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Evaluating the Accuracy of Equivalent Static vs. Response Spectrum Method for Seismic Analysis of Buildings of Varying Heights

Rojseen Shrestha[1], Mantu Shrivastav[2*], Raju Pal[3]
[1]*Department of Civil Engineering, Thapathali Campus, Thapathali, Kathmandu, Nepal,* rojseen.078bce093@tcioe.edu.np
[2]*Department of Civil Engineering, Thapathali Campus, Thapathali, Kathmandu, Nepal,* mantu.078bce061@tcioe.edu.np
[3]*Department of Civil Engineering, Thapathali Campus, Thapathali, Kathmandu, Nepal,* raju.077bce100@tcioe.edu.np

Abstract
A key choice should be made between Equivalent Static Method (ESM) and Response Spectrum Method (RSM) during the seismic design of buildings. The current paper tests and compares the performance of these two procedures to reinforced concrete dual-system structures of different heights. The cases of 4-story, 8-story, and 16-story regular buildings were modelled with the use of software ETABS v21.0.0 in accordance with the Nepal National Building Code (NBC 105:2020). The important parameters in seismic response comparison such as base shear, roof displacement and maximum inter-story drift were compared. The findings show that an important trend exists, which is, the deviation between the methods grows as the height of the building increases. For base shear, ESM for the 4-story building predicted values 9.9 % and 12.5 % higher in X and Y-direction respectively. However, for the 8-story and 16-story buildings, ESM was found to underestimate the seismic load by approximately 25.1% and 25.4% in the X-direction, and by 24.7% and 25.6% in the Y-direction, respectively, when compared to RSM. Regarding roof displacement in the X-direction, RSM consistently predicted larger values, with the absolute difference growing from 1.39 mm to 14 mm and finally to 31 mm in the 4,8 and 16 story buildings respectively. Similarly, for maximum story drift the absolute difference widened from 0.0191 % to 0.0779 % and finally to 0.1106 % in the 4,8 and 16 story buildings respectively. The paper concludes that the ESM might prove to be adequate in the case of low-rise buildings but cannot be effective in the design of midrise to high rise buildings where the Response Spectrum Method is preferred.

Keywords: Equivalent Static Method, Response Spectrum Method, Base Shear, Roof displacement, Inter-story drift

1. Introduction

The seismic analysis of structures is a fundamental aspect of civil engineering, aimed at designing buildings that can safely withstand the forces exerted by earthquakes. To achieve this, engineers employ various analytical methods to predict a building's response to ground motion. The choice between Equivalent Static Method (ESM), Response Spectrum Method (RSM), the non-linear static pushover analysis, and the more advanced Time history method, is often dictated by factors such as the building's height, structural regularity, expected performance level and the governing building codes.

The Equivalent Static Method is a simplified approach that represents the dynamic effects of an earthquake through a set of static forces applied to the building (Chopra, 2017). Its relative simplicity makes it a common choice for preliminary analysis and for the design of regular, low-rise structures where the first vibration mode dominates the structural response and higher mode effects are considered negligible (Meleka et al., 2012; Gottala & Yajdhani, 2019). The primary goal of ESM is to ensure that anticipated lateral deflection does not exceed acceptable limits, thereby preventing structural yielding, pounding effect, and maintaining global stability (ASCE/SEI 7-16, 2017).

However, ESM comes with significant limitations, and its applicability is strictly governed by various international building codes. For instance, the Indian Standard code IS 1893:2016 restricts its use to regular buildings typically less than 15 meters or 40 meters in height, depending on the seismic zone (Gottala &

Yajdhani, 2019). Eurocode 8 limits the method to buildings exhibiting "regularity in elevation" and with fundamental periods not exceeding certain thresholds. Similarly, ASCE 7 (Minimum Design Loads and Associated Criteria for Buildings and Other Structures) and other codes like the Nepal Building Code (NBC 105:2020) or British Standards (BS/EN) impose restrictions based on building height, structural irregularities, and seismic intensity, generally recommending dynamic analysis for taller or more complex structures (ASCE/SEI 7-16, 2017; Meleka et al., 2012). ESM's inherent simplicity can lead to an underestimation of complex dynamic behaviors, particularly in structures with significant irregularities or those susceptible to higher mode effects (Abbas et al., 2023).

In contrast, the Response Spectrum Method (RSM) is a more sophisticated dynamic analysis technique. It considers the dynamic properties of a building, including its natural periods, mode shapes, and damping, in conjunction with a response spectrum that characterizes the seismic ground motion (Chopra, 2017). The fundamental premise of the response spectrum method is to compute the seismic response as a combination of the extreme responses of several single-degree-of-freedom oscillators, each corresponding to a mode of the analyzed structure (Nguyen et al., 2014). This method accounts for the participation of multiple vibration modes, providing a more comprehensive understanding of a structure's behavior under seismic excitation (Chopra, 2017).

RSM is generally considered to provide a more realistic assessment of a structure's seismic performance, particularly for taller, less stiff, more flexible, and more complex buildings where higher mode effects become significant (Chopra, 2017). Due to its enhanced accuracy, building codes often mandate the use of RSM for structures exceeding specific height thresholds (e.g., greater than 15 meters in all seismic zones or greater than 40 meters as per some interpretations of IS 1893:2016) or those with unusual configurations (Gottala & Yajdhani, 2019; Suganya & Maheswaran, 2015). RSM also offers computational advantages over time history analysis due to its ability to decouple multi-degree-of-freedom systems into single-degree-of-freedom systems, making it a widely adopted dynamic method for linear elastic analysis (Chopra, 2017).

For structures demanding the highest level of accuracy, particularly those with significant non-linear behavior or requiring performance-based seismic design, the Time-History Method (THM) is employed. This advanced dynamic analysis technique directly integrates actual or artificially generated ground motion records over time, providing a detailed, step-by-step response of the structure to a specific earthquake event (Chopra, 2017). THM accounts for the full temporal variation of earthquake forces and can incorporate sophisticated non-linear material models, making it capable of capturing hysteretic behavior, strength degradation, and other complex phenomena that simpler methods cannot (FEMA P-1050, 2015). The primary advantage of THM lies in its ability to provide the most accurate and realistic prediction of structural response, especially when non-linear behavior is expected, or for very critical structures such as nuclear power plants, long-span bridges, or high-rise buildings (FEMA P-1050, 2015). However, THM comes with notable disadvantages, including high computational cost, sensitivity to the selection and scaling of appropriate ground motion records, and the complexity of interpreting the large volume of results (ASCE/SEI 7-16, 2017). Therefore, it is typically reserved for specialized applications or when mandated by codes for structures that exceed the limitations of RSM, such as those requiring explicit non-linear analysis for performance objectives (ASCE/SEI 7-16, 2017).

Extensive research has been conducted to compare these seismic analysis methods, often revealing varying outcomes depending on structural characteristics, seismic intensity, and code provisions. A study on a three-and-a-half-story residential building indicated that RSM, as prescribed by the Nepal Building Code, yielded higher seismic parameters such as base shear and story drift compared to ESM from the Indian Standard code (Pokhrel et al., 2023). For a four-story RC building in Cyprus, differences were also highlighted between static and dynamic analyses, suggesting that RSM can be more conservative even for low-rise structures (Resatoglu & Hamed, 2019). Similarly, research comparing static and dynamic analyses of medium to high-rise RC buildings found that ESM generally gave higher results for drifts and overturning moments when using codes like ECP 2012, EC8:2004, and UBC 1997 (Meleka et al., 2012). For a G+10 multistory building, dynamic analysis was found to yield bending moments 35% to 45% higher than static analysis results (Patil & Sonawane, 2017). Another comparison for regular RC buildings found that displacements, shear forces, and bending moments obtained from RSM were often *less* than those from ESM, with differences ranging from 20% to 80% (Adhikari & Rajasekhar, 2021). A study on 5, 10, and 15-storey regular buildings found that Equivalent Static Analysis resulted in higher maximum story displacement and drift ratios (34-38% and 27-33% higher, respectively) compared to Response Spectrum Analysis in seismic zones IV and V as per IS1893-2016 (Gottala & Yajdhani, 2019). These variations underscore the complexity and dependence of the results on specific building characteristics, seismic zones, and code provisions.

The divergence between ESM and RSM is often observed to increase with building height, making dynamic analysis increasingly critical for taller buildings. Research indicates that the difference in displacement calculated by static and dynamic analysis generally increases with the height of the structure (Shinde & Khot, 2017). For example, a study using equivalent static and time history analysis recommended that structures 9 stories or higher are not acceptably designed using ESM, necessitating dynamic methods (Haque et al., 2014). For 7-story buildings, while ESM might be deemed adequate for base shear, Time History analysis provides more accurate results (Haque et al., 2014).

The regularity of a structure also plays a crucial role in the applicability and accuracy of these methods. For regular framed structures, studies have shown that the lateral displacement values obtained from both linear static and linear dynamic methods are quite similar (Abbas et al., 2023). However, for irregular structures, the dynamic method tends to produce higher displacement values, indicating a potential underestimation of seismic effects by the static method in such cases (Abbas et al., 2023). Structural irregularities, whether in plan or elevation, mass, or stiffness, significantly affect seismic performance, leading to increased drifts, torsional effects, and overall vulnerability. Linear static methods, which assume a regular distribution of stiffness and mass, are inadequate for irregular structures and may underestimate displacement demands and internal forces (Vivek P. & Meshram, 2017). Thus, for buildings with significant plan or vertical irregularities, dynamic analysis methods such as response spectrum or time-history analysis are recommended for a more accurate and realistic assessment.

Furthermore, accurate seismic assessment often requires moving beyond simple bare-frame models. For instance, the inclusion of non-structural elements like unreinforced masonry infill can significantly alter the seismic fragility and overall performance of low-rise RC frames, a complexity often overlooked by simplified models (Suwal & Uprety, 2023). Realistic structural behavior is also better captured when considering the bidirectional effects of earthquake ground motions, which can induce combined stresses that uniaxial analyses might miss (Uprety & Suwal, 2023a). Similarly, the simultaneous action of multiple earthquake components on global and local responses of RC moment resisting frames necessitates advanced analysis to prevent underestimation of critical forces and displacements (Uprety & Suwal, 2023b). These inherent complexities and the potential for non-linear behavior further justify the use of more advanced dynamic analysis methods over simplified static approaches, even for buildings of modest height, to ensure adequate safety and performance.

This study quantifies the increasing divergence between the Equivalent Static Method (ESM) and Response Spectrum Method (RSM) across a spectrum of building heights through the analysis of key response parameters, base shear, roof displacement and inter-story drift.

2. Methodology

This study employs a three-dimensional finite element modeling approach to analyze a series of regular buildings of varying heights, all utilizing a dual structural system. The objective is to compare the seismic demands computed using the Equivalent Static Method (ESM) and the Response Spectrum Method (RSM) as prescribed by the Nepal National Building Code. The commercial software ETABS, which is particularly well-suited for modeling the combined behavior of frames and shear walls in dual systems, was utilized for all analyses.

2.1. Structural system and geometry

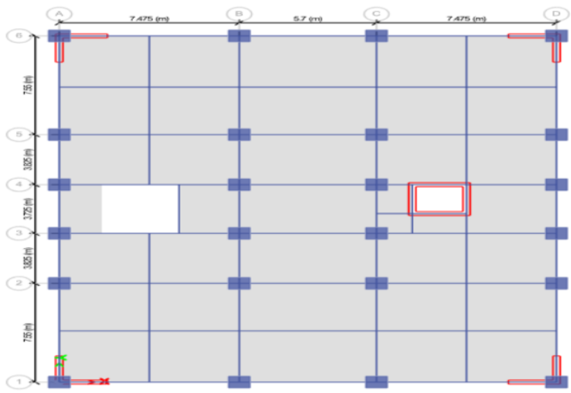

Figure 1. Typical Plan view of 4,8 and 16 Storey Building Models.

To systematically evaluate the effect of building height, three structures were modeled: a low-rise (4-story, 12m), a mid-rise (8-story, 24m), and a high-rise (16-story, 48m) building. The lateral force-resisting system in all models is a reinforced concrete (RC) dual system, comprising special moment-resisting frames interacting with structural shear walls to resist lateral loads. This system is common for mid- to high-rise construction in seismic regions.

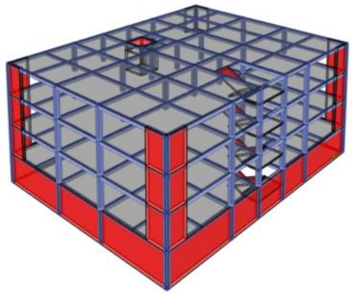

Figure 2. 3D View of 4-Storey Building Model in ETABS

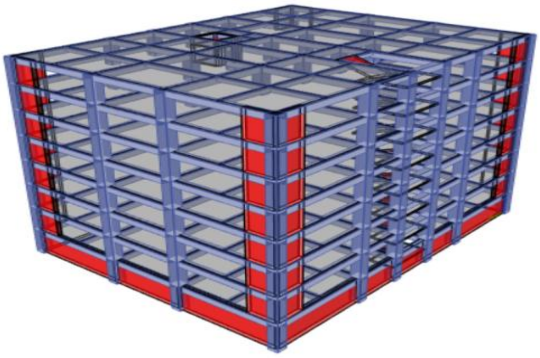

Figure 3. 3D View of 8-Storey Building Model in ETABS

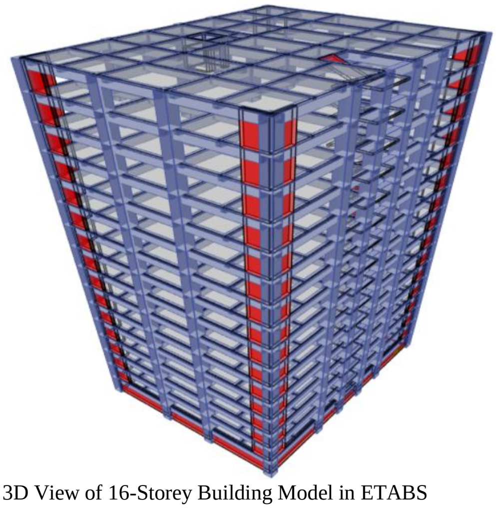

Figure 4. 3D View of 16-Storey Building Model in ETABS

To isolate the effect of height, all models were designed with a regular, symmetrical floor plan. This ensures that torsional effects are minimized and the comparison remains focused on the fundamental differences between the two analysis methods. A typical floor-to-floor height of 3m was used for all models.

2.2. Material properties and section details

The material properties and section sizes were scaled appropriately for each building's height and design demands, reflecting standard engineering practice. The details are summarized in the table below:

Table 1. Geometric and material properties of building models

Building Height	Concrete Grade	Slab Thick.	Waist Slab Thick.	Secondary Beam	Main Beam	Column
4-Story	M25	150 mm	150 mm	150 × 225 mm	230 × 300 mm	350 × 350 mm
8-Story	M30	150 mm	200 mm	300 × 450 mm	450 × 600 mm	700 × 700 mm
16-Story	M35	150 mm	225 mm	450 × 550 mm	500 × 800 mm	900 × 900 mm

High-yield strength deformed reinforcing steel of grade Fe500 was used for all models.

2.3. Seismic parameters and analysis methods

The seismic analysis for all models was performed according to the Nepal National Building Code (NBC 105:2020). The key parameters, assuming a location in Kathmandu, are as follows:

- Seismic Zone Factor (Z): 0.35 (for Kathmandu)
- Soil Type: D (Very Soft Soil)
- Importance Factor (I): 1.25
- Structural System: Dual System (RC Moment Resisting Frames with RC Structural Walls)
- Ductility Factor (μ): 3.5
- Overstrength Factor for ultimate limit state (Ωu): 1.4
- Overstrength Factor for serviceability limit state (Ωs): 1.2

Two distinct analysis methods as defined in the code were applied to each model: the Equivalent Static Method (ESM) and the Response Spectrum Method (RSM). For RSM, a damping ratio of 5% was considered, and modal responses were combined using the Complete Quadratic Combination (CQC) method, with sufficient modes included to achieve at least 90% mass participation.

3. Results and Discussion

The analysis of the 4, 8, and 16-story dual-system buildings yielded a clear and significant finding: the divergence in seismic response parameters calculated by the Equivalent Static Method (ESM) and the Response Spectrum Method (RSM) increases substantially with the height of the structure. This trend was consistently observed across the key parameters of base shear, roof displacement, and inter-story drift, though the nature of the divergence varied.

3.1. Base Shear

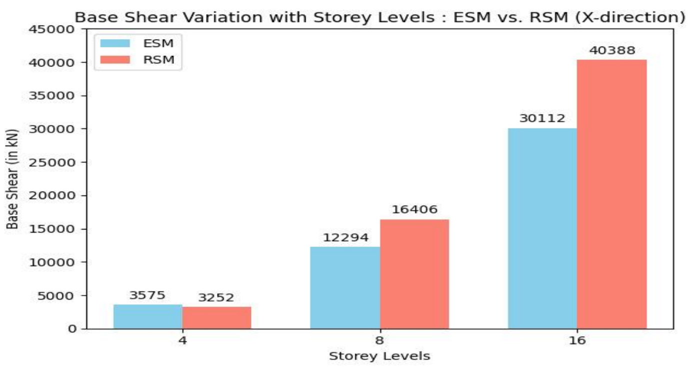

Figure 5. Base Shear Variation with Storey Levels: ESM vs RSM(X-direction)

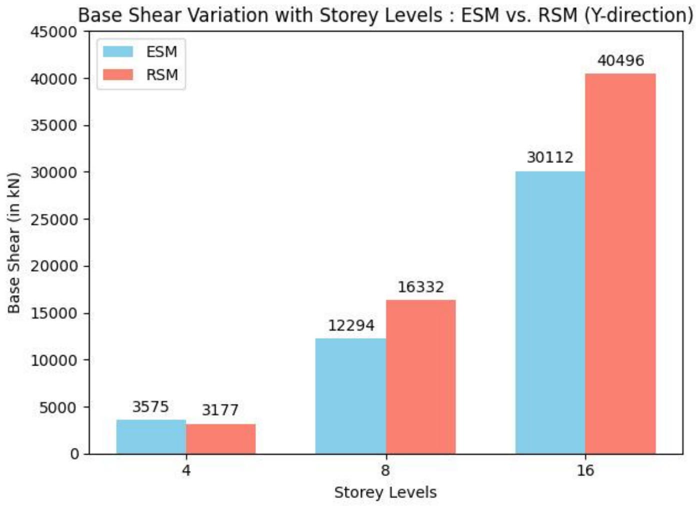

Figure 6. Base Shear Variation with Storey Levels: ESM vs RSM(Y-direction)

The comparison of base shear revealed the most critical finding of this study. For the 4-story building, the ESM was found to be conservative, predicting a base shear 9.9% higher in the X-direction (3575 kN vs. 3252 kN) and 12.5% higher in the Y-direction (3575 kN vs. 3177 kN) compared to the RSM.

However, this relationship dramatically reverses as the building height increases. While design codes often restrict the application of ESM to buildings of limited height (e.g., typically around 40m or fewer stories depending on regularity and seismic zone), the 8-story and 16-story buildings were included as case studies to systematically demonstrate and quantify the extent of ESM's limitations and its potential for unsafe predictions in structures where higher modes of vibration become significant. For the 8-story building, the ESM significantly underestimated the seismic load, yielding a base shear that was 25.1% lower in the X-direction (12294 kN vs. 16406 kN) and 24.7% lower in the Y-direction (12294 kN vs. 16332 kN) than the RSM. This underestimation became even more pronounced for the 16-story building, where the ESM base shear was found to be 25.4% lower in the X-direction (30112 kN vs. 40388 kN) and 25.6% lower in the Y-direction (30112 kN vs. 40496 kN).

This reversal highlights a fundamental limitation of the ESM for taller structures. The ESM simplifies seismic demand by primarily considering the building's fundamental mode of vibration, where the equivalent static forces are distributed based on a mass participation that is typically assumed to be 100% for the first mode approximation. In contrast, the RSM, as a dynamic method, combines the responses from multiple modes of vibration, each contributing according to its effective modal mass. While the total effective mass participation across all modes sums up to 100% of the building's total mass (not greater than 100%), the contribution of higher modes to the overall base shear can be significant, especially in taller and more flexible structures. The dynamic combination of these modal responses (e.g., using SRSS or CQC methods) in RSM effectively captures the cumulative effect of these higher modes, which are increasingly excited by earthquake ground motions. This comprehensive modal combination leads to a higher total base shear prediction by the RSM in such cases, as it accounts for dynamic amplifications not considered by the simplified first-mode-dominated ESM. While some design codes include provisions for scaling the RSM base shear if it falls below a certain percentage of the ESM base shear (typically 85% to 100% of the base shear calculated using the fundamental period for code compliance), this is a minimum design requirement and does not negate the analytical prediction that RSM, by virtue of its dynamic nature, can inherently yield larger base shear values due to the inclusion of higher mode effects. Therefore, the reliance on ESM for the 8-story and 16-story buildings, without adequately accounting for these higher mode contributions, would lead to a dangerous under-design of the lateral force-resisting system.

3.2. Roof Displacement

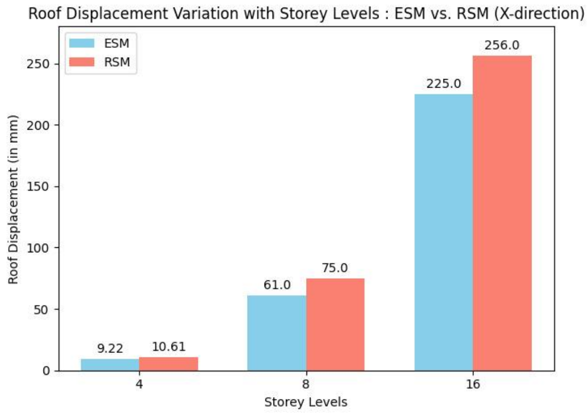

Figure 7. Roof Displacement Variation with Storey Levels: ESM vs RSM(X-direction)

For roof displacement, the RSM consistently predicted larger values than the ESM across all building heights. More importantly, the absolute difference between the two methods grew substantially with height, indicating a significant divergence in their predictions for taller structures.

- For the 4-story building, the difference was minor. ESM predicted 9.22 mm while RSM predicted 10.61 mm in the X-direction, a difference of only 1.39 mm.
- For the 8-story building, this gap widened considerably. ESM predicted 61 mm while RSM predicted 75 mm in the X-direction, with the difference increasing to 14 mm
- For the 16-story building, the disparity became even more pronounced. ESM predicted a displacement of 225 mm, whereas RSM predicted 256 mm, a substantial difference of 31 mm in the X-direction. A similar trend was observed in the Y-direction.

Roof displacement is a measure of the overall flexibility and deformation of a structure. The RSM consistently provides a more conservative (larger) estimate because it accounts for the cumulative effect of multiple mode shapes on the building's deformed profile. The simplified linear force distribution of ESM does not capture this complex dynamic behavior as accurately, leading to an underestimation of the total displacement. As demonstrated by the data, this underestimation becomes more significant in absolute terms for taller, more flexible structures where higher modes have a greater impact.

3.3. Maximum Inter-story drift

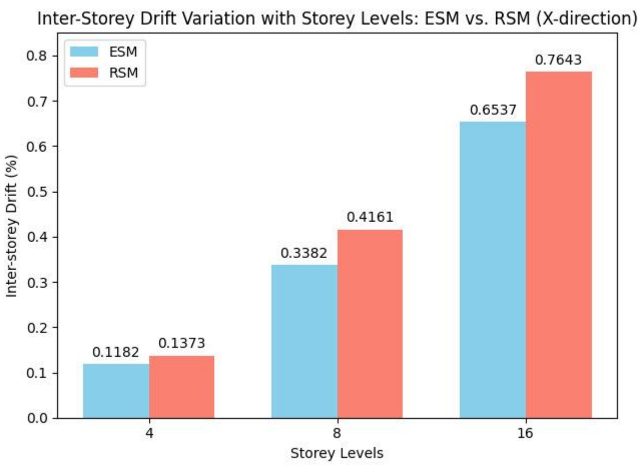

Figure 8. Max Inter-Storey Drift Variation with Storey Levels: ESM vs RSM(X-direction)

A similar pattern of increasing divergence was observed for maximum inter-story drift. The RSM consistently predicted higher drift values, and the absolute difference in these predictions between the two methods widened significantly as the buildings became taller.

- For the 4-story building, the difference was minimal. ESM calculated a drift of 0.1182% while RSM calculated 0.1373% in the X-direction, an absolute difference of just 0.0191%.

- For the 8-story building, this gap increased substantially. ESM predicted a drift of 0.3382% compared to RSM's 0.4161%, marking a larger difference of 0.0779%.

- The divergence was most significant in the 16-story building. Here, the ESM predicted a drift of 0.6537%, while the RSM predicted 0.7643%, resulting in the largest absolute difference of 0.1106%. A consistent trend of increasing difference was also noted in the Y-direction.

Inter-story drift is a critical parameter for assessing potential damage to both structural and non-structural components. The data shows that the absolute difference in predicted drift grows from approximately 0.02% for the low-rise to over 0.11% for the high-rise structure. This growing underestimation by the ESM suggests

it may not provide a safe or realistic basis for damage control design in mid- to high-rise structures. The RSM, by providing a more accurate representation of the building's dynamic response, offers a more reliable prediction of potential damage.

4. Limitations and future work

1. Our all three models included shear walls and a basement for a fair comparison, which made the buildings quite stiff and resulted in low drift values.
2. Beam and column sizes were chosen to be representative for each building height rather than undergoing a full, detailed design process.
3. Building codes typically limit ESM to structures below 40m. Our study purposefully examined taller buildings to quantify ESM's inaccuracies when higher modes become significant.
4. Investigate structural behavior using non-linear analysis methods (e.g., pushover, time history) to assess actual damage and collapse potential, extending beyond linear elastic predictions.

5. Conclusion

This study systematically evaluated the accuracy of the Equivalent Static Method versus the Response Spectrum Method for the seismic analysis of 4, 8, and 16-story dual-system buildings designed according to NBC 105:2020. While the general limitations of ESM for taller structures are acknowledged in seismic design practice, this research quantifies the extent of the divergence between these two methods across different building heights.

The primary conclusions are:

- **Base Shear:** ESM proved conservative for the 4-story building, predicting base shear 9.9% higher in the X-direction and 12.5% higher in the Y-direction compared to RSM. However, for taller structures, ESM became critically unconservative, underestimating the seismic load by approximately 25.1% (X) and 24.7% (Y) for the 8-story building, and by 25.4% (X) and 25.6% (Y) for the 16-story building. This is attributed to ESM's inability to capture the significant contributions of higher modes of vibration in taller, more flexible structures.
- **Roof Displacement:** The RSM consistently predicted larger roof displacement values across all building heights. The absolute difference between the methods significantly increased with height: 1.39 mm for the 4-story building (ESM 9.22 mm vs. RSM 10.61 mm), widening to 14 mm for the 8-story building (ESM 61 mm vs. RSM 75 mm), and becoming most pronounced at 31 mm for the 16-story building (ESM 225 mm vs. RSM 256 mm) in the X-direction.
- **Inter-story Drift:** A similar trend of increasing divergence was observed for maximum inter-story drift. The RSM consistently predicted higher drift values, with the absolute difference widening from 0.0191% for the 4-story building (ESM 0.1182% vs. RSM 0.1373%) to 0.0779% for the 8-story building (ESM 0.3382% vs. RSM 0.4161%), and reaching 0.1106% for the 16-story building (ESM 0.6537% vs. RSM 0.7643%) in the X-direction.

Therefore, this research concludes that while the ESM may offer a simplified and sufficiently conservative approach for low-rise dual-system buildings within the NBC 105:2020 framework, its application leads to significant underestimation of seismic demands and deformations for mid- to high-rise structures. The presented quantitative data underscores that ESM is not a reliable or safe approach for the final design of such taller buildings, as its use would result in an under-design of both required structural strength and potential damage control. For these structures, the application of the Response Spectrum Method is essential to ensure a safe, accurate, and reliable seismic design that accounts for complex dynamic behavior, including higher modal effects.

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References

Abbas, M. F., Salman, M. M. and Muhammad Ghaltan, J., 2023. A Comparative Study of Static and Dynamic Seismic Analysis of Regular RC Buildings. Journal of Applied Sciences, 19, pp.495-503.

Adhikari, S. and Rajasekhar, C., 2021. Comparative Study on Static and Dynamic Analysis for Medium to High-Rise RC Buildings. ERJ. Engineering Research Journal.

ASCE/SEI 7-16, 2017. Minimum Design Loads and Associated Criteria for Buildings and Other Structures. American Society of Civil Engineers.

Chopra, A. K., 2017. Dynamics of Structures: Theory and Applications to Earthquake Engineering. 5th ed. Pearson.

Department of Urban Development and Building Construction, 2020. NBC 105:2020. Nepal National Building Code. Nepal.

European Committee for Standardization, 2004. EN 1998-1: Eurocode 8: Design of structures for earthquake resistance.

Federal Emergency Management Agency (FEMA), 2015. FEMA P-1050, NEHRP Recommended Seismic Provisions for New Buildings and Other Structures.

Gottala, A. and Yajdhani, S., 2019. Comparison of Equivalent Static Analysis and Response Spectrum Analysis on G+10 Storied Building in All Seismic Zones and Soil T. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 7(4), p.2572.

Haque, M. S., Salam, M. A. and Ullah, M. R., 2014. Acceptability of the Equivalent Static Method for Designing Multi-Story Structures. In: Atlantis Press.

Meleka, N., Hekal, G. and Rizk, A., 2012. Comparative Study on Static and Dynamic Analysis for Medium to High-Rise RC Buildings. ERJ. Engineering Research Journal.

Nguyen, T. C., Erlicher, S. and Martin, X., 2014. The Response Spectrum Method: A Critical Review and a New Formulation. Earthquake Engineering & Structural Dynamics, 43(13), pp.2007-2028.

Patil, M. N. and Sonawane, Y. N., 2017. Comparative Study of Static and Dynamic Seismic Analysis of Multistoried RCC Building by ETABS. International Journal of Advanced Research in Science and Engineering, 6(3).

Pokhrel, A., Shrestha, S. S. and Paudel, P., 2023. Comparative Study on Seismic Analysis of a Residential Building Using NBC and IS Codes. Journal of Nepal Geological Society.

Resatoglu, H. and Hamed, E., 2019. Static versus Dynamic Seismic Analysis of RC Buildings: A Case Study in Cyprus. International Journal of Engineering Research and Development, 15(7), pp.10-18.

Shinde, S. L. and Khot, P. D., 2017. Seismic Analysis of Multi Storied Building for SMRF and SMRF with Shear Wall by using Static and Dynamic Methods. International Journal of Engineering Research & Technology (IJERT), 6(06), pp.405-408.

Suganya, V. and Maheswaran, P. T., 2015. Effect Of Area and Height of Building on Lateral Forces Using SCM And RSM. International Journal of Engineering Research & Technology (IJERT), 4(03).

Suwal, R. and Uprety, R., 2023. Seismic fragility assessment of low-rise reinforced concrete frame: A comparative study of bare and infill model. Journal of Engineering Issues and Solutions, 2(1), pp.37-49.

Uprety, R. and Suwal, R., 2023a. Bidirectional effect of earthquake on low-rise RC frames with and without the consideration of in-plane effect of unreinforced masonry infill. Structures, 47, pp.648-664.

Uprety, R. and Suwal, R., 2023b. Effect of earthquake components on global and local response of RC moment resisting frames. Asian Journal of Civil Engineering, 24(6), pp.1501-1514.

Vivek P., S. and Meshram, A. A., 2017. DESIGN AND ANALYSIS OF IRREGULAR SHAPE BUILDING IN STAAD PRO. Journal of Engineering Sciences, 8(3), pp.5-10.