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A Study of Regular and Irregular Frame Structures Using Diaphragm by Structural Software

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ABSTRACT—

Analysis of multi-story buildings is typically carried out with more advanced methods and procedures. Therefore, structural engineers and researchers can benefit greatly from accepting contemporary methods of seismic analysis of multi-story buildings. Therefore, the goal of this study is to compare the seismic analysis performance of various plan buildings with constant plan area and rigid, semi-rigid, and no diaphragm, including regular and irregular geometries. This study took into account a thorough review of the literature as well as an analysis of several building plans with different specifications, including the maximum bending moment, the shear force, the maximum displacement, and the storey.

Maximum Displacement

Since semi-rigid diaphragms yield nearly identical results when the displacement is at its maximum, semi-rigid diaphragms are equivalent to diaphragm-free structures.It can be observed that in terms of maximum displacement, rigid diaphragm is the minimum and absence of diaphragm is the maximum. Rigid diaphragm is effective and crucial without it.A rigid diaphragm decreases displacement three times more than other diaphragms when compared to all diaphragms.

Beam forces

The observation that semi-rigid diaphragms yield nearly identical results in bending moments to those of diaphragm-free structures indicates that semi-rigid diaphragms are equivalent to diaphragm-free structures.It is observed that in the bending moment, the rigid diaphragm is the minimum and the absence of diaphragm is the maximum. Rigid diaphragm is effective and crucial without it.The observation that semi-rigid diaphragms yield nearly identical results to those of diaphragms absent in shear force implies that semi-rigid diaphragms are structurally equivalent to diaphragm-free diaphragms.It can be observed that in shear force, rigid diaphragm is minimum and without diaphragm is maximum. This indicates that rigid diaphragm is efficient and without frame is critical.

Maximum Storey displacement

It is observed that in the maximum storey displacement, semi-rigid diaphragm and no diaphragm produce nearly identical results, indicating that semi-rigid diaphragm is the same as no diaphragm structure.It can be observed that in the maximum storey displacement, rigid diaphragm is the minimum and without diaphragm is the maximum. Rigid diaphragm is effective and crucial without it.A rigid diaphragm decreases displacement three times more than other diaphragms when compared to all diaphragms. According to the current study, rigid diaphragms are significantly more effective than other diaphragms at lowering moment, storey displacement, and peak displacement. The current study's analysis unequivocally demonstrates that semi-rigid diaphragm models generate greater moments and frame displacement than rigid diaphragm models. According to an analysis of several buildings, the plaza building is the most important of all the buildings, while the without-frame building is less important. When a building has no diaphragm, the rigid diaphragm works better. The building with rigid diaphragms is determined to be structurally sound, which will save a significant amount of money on reinforcement steel.

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

1. Introduction

Reinforced concrete construction began in the early 1900s. But at that time reinforced concrete buildings were limited to only a few stories in height, since the structural system employed was the traditional beam-column frame system. This traditional beam- column system made the construction of taller buildings very expensive and economically impractical. New structural methods (shear wall frame systems) are created in the early 1950s, making it possible to utilise reinforced concrete in apartment and office buildings as tall as 30 stories. Buildings taller than 30 stories were still uneconomical, since the shear walls, which were mostly located in the core of the building, were small in size, to give sufficient stiffness to resist transverse loads that is, the overall size of the shear walls were too small to economically provide the stability and stiffness for buildings over 30 stories. On the other hand the socio economic situations and an increasing demand for space in the growing U.S. cities created a strong need to the construction of tall buildings.

2. OBJECTIVES OF THE PRESENT STUDY

This is achieved by doing comparative analysis of the building frames with rigid diaphragm, semi-rigid diaphragm and without diaphragm building frames.

3. LITERATURE REVIEW

Sheng-Jin Chen (1988) adopted the diaphragm characteristics of three commonly used reinforced concrete floor systems have been studied both analytically and experimentally.

Many important constants, such as the strength, stiffness and deformation capacity have been considered. These characteristics are fundamental in the study of diaphragm behaviour of floor systems and its effect on building structural response.

Kunnath (1991) It has been found that many different forms of reinforced concrete structures' seismic response is influenced by the in-plane flexibility of floor-slab systems. In order to simplify engineering assessments without significantly reducing the accuracy of seismic response prediction for the majority of structures, the assumption of stiff floor diaphragms is frequently used. Despite this, the impact of diaphragm flexibility cannot be ignored for some types of structures, such as long, narrow buildings (especially those with dual-braced lateral load-resisting systems) and structures with horizontal (L- or T-shaped) or vertical (cross-walls or setbacks) offsets. This paper presents an simplified macro modelling scheme to incorporate the effect of inelastic floor flexibility in the seismic response analysis of RC structures. The slab model includes effects of both in-plane moment and shear

Dong-Guen et al. (2002) examined constructions using the box system, using simply RC walls and slabs. This study analyses high-rise box system structures while taking the effects of floor slabs into account.

Roy and Dutta (2010) Recognised that due to the soil-structure interaction, which implies a limited applicability of the dual-design philosophy, inelastic response for short period systems is particularly sensitive to reduction factors (R) and may be dramatically exaggerated even for tiny R. Buildings demonstrate that the soil structural interaction does not significantly affect the inelastic response of the asymmetric structure compared to its symmetric counterpart. The research also demonstrates that, at least for short-period systems, an analogous single-story model that uses the real system's lowest period rather than its fundamental one tends to produce cautious estimates of inelastic demand.

Kesavan and Menon (2022) In addition to other numerical modelling assumptions, the seismic incidence angle taken into account in the seismic analysis might affect the results of structural assessments of existing buildings. The expected direction of ground motion cannot be predicted in advance since seismic excitation is a random process. Currently, load patterns are applied along two randomly selected mutually orthogonal directions in nonlinear static analysis of three-dimensional building models to derive the structural responses. If the seismic demand were to act in a different direction, the results would either be higher or lower. In order to take these impacts into account, this work proposes a nonlinear static technique for unreinforced masonry buildings based on the well-liked N2 method. It would not be necessary to perform a time-consuming multi-directional static/dynamic examination. Additionally, the
report includes polar charts that demonstrate how the seismic incidence angle has a substantial impact on the resulting displacements at floor levels

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.

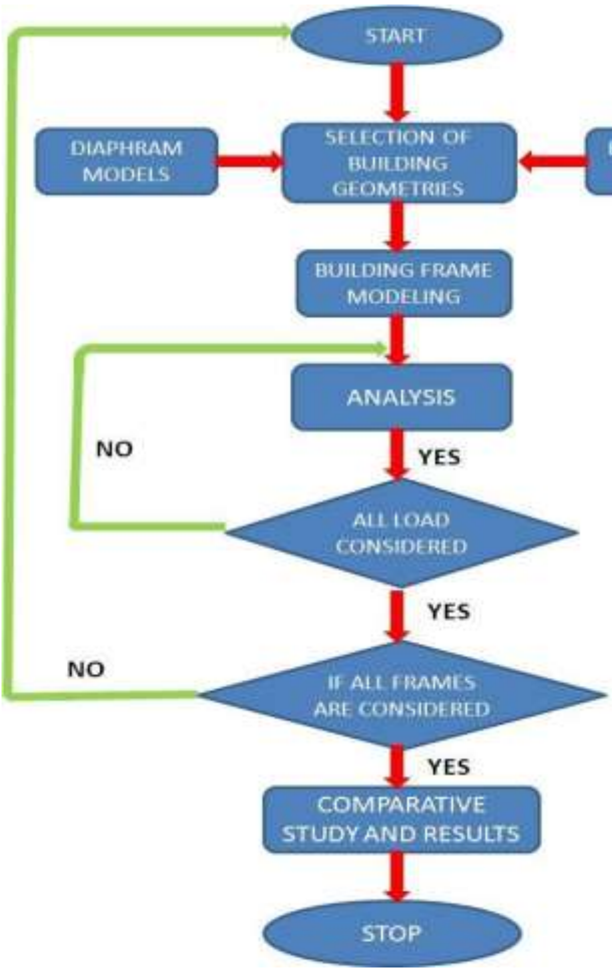


Figure 1 Modelling of structure

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

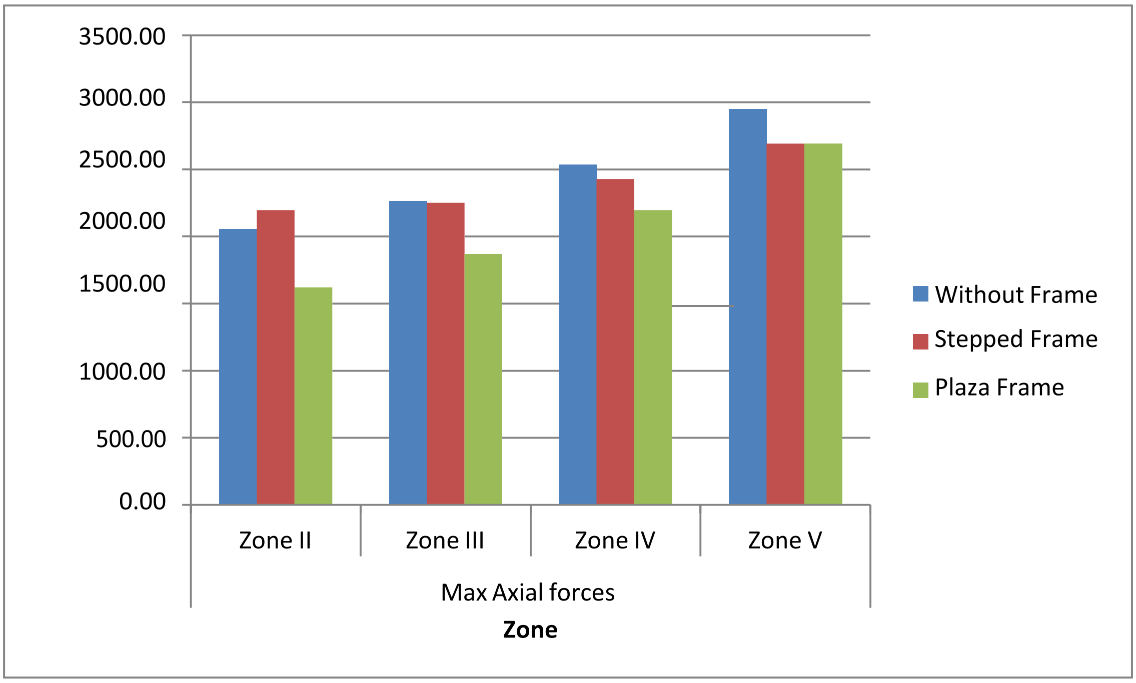
5. Result and discussion

STAAD. Pro is used in modelling of building frames. STAAD. Pro is Structural Analysis and Design Program is a general purpose program for performing the analysis and design of a wide variety of structures. The essential 3 activities which are to be carried out to achieve this goal are -

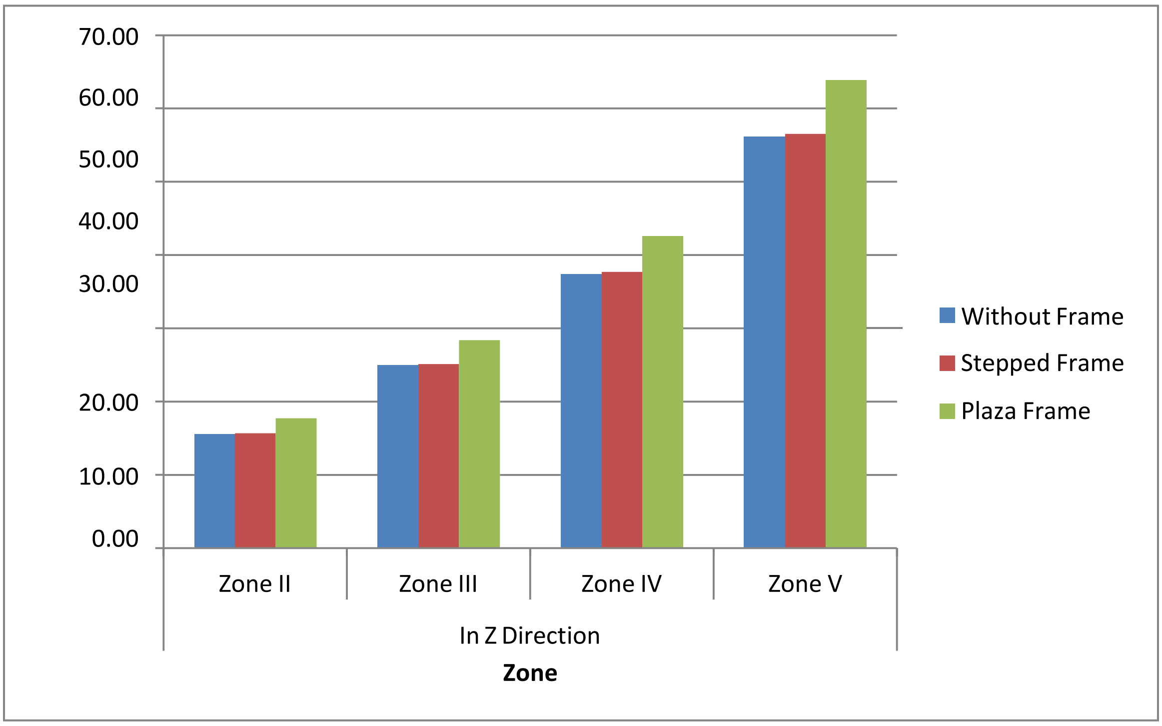
a. Model generation

b. Calculations to obtain the analytical results

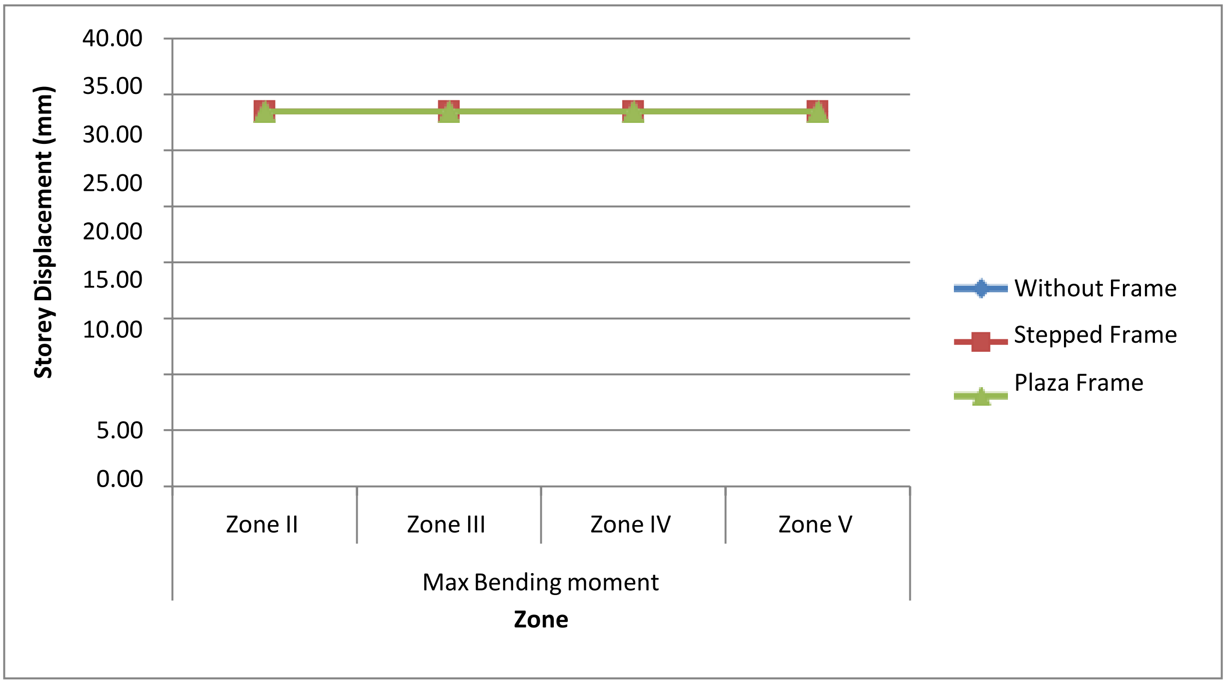
Result verification- These are all facilitated by tools contained in the program's graphical environment



Graph 1: Max. peak storey displacement in Z direction



Graph 2: Max. axial force in column



Graph 3: Max. bending moment in beam

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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