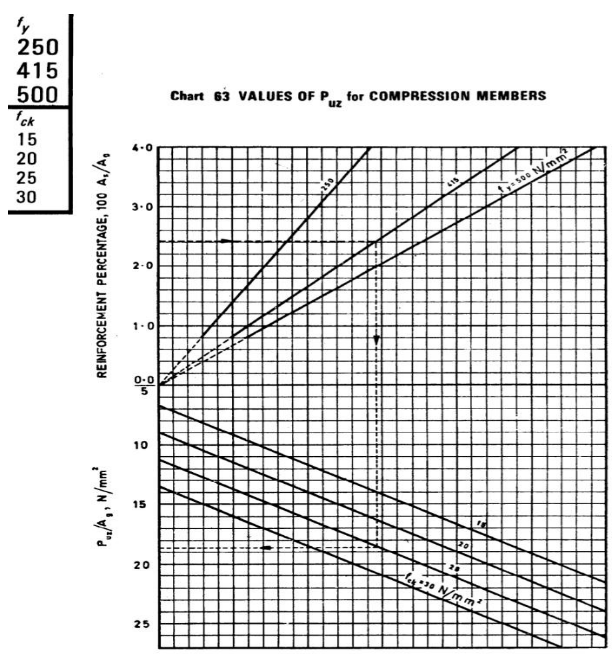


Fig.14 Chart for compression members

Fig.15 Compression with bending chart

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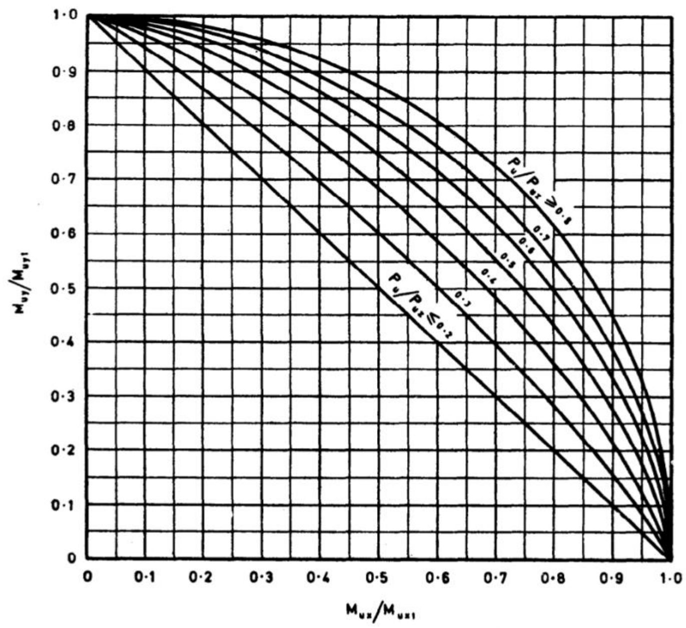


Fig.16 chart for biaxial bending in compression member

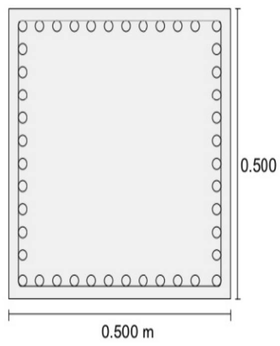
TABLE 8. Column Design

Column No.		101	201	301	401	501	601	701
Pu		596.8	1253.6	1984.2	2802.3	3714.7	4715.5	5425.8
Moment	Mux	15.2	31.9	54.4	71.3	94.5	111.6	118.2
	Muy	15.2	31.9	54.4	71.3	94.5	111.6	118.2
Calculated eccentricity	Ex	25.4	25.4	27.4	25.4	25.4	23.6	21.8
	Ey	25.4	25.4	27.4	25.4	25.4	23.6	21.8
Pt.		1.2	1.2	1.2	1.2	1.2	1.2	1.2
$\frac{Pu}{fck*b*d}$		0.095	0.2	0.32	0.45	0.59	0.75	0.6
Mux1		250	312	281	287	303	187	216
Muy1		250	312	281	287	303	187	216
Pu2		3750	3750	3750	3750	3750	3750	3750
$\frac{Mux1}{fck*b*D*D}$		0.08	0.1	0.09	0.092	0.097	0.06	0.04
$\frac{Muy1}{fck*b*D*D}$		0.08	0.1	0.09	0.092	0.097	0.06	0.04
$\frac{P}{fck}$		0.05	0.05	0.05	0.05	0.05	0.05	0.05
$\frac{Pu}{Pu2}$		1.5	1.5	1.5	1.5	1.5	1.5	1.5

STAAD.Pro Query Concrete Design

Beam no. 173

Design Code: IS-456



Design Load

Load	5
Location	End 2
Pu(Kns)	3483.270020
Mz(Kns-Mt)	114.290001
My(Kns-Mt)	114.290001

Design Results

Fy(Mpa)	415
Fc(Mpa)	25
As Reqd(mm²)	4919.000000
As (%)	1.991000
Bar Size	12
Bar No	44

Fig.17 Reinforcement details of a column

a) *Output:* Due to very huge and detailed explanation of staad output for each and every column we have shown a column design results below showing the amount of load, moments, amount of steel required, section adopted etc.

The main problem with staad is it takes all columns also as beams initially before design and continue the same.So here output of column 1 which is actually 131st beam as most of beams are used in drawing the plan.

Output for column (Beam no.26)

Column N0. 173 Design Results

M25 Fe415 (Main) Fe415 (Sec.)

Length: 4100.0 mm; Cross Section: 500.0 mm X 500.0 mm; Cover: 40.0 mm

Guiding Load Case: 5; End Joint: 105 Short Column

Reqd. Steel Area : 4919.00 mm^2

Reqd. Concrete Area: 245081.00 mm^2

Main reinforcement: Provide 44 #12ϕ (1.99%, 4976.28 mm^2)

(Equally distributed)

Tie reinforcement: Provide 8 mm dia. rectangular ties @ 190 mm c/c

Section capacity based on reinforcement required (kN-m)

Puz: 4288.20; Muz1: 171.13; Muy1: 171.13

Interaction Ratio: 0.89 (as per Cl. 39.6, IS456:2000)

Section capacity based on reinforcement provided (kN-m)

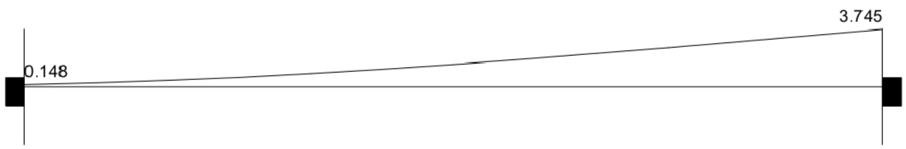
Worst load case: 5

End joint: 105; Puz: 4305.39; Muz: 175.41; Muy: 175.41

STAAD.Pro Query Deflection Result

Beam no. 173

Deflection in Global X axis. Load case 1.



Dist.m	X(mm)	Y(mm)	Z(mm)
0.000000	0.1480	0.0076	-0.0016
0.341667	0.2605	0.0108	-0.0021
0.683333	0.4221	0.0140	-0.0033
1.025000	0.6285	0.0173	-0.0048
1.366667	0.8749	0.0205	-0.0065
1.708333	1.1570	0.0238	-0.0082
2.050000	1.4700	0.0270	-0.0096
2.391667	1.8096	0.0303	-0.0105
2.733333	2.1710	0.0335	-0.0109
3.075000	2.5499	0.0368	-0.0103
3.416667	2.9416	0.0400	-0.0087
3.758333	3.3415	0.0433	-0.0059
4.100000	3.7453	0.0465	-0.0016

Fig.18 Deflection of column

F. Design of footing:

Isolated square footing
Data
Size of column = 600mm* 600 mm
Pu = 6295 kN
Fck = 30 N/mm^2
Fy = 415 N/mm^2
Sbc = 200

Size of footing = $\frac{load\ on\ footing}{sbc} = \frac{6295}{200}$ = 31.475 m^2
So provide footing = √31.475 = 5.610 m = 5.61*65.61 m.
Net upward pressure, = $\frac{factored\ load}{area\ of\ footing} = \frac{9442.5}{5.61*5.61}$ = 300.027 kN/mm^2

Bending moment calculation
$\frac{5610}{2} - \frac{600}{2}$ = 2505 mm= 2.505 m.
Load on critical section = 300.27*5.61 = 1683.15 kN
BM = $\frac{w*l*l}{2} = \frac{1683.15*2.505*2.505}{2}$ = 5280.908 kN.m

Depth of footing calculation
Mu = 0.138*fck*b*d^2
∴ d = 522.350 mm.

We can take 2 to 2.5 time's higher value for a shear check. So take, d = 960mm.
Total depth, D = d* effective cover + ϕ + $\phi/2$ = 960+50+20+20/2 = 1040 mm.

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Reinforcement calculation
Percentage of reinforcement

Pt = $\frac{50fck}{fy}$ * [1 - $\sqrt{1-\frac{4.6*Mu}{fck*b*d\wedge2}}$] = $\frac{50*25}{415}$ * [1 - $\sqrt{1-\frac{4.6*5280.908*10\wedge6}{25*5610*960*960}}$] = 0.297 %

Ast = $\frac{pt}{100}$ * b*d = $\frac{0.297}{100}$ * 5610 * 960 = 15995.232 mm^2

Take, 20mm ϕ bar,

Ast = $\frac{\Pi}{4}$ * 20*20 = 315.159 mm^2

No. of bars = $\frac{15995.232}{314.159}$ = 50.91 51 nos.

Provide, 51 bars of 20 mm ϕ

Ast provided = 51 * $\frac{\Pi}{4}$ * 20 * 20 = 16022.109 mm^2

Ast < ast provided….hence ok.
Check the clear spacing between bars.
As per IS-456 Table No. 15
Clear spacing forfe415 = 180 mm.

C/c spacing = $\frac{5610-cover-cover-\frac{\phi}{2}-\phi/2}{no.\ of\ bars-1}$ = $\frac{5610-50-50-\frac{20}{2}-20/2}{51-1}$ = 109.8 mm.

Clear spacing = 109.8-ϕ/2-ϕ/2 = 109.8-20/2-20/2 = 89.8 mm
89.8 mm < 180 mm …….hence, ok.

Check for one way shear
One way shear check at critical section for one way shear
At distance d from face of the column

Vu = upward pressure * area of highlighted portion= 300.027 * ($\frac{5610}{2}-\frac{600}{2}-960$) = 2520.226 kN.

τv = $\frac{vu}{b*d}$ = $\frac{2520.22*1000}{5610*960}$ = 0.467 N/mm^2

IS 456 Table No. 19

Pt provided = $\frac{10*Ast}{b*d}$ = $\frac{100*16022.109}{5610*960}$ = 0.297 %

τc = 0.49
τv < τc…..hence, ok.

Check for two way shear

At pheripherical d/2 distance from face of the column, size of column = 600*600mm.

Area of highlighted portion = 600 + $\frac{960}{2}$ + $\frac{960}{2}$ = 1560mm = 29.03 mm^2.

Shear at particular section,
Vu = upward pressure * area of highlighted portion = 300.027 * 29.03 = 8709.78 kN.

TV = $\frac{vu}{b!*d}$ = $\frac{8709.78}{6240*960}$ = 1.45 * 10^{-3}

τc' = KS * τc
KS = 1…..for square column
τc = 0.25 √fck = 0.25 √25 = 1.25 N/mm^2
τc' = 1 * 1.25 = 1.25 N/mm^2
τv < τc…..hence, ok.

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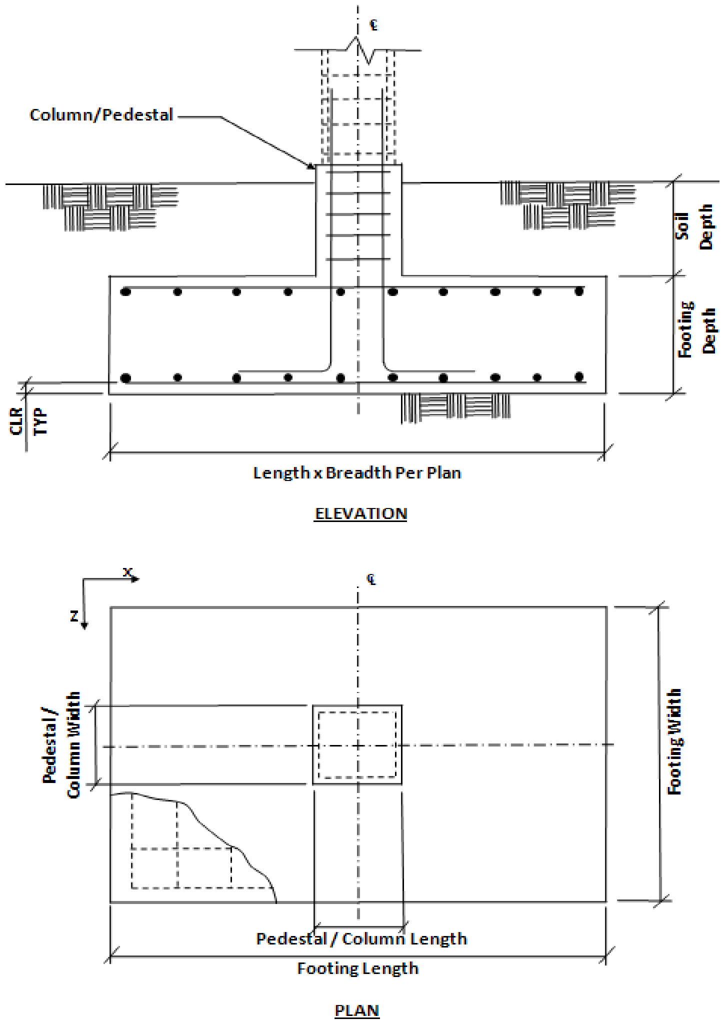

Fig.19 Plan and Elevation of Footing

1) Footing Geometry

Footing thickness (Ft): 305.00 mm
Footing length-X (Fl): 1000.00 mm
Footing Width - Z (Fw): 1000.00 mm
Eccentricity along X (Oxd): 0.00 mm
Eccentricity along Z (Ozd): 0.00 mm

2) Design Parameters

Concrete and Rebar Properties
Unit Weight of Concrete: 25.00 kN/m^3
Strength of Concrete: 25.00 N/mm^2
Yield Strength of Steel: 415.00 N/mm^2
Minimum Bar Size: Ø6
Maximum Bar Size: Ø32
Minimum Bar Spacing: 50.00 mm
Maximum Bar Spacing: 500.00 mm
Pedestal Clear Cover (P, CL): 50.00 mm
Footing Clear Cover (F, CL): 50.00 mm

3) Soil Properties

Soil Type: Drained
Unit Weight: 22.00 kN/m^3
Soil Bearing Capacity: 100.00 kN/m^2
Soil Surcharge: 0.00 kN/m^2
Depth of Soil above Footing: 0.00 mm
Cohesion: 0.00 kN/m^2
Min Percentage of Slab: 0.00

4) Design Calculations

Footing Size,
Initial Length (L_o) = 1.000 m
Initial Width (W_o) = 1.000 m
Uplift force due to buoyancy = 0.000 kN
Effect due to adhesion = 0.000 kN
Area from initial length and width, $A_o = L_o$ X W_o = 1.000 m^2
Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 39.255 m^2

5) Final Footing Size

Length (L_2) = 6.60 m
Width (W_2) = 6.60 m
Depth (D_2) =0.70 m
Area (A_2) = 43.56 m
Provide reinforcement is 10mmϕ@50mm c/c

IV. RESULT

TABLE 9. Comparative Result

Section	Total reinforcement (mm^2)		Comparison (%)
	Staad pro	Manual	
slab	10932.73	9952.54	8.96
Beam	6927.20	5969.09	13.83
Column	6383.71	3945.86	38.18
Footing	21733.86	15995.23	73.60

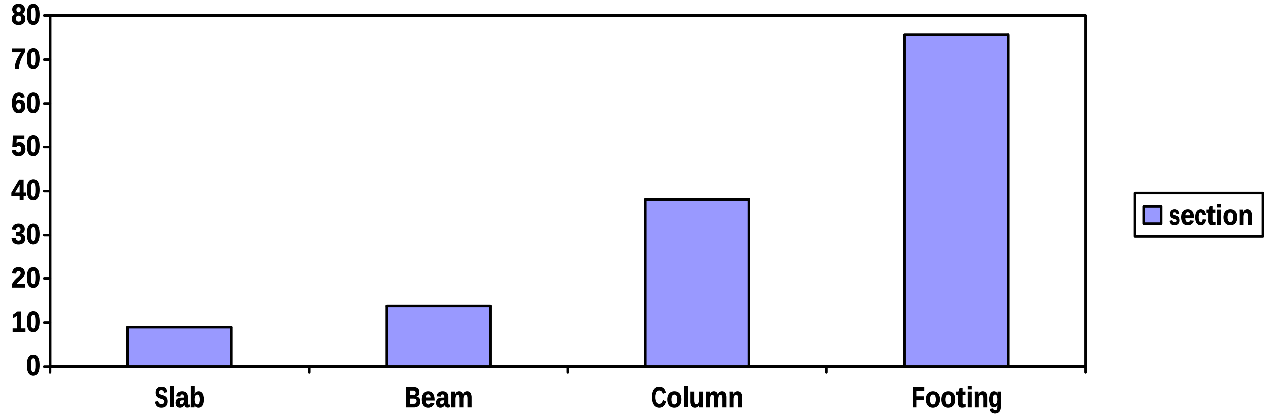

Fig.20 Comparative Parameters of Manual and STAAD Pro software values

V. CONCLUSION

A. Steel require by software is more than manually.
B. Time required for calculation is more in manual method than software.
C. Skilled supervisor required for STAAD Pro.
D. Details of each and every member can be obtained using STAAD Pro.
E. All the List of failed beams can be obtained and also Better Section is given by the software.
F. Accuracy is improved by using software.
G. The results getting by STAAD is little bit more than manual analysis.
H. The value of base shear in STAAD is more than the value of base shear by manual analysis.
I. Always better to know two or more than a single software so that a counter check can be made especially for a large and mega projects to avoid suspicious results and to continue has design with peace of mind.

VI. ACKNOWLEDGEMENT

We express our satisfaction on the completion of this project as a part of the curriculum for the degree of Bachelor of Technology in Civil engineering. We express our deepest gratitude to our project guide Ganesh Suryavanshi and HoD of Civil Department Dr. S. R. Bhagat for his kind guidance during the entire period of project. Also we thankful to Dr. S. M. Pore for his consistent support and advices has helped us to complete this research project successfully. Also all teachers have always been a source of inspiration to us.

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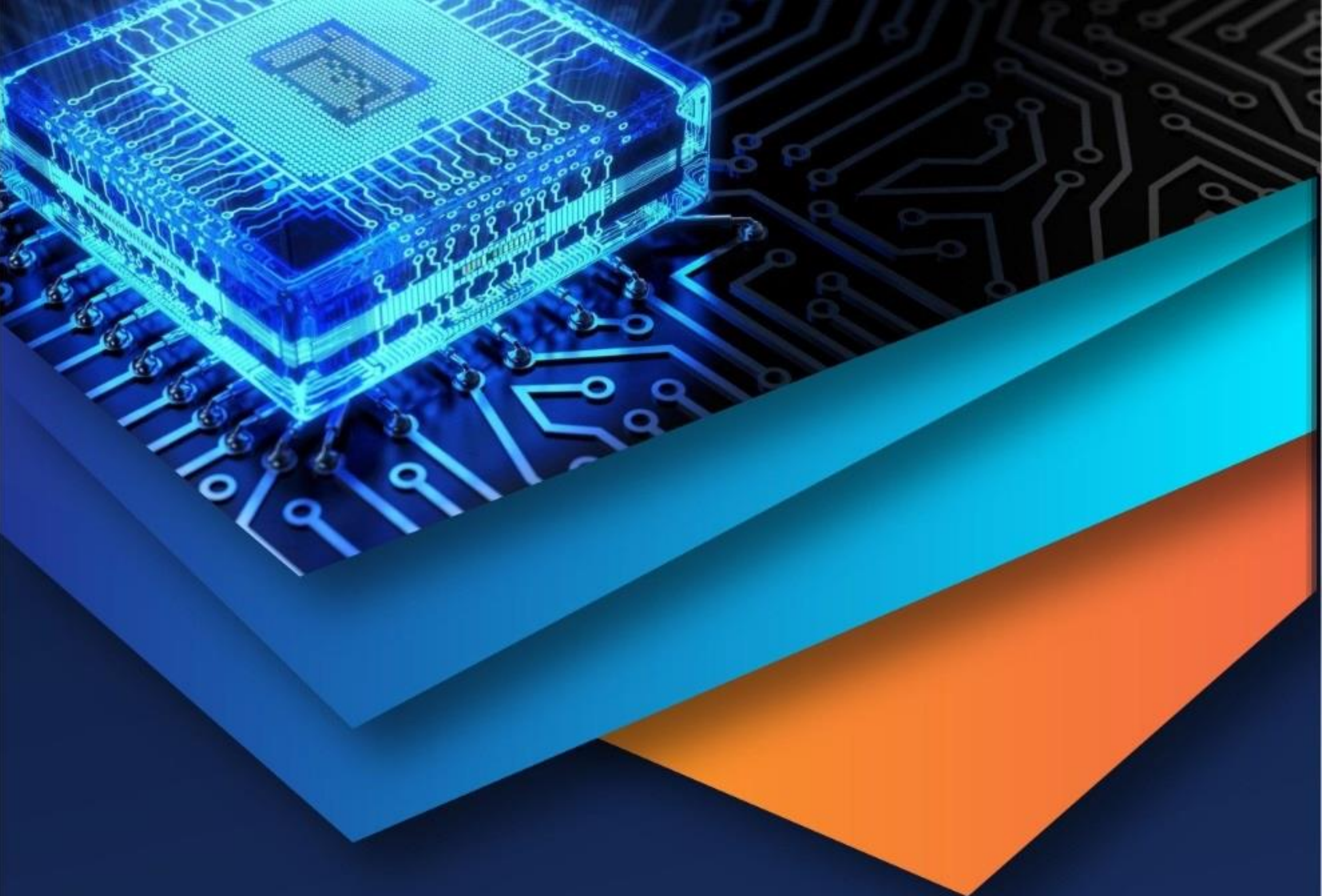

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