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Comparison Of Seismic Behaviour Of Typical Braced Multistorey RC Structure With Composite Structure

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ABSTRACT

This project investigates the seismic behavior of two distinct types of multistory reinforced concrete (RC) structures: a typical braced structure and a composed structure. Seismic forces present significant challenges in structural design, particularly in multi-storey buildings where how the lateral forces are distributed can lead to varying levels of stress and deformation. This study aims to compare these two structural system's performances under seismic loading by analyzing parameters such as base shear, storey drift, and displacement. Using advanced structural analysis software, the dynamic responses behaviour of the structure reinforced of both systems are evaluated through time history and spectrum of responses analyses. The results provide insights into the relative advantages and limitations of bracing systems and composed structures in mitigating seismic impacts, ultimately guiding the design of safer and more efficient multistory buildings in seismic-prone regions.

Key Words- RC Framed Structure, Bracings, Storey Displacement, Storey Drift, Base Shear.

I INTRODUCTION

Seismic events may cause significant damage to existing RC structures that were not constructed with seismic criteria in mind. Also, the structure's behaviour without ductile detailing causes the beams and columns to have insufficient transverse reinforcement. Two separate approaches may be considered for seismic execution redesign in light of these shortcomings: i. Reinforcing RC structures with steel bracings or RC shear walls. ii. The structural components are strengthened using concrete, steel, and fibre reinforced plastic. As an initial step, buildings may be reinforced using steel braces or reinforced concrete shear walls. However, there are practical and economic benefits to adding steel bracing to RC structures. Research has shown that bracings may effectively counteract earthquake stresses while also making buildings more rigid. The bracings lessen the building's displacement of stories and boost its ability to dissipate energy. These bracing devices act as a barrier against horizontal stresses like earthquakes and winds. They transfer these pressures to the building's substructure. The RC components' tension and compression are transferred to these bracings, which come in many shapes. Column bending moments are prevented by these bracings. X, V, Inverted V, Eccentric forward, Eccentric backward, and more bracing methods are offered.

1.1 INTRODUCTION TO COMPOSITE STRUCTURES

As an auxiliary component, RCC members are often used in India, and they are widely considered to be the best outline solution for low-rise structures. When designing tall structures, reinforced concrete members should not be used due to concerns about dead load, span length, and stiffness. Therefore, a different approach to addressing these flaws is required. As an alternate material, steel is ideal for the building. The most efficient method for constructing high-rises and other civil constructions is using composite sections, which consist of steel encased in concrete. Composites' reduced self-weights and increased strengths have contributed to their recent meteoric rise in popularity.

1.2 COMPONENTS OF COMPOSITE STRUCTURE

The following are the structural components used in steel-concrete composite construction:
- Composite Column
- Composite beam

- Composite deck section (deck slab)
- Shear connector

II. LITERATURE REVIEW

- Nitin.N.Shinde, et. al. has carried out the "Analytical study of unsymmetrical braced rc structures". In this paper they have analysed the two separate buildings, i.e one with braced & the other is unbraced RC building. For the analysis purpose they adopted SAP2000 software. They used different bracing systems and studied their seismic performance. They considered the IS 1893-2002 for different load combinations. Their main objective was to compare the behavior of the braced & unbraced RC building subjected to seismic loads and also to recognize the best bracing system under earthquake loads. They found that the displacement & drift is maximum for the unbraced building compared to the braced building and they concluded that performance of X bracing is better than inverted V and 2 storey X bracing system.
- Viswanath K.G1, et. al. has studied on the "Seismic analysis of braced rc frames". They analyzed the four storey residential structure which is located in Zone IV and for analysis they used STAAD-Pro software. They observed the effect of different bracing system on the residential building. Further they carried out the analysis for 8, 12 and 16 storied buildings. They compared the results in terms of displacements and drifts. They concluded that steel bracings are the best alternates for strengthening the buildings and they found that bracings avoid the shear and flexure demands on RC components. They also found that X bracing is best among the other bracings they have used.
- Umesh.R.Biradar et al. they carried out the study on "Seismic behavior of rc frames using various bracing systems". They analyzed total 7 models with six types of bracing systems. The various types of bracings adopted are X, V, Inverted V, Diagonal forward, Diagonal backward and K type bracings. All the models are compared with bare frame model. They used ETABS software and used linear static, linear dynamic, non-linear pushover & time hiStorey methods for the analysis purpose. They found that base shear obtained from IS code method does not matches with equivalent static & Response spectrum method using ETABS. They demonstrated that time period reduces with various types of bracings used. They showed displacements and drifts are in the range using ESA & RSA methods. Finally they too found that X bracing behavior is better than all other bracings under lateral loads.
- Rakshith K L et. al. they studied the "Effect of bracings on multistoried rcc frame structure under dynamic loading". They modeled total 12 models 6 models are regular & other 6 models are vertically irregular. X, V, Inverted V, Eccentric forward, eccentric backward are the 5 different types of bracings used by them. They carried out analysis in ETABS using Response spectrum method. They considered III zone for all the structures. They compared the response of the structure in terms of storey shear, displacements, storey drifts etc. They clarified that regular building is stiffer than vertically irregular building. Compared to other type of bracings X bracing minimizes the displacement & drift in both regular & irregular building.
- K.K.Sangle et. al. has carried out the study on "Seismic analysis of high rise steel frame building with and without bracing". They analyzed two high rise steel framed structure by time history analysis method. One structure is without bracings which is of G+40 while the other is with bracings, the no. of stories being the same. Their aim was to study the seismic behavior of both the structures. They used diagonal brace A , X brace , Knee brace & Diagonal brace B. they arrived at the conclusion that base shear for braced steel structure is 38% more than without braced steel structure. At the roof level the displacements are reduced upto 43- 60% by using various bracings. The modal time period is minimized by 65%. They found diagonal brace B is more effective & economical compared to other bracing systems.

III OBJECTIVES

- In order to learn how RC-framed structures with various bracing types—including X, V, and Inverted V—during seismic events subjected to dynamic loads.
- The purpose of this analysis is to compare the seismic responses of braced and unbraced structures.
- Identify the optimal bracing mechanism to effectively withstand earthquake and wind forces.
- In order to evaluate the outcomes in relation to overturning moments, base shear, storey displacements, storey drifts, and storey shear rates.

IV. METHODOLOGY

➢ STRUCTURAL MODELING

This research models a G+10 residential complex. We end up with five different models like this. Modelling is done using ETABS 2015. The bare frame, or standard typical RCC construction, is the first model. The X-braced, V-braced, and Inverted V-braced versions are numbered from 2 to 4. Composite structure is the sixth model. All five models have the same characteristics, including the number of storeys, sizes of RC components, and loading scenarios. The structures are analysed using a dynamic technique, namely the Response Spectrum analysis method.

➢ INTRODUCTION TO SOFTWARE ETABS

Extended Three-Dimensional Analysis of Building Systems is what ETABS is all about. Because it offers a lot of room to work, structural engineers use this program often while constructing both tall and residential structures. Additionally, the program can analyse data using the push-over, time-history, static, non-linear, and dynamic methods. Due to the large number of megaprojects completed with ETABS over the last 20 years, it has become the de facto standard in the industry. For both static and dynamic study of tall structures, this program is the best option.

➢ DETAILS OF BUILDING

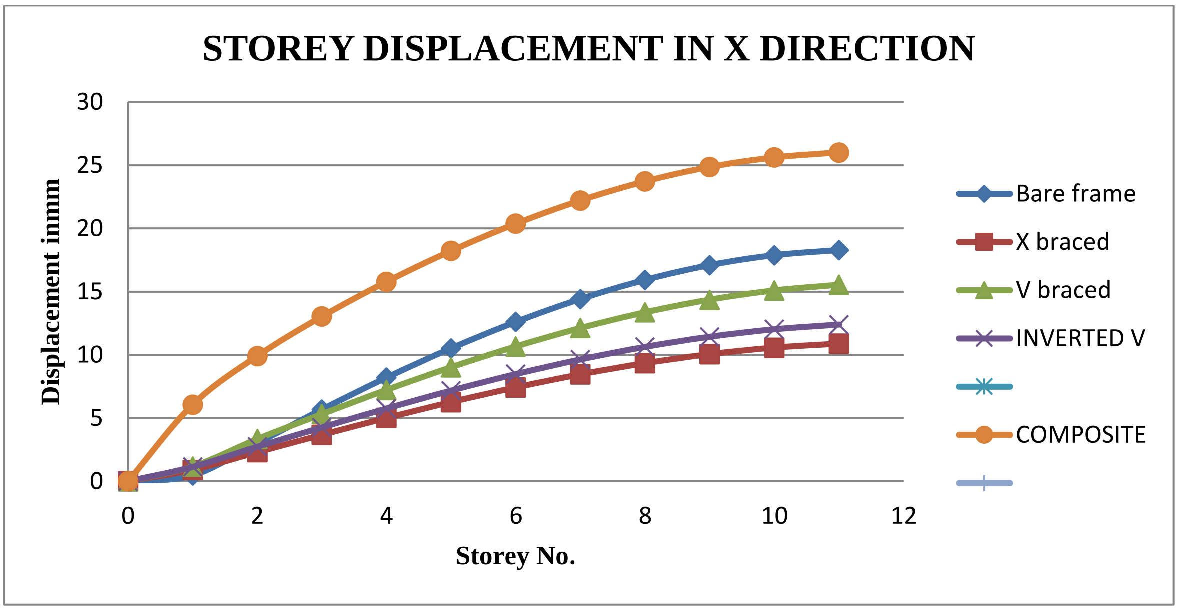
Assuming it is in seismic zone V, this study takes into account the earthquake loading requirements of IS:1893(part 1)-2002 for a G+10 Storey residential structure. The dimensions of the building plan are 36 by 27 meters. The layout is split into 8 bays in the X direction and 6 bays along the Y direction. There are four bays, each measuring 4.5 metres. Three meters is the height of each floor. The results of the study are given after using the Response spectrum approach on braced, bare frame, and composite structures.

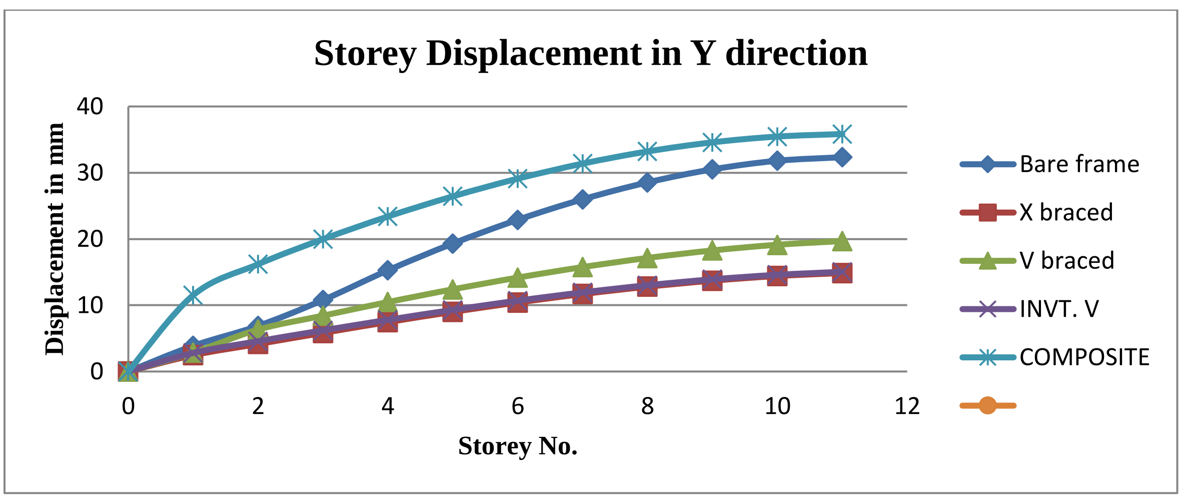
Table-1 Details of the project

Plan dimension		36m × 27m
Height of each storey		3 m
Height of parapet		1 m
Thickness of slab		0.125 m
Thickness of wall		0.23 m
Floor finish		1 KN/m^2
Live load	Storey	2 KN/m^2
	Roof	1.5KN/m^2
Density of concrete		25 KN/m^2
Density of brick		20 KN/m^2
Grade of reinforce steel		Fe415
Grade of concrete		M25
Seismic zone		V

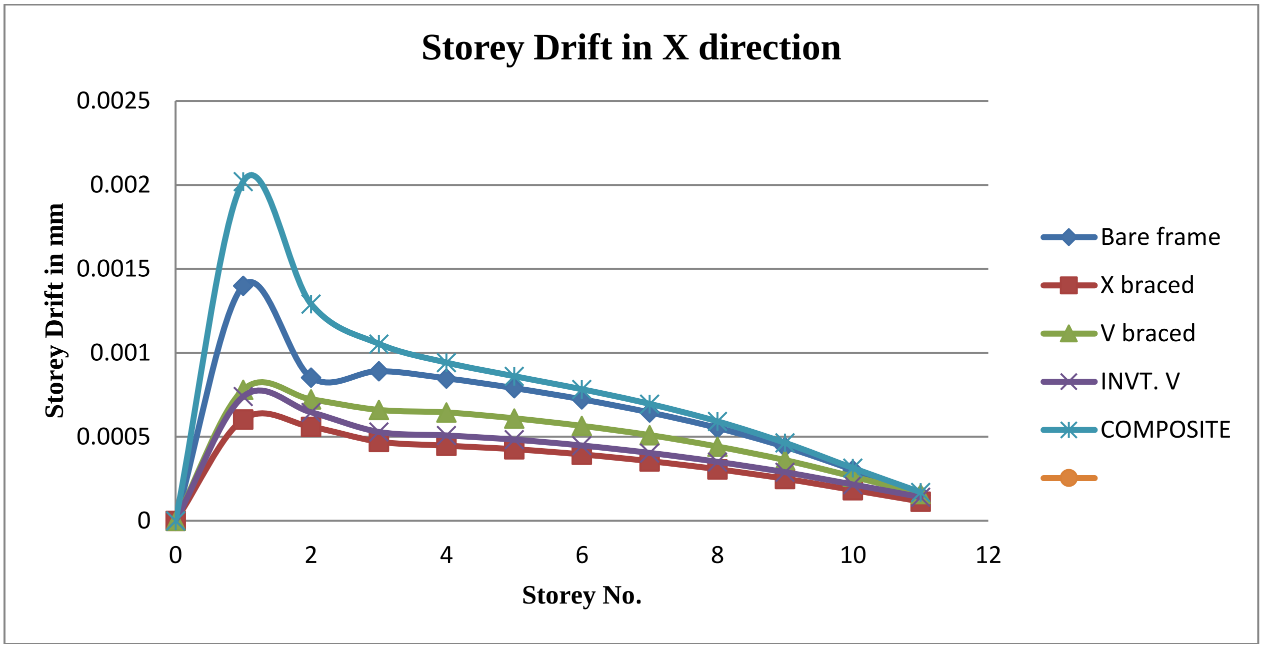
Soil condition	Medium soil
Importance factor	1
Zone factor	0.36
Damping ratio	5%
Column size RCC	230mm × 600mm
Beam size RCC	230mm × 450mm
Column size composite	230mm × 600mm ISHB400-2
Beam size composite	Primary- ISWB400

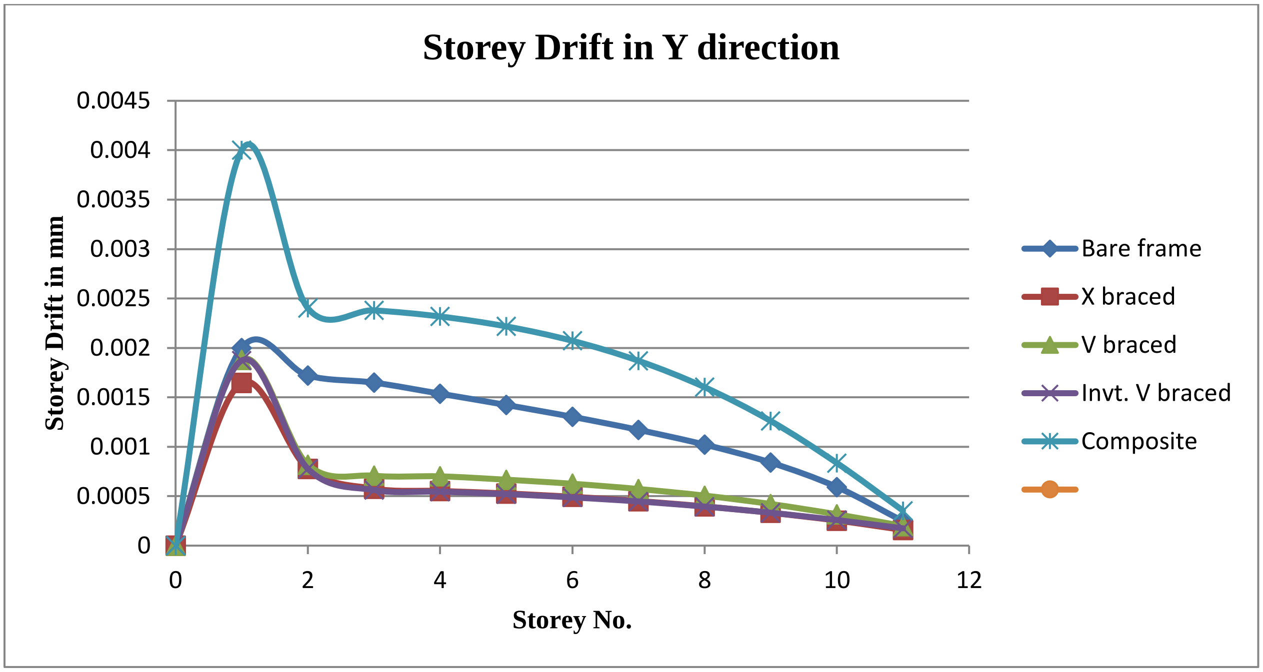
V. STOREY DISPLACEMENTS



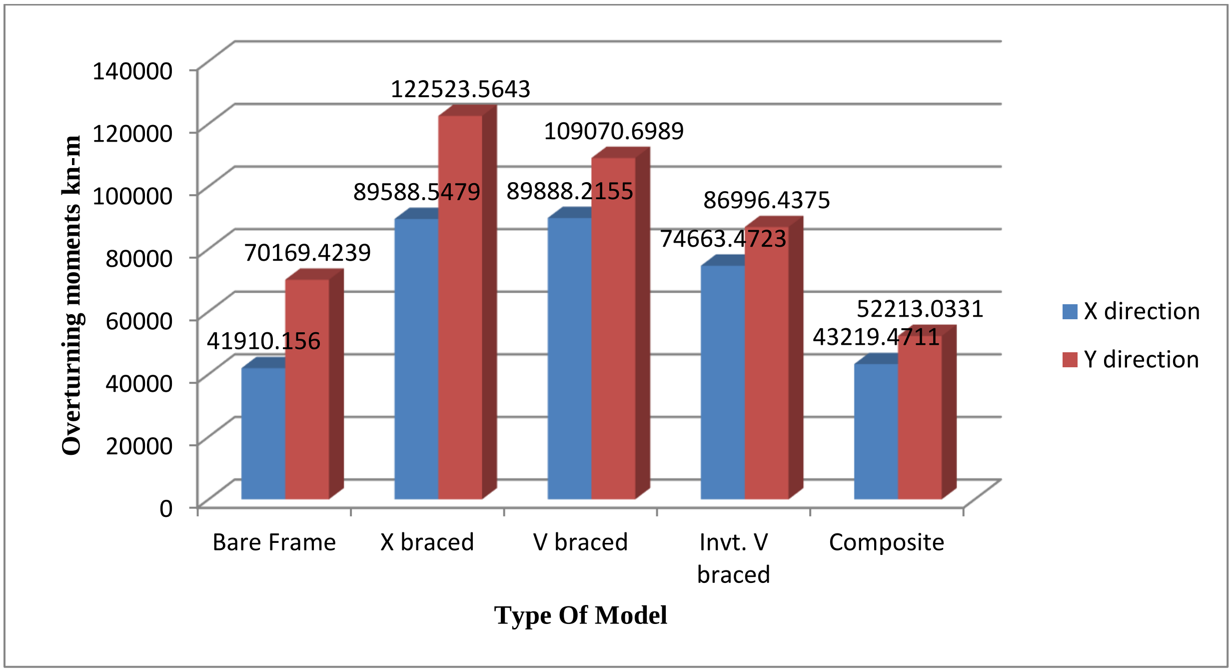


VI. STOREY DRIFT

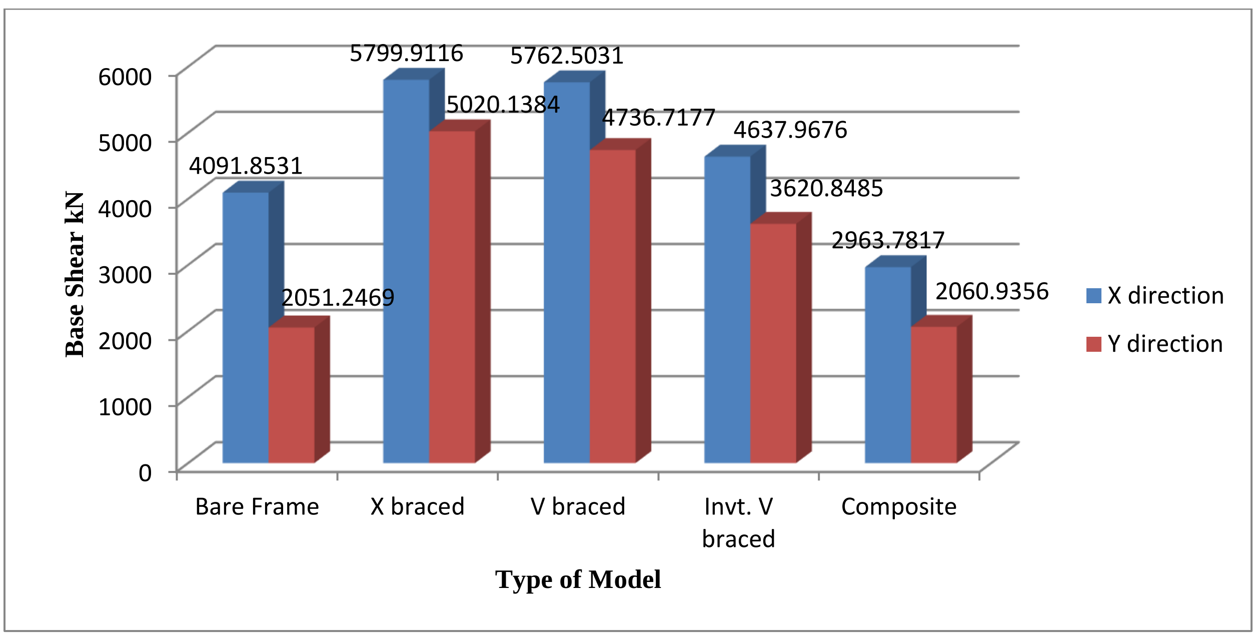




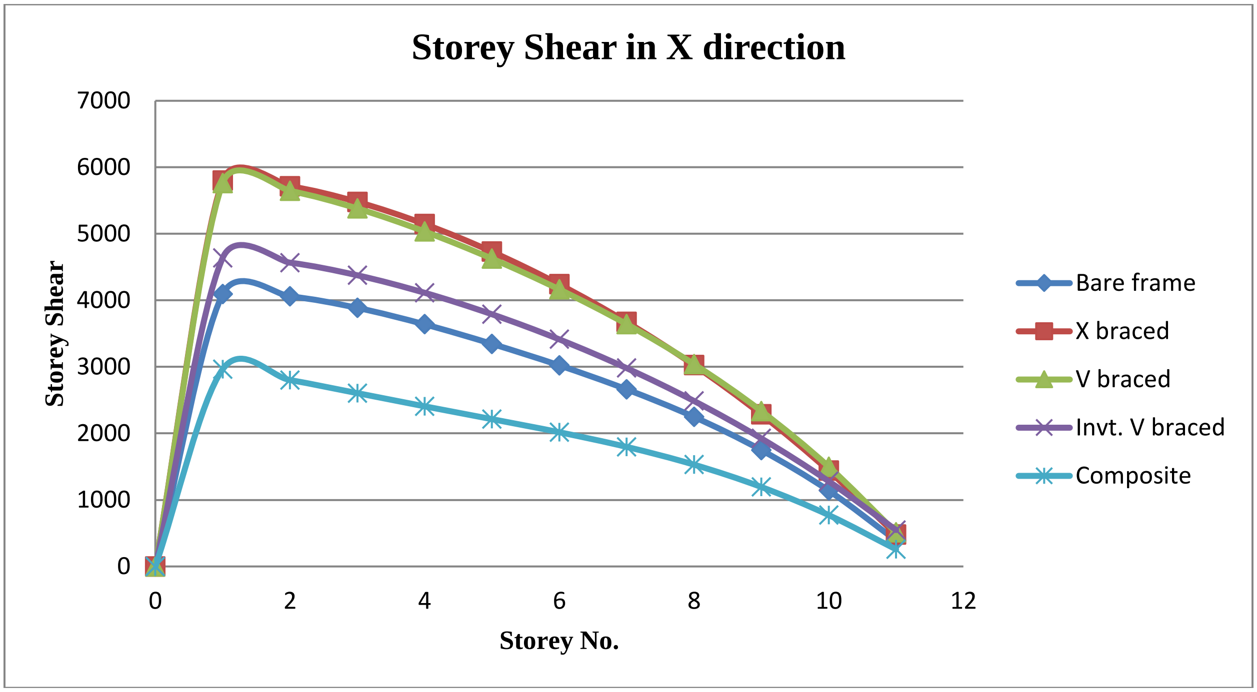
VI. BASE OVERTURNING MOMENTS

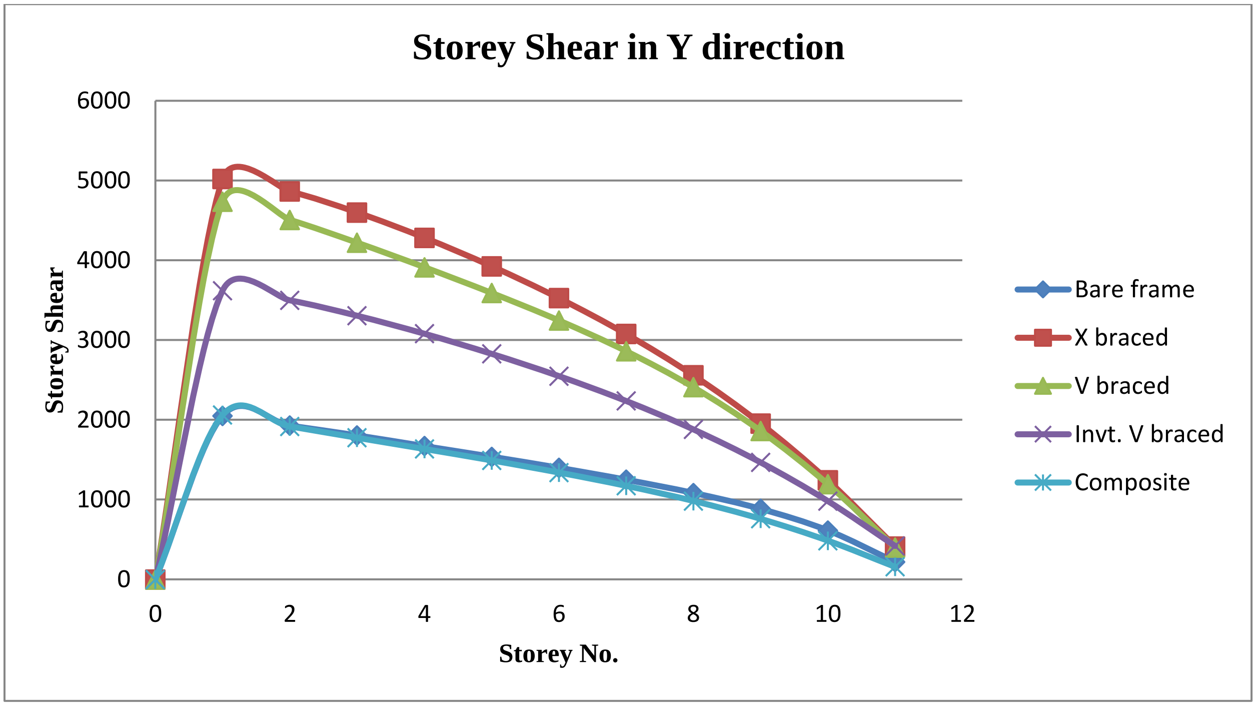


VII. BASE SHEAR

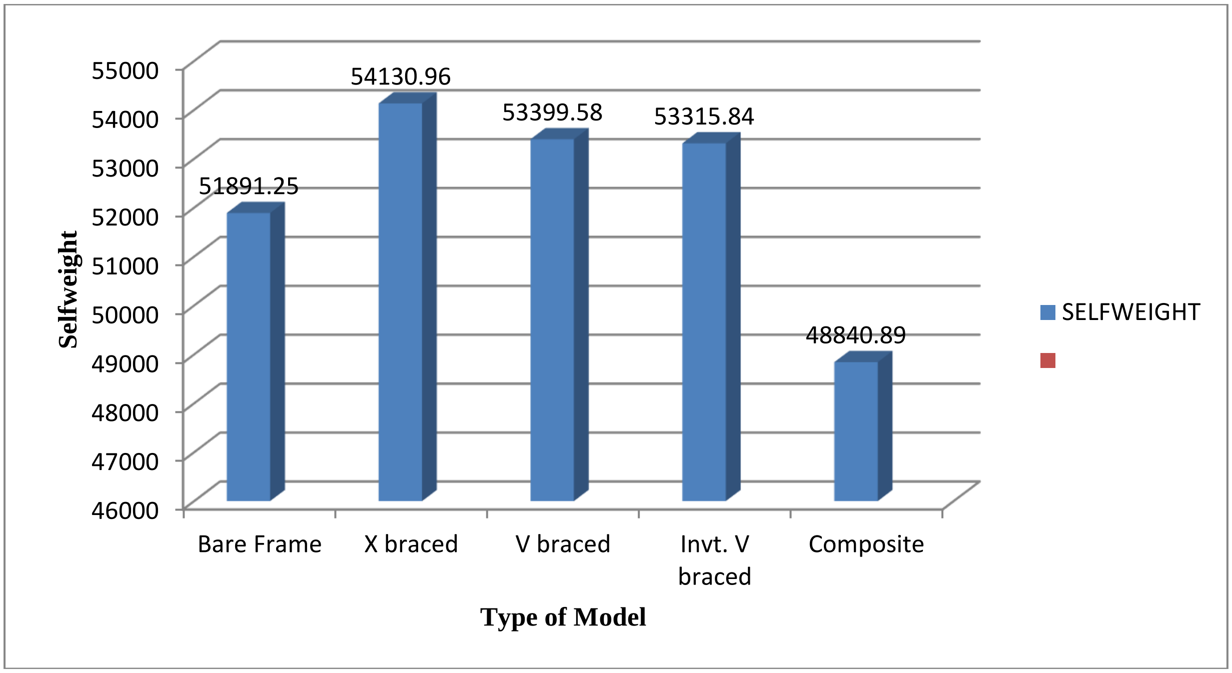


VIII. STOREY SHEAR





VIII. SELFWEIGHT



IX. CONCLUSION

- When compared to the composite and bare frame structures, the braced structure is less affected by displacements, depending on the kind of bracing systems used.
- The braced structures had reduced storey drift and overall structural response as compared to the composite structure and bare frame model.
- According to the findings of the analysis, X bracing is the best option for effectively resisting lateral stresses, as compared to V bracing and Inverted V bracing.
- When comparing the X braced construction to the composite and bare frame structures, the base over-turning moments are highest for the former.
- In terms of earthquake performance, the following models rank the structures: X braced, inverted V braced, V braced, composite structure, and bare frame.

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