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Analysis & Design Of Earthquake Resistant (C+G+10) Using E-Tabs

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Abstract : The main steps of any building construction and planning is drafting, analyzing and designing the building. In the present days of improving science and technology, analyzing and designing of a building has been made easy by using ETABS software. ETABS software helps civil engineers to make their work easy and decreases time necessary for planning.

The project going to be done is design of a multi-story building which is going to be used as a residential. The building plan has been drafted using the AutoCAD software by the requirement and available area. The super structure i.e., the building frame has been analyzed and designed using the ETABS software.In the present project C+G+10 building considers to analysis and design for both gravity and lateral (wind and earth quake) loads as per Indian standards.

By using the software building can be analyzed and we can check for any failures in the analysis and redesign them, so that we can prevent failures after construction. By using the output building can be constructed according to the design.

Keywords: Building, Earth quake, ETABS.

I. Introduction

Structural response to earthquakes is a dynamic phenomenon that depends on dynamic characteristics of structures and the intensity, duration, and frequency content of the exciting ground motion. Although the seismic action is dynamic in nature, building codes often recommend equivalent static load analysis for design of earthquake-resistant buildings
due to its simplicity. This is done by focusing on the predominant first mode response and developing equivalent Static forces that produce the corresponding mode shape,
with some empirical adjustments for higher mode effects. The use of static load analysis in establishing seismic design Quantities is justified because of the complexities and
difficulties associated with dynamic analysis. Dynamic analysis becomes even more complex and questionable when nonlinearity in materials and geometry is considered. Therefore, the analytical tools used in earthquake engineering have been a subject for further development and refinement, with significant advances achieved in recent years

THE PROCEDURES FOR THE EARTHQUAKE ANALYSIS OF THE STRUCTURES:

- ✓ Linear Static Procedure
- ✓ Linear dynamic Procedure
- ✓ Response Spectrum method
- ✓ Time history method
- ✓ Nonlinear Static Procedure (Pushover analysis)
- ✓ Nonlinear dynamic procedure

II. DEFINITIONS

Story: when the multi-story building or the residential building is constructed in that when the floor-to-floor gap will be there that is the story.

Story Shear (VI): We will calculate all the lateral loads at each floor of the building.

Story Drift: is defined as the difference in lateral deflection between two adjacent stories. During an earthquake, large lateral forces can be imposed on structures; Lateral deflection and drift have three primary effects on a structure; the movement can affect the structural elements (such as beams and columns); the movements can affect non-structural elements (such as the windows and cladding); and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effects on structural elements, nonstructural elements, and adjacent structures

A. Effect of Drift on The Structure:

In terms of seismic design, lateral deflection and drift can affect both the structural elements that are part of the lateral force resisting system and structural elements that are not part of the lateral force resisting system. In terms of the lateral force resisting system, when the lateral forces are placed on the structure, the structure responds and moves due to those forces. Consequently, there is a relationship between the lateral force resisting system and its movement under lateral loads; this relationship can be analyzed by hand or by computer. Using the results of this analysis, estimates of other design criteria, such as rotations of joints in eccentric braced frames and rotations of joints in special moment resisting frames can be obtained. Similarly, the lateral analysis can also be used and should be used to estimate the effect of lateral movements on structural elements that are not part of the lateral force resisting system, such as beams and columns that are not explicitly considered as being part of the lateral force resisting system. Design provisions for moment frame and eccentric braced frame structures have requirements to ensure the ability of the structure to sustain inelastic rotations resulting from deformation and drift. Without proper consideration of the expected movement of the structure, the lateral force resisting system might experience premature failure and a corresponding loss of strength. In addition, if the lateral deflections of any structure become too large, P-Δ effects can cause instability of the structure and potentially result in collapse.

B. Seismic weight of building:

The seismic weight of the building means that is calculated on the entire floors weight of the building Fundamental Natural period as per IS 1893(part1):2002

1. The approximate fundamental natural period of vibration (Ta)in seconds of a moment resisting frame building without brick infill panels may be estimated by the empirical expression

$Ta=0.075h^{0.75}$ for RC framed building $Ta=0.075h^{0.75}$ for steel framed building Where h =height of building

2. The approximate fundamental natural period of vibration (Ta) in seconds, of all other buildings, including moment – resisting frame buildings with brick infill panels, may be estimated by the empirical expression:

$Ta= 0.09h/\sqrt{d}$

Where h = height of building

d = Base dimensions of the building at the plinth level in m, along the considered direction of lateral force

C. Design Seismic Base Shear:

The total design lateral force or design seismic base shear (Vb) along any principal direction shall be determined by the following expression

$Vb = AhXW$

Where Ah = Design horizontal acceleration spectrum value as per clause 6.4.2 IS 1893(part1):2002 using the fundamental natural period Ta as per clause 7.6 IS 1893(part 1):2002 in the consider direction of vibration W = Seismic weight of building

III. MATERIAL PROPERTIES OF THE STRUCTURE
Grade of Slab, Beam concrete M25
Grade of column concrete M25
Grade of steel Fe 415
Column sizes = 0.9X0.30 m
Beam sizes = 0.65X0.30 m
Slab thickness = 0.150 m
Number of stories = G+15
Height = 3 meters
Wall load = 12 kN/m
Live load = 2 kN/m2

SCOPE OF WORK

The analysis is implemented for Analysis and Design of Multi Storied Residential Building using ETABS. The structure is analyzed for lateral loads (seismic). The individual structural elements are designed for worst load combinations.

III. MODELING OF THE STRUCTURE

GENERAL

R.C moment resisting frame structure having C+G+10 story is analyzed for gravity and lateral load (earth quake and wind loads). The effect of axial force, out of plane moments, lateral loads, shear force, story drift, story shear and tensile force are observed for different stories. The analysis is carried out using ETABS and data base is prepared for different story levels as follows.

MODELLING OF R.C MOMENT RESISTING FRAME STRUCTURE

In this present study C+G+10 Multistorey building is considered. The constriction Technology is R.C.C frame structure and slabs. The modelling is done in ETABS as follows.

- The structure is divided into beam and column elements.
- The nodes are created as plan architect plan and node are connected through beam command; columns also connected.
- Boundary conditions are assigned to the nodes wherever it is required. Boundary conditions are assigned at the bottom of the structure i.e., at ground level where restraints should be against all movements to imitate the behavior of structure.
- The material properties are defined such as mass, weight, modulus of elasticity, Poisson's ratio, strength characteristics etc. The material properties used in the models.
- The geometric properties of the elements are dimensions for the section.
- Elements are assigned to structure.
- Loads are assigned to the joints as they will be applied in the real structure.
- The model should be ready to be analyzed forces, stresses and displacements

IV. ANALYSIS AND RESULT

GENERAL

Structure having C+G+10 story is analyzed for gravity and lateral loads (seismic and wind load). The effect of axial force, out of plane moments, lateral loads, shear force, story drift, story shear and tensile force are observed for different stories. The analysis is carried out using ETABS and data base is prepared for different story levels as follows.

LOAD CASES AND LOAD COMBINATIONS

In this present work consider both gravity and lateral load case (SESIMIC AND WIND).

The load combinations as per the Indian standards are considered. The primary load cases and the load combinations are shown following tables respectively.

Primary Static Load cases

Case	Type	SW Multiplier	Autoload
DEAD	DEAD	1	
LIVE	LIVE	0	
WALL	SUPER DEAD	0	
EQX	QUAKE	0	IS1893 2002
EQY	QUAKE	0	IS1893 2002

DEAD LOAD (DL): -

DEAD LOAD is defined as the the load on a structure due to its own weight (self-weight). It also added other loads if some permanent structure is added to that structure.

LIVE LOAD (LL):-

LIVE LOAD Or IMPOSED LOAD is defined as the load on the structure due to moving weight. The LIVE LOAD varies according to the type of building. For example, generally for a Residential Building the LIVE LOAD is taken as 2kn/m2.

1. DEAD LOAD CALCULATION:

MAIN WALL LOAD (From above plinth area to below the Roof) should be the cross-sectional area of the wall multiplied by unit weight of the brick. (Unit weight of brick is taken as 19.2 kn/m3).

According to the IS-CODE PLINTH LOAD should be half of the MAIN WALL LOAD. Internal

FLOOR PLAN

PLINTH LOAD should be half of the PLINTH LOAD.

PARAPATE LOAD should be the cross sectional is multiplied by unit weight.

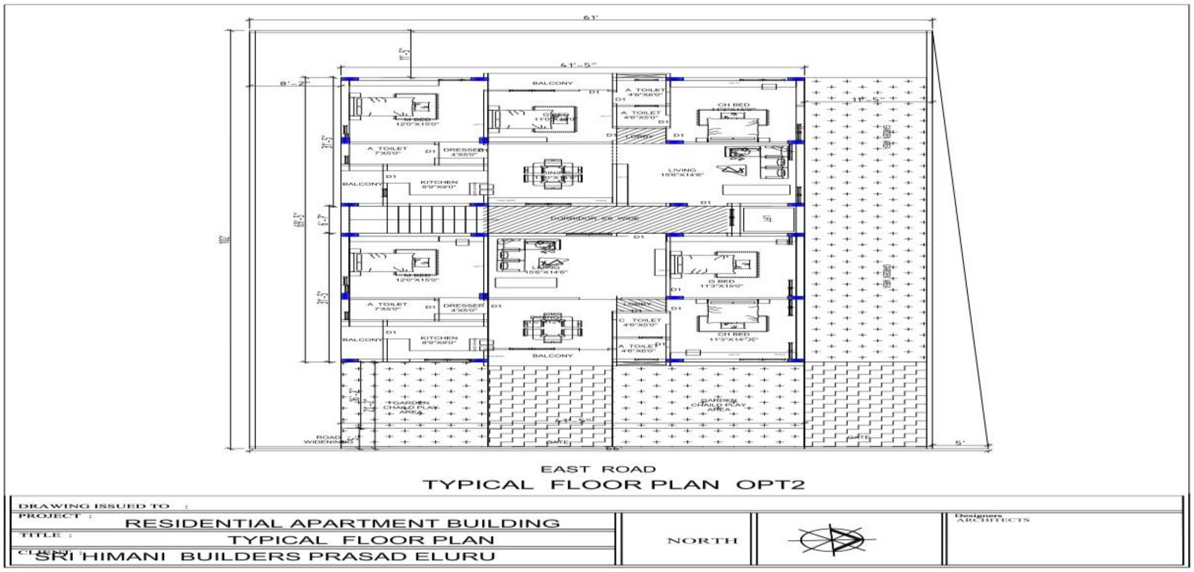
SLAB LOAD should be combination of slab load plus floor finishes. SLAB LOAD can be calculated as the thickness of slab multiplied by unit weight of concrete (according to IS-CODE unit weight of concrete is taken as 25 kn/m^3).and FLOOR FINISHES taken as .1.5 kn/m2.

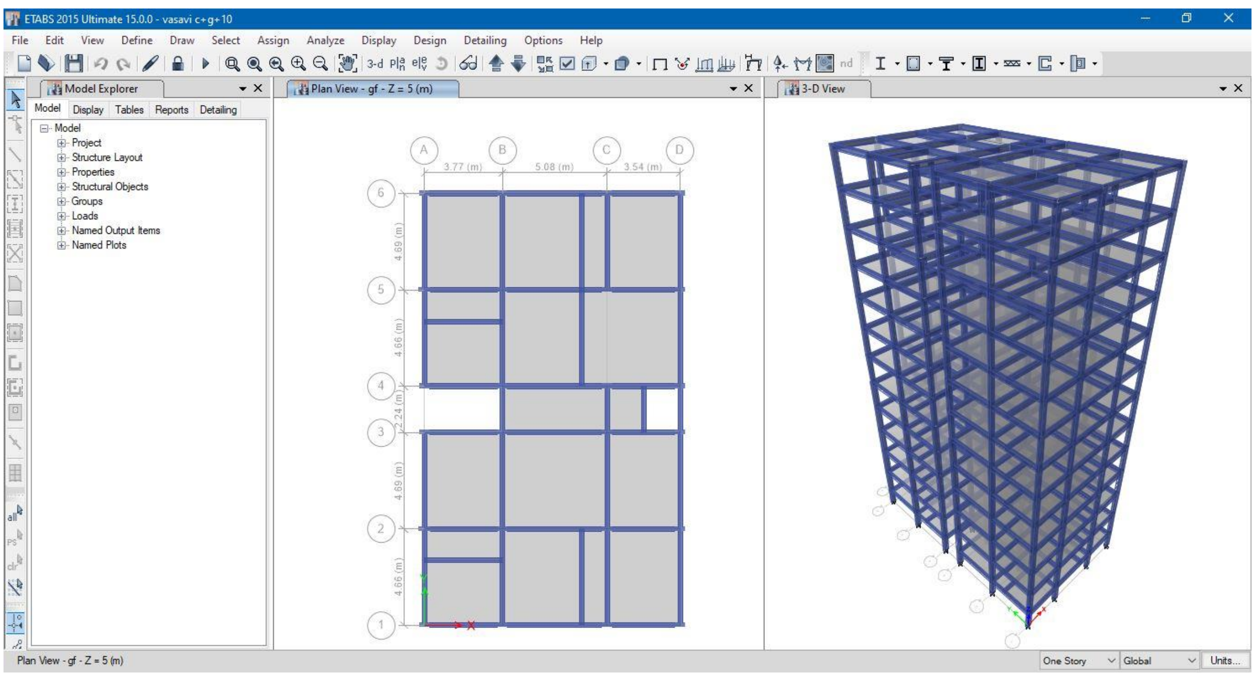
2. LIVE LOAD CALCULATION:

LIVE LOAD is applied all over the super structure except the plinth .Generally LIVE LOAD varies according to the types of building. For Residential building LIVE LOAD is taken as ----2kn/m2 on each floor and 2kn/m2 on roof.

DATA REQUIRED FOR THE ANALYSIS OF THE FRAME.

- Type of structure --> multi-story fixed jointed plane frame.
- Number of stories 10
- Floor height 3.2 m.
- Imposed load 2 kn/m2 on each floor and 2 kn/m2 on roof.
- Materials Concrete (M 25) and Reinforcement (Fe415).
- Size of column 0.6m×0.6m
- Size of beam 0.23m×0.75m
- Depth of slab 125 mm thick
- Specific weight of RCC 25kn/m3.
- Specific weight of infill 19 kn/m3
- Type of soil medium soil.





3D VIEW OF THE STRUCTURE

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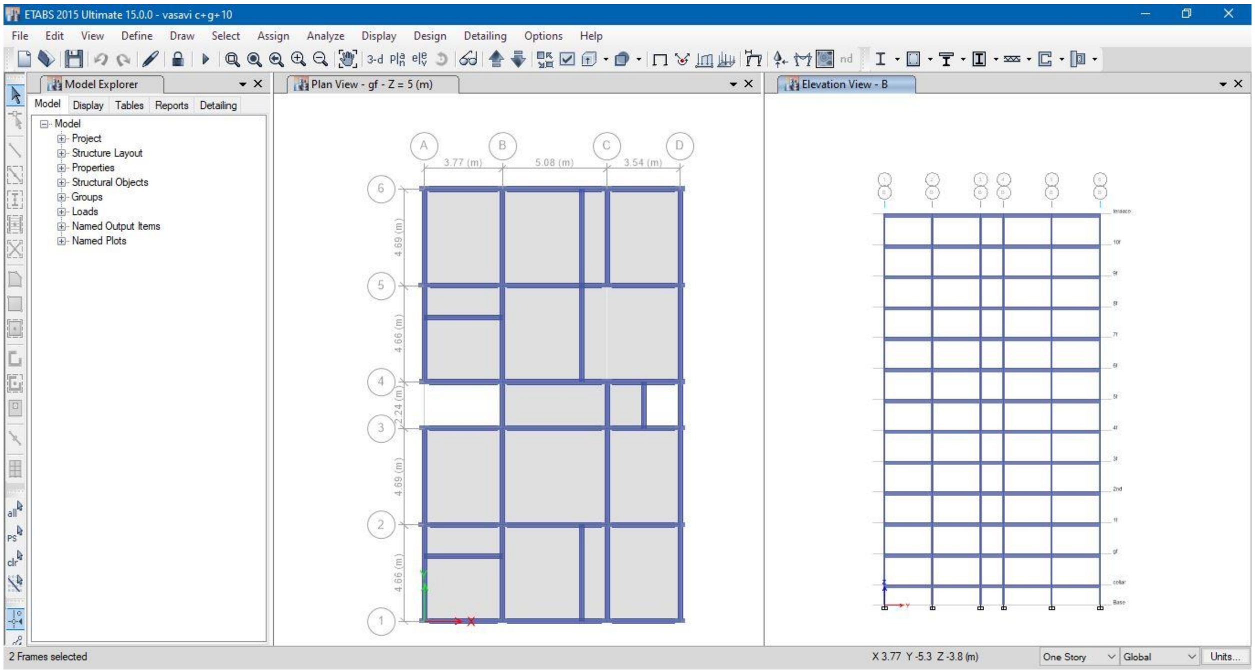
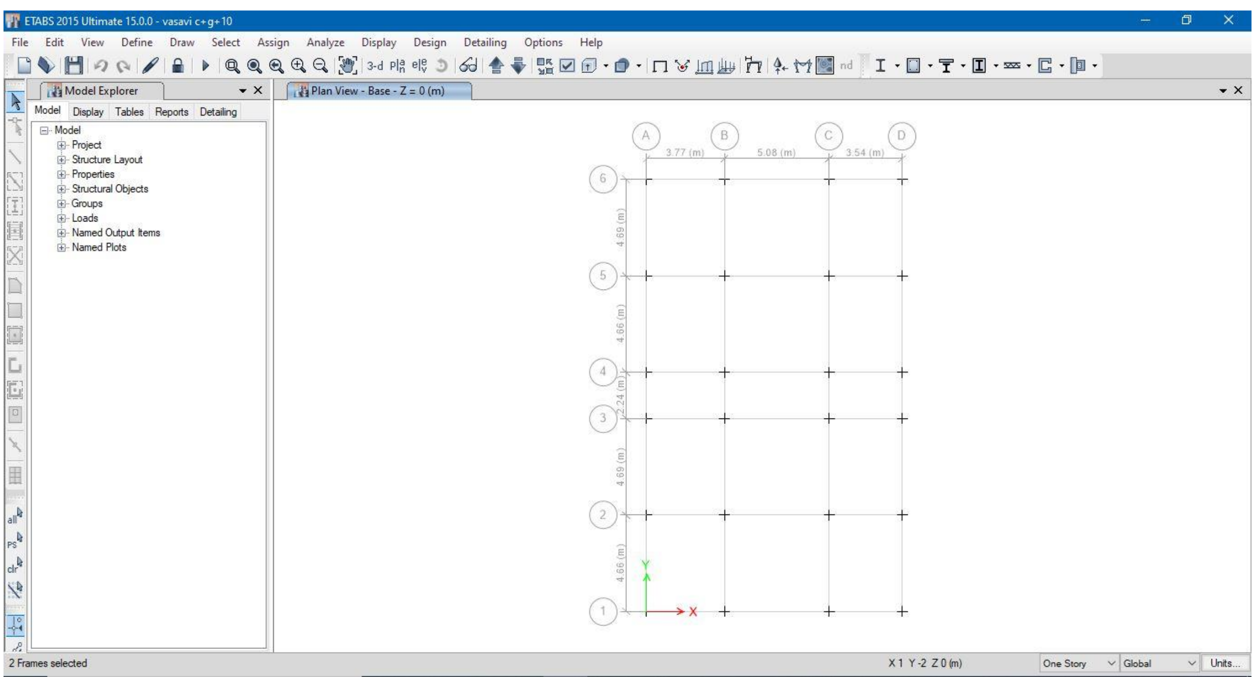


ELEVATION OF THE STRUCTURE

Supports

The supports given here are of fixed one, as shown in the above figure.



SUPPORT

LOADS INPUT

Dead load is calculated as per IS 875 part1

Dead load : Assuming that slab is of 150mm thickness as per span/depth calculations of IS456.
Then total dead load is calculated as
0.15x24 = 3.6KN/m^2 + 1.5KN/m^2 (Floor finishing) = 5.1KN/m^2
The value of 5.1KN/m^2 has been assigned to the structure as shown in the figure and its distributing pattern also shown.

WALL LOADS

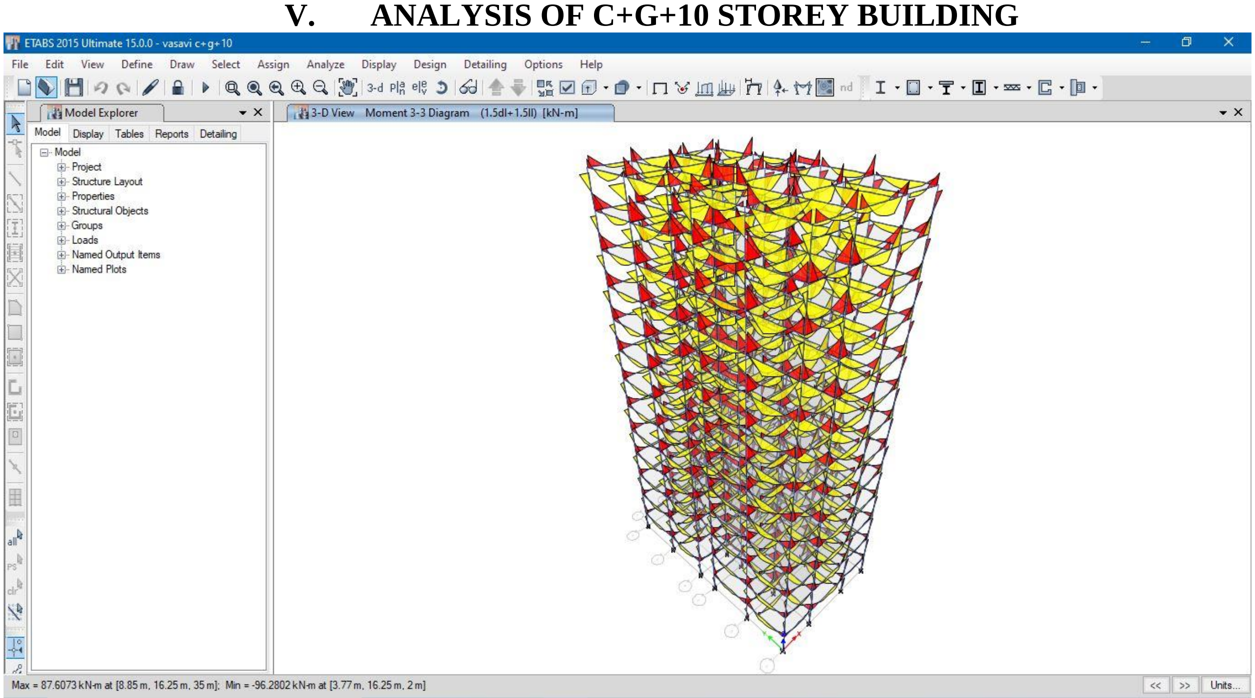
Here two types of walls are considered, i.e. 9” thickness wall (230mm) and $4\frac{1}{2}$” thickness wall (115mm).

230mm is given to external walls (perimeter) and 115mm is assigned to all internal walls.

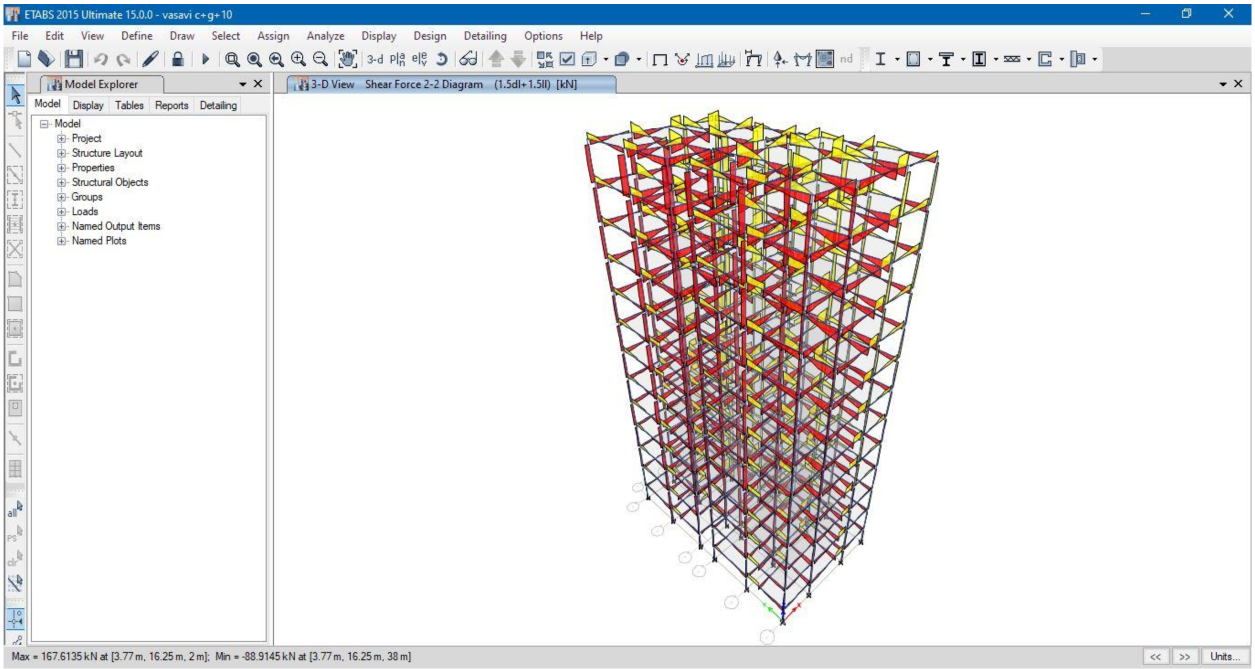
LIVE LOAD

As per IS 875 part 2, the live load on the residential buildings should be taken as 2KN/m^2.So, here 2KN/m^2 has been assigned to entire structure.
For all the secondary beams, moment has been released, i.e. torsion effect has been removed and is treated as simply supported beams.

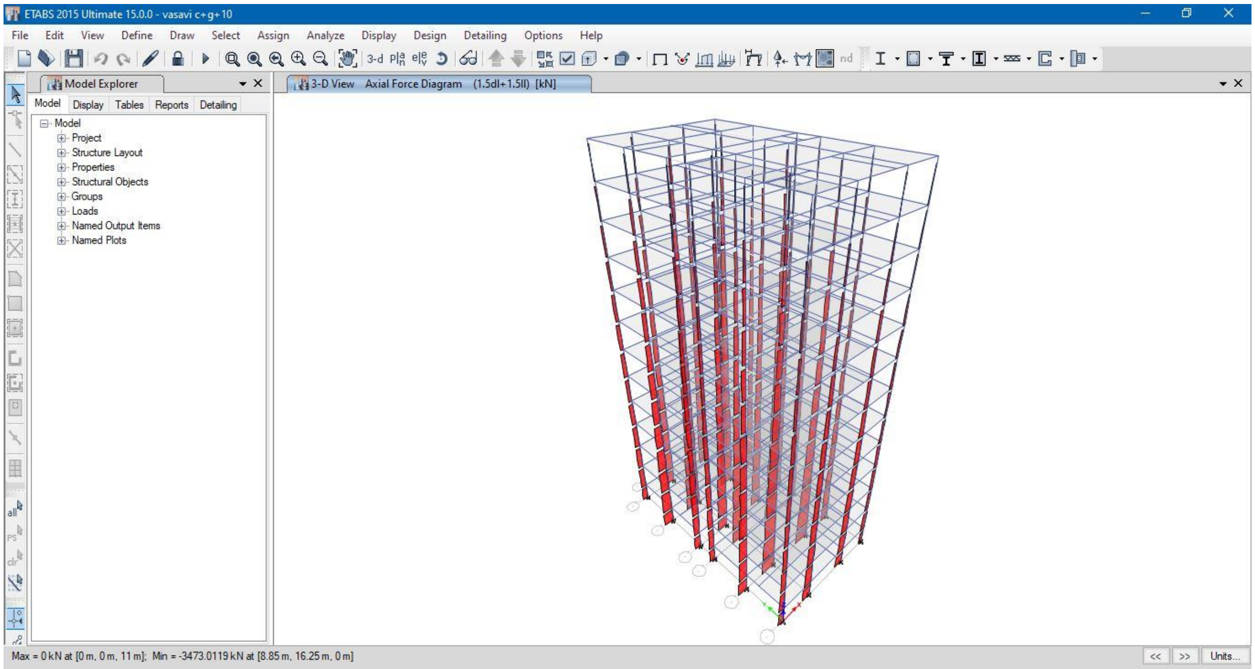
V. ANALYSIS OF C+G+10 STOREY BUILDING



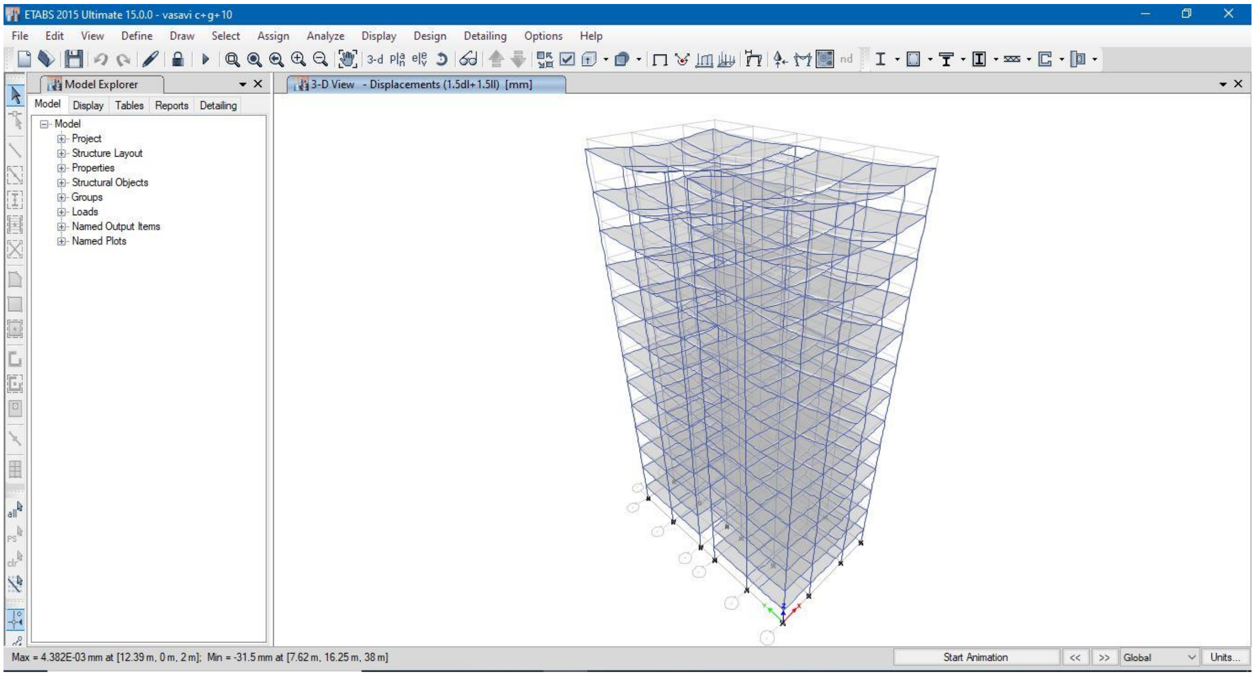
BENDING MOMENT OF THE STRUCTURE



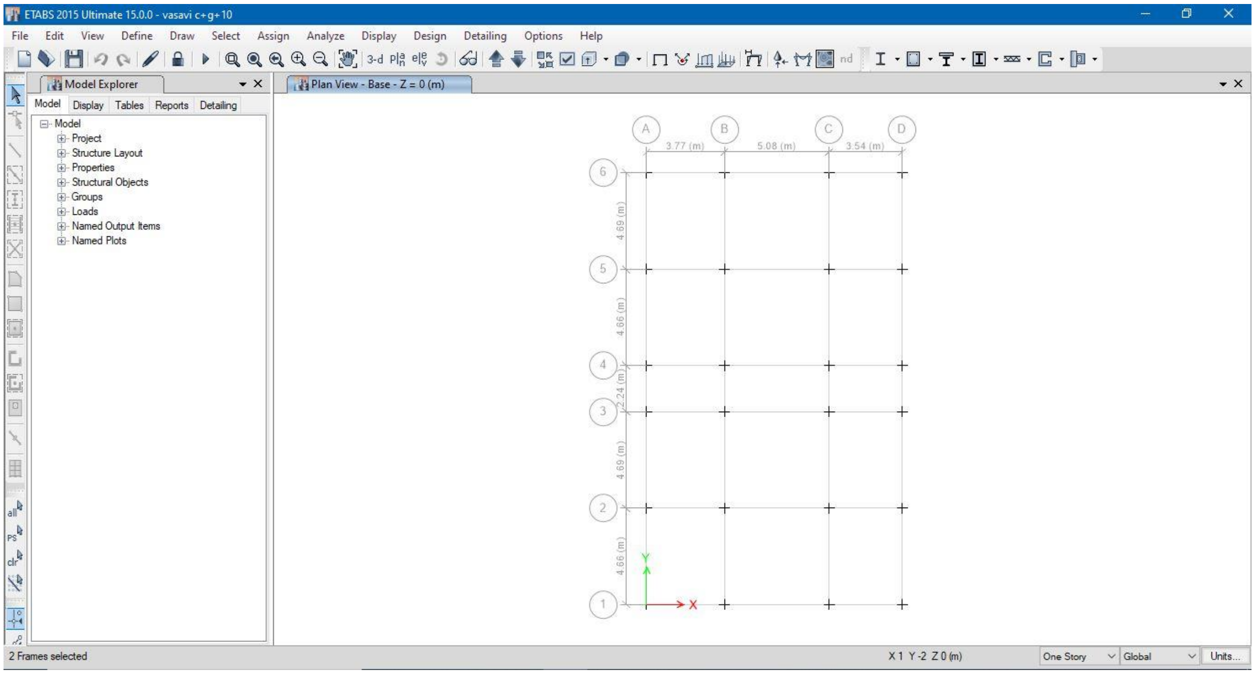
SHEAR FORCE OF THE STRUCTURE



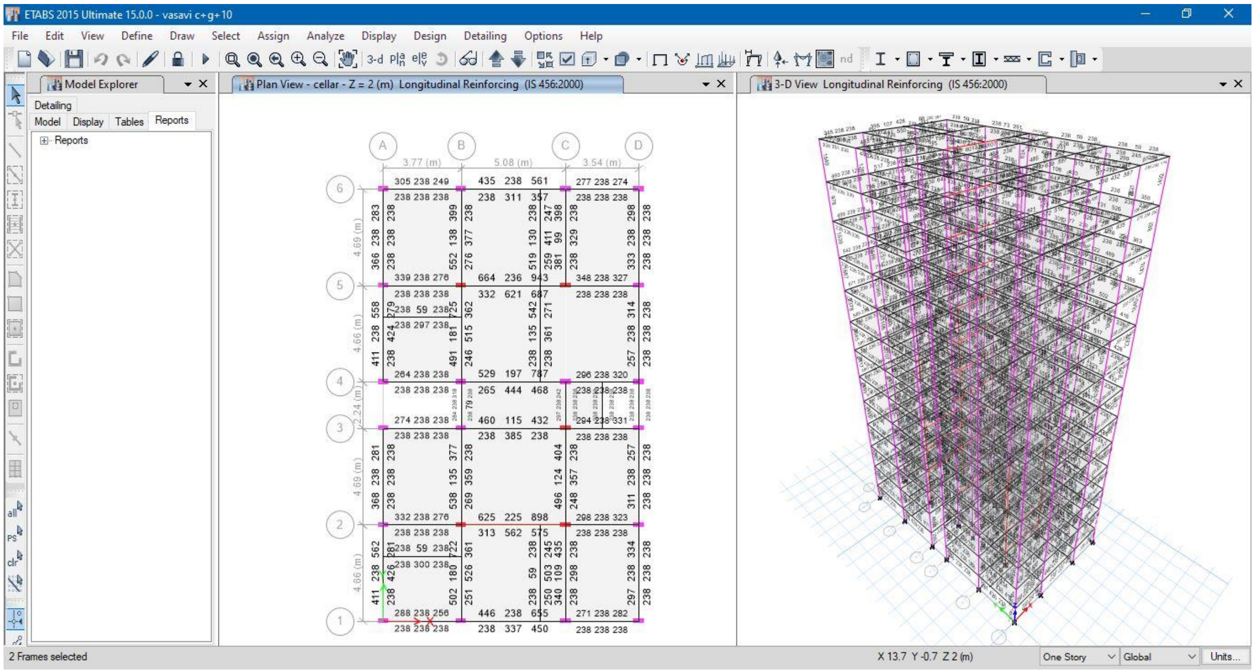
AXIAL FORCES



DISPLACEMENT



SUPPORT



Concrete Beam Design Information (Indian IS456-2000)

VI. CONCLUSION

- The displacement is decreased in shear wall structure as compared to frame structure
- The story stiffness is more in shear structure than the frame structure.
- The story drift is decreased in shear wall structure than the frame structure.
- The modal period and frequency is less in frame structure & more in shear wall structure.
- The story acceleration is more in shear structure than the frame structure.
- From this analysis and design, we can conclude that the performance of shear structure is batter then the frame structure.
- The cost of the frame structure may be less than the shear structure
- The shear structure is suitable in earthquake prone area due to its higher stiffness & less displacement.

INDIAN STANDARD CODE

- IS CODE 456-2000
- IS CODE 875-1987 PART I
- IS CODE 875-1987 PART II
- IS CODE 875-1987 PART III
- DESIGN AIDS TO IS -456-2000 (SP 16)
- ARRANGEMENT OF REINFORCEMENT USING SP 34

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