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Advanced Structural Analysis And Design Optimization Of High- Rise Building Utilizing Building Information Modeling (BIM) Techniques

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ABSTRACT

In this study, we will be exploring the advanced structural analysis and design optimization techniques for a G+16 high-rise RCC building using STAAD.Pro V8i SS6. Based on IS codes, the building is evaluated for dead, live, and seismic loads, with manual calculations and software evaluations being utilized to evaluate the data. This involves evaluating the design elements, including stresses on beams and columns, reinforcement detailing, and structural stability. Other important considerations are also given. These findings provide evidence that STAAD.Pro can design high-rise buildings with accuracy, safety, and affordability without requiring manual methods, while also being an excellent substitute for advanced software tools.

Key Words: Staad.Pro V8i Ss6, Structural Analysis, G+16 Structure, Seismic Load, Limit State Design, Is 456:2000.

I. INTRODUCTION

The growing population in big cities has led to a higher demand for tall buildings. These high-rises make better use of land and provide more options in crowded areas. Thanks to advancements in building design, engineers now have better ways to analyze and plan these structures using modern software.

This paper looks at the structural analysis and design of a 16-story residential building made of reinforced concrete, using STAAD.Pro V8i SS6, a well-known engineering tool. The design follows Indian standards like IS 456:2000 for concrete and IS 875 for loads. We use the Limit State Design approach to ensure everything is safe and works well under different loads like weight and earthquakes.

1.2 Study Objectives- The main goals of this study are: -

- To analyze a G+16 reinforced concrete high-rise building using STAAD.Pro V8i SS6, focusing on its stability and how it performs under different loads.
- To design key structural parts like beams, columns, and slabs, following Indian Standards (IS 456:2000, IS 875, IS 1893).
- To compare results from the software with manual design methods like Moment Distribution and IS Code Coefficient methods to check for accuracy and efficiency.
- To improve the structural design by reducing material use while keeping safety, cost, and code rules in mind.

III. LITERATURE REVIEW

The way we design high-rise buildings has completely changed with the introduction of computer tools for analysis and design. STAAD.Pro V8i SS6 is a popular choice among engineers because it’s accurate, flexible, and meets global design standards.

2.1 High-Rise Structural Systems

High-rise buildings need strong structural systems to handle both vertical and sideways forces effectively. According to Smith and Coull (1991), picking the right structural system is crucial for a building's stability, usability, and cost.

2.2Role of Structural Analysis Software

Research by Shah and Kadu (2013) shows that structural analysis software, like STAAD.Pro, plays an important role in cutting down manual mistakes and speeding up calculations.

2.3 STAAD.Pro in Practice

Several studies, including one by Patil et al. (2016), show how well STAAD.Pro works for tall buildings. Their findings highlight how the software helps create safe and cost-effective designs that follow IS codes.

III. METHODOLOGY

In this study, we look at how to analyze and design a G+16 high-rise building (40m × 43m) using STAAD.Pro V8i SS6. Here's how we went about it:

- **Model Development:**
- First, we created a 3D model of the reinforced concrete structure in STAAD.Pro. We set up the building's shape, member properties, and the materials we'd be using (M30 concrete and Fe500 steel)
- **Load Considerations:**
- Next, we applied different loads like dead weight, live weight, wind, and seismic forces based on IS 875 (Parts 1-3) and IS 1893 (Part 1): 2016. We also made the necessary load combinations according to IS 456:2000.
- **Structural Analysis:**
- We then performed linear static and dynamic analyses (using response spectrum) to see how the structure handles lateral and gravity loads.

IV. INTRODUCTION TO STAAD.PRO

STAAD.Pro V8i SS6, a Bentley Systems product, stands as a widely adopted structural analysis and design software. Its robust capabilities facilitate comprehensive evaluation of structural integrity for diverse projects, encompassing buildings, bridges, and towers. Furthermore, its compatibility with international design codes, including IS, ACI, BS, and Eurocodes, solidifies its suitability for global engineering endeavors.

4.1 Structural Element Analysis and Design Methodology:

STAAD.Pro V8i SS6 was employed to conduct a comprehensive structural analysis and design of critical elements within a G+16 building (40m x 43m footprint). This included beams, columns, slabs, and foundation systems. The analysis incorporated dead loads, live loads, wind loads, and seismic loads, adhering strictly to relevant IS codes.

Structural analysis and modeling were performed utilizing STAAD.Pro software,

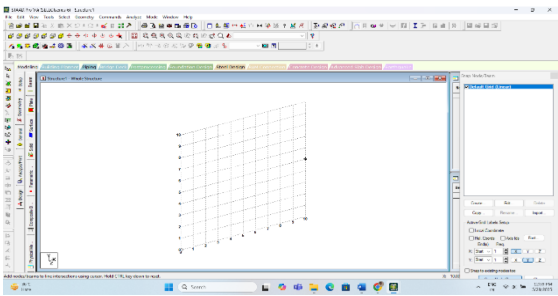

Fig 1. User-Friendly Graphical Interface

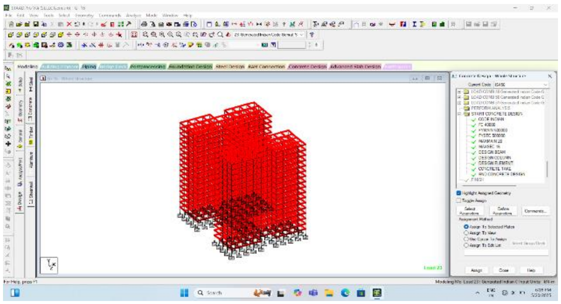

Fig 2. Analysis & Design of Beam

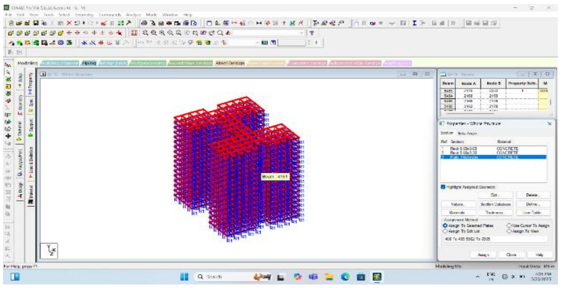

Fig 4. Column Design

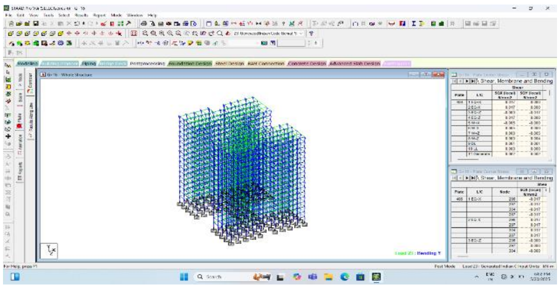

Fig 5. Load Combination & Analysis

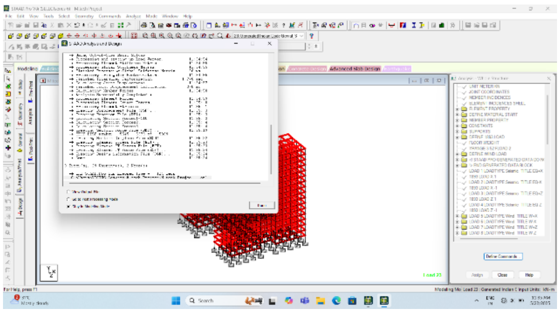

Fig 6. Analysis & Report Generation

V. MODELING AND DESIGN OF G+16 BUILDING:

5.1 Building Description

- Structure Type: High-rise residential/commercial RCC building
- Configuration: G + 16 floors (17 levels total)
- Plan Area: 40 m × 48 m
- Typical Storey Height: 3.0 m
- Total Building Height: 51 m
- Structural System: RCC moment-resisting frame with shear walls (optional)
- Foundation Type: Isolated and combined footings (depending on axial load magnitude and spacing)

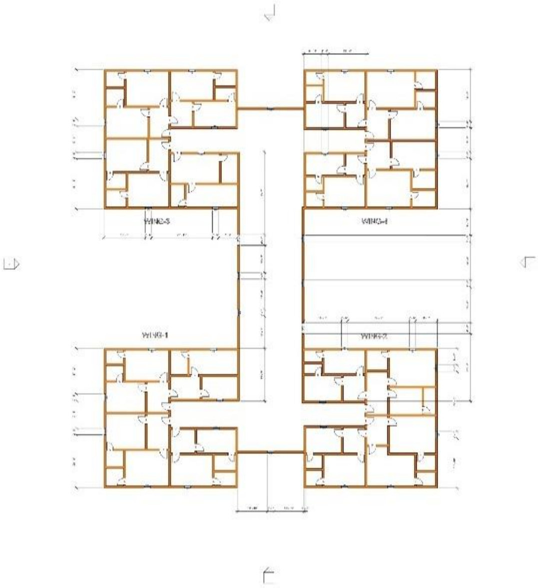

Fig 5.1 Project Plan of Revit

5.2 Geometry Creation

- Grid Dimensions: o X-direction: 8 bays @ 5.0 m = 40 m o Z-direction: 6 bays @ 8.0 m = 48 m
- Y-direction (Height): 17 storeys @ 3.0 m each = 51.0 m

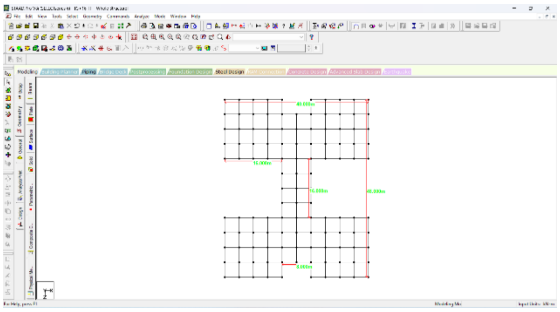

Fig 5.2 Project Plan of Staad Pro.

5.3 Material Properties and Sections

- Concrete Grade: M40
- Steel Grade: Fe500
- Structural Elements:
➢ Columns: 690 × 690 mm (lower storeys), reducing to 450 × 750 mm (upper storeys)
➢ Beams: 300 × 690 mm (primary), 300 × 690 mm (secondary)
➢ Cover: 25mm.
➢ Slab thickness (assumed for DL): 150 mm

5.4 Load Considerations

Dead Load (DL)

- Calculated automatically by STAAD from member dimensions.
- Floor finishes: 1.0 kN/m² (as per IS 875 Part 1)
- Slab self-weight: 3.75 kN/m² (0.15 m × 25 kN/m³)

Live Load (LL)

- Residential areas: 2.0 kN/m²

- Common corridors/staircases: 3.0 kN/m² (IS 875 Part 2)

Wind Load

- Basic wind speed: 39 m/s (location-dependent)
- Terrain Category: 2
- Applied as per IS 875 Part 3 using STAAD's wind load generator

Earthquake Load

- IS 1893:2016 Parameters:
- Zone: III (Z = 0.16)
- Importance Factor (I): 1.0
- Response Reduction Factor (R): 5.0 (SMRF)

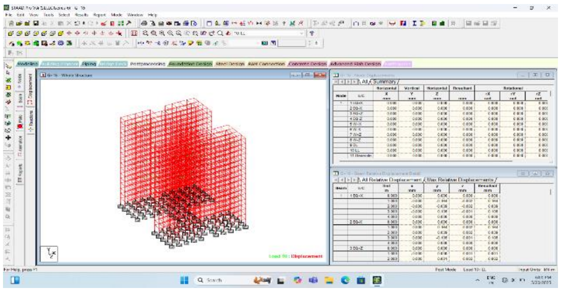

Fig 5.4 Various Load Consideration

5.5 Isolated Footing Design (IS 456-2000):

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Isolated Footing Design (IS 456-2000)

Design For Isolated Footing 1
Design For Isolated Footing 2
Design For Isolated Footing 3
Design For Isolated Footing 4
Design For Isolated Footing 5
Design For Isolated Footing 7
Design For Isolated Footing 8
Design For Isolated Footing 9
Design For Isolated Footing 10
Design For Isolated Footing 11
Design For Isolated Footing 23
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	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
203	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
204	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
205	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
206	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
207	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
208	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
209	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
221	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
222	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
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225	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
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231	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
243	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
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246	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
247	Ø12 @ 60 mm c/c	Ø12 @ 60 mm c/c	Ø10 @ 50 mm c/c	Ø10 @ 55 mm c/c	N/A	N/A
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249	Ø12 @ 60 mm c/c	Ø12 @ 60 mm c/c	Ø10 @ 50 mm c/c	Ø10 @ 55 mm c/c	N/A	N/A
250	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
251	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
252	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
253	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
265	Ø12 @ 70 mm c/c	Ø12 @ 70 mm c/c	Ø10 @ 50 mm c/c	Ø10 @ 50 mm c/c	N/A	N/A
266	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
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268	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
269	Ø12 @ 70 mm c/c	Ø12 @ 70 mm c/c	Ø12 @ 70 mm c/c	Ø12 @ 70 mm c/c	N/A	N/A
271	Ø12 @ 70 mm c/c	Ø12 @ 70 mm c/c	Ø12 @ 70 mm c/c	Ø12 @ 70 mm c/c	N/A	N/A
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273	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
274	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	Ø12 @ 65 mm c/c	N/A	N/A
275	Ø12 @ 70 mm c/c	Ø12 @ 70 mm c/c	Ø10 @ 50 mm c/c	Ø10 @ 50 mm c/c	N/A	N/A

Isolated Footing 1

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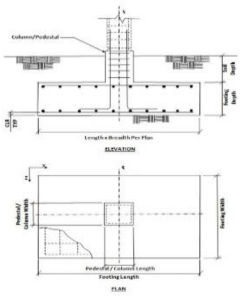

Input Values

Footing Geomtery

Design Type : Calculate Dimension
Footing Thickness (Ft) : 305.000 mm
Footing Length - X (Fl) : 1000.000 mm
Footing Width - Z (Fw) : 1000.000 mm
Eccentricity along X (Oxd) : 0.000 mm
Eccentricity along Z (Ozd) : 0.000 mm

Column Dimensions

Column Shape : Rectangular
Column Length - X (Pl) : 0.690 m
Column Width - Z (Pw) : 0.690 m

Pedestal

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Include Pedestal? No
Pedestal Shape : N/A
Pedestal Height (Ph) : N/A
Pedestal Length - X (Pl) : N/A
Pedestal Width - Z (Pw) : N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3
Strength of Concrete : 25.000 N/mm2
Yield Strength of Steel : 500.000 N/mm2
Minimum Bar Size : Ø6
Maximum Bar Size : Ø32
Minimum Bar Spacing : 50.000 mm
Maximum Bar Spacing : 500.000 mm
Pedestal Clear Cover (P, CL) : 50.000 mm
Footing Clear Cover (F, CL) : 50.000 mm

Soil Properties

Soil Type : Drained
Unit Weight : 22.000 kN/m3
Soil Bearing Capacity : 200.000 kN/m2
Soil Surcharge : 0.000 kN/m2
Depth of Soil above Footing : 0.000 mm
Cohesion : 0.000 kN/m2
Min Percentage of Slab : 0.000

Sliding and Overturning

Coefficient of Friction : 0.500
Factor of Safety Against Sliding : 1.500
Factor of Safety Against Overturning : 1.500

Load Combination/s- Service Stress Level	
Load Combination Number	Load Combination Title
101	1.000 x DI +1.000 x DI +1.000 x DI +1.000 x DI +1.000 x DI +1.000 x DI +1.000 x DI +1.000 x DI +1.000 x DI +1.000 x DI
102	0.800 x DI +0.800 x DI +0.800 x DI +0.800 x DI +0.800 x DI +0.800 x DI +0.800 x DI +0.800 x DI +0.800 x DI +0.800 x DI
Load Combination/s- Strength Level	
Load Combination Number	Load Combination Title

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202	0.960 x DL+0.960 x DL+0.960 x DL+0.960 x DL+0.960 x DL+0.960 x DL+0.960 x DL+0.960 x DL+0.960 x DL+0.960 x DL
203	1.200 x DL+1.200 x DL+1.200 x DL+1.200 x DL+1.200 x DL+1.200 x DL+1.200 x DL+1.200 x DL+1.200 x DL+1.200 x DL
204	0.900 x DL+0.900 x DL+0.900 x DL+0.900 x DL+0.900 x DL+0.900 x DL+0.900 x DL+0.900 x DL+0.900 x DL+0.900 x DL

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
101	5440.941	-8.977	-6.579	-7.038	12.264
102	4352.753	-7.181	-5.263	-6.631	9.811

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
201	8161.411	-13.465	-9.869	-10.558	18.396
202	5223.304	-8.618	-6.316	-6.757	11.773
203	6529.129	10.772	7.895	8.446	14.716
204	4896.847	-8.079	-5.921	-6.335	11.037

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

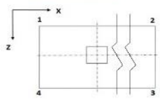
Area from initial length and width, $A_o = L_o \times W_o = 1.000\ m^2$
Min. area required from bearing pressure, $A_{min} = P / q_{max} = 31.702\ m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) =	5.750	m	Governing Load Case :	# 101
Width (W_2) =	5.750	m	Governing Load Case :	# 101
Depth (D_2) =	1.310	m	Governing Load Case :	# 101
Area (A_2) =	33.063	m^2		

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
101	**198.6604**	197.4847	196.7759	197.9515	0.000
101	198.6604	**197.4847**	196.7759	197.9515	0.000
101	198.6604	197.4847	**196.7759**	197.9515	0.000
101	198.6604	197.4847	196.7759	**197.9515**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
101	**198.6604**	197.4847	196.7759	197.9515
101	198.6604	**197.4847**	196.7759	197.9515
101	198.6604	197.4847	**196.7759**	197.9515
101	198.6604	197.4847	196.7759	**197.9515**

Details of Out-of-Contact Area
(If Any)

Governing load case = N/A
Plan area of footing = 33.063 sq.m
Area not in contact with soil = 0.000 sq.m
% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	

Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
101	360.929	492.461	1216.953	791.151
102	375.397	512.201	1265.732	822.863

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 101
Governing Disturbing Force : -8.977 kN
Governing Restoring Force : 3239.965 kN
Minimum Sliding Ratio for the Critical Load Case : 360.929
Critical Load Case for Overturning about X-Direction : 101
Governing Overturning Moment : -15.308 kNm
Governing Resisting Moment : 18629.458 kNm
Minimum Overturning Ratio for the Critical Load Case : 1216.953

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 101
Governing Disturbing Force : -6.579 kN
Governing Restoring Force : 3239.965 kN
Minimum Sliding Ratio for the Critical Load Case : 492.461
Critical Load Case for Overturning about Z-Direction : 101
Governing Overturning Moment : 23.547 kNm
Governing Resisting Moment : 18629.458 kNm
Minimum Overturning Ratio for the Critical Load Case : 791.151

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #201

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 1.254 m

Governing moment (M_u) = 4551.980 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.456026

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times k_{umax})$ = 3318.146612 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 30002.023582 kNm

$M_u <= M_{umax}$ hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

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Critical Load Case = **#201**

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 1.254 m

Governing moment (M_u) = 4557.051 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.456026

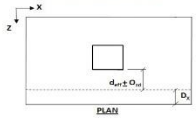
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times k_{umax})$ = 3318.146612 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 30002.023582 kNm

$M_u <= M_{umax}$ hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



PLAN

Critical Load Case = **#201**

D_X = 1.254 m

Shear Force(S) = 1815.261 kN

Shear Stress(T_v) = 251.752440 kN/m2

Percentage Of Steel(P_t) = 0.1254

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 268.030 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)

file:///C:/Staad.foundation%205.3/CalcXsl/footing.xml 5/24/2025

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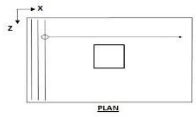


PLAN

Minimum Area of Steel (A_{stmin}) = 9039.000 mm2

Calculated Area of Steel (A_{st}) = 8687.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 9039.000 mm2

$A_{stmin} <= A_{st,Provided}$ Steel area is accepted

Governing Moment = 642.545 kNm

Selected bar Size (d_b) = Ø10

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 51.273 mm

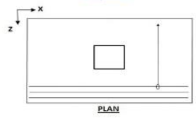
$S_{min} <= S <= S_{max}$ and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø10 @ 50 mm o.c.

Along X Axis



PLAN

file:///C:/Staad.foundation%205.3/CalcXsl/footing.xml 5/24/2025

Isolated Footing Design Page 20 of 1071

Minimum Area of Steel (A_{stmin}) = 9039.000 mm2

Calculated Area of Steel (A_{st}) = 8687.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 9039.000 mm2

$A_{stmin} <= A_{st,Provided}$ Steel area is accepted

Governing Moment = 642.545 kNm

Selected bar Size (d_b) = Ø10

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 51.273 mm

$S_{min} <= S <= S_{max}$ and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø10 @ 50 mm o.c.

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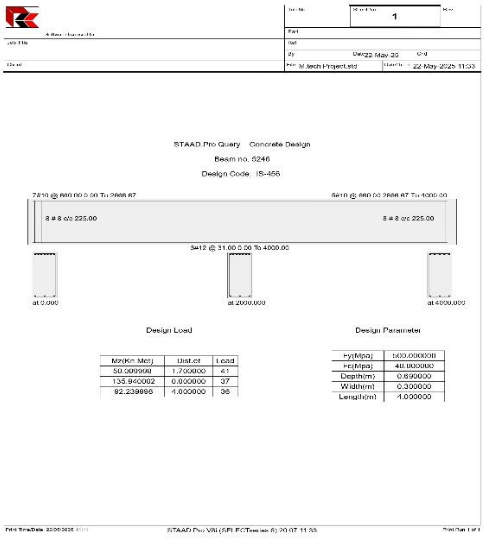
file:///C:/Staad.foundation%205.3/CalcXsl/footing.xml 5/24/2025

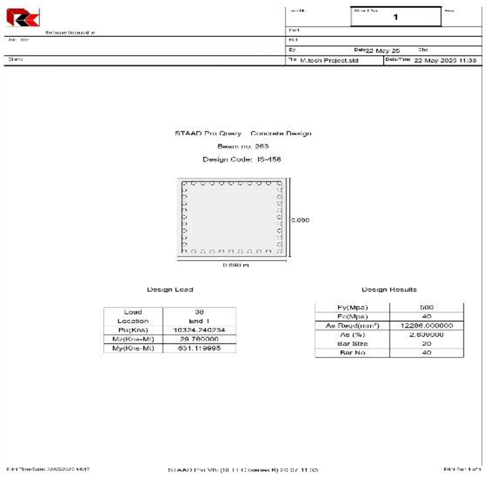
5.6 Beam Design:



Mz(Kn Met)	Dist.of	Load
50.009998	1.700000	41
135.940002	0.000000	37
92.239998	4.000000	36

Fy(Mpa)	500.000000
Fc(Mpa)	40.000000
Depth(m)	0.690000
Width(m)	0.300000
Length(m)	4.000000

5.7 Column Design:



Load	38
Location	End 1
Pu(Kns)	10324.240234
Mz(Kns-Mt)	29.760000
My(Kns-Mt)	631.119995

Fy(Mpa)	500
Fc(Mpa)	40
As Reqd(mm²)	12286.000000
As (%)	2.639000
Bar Size	20
Bar No	40

VI. RESULTS AND DISCUSSION

6.1.2 Lateral Displacement Control

- Maximum Displacement (Top Storey):
  - X-direction: 32.5 mm
  - Z-direction: 28.1 mm
- Permissible Limit: According to IS 1893:2016, the maximum lateral displacement should not exceed H/500, where H is the total height of the building (51 m).
  - Allowable = 51000 / 500 = 102 mm

6.1.3 Inter-Storey Drift Check

- Maximum Inter-Storey Drift Observed:
  - ~0.0028 (between 10th and 11th floors) • Limit as per IS 1893:2016:
  - ≤ 0.004 × Storey Height = 0.004 × 3.0 m = 12 mm

6.1.4 Member Force Analysis

- Beams:

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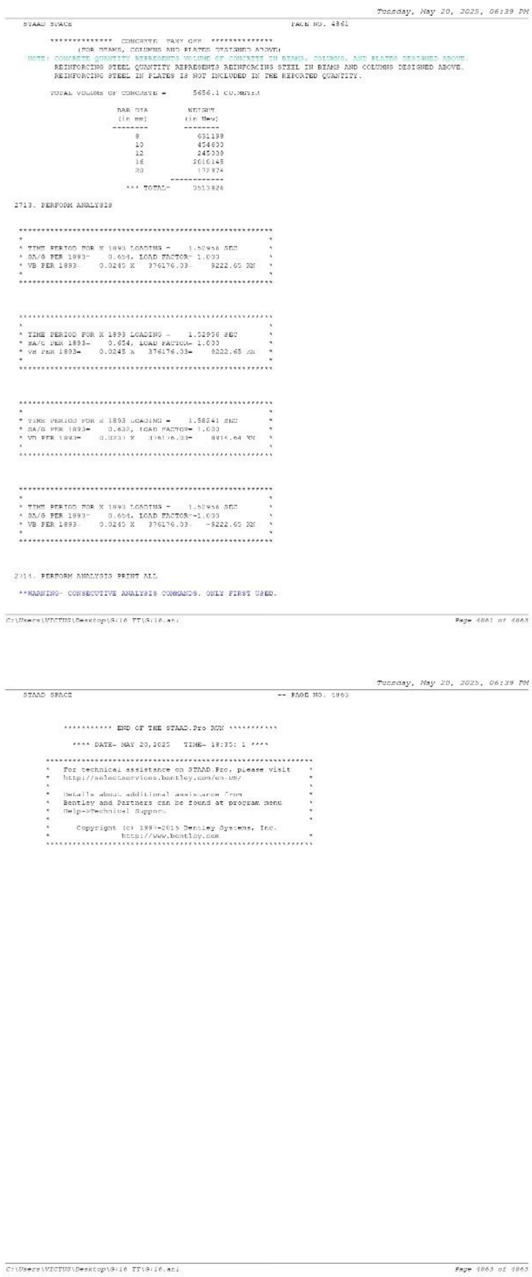
- o Most critical bending moment observed: 190 kNm
- o STAAD's design module confirms safe reinforcement design with ductility checks. • Columns:
- o Maximum axial force: ~2900 kN (Ground Floor)

6.1.5 Foundation Pressure and Stability

- Max Net Bearing Pressure: o Isolated footings: ~165 kN/m²
  - o Combined footings: ~180 kN/m²
- Soil Bearing Capacity (SBC): 200 kN/m²



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      **************  CONCRETE  TAKE OFF  **************
            (FOR BEAMS, COLUMNS AND PLATES DESIGNED ABOVE)
 NOTE: CONCRETE QUANTITY REPRESENTS VOLUME OF CONCRETE IN BEAMS, COLUMNS, AND PLATES DESIGNED ABOVE.
       REINFORCING STEEL QUANTITY REPRESENTS REINFORCING STEEL IN BEAMS AND COLUMNS DESIGNED ABOVE.
       REINFORCING STEEL IN PLATES IS NOT INCLUDED IN THE REPORTED QUANTITY.

      TOTAL VOLUME OF CONCRETE =      5656.1 CU.METER

                    BAR DIA         WEIGHT
                    (in mm)         (in New)
                    --------        --------
                        8             631138
                       10             454600
                       12             245000
                       16            2010145
                       20             172874
                                 ------------
                    *** TOTAL=       3513826

 2713. PERFORM ANALYSIS

  *********************************************************
  *                                                       *
  * TIME PERIOD FOR X 1893 LOADING =     1.52958 SEC      *
  * SA/G PER 1893=     0.654, LOAD FACTOR= 1.000          *
  * VB PER 1893=    0.0245 X   376176.03=     9222.65 KN  *
  *                                                       *
  *********************************************************

  *********************************************************
  *                                                       *
  * TIME PERIOD FOR X 1893 LOADING =     1.52958 SEC      *
  * SA/G PER 1893=     0.654, LOAD FACTOR= 1.000          *
  * VB PER 1893=    0.0245 X   376176.03=     9222.65 KN  *
  *                                                       *
  *********************************************************

  *********************************************************
  *                                                       *
  * TIME PERIOD FOR Z 1893 LOADING =     1.58241 SEC      *
  * SA/G PER 1893=     0.632, LOAD FACTOR= 1.000          *
  * VB PER 1893=    0.0233 X   376176.03=     8814.64 KN  *
  *                                                       *
  *********************************************************

  *********************************************************
  *                                                       *
  * TIME PERIOD FOR X 1893 LOADING =     1.52958 SEC      *
  * SA/G PER 1893=     0.654, LOAD FACTOR=-1.000          *
  * VB PER 1893=    0.0245 X   376176.03=    -9222.65 KN  *
  *                                                       *
  *********************************************************

 2714. PERFORM ANALYSIS PRINT ALL

  **WARNING- CONSECUTIVE ANALYSIS COMMANDS. ONLY FIRST USED.

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                                                  Tuesday, May 20, 2025, 06:39 PM
 STAAD SPACE                                     -- PAGE NO. 4863

          *********** END OF THE STAAD.Pro RUN ***********

            **** DATE= MAY 20,2025   TIME= 18:35: 1 ****

      ************************************************************
      *  For technical assistance on STAAD.Pro, please visit     *
      *  http://selectservices.bentley.com/en-US/                *
      *                                                          *
      *  Details about additional assistance from                *
      *  Bentley and Partners can be found at program menu       *
      *  Help->Technical Support                                 *
      *                                                          *
      *     Copyright (c) 1997-2015 Bentley Systems, Inc.        *
      *              http://www.bentley.com                      *
      ************************************************************

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VII. CONCLUSION AND RECOMMENDATION

Conclusion: The structural analysis of the G+16 high-rise building (40m x 43m) using STAAD.Pro V8i SS6 demonstrates its structural integrity and stability under various loading conditions. The software effectively optimized material usage while adhering to relevant design codes.

Recommendations: Future development should explore performance-based design methodologies, integrate Building Information Modelling (BIM) for enhanced collaboration, and prioritize sustainable material selection. Comparative analysis with alternative software solutions would provide a more comprehensive validation of the design.

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