SEYBOLD Report
ISSN: 1533 - 9211
https://seyboldreport.net/

COMPARATIVE ANALYSIS OF G+9 MULTI-STORIED BUILDING FOR DIFFERENT POSITIONS OF SHEAR WALL BY USING STAAD.PRO

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Abstract- Shear walls or reinforced concrete structural walls serve as a key component of an earthquake-resistant construction. An effective bracing system and source of lateral load resistance are structural walls. One of the most widely employed lateral-load resisting technologies in high-rise structures is the shear wall system. Shear walls are particularly useful in many structural engineering applications because of their high in-plane stiffness and strength, which may be used to support gravity loads while also supporting huge horizontal loads. It is crucial to properly assess the seismic response of the walls since the characteristics of these seismic shear walls heavily influence how the buildings respond. Comparing the dynamic reactions of frame structures with and without shear walls is the primary goal of this study. Three models are created with different heights with both shear walls and no shear walls. The height-dependent generation of G+5, G+10, and G+15 R-C frame models with and without shear walls results in different structural member dimensions. With regard to seismic zone V in STAAD, the models are analysed using the static method and response spectrum method. Pro V8i. For all the models (with and without shear walls), parameters including lateral displacement, story drift, base shear, and mode shapes are calculated by the three approaches, compared, and the benefits of shear walls are listed. Moreover, comparisons are drawn based on some earlier investigations completed by the other authors.

Keywords— Comparative Analysis, G+9 Multi-Storied Building, Different Positions, Shear Wall, Staad.Pro.

INTRODUCTION

The building vibrates as a result of the ground's seismic movement, which also results in structural deformation. The overall reaction of the structure is determined by a number of characteristics related to this deformity, including vibration frequency, period, and amplitude. The distribution of seismic forces within the structure, which again depends on the method employed to compute this distribution, also affects the total response. With the advancement of technology, several techniques for 3-Dimensional dynamic analysis of structures have improved in effectiveness. Natural disasters like earthquakes strike with no prior notice. These are erratic motions of the ground that inflict significant harm quickly. 90% of earthquakes are the result of tectonic events, primarily the movement of faults. Volcanoes, man-made activities, and many other repercussions could account for the remaining 10%. If earthquakes strike in cities with higher population densities, the damage will be greater. Due to the widespread and intense construction activity, it is important to research historical Indian earthquakes and gather seismic data for use in the future. After making multiple attempts to analyse seismic data, the Bureau of Indian Standards eventually adopted the Indian Standard code IS1893, PART1 for General Provisions in Buildings in 1962. The most recent revision is IS1893 (Part1):2016, though several revisions have been made. With its third iteration, the standard rationally included seismic zone factors. Only four zones (Zone I and Zone II are combined and are referred to as Zone II) are included in the fifth iteration. To categorise the regions with similar likely earthquake intensities, seismic zoning is used. The lateral loads placed on a structure can be determined from the zoning data, and it is at this point that an earthquake-resistant construction is developed. Hence, seismic zoning is useful for town planning. The occurrence of earthquakes produces significant lateral stresses. In order to resist the lateral loads, the structure must have ductility. Ductility is a characteristic that results from inelastic behaviour, hence it is important to specify reinforcement in a way that avoids its brittle nature. The arrangement of the structural components can be changed while still employing the same amount of material to create a construction that is more stable. By including shear barriers, the difference between the actual and design forces can be minimised.

LITERATURE REVIEW

The comparable static lateral load approach of design for multi-story masonry structures was described by Touqanaet et al. [1]. The damage assessment of irregular buildings based on static and dynamic analysis was compared by Bagheriet et al. [2]. Bagheriet et alanalysis .'s of a multi-story irregular building [3] contrasted the outcomes of the static and dynamic analysis techniques. The impacts of response spectrum analysis on building height were examined by Khan [4]. High-rise building seismic analysis was carried out utilising the response spectrum method by Patil et al. [5]. Using the help of the response spectrum method and the time history method, Harshitha et al. [6] described seismic analysis of a symmetric RC frame. Comparative analysis of the performance of RCC multi-storey buildings for the Koyna and Bhuj earthquakes was presented by Bhagwatet et al. [7]. Dynamic analysis was used to evaluate base shear and storey drift in [8]. Multi-storeyed RCC buildings were subjected to time history analyses by Patil et al. [9] for various earthquake intensities. Seismic Analysis of RCC Buildings with and without Shear Walls was explained by Chandurkaret et al [10]. A multi-story building's shear wall placement was solved by Anshuman et al. [11]. The structural response of soft storey high rise buildings to various shear wall locations was explained by Misam et al. [12]. Using the use of equivalent static approach, time history method, and response spectrum method, the primary goals of this research are to compare the seismic behaviour of multistory reinforced concrete rigid frame structures of varied heights with and without shear wall. On the G+6 RCC, Akash Panchal and Ravi Dwivedi conducted analysis. modelled the structure using the comparable static approach in several seismic zones, and came to a conclusion by comparing changes in shear force, bending moment, and deflection. In their study of the impact of placement on the seismic response of RC buildings on hilly and flat terrain, Anjali B.U. and Godisiddappa discovered that straight form shear wall design produces better results. When Mohd Atif evaluated multi-story buildings with bracing and shear walls, he found that the latter were significantly less efficient than the former. A 20-story building in Zone IV was analysed by Sachin.P.Dyavappanavar who determined that a building with a shear wall at the corner is not structurally sound. In this study, a structure's shear walls at corners, exterior centre bays, alternating bays, and a structure without shear walls are all compared to one another.

METHODOLOGY

The inertia forces that a structure develops when it is activated by rapid dynamic loads are the subject of dynamic analysis (e.g., wind blasts, explosion, and earthquake). A static load is one that changes extremely gradually over time. When compared to the structure's natural frequency, a dynamic load is one that changes rather quickly over time. Static analysis can be used to predict a structure's response if it changes gradually, but dynamic analysis is required to predict a structure's response if it changes rapidly relative to the structure's capacity to adapt. A component of structural analysis called dynamic analysis of structures examines the behaviour of flexible structures that are subjected to dynamic loads. Dynamic load constantly varies over time. Wind, live load, seismic load, and other dynamic loads are included. So, it is safe to assume that practically all problems encountered in daily life can be explored dynamically. The Equivalent Lateral Force Method (Static Linear Method) and Reaction Spectrum Method are two types of seismic analysis that were used in this study. The lateral force is attempted to be determined in this research using the Equivalent Static method. The Equivalent Static technique, which is utilised in this case, is based on the distribution of forces and the natural period to determine the amount of lateral forces. using the STAAD.Pro V8i programme to calculate the fundamental elements, such as deflection, bending moments, support responses, and beam end forces, and comparing the results. Equivalent Static Technique is used to do the analysis. To boost the seismic reaction to the structure, several seismic configurations are modelled into the models.

(i) Building Modeling- A RC model of a multi-story building with 10 stories is used to model this structure.

Each level is 3 metres high, and the foundation is 2 metres deep. A bay model without shear walls, a bay model with shear walls at corners, a bay model with shear walls at middle outside bays, and a bay model with shear walls at alternate bays are four possible configurations that are modelled. The building is rectangular in shape, measuring 21.5m along the X axis and 10m along the Z axis. These are the designs for all four of the different configurations that were compared:

ISSN: 1533 - 9211

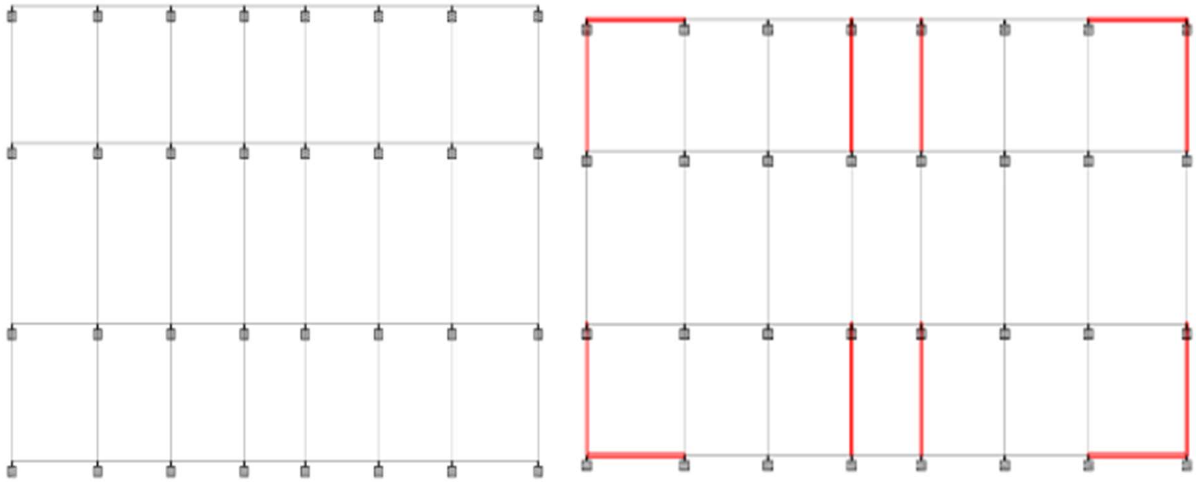

Figure 1 & Figure 2

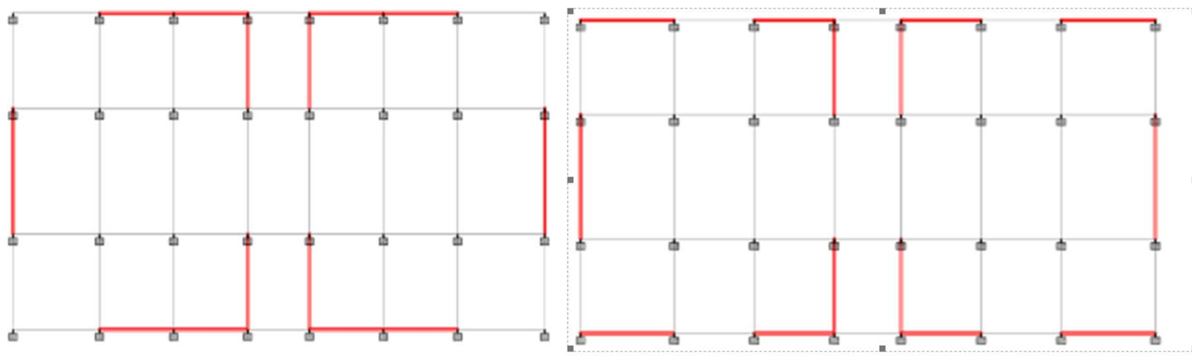

Figure 3 & Figure 4

(ii) Equivalent Lateral Force- According to the equivalent lateral force approach, each floor that can transfer lateral loads will receive a portion of the seismic force (base shear). By using this method, the estimated forces are generated and applied to rigid (or semi-rigid) diaphragms or vertical parts (columns, walls). Every code suggests particular restrictions on applying such a technique. Regularity and height of a construction are two frequent restrictions. The storey's mass consists of dynamic masses from transformed loads as well as newly introduced masses. Diaphragms assure proportional distribution of seismic loads on vertical elements. Apply the generated force to the diaphragm's centre of mass. Not positioned in the plane of the storey top, a diaphragm or panel does not carry seismic force. Masses of nodes lying at the plane of the story top (floor plane) are taken into consideration in the absence of diaphragms. The distribution of force that is proportional to mass must then be calculated. Based on the structure's mass, fundamental period of vibration, and associated mode shape, the base shear the total horizontal force acting on the structure is determined. According to the code formula, the base shear is distributed along the height of structures in terms of lateral force. For low to medium height buildings with regular conformation, this strategy is conservative.

(iii) Response Spectrum Analysis- This technique is appropriate for systems whose responses are strongly influenced by modes other than the basic one. According to this method, the response of a multi-degree-of-freedom (MDOF) system is calculated as the superposition of modal responses, each of which is obtained from a spectral analysis of a single degree-of-freedom (SDOF) system. Modal analysis provides the structure's response history to a given ground motion, however the technique is typically combined with a response spectrum. Simply put, a response spectrum is a depiction of the peak or steady-state response (displacement, velocity, or acceleration) of a number of oscillators that are propelled into motion by the same force and have varied natural frequencies.

(iv) Specifications- For each of the 16 models, the plan dimensions listed below are provided in order to complete the building modelling process.

S. No	Parameters	Dimensions/Type
1.	Plan dimension	10m x 21.5m
2.	Number of storeys	G + 9
3.	Total height of the building	30m
4.	Height of each storey	3m
5.	Exterior column dimension	0.6m x 0.6m
6.	Interior column dimension	0.45m x 0.45m
7.	Beam size	0.3m x 0.45m
8.	Model type	SMRF
9.	Type of Soil	Medium soil
10.	Inner wall thickness	0.2m
11.	Outer wall thickness	0.3m
12.	Slab thickness	150mm
13.	Shear wall thickness	250mm
14.	Unit weight of concrete	$25KN/m^3$
15.	Unit weight of brick	$20KN/m^3$

Table 1- Dimensions of the Structural elements and type of materials

Material properties	
Grade of concrete	M25
Elastic modulus of concrete	$25000\ N/mm^2$
Poisson's ratio of concrete	0.15
Grade of reinforcing steel	Fe415
Elastic modulus of steel	$2 \times 10^5\ N/mm^2$
Poisson's ratio of steel	0.286

Table 2- Material properties of concrete and steel

(v) Material Properties- Material properties of the models are taken as the same for all the models and the values given above are used for analysis.

FLOWCHART OF THE WORK

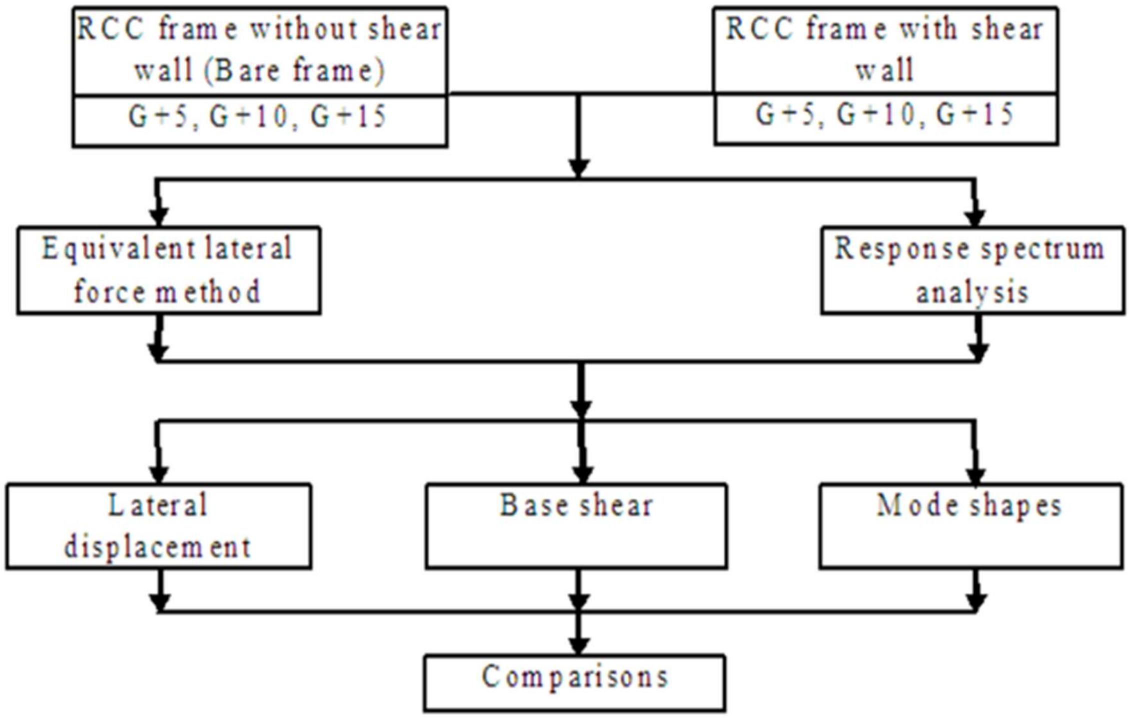

Figure 5- Flowchart of the Work

VALIDATION

To check the accuracy of the software and to establish a close understanding on the papers reviewed, validation of the past works are conducted. In this study, the results obtained from STAAD are compared with the paper of Harshitha et al. (2014). Few of comparisons are shown below.

(i) Comparison of Mode Shape

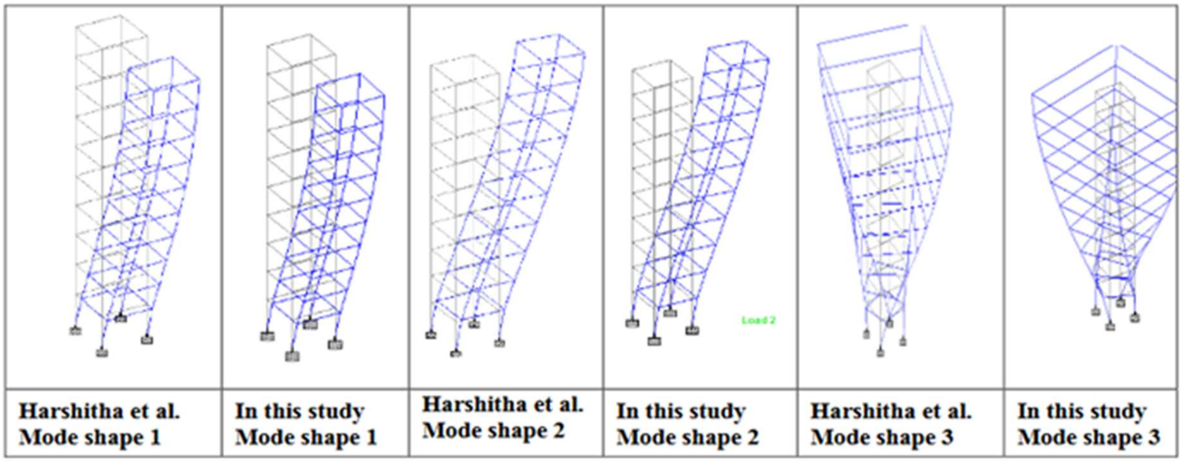

Figure 6- Comparison of Mode Shape

(ii) Comparison of Natural Frequency of the Building by Response Spectrum Method

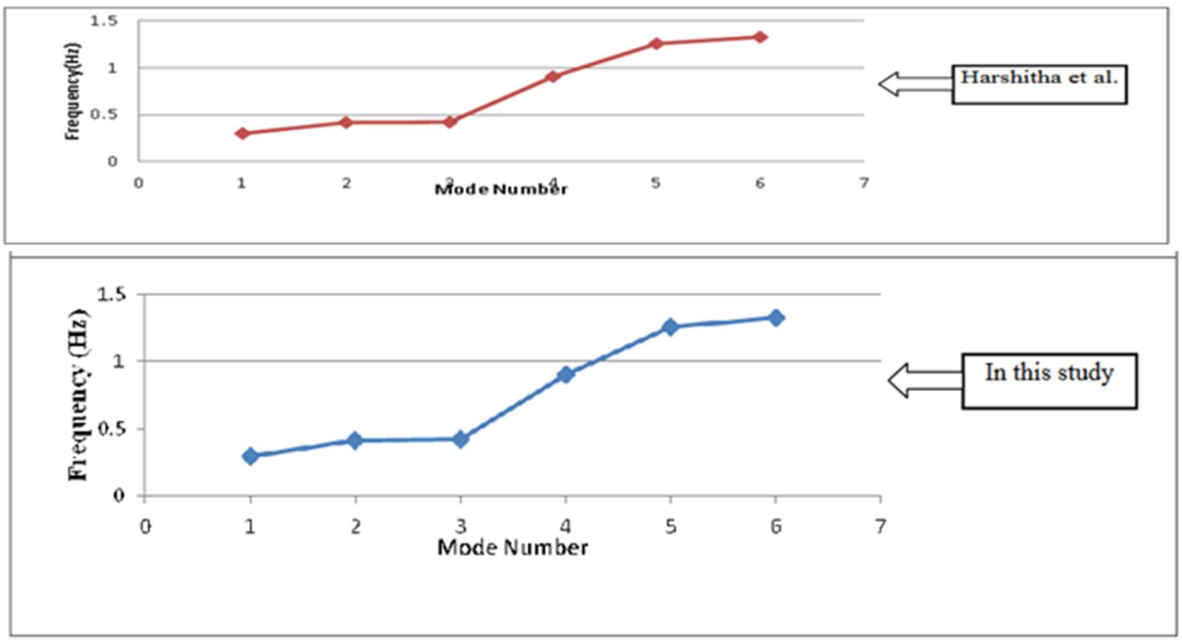

Figure 7- Comparison of Natural Frequency of the Building by Response Spectrum Method

(iii) Comparison of Base Shear in Response Spectrum Method

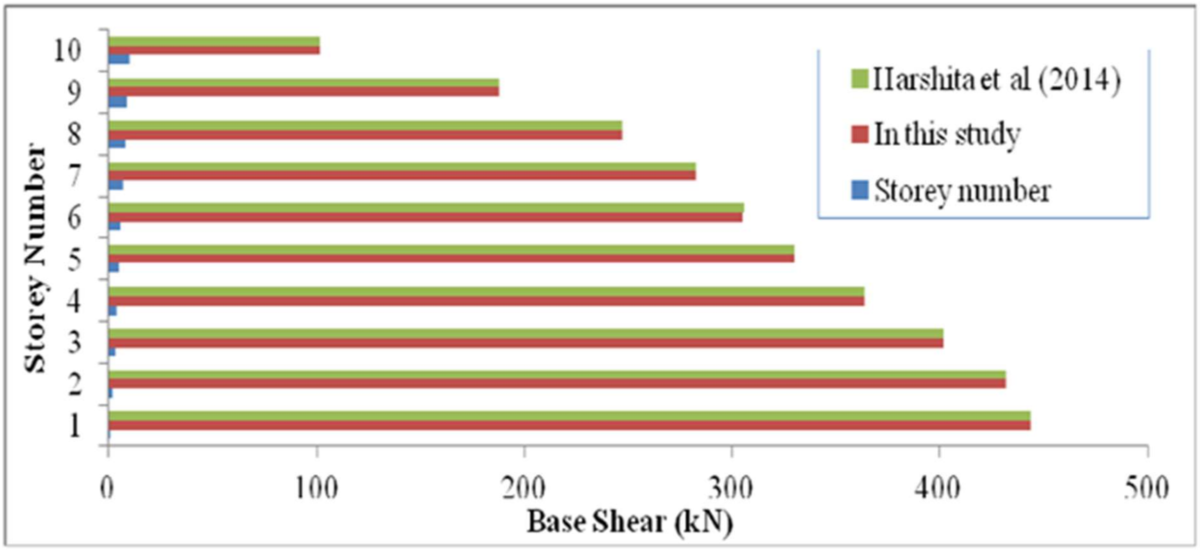

Figure 8- Comparison of Base Shear in Response Spectrum Method

CONCLUSION

The study's findings can be inferred as follows: It can be seen that STAAD software accurately matches the design seismic coefficient values, such as fundamental natural period and spectrum acceleration coefficient, computed by IS 1893:2002. STAAD's measurement of the design horizontal seismic coefficient is consistent with code. The most crucial earthquake design factor, base shear, as determined by all models, follows the code exactly. Also, the weight of the building is determined manually and compared to the results of the software. More displacement was shown by the bare-frame model than by the shear-walled-frame model. In addition, it has been noted that all shear wall frame models exhibit significantly higher lateral stiffness when compared to bare frames. As height increases, there is a rise in the displacement variation between the bare frame and shear walled frame models; however, the displacement variation between the two frames for G+5 floors was less than that for G+15 stories. The displacement levels depend on the frequency of the earthquakes and the natural frequency of the building, and structures with short lifespans typically experience greater accelerations but less displacement. A total of sixteen models were examined, with the outcomes among them being compared. Four models in four seismic zones were examined. For all sixteen models in all four seismic zones, the shear wall thickness, beam, and column dimensions are used as-is. The two load cases 1.5(D.L+EQX) and 1.5(D.L+EQZ) have had the most impact on the structure out of all the load cases. In all seismic zones, the displacement, bending moment, and base shear are significantly reduced by the presence of shear walls.

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