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A Study on The Variations in Lateral Loading Imapcats Between Medium and High-Rise Buildings Under Diverse Enviromental Conditions

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Abstract:

This thesis investigates the lateral loading effects on medium and high-rise buildings and compares their responses under different loading conditions. The study aims to provide insights into the behavior of these structures and aid in designing safer and more efficient buildings. The research methodology comprises analytical and numerical simulations of both medium and high-rise buildings subjected to various lateral loads. The analytical approach involves the use of hand calculations and mathematical models to determine the response of the building under different loading scenarios. The numerical simulations utilize computer software to model the structural behavior of the buildings and predict their response to lateral loads. The study focuses on four main lateral load types: wind loads, seismic loads. The loading conditions are applied to the buildings individually, and their responses are compared in terms of their lateral displacement, drift, and acceleration. The results show that both medium and high-rise buildings are susceptible to lateral loads, and their response depends on various factors such as building height, stiffness, and load duration. The lateral displacement of the high-rise building is more significant than the medium-rise building under all types of loading conditions. The results also show that the acceleration of the high-rise building is more significant under seismic loads than wind load. The study provides valuable insights into the behavior of medium and high-rise buildings under different lateral loading conditions. The findings of the study can be used to improve the design of these structures and enhance their resilience to lateral loads. The study recommends that designers should pay close attention to the building's lateral load resisting system and consider the impact of structural irregularities to ensure the building's safety and stability.

Keywords: Medium-rise buildings, High rise buildings, Seismic loads, Wind Loads, Lateral displacement

1. Introduction:

In the pursuit of urban development and the relentless desire to accommodate a growing global population, the construction of medium and high-rise buildings has become increasingly common. These structures stand as magnificent symbols of progress and prosperity, boasting architectural ingenuity and innovative engineering. However, they also face formidable challenges, particularly in regions prone to seismic activity, high winds, or other lateral loading conditions. The lateral loading effect has emerged as a pivotal concern for engineers and architects alike, as it significantly impacts the stability, safety, and overall performance of these towering structures. This research paper aims to delve deep into the realm of lateral loading and its impact on medium and high-rise buildings under different environmental and dynamic conditions. Through a comprehensive comparative analysis, we seek to uncover critical insights into the behavior of buildings subjected to lateral forces, aiding in the development of safer and more resilient structures for the future.

The lateral loading effect on buildings can arise from various sources, including earthquakes, strong winds, and human-induced activities. Each of these factors presents distinct challenges, and understanding how medium and high-rise buildings respond differently under such conditions is vital to mitigating potential risks and optimizing their design.

1.1 Objectives: -

1. Assessing the behavior of medium and high-rise buildings subjected to lateral loading in seismic-prone regions.
2. Analyzing the impact of high winds on building sway and stability.
3. To investigate and compare the lateral loading effects on medium-rise and high-rise buildings under various loading conditions, including seismic, wind, and dynamic loads.
4. To analyze the structural response and behavior of medium-rise and high-rise buildings subjected to lateral loading, considering differences in building height, stiffness, and material properties.
5. To assess the impact of lateral loading on the safety, stability, and performance of medium-rise and high-rise buildings in different geographical locations prone to various loading conditions.
6. To identify the critical factors that significantly influence the lateral response of medium

2. LITERTATURE REVIEW: -

Comparative Study of Wind and Seismic Lateral Load Effects on Tall Buildings with Different Structural Systems" by H. V. Lin and Y. F. Tsai (2015) - This study compared the effects of wind and seismic lateral loads on tall buildings with different structural systems, including steel frame and reinforced concrete. The study found that braced frames were the most effective protection device in reducing lateral load effects.

"Comparison of Lateral Load Effects on Tall Buildings with Different Building Configurations" by S. V. Patil and S. S. Sane (2013) - This study compared the lateral load effects on tall buildings with different building configurations. The study found that buildings with a regular and symmetrical configuration were more resistant to lateral loads than irregularly shaped buildings.

"Impact of Soil-Structure Interaction on Lateral Load Effects on Tall Buildings" by H. A. Rahgozar and M. K. Sharbatdar (2019) - This study investigated the impact of soil-structure interaction on the lateral load effects on tall buildings. The study found that soil conditions greatly affected the building's ability to resist lateral loads.

"Assessment of Lateral Load Effects on High-Rise Buildings in Different Seismic Zones" by G. G. Akbas and E. Yilmaz (2017) - This study assessed the lateral load effects on high-rise buildings in different seismic zones. The study found that the use of braced frames and moment frames reduced the impact of lateral loads in seismic zones.

"Comparative Study of Lateral Load Effects on Tall Buildings with Different Geometries" by S. Alhazmi and A. Alharbi (2018) - This study compared the lateral load effects on tall buildings with different

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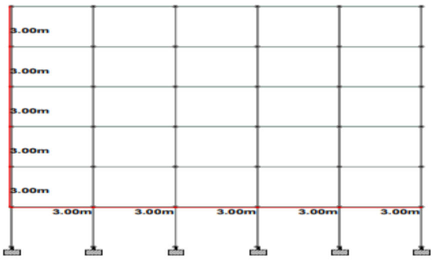
geometries, including rectangular, circular, and triangular. The study found that buildings with a circular geometry were the most resistant to lateral loads.

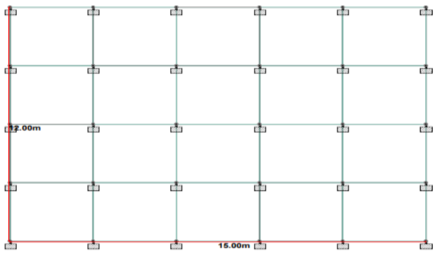
"Effect of Building Configuration on Lateral Load Resistance of High-Rise Buildings" by A. H. Shekhar and K. D. Garg (2015) - This study investigated the effect of building configuration on the lateral load resistance of high-rise buildings. The study found that buildings with a regular and symmetrical configuration were more resistant to lateral loads.

3. METHODOLOGY: -

3.1. Model: - 1

Model consists of G+5 storey RCC building having five bays in X- direction and four bays in Z-direction with height of bay as 3.0m. The story height for each floor and plinth height is kept as 3.0 respectively. The RCC frame consists of beam and column of sizes 0.225m x 0.3m and 0.300m x 0.300m respectively. Slab thickness is taken as 0.120m. The models are analysed on different condition of lateral loading effect. The concrete of grade M20 and steel of grade Fe 415 are used for this analysis.

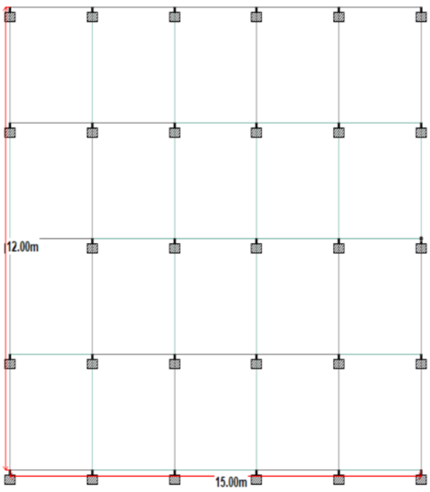


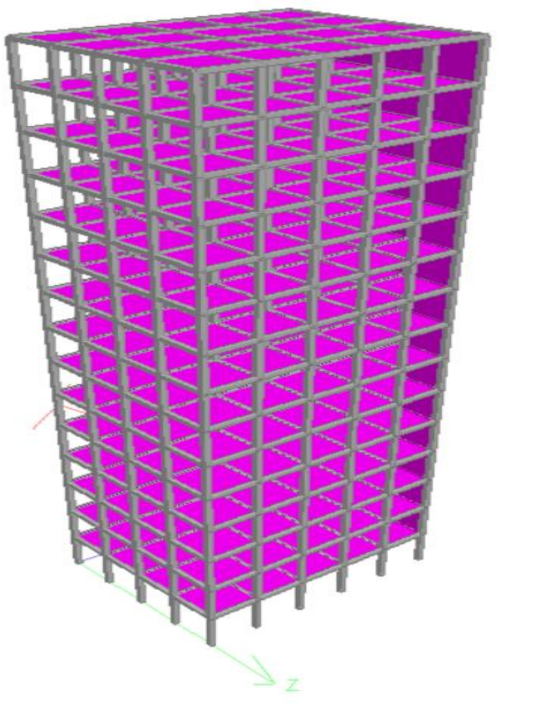


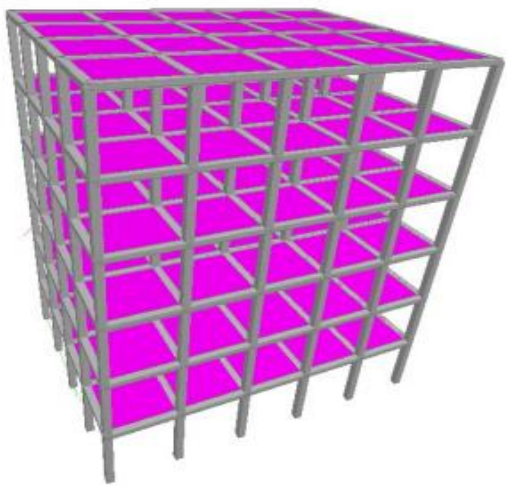
S.No.	Specification	Dimension	Unit
1.	Plan	15x12	m^2
2.	Length in X-direction	15	Meter
3.	Length in Z-direction	12	Meter
4.	Height of each floor	3.0	Meter
5.	No. of stories	6.0	Meter
6.	Soil type	Medium	-
7.	Seismic zone	V	-
8.	Wind zone	IV	-

3.2. Model: - 2

S.No.	Specification	Dimension	Unit
1.	Plan	15x12	m^2
2.	Length in X-direction	15	Meter
3.	Length in Z-direction	12	Meter
4.	Height of each floor	3.0	Meter
5.	No. of stories	15	Meter
6.	Soil type	Medium	-
7.	Seismic zone	V	-
8.	Wind zone	IV	-







3.3. Load Case Details

The lateral loads can be wind loads or seismic loads, depending on the location of the building. To define the lateral loads, select “load and definition” command in STAAD Pro and select the appropriate load type (wind and seismic). Assign the lateral loads to the building. Once the lateral loads have been defined, further need to assign them to the building. To do this, you can use the "Assign" command in STAAD Pro and select the lateral load case that defined. Specify the load combinations: In addition to the lateral loads, the building is also subjected to other loads, such as dead loads, live loads, and snow loads. To account for the combined effect of all these loads, need to specify load combinations. STAAD Pro allows to define load combinations using the "Load Combination" command.

4. RESULT: -

4.1. Maximum Joint Displacement

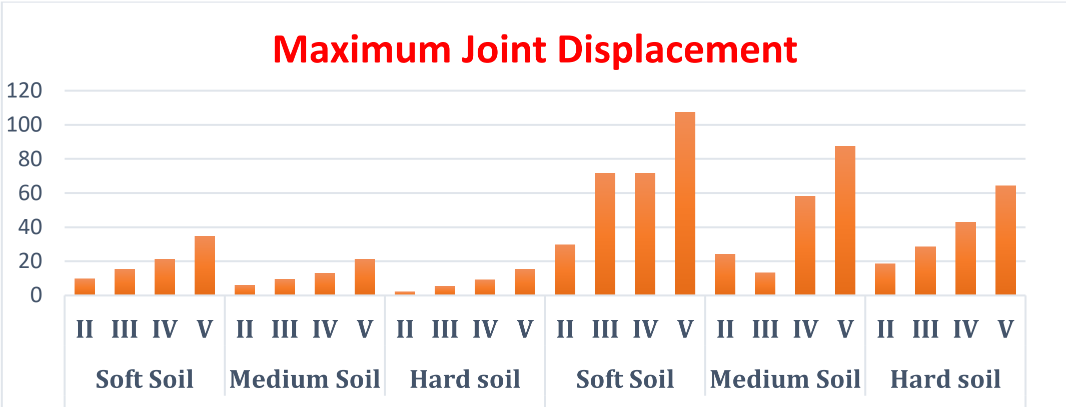


Figure: - Maximum Joint Displacement of Medium vs High-Rise Buildings under Lateral Loading Conditions.

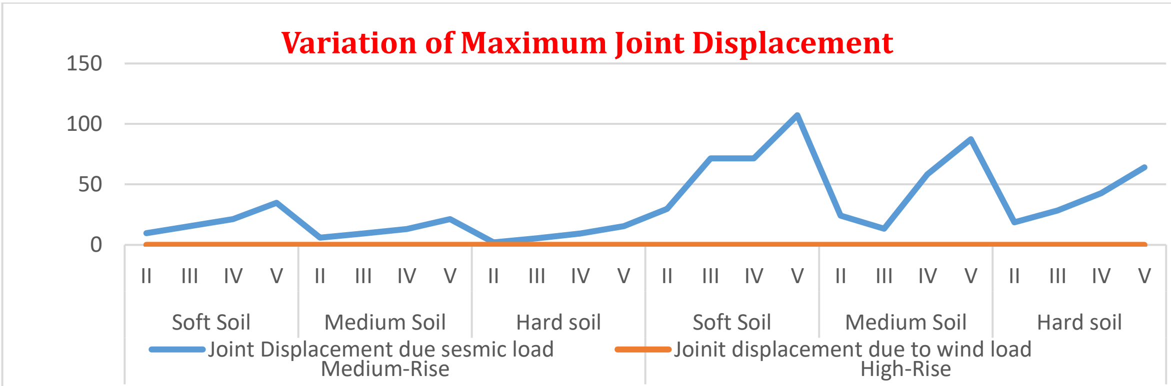


Figure: - Variation of maximum Joint Displacement of Medium vs High-Rise Buildings under different lateral Loading and soil conditions

4.2. Maximum Section Displacement

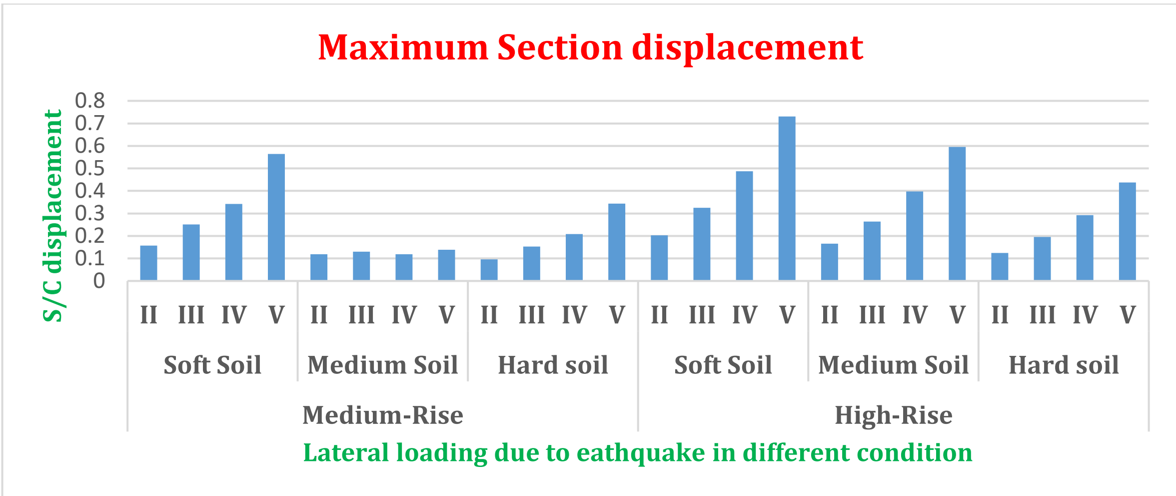


Figure: Displacement of Medium and High-Rise Buildings and High-Rise Building Due to seismic load and different soil condition.

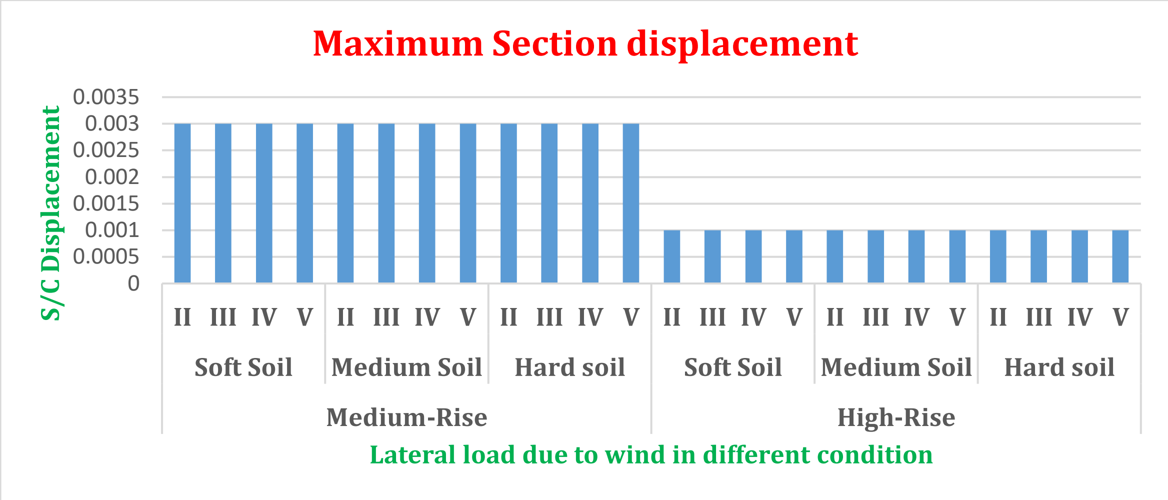


Figure: Displacement of Medium and High-Rise Buildings and High-Rise Building Due to wind load and different soil condition.

4.3. Maximum Axial force

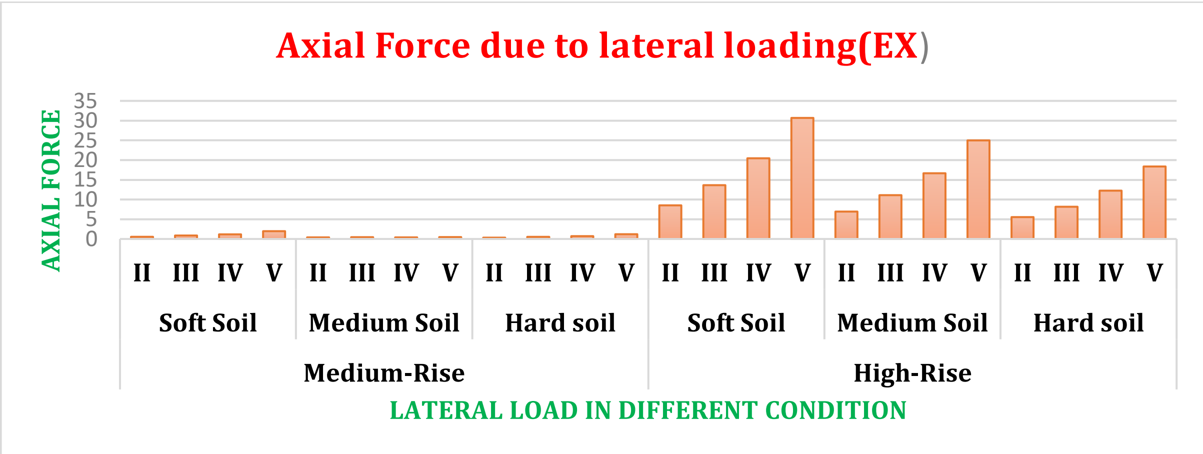


Figure: Maximum axial force of Medium and High-Rise Buildings and High-Rise Building Due to seismic load and different soil condition.

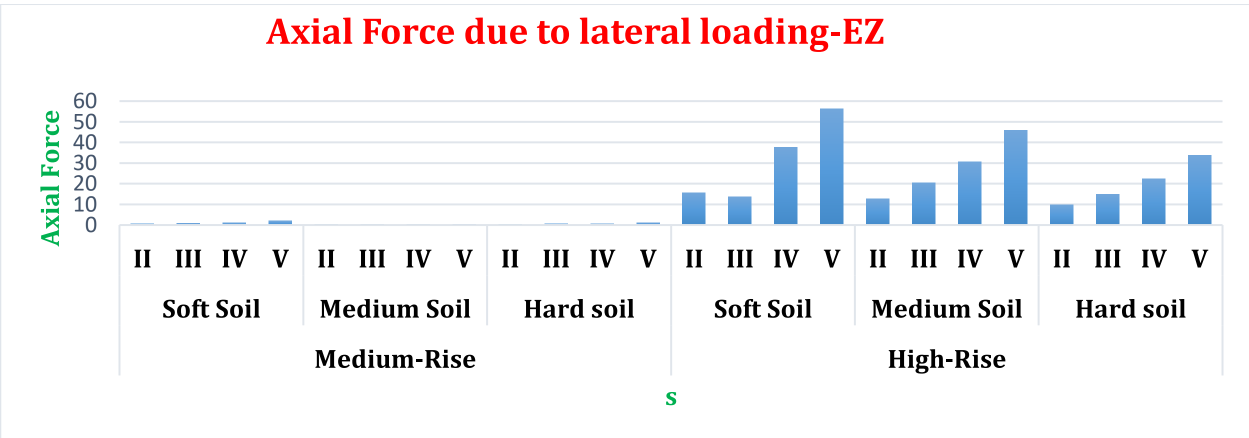


Figure: Maximum axial force of Medium and High-Rise Buildings and High-Rise Building Due to seismic load and different soil condition.

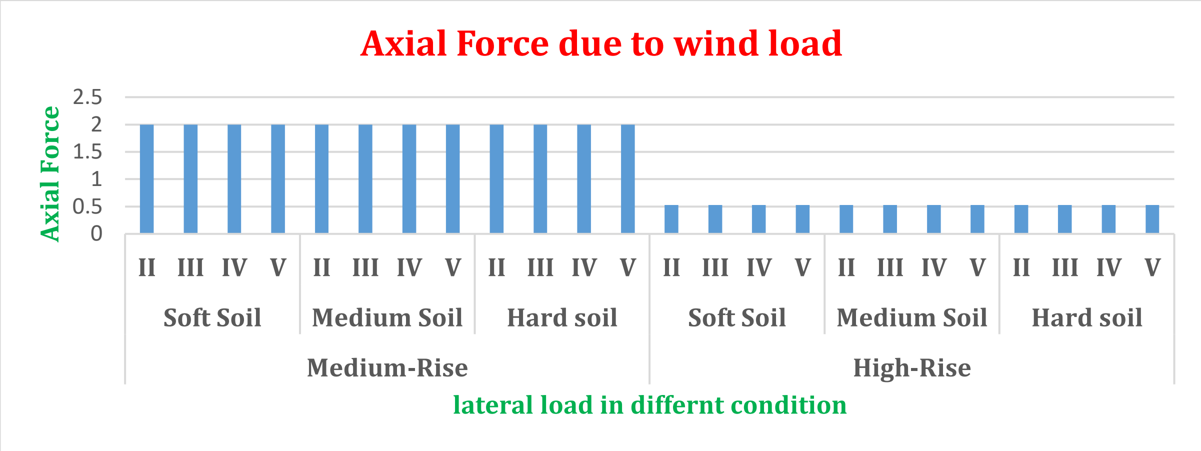


Figure: Maximum axial force of Medium and High-Rise Buildings and High-Rise Building Due to seismic load and different soil condition.

4.4. Maximum Section axial force

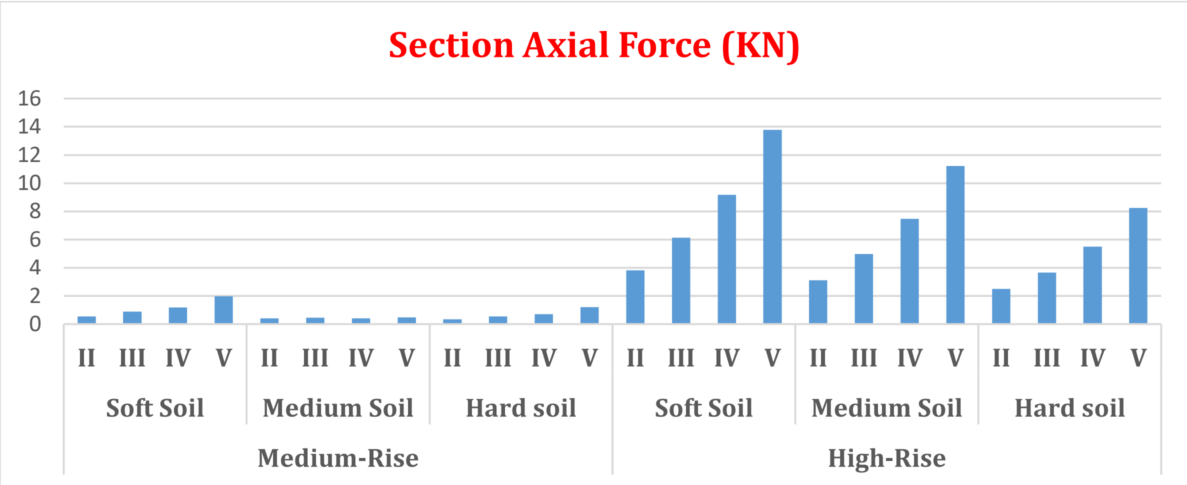


Figure: Maximum section axial force of Medium and High-Rise Buildings and High-Rise Building Due to seismic load and different soil condition.

5. CONCULUSION:

1. The research findings revealed that the behaviour of medium and high-rise buildings under lateral loads in different scenarios is significantly influenced by several factors such as building height, soil type, wind speed, and earthquake intensity.
2. The study also found that the response of high-rise buildings to lateral loads is more sensitive and complex than that of medium-rise buildings.
3. The results of the study showed that under wind load, high-rise buildings experience higher wind-induced lateral deflection, lateral drift, and bending moment as compared to medium-rise buildings. On the other hand, under earthquake load, high-rise buildings experience higher base shear, maximum inter-story drift, and floor acceleration than medium-rise buildings.
4. In terms of soil type, the study revealed that the behaviour of the buildings under lateral loads is influenced by the soil's stiffness and damping. Buildings on soft soils are more prone to lateral deformation and lateral drift compared to buildings on stiff soils.

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