iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** XII **Month of publication:** December 2025

DOI: https://doi.org/10.22214/ijraset.2025.73759

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XII Dec 2025- Available at www.ijraset.com

Review on Seismic Performance Evaluation of a G+15 Steel Frame Building using Pushover Analysis

Prabhanshu Mishra[1], Rakesh Kumar Grover[2]
Department of Civil Engineering, Jabalpur Engineering College, Jabalpur

Abstract: The present study investigates the seismic performance of a G+15 steel moment-resisting frame using nonlinear static (pushover) analysis. The analysis was carried out in STAAD.Pro V8i SS4, following FEMA-356 and ATC-40 guidelines to evaluate inelastic behavior and performance level under seismic loading. The structure was modeled in accordance with IS 1893 (Part 1):2016 and IS 800:2007, and subjected to incrementally increasing lateral loads in both X and Z directions. The pushover capacity curve revealed a peak base shear of 8,416.24 kN at a roof displacement of 74.29 mm, beyond which stiffness degradation and loss of stability were observed. During the final load increments, column 643 failed in deformation-controlled action, while columns 642 and 644 failed in force-controlled action with interaction ratios exceeding 1.0, indicating the onset of localized yielding and strength exceedance. The structural response achieved the Life Safety (LS) performance level, demonstrating satisfactory ductility and energy dissipation before collapse. The study confirms that pushover analysis provides an effective, computationally efficient means of assessing the nonlinear seismic capacity of high-rise steel buildings, aiding in the development of performance-based seismic design and retrofitting strategies.
Keywords: Seismic performance, Pushover analysis, Nonlinear static analysis, Base shear, Plastic hinge formation , Steel multistory, story drift

I. INTRODUCTION

In recent years, the seismic safety of high-rise steel structures has become a major focus in performance-based design. Conventional elastic analysis are often insufficient to capture inelastic deformations and local failures that occur under severe earthquake loading. To overcome these limitations, pushover analysis—a nonlinear static approach—has emerged as a reliable and practical method for estimating the global and local performance of structures. It enables engineers to visualize the sequence of yielding, hinge formation, and collapse mechanisms that develop progressively as lateral loads increase.

This method provides insights into critical response parameters such as base shear, roof displacement, story drift, and hinge rotation, which are essential for assessing the strength and deformation capacity of a structure. By approximating the results of nonlinear dynamic time-history analysis, pushover analysis offers a simplified yet effective approach to understanding the inelastic behavior of building frames. Steel, being ductile and lightweight, offers several advantages in seismic regions compared to reinforced concrete. Its high strength-to-weight ratio, ease of fabrication, and ability to undergo large inelastic deformations without failure make it a preferred material for tall structures. Hence, studying the seismic performance of multi-storey steel frames through pushover analysis provides valuable insights for safe and economical design in accordance with modern codes such as IS 1893 (Part 1):2016 and IS 800:2007. The present research focuses on evaluating the seismic capacity and performance level of a G+15 steel moment-resisting frame modeled and analyzed in STAAD.Pro V8i SS4. The study aims to identify critical members, observe hinge development, and determine the overall performance level in terms of FEMA-356 and ATC-40 guidelines. The results contribute to the broader understanding of performance-based seismic design for high-rise steel structures in Indian conditions. [1].

“The main objective of this study is to determine the capacity, ductility, and hinge performance of a G+15 steel frame and to identify its performance level under design-level seismic loading.”

II. PURPOSE

The pushover is expected to provide information on many response characteristics that cannot be obtained from an elastic static or dynamic analysis. The following are the examples of such response characteristics: The realistic force demands on potentially brittle elements, such as axial force demands on columns, force demands on brace connections, moment demands on beam to column connections, shear force demands in reinforced concrete beams, etc.

1) Estimates of the deformations demands for elements that have to form in elastically in order to dissipate the energy imparted to the structure consequences of the strength deterioration of individual elements on behavior elements on behavior of structural system.
2) Identification of the critical regions in which the deformation demands are expected to be high and that have to become the focus through detailing.
3) Identification of the strength discontinuous in plan elevation that will lead to changes in the dynamic characteristics in elastic range.
4) Estimates of the inter story drifts that account for strength or stiffness discontinuities and that may be used to control the damages and to evaluate P-Delta effects

III. STEEL STRUCTURE

Steel is the most useful construction material for building. Nowadays steel industries are the backbone of industry growth of the country. Steel having ten times more strength as compared to concrete, for modern & advanced construction steel is the perfect material. Factor like strength, erection time, prefabrication requirement, and demount ability make it more useful for construction. For load-bearing structures in buildings, and as members in a structure like trusses, bridges, and space structures steel are much useful. Another application of steel is used as fire and corrosion protection structure.

IV. PUSHOVER ANALYSIS

General Pushover Analysis option will allow engineers to perform pushover analysis as per FEMA -356 and ATC-40. Pushover analysis is a static, nonlinear procedure using simplified nonlinear technique to estimate seismic structural deformations. It is an incremental static analysis used to determine the force displacement relationship, or the capacity curve, for a structure or structural element. The analysis involves applying horizontal loads, in a prescribed pattern, to the structure incrementally, i.e. pushing the structure and plotting the total applied shear force and associated lateral displacement at each increment, until the structure or collapse condition. Pushover analysis is a technique by which a computer model of the building is subjected to a lateral load of a certain shape (i.e., inverted triangular or uniform). The intensity of the lateral load is slowly increased and the sequence of cracks, yielding, plastic hinge formation, and failure of various structural components is recorded. Pushover analysis can provide a significant insight into the weak links in seismic performance of a structure. A series of iterations are usually required during which, the structural deficiencies observed in one iteration, are rectified and followed by another. This iterative analysis and design process continues until the design satisfies pre-established performance criteria. The performance criteria for pushover analysis are generally established as the desired state of the building given roof-top or spectral displacement amplitude.
1) Estimates of force and displacement capacities of the structure. The sequence of the member yielding and the progress of the overall capacity curve.
2) Estimates of force (axial, shear and moment) demands on potentially brittle elements and deformation demands on ductile elements.
3) Estimates of global displacement demand, corresponding inter-storey drifts and damages on structural and non-structural elements expected under the 20 earthquake ground motion considered.
4) Sequences of the failure of elements and the consequent effect on the overall structural stability.
5) Identification of the critical regions, when the inelastic deformations are expected to be high and identification of strength irregularities (in the plan or in elevation) of the building.

Pushover analysis delivers all these benefits for an additional computational effort (modeling nonlinearity and change in analysis algorithm) over the linear static analysis. Step by step procedure of pushover analysis is discussed next.

V. LITERATURE REVIEW

Al-Fadhli, S.K.I.[2000] Analysis methods such as pushover and time history analysis are acceptable to check out the behavior of buildings design by codes. Pushover analysis classified within the simplified nonlinear seismic static analysis. The benefit of this analysis is to evaluate structural elements under the effects of seismic demands imposed by ground motion. Time history as dynamic linear analysis is an accurate approach to apply as acceleration as function of time. Ground plus three stories reinforced concrete building was adopted in this research to check out the effects of pushover analysis and linear time history loadings on the performance of all structural elements, which were designed without the presence of these analysis, under the effects of wind, gravity, and seismic loadings by equivalent lateral force that suggested by ASCE.

The prototype building is simulated using finite elements approach by SAP2000 package using worst loading combination such as dead, live, wind and seismic loadings. The adopted loading requirements such as wind and seismic loads are based on the Iraq topography. The capacity spectrums based on ATC-40 with the spectral displacement and different values of site location are taken into accounts, and the El Centro 1940 in case of linear time history. The results for different values of site locations and performance points were discussed in case of pushover analysis and compared with that of same site locations of the analysis of time history. Based on the analysis results the shear and displacement increased as magnitudes of site location increased.

Acharya V.et al.,[2000] Buildings, which appeared to be strong enough, may crumble like houses of cards during earthquake and deficiencies may be exposed. In last decade, four devastating earthquakes of world have been occurred in India, and low to mild intensities earthquakes are shaking our land frequently. It has raised the questions about the adequacy of framed structures to resist strong motions, since many buildings suffered great damage or collapsed. A number of multi-storey car parking structures in urban India are constructed at airports, railway stations, etc. in regular and irregular shape for architectural, aesthetic or economic reasons to reduce the problem of parking. The materials being used for the structures may be having same properties and in some times it may vary in strength, mass etc. To evaluate the performance of framed buildings under future expected earthquakes, a non-linear static pushover analysis has been conducted on a typical multi-storey car parking structure. To achieve this objective, a 3D framed multi storey car parking structure (G+3) is modeled in SAP 2000 in which the structure is open in all stories with rigid floors. Such features are highly undesirable in buildings built in seismically active areas because of lesser mass of the structures, this has been verified in numerous experiences of strong shaking during the past earthquakes. We are investigating the effect of strength irregularities in the present multi-storey car parking structure of R/C frames on the seismic performance using nonlinear static push-over analysis based on computational models. From output non-linear analysis, we compare the Base shear and Displacement occurs in different strength irregularities for the different load combinations in seismic zone IV.

NaqashT. [2020] Seismic codes use the behaviour factorto consider the ductility andthe structure's non-linearity to improve the system's overall performance. Generally, Steel moment-resisting frames are characterized by a relatively high period showing high deformability and,foreseen that withstringent damageability criteria, the adopted behaviour factor mightnot optimally be utilized for achieving better performance of the frames. The design is generally governed by stiffness, leaving behind a complex structural system where the capacity design rules are disturbedand therefore necessitates to relax the drift limits for such frames. Given this and with extensive parametric analysis, the current paper aims to examine the behaviour factor of steel Moment Resisting Frames (MRFs).

Bakalis A.et al.,[2021] A documented pushover procedure on asymmetric, single-story, reinforced concrete (RC) buildings using inelastic dynamic eccentricities is extending in this paper on asymmetric multi-story RC buildings, aiming at the Near Collapse state. The floor lateral static forces of the pushover procedure are applied eccentric to the Mass Centers using appropriate inelastic dynamic or design eccentricities (dynamic plus accidental ones) to safely estimate the ductility demands of both the flexible and stiff sides of the building due to the coupled torsional/translational response. All eccentricities are applied with respect to the “Capable Near Collapse Principal System” of multi-story buildings, which is defined appropriately using the well-known methodology of the torsional optimum axis. Moreover, two patterns of lateral forces are used for performing the analysis, where in the second one an additional top-force is applied to consider the higher-mode effects. A six-story, asymmetric, torsionally-sensitive RC building is examined to verify the proposed pushover procedure relative to the results of non-linear dynamic analysis. The outcomes indicate that the proposed pushover procedure can safely predict the seismic ductility demands at the flexible and stiff sides, providing reliable estimates for the peak inter-story drift-ratios throughout the building as well as a good prediction of the plastic mechanism.

Oksanen J. [2021] The objective of this master’s thesis was to gain knowledge about an advanced seismic analysis method, pushover analysis, and to study its applicability in seismic steel structure design. The applicability of RFEM and Eurocode 8 for pushover analysis were studied by analysing 2D and 3D structures obtained from the literature.

A pushover analysis has some advances compared to simpler and much wider used linear response spectrum analysis. It gives valuable information about the location of first yield, overstrength ratio for behaviour factor revision and the actual plastic mechanism of the structure in an earthquake. However, the current guidelines in standards are not at a level that would allow the method to be applied easily and unambiguously in industrial design.

It was found out that regular moment resisting frames are suitable for pushover analysis with RFEM and it can calculate the capacity curves and inspect the plastic hinge Eurocode 8 limit states. However, RFEM does not have the means to calculate the target displacement and is not suitable for pushover analysis of braced frames. If a structure is to be analysed with pushover analysis according to Eurocode 8, it should be ensured that the requirements for regularity in plan and in elevation are met.

Moghimi G., & Makris N. [2022] This paper investigates the seismic response analysis of the 9-story SAC building equipped with pressurized sand dampers, a new type of low-cost energy dissipation device where the material enclosed within the damper housing is pressurized sand. The strength of the pressurized sand damper is proportional to the externally exerted pressure on the sand via prestressed steel rods; therefore, the energy dissipation characteristics of a given pressurized sand damper can be adjusted according to a specific application. The strong pinching behavior of pressurized sand dampers was characterized with a previously developed three-parameter Bouc-Wen hysteretic model that for this study was implemented in the open source code OpenSees with a C++ algorithm, and it was used to analyze the seismic response of the 9-story SAC building subjected to six strong ground motions that exceed the design response spectrum for all soil categories. The paper shows that for the family of strong ground motions used in this study, pressurized sand dampers with strength of the order of 5%–10% of the weights of their corresponding floors were able to keep the interstory drifts of the 9-story SAC building at or below 1%, while base shears and peak plastic hinge rotations were reduced in the damped configuration. Supplemental damping produced mixed results on floor accelerations; nevertheless, in most floors, peak accelerations were reduced.

Mahmood M. N., & Mahmood H. J. M. *[2022]* One of nature's most dangerous phenomena are earthquakes which cause significant harm to both people's lives and property. In this study, four alternative approaches are used to demonstrate the distribution of lateral loads and compare its impacts on the results of a non-linear static pushover analysis of a ten-storey reinforced concrete (RC) building and study its response to the impact of an earthquake. In order to determine how the structure would respond to earthquake effects, pushover analysis which is an alternative way of time history analysis was adopted and the predicted results are compared with those of nonlinear time history analysis. Given that the building is situated in an area that is actively experiencing earthquakes and has rocky soil, the distributed lateral force is assumed to be equivalent to the design base shear. The study indicated an almost good suitable fit between two categories of pushover loading methods regarding security of the building, maximum base shear, and maximum displacement. The paper also presents a comparison between the results of nonlinear time history analysis at a particular roof displacement with that of pushover analysis.

Qiu C. et al.,[2022] Buckling-restrained braces (BRBs) have been widely used in seismic prone areas around the world. However, one major problem associated with the steel BRB frames is the excessive residual deformation under strong earthquakes, mainly due to the low post-yield stiffness ratio of the steel BRBs. Recently, the community has fabricated the iron-based shape memory alloy (FeSMA) BRBs, which exhibited full hysteresis with high post-yield stiffness ratios, but the seismic behavior of the FeSMA BRB frames still remains unknown. As such, this paper conducts seismic performance analysis of multi-story steel frames equipped with the FeSMA BRBs, through a comparison with those equipped with conventional steel BRBs. Incremental dynamic analysis (IDA) is further conducted to establish the probability seismic demand models. Based on the IDA data, bivariate fragility analysis is conducted to quantify the probability of exceedance, conditioned on various limitations of the maximum and residual interstory drift ratios. According to current analysis, it indicates that both the maximum interstory drift ratios and the maximum floor accelerations are comparable between these two types of BRB frames. The major advantage of the FeSMA BRBs over the steel BRBs is that the former can better control residual interstory drift ratios.

Gustafson A. K. [2023] The introduction of AS1170.4 2007 in Australia has outlined specific seismic design and performance criteria for building structures and their structural response. Further, combined with the release of AS3600 2018, specifically section 14 design for earthquake actions, the seismic design and analysis of reinforced concrete structures has become more onerous for ductile response. The increased detailing requirements for ductile sway frame structures in particular results in more costly structures both in terms of section size and reinforcement quantity. This has compounding effects for space and cost viability for commonly built commercial structures in Australia such as retail spaces and carparking structures. From a professional engineering office perspective, the increased detailing associated with a higher ductility class is not cost effective or practical, and the choice of analysis method is based entirely on reducing cost whilst meeting performance criteria. For retail structures that don't contain shear core or wall structures, moment resisting frames (MRF's) are the only lateral bracing against seismic loads. Typically, these MRF's in Australia are constructed with small columns, one way band beams, and one-way slabs which are post-tensioned for deflection control. Any stair or lift cores are often limited in number or isolated in positions across the floor plate that provide little overall structural bracing. Therefore, more sophisticated methods of analysis are necessary to achieve a viable and practical design for these structures in the low seismic risk region of Australia. This paper presents the use of non-linear push over analysis with the Capacity Spectrum Method for one-way band beam and slab sway frame structures built throughout the state of Queensland. The method may be used to demonstrate that standard detailing to the main body of AS3600 achieves a minimum ductility of 2 (limited ductility) without the need for higher ductility class detailing to section 14 to satisfy seismic demand. A mixed-use retail building is presented with transfer beams and is analysed using a 2D and 3D frame pushover analysis.

Dhannur B., & Sushmitha N. [2023] The performance assessment of the structure under an unexpected earthquake is the key thing to recognize the individual failure of elements of a structure by conducting an inelastic static pushover analysis. If there are multiple earthquakes in any of the year, the performance of structure assessed from linear elastic analysis is not sufficient therefore there is a need of study on non-linear behavior of the structure to provide an extra safety to the structures. The nonlinear dynamic analysis needs lot of data to be given to the generated model in software for studying the behavior of the structure but there is another promising method to overcome the above complexity that is nonlinear static analysis (Pushover analysis) to the assess the behavior of the structure when subjected to multiple earthquakes. For the present study, A G+6 Story 'L' Shape plan irregular steel structure (model 1) with floor to floor height as 3 m and 7 bays in 'X' & 'Y' direction of each 4 m is considered. From Pushover analysis on 'L' shape steel structure, it was observed that some of corner columns reached capacity ratio due to excessive stress at beam-column junction and to overcome this, the retrofitting technique was adopted that is consideration of those corners columns as composite columns in the same steel structure (model 2). The plastic hinges formed due to PUSHX for model 1 have reached immediate occupancy performance level to life safety performance level but at 9th iteration, 8 numbers of plastic hinges have been formed in Collapse presentation level hence there might be partial or complete collapse of structure. After retrofitting model 1, the plastic hinges in greater than CP level were formed in different step number so therefore, model 2 sustains more damage before it collapse.

Jesusahayaraj C. J. R., & Muthu V. K.[2023] The investigation evaluates the seismic performance of scrap tyre rubber pad (STRP) bearings manufactured from used hazardous automobile tyres using Nonlinear static procedures. In this study, the four-story regular building and irregular-shaped buildings such as plan irregularity (H shape and square core type) and vertical geometry irregularity (two types) of fixed and STRP base were analysed using the SAP 2000 software package. The concept of Nonlinear static pushover analysis (NSP) is implemented which is reliable in its outcomes. For instance, the buildings are designed as per the design principles of the Uniform Building Code (UBC) suitable for Indian conditions. NSP is applied using two popular methods such as ATC-40 Capacity Spectrum Method and the FEMA-356 Displacement coefficient Method. The performance points such as spectral acceleration, spectral displacements, Base shear, and roof displacements are obtained and compared for the fixed base and STRP base. Moreover, the possible formation of hinges pertaining to life safety, immediate occupancy, and collapse prevention stages are significantly dealt with and reported for the buildings considered. From the investigation, it is evident that in the case of irregularly shaped buildings, the seismic response such as base shear and its corresponding roof displacements of plan irregular buildings is prodigious compared to vertical geometry irregular buildings. Nevertheless, the analysis reports that the response of regular-shaped buildings is prominent compared to irregularly shaped buildings with STRP as the base isolator.

Zihni M. et al.,[2023] Indonesia is located at the confluence of three main tectonic plates which makes it one of the countries with the highest earthquake risk in the world. Recorded experiences has showed that the earthquake cause damage to buildings particularly multi-storey building structures. The purpose of this study is to determine the performance level of multi-storey reinforced concrete structures using a performance-based design method based on the ATC-40 and FEMA 440 regulations. The buildings in this study are 4-storey and 8-storey buildings. The effect of column size, beam size, and concrete quality are investigated. This study results the performance level, capacity curve, level of effectiveness of variations based on pushover analysis using the ATC-40 and FEMA 440. It can be concluded that the building structure is considered as Operational category based on the ATC-40 and FEMA 440 regulations. On the other hand, for the level of effectiveness of variations in building structures, it is more effective to enlarge the column cross-sectional dimensions and increase the height of the beam for 4-storey and 8-storey buildings, respectively.

Chaudhary H., & Tiwary A. K. [2023] This research uses pushover analysis to study the seismic performance of bracing systems on composite structures. Due to excellent strength, durability, and cost-effectiveness, composite structures have become broadly utilized in current construction. Steel bracing is frequently used in composite structures as a lateral load-resisting mechanism to increase seismic performance. The seismic performance of composite structures in this study is assessed using the pushover analysis method, which entails gradually applying lateral loads to the structure until a predetermined displacement limit is reached. The study examines and contrasts the behavior and performance of composite structures with different bracing systems under lateral loads. The research investigates the effect of steel bracing on various structural parameters, including lateral displacement, base shear, story drift, and plastic hinge formation. The pushover analysis results are compared and evaluated to determine how effectively bracing techniques improve the seismic performance of composite constructions. This research provides a valuable understanding of the behavior of composite structures in different bracing systems under seismic loads. This study offers to the body of research in the field of earthquake, engineering, and recommendations for designing more resilient composite structures in earthquake-prone regions.

Shen L. I. et al.,[2023] The high-strength steel frame with D-eccentric brace presents a novel structural system that demonstrates exceptional plastic deformation capabilities when exposed to high levels of earthquake hazards. This system employs ordinary steel links with a yield strength below 345 MPa, while the frame beam and column utilize high-strength steel (yield strength above 460 MPa, such as Q460 or Q690 steel) to reduce cross-sectional dimensions while ensuring elasticity of non-energy consuming components. The resulting structure exhibits outstanding ductility and energy-dissipating capacity. The response modification factor (R), a crucial parameter in performance-based seismic design, plays a significant role in achieving appropriate and cost-effective seismic designs. Unfortunately, the 2016 edition of China's code for Seismic Design of Buildings (GB50011-2010) did not consider the concept of R and instead employed a constant value for all structural systems, which is unreasonable. Therefore, a comprehensive investigation of the R value for the high-strength steel frame with D-eccentric brace is imperative to enhance structural performance design, provide guidance for future designs, and promote the widespread implementation of this structure in seismic regions, where it exhibits superior seismic performance. This study utilizes the performance-based seismic design approach to design structures with varying numbers of stories (4, 8, and 12), link lengths (900, 1000, and 1100 mm), and different steel strengths (Q460 and Q690). An improved pushover analysis method is employed to calculate the R values for each prototype, considering the number of structural stories (N) and the link length (e). The derived values of each performance coefficient serve as valuable references for future performance designs of novel structural systems.

Mahurkar T & Dabhekar K. [2024] The objective of this study is to perform a comprehensive seismic analysis and design of a multi-storey steel building incorporating different bracing systems. Earthquakes pose a significant threat to the structural integrity of buildings, making it imperative to employ effective seismic-resistant strategies. Bracing systems play a vital role in enhancing a building's ability to withstand seismic forces by providing stiffness and dissipating energy. This research investigates the performance of various bracing configurations, including X-bracing, chevron bracing, and eccentric bracing, in the context of a multi-storey steel building subjected to seismic loading. The analysis involves the utilization of advanced numerical modeling techniques and rigorous seismic design codes to accurately simulate and evaluate the structural behavior under different earthquake scenarios. The study aims to assess the effectiveness of each bracing system in terms of its ability to limit structural deformations, mitigate excessive lateral displacements, and distribute seismic forces efficiently throughout the building. Through extensive numerical simulations, the study will analyze the dynamic response of the steel structure and identify the bracing system that exhibits superior seismic performance. Furthermore, this research investigates the influence of various design parameters, such as bracing member sizes, configurations, and locations, on the overall structural response. The results will provide valuable insights into optimizing the design and placement of bracing systems to enhance the seismic resilience of multi-storey steel buildings.

VI. CONCLUSION

The nonlinear static pushover analysis of the G+15 steel frame structure provided a clear understanding of its seismic performance and deformation characteristics. The capacity curve indicated that the building exhibited a linear response up to approximately 25 mm of roof displacement, after which nonlinear behavior became dominant. The maximum base shear of 8416.24 kN was attained at a displacement of 74.29 mm, marking the ultimate capacity of the structure. Beyond this stage, a reduction in base shear signified the onset of stiffness degradation and potential instability.

The formation of plastic hinges in column members 642, 643, and 644 confirmed localized yielding prior to global collapse. Column 643 reached a deformation-controlled failure, while columns 642 and 644 exhibited force-controlled failures, indicating critical zones of combined axial and flexural stress exceedance. The structure demonstrated stable ductile behavior up to the Life Safety (LS) performance level as per FEMA-356, reflecting adequate energy dissipation and lateral strength for design-level earthquakes.

Overall, the study highlights that pushover analysis is an effective and computationally efficient method for evaluating the seismic performance of high-rise steel buildings. The results emphasize the need for detailed performance-based design and targeted retrofitting of critical elements to enhance ductility and prevent progressive collapse in future seismic events.

REFERENCES

[1] Acharya, V., Akshaya, S. S., & Suresh, H. L. PERFORMANCE EVALUATION OF A MULTI STOREY CAR PARKING STRUCTURE UNDER STRENGTH IRREGULARITIES BY PUSH OVER ANALYSIS.

[2] Al-Fadhli, S. K. I. (2020, March). Performance of multistory building under nonlinear static push-over. In AIP Conference Proceedings (Vol. 2213, No. 1). AIP Publishing.

[3] Bakalis, A., Makarios, T., & Athanatopoulou, A. (2021). Inelastic dynamic eccentricities in pushover analysis procedure of multi-story RC buildings. Buildings, 11(5), 195.

[4] Chaudhary, H., & Tiwary, A. K. (2023). Seismic analysis of steel bracing on composite structure by pushover analysis. Journal of The Institution of Engineers (India): Series A, 104(4), 927-941.
[5] Dhannur, B., & Sushmitha, N. (2023). Performance assessment of composite steel building with considering plan irregularity before and after Retrofit"-Pushover Analysis. Materials Today: Proceedings, 88, 71-76.
[6] Gustafson, A. K. (2023). Non-Linear Pushover Analysis of Ordinary Moment Resisting Frame Structures in Australia.
[7] Jesusahayaraj, C. J. R., & Muthu, V. K. (2023, June). Assessment of seismic response of RC framed buildings with scrap tyre as the base isolator using nonlinear static push over analysis. In AIP Conference Proceedings (Vol. 2766, No. 1). AIP Publishing.
[8] Mahmood, M. N., & Mahmood, H. J. M. (2022). Dynamic and pushover analysis of multi-storey reinforced concrete building using different load distribution pattern. Journal of Applied Engineering Science, 20(4), 1325-1334.
[9] Mahurkar, T., & Dabhekar, K. (2024, August). Design and analysis of a multi-storey steel building (G+ 8) by response spectrum analysis. In AIP Conference Proceedings (Vol. 3139, No. 1). AIP Publishing.
[10] Moghimi, G., & Makris, N. (2022). Seismic response of yielding multistory steel buildings equipped with pressurized sand dampers. Journal of Structural Engineering, 148(7), 04022071.
[11] Naqash, T. (2020). Pushover response of multi degree of freedom steel frames. Civil Engineering Journal, 6, 86-97.
[12] Oksanen, J. (2021). Applicability of pushover analysis in seismic steel structure design.
[13] Qiu, C., Zhang, A., Jiang, T., & Du, X. (2022). Seismic performance analysis of multi-story steel frames equipped with FeSMA BRBs. Soil Dynamics and Earthquake Engineering, 161, 107392.
[14] Shen, L. I., Yuting, G., Hongchen, W., & Ningjun, D. (2023, September). Response modification factor of high strength steel frame with D-eccentric brace using improved pushover analysis method. In Structures (Vol. 55, pp. 1732-1762). Elsevier.
[15] Zihni, M., Suwondo, R., & Suangga, M. (2023, April). Pushover analysis of multi-storey concrete structures. In IOP Conference Series: Earth and Environmental Science (Vol. 1169, No. 1, p. 012005). IOP Publishing.