SESISMIC ANALYSIS OF MULTISTOREY BUILDING USING ETABS

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Abstract – *This project presents RCC framed building designed and analyzed under the lateral loading effect of wind and earthquake using E-tabs software. It is incorporated with all, major analysis of static, dynamic linear and non-linear loads. At the modelling stage, the members are arranged as line members, taking the horizontal effects of wind & seismic forces.*

***Key Words*: Etabs, Multi-storey building in Etabs, Lateral load, shear/Lift wall, Optimum position of shear wall, Base shear, centrally placed shear wall.**

1. INTRODUCTION

The increase in population has increased the demand for land occupancy which in turn has led to the construction of high raised buildings. The primary purpose of structural components is to resist the gravity loads. In addition to these loads, the structure must be designed to resist lateral forces to ensure structural stability. The Shear walls are the structural components most widely employed to design an earthquake resistant structure.

But the codal provisions for seismic design do not allow reduction in column thickness. In this study an attempt is made to reduce the thickness of column and at the same time without violating the codal suggestions. The main objective of the study is to satisfy the architectural demand with better stability of the structure. The present paper briefly describes the comparative behaviour of models in which column is designed as shear wall to that of column designed with minimal thickness as that of wall.

1.1 Structural system

RCC columns, shear walls and beams have been laid out in plan in coordination with architectural and services drawings is provided. The seismic zone III is considered for Chennai. Regarding sub structure, as per the soil report pile foundation is recommended. The cut-off level of the piles has been considered as 1m below the existing ground level. The refusal strata were encountered at 7.5m depth. Hence, the effective length of the piles to be taken will be 8-9.5 m. The load carrying capacity of different diameter piles and depth are given below:

Diameter of pile(mm)	Load carrying capacity (KN)	Uplift capacity (KN)
450	700	300
500	900	400
600	1250	600

A structure is said to be designed efficiently if all the members are so arranged in a way that they transmit their self weight and other imposed loads to foundation and supporting structures by cost effectively so as to satisfy the requirement of architecture, structural stability and the nature of the site with sufficient safety. In addition to engineering calculation, experience and good judgement may also do much towards safety and economy of the structure.

1.2 Design codes

Design RCC design has been based on provision laid down as IS: 456-2000 General construction in plain and reinforced concrete- code of practice, following Limit state philosophy. Other codes of practice to be referred to are as follows:

1) IS 875-1987 Part (I, II and IV) code of practice for design loads for buildings and structures (other than earthquake)
2) IS 875 Part III-2015 code of practice for wind loads for buildings and structures.
3) IS 1893-2016 criteria for earthquake resistant construction of buildings.
4) IS 4326-1993 Earthquake resistant construction of buildings.
5) IS 456-2000 Code of practice for plain and reinforced concrete.

2. Material of specifications

Grade of concrete

The Indian Code IS: 456-2000, permits a minimum grade of concrete for reinforced members as M 25 and the following concrete Grades have been for various structural elements.

1) M-25 grade concrete has been used for all structural elements.
2) M-25 grade concrete has been used for piles and pile caps (400kg/m3)

Reinforcement

All reinforcement bars to be used in the structural elements shall be high yield strength deformed thermo- mechanically treated bars with yield stress of 500 MPa and minimum elongation of 18.0% conforming to IS: 1786-1985.

Cover to Reinforcement

Minimum values for the nominal cover to be provided to all reinforcement, including links of normal weight aggregate concrete depend on the condition of exposure and minimum specified period of fire resistance. Clear cover to the main reinforcement in the various structural elements depends on above criteria shall be:

1) Pile cap - 75mm
2) Columns – 40mm
3) Pedestals – 40mm
4) Beams – 30mm or bar diameter
5) Slabs – 20mm
6) Staircase – 20mm
7) Water tank walls and slabs – 30mm
8) Shear walls – 25mm

2.1 Loads

Dead Loads

Following unit weight of building materials have been considered in accordance with IS: 875(Part- I) and IS 1911

1) Reinforced cement concrete - 25KN/m3
2) Plain cement concrete – 25KN/m3
3) Brick masonry – 19KN/m3
4) Light weight filling in sunken area – 10KN/m3
5) Cement mortar/plaster – 20KN/m3
6) Floor finish – 2KN/m3
7) Brick bat for terrace – 20KN/m3

Live Loads

Following live loads have been considered in design in accordance with IS: 875(Part II)-1987

1) General Floor area – 2KN/m3
2) Staircase & corridor – 4KN/m3
3) Play area, Gym floor load – 5KN/m3

Seismic Loads

As per IS 1893 (Part I)-2002
Where,

Ah – Design Horizontal seismic coefficient
W – Seismic weight of the building
Design Horizontal seismic coefficient,
Ah = z/2*I/R*Sa/g
Z – Zone factor = 0.16 as applicable for structure Built in Zone III

I – Importance factor for the building = 1.5

R – Response reduction factor = 5 (SMRF)

Sa/g – Average response acceleration coefficient is taken for soil type – 2 and 5% damping

Seismic forces are calculated for full dead load plus percentage of imposed load.

Wind Loads

It can be mathematically expressed as follows

$$Vz = Vb \times K1 \times K2 \times K3$$

Design Wind speed (Pz)

The wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind speed

$Pz = 0.6\ Vz^2$
Where,
Pz = Wind pressure at height z, in N/m^2 and
Vz = Design wind speed at height z, in m/s

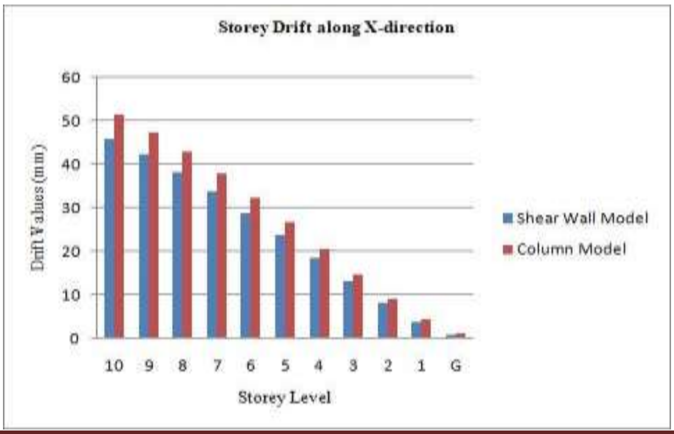
Load Combination

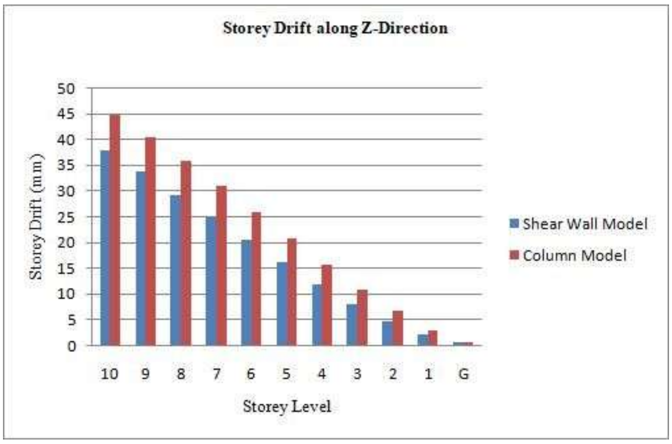
The building is analyzed for following Load combinations as indicated in IS: 456-2000. Whenever dead & imposed load is combined with earthquake load with appropriate part of the imposed load as specified in IS: 1893-2002 is adopted both for evaluating effect and for combined load effects used in such combinations

1) 1.5 x (Dead load + Live load)
2) 1.5 x (Dead load ± Earthquake load/wind load in X-direction
3) 1.5 x (Dead load ± Earthquake load/wind load in Z-direction
4) 0.9 x (Dead load) ± 1.5 (Earthquake load/wind load in X-direction)
5) 0.9 x (Dead load) ± 1.5 (Earthquake load/wind load in Z-direction)
6) 1.2 x (Dead load + Live load ± Earthquake load/wind load in X-direction)
7) 1.2 x (Dead load + Live load ± Earthquake load/wind load in Z-direction)

2.2 Design Methodology

The RCC design shall be based on provisions laid down in IS: 456-2000 code of practice for plain and reinforced concrete, following limit state of philosophy. The structure model involves the assemblage of structural elements that present the typical frame in a building and its behaviour under external loading is observed. It has been assumed that buildings falls under seismic loading. The height of each storey is 3m. The grade of concrete used is M25 and the grade of steel used is Fe500. Beams and columns were modelled as frame elements and the beam-column joints are assumed to be rigid, intended to get bending moments at the face of beam and column.





3. CONCLUSION

From the results obtained, it has been noticed that the model shear wall is more stable than the model designed with column against lateral forces. At the same time, the base shear is higher in shear wall model as that compared with column model. Hence it advisable to place shear wall in appropriate positions in the structure wherever required. Usage of ETABS software minimizes the time required for analysis and designs.

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