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ANALYSIS OF A MULTISTORY STRUCTURAL FRAME CONSIDERING VERTICAL IRREGULARITY USING ANALYSIS TOOL

Vivek Jaiswal[1] , Hitesh Kodwani[2] and Dr. Aslam Hussain[3]

[1] Research Scholar, Civil Engineering Dept., Sam College of Engineering and Technology, Bhopal-462021, Madhya Pradesh, India (corresponding author).

[2] Assistant Professor, Civil Engineering Dept., Sam College of Engineering and Technology, Bhopal-462021, Madhya Pradesh, India.

[3] Assistant Professor, Civil Engineering Dept., University Institute of Technology, Rajiv Gandhi Technical University, Airport Road, Bhopal, Madhya Pradesh 462036, India

Abstract:

Lateral Load assume the administering part in the examination and plan of tall RCC structures. The firmness assuming administering part in the examination and plan of the construction in tall structures when exposed to horizontal burdens. Second opposing casing is a primary framework that is fit for conveying the lateral loads in low to mid-ascent structures. It conveys the sidelong loads by joined pivotal shear-twisting activity of pillars and segments.

In this research, attempt has been made to find out the effect of vertical irregularities, in building plan on overall stiffness and wind pressure over building subjected to ground shaking. A G+14 storey RC building has modelled in ETABS software with different height of the storey as 2.7m, 3m and 3.5m.Wind response is considered as per region of the building. The analytical result of each model has compared in terms of forces, Storey Displacement, Storey Drift and Bending Moment.

***Keys Words* –Moment resisting System, Lateral Loads, ETABS, Wind response etc.**

Introduction:

The effective length factor (K-factor) is one of important parameters in design of column or beam-column members in framed structures and the stability design method based on this effective length is quite a common practice to engineers for many years. There are various approaches to calculate the K-factor of compression members and among them the most widely accepted method for designing framed structures is the isolated subassembly approach, known as the alignment chart method or the Gfactor method. And now, several design codes such as AISC (2005), ACI (2005), AASHTO (1998), DIN 18800 (1990), and Eurocode 3 (2002) adopt this method. This isolated subassembly approach is the traditional method used to assess the rotational end restraint of the isolated column, which represents the stiffness ratio between column and beam. However in spite of its popularity, this approach has major drawback in that it does not properly reflect the interaction effect of neighboring members except for very closely adjacent columns and beams.

Since this approach is based on several fundamental assumptions, which basically limit the use of this method only for idealized cases, it may lead to the inadequate estimation of the K-factor when these assumptions are not satisfied.

As our nation is the quickest developing country across the globe so the requirement for cover for exceptionally populated urban areas where the expense of land is high and further even extension is unimaginable because of the inaccessibility of room, so the lone arrangement is vertical development. The foundational layout is the essential part of structural designing. The first rudiments in the construction are the plan of basic fundamental segments and individuals from a structure like sections, shafts, segments, and footings. To plan them, it is essential to initially get the arrangement of the specific structure. Consequently relying upon the reasonableness plan format of shafts and the situation of segments are fixed. From there on, the vertical burdens are determined in particular the dead burden and live burden.

ETABS is a designing programming item that obliges multi-story building investigation and plan. Displaying devices and layouts, code-based burden remedies, examination strategies and arrangement procedures, all organized with the matrix-like calculation extraordinary to this class of design. Essential or progressed frameworks under static or dynamic conditions might be assessed utilizing ETABS. For a refined appraisal of seismic execution, modular and direct-reconciliation time-history investigations may couple with P-Delta and Large Displacement impacts. Nonlinear connections and concentrated PMM or fibre pivots may catch material nonlinearity under monotonic or hysteretic conduct. Natural and coordinated highlights make uses of any intricacy commonsense to execute. Interoperability with a progression of plan and documentation stages makes ETABS an organized and beneficial apparatus for plans that range from basic 2D casings to expand new elevated structures.

Literature review:

Alfredet.al (2019) the goal of the examination paper was to decide, analyze and censure the powerful length of pressure individuals in steel structure utilizing Wood's strategy or suggestion, Euler's hypothetical methodology/technique and BS 5950 arrangement. Analyze the strength of the subsequent construction planned to utilize the different approach and assess the disparities emerging from the different strategies and counsel on their primary ramifications in assessing the basic clasping load and basic reasonable pressure.

The calculation shows that both clasping load and reasonable pressure for the specific slim section is most noteworthy when the compelling length was assessed utilizing Wood's proposal and least under BS 5950 arrangement. Furthermore, a plan utilizing the BS 5950 methodology can likewise be viewed as a traditionalist plan since the primary part can in any case stand when the basic burden is achieved.

ApoorvChoudhary et.al (2018) the principle objective was to comprehend the impact of thinness in the corner, edge and inward segment via completing a parametric report on level plate structures as it were. The exploration completes a parametric report to investigate the thinness impact in section plan of built-up concrete cement (RCC) level - plate structures dependent on Indian norm (IS) codes specifically, IS 456: 2000 and IS 875. This examination was directed on a day and a half at three areas (for example corner, edge and internal sections) in 12 level - plate RCC underlying models. To start with, the techniques depicted in the Indian standard code for planning slim section is assessed physically for one primary model and afterwards, FEM models are produced by utilizing ETABS programming. A parametric report is accomplished by considering: four distinct lengths of section range from 3m to 6m utilizing an addition of 1m and three-piece board's size 4.5m x 4.5m, 6m x 6m and 7.5m x 7.5m with three boardsbothy.

Result reasoned that corner and edge segment has most thinness impact. Section tallness increment on and past 5m is considerably powerless for influence impact. On the off chance that section length increments starting with one specific stage then onto the next, the steel proportion increments. As a rule, a section isn't thin by considering a present influence outline however exceptionally slim by considering an influence outline.

KuldeepDubey and Dr.Rakesh Patel (2018)the objective of the exploration paper was to assess the conduct of multi-story working with drifting section under tremor excitation. Eliminate inconsistency in multi-story building and estimation of base shear, upsetting, float on the multi-story building.
In powerful burden; drifting section structure is discovered dangerous. for example In a quake, this structure discovered risky. So to make the design safe shafts and segments size are to be expanded. With the increment in size, the amount of solid material is expanded by 27.40%. With the increment in uprooting, bowing second, shear power and hub power in pillars and sections in the construction support expanded by 15.05%. The increment in the amount of cement and support building cost is expanded by 16.02%. Subsequent to expanding size and giving support; the structure discovered protected in powerful burden in staad expert examination. The thickness of the supporting pillar is diminished up to 500mm. In a segment at which the supporting shaft is rest, no. of support is discover more. so support is expanded and the cross-sectional zone is increments. By presenting a coasting segment, abnormalities are taken out from the design.

Objectives:

The following objectives were considered in the study:

- To determine the effect of vertical irregularity over the structural stability.
- To compare three cases with different floor height.
- To determine the effect of lateral load over a tall structure using ETABS.

Methodology

Step 1: Accessing various authors research papers related to similar topics in relation to analysis of structure with different height or size of column using different analytical tools.

Step 2: the initial step is to define the unit system is ETABS as this application is used throughout globe which support different country codes as American code, Australian codes and many more. In the case here, IS codes is used as structure is modelled and designed as per INDIAN standards. Display units are SI metric where the steel section database is INDIAN. Steel code IS 800:2007 and concrete design code IS 456:2000 is followed.

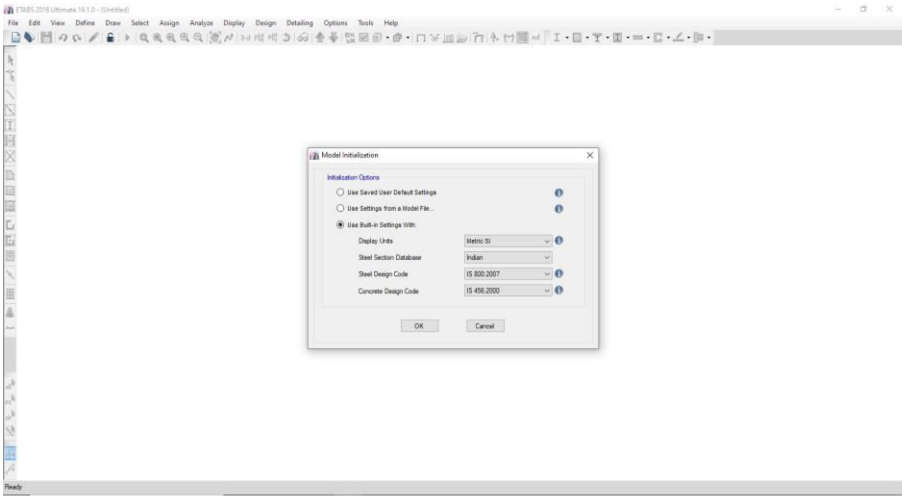


Fig 1 Model Initialization

Step 3: Three models are considered different storey height in G+15 model.

Case I Storey height 2.7 m

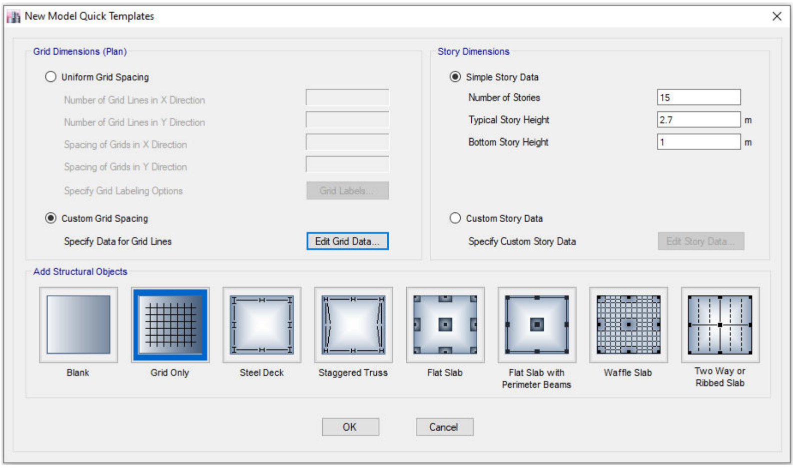


Fig 2 Storey height 2.7 m

Case II Storey height 3m

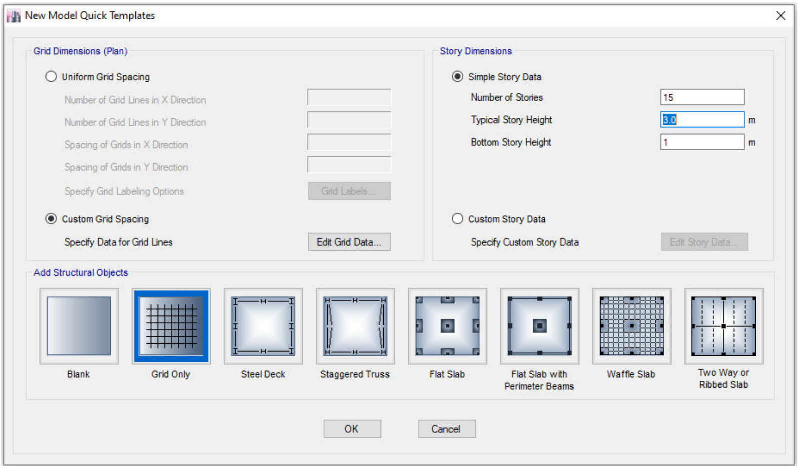


Fig 3 Storey Height 3m

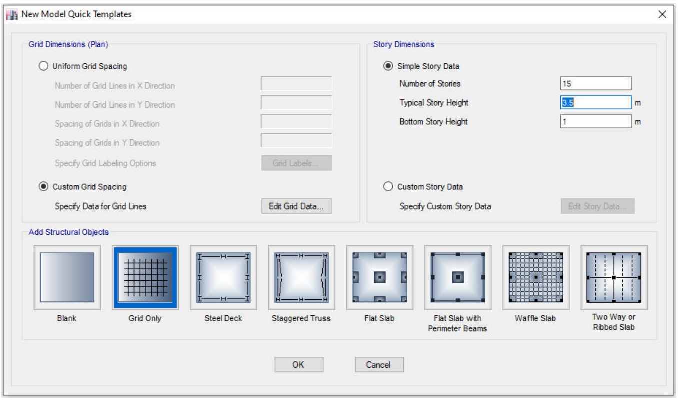


Fig 4 Storey Height 3.5m

Step 4: Defining Grid system data on the coordinates in X and Y Direction, X direction grid ID is marked with initials A,B,C, D….. and Y direction grid ID is marked with initials 1,2,3,4..

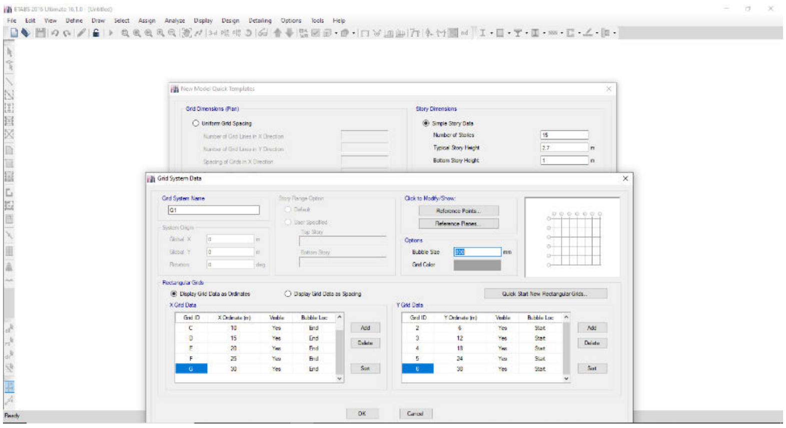


Fig 5 Grid System Data.

Step 5: Frame is modelled as per grid defined in the previous step, the ETABS application window which is defined in three frames as Model Explorer, 2D plan view where in the case Z varied due to different height of column and 3D view of the model.

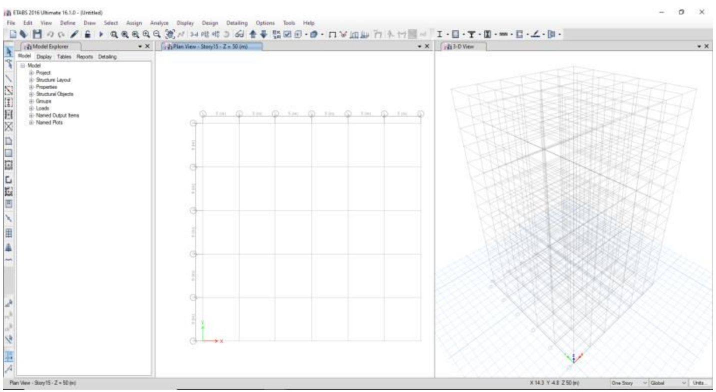
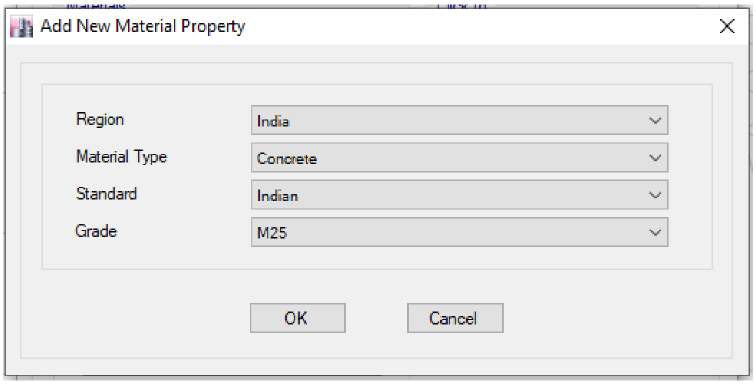
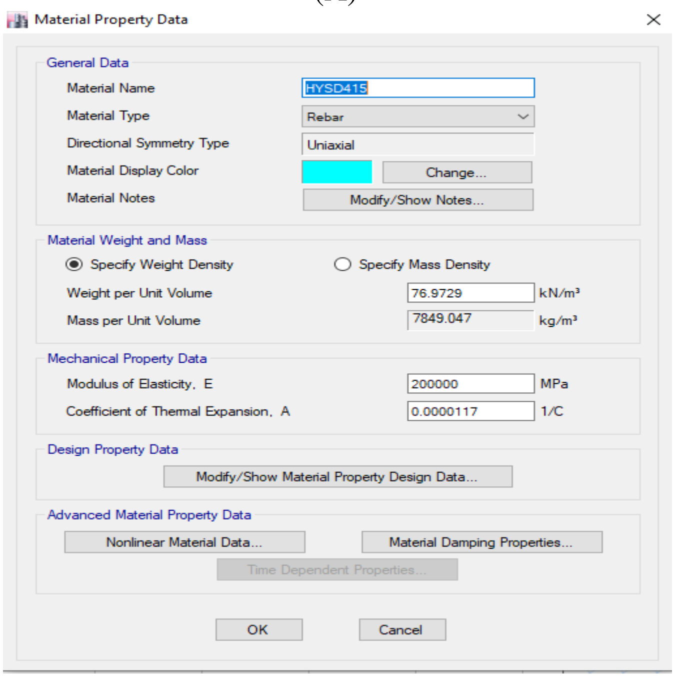


Fig 6 Plan View

Step 6: Defining material property to the designed frame assigning concrete and rebar to the entire frame.



(A)



(B)

Fig 7 (A) Selection of material type concrete with grade M25. (B) Selection of Rebar HYSD 415 with the predefined properties.

Step 7: Defining section properties namely column and beam. Here the depth and beam is considered as 400mm and 400mm with concrete rectangular shape with the predefined material as M25. Considered rebar material was HYSD415.

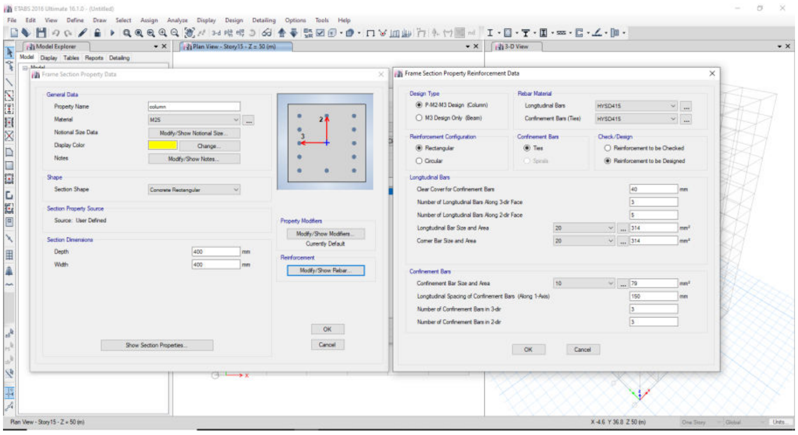


Fig 8 Defining section properties to the frame with the predefined material.

Step 8: Defining and Assigning Slab Data considering shell thin type with thickness of 125mm.

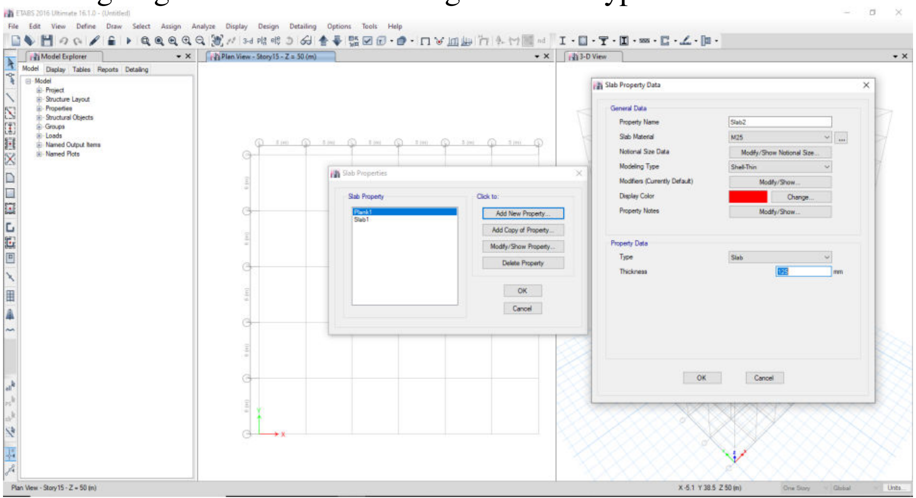


Fig 9 Defining Slab Property Data

Step 9: Assigning Fixed Support at the bottom of the structure.

Step 10: Designing Load combination for concrete frame design.

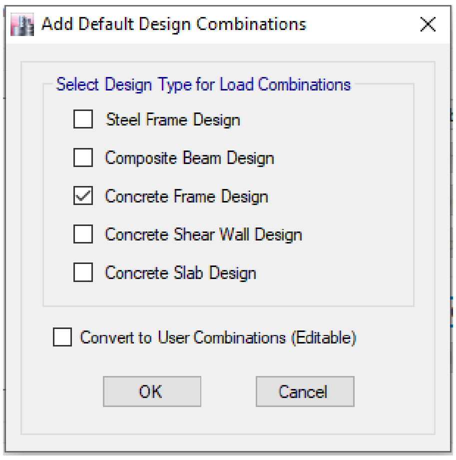


Fig 10 Designing load Combination.

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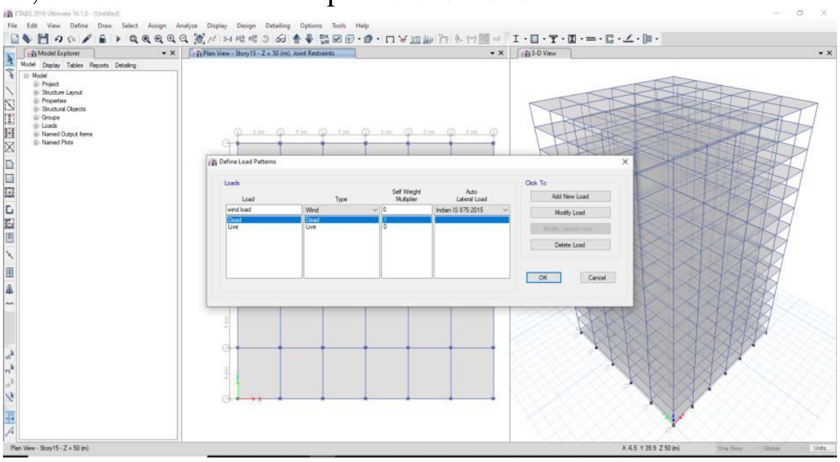
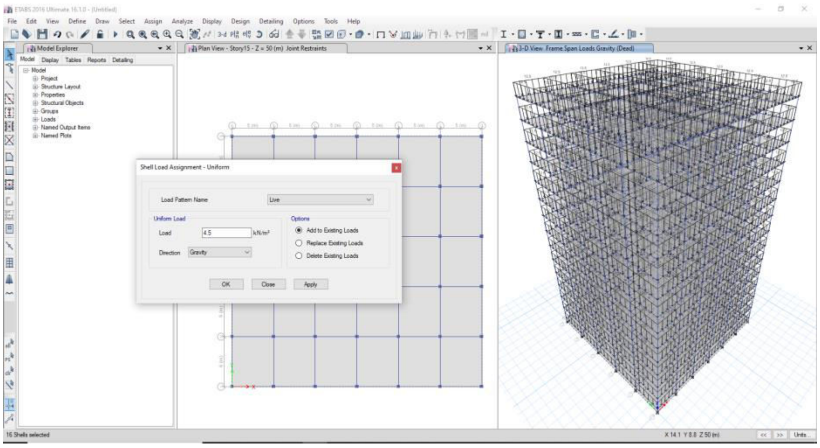
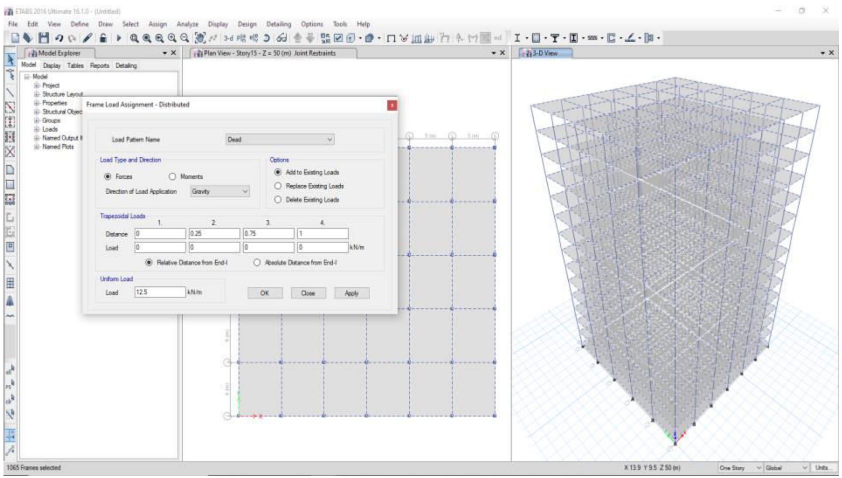
Step 11: Defining Dead, live and wind load as per IS 875:2015.



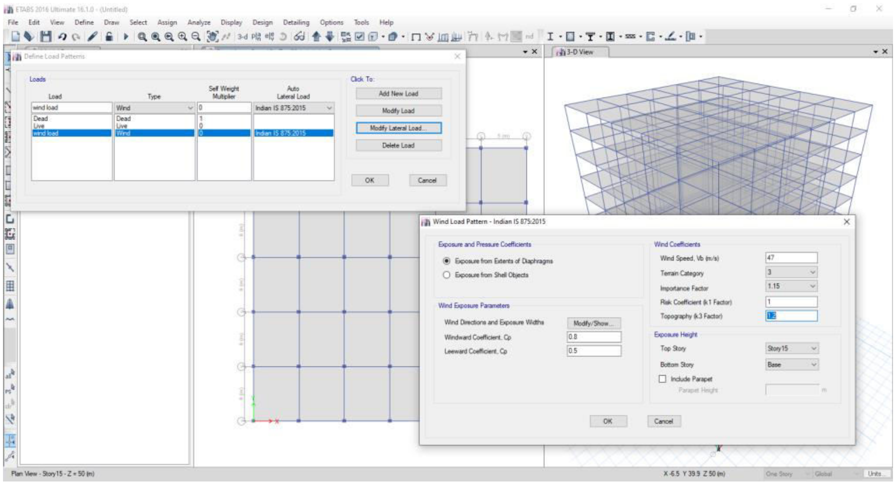
(A) Defining Load pattern.



(B) Defining uniform Shell Load Assignment.



(C) Defining Distributed Frame Load Assignment with uniform load 12.5 kN/m.



(D) Defining Wind Load Pattern as per IS 875-2015.

Fig 11 (A) assigning live, dead and wind load as per IS 875:2015.

Step 12: Analysis of the model on basis of bending moment, displacement and shear force.

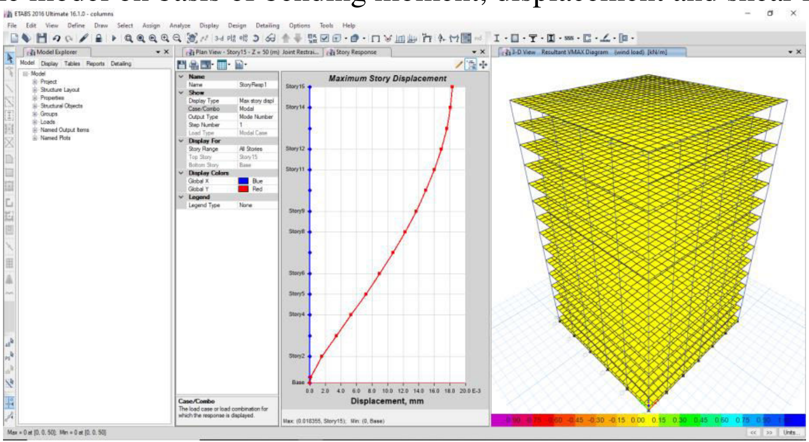


Fig 12 Analytical Results

Step 13: Valuating the results and tabulating the values for the comparative analysis using MS Excel.

Table 1: Geometrical description

Structural Data	
No of stories	G+15
Plan shape	Rectangle
Plan Dimension	20m x 30m
Typical Floor height	2.7m, 3m and 3.5m
Typical Column Size	(400mmx400mm)
Typical Beam Size	350mm x 250mm
Slab thickness	125mm
Damping	5% for RCC, 2% for steel
Grade of concrete	M-25

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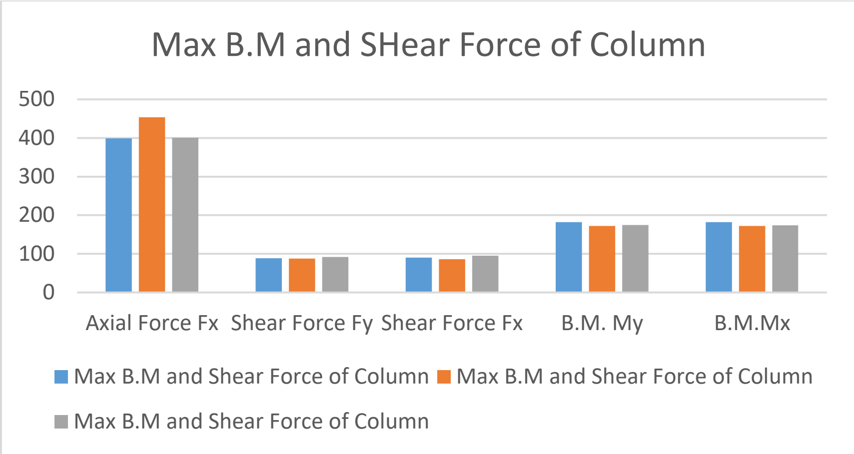
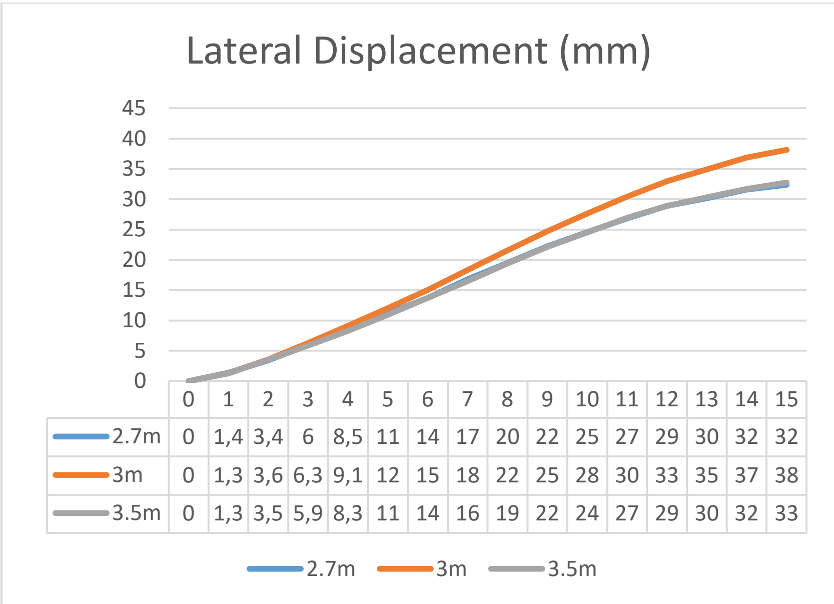
Grade of steel	Fe-415
Live load	3 KN/ sq.m.
Floor Finish	1.5 KN/ sq.m
Soil Type	Medium

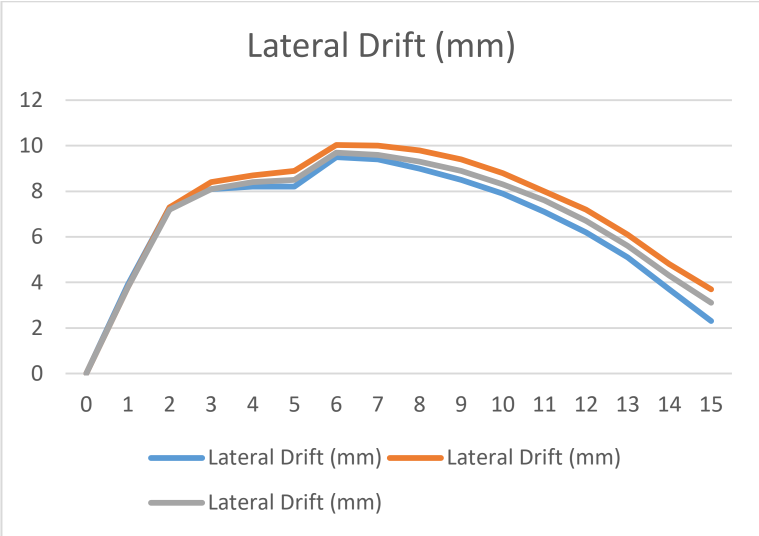
Analysis:



Graph 1: forces in column



Graph 2: Storey Displacement



Graph 3: Lateral Drift

Conclusion:

The distinction drawn from numerical examples is summarized as follows:

(1) Maximum Bending Moment and Shear Force on Beam

Bending moment increased with increase in floor to floor height of the structure whereas shear force decreased with increase in height. Bending moment was valuated in in Y and Z direction and shear force was valuated in Z direction. Increase in 4.8 % was seen as increase in height and decrease of 7.1 % was seen in shear force with increase in height when beam was subjected to force.

(2) Maximum Bending Moment and Shear force on Column.

Axial Force, Shear Force and Bending Moment was compared in different directions. Axial Force was maximum in Case II in comparison to other two cases and similar results were seen while valuating shear force in X and Y Direction.

Storey Displacement

Storey displacement was maximum in Case II with increase in gap of results from 4thstorey and increase drastically in comparison to other two cases which proved that other cases were more favorable.

Storey Drift

The results were quite similar till 4thstorey in all the three cases and the results prominently changed with increase in storey. Maximum Drift was seen in 6thstorey in Case II in comparison to other considered cases and the values decreases in the curves after 7thstorey.

References:

1. Koji Kinoshita and Shogo Yamamoto, [Analyses of RC columns in a variety of sizes], The 5th International Conference of Euro Asia Civil Engineering Forum (EACEF-5), Procedia Engineering 125 (2015) 1114 – 1120.

2. MarkandeyaRajuPonnada, [Effect of Column Spacing on Economy of G+5 R.C Moment Resisting Frame – A Typical Computer Aided Case Study], International Journal of u- and e- Service, Science and Technology Vol.8, No.4 (2015), pp.85-102.

3. ILOEGBU L. B, CHIDOLUE C.A and EZEAGU C. A, [The Effects of Design Methods on Compressive Members in Steel Frame Work], FEB 2019 | IRE Journals | Volume 2 Issue 8 | ISSN: 2456-8880.

4. ApoorvChoudhary, Milind Malik, Jay Prakash, Ajay Kumar and Sachin Tiwari, [A numerical analysis on slender columns for flat-plate structures using finite element method (FEM) technique], Material Science Engineering, 455, (2018).

5. KuldeepDubey and Dr. Rakesh Patel, [Reliability Analysis of Multi-Storey Building with Floating Column for Long Span], International Journal of Innovative Research in Science, Engineering and Technology, Vol. 7, Issue 9, September 2018.

6. Mohammad Hossain and Fayez Moutassem, [Column Slenderness Analysis for Reinforced Concrete Frame Structures using Finite Element Modelling], Journal of Buildings and Sustainability, 2017, Vol. 2, No. 2.
7. Jawid Ahmad Tajzadah and Vimlesh V. Agrawal, [Effect of Column Size, Shape and Orientation on Seismic Performance of RC Building], Journal of Emerging Technologies and Innovative Research (JETIR), May 2019, Volume 6, Issue 5.
8. SayyedFerozSikandar, Shaikh Zameeroddin. S and Agrawal. A. S, [Analysis and Design of Multistory Building using ETABS 2017], IJESC, June 2019.
9. Chunyi Yu, HuaMa , YongpingXie , Zhenbao Li and Zhenyun Tang, [Size Effect on the Seismic Performance of High-Strength Reinforced Concrete Columns with Different Shear Span-to-Depth Ratios], Hindawi Mathematical Problems in Engineering, Volume 2018, Article ID 2723198, 19 pages.
10. A. Webber, J.J. Orr, P. Shepherd and K. Crothers, [The effective length of columns in multi-storey frames], Engineering Structures 102 (2015) 132–143.