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DESIGN AND ANALYSIS OF G+30 BUILDING BY USING ETABS SOFTWARE

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ABSTRACT
The majority of buildings have simple geometry, with vertical columns and horizontal beams. In most situations, a basic grid system consisting of horizontal floors and vertical column lines may generate building geometry with little effort, even if ETABS version 2009 allows for any structure form. The floor levels of many structures are comparable. Modelling and design time may be significantly decreased by using this commonality.

Our primary goals are to finish a high-rise building, make sure the structure is safe and cost-effective under gravity loading circumstances, and accomplish the purpose for which the buildings were constructed. Both the dead load and the live load are taken into account while designing the structure. The ETABS software tool was used for the structure's study and design. IS 456-2000 is in agreement with the design.

ETABS software is used in this research to model, analyse, and design the G+30 building. Analysis outcomes such as storey drift, shear, bending, and torsion are examined. The G+30 building model is used to carry out the design outcomes, such as beam scheduling, column scheduling, and foundation design.

Key words: ETABS 9.7.4, narrative drift, shear force, building torsion, bending moment, foundation design, beam design and column design; earthquake.

I. INTRODUCTION

1.1 General

Since our nation is the one with the highest rate of population growth in the world, there is a demand for housing for densely populated cities. Since land is expensive and more horizontal development is not feasible due to space constraints, vertical expansion is the only viable option. The fundamental component of civil engineering is structural design. The design of a building's fundamental elements, such as slabs, beams, columns, and footings, is the most fundamental aspect of structure. It's crucial to first get the building's blueprint in order to create them. Thus, the arrangement of beams and the placement of columns are established based on the appropriateness plan. The vertical loads—the dead load and the live load—are then computed. The component that bears the load initially, such as the slabs, may be developed after the loads have been determined. Slab design is influenced by the end state, loading, and whether the slab is one-way or two-way. The loads are transmitted to the beam from the slabs.

Triangular or trapezoidal loads may be applied to the beam from the slabs. The beam may be designed based on this. The columns then absorb the loads from the beams, primarily shear loads. Knowing the moments that columns are exposed to is essential for their design; the Kanis approach is used for frame analysis. The design of the column is then undertaken based on eccentricity, end conditions, moments, and whether the column is short or thin. Lastly, the footings are developed depending on the soil carrying capacity value for that specific region as well as the loading from the column. Above all, the sections need to be examined for all components in terms of their strength and serviceability.

A complex, but user-friendly, special purpose analysis and design software created especially for building systems is called ETABS. Unmatched modelling, analytical, and design processes are combined with an easy-to-use and robust graphical user interface in ETABS Version 9.7.4, which is entirely integrated utilising a single database. ETABS is the tool of choice for structural engineers in the construction business because it can handle the biggest and most complicated building models, including a broad variety of nonlinear behaviours, whilst being rapid and simple for basic structures.

1.2 Design philosophies

Three design theories exist for reinforced concrete, including:

1. Working stress method
2. Ultimate load method
3. Limit state method

Stages in structural design

The following steps are included in the structural design process:

1. Structural planning.
2. Estimation of loads.
3. Analysis of structure. Member design.
4. Drawing, detailing and preparation of structures.

1.3 Design of high rise buildings

The number of tall residential and commercial buildings has significantly increased recently, and higher constructions are the current trend. Tall buildings are a common feature in both developed and developing economies these days. As the population grows and there are fewer open spaces, multi-story buildings are becoming more and more popular in place of single-story structures. As a result, special consideration must be given to the analysis of these structures by taking into account the dynamic nature of earthquakes and wind. Therefore, the impacts of lateral loads, such as earthquake and wind forces, are becoming more and more significant, and almost every designer must deal with the challenge of providing sufficient strength and stability against lateral pressures. Therefore, while designing high-rise buildings, it is important to assess the wind and seismic loads.

Objectives of the study

The goals of the research are as follows:

1. To use response spectrum analysis to determine the design lateral forces on G+30 story structures.
2. To use Zone 2 seismic zones to examine the construction.
3. To determine how structures will react to low, middle, and high frequency ground vibrations, among other kinds of ground motions.
4. To conduct research utilising the IS 456-2000 code.

Summary

The majority of buildings nowadays are characterised by uneven vertical and plan arrangements. A detrimental coupled lateral response may result from irregularities in arrangement and a lack of symmetry, which may indicate important eccentricity between the building mass and stiffness centres (Giordano, Guadagnuolo, and Faella, 2008). Furthermore, it takes a lot of engineering and design work to design and analyse an irregular structure, but a bad designer will develop and analyse choices that are simple to understand. To put it another way, those with irregular choices suffer more harm than those with regular ones. As a result, irregular buildings need a more thorough structural study in order to function well after a catastrophic earthquake (Herrera, Gonzalez, and Soberon, 2008).

Indian Standard Code (IS 1893) anomalies in elevation and plan: The structure's irregularities may be divided into two categories: plan and vertical. These are frequently distinguished by five different types, such as torsional, re-entrant corners, diaphragm separation, out-of-array offset, and non-parallel systems for plan irregularities, and stiffness (soft storey), mass, vertical geometric, in-plane separation in vertical components resisting lateral force, and separation in capability (weak storey) for vertical irregularities. (Part I of IS 1893: 2002)

The irregularity of the re-entrant corners was described in IS 1893 (Part I): 2002. Every projection of the structural document serves as a template for the re-entrant corner irregularity arrangement seen in a building's lateral force-resisting system. The Journal's website offers the option to download an electronic copy. Please contact the journal publishing committee using the information provided on the journal website if you have any issues about the article guidelines. The conference website has details on submitting the final paper.

II. LITERATURE REVIEW

R.Master Praveen Kumar, A. Pavan Kumar Reddy, et al. (2017)

We have known since ancient times that earthquakes may cause disasters. These days, buildings are becoming narrower and more prone to wobble, which makes them more dangerous during earthquakes. In the past, engineers and researchers have sought to make buildings earthquake-resistant. Using ETABS 9.7.4, it has been demonstrated through numerous functional reports that the use of lateral load resisting techniques in the construction configuration has significantly improved the structure's performance in earthquakes. Work has been done for the unique instances using shear walls and bracings for the exceptional heights, with a maximum top regarded for the reward gain knowledge of being 93.5m. The modelling is finished in order to investigate the effects of certain heights and peculiar conditions on seismic parameters such as base shear, lateral displacements, and lateral drifts. As specified in IS 1893-2002, the information gained has been applied to Zones IV and V in Soil Type II (medium soils).

According to the study's findings, story drift in zones 4 and 5 rises from the top story to the bottom story, with story 31 seeing the most drift in comparison to other stories. When comparing the drift values in zones 4 and 5, we find that zone 5 has a larger drift value. When compared to the forces in all stories for zones 4 and 5, the story shear is at its highest at those times. When compared to zone 4, the shear value in zone 5 is greater. When compared to X and Y direction support responses in zones 4 and 5, the Z direction force for support reactions has the highest value. When compared to the Y and Z direction moments in zones 4 and 5, the X direction moment for support responses has the highest value.

A. Mounika Vardhan, Narla Mohan, et al. (2017)

When an earthquake occurs, a structure will vibrate in response. The vertical direction (z) and the two horizontal directions (x and y) are the three mutually perpendicular directions that make up an earthquake force. The building shakes or vibrates in all three directions as a result of this motion, with horizontal shaking being the most common direction. When analysing reinforced concrete structures, it is crucial to take into account the effects of lateral stresses caused by earthquakes and wind, particularly for high-rise buildings. Buildings should be able to withstand small earthquakes without suffering damage, according to the fundamental goal of analysis for earthquake-resistant constructions. It may withstand mild earthquakes without suffering structural damage, although sometimes non-structural damage can withstand strong earthquakes without the principal structure collapsing. Only multi-story commercial buildings made of reinforced concrete (RC) with FOUR distinct zones—II, III, IV, and V—are included in this research. ETabs, a program for FEM software, is used to carry out the study. Twenty stories with a constant storey height of three meters make up the study's building model. Four models with varying bay lengths are analysed; for ease, the number of bays and the bay-width along two horizontal directions are maintained constant in each model. Various SEISMIC ZONE FACTOR values are obtained, and the findings are evaluated in light of their respective impacts.

This research came to the conclusion that when we go into greater seismic zones, the base shear of the structure rises. ZONE V's base shear value is 2889 KN, whereas ZONE II's is 802.6 KN for a comparable structure. This indicates that if seismic ZONE shifts from II to V, base shear rises by more than 350%. As earthquake zones expand, so does the displacement of building models. At the base, the displacement is extremely low, and at the ceiling, it is quite high. ZONE II has a displacement of 0.1033, whereas ZONE IV has a displacement of 0.372. This indicates that if seismic ZONE shifts from II to V, base shear rises by more than 27%. The more wind pressure there is, the more building models relocate. At the base, the displacement is extremely low, and at the ceiling, it is quite high. The displacement is 0.2411 at wind speeds of 39 m/s and 0.3963 at wind speeds of 50 m/s. This indicates that from 39 m/s to 50 m/s, the displacement has increased by more than 50%.

I. Ramaprasad Reddy, J. Chiranjeevi Yadav, et al. (2017)

Buildings with the best results in terms of the best sizing and reinforcing of the structural elements—primarily beam and column members in multi-bay and multi-story RC structures—are becoming more and more important in the current construction industry. In addition to saving money compared to standard state-of-the-art design techniques, optimum sizing takes into account the best stiffness correlation between structural parts. "Optimisation" refers to producing the best possible situation. There have been difficulties in the pursuit of unprecedented heights and architectural designs. The rigidity of the structure becomes increasingly crucial as the building's height grows. Due to dominant lateral loads, tall constructions have been able to ascend higher and higher despite odd loading effects and very high loading values. Tall structures must be designed with human comfort, serviceability, strength, and stability in mind. As a result, the impacts of lateral loads, such as wind loads and earthquake forces, are becoming more significant, and almost all designers must deal with the challenge of providing sufficient strength and stability against lateral loads. In addition to comparing the outcomes of zones 2 and 5, the effects of lateral load on moments, axial forces, shear force, base shear, maximum storey drift, and tensile forces on the structural system are examined.

According to the study's findings, zone 2 soils have larger story drift x and story drift y in earthquakes than spectrum, as shown by table 2, graph 1, and table 3 graph 2. Graph 19 and Table 21 and Graph 20 show that zone 5 has more narrative drift than zone 2. According to table 22, graph 21, and table 23, graph 22, zone 5 has more narrative shear than zone 2. Etabs will get the designs for each and every participant. All of the failed beams will be listed, and the software will also provide a higher section. Software is used to increase accuracy.

K Jaya Prakash, V. Rajesh, and others (2016)

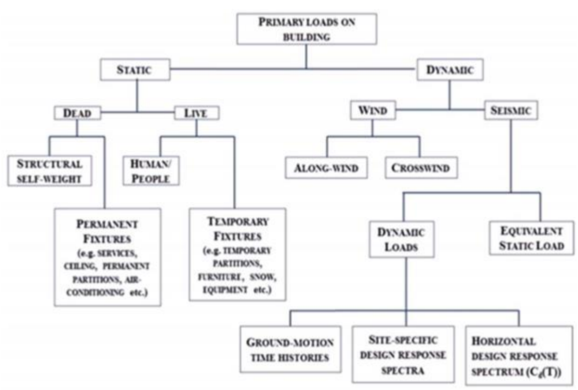
These days, buildings are designed to meet our basic needs and provide better serviceability. Building construction is not a problem in any way; what is crucial is creating an effective structure that will function well for many years to come. "Wind and seismic analysis and design of multi-story buildings" (G+30) is the project's title. The purpose of "BY USING STAAD PRO" is to find a better way to create geometry, define cross sections for columns, beams, etc., create specifications and supports (to define whether a support is fixed or pinned), and then define loads. "Run Analysis" is then used to analyse the model. The results are then reviewed to see whether the beam column passed or failed in loads. After that, the design is carried out.

The top beams of a building under wind load combination required more reinforcement than the building under seismic load combination, as can be seen from the comparison of two 30-story buildings with the same beam and column size but different load combinations—for instance, beam number 1951 required five 20 mmØ and six 20 mmØ bars, while the building under seismic load combination required thirteen 10 mmØ and twenty-one 10 mmØ bars. However, compared to seismic, wind load combinations exhibit more deflection and shear bending. However, more strengthening is needed for the wind load combination in lower beams. The area and percentage of steel needed for a column are always higher for wind load combinations than for seismic load combinations. (For instance, column no. 129 Whereas the SL combination requires an Ast of 1911 mm2 and a percentage of steel of 3.43, the WL combination requires an Ast of 8371 mm2 and a percentage of steel of 1.56. Compared to the SL combination, the WL combination has a higher deflection value.

III. STRUCURAL LOADS AND THEIR CALCULATIONS

3.1 Loads on Models

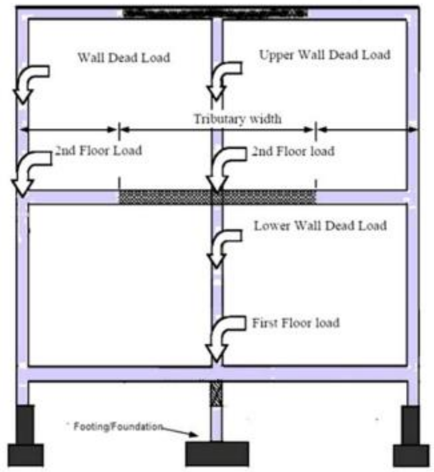
Although not all constitutions now analyse or design for all of these forces, gravity, wind, and earthquakes are the main hundreds of factors that determine the construction of many on-ground structures. A unique structure's location, problem, environmental requirements, architectural design, height, width, use, client needs, and other factors all influence its structural analysis. As shown by determine, hundreds that emerge on a multi-story building may also be generically classified into static and dynamic loads and their derivatives.



Loads on model

GRAVITY LOADS

Gravity hundreds, also known as gravitational loads or vertical hundreds, are masses and forces that appear towards the earth's core. Determine 4.2, which also displays the load tributary region or load catchment topic of the vertical assistance, i.e., column, provides the fundamental determine of vertically acting hundreds. Dead hundreds (G) and living hundreds (Q) are included in the gravity masses, which are computed using IS (determine 4.1).



Basic figure of gravity load flow

Dead loads

Dead loads are fixed or permanent loads that are applied to a structure during the course of its lifetime. Dead loads are mostly caused by the self-weight of permanent walls, structural components, and fixed fixtures and equipment. These loads will be computed by multiplying the unit weight by an estimate of each material's quality. IS: 875(PART-1)-1987 provides the unit weight of the different materials used in building construction. The following lists the unit weights of frequently used construction materials.

Weights per unit of typical construction materials

S. No	Materials	Unit Weight kN/m^3
1	Plain concrete	24
2	Reinforced concrete	25
3	Brick masonry , cement plaster	20
4	Stone masonry	24
5	Wood	8
6	Steel	78.5
7	Floor finish	0.6-1.2

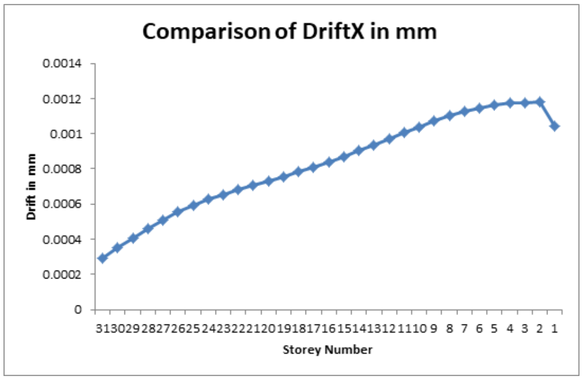
IV. RESULTS AND ANALYSIS

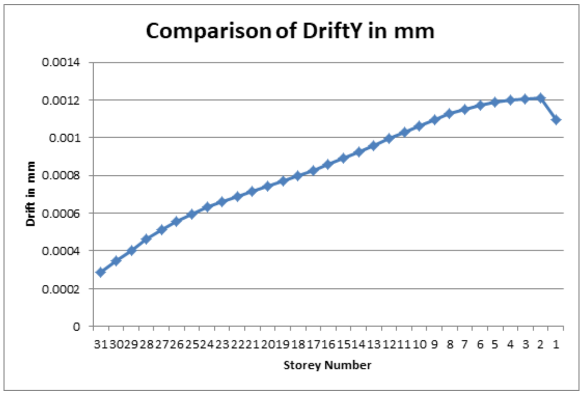
Comparison of Storey Drift in X Direction

Story Number	Drift X in mm
31	0.000294
30	0.000351
29	0.000409
28	0.000463
27	0.000511
26	0.000555
25	0.000593
24	0.000626
23	0.000655
22	0.000681
21	0.000706
20	0.00073
19	0.000755
18	0.000782
17	0.00081
16	0.00084
15	0.000872
14	0.000905
13	0.000938
12	0.000973
11	0.001007
10	0.00104
9	0.001072
8	0.001101
7	0.001127
6	0.001148
5	0.001163
4	0.001173
3	0.001176
2	0.001179
1	0.001045

Comparison of Storey Drift in Y Direction

Story Number	Drift Y in mm
31	0.000286
30	0.000345
29	0.000405
28	0.000461
27	0.000512
26	0.000557
25	0.000597
24	0.000632
23	0.000663
22	0.000691
21	0.000717
20	0.000742
19	0.000769
18	0.000797
17	0.000826
16	0.000857
15	0.00089
14	0.000924
13	0.000959
12	0.000994
11	0.00103
10	0.001064
9	0.001097
8	0.001127
7	0.001153
6	0.001175
5	0.001191
4	0.001201
3	0.001205
2	0.001211
1	0.001094





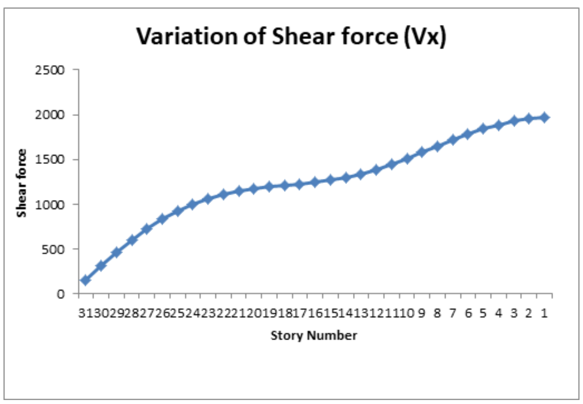
Storey Shear

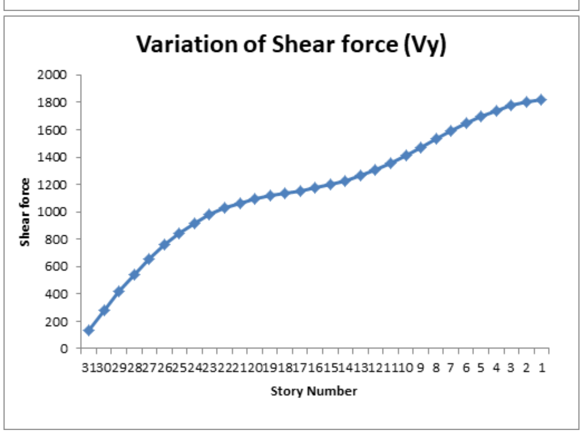
X Direction

Story Number	Shear force (VX) in kN
31	147.77
30	311.5
29	462.83
28	600.46
27	723.39
26	830.97
25	922.96
24	999.56
23	1061.44
22	1109.78
21	1146.3
20	1173.23
19	1193.27
18	1209.5
17	1225.2
16	1243.62
15	1267.64
14	1299.42
13	1340.18
12	1390.03
11	1448.03
10	1512.4
9	1580.75
8	1650.41
7	1718.61
6	1782.7
5	1840.3
4	1889.34
3	1928.17
2	1955.53
1	1971.37

Y Direction

Story Number	Shear force (VY) in kN
31	132.91
30	280.94
29	418.56
28	544.57
27	658.03
26	758.3
25	845.1
24	918.53
23	979.08
22	1027.72
21	1065.83
20	1095.26
19	1118.22
18	1137.29
17	1155.17
16	1174.57
15	1197.93
14	1227.13
13	1263.33
12	1306.81
11	1356.98
10	1412.51
9	1471.53
8	1531.85
7	1591.16
6	1647.21
5	1697.9
4	1741.41
3	1776.24
2	1801.27
1	1816.31





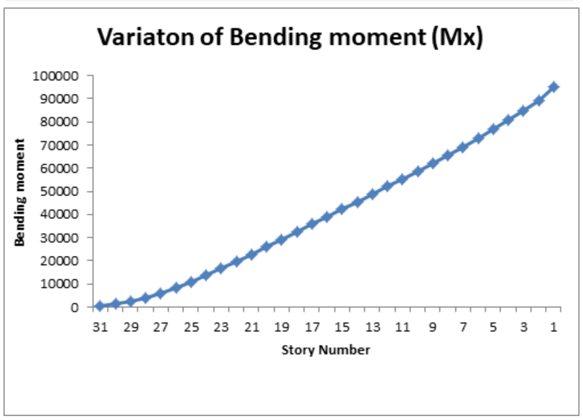
Storey Bending

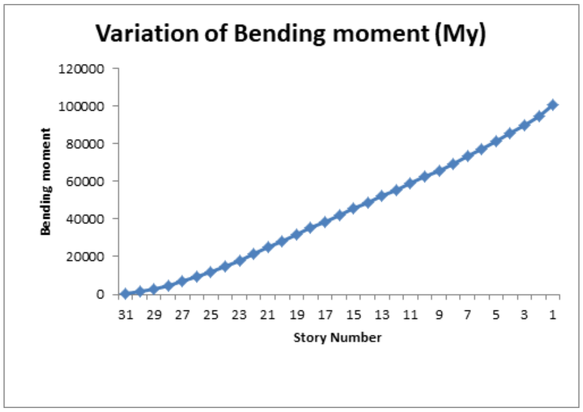
X Direction

Story Number	Bending moment (MX) in kN-m
31	398.732
30	1241.523
29	2497.057
28	4130.314
27	6103.26
26	8375.656
25	10905.96
24	13652.31
23	16573.49
22	19630.04
21	22785.22
20	26006.03
19	29264.13
18	32536.67
17	35806.87
16	39064.56
15	42306.27
14	45535.19
13	48760.66
12	51997.4
11	55264.32
10	58583.06
9	61976.33
8	65466.12
7	69071.97
6	72809.46
5	76688.98
4	80714.97
3	84885.63
2	89193.03
1	95124.57

Y Direction

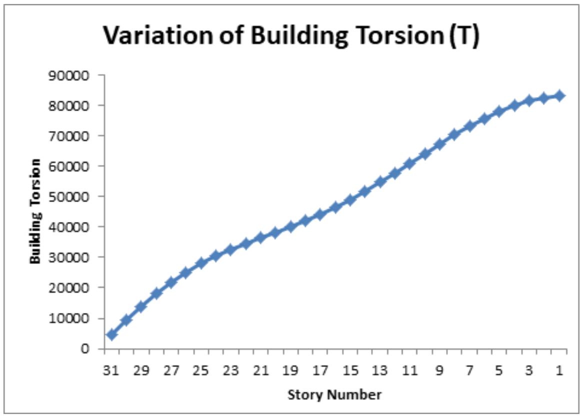
Story	Bending moment (MY) in kN-m
31	443.301
30	1377.777
29	2766.108
28	4566.969
27	6735.813
26	9225.81
25	11988.88
24	14976.82
23	18142.42
22	21440.69
21	24830.03
20	28273.32
19	31739.04
18	35202.16
17	38644.91
16	42057.27
15	45437.22
14	48790.55
13	52130.38
12	55476.09
11	58851.96
10	62285.38
9	65804.76
8	69437.36
7	73207.18
6	77133.13
5	81227.55
4	85495.43
3	89934.02
2	94533.22
1	100885.5



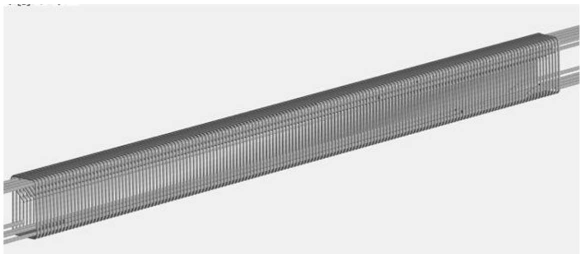


Building Torsion T

Story Number	Building Torsion (T) in kN-m
31	4448.486
30	9382.82
29	13950.08
28	18114.12
27	21850.27
26	25149.07
25	28020.83
24	30501.34
23	32657.24
22	34585.05
21	36396.76
20	38196.84
19	40067.71
18	42068.53
17	44239.42
16	46604.79
15	49174.31
14	51942.33
13	54887.01
12	57970.56
11	61140.95
10	64335.23
9	67483.54
8	70513.39
7	73353.41
6	75936.44
5	78201.98
4	80098.03
3	81582.36
2	82623.27
1	83226.88



Reinforcement Cage view for Example Beam



Reinforcement Cage view for Example Column

V. CONCLUSION

The research mentioned above led to the following results.

1. From the top tale (the thirty-first story) to the bottom story (the first story), the values of narrative drift rise.
2. Shear force rises from the top story (the thirty-first story) to the bottom story (the first story) in both the X and Y directions.
3. From the top story (the thirty-first story) to the bottom level (the first story), the values of the building moment rise in both the X and Y directions.
4. From the perspective of building torsion, the maximum torsion values increased from the top story (the thirty-first story) to the bottom level (the first story).
5. Designing using software such as ETABS saves a significant amount of time. Every member's details will be acquired by ETABS.
6. The program will provide a higher section along with a list of all failed beams. Accuracy is increased by software.

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