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ANALYSIS AND DESIGN OF G+18 COMMERICAL BUILDING

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Abstract

This project mainly intended to present a high raised residential building's analysis & design by taking in to consideration the effects of lateral loads and earthquake effect in line with IS-1893 & IS- 4326 for ductile detailing. The analysis is performed by considering the building to be in earthquake zone IV. The whole ETABS software is enhanced 3D structural analysis software. This is used to analyze and design the both conventional and complicated structural elements. Linear static analysis will be more appropriate if the structural system is of lower height with a regular shape, size. But for any high raised structural system which is irregular shaped a dynamic analysis method is used which will take into consideration the torsion effect. In equivalent-static way of analysis method any structure will be treated with a multi-degree of freedom system.

Index Terms: Shear Wall, Storey Drift, Displacement, Time period, Base Shear, Materials, Response Spectrum Method.

I. INTRODUCTION

A Commercial Complex Building has been chosen for the task as an ordinary moment resist RCC frame. This Building Complex is designed with two basements, first one is completely below the Normal Ground Level i.e. Land Level, followed by a second basement level with additional parking which is partially placed above ground or the Natural Land Level with a perched atop of it. Floors are a total of (2B+G+18) levels. The Terrace Floor is sited above the all floors, like other any ordinary building to cover the top floor. We are assuming this erection to be placed in Zone IV in accordance with the IS:1893-2002. The optimum use of the basements of the building is to provide the large parking area for the two and four wheelers. With the objective of the Shear Walls is to enhance the rigidity of the structure by enclosing it. Shear Walls are used to surround the elevator area and the staircase, this assists the building structure to deal with the earthquake effects that could develop in Zone IV. The ETABS 2016 (developed by CSI America) software has been used for carrying out the Building Analysis and Design. The manual design is carried out by following the software-based building analysis and design. The four structural members which are selected at random is tested, after which we did comparison to check the outcomes to match the selected codes. Increasing population of the country is a big challenge to provide the better accommodation and society with basic needs with the limited accessibility of the land. Due to the limited land there is a need of Architects and Engineers to plan and design the High Rise Buildings. Buildings may be a residential or commercial which are very common in urban areas rather than rural areas. Planning a high rise structure is coming out to be a big challenge especially in fast developing metropolis where we have to plan the structures very closely due to less land. Where the buildings are placed so close then we keep in mind that we need to counter the naturally occurring loads like wind and earthquake or the man-made activities etc. The earthquake shaking causes vibration of the building’s mass by which an inertia force is expected to be produced. Due to inertial force the building may be damage if a supreme care is not taken while doing the Structural Designing. Tall Buildings or High Rise Buildings is more likely to get damaged due to 12 seismic conditions if the structure’s total mass will be relatively more that will be supported with generally long columns. The seismic parameter like storey drift or lateral displacements are relatively higher as we go vertically upwards along the stories. If the enough space between the two adjacent structures or buildings is not sufficient then it can also lead to casualty based on the earthquake intensity according to zone. A earthquake is a natural occurring phenomenon which can create or develop the most destructive impact on the structure. This can be managed by appropriate structural design & detailing of each and every structural component by a ductile design form of failure, through this the structural building could sustain against any seismic impact. The main objective of an earthquake resistant design is to carried out the construction of the structural buildings which could act in a better way during seismic condition. In this project a RCC Commercial Building is considered for the Seismic Analysis and Design. The desired building is a (2B+G+18) RCC Structure. This building is analyzed for seismic effects in Zone IV with IS:1893-2002. Vertical Loads like Dead Load (DL) & Imposed Load (IL), Lateral Loads from wind & seismic are also considered for the analysis of the desired building. The Analysis of a desired building will be done with the help of a Analysis Software i.e. ETABS. Whereas ETABS is one of the popularly known software for the Building Analysis & Design of any type of structure especially high rise buildings by considering the seismic forces, re-evaluating and speedily revising the performance of multi storied structure by various available analysis methods which are provided by IS Codes.

II. ANALYTICAL STUDY

GEOMETRICAL PROPERTIES:

- Total building height = 53.94m
- X direction distance = 100.50m
- Y direction distance = 21.075m
- Concrete grade = M30, M35, M40, M45.
- Rebar grade = 500 HYSD
- Steel grade = Fe 250, 345.
- Column size -

C1 = 750mmx1500mm
C2 = 950mmx1200mm
C3 = 1000mmx1600mm
C4 = 1350mmx800mm
C5 = 750mmx1200mm
C6 = 1350mmx1500mm

- Beam size-

B1 = 1000mmx300mm
B2 = 750mmx300mm

- Slab thickness = 150mm

LOADS-

Dead load:

All specifications are given as I.S 875 (part 1):1987.

- Unit weight of RCC = 25KN/m
- Unit weight of plaster = 20KN/m
- Unit weight of brick masonry work = 19.2 KN/M
- Unit weight of soil = 17 KN/m
- 150 thickness of RCC slab and 400mm floor finishing.

Live load:

All specifications are given as I.S 875 (part 2):1987.

- All Shop =3.0
- Toilet and bath =2.0
- Balconies = 3.0
- Corridors, passages =3.0
- Stair-case including time escapes and storeroom = 3.0

Wind load:

All the parameters given as I.S 875(part-3):1987.

- Wind speed = 47m/s
- Terrain category = 3
- Risk coefficient (k1) = 1
- Topography (K3) = 1

Seismic loading:

All the parameters given as I.S 1893(part-3):1987.

- Seismic zone = IV
- Seismic zone factor = 0.24
- Soil types = medium soft soil
- Story range = base to 18
- Importance factor (I) = 1
- Time period x direction = 0.4635
- Time period y direction = 1.015

Special specification:

- Torsional constant = 10%
- Moment if inertia for column = 0.7
- Moment of inertia for beam = 0.35
- Moment of inertia for shear wall = 0.7
- Moment of inertia for slab = 0.25

III. METHODOLOGY

Step 1. Setup the standard country codes.

We selected the new model template open and mention country codes and display units.

Step 2. Create grid line according to plan:

The create grid dimension and story dimension define the master story according to plan.

Step 3. Define Materials property:

We define the material property and go to the define menu, Material properties template. We add a new material defined as concrete, rebar, and steel.

Step 4. Define Section Property:

Go to define menu and go section property template. Apply beam, column, slab, and shear wall size according to the building plan.

Step 5. Create structure elements:

After defining section properties next step is to start the modeling process. Place beam, column, slab, and shear wall.

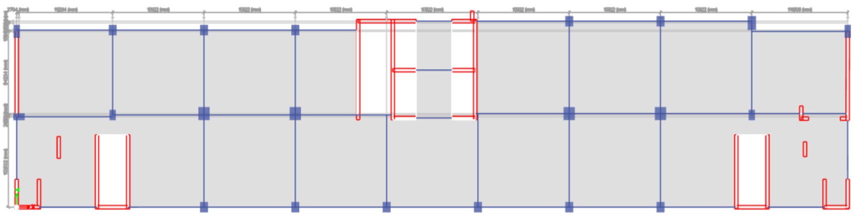


Figure: 1. Plan

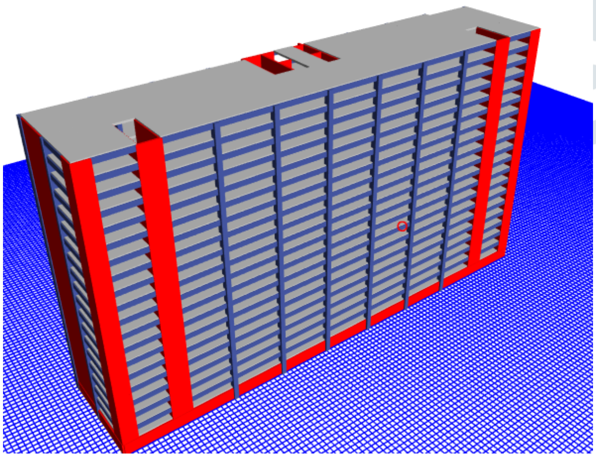


Figure: 2. 3D Modelling

Step 6. Assign supports:

Go to the assign menu and apply joint/ frame /fixed reaction. Select the base area and apply fixed supports.

Step 7. Assign dead load:

Gravity load is frame loads available in the structure. Calculate dead load value and assign outer walls and internal walls. We have gone to assign menu, frame loads, distributed and absolute distance, apply load then OK.

Step 8. Assign live load:

As per I.S code for given the all specification value, apply live load. Go to shell load, uniform, apply then OK.

Step 9. Assign earthquake load:

It defines I.S 1893:2016. All parameters are given like time period, seismic zone factor, soil profile, etc. properties.

Step 10. Assign wind load:

Using I.S 875(part3): 1987, this code is given wind speed, risk coefficient, terrain roughness, topography factor, importance factor, etc. properties.

Step 11. Create load combination:

The Combination is defined as it applies to the result for every object in the structure. Go to define menu, load cases template, and add n new combination.

Step 12. Define p-delta, mass source, and response spectrum method:

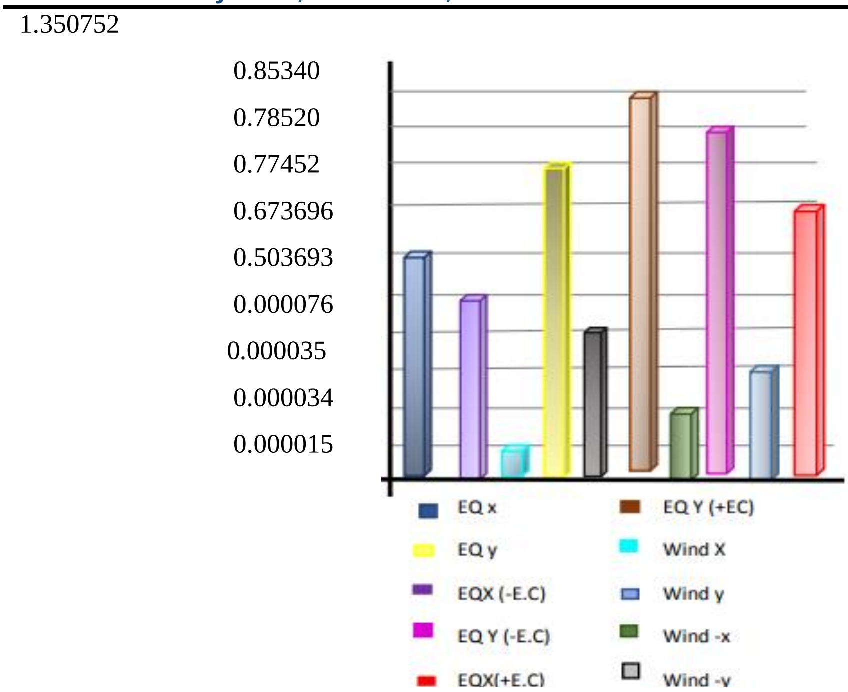
Apply response spectrum method and define p-delta value sand, mass sources value.

Step 13. Analysis of the model:

After the completion of all the modeling steps. We have performed the analysis process and checked errors. Go to the analysis menu and the first step is to apply the check model. The next step is the active degree of freedom, set load case run, auto mesh setting for floor and wall, and then run analysis. These are analysis steps are completed and read the last analysis. In this list check the stability of the model, linear static case using for p-delta readings, RITZ model analysis, response spectrum x, y, and z-direction. Several joints with restraints and mass sources.

IV. RESULT AND DISCUSSION

DISPLACEMENT OF STRUCTURE(MM)							
Cond ition	MODE 1	MODE - 2	MODE - 3	MODE -4	MODE -5	MODE -6	MODE -7
E Q (X)	0.61 9555	0.57 6917	0.57 6396	0.35 4436	0.33 8359	0.32 3872	1.27 6244
E Q (Y)	0.46 7683	1.07 1975	0.89 0181	0.49 1641	0.46 5721	0.44 2602	1.99 5065
E.Q X(+E C)	0.70 3141	0.87 3275	0.74 9098	0.47 4506	0.45 3696	0.43 4869	1.49 697
E.Q X(- EC)	0.44 5971	0.50 4101	0.40 3693	1.252 4367	0.22 3022	0.21 2874	1.55 0734
E.Q Y(+E C)	1.21 3968	1.33 7798	1.20 798	0.64 3559	0.61 1245	0.58 2293	2.33 9465
E.Q Y(- EC)	1.00 8931	1.11 1316	0.93 1937	0.54 3331	0.51 6175	0.49 1906	2.26 7242
Win d X	0.00 0006	0.00 0007	0.00 0006	0.00 0004	0.00 0003	0.00 0003	0.00 0022
Win d Y	0.00 0038	0.00 0043	0.00 0035	0.00 00119	0.00 0018	0.00 0017	0.00 0088
Win d -X	0.00 0027	0.00 003	0.00 0025	0.00 0014	0.00 0014	0.00 0013	0.0001
Win d -Y	0.00 038	0.00 0043	0.00 003	0.00 0019	0.00 0018	0.00 0017	0.00 0099



Graph 1Displacement in mm

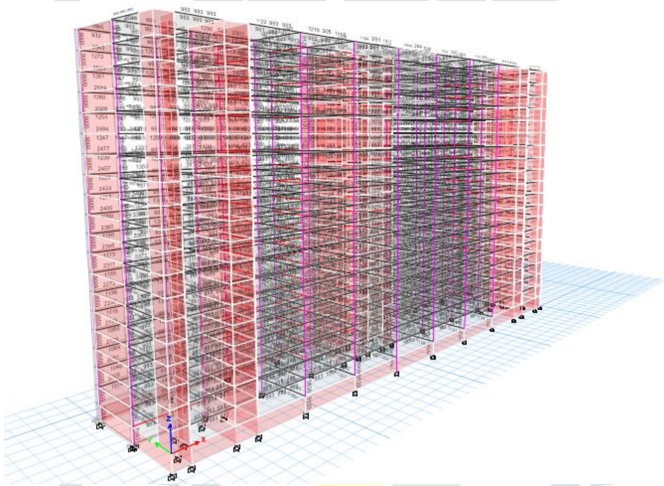


Figure: 3. Rebar Percentage

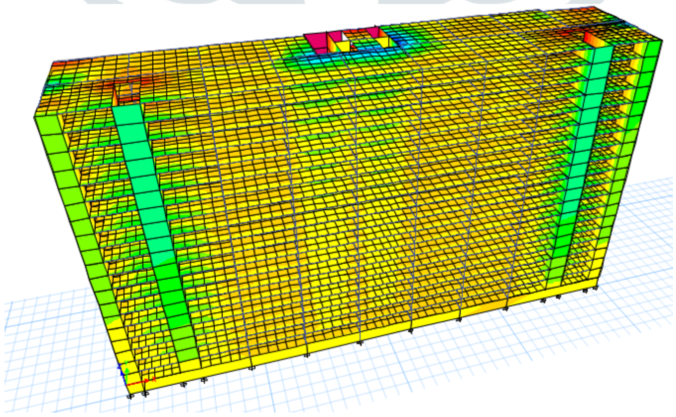


Figure: 4. Displacement x - direction

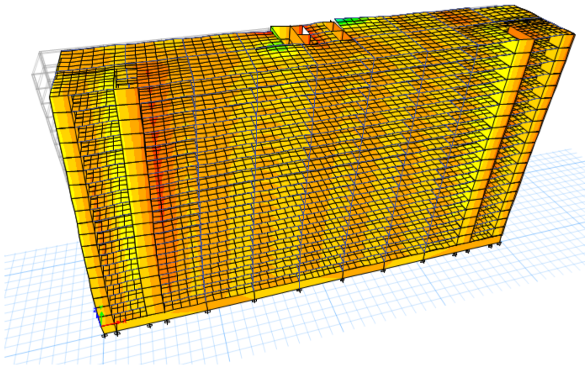


Figure: 5. Displacement Y - direction

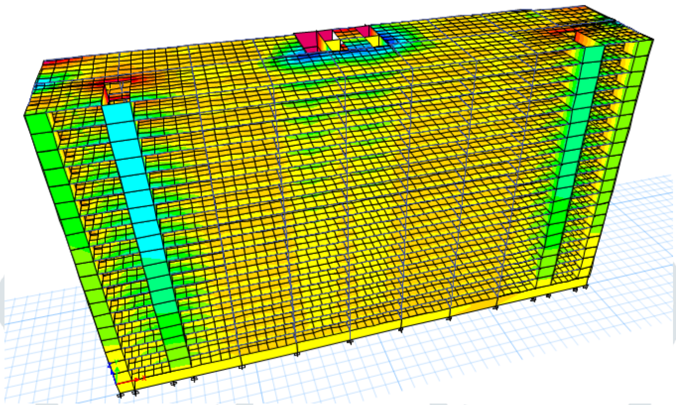


Figure: 6. Displacement Z – direction

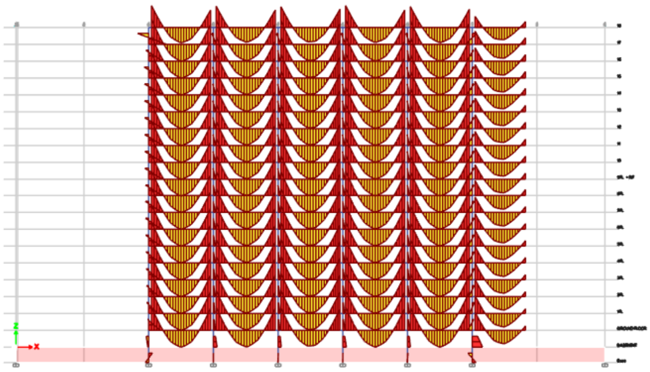


Figure: 7. Force stress diagram

V. CONCLUSIONS:

- The initial placement of building components like columns and beams before the effectiveness of the modelling with regard to seismic behaviour was established..
- The concrete grade was M35 and M40. These factors allowed us to achieve nominal reinforcement spacing with a minimum diameter of 8 mm..
- The supplied column and beam sections could withstand the loads and moments brought on by the wind and seismic loads. The percentage of steel obtained during the design process makes this clear. Most columns and beams have very little reinforcing. As a result, the chosen portions are strong enough to withstand weights and moments.
- Calculation of the values manual and software almost same results.

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