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Computational Intelligence on High Rise Structure with Effect of Diverse Load Conditions

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Abstract

The construction of high-rise buildings all over the world and India is overgrowing. Steel has more advantages in the modern world. It provides an innovative frame system, easy assembly, a high weight-to-weight ratio, different strengths, and a more extensive section range. The high-rise structures are environmentally friendly, which is why steel is used in high-rise buildings worldwide. So far, designers have only considered gravity when planning buildings. Earthquakes, wind, and lateral forces have been added to the design. The challenge is to find the economic structure system of high-rise buildings in the Indian scenario. This document covers various structural steel systems: moment stabilization frame system, composite frame system, roof rack system with stabilizing belt, shear wall frame system, frame tube system. When designing multi-storey buildings, truss systems, cluster piping systems for high-rise buildings, lateral loads (wind or seismic loads) are mainly responsible for demolition, which usually determines structural systems for high-rise buildings. To make the drift as a minimum, the beams, and columns to be enlarged. In a building with a small number of floors, the lateral load rarely affects the increase in the building and the increase in size. Considering the live and dead loads, the component structure is an option for possible rearrangement of the structure. In other side load resistance systems under study, the side displacement in the torque frame is the highest. The lateral displacement of the double frame is the smallest, and the lateral displacement of the sliding wall system is slightly higher than that of the double system.

Keywords: Demolition & demolition between floors, shear wall & double frame wall system, bending & cross-brace frame

1. Introduction

The restrictions on the number of residential buildings and the high cost of available land nowadays, high-rise buildings are the most popular because increasing the structure's height increases the side load. A sturdy structure is essential for side loads, not structure that can withstand traction loads. They are only acceptable structural shapes that cause the elevation of concrete building, as

result, modern LCD skyscraper have become more complex than before. Therefore, it will be interesting to study structural systems and the related behavior of these structures. The transverse load structure consists of shear walls, composite columns, composite beams and cover plates. The shear wall has high rigidity on the plane. Therefore, they resist the lateral mass and

effectively deflect the deflection. The shear wall is universal in the orthogonal plane and can distribute the lateral load in its plane, thereby generating bending moment and shear resistance. Reinforced concrete columns, steel beams and concrete center pipes have recently been included in the construction. Most of the benefits of building a high-rise composite RCC are related to time and cost. The reinforced concrete column can be a compression element composed of a concrete-lined hot-rolled steel profile or a hollow profile filled with hot-rolled reinforced concrete and is mainly used as a supporting element of a heavy composite structure for a given cross-sectional size. Increased rigidity leads to decreased flexibility and increased bending strength; concrete-lined columns have moderate chimney resistance; corrosion protection of lining columns. The moment is usually obtained through different steel thickness, concrete strength and steel reinforcement. As a result, the external dimensions are maintained on multiple floors of the building, thereby simplifying the design and detailed design of the area of interest. Construct buildings very economically. The hollow concrete contour does not require X formwork. As can be seen from the name, I-beam (or I-beam) is produced in the factory in the form of a capital letter "I". The core of the I-beam, usually called the web, can provide shear resistance. Sanhik Kar et al. (2014) [1] Analyzed and designed different types of building structures using the design software STAAD.prov8i [G + 7]. In this study, the seismic and wind effects according to the codes IS: 875 (Part-3) and IS: -1893-2002 (Part-1) and IS: 875 (Part-1 and Part-2 A) were considered and compared. . The software is designed to analyze all types of factors and analyze different types of structures under wind pressure and earthquakes. The corresponding conclusions are as follows: 1. the wind acts on each building. The code determines the wind intensity according to the following: For each building, the seismic force and seismic intensity depend on the location, importance, and structure of the building. The periodic factor of the elements depends on the size and weight of the building and the overlap, which will determine when the wind speed and the base area factor in a certain area of India will change. For the following situations, the design of the area

will be more economical. Anupam Armani and others. (2015)[2, 6] Discussed the analysis and research carried out in it. Viol is a 15-story, 30-story and 45-story multi-storey building. Several bridges and buildings with different shapes are being studied, namely, circle, rectangle, square and triangle. Subsequently, the results of buildings with different shapes and different floors are explained, making it possible to infer which shape of the building, depending on the height, is more stable for different conditions. Reddy et al. (2014) [3, 5] conducted a comparative study of wind and seismic loads to determine the design loads of multi-storey buildings. According to IS 1893, the seismic load of multi-storey buildings in different areas is analyzed, and the wind load is analyzed according to IS 1893. IS: Code 875 estimates the wind load based on the planned wind speed in the area, with a deviation of 20%. The wind load generated on the building was compared with the seismic load. Finally, the wind load was determined by Mahesh et al. (2014) [4,7-8]. They used ETABS and STAAS PRO V8i to inspect the earthquake and wind loads of the G+11 multi-storey residential building. It is assumed that the material properties are linear, static and dynamic. These analyses are carried out in consideration of the effects of various earthquakes.[8-12].

2.Behavior Moment Resistance Structural Systems

As the number of floors increases, managing demolition becomes difficult and expensive. The rigid frame bears side loads by generating shear and bending moments in the frame parts and connectors. Bend along a hyperbola, with are verse bending point approximately in the middle of the floor. By bending the hinged beam into a double curvature and having a reverse bending point around the center span, the moment at the joint can be accommodated. The type of lateral deformation is usually in a shear state. The total lateral load moment is offset by the torque generated by the axial thrust and pressure of the strut. This type of deformation has a curved configuration with a shear structure. Two cycles of torque distribution, the gantry or cantilever method, can solve the torque tight frame problem to approximate the rod force caused by the horizontal load. Soil demolition and total demolition are the sums of these three components, namely, soil demolition

caused by beam rotation, soil demolition caused by column rotation, and soil demolition caused by ordinary bending. In the past, supports were used as lateral load protection systems in most of the tallest buildings in the world. Different types of brackets can be used for the structure, such as B. Single diagonal, double diagonal, V-shaped, inverted V-shaped, K-shaped bracket, eccentric bracket, limited buckling support, etc. The belt for vertical truss. Side loads in buildings are reversible; therefore, the bond is subject to tension and contraction but is usually designed to compress and control tension. The axial force resists the horizontal shear in the diagonal and the girders. At the same time, the external moments are counteracted by the axial tension and tension forces and the compression in the diagonal and the girders. As the uprights under the side load frame deform axially, they will deflect in a bent state. The axial deformation in the inclined beam and the frame deflects in the form of shear. The resulting deflection shape is a combination of bending deformation and shear deformation. The main disadvantage of this system is the internal partitions and obstacles to the arrangement of doors and windows.[13-18].

3. Work on Computational

Analysis and design are done by using ETABS Software, different loads taken for analysis and design and. With the help of IS 875 (part-3rd), analysis and design are done for wind load, and for RCC, we have used IS 456.

Type of analysis: Linear analysis

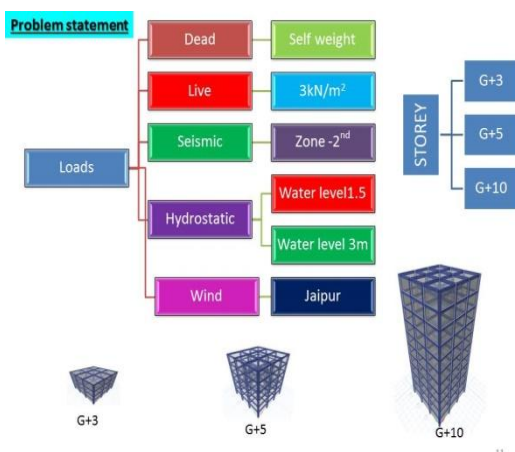


Fig 1: Problem statement and distinct load conditions

Problem: Analysis and design of RCC g+3, g+5, g+10 storey building under the action of self-

weight, live load Earthquake force Building is existing in Jaipur Span =5m.

Loads Before a structure can be analysed, the nature & magnitude of loads must be known.

Following are the critical type of loads.

Dead Load: This can be precisely known. The weight of the structure & components permanently attached to the structure contribute to the dead load. IS: 875-1978 list unit weights of materials required to evaluate dead load.

Live Load: From IS: 875 – 1978, we get the live load values for various buildings.

Wind load: These loads are frequently of such short recurring to cause inertial forces in the structure. So this is addition to the applied loads, some effects cause dimensional changes in the structure. If the structure's support conditions prevent these changes, internal stresses must be calculated.

Dead Loads: Considered dead load as follows.

Depth of beam section = 450 mm

Each storey height = 3300 mm

Thickness of brick wall = 200 mm

Thickness of plaster = 25 mm each side

Brick material density = 22 kN/m³

Unit weight of concrete = 25 kN/m³

Weight of wall = (3.3-0.5) x 0.2 x 22 = 12.32 = 12.32 kN/m

UDL of plaster = (3.3-0.5) x (0.025x2) x 25 = 3.375 = 3.6 kN/m

Total load = 12.32 + 3.6 = 15.92 kN/m

UDL of wall on outer beam = 15.92 kN/m

Thickness of partition wall = 100 mm thickness

UDL coming on interior beam = 7.7 kN/m

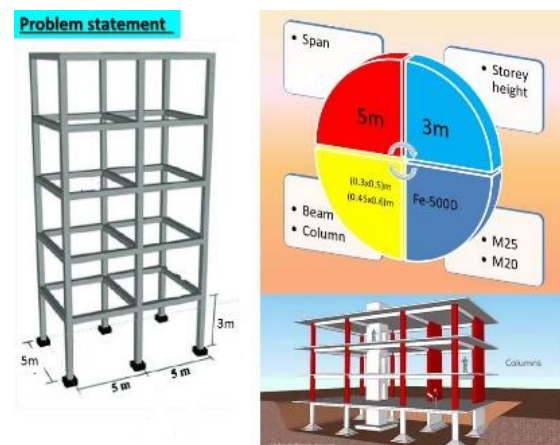


Fig 2: Problem statement parameters

4. Experimental Results and Discussion

Case -1: (DL+LL)

Axial force comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live is acting. Found maximum axial force at the building base in all cases under load combination $1.5x$ (dead + live). The value of maximum axial force in G+3 storey building is 1221.19 kN (compression). Similarly, the maximum axial force in the G+5 storey building is 3204.4 kN (compression), and in the case of the G+10 storey, the building is 5334.7 kN (compression).

Shear force comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live is acting. Found maximum axial force at the building base in all cases under load combination $1.5x$ (dead + live). The value of maximum shear force in a G+3 storey building is 58.02 kN. Similarly, the maximum shear force in a G+5 storey building is 80.59 kN, and in the case of a G+10 storey building is 119.39 kN. Bending moment comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live is acting. The found maximum bending moment at the building base in all cases under load combination $1.5x$ (dead + live). The value of maximum bending moment in the G+3 storey building is 51.78 kNm. Similarly, a maximum bending moment in a G+5 storey building is 92.89kNm, and in the case of a G+10 storey building is 115.62 kNm.

Case -2: (DL+LL+HY)

Axial force comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and hydrostatic load is acting. Found maximum axial force at the building base in all cases under load combination $1.5x$ (dead + live). The value of maximum axial force in G+3 storey building is 1221.19 kN (compression). Similarly, the maximum axial force in the G+5 storey building is 3204.4 kN (compression) and in the case of the G+10 storey building is 5334.7 kN (compression). Shear force comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and hydrostatic load is acting. Found maximum axial force at the building base in all cases under load combination $1.5x$ (dead + live). The value of maximum shear force in a G+3 storey building is 58.02 kN. The maximum shear force in a G+5 storey building is 80.59 kN, and in

the case of a G+10 storey building is 119.39 kN. Bending moment comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and hydrostatic load is acting. The found maximum bending moment at the building base in all cases under load combination $1.5x$ (dead + live). The value of maximum bending moment in the G+3 storey building is 51.78 kNm. The maximum bending moment in a G+5 storey building is 92.89kNm & in the case of a G+10 storey building is 115.62 kNm.

Case -3: (DL+LL+WL)

Axial force comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and earthquake load is acting. Found maximum axial force at the building base in all cases under load combination $1.2x$ (dead + live + EQ). The value of maximum axial force in G+3 storey building is 802.3 kN (compression). The maximum axial force in a G+5 storey building is 1025.90kN (compression) and in the case of G+10 storey building is 2494.10kN (compression).

Shear force comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and earthquake load is acting. Found maximum axial force at the building base in all cases under load combination $1.2x$ (dead + live + EQ). The value of maximum shear force in a G+3 storey building is 37.78 kN. The maximum shear force in a G+5 storey building is 53.41kN, and in the case of a G+10 storey building is 79.31kN. Bending moment comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and earthquake load is acting. The found maximum bending moment at the base of building in all cases under load combination $1.2x$ (dead + live +EQ). The value of maximum bending Moment in G+3 storey building is 25.04kNm. The maximum bending moment in a G+5 storey building is 29.03kNm, and in the case of a G+10 storey building is 38.35 kNm.

Case -4: (DL+LL+EQ)

Axial force comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and earthquake load is acting. Found maximum axial force at the building base in all cases under load combination $1.2x$ (dead + live + wind). The value of maximum axial force in a G+3 storey building is 909.33kN (compression). The maximum axial force in the G+5 storey building is 1097.64kN (compression) and in the case of G+10

storey building is 3598.52kN (compression).

Table 1: Results of load case (dead load + live load)

Parameters	G+3	G+5	G+10
Axial force (kN)	909.33	1097.64	3598.52
Shear force (kN)	93.28	122.75	156.23
Bending moment (kNm)	67.13	98.25	173.42
Rebar percentage	Top - 0.27 Bottom- 0.28	Top -0.43 Bottom- 0.43	Top - 0.80 bottom -0.87

Shear force comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and earthquake load is acting. Found maximum axial force at the building base in all cases under load combination 1.2 x (dead + live + wind). The value of maximum shear force in a G+3 storey building is 93.28kN. The maximum shear force in a G+5 storey building is 122.75kN and in the case of a G+10 storey building is 156.23kN. Bending moment comparison of G+3 Storey, G+5 storey, and G+10 Storey buildings when dead, live, and earthquake load is acting. The found maximum bending moment at the base of building in all cases under load combination 1.2 x (dead + live + wind). The value of maximum bending Moment in G+3 storey building is 67.13kNm. The maximum bending moment in a G+5 storey building is 98.25kNm, and in the case of a G+10 storey building is 173.42 kNm.

Table 2: Results of load case (dead load +live load +Wind load)

Parameters	G+3	G+5	G+10
Axial force(kN)	1221.198	3204.4072	5334.75
Shear force(kN)	58.02	120.138	119.389
Bending moment (kNm)	51.789	92.89	115.629
Rebar percentage	Top-0.30 Bottom- 0.23	Top-0.34 Bottom- 0.27	Top- 0.46 Bottom- 0.25

From Table 2, one can conclude that shear force increment in beam and column member in wind load is more than the earthquake and hydrostatic load.

Table 3: Results of load case (dead + live + earthquake)

Parameters	G+3	G+5	G+10
Axial force(kN)	802.3	1025.9	2494.1
Shear force(kN)	33.78	53.41	79.31
Bending moment (kNm)	25.04	29.03	38.35
Rebar percentage	Top-0.27 Bottom- 0.28	Top- 0.79 Bottom- 0.80	Top - 1.56 Bottom- 1.63

Table 3, one can conclude that in the case of earthquake force, the column moment increases compared to other wind and hydrostatic load so that column reinforcement percentage increases.

Table 4: Results of load case (dead+ live +hydrostatic load)

Parameters	G+3	G+5	G+10
Axial force(kN)	909.33	1097.64	3598.52
Shear force(kN)	93.28	122.75	156.23
Bending moment (kNm)	67.13	98.25	173.42
Rebar percentage	Top- 0.27 Bottom - 0.28	Top -0.43 Bottom- 0.43	Top- 0.80 Bottom- 0.87

From Table 4, one can find out that in the case of hydrostatic load in building structure up to 1 storey height is not significant due to less water level height and which cause the insignificant amount of forces induced from the hydrostatic load when the water level is less.

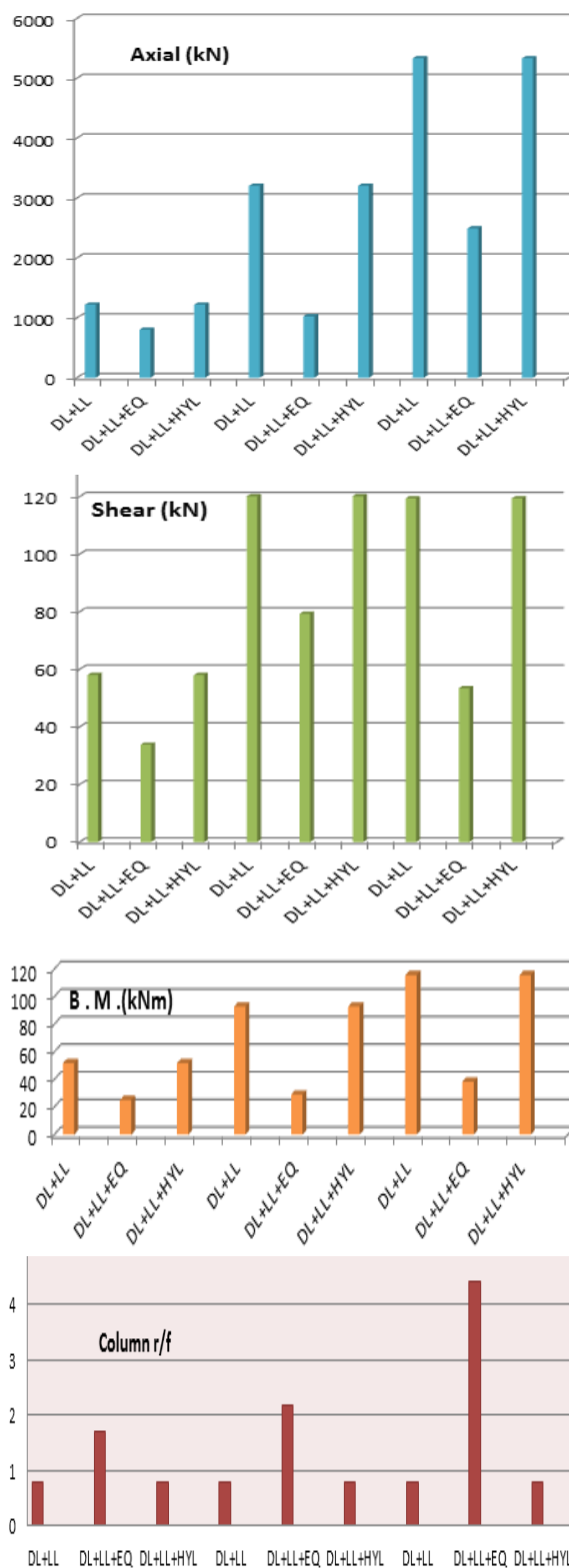


Fig.3: Different forces and column r/f for all load case and modals

Fig.3 showing that when we increase the structure height, the axial load increases proportionally. From bar chat, one can see that axial force for G+3 & G+5 building is lesser than G+10. The indirectly

the axial force in structure showing the load coming on the column. Here axial force values are higher for hydrostatic load case and dead + live load case. With an increase in the structure height, then shear forces values are increasing. From bar chat, we can see that the shear force for G+3 & G+5 buildings is lesser than G+10. With an increase in the structure height, then bending moment values are increasing. From bar chat, one can see that the shear force for G+3 & G+5 building is lesser than G+10. The increase in structure height then due to load coming on column increases from G+3 to G+5 & G+10 column reinforcement percentages increase. In comparison to other load combinations in earthquake load combination, the column reinforcement percentage is more significant. From the Moment diagram, we find that moment is more prominent in the case of earthquake load .so reinforcement percentage is more significant.

Conclusions

The study was carried on a structure to carry out the effects of diverse load conditions on a structure on regular shape without considering the P-Delta effects on the different modal of high rise and low rise structures. As the earthquake force. The inertia force experienced by the roof is transferred to the ground via the columns, causing forces in columns. The columns undergo relative movement (u) between their ends horizontal displacement (u); the more prominent is, the more significant the internal force in columns. Also, the stiffer the columns are, the larger this force is. These internal forces in the columns are called stiffness forces. The wind force in a building is insignificant up to a lesser storey height. The number of the storey beyond 5th storey then wind force plays a significant role. Since the wind forces are lateral in direction, it increases the shear force in the structural component significantly, leading to the increase in other component secondary forces and increase in bending moment and axial forces are lesser in structural component compared to earthquake forces. Suppose the building is subjected to hydrostatic force due to any submergence of water. In that case, .then conclusion carried out from study is that due to hydrostatic pressure the forces generated in structure is very more minor because of lesser height and specific weight of water and forces

generated are directly proportional to both specific weight and square of height, So it is not much significant as earthquake and self-weight and live load of the structure. The analysis was carried by using computer programs like STAAD PRO, ETABS structural analysis software.

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