

# PLANNING, ANALYSIS AND DESIGN OF HIGH RISE BUILDING USING STAAD.PRO

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**Abstract:** High rise buildings are becoming prominent these days due to following reasons, scarcity of land, increasing demand for business and residential space, economic growth, technological advancement innovations in structural systems, desire for aesthetics in urban setting cultural significance, and prestige human aspiration to build higher. First, the exploding population, largely urban, creates an increasing demand for tall buildings. The ever increasing population and growing economies in major cities of the world mean increasing urbanization globally and the continuing rise in population density in urban areas. The tall building can accommodate many more people on a smaller land than would be the case with low-rise building on the same land. A tall building is in effect a vertical transformation of horizontal expansion. High rise buildings minimum floors is 13 floors or above.

Due to growing population and less availability of land, multi-storey buildings are constructed which can serve many people in limited area. The main objective of this paper is to planning, analyse and design a (G+20) high rise building using STAAD Pro. The paper aims to give proper awareness to right designing and detailing of the building. First of all, the planning is done as per NBC guidelines and state government GO's. AUTO CAD software is to be used for developing plans. The design involves load calculations manually and the structure is analysed and designed using STAAD Pro. The code refers for this project are NBC, IS 456-2000, SP16. The concrete mix used in this project is M30. The LIMIT STATE METHOD of design has been adopted. This paper is to give a complete experience in the field of design and to gain the knowledge in a practical way.

**Key words:** STAAD Pro, Concrete mix, Steel strength, Limit state method.

## 1. Introduction:

In every aspect of human civilization, we needed structures to live. The structures should be built in an efficient manner so that it can serve people and save money. In simple words, the building means an empty surrounded by walls and roofs, in order to give shelter for human beings. In early times humans have lived in caves to protect themselves from wild animals, rain etc. Then, humans developed and built their homes using timbers and lived. Now a days the recent homes are developed into individual and multi-storey buildings.

Buildings are the necessary indicator of social progress of the country. At current situation, many new techniques have been developed for constructions. So, that the buildings are built economically and quickly to fulfil the needs of the people. A building frame is a three-dimensional structure which consists of column, beams and slabs. Because of growing population, high rise buildings are coming into demand. Buildings constitute a part of the definition of civilizations, a way of life advanced by the people. The buildings should be constructed for human requirements and not for earning money. Buildings are built in different sizes, shapes and functions.

## 1.1 Building Description:

Table-1 : Details of Building

Building Details			
Model	G+20	Outer Wall Thickness	0.23m
Location	Delhi	Grade of Concrete	M30
No. of Bays along Length	4	Grade of Steel	Fe415
No. of Bays along width	9	Column Dimensions	0.61*0.46m
Floor to Floor Height	3m	Beam Dimensions	0.46*0.46m
Depth of Foundation	3m	Slab Thickness	0.15m
Total Building Height	63m	Seismic Zone	IV
Live Load	3kN/m <sup>2</sup>	Soil Type	Medium Soil
Inner Wall Thickness	0.115m	Structure Type	RC Frame Building

## 2. A Brief Description of Software Used:

The software's used in this paper are,

- AUTO CAD
- STAAD PRO
- STAAD FOUNDATION

### 2.1 Auto CAD:

The word auto came from Auto Desk Company and CAD stands for computer aided design. Auto CAD is used for drawing different layouts, details, plans, elevations, sections and different sections can be shown in auto CAD. Learning of certain commands is required to draw in Auto CAD.

### 2.2 STAAD:

STAAD is powerful design software licensed by Bentley. STAAD stands for structural analysis and design. Any object which is stable under a given loading can be considered as structure. So first find the outline of the structure, where as analysis is the estimation of what are the type of loads that acts on the beam and calculation of shear force and bending moment comes under analysis stage. Design phase is designing the type of materials and its dimensions to resist the load this we do after the analysis. This software can be used to carry RCC, Steel, Bridge, Truss etc. according to various country codes.

### 2.3 Staad Foundation:

STAAD foundation is a powerful tool used to calculate different types of foundations. Analysis and design carried in STAAD and post processing in STAAD gives the load at various supports. These supports are to be imported into this software to calculate the footing details i.e., regarding the geometry and reinforcement details.

## 3. Planning:

The auto cad represents the plan of a g+20 building. The plan shows the details of dimensions of each and every room and the type of room and orientation of the different rooms like bed room, bathroom, kitchen, hall etc..



Fig 1: Site Plan

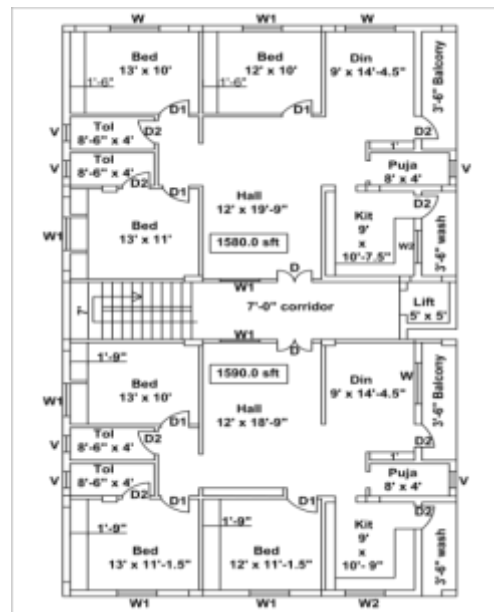


Fig 2: Floor Plan

#### 4. Types of Loads Used:

The loads which are considered for analysis are:

1. Seismic Loads(Earthquake Loads)
2. Wind Loads
3. Dead Load
4. Live Load
5. Floor Load

##### 4.1 Earthquake Loads:

Based on the occurrence of earthquakes in the past around India, the country is divided into four seismic zones, namely zones II, III, IV, V, where II is the least severe and V is the most severe. Based on this zoning, about 60% of India's land area is under moderate seismic threat or more, i.e., under seismic zone III or above in fact, the Gujarat, Latur earthquake which were fatal. Even now amongst our four mega-cities, Delhi is in seismic zone IV, which Mumbai, Kolkata, and Chennai are in seismic zone III.

##### 4.2 Wind Loads:

Designing wind load can be assigned in two ways

1. Collecting the standard values of load intensities for a particular height and assigning of the loads for respective height.
2. Calculation of wind load as per **IS 875 part 3**.

We designed our structure using second method which involves the calculation of wind load using wind speed.

##### 4.3 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. Dead loads are specified in **IS 875(Part1)**.

#### 4.4 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. For our structure pressure of the live load is taken as **3kN/m<sup>2</sup>** for design. Live loads are calculated as per **IS 875 (Part 2)**.

#### 4.5 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. The pressure of the floor load taken is: **1kN/m<sup>2</sup>**. -ve sign indicates that floor load is acting downwards.

#### 4.6 Load Combinations:

The different combinations used in the project are

- 1.5(D.L+L.L)
- 1.2(D.L+L.L ± WX)
- 1.2(D.L+L.L ± WZ)
- 1.2(D.L+L.L ± EQ X)
- 1.2(D.L+L.L ± EQ Z)
- 1.5(D.L ± W X)
- 1.5(D.L ± W Z)
- 1.5(D.L ± EQ X)
- 1.5(D.L ± EQ Z)
- 0.9D.L ± 1.5EQ X
- 0.9D.L ± 1.5EQ Z

#### 5. Design of Slab:

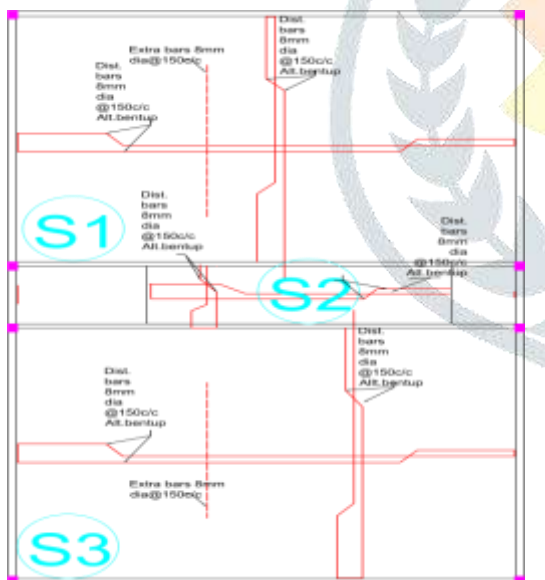
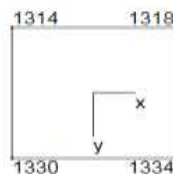


Fig 3 : Slab Reinforcement

STAAD.Pro Query Property

Element no 3107



Physical Properties

Node	Thickness (m)
1314	0.150000
1318	0.150000
1334	0.150000
1330	0.150000

Material Properties

Elasticity(kN/mm <sup>2</sup> )	Density(kg/m <sup>3</sup> )	Poisson	Alpha
21.718	2402.615	0.170	10 E-6

Fig 4 : Reinforcement details of Slab

Table-2 : Slab Details

Plate No.	Node	Area (cm <sup>2</sup> )	Thickness (m)
3107	1314	1010320.59	0.150
	1318		
	1334		
	1330		
3109	1351	1014674.99	0.150
	1355		
	1339		
	1335		

6. Design of beam:

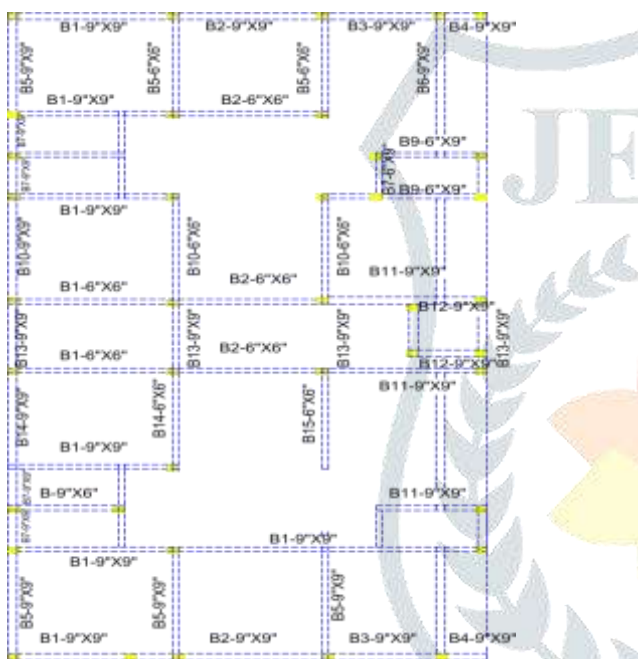


Fig 5 : Beam Layout

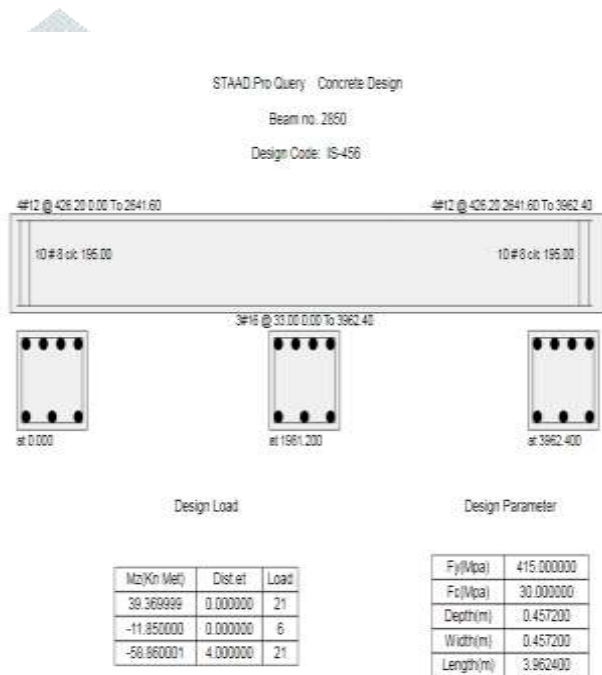


Fig 6 : Reinforcement details of beam

Table-3 : Beam Details

Beam No.	Grade of concrete	Grade of steel	Depth (m)	Width (m)	Fy (KN)	Mz (KNm)	Displacement (m)
1	30	415	0.46	0.46	-7.998	-16.295	0.397
91					-0.277	-0.334	0.397
190					-9.828	-20.007	1.118
260					-0.486	-0.630	1.118
330					-10.820	-22.072	2.005
400					-0.672	-0.899	2.004
2430					-6.233	-13.026	21.434
2570					-5.079	-10.691	22.559
2710					-3.614	-7.667	23.6
2850					-1.328	-3.507	24.528

7. Design of Column:

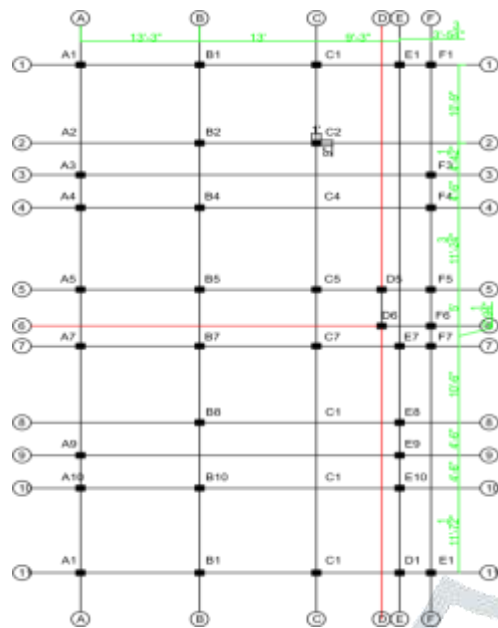
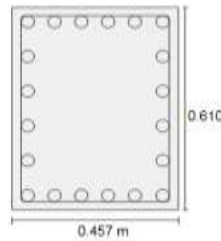


Fig 7 : Column Layout

STAAD Pro Query Concrete Design

Beam no. 90

Design Code: IS-456



Design Load

Load	3
Location	End 1
Pu(Kns)	-0.560000
Mz(Kns-Mt)	0.250000
My(Kns-Mt)	0.020000

Design Results

Fy(Mpa)	415
Fc(Mpa)	30
As Reqd(mm <sup>2</sup> )	2230.000000
As (%)	0.812000
Bar Size	12
Bar No	20

Fig 8 : Reinforcement details of column

Table-4 : Column Details

Column No.	Thickness of column	Width (m)	Fy (KN)	Mz(KNm)	Displacement (mm)	As Req(mm <sup>2</sup> )	Pu(kns)
5	0.61	0.46	10.047	25.993	0	2230	-225.06
14			9.257	24.388	0		-256.99
89			12.693	27.444	0		-1.45
194			8.182	15.943	0.397		-216.11
259			7.683	15.337	0.371		-0.32
334			8.983	16.180	1.118		-204.32
399			6.476	12.325	1.031		-0.26
614			10.194	17.170	3.018		-179
679			5.497	9.918	2.730		-0.22
819			5.273	9.256	3.717		-0.22

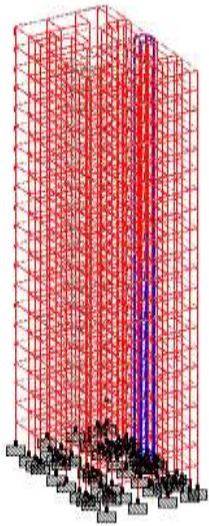


Fig 9:Bending Moment

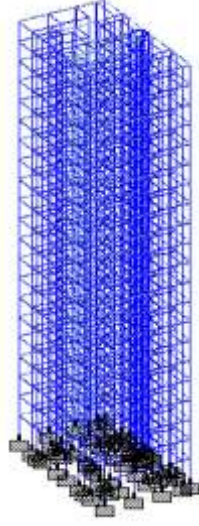


Fig10:Shear Force

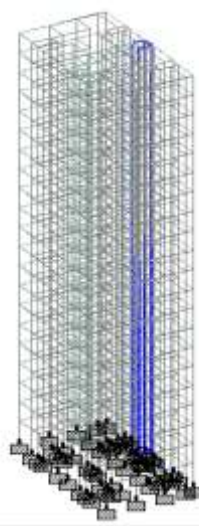


Fig11:3D-View

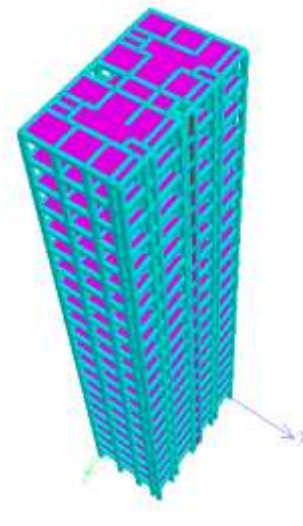


Fig 12 : 3D-Rendering View

## 8. Conclusion:

- All the room dimension, set backs are taken as per NBC norms and GO's 168.
- The building is analyzed for gravity loads and seismic loads as per 1893:2002.
- The building is located in zone IV.
- All the necessities are drawn using Auto CAD software.
- STAAD.Pro is used for analysis and design of building.

## 9. References:

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