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# Analysis & Design of G+11 RCC Frame Structure using E-Tabs.

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**Abstract -** *The RCC buildings have to withstand many types of loads, including seismic and wind loads. In this project, we have carried out an analysis on a G+11 RCC building using ETABS software while taking into consideration seismic and wind loads. In this analysis, we have also used Response Spectrum Analysis as per IS:1893-2016 and Wind Load Analysis as per IS:875-2015. Shear walls were also provided to enhance lateral resistance in the building. Also, P-Delta analysis was carried out on the building model. As per the analysis results, it is seen that the displacement in the building remains within limits. The addition of shear walls in the building model has significantly increased its stiffness, while in P-Delta analysis, there is an increase in displacement in the building model.*

***Key Words*: AutoCAD, E-Tabs, Analysis, Seismic Analysis, Civil Engineering, Structural Engineering, P-Delta**

## 1. INTRODUCTION

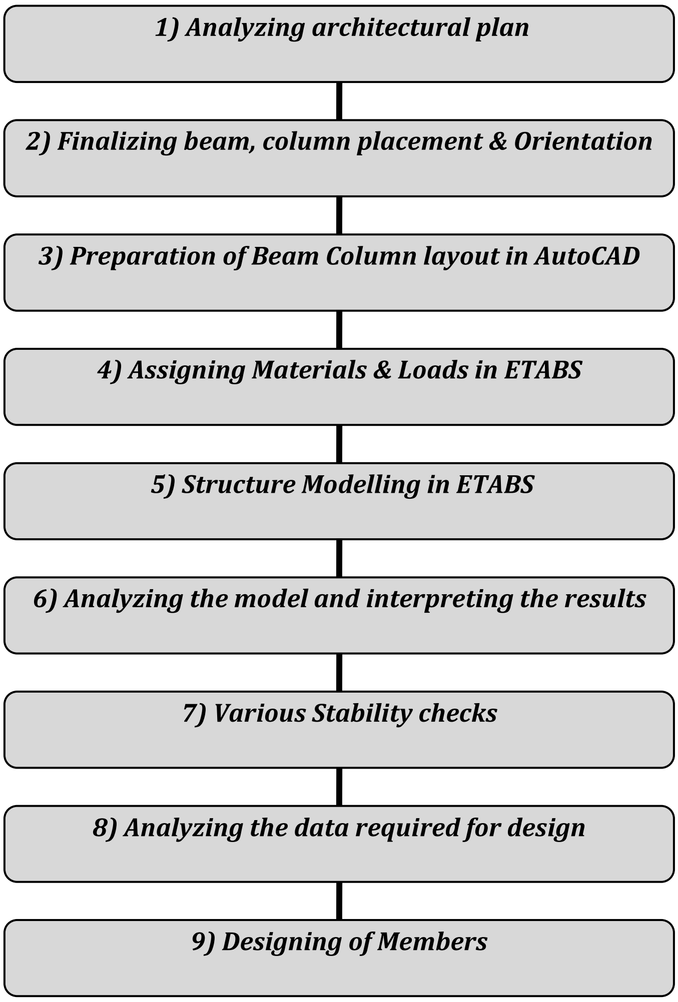
RCC buildings are widely used in construction because they are strong, durable and also economical compared to other systems. Due to increase in population and development of cities, multi-storey buildings are being constructed more frequently. For such buildings, it becomes important to ensure that they are safe under different types of loads.

Apart from normal dead load and live load, buildings are also subjected to lateral loads like earthquake and wind. These loads are not always visible but they can have a major effect on the structure, especially in taller buildings. If these are not considered properly during design, it may lead to excessive movement or even failure in some cases.

In India, different standard codes are used for analysis and design of RCC structures. IS 456:2000 is used for general design of concrete members, IS 1893:2016 is used for earthquake analysis, and IS 875 is used for calculating different loads including wind load.

These codes help in maintaining safety and uniformity in design. In this work, a G+11 RCC building is modelled and analysed using ETABS software by considering seismic and wind effects. Shear walls are provided to improve stability of the structure, and P-Delta analysis is also carried out to study additional effects due to deformation. The purpose of this study is to understand the behaviour of the building and to check whether it satisfies the basic safety requirements.

## 2. METHODOLOGY



### 2.1. Analyzing architectural plan:

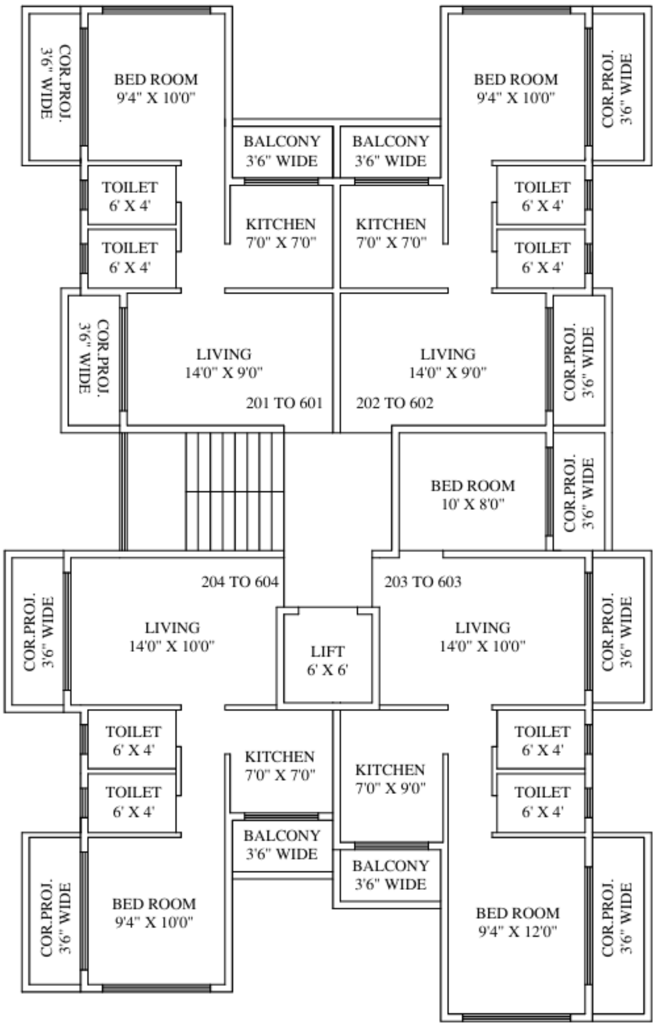



**Figure 1:** Floor plan.

**Basic Details:**

1) Type of structure: Residential building
2) Plan Dimensions: 13.5 m * 21.03m
3) No of Floors: G+11
4) Floor to floor height: 3.2m
5) Canopy: Yes
6) Accessible Roof: Yes
7) Shear Wall: Yes
8) Location: Mumbai
9) Soil Type: II
10) Seismic Zone: III
11) Ductile Designing Required: Yes
12) Cantilever Balcony: Yes
13) Total Height of the building: 44.8m

### 2.2. Finalizing beam, column placement & orientation:

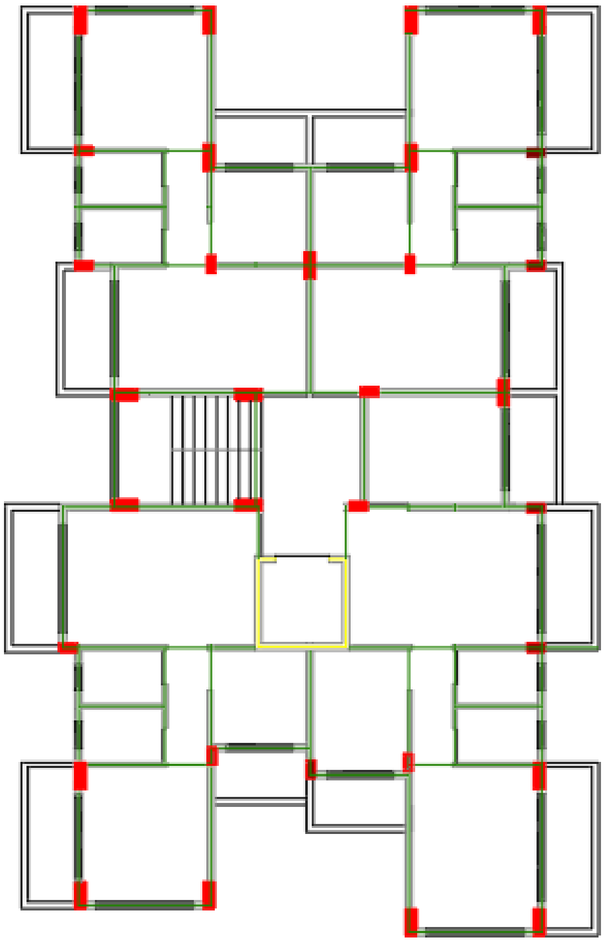


**Figure 2:** Beam, Column & Shear wall placement

*NOTE: Sizes of column shown in the line plan do not represent the actual size of column they placed just to represent the position of column & not the size.*

Beam, Column and Shear wall line layout is drafted using AutoCAD & after that, it is imported in E-tabs for designing

| **1) Column** | **600*600 (mm)** |
|---|---|
| **2) Column** | 350*600 (mm) |
| **3) Column** | 350*550 (mm) |
| **4) Beam** | 250*250 (mm) |
| **4) Beam** | 350*550 (mm) |
| **4) Shear Wall** | 200 mm (mm) |

**Table 1:** Member Dimensions

### 2.3 Preparation of Beam Column layout in AutoCAD:

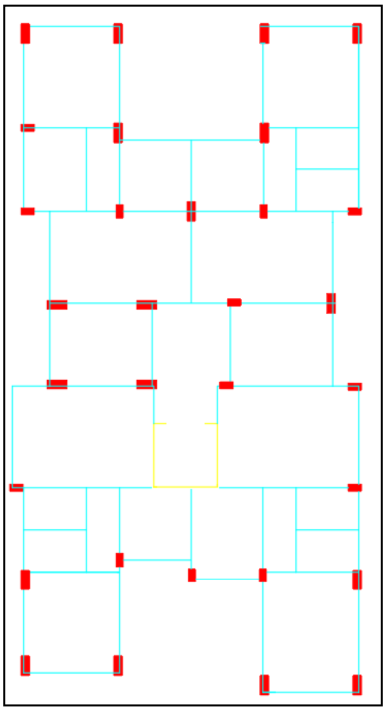


**Figure 3:** Final Beam, Column & Shear wall line plan

### 2.4. Assigning Materials & Loads in ETABS

### A) Material Property:

**Table 2:** Material Properties

| Member | Group (mm) | Material Property |
|---|---|---|
| Column | 600*600 | M30 |
| | 350*600 | M30 |
| | 350*550 | M30 |
| Beam | 250*250 | M30 |
| | 350*550 | M30 |
| Slab | 150 | M25 |
| Shear Wall | 200 | M25 |

After assigning the materials, a 3d model is prepared in ETAB, in which 1) Structural elements like Beam, Column, Slab, Shear wall, etc. is designed. 2) Load Combinations are assigned with reference to respective IS Codes.

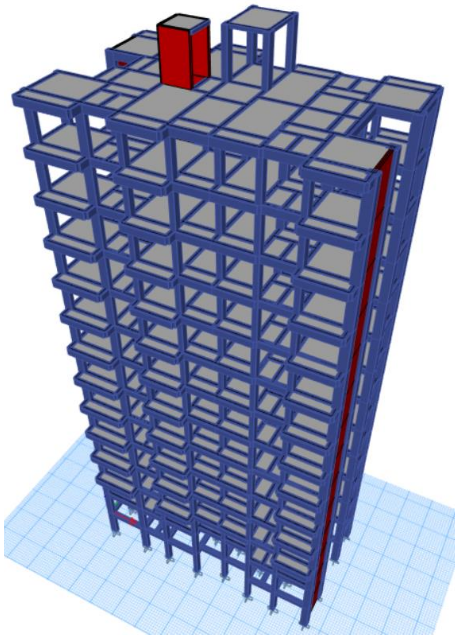


**Figure 4:** Front Extruded View

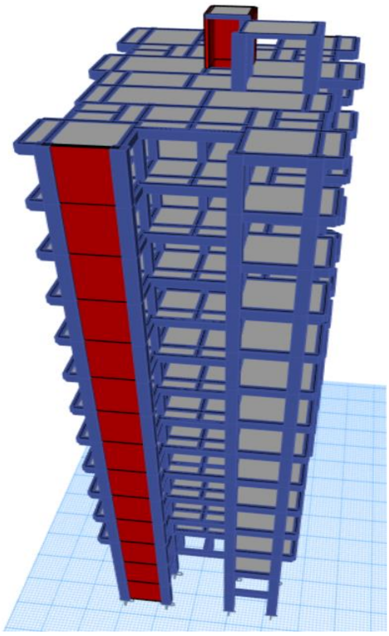


**Figure 5:** Side Extruded View

### B) Loads:

#### a) Gravity Loads:

**Table 3:** Gravity Load Values

| TYPE OF LOADS | VALUE | | | | REFERENCE |
|---|---|---|---|---|---|
| | Slab | Beam | Column | Shear wall | |
| **Dead load** | As per member dimensions | As per member dimensions | As per member dimensions | As per member dimensions | IS 456: 2000 & IS 875 Part 1: 2015 |
| **Floor Finish + Ceiling Plaster** | 2 kN/m$^2$ | N/A | N/A | N/A | IS 875 Part 1: 2015 |
| **Live load** | 2 kN/m$^2$ (All rooms & Kitchens) + (Toilet & Bathrooms)<br><br>3 kN/m$^2$ (Corridors, Passage & Balconies) | N/A | N/A | N/A | IS 875 Part 2: 2015 |
| **Roof live** | 1.5 kN/m$^2$ | N/A | N/A | N/A | IS 875 Part 2: 2015 |
| **Wall load** | N/A | 4.7 kN/m (Internal & External Wall)<br><br>1.5 kN/m (Parapet wall) | N/A | N/A | IS 875 Part 1: 2015 |

#### b) Earthquake Loads (Linear Static) (As per IS 1893:2016):

**Table 4:** Earthquake Loads Data

| TYPE | Response Reduction Factor (R)<br>*(Clause 7.2.6)* | Seismic zone (Z)<br>*(Clause 6.4.2)* | Soil Type | Importance Factor<br>*(Clause 7.2.3)* | Time Period<br>*(Clause 7.6.2-c)* |
|---|---|---|---|---|---|
| EQ- X | 5 (SMRF RC WALL) | 0.16 (Zone III) | II | 1 | 0.832 |
| EQ- Y | 5 (SMRF RC WALL) | 0.16 (Zone III) | II | 1 | 1.061 |

NOTE: As per clause 6.4.3, Equivalent static method may be used for regular structures with approximate Natural Time Period (Ta) less than 0.4s.

As time period for EQ-X (0.832) and EQ-Y (1.061) is greater than 0.4s, "RESPONSE SPECTRUM ANALYSIS" is performed.

### c) Response Spectrum Analysis (Linear Dynamic):

As Response Spectrum Analysis is performed, the first step is to run the analysis and match the base shear by scaling the for both RS-X & RX-Y.

**RS-X:**

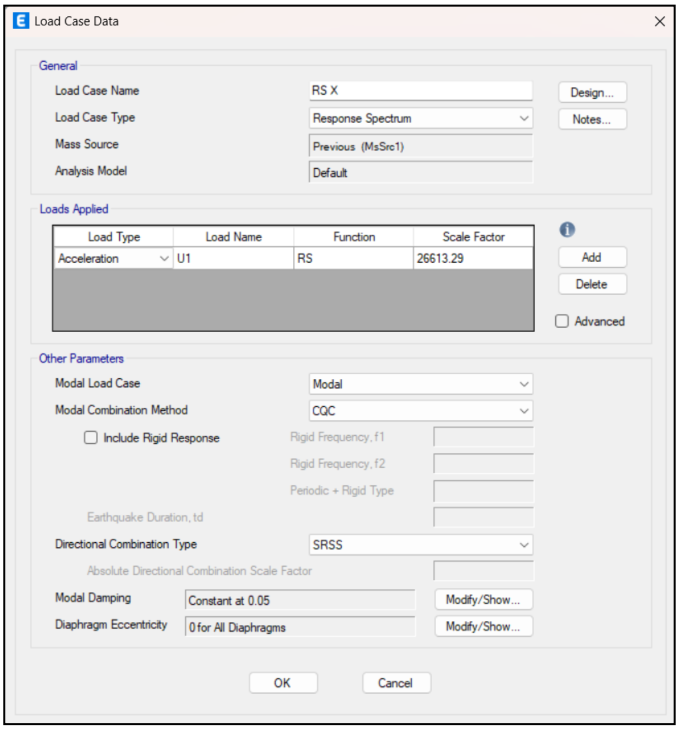



**Figure 6:** Load Case Data for RS-X

**Basic Data:**

**Table 5:** RS-X Data

| | |
|---|---|
| Direction | U1 (X direction) |
| Scale Factor | 26613.29 |
| Modal Load Case | Modal |
| Modal Combination Method | CQC Method |
| Directional Combination Type | SRSS Method |
| Damping Percentage | 5% |

**RS-Y:**

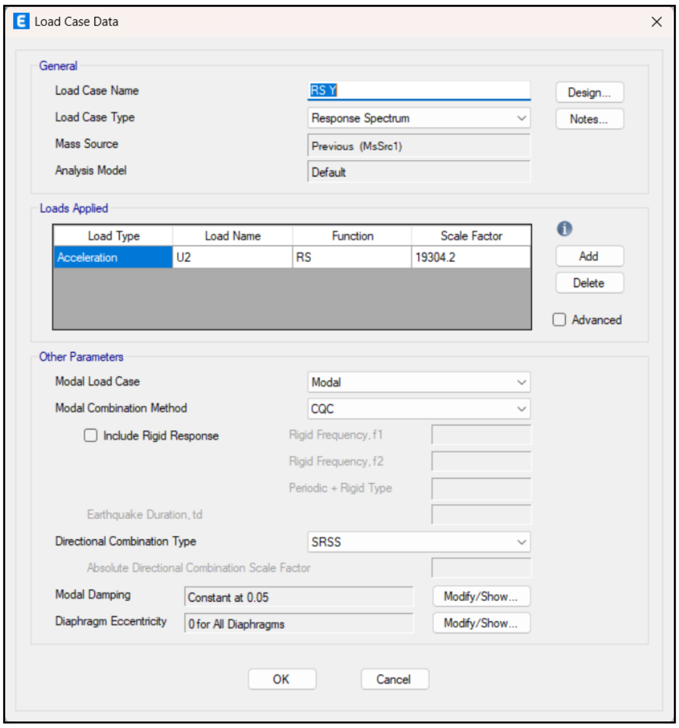



**Figure 7:** Load Case Data for RS-Y

**Basic Data:**

**Table 6:** RS-Y Data

| | |
|---|---|
| Direction | U2 (Y direction) |
| Scale Factor | 19304.21 |
| Modal Load Case | Modal |
| Modal Combination Method | CQC Method |
| Directional Combination Type | SRSS Method |
| Damping Percentage | 5% |

### d) Wind Load:

Wind Load is performed using IS 875 Part III: 2015.

**Basic Data:**

**Table 7:** Wind Loads Data

| | Value | Reference |
|---|---|---|
| **Location** | Mumbai | - |
| **Wind Speed** | 44 (m/s) | Clause 6.2 |
| **Terrain Category** | 4 | Clause 6.3.2 |
| **Importance Factor** | 1 | Clause 6.3.4 |
| **Risk Coefficient (k1)** | 1 | Clause 6.3.1 |
| **Topography (k3)** | 1 | Clause 6.3.3 |

### 2.5. Structure Modelling in ETABS:

#### a) Defining Mass Source:

Mass source represents the seismic mass of the structure considered for dynamic analysis. It is calculated from the seismic weight, which includes full dead load and an appropriate percentage of imposed load as specified in *IS 1893 (Part 1): 2016*. This mass is used to determine inertia forces during earthquake analysis.

*As per Clause 7.3.1: For various loading classes specified in IS 875 Part 2, design seismic force shall be estimated using full dead load plus percentage of imposed load.*

*As per Table 10 of IS 1893 P1: 2016:*

**Table 8:** Table 10 of IS 1893:2016 (P1)

| *Imposed Uniformity Distributed Floor Loads kN/m2* | *Percentage of Imposed Load* |
|---|---|
| *Up to and including 3.0* | *23* |
| *Above 3.0* | *50* |

*As per clause 7.3.2: For calculation of design seismic forces of buildings, imposed load on roof need not be considered.*

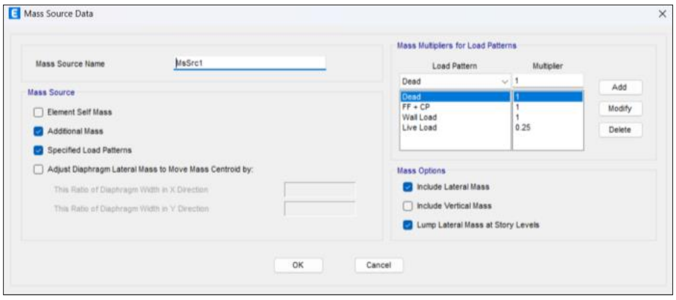



**Figure 8:** Mass Source data

#### b) Diaphragm Assignment:

Diaphragm is a horizontal structural element, such as a slab, that transfers lateral loads to vertical resisting elements (columns, shear walls). It acts as a rigid or semi-rigid plate, ensuring uniform distribution of seismic forces in accordance with *IS 1893 (Part 1): 2016*.

Before going for analysis is E-tabs it is mandatory to assign a proper diaphragm for each floor.
Diaphragm are of two types 1) Rigid 2) Semi Rigid.

In this designing process we have used "Rigid Diaphragm".

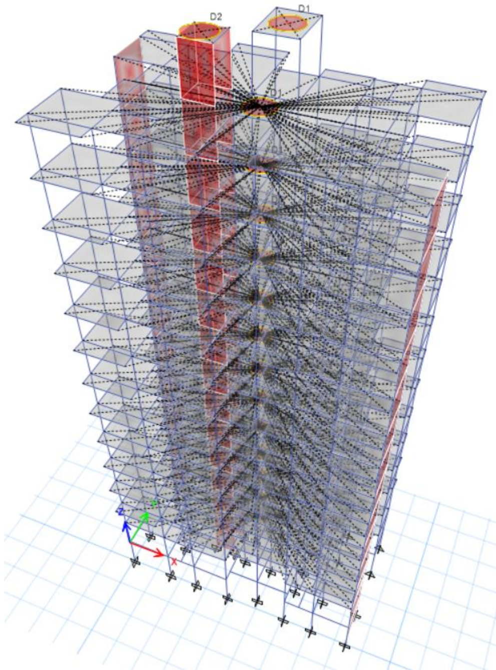



**Figure 9:** Diaphragm (Full Building)

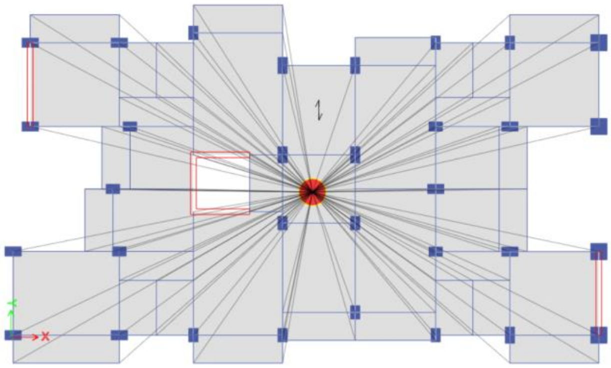


**Figure 10:** Diaphragm (Floor Plan Ground to Roof)

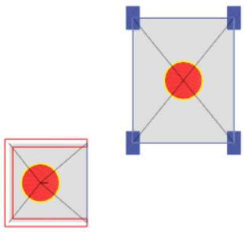


**Figure 11:** Diaphragm (Floor plan Canopy Level)

### c) P-Delta Effect Δ:

P–Delta effect is a second-order effect in which additional moments are generated in a structure due to axial loads acting on laterally displaced members. This effect becomes significant in tall and slender structures and is considered in analysis.

P-Delta analysis is mandatory when it comes to high rise or irregular structures and even for the structures which are located in high seismic zones.

Consideration of P-Delta in analysis gives more accurate results which is very important for safe structural designing.

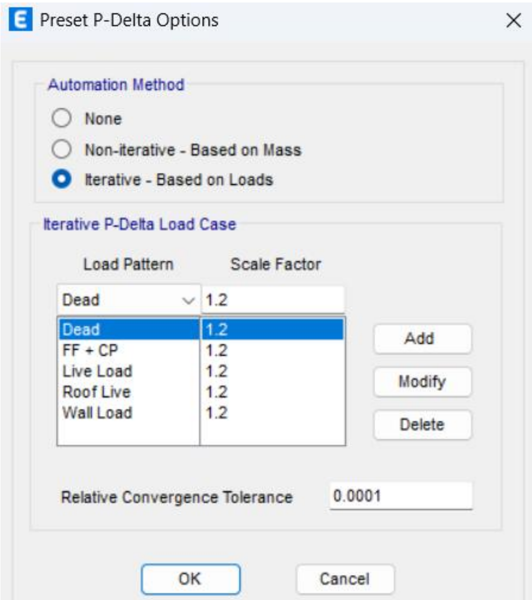



**Figure 12:** P-Delta Load Cases

| Load Pattern | Scale Factor |
|---|---|
| Dead | 1.2 |
| Floor Finish + Ceiling Plaster | 1.2 |
| Live Load | 1.2 |
| Roof Live | 1.2 |
| Wall Load | 1.2 |

**Table 9:** P-Delta Loads & Scale Factor

*NOTE: Scale Factor for P-Delta is not explicitly mentioned anywhere in IS Codes, while designing engineers use the scale factor as per the designing needs and their own experience.*

Now, after modelling the structure it is very important to check whether all the members all passing the "Modal Check".

### d) Modal Check:

Model check is the process of verifying the correctness, completeness, and stability of the analytical model before performing structural analysis. It ensures that geometry, material properties, connectivity, boundary conditions, and load assignments are properly defined to obtain reliable results.

In simple terms: "*Model check ensures that the analytical model is error-free and suitable for accurate structural analysis*"

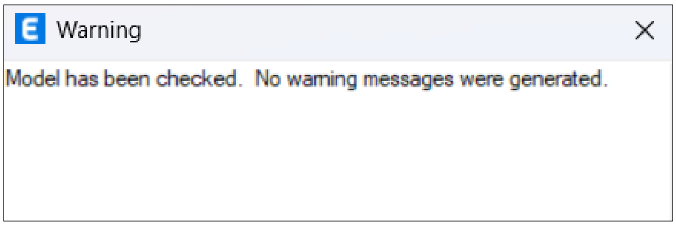



**Figure 13:** Modal Check Passed

*Model has been checked. No warning message were generated.* Hence the model is error free and is passed and we can proceed for the analysis step.

## 2.6. Analyzing the model and interpreting the results:

After analysis is performed in Etabs various data is obtained and checked some of them are as follows:

### a) Deflection:

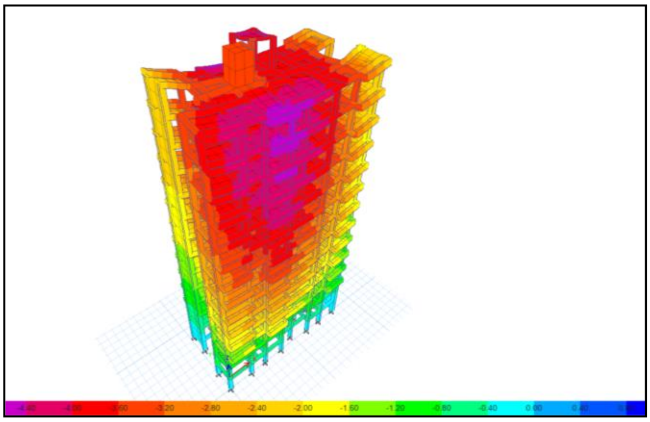


**Figure 14:** Deflection in UZ direction

The above deflection reflects deflection in UZ direction along with the maximum deflection occurring in the structure i.e., -4.40mm. The deflection is checked using the unfactored loads. As per *IS 456:2000.*

### b) Maximum Storey Displacement:

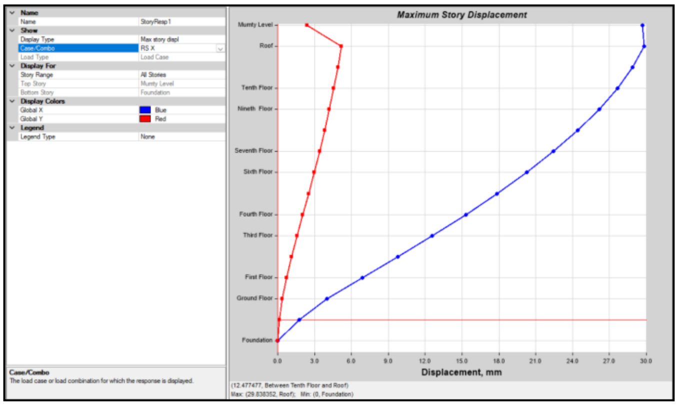



**Figure 15:** Maximum Storey Displacement (RS-X)

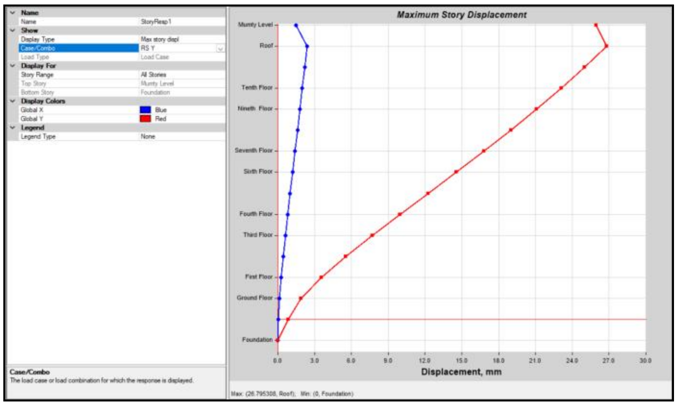



**Figure 16:** Maximum Storey Displacement (RS-Y)

The displacement of the structure increases gradually from base to top storey in both X and Y directions. Maximum displacement is observed at the roof level. The overall trend shows smooth variation along the height of the building. No sudden irregularity is observed in the displacement profile.

### c) Maximum Storey Drift:

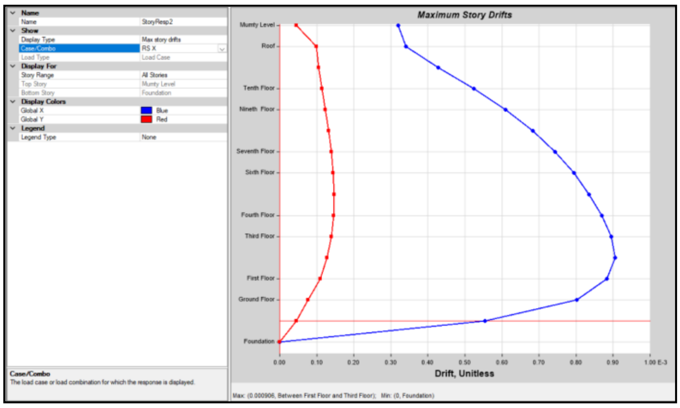



**Figure 17:** Maximum Storey Drifts (RS-X)

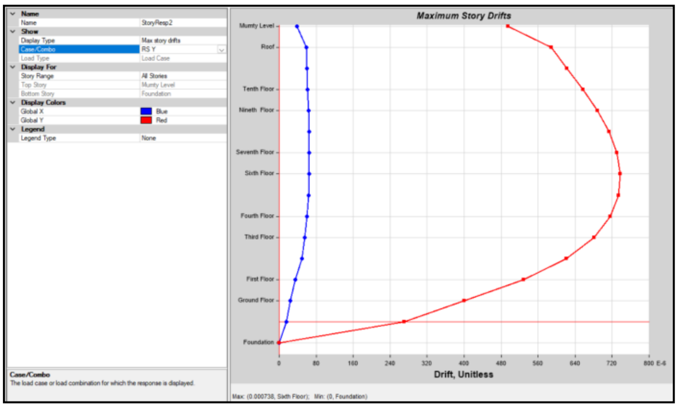



**Figure 18:** Maximum Storey Drifts (RS-Y)

The storey drift increases along the height of the structure in both X and Y directions, with maximum drift observed at upper storey. The variation of drift is smooth without any sudden irregularity. The drift profile indicates stable structural behavior under lateral loading.

### d) Storey Shear:

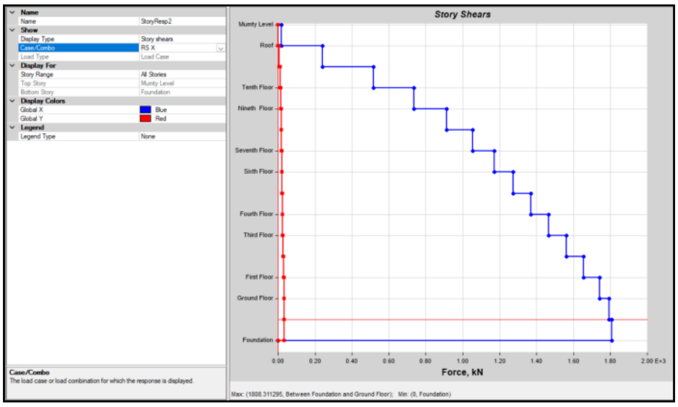



**Figure 19:** Storey Shear (RS-X)

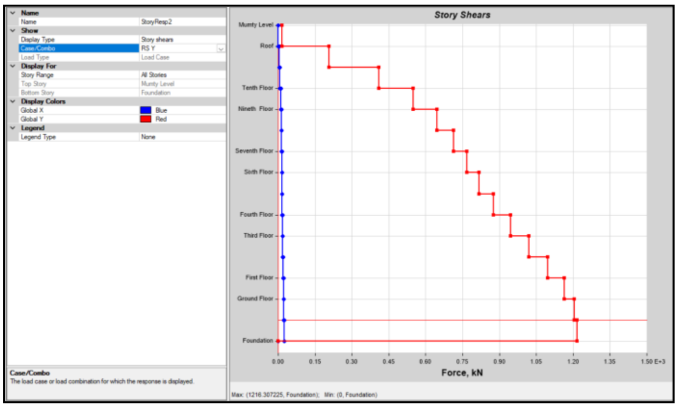



**Figure 20:** Storey Shear (RS-Y)

## e) Average Drift Ratios:

| Story | Output Case | Case Type | Item | Max Drift | Avg Drift | Ratio |
|---|---|---|---|---|---|---|
| Mumty Level | RS X | LinRespSpec | Diaph D1 X | 0.000175 | 0.000169 | 1.035 |
| Mumty Level | RS X | LinRespSpec | Diaph D2 X | 0.000319 | 0.000319 | 1.001 |
| Roof | RS X | LinRespSpec | Diaph D1 X | 0.000341 | 0.000322 | 1.057 |
| Eleventh Floor | RS X | LinRespSpec | Diaph D1 X | 0.000429 | 0.000408 | 1.049 |
| Tenth Floor | RS X | LinRespSpec | Diaph D1 X | 0.000524 | 0.000501 | 1.045 |
| Nineth Floor | RS X | LinRespSpec | Diaph D1 X | 0.00061 | 0.000585 | 1.043 |
| Eighth Floor | RS X | LinRespSpec | Diaph D1 X | 0.000683 | 0.000656 | 1.042 |
| Seventh Floor | RS X | LinRespSpec | Diaph D1 X | 0.000744 | 0.000714 | 1.041 |
| Sixth Floor | RS X | LinRespSpec | Diaph D1 X | 0.000794 | 0.000763 | 1.04 |
| Fifth Floor | RS X | LinRespSpec | Diaph D1 X | 0.000835 | 0.000804 | 1.04 |
| Fourth Floor | RS X | LinRespSpec | Diaph D1 X | 0.00087 | 0.000838 | 1.038 |
| Third Floor | RS X | LinRespSpec | Diaph D1 X | 0.000895 | 0.000863 | 1.036 |
| Second Floor | RS X | LinRespSpec | Diaph D1 X | 0.000906 | 0.000876 | 1.033 |
| First Floor | RS X | LinRespSpec | Diaph D1 X | 0.000883 | 0.000861 | 1.026 |
| Ground Floor | RS X | LinRespSpec | Diaph D1 X | 0.000802 | 0.000732 | 1.096 |

**Figure 21:** Average Drift Ratio (RS-X)

| Story | Output Case | Case Type | Item | Max Drift | Avg Drift | Ratio |
|---|---|---|---|---|---|---|
| Mumty Level | RS Y | LinRespSpec | Diaph D1 Y | 0.000431 | 0.00043 | 1.002 |
| Mumty Level | RS Y | LinRespSpec | Diaph D2 Y | 0.000495 | 0.000492 | 1.008 |
| Roof | RS Y | LinRespSpec | Diaph D1 Y | 0.000589 | 0.000526 | 1.119 |
| Eleventh Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000622 | 0.000559 | 1.113 |
| Tenth Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000657 | 0.000593 | 1.108 |
| Nineth Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000688 | 0.000624 | 1.104 |
| Eighth Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000714 | 0.000648 | 1.102 |
| Seventh Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000731 | 0.000665 | 1.1 |
| Sixth Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000738 | 0.000673 | 1.097 |
| Fifth Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000734 | 0.000671 | 1.093 |
| Fourth Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000716 | 0.000659 | 1.088 |
| Third Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000681 | 0.00063 | 1.08 |
| Second Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000622 | 0.00058 | 1.072 |
| First Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.000528 | 0.000498 | 1.06 |
| Ground Floor | RS Y | LinRespSpec | Diaph D1 Y | 0.0004 | 0.000359 | 1.114 |

**Figure 22:** Average Drift Ratio (RS-Y)

## e) Modal Mass Participation Ratio:

| Case | Mode | Period sec | UX | UY | SumUX | SumUY | RZ | SumRZ |
|---|---|---|---|---|---|---|---|---|
| Modal | 1 | 1.592 | 0.0002 | 0.7338 | 0.0002 | 0.7338 | 0.0061 | 0.0061 |
| Modal | 2 | 1.463 | 0.7915 | 0.0007 | 0.7916 | 0.7345 | 0.0186 | 0.0247 |
| Modal | 3 | 1.385 | 0.0208 | 0.0064 | 0.8124 | 0.741 | 0.7152 | 0.7399 |
| Modal | 4 | 0.459 | 0.1083 | 0.0001 | 0.9207 | 0.741 | 0.0002 | 0.7401 |
| Modal | 5 | 0.422 | 0.0001 | 0.1515 | 0.9208 | 0.8925 | 0 | 0.7401 |
| Modal | 6 | 0.361 | 0.0002 | 0.0001 | 0.921 | 0.8926 | 0.1493 | 0.8894 |
| Modal | 7 | 0.249 | 0.0331 | 1.848E-05 | 0.9541 | 0.8926 | 2.865E-05 | 0.8895 |
| Modal | 8 | 0.195 | 1.887E-05 | 0.0495 | 0.9541 | 0.9421 | 0.0002 | 0.8896 |
| Modal | 9 | 0.165 | 0.0157 | 1.689E-05 | 0.9698 | 0.9421 | 4.366E-05 | 0.8897 |
| Modal | 10 | 0.162 | 0 | 0.0003 | 0.9698 | 0.9424 | 0.0523 | 0.9419 |
| Modal | 11 | 0.12 | 0.0081 | 0.0001 | 0.9779 | 0.9425 | 2.586E-05 | 0.942 |
| Modal | 12 | 0.117 | 2.187E-05 | 0.0241 | 0.9779 | 0.9666 | 0.0001 | 0.9421 |

**Figure 23:** Modal Mass Participation Ratio

### 2.7. Various Stability Checks:

| Category | Parameter | Value | Permissible Limit | Clause Reference | Status |
|---|---|---|---|---|---|
| **Seismic** | Max Storey Drift | 0.000906 | ≤ 0.004 | IS 1893:2016 Part 1 (*Clause 7.11.1.1*) | Safe |
| **Stability** | Torsional Irregularity | 1.119 (RS Y) | ≤ 1.2 | IS 1893:2016 Part 1 (*Table 5*) | Safe |
| **Serviceability** | Lateral Sway (Wind) | 11.34 mm | ≤ H/500 i.e., 89.6mm | IS 456:2000 (*Clause 20.5*) | Safe |
| **Serviceability** | Vertical Deflection | -4.40 mm | ≤ (Span/350 or 20 mm) | IS 456:2000 (*Clause 23.2-b*) | Safe |
| **Modal** | Modal Mass UX | 97.79% | ≥ 90% | IS 1893:2016 Part 1 (*Clause 7.7.5.2*) | Safe |
| **Modal** | Modal Mass UY | 96.66% | ≥ 90% | IS 1893:2016 Part 1 (*Clause 7.7.5.2*) | Safe |
| **Modal** | Modal Mass UZ | 94.21% | ≥ 90% | IS 1893:2016 Part 1 (*Clause 7.7.5.2*) | Safe |
| **Dynamic** | Model 1 Translation Y | 73.38% | ≥ 65% | IS 1893:2016 Part 1 (*Table 6)* | Safe |
| **Dynamic** | Model 2 Translation X | 79.15% | ≥ 65% | IS 1893:2016 Part 1 (*Table 6)* | Safe |
| **Dynamic** | Model 1 Translation (Pure Torsion) | 71.52% | ≥ 65% | IS 1893:2016 Part 1 (*Table 6)* | Safe |

**Table 10:** Final Check

The structural performance of the G+12 RCC building was evaluated through a series of stability and serviceability checks in accordance with relevant Indian Standard codes. The maximum storey drift obtained from response spectrum analysis in both X and Y directions was found to be within the permissible limit of 0.004 times the storey height as specified in IS 1893:2016, indicating adequate lateral stiffness of the structure.

The torsional irregularity ratio, defined as the ratio of maximum to average storey drift, was observed to be within the acceptable limit of 1.2, confirming that the structure does not exhibit significant torsional irregularity. This indicates a reasonably symmetric distribution of mass and stiffness along the plan.

The maximum lateral displacement of the structure under wind loading was found to be within the permissible limit of H/500 as per IS 456:2000, ensuring satisfactory serviceability performance under wind effects.

Further, modal analysis results showed that the cumulative modal mass participation exceeded 90% in both principal directions, satisfying the requirements of IS 1893:2016. The fundamental modes predominantly exhibited translational behaviour in the respective directions, indicating proper dynamic characteristics of the structure.

Overall, all stability and serviceability criteria were satisfied, confirming that the structure is safe, stable, and performs adequately under both seismic and wind loading condition

### 2.8. Analyzing the data required for design:

After conducting the stability and other important checks, the next step is to analyze the data required for the design of members.

The three important data points that we will need are:
a) Bending Moment Diagram.
b) Shear Force Diagram.
c) Axial force Diagram.

### a) Bending Moment Diagram:

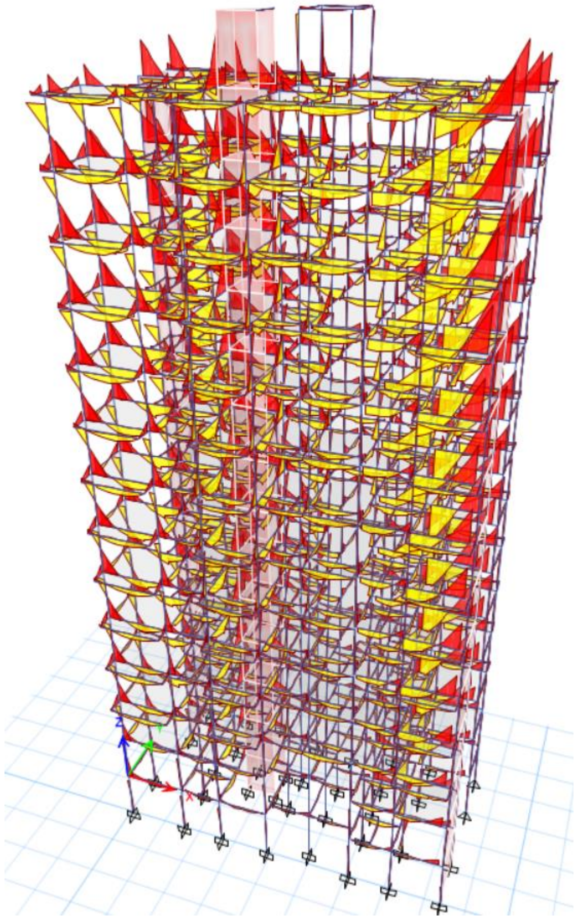


**Figure 24:** Bending Moment Diagram

### b) Shear Force Diagram

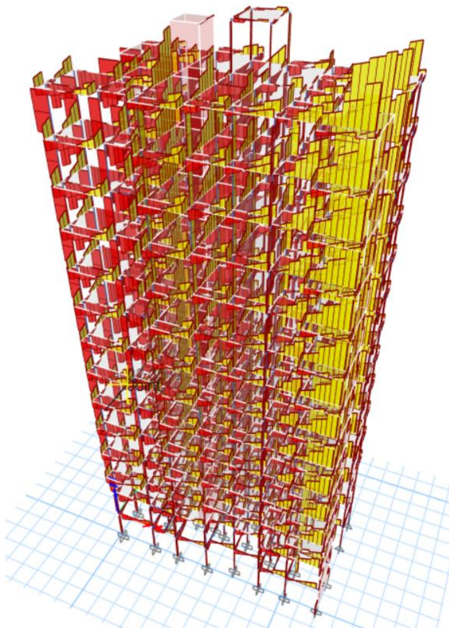


**Figure 25:** Shear Force Diagram

### c) Axial Force Diagram

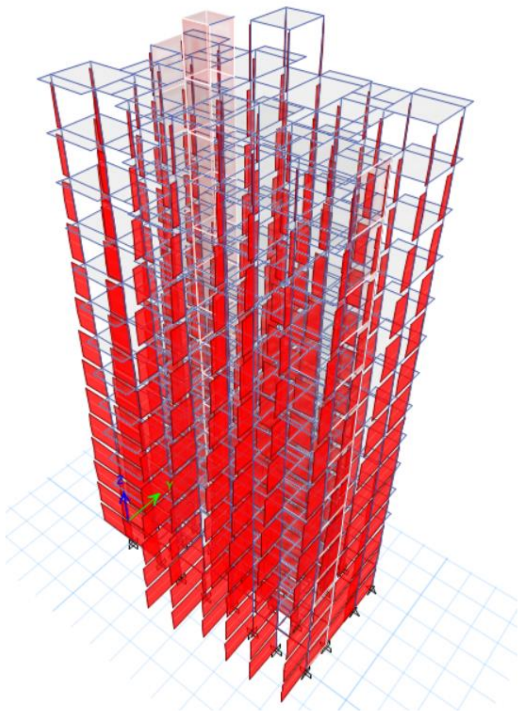


**Figure 26:** Axial Force Diagram

### 2.9. Designing of Members:

#### a) Load Combinations used:

| A) | Gravity Load Combination (IS 456: 2000) |
|---|---|
| 1 | 1.5 (DL + LL) |
| 2 | 1.2 (DL + LL) |
| 3 | 1.5 (DL) |
| **B)** | **Seismic Load Combinations (IS 1893:2016 – Response Spectrum)** |
| 1 | 1.2 (DL + LL + EQx) |
| 2 | 1.2 (DL + LL – EQx) |
| 3 | 1.2 (DL + LL + EQy) |
| 4 | 1.2 (DL + LL – EQy) |
| 5 | 1.5 (DL + EQx) |
| 6 | 1.5 (DL – EQx) |
| 7 | 1.5 (DL + EQy) |
| 8 | 1.5 (DL – EQy) |
| 9 | 0.9 DL + 1.5 EQx |
| 10 | 0.9 DL – 1.5 EQx |
| 11 | 0.9 DL + 1.5 EQy |
| 12 | 0.9 DL – 1.5 EQy |
| **C)** | **Wind Load Combinations (IS 875 Part 3)** |
| 1 | 1.2 (DL + LL + WLx) |
| 2 | 1.2 (DL + LL – WLx) |
| 3 | 1.2 (DL + LL + WLy) |
| 4 | 1.2 (DL + LL – WLy) |
| 5 | 1.5 (DL + WLx) |
| 6 | 1.5 (DL – WLx) |
| 7 | 1.5 (DL + WLy) |
| 8 | 1.5 (DL – WLy) |
| 9 | 0.9 DL + 1.5 WLx |
| 10 | 0.9 DL – 1.5 WLx |
| 11 | 0.9 DL + 1.5 WLy |
| 12 | 0.9 DL – 1.5 WLy |

**Table 11:** Load Combinations

***IMPORTANT NOTE****: ETABS software is mainly used for analysis purpose. It should be understood that ETABS is not a dedicated design software, and its main role is to generate analysis results like forces, displacements and stability parameters which are required for design. However, ETABS also provides basic design and checking options, which we have used in this project to check member behaviour, identify critical members and get approximate reinforcement requirement. These results are used only for checking and validation purpose. Also, detailing of structural members is done in ETABS itself and no separate detailing software is used. But still, ETABS is mainly considered as an analysis tool in this project.*

*But for more accurate detailing as per codal provisions, one can use, CSI SAFE for Foundation & Flat Slabs analysis and RCDC for Structural designing and detailing.*

#### b) Designing:

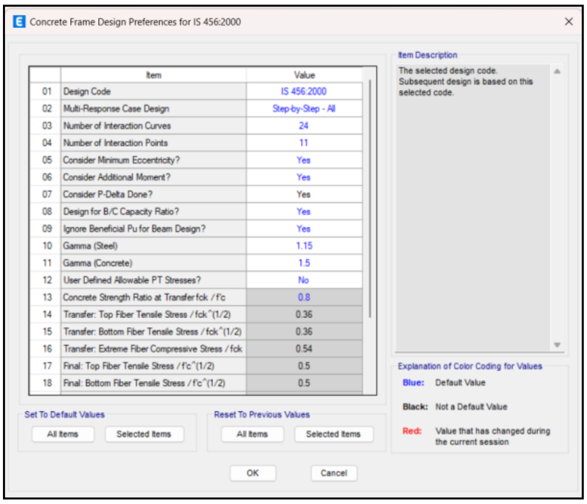



**Figure 27:** Design Preferences

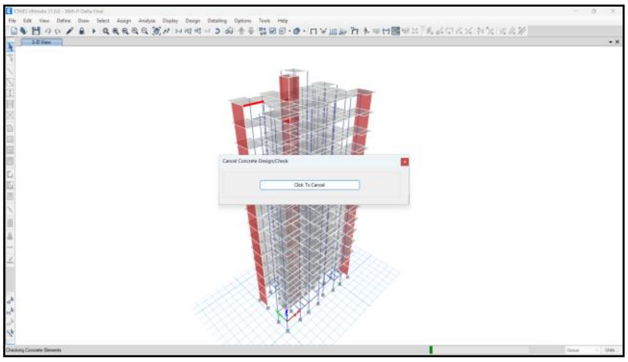


**Figure 28:** Designing Check

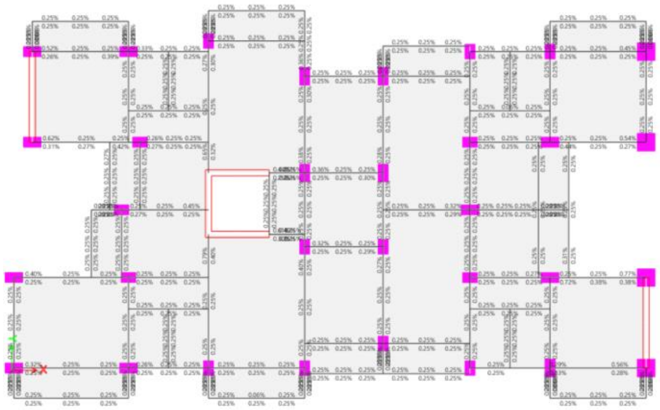


**Figure 29:** Total Rebar Percentage (Beam)

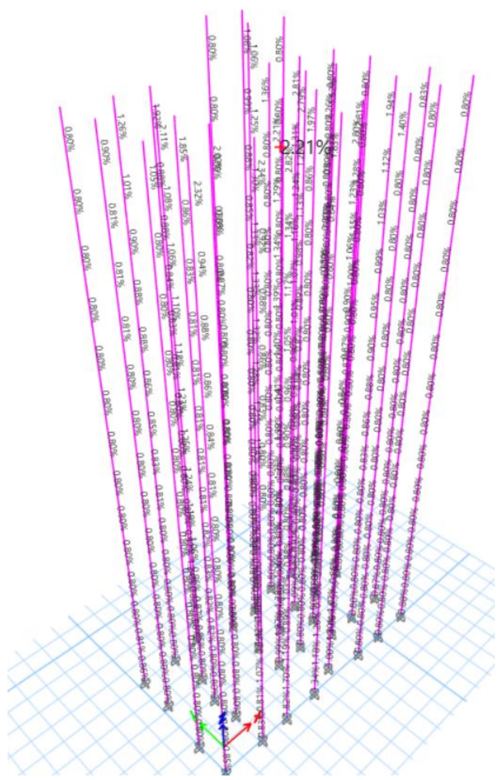


**Figure 30:** Total Rebar Percentage (Column)

Figures 29 and 30 show the reinforcement percentage taken from ETABS for beams and columns. The software gives required steel percentage based on analysis results, and this is mainly used for checking purpose. Further reinforcement detailing is done manually using these values. Also, minimum reinforcement as per IS 456:2000 is checked separately to make sure the design is safe.

**Figure 31:** Design Check

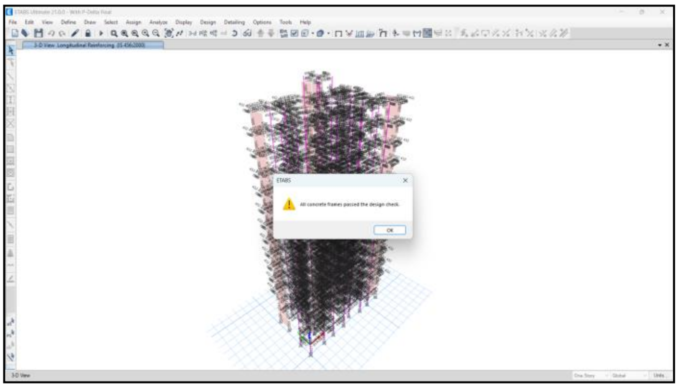


Figure 31 shows the design check carried out in ETABS. The model was checked for all structural members to verify safety under applied loads. The software indicates whether the members are safe or not based on design criteria as per IS codes. Any warnings or design issues were reviewed and necessary corrections were made in the model.

## 2. CONCLUSION:

The G+11 RCC building is analysed and designed using ETABS. The structure is checked for gravity, wind and seismic loads using response spectrum method as per IS codes. All members are designed and checked for safety.

From results it is seen that displacement and storey drift is within limit, so structure is safe. Reinforcement given in beams and columns is ok as per design. Overall structure is safe and stable for given loading

***HENCE THE STRUCUTRE IS SAFE.***

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