International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Seismic Analysis of Regular and Irregular Frame Structures Using Diaphragm by Staad Pro. Software

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ABSTRACT—

Multi-storey building analysis is generally performed using more sophisticated techniques and procedure. Therefore, accepting modern ways to seismic analysis of multi-storey buildings can be very valuable to structural engineers and researchers.The intention of this study is therefore, to investigate the effect of different plan buildings with constant plan area in various seismic analysis performance by comparing it with rigid diaphragm, semi-rigid diaphragm and without diaphragm including regular and irregular geometries. This study considered, comprehensive literature survey and analysis of different plan of buildings with various parameters like maximum bending moment, shear force, maximum displacement.displacement and storey.

Maximum Displacement

In maximum displacement, it is seen that without diaphragm and semi rigid diaphragm has almost same results means semi rigid diaphragm is equivalent to without diaphragm structure.In maximum displacement, It is seen that without diaphragm is maximum and rigid diaphragm is minimum means Without Frame is critical and rigid diaphragm is efficient.In comparison to all diaphragms, rigid diaphragm reduces thrice the displacement among other diaphragms

Beam forces

In bending moment, it is seen that without diaphragm and semi rigid diaphragm has almost same results means semi rigid diaphragm is equivalent to without diaphragm structure.In bending moment, It is seen that without diaphragm is maximum and rigid diaphragm is minimum means Without Frame is critical and rigid diaphragm is efficient.In shear force, it is seen that without diaphragm and semi rigid diaphragm has almost same results means semi rigid diaphragm is equivalent to without diaphragm structure.In shear force, It is seen that without diaphragm is maximum and rigid diaphragm is minimum means Without Frame is critical and rigid diaphragm is efficient.

Maximum Storey displacement

In maximum storey displacement, it is seen that without diaphragm and semi rigid diaphragm has almost same results means semi rigid diaphragm is equivalent to without diaphragm structure.In maximum storey displacement, It is seen that without diaphragm is maximum and rigid diaphragm is minimum means Without Frame is critical and rigid diaphragm is efficient.In comparison to all diaphragms, rigid diaphragm reduces thrice the displacement among other diaphragms

From the present study it is seen that Rigid diaphragm compared to other diaphragms is much efficient in reducing moment, storey displacement, peak displacement. The analysis done in the present study clearly shows that semi-rigid diaphragm models produce more frame displacement and moments than the Rigid diaphragm models. It has been found from the analysis of various building, Without Frame is less critical and plaza building is critical among all building. The Rigid diaphragm is more effective in case of a without diaphragm building. It is concluded that the building with Rigid diaphragms will be structurally economic resulting into a great deal of saving in reinforcement steel.

Keywords: seismic analysis, rigid diaphragm, semi-rigid diaphragm, without diaphragm, bending moment, shear force.

1. Introduction

Multi-storey buildings are a special class of structures with their own peculiar characteristics and necessities. Multi-storey buildings are occupied by a massive amount of population. As a result, their accident and destruction may have significant negative effects on both the economy and quality of life. Because each multi-storey structure represents a sizable investment, multi-storey building study is typically carried out utilising more advanced techniques and procedures. Therefore, structural engineers and researchers can benefit greatly from adopting contemporary methods for seismic analysis of multistory buildings. Therefore, the purpose of this study is to compare the performance of various seismic zones with rigid, semi-rigid, and without diaphragm buildings with varying plans and constant plan areas. This will be taken into account in the study work by conducting an extensive literature review and analysis of various construction plan

2. OBJECTIVES OF THE PRESENT STUDY

- The main objective of this thesis is to investigate the effectiveness of building, considering various geometries under different seismic parameters .

3. LITERATURE REVIEW

Moon and Lee (1994) Due to the ease of the analytical process, the rigid floor diaphragm assumption was used for the analysis of multistory building structures.

Prakash (2004) provides information on Performance Based Engineering (PBE) opportunities in our nation. He lists the prerequisites that allowed PBE to emerge in California, including the requirements for earthquake-resistant building design as set down by the Bureau of Indian Standards (BIS). By combining zones I and II, IS 1893-2002 reduced the number of seismic zones to four and implemented a modified CIS-64 scale for seismic zoning.

Fan et al. (2009) to construct the finite element (FE) model of the tall structure, it was conducted a shaking table test to ascertain the constitutive relationships for the concrete filled steel tube (CFT) columns and steel members. Then, a numerical analysis of the tall building's earthquake responses was performed

Wakchaure and Ped (2012) The impact of brick walls on tall buildings is examined. Analyses of various layouts are performed using linear dynamics. For the analysis, a G+9 R.C.C.-framed building is modelled. The framed building has earthquake time history applied to it, and numerous analysis instances are used. Utilising software (ETABS), this work will be analysed. On the basis of several parameters including beam forces, column forces, and displacements, analysis is calculated, and the results of all the models are compared.

Liang and Lucia (2012) explores the inelastic behaviour of the 4, 8 and 12-story elastic zipper braced frame (E-ZBF) buildings under crustal, subduction, and near-field ground movement ensembles in Victoria, British Columbia, a seismically active area.

Devi et al (2022) The present study deals in the zone 5 and for school building which constructed in district mandi, Himachal Pradesh. A multi-storied framed school structure of (G+3) pattern is selected. Linear seismic analysis is done for the building by static method using Staad-Pro as per the IS-1893-2002- Part-1 and dynamic method (Response Spectrum Method) using Staad-Pro as per the IS-1893-2016- Part-1. A comparison is done between the static and dynamic analysis, the results such as Bending moment, area of steel required, compared and summarized for Beams, Columns and Structure as a whole during both the analysis

Zhong Ma et al. (2022) Low-rise residential buildings can benefit from the cost- and structurally-efficient light timber framed (LTF) structures. The seismic performance of single-storey LTF buildings covered in gypsum-plasterboards (GPBs), a common lining material in New Zealand homes, is examined in this research. When used to brace walls to withstand earthquake stresses, GPBs are typically more prone to damage than wood-based structural panels. This study intends to shed light on how the in-plane rigidity of ceiling diaphragms and the bracing wall irregularity permitted by the current New Zealand standard NZS 3604 affect the overall seismic performance of these GPB-braced LTF buildings. A number of single-story baseline buildings with varying degrees of bracing wall imperfections and ceiling diaphragm rigidity underwent nonlinear time-history evaluations. The eccentric bracing wall configuration with semi-rigid/rigid ceiling diaphragms created a considerable torsional effect, as evidenced by the results. Under the rigid diaphragm assumption, the average bracing wall drift demand resulting from extreme bracing wall abnormalities was three times greater than it was in the standard bracing wall configuration. This result was in line with the house survey conducted following the 2011 Canterbury earthquake, which revealed that homes with asymmetrical bracing wall arrangements and particularly inflexible diaphragms had much more damage than other homes. To prevent excessive damage in these LTF buildings during future events, it is advised to limit the level of bracing wall eccentricity and ensure that the diaphragms are appropriately rigid.

Intekhab et al. (2023) High-rise buildings must undergo seismic analysis before being designed because they pose a risk to both the built environment and human life. It was noted, however, that the majority of high-rise buildings exhibit abnormalities in terms of mass, stiffness, strength, design, etc. The architectural designs, the non-orthogonal positioning of columns, the irregular placement of mass in the building, etc. all contribute to the irregularities. The researchers found that because the design codes only take into account regular structures, the irregular structures could not be examined using the regular methodologies specified in the codes.

Liu and Li (2023) Low-rise light timber-framed (LTF) buildings, built in accordance with the mandatory standard NZS 3604:2011 Timber-framed buildings, make up the majority of residential structures in New Zealand. The NZS 3604:2011 standard provides the test method for assessing the seismic resistance of proprietary LTF walls, which are frequently made of plasterboard, and tabulates the seismic demand. If the bracing arrangements comply with the prescribed irregularity limits, designers must ensure that the overall seismic bracing capacity offered is at least equal to the entire seismic bracing demand.Instead of using rigorous scientific evidence, the irregularity limits for bracing arrangements in NZS3604:2011 were developed based on engineering best practises. Simple regular LTF homes functioned well, according to seismic damage shown in the 2010–2011 Canterbury earthquake sequence, whereas irregular homes frequently sustained major damage that was uneconomical to restore. This revealed that one key reason for the increased seismic damage was the irregularity of LTF buildings.

Table 1 Mapping Seismic Zones to Intensities in IS 1893-2016

In IS : 1893-2016	
Earthquake Zone	**Mapped to a Modified CIS-64 Scale**
II	VI and below
III	VII
IV	VIII
V	IX and above

4. METHODOLOGY, SOFTWARE USED AND FLOW CHART

This Present work deals with comparative study of behaviour of high rise building frames considering different geometrical configurations and diaphragm constraints under earthquake forces. A comparison of results in terms of moments, shear force, displacements, and storey displacement has been made. Following steps are applied in this study

4.1 Flow Chart By Staad Pro.

Figure 3.2 Modelling of structure

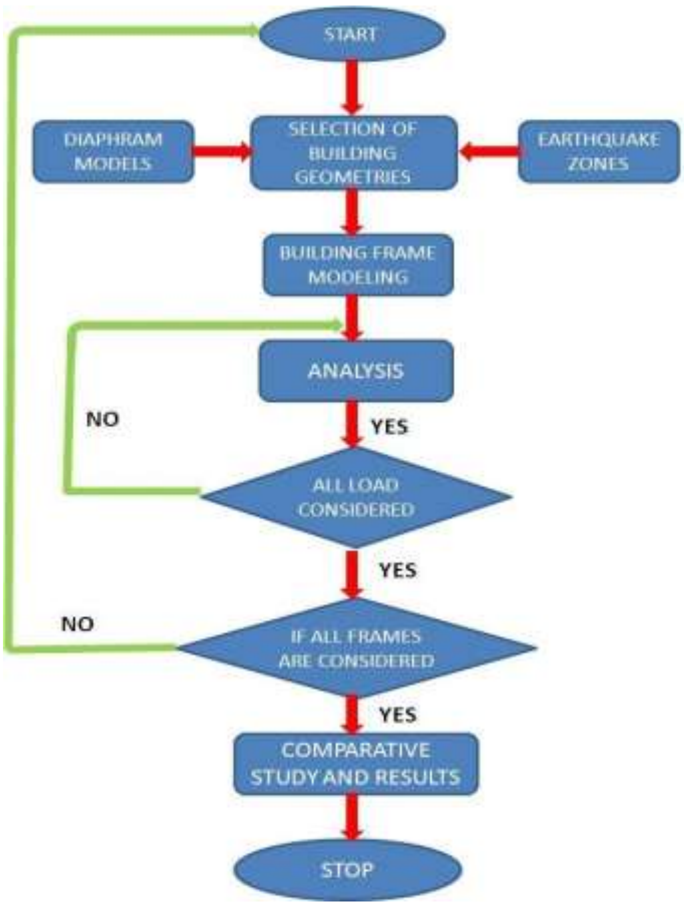


Figure 1 Modelling of structure

Table 2: Different types of diaphragm models

1

Case	Model
Type 1	Without Diaphragm
Type 2	Rigid Diaphragm
Tpye 3	Semi-Rigid Diaphragm

Table 3: Seismic zones for all cases

2

	Case	Model	Earthquake zones as per IS 1893 (part-1) : 2016
		RCC Structure	II, III, IV, V

Table 4: Load case details

3

Load case no.	Load case details
1.	E.Q. IN X_DIR.
2.	E.Q. IN Z_DIR.
3.	DEAD LOAD
4.	LIVE LOAD
5.	1.5 (DL + LL)
6.	1.5 (DL + EQ_X)
7.	1.5 (DL - EQ_X)
8.	1.5 (DL + EQ_Z)
9.	1.5 (DL - EQ_Z)
10.	1.2 (DL + LL + EQ_X)
11.	1.2 (DL + LL - EQ_X)
12.	1.2 (DL + LL + EQ_Z)
13.	1.2 (DL + LL - EQ_Z)

. Table 5Modelling of Structure

Case-1: Rcc Regular Structure Without Diaphragm

Case-2: Rcc Regular Structure With Rigid Diaphragm

Case-3: Rcc Regular Structure With Semi-Rigid Diaphragm

Case-4: Rcc Irregular (Steped) Structure Without Diaphragm

Case-5: Rcc Irregular (Steped) Structure With Rigid Diaphragm

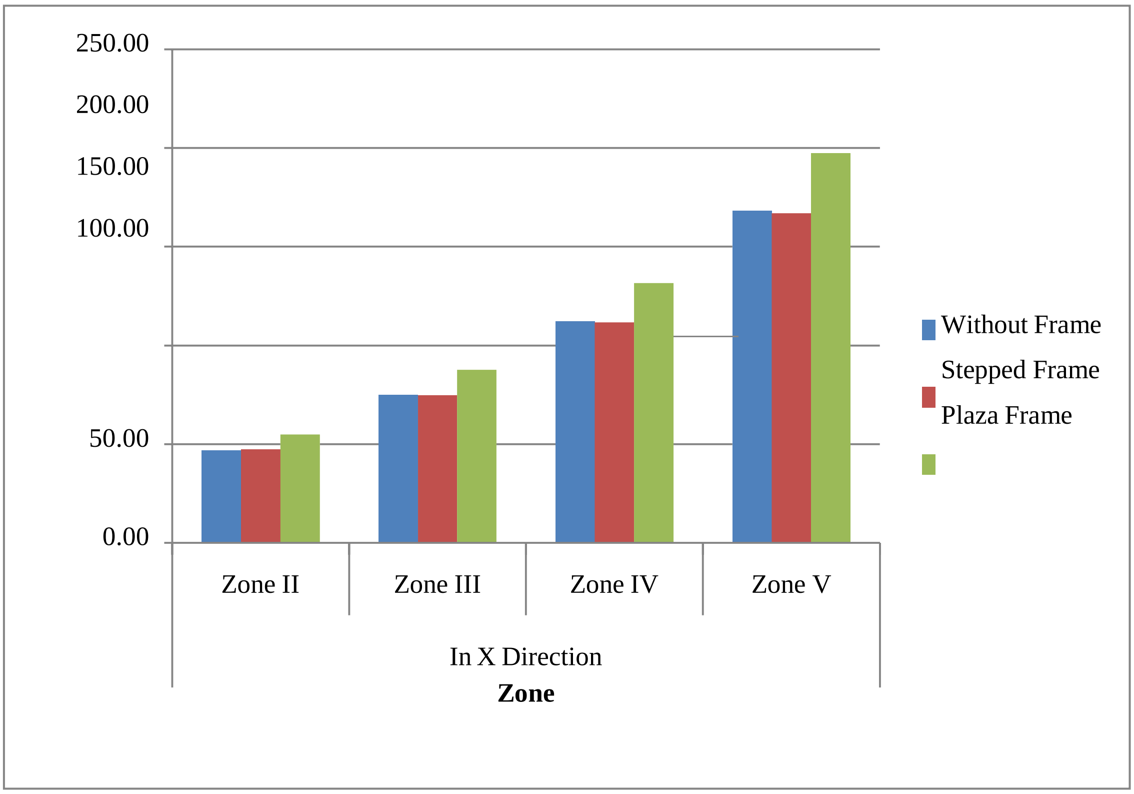
Case-6: Rcc Irregular (Steped) Structure With Semi-Rigid Diaphragm

Case-7: Rcc Irregular (Plaza) Structure Without Diaphragm

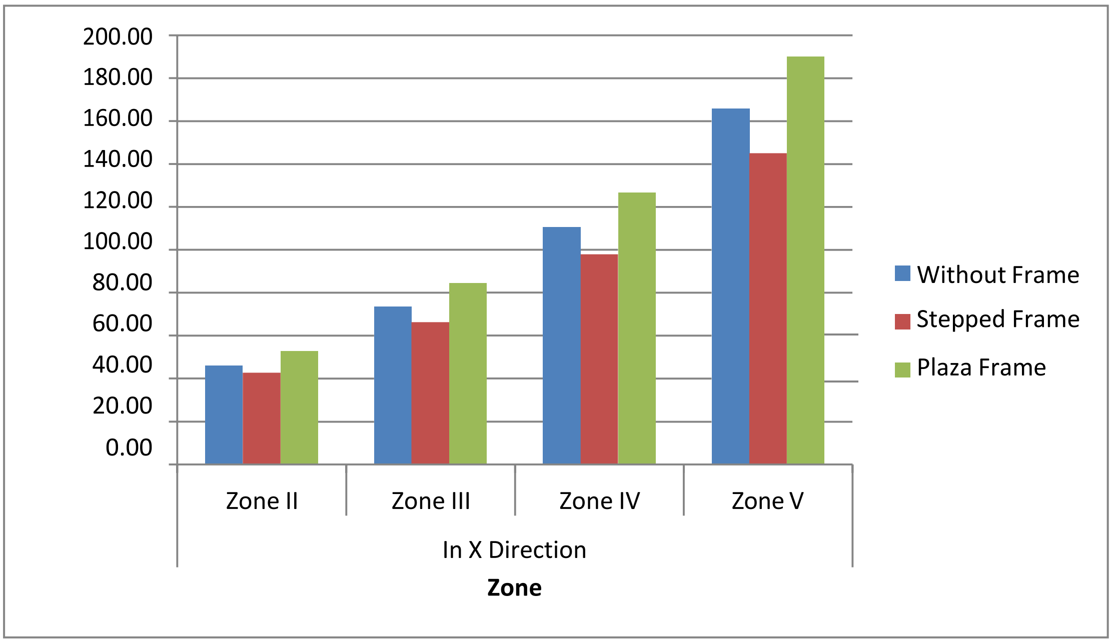
Case-8: Rcc Irregular (Plaza) Structure With Rigid Diaphragm

Case-9: Rcc Irregular (Plaza) Structure With Semi-Rigid Diaphragm

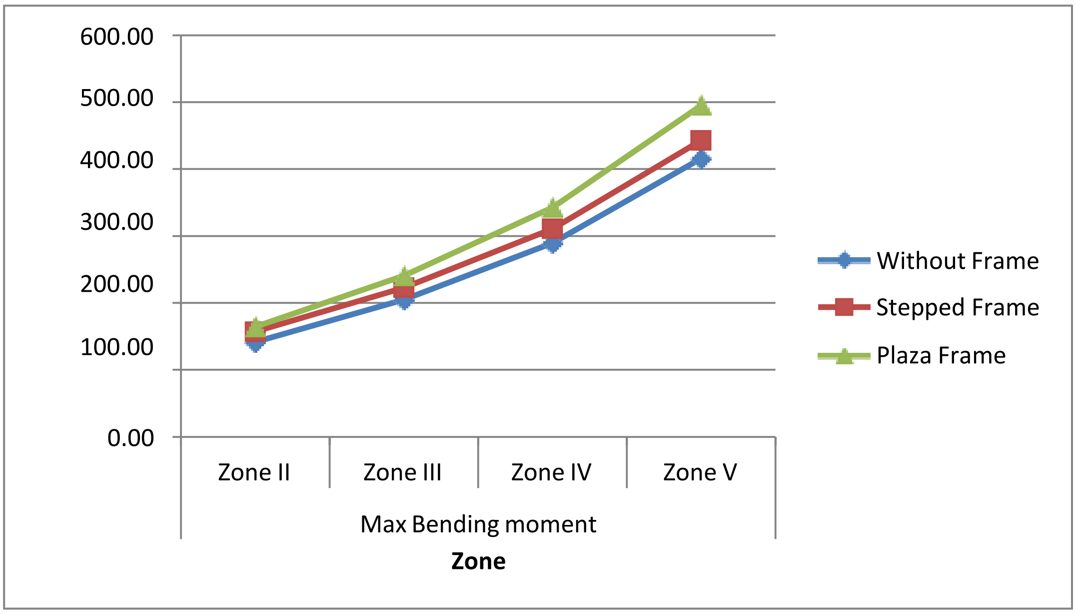
5. RESULTS AND DISCUSSION



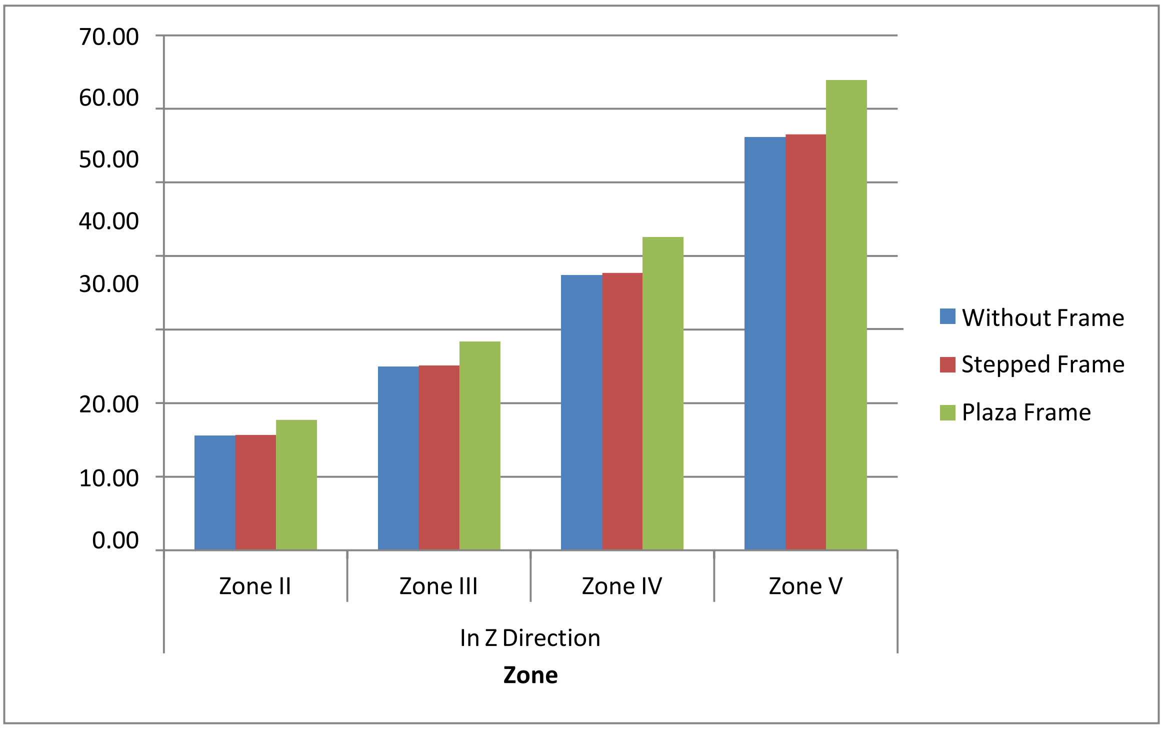
Graph 1: Maximum Displacement in X direction



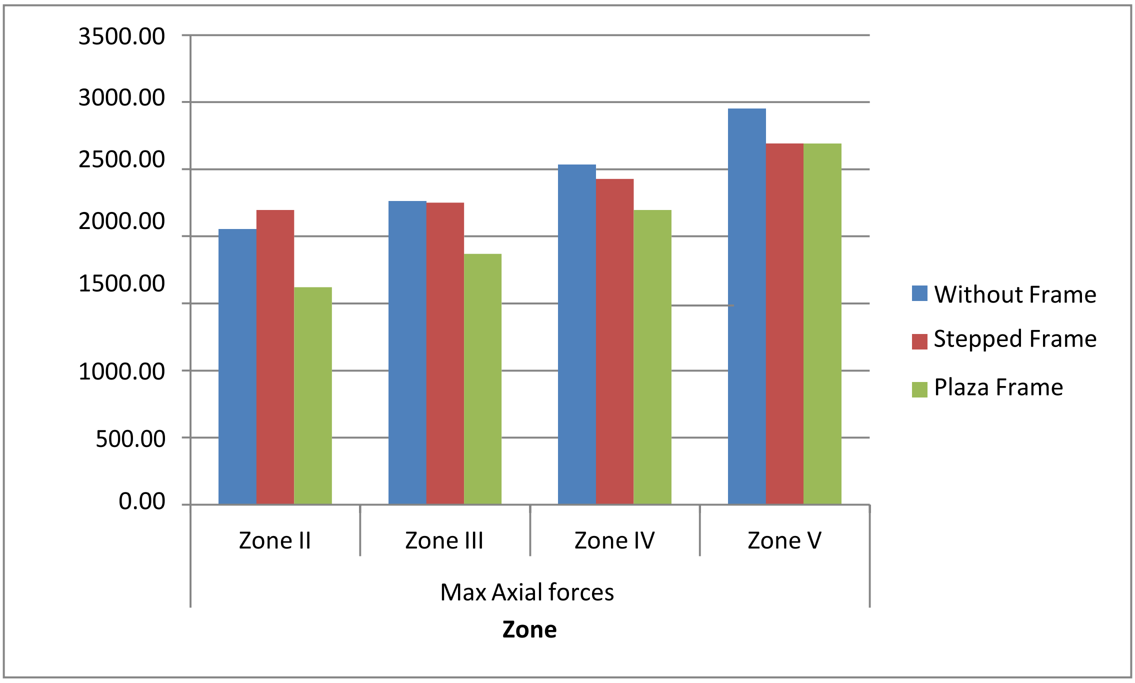
Graph 2: Maximum Displacement in X direction



Graph 3: Max. bending moment in beam



Graph 4: Max. peak storey displacement in Z direction



Graph 5: Max. axial force in column

6. CONCLUSION

1. ***Maximum Displacement***

- In maximum displacement, it is seen that without diaphragm and semi rigid diaphragm has almost same results means semi rigid diaphragm is equivalent to without diaphragm structure.

2. ***Beam forces***

- In bending moment, it is seen that without diaphragm and semi rigid diaphragm has almost same results means semi rigid diaphragm is equivalent to without diaphragm structure.

3. ***Maximum Storey displacement***

In maximum storey displacement, it is seen that without diaphragm and semi rigid diaphragm has almost same results means semi rigid diaphragm is equivalent to without diaphragm structure

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