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Comparative analysis of shear core outrigger systems, wall belt systems, and truss belt systems for residential units

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Abstract

The outrigger structural system is one of the systems that withstand horizontal loads. The belt truss, which in this configuration joins all of the outer columns situated on the structure's periphery to the central support beam, prevents rotation of the exterior columns. The shear wall resisted tangential loads. To achieve this characteristic, the construction should use the Outrigger & wall belt system. This study examines a G+10 Storey structure using seven different instances, RA1 through RA7-OTA. At various locations along the transverse axis and ten stories, the numbers 1 through 7 indicate single outrigger systems, shear core outrigger systems, and truss belt support systems.This analysis defines the high-rise building as a G+, 10-story building in Zone III. The 315 m2 plinth area is in use. Wall Belt Systems, Shear Core Outrigger Systems, and Truss Belt Systems on Residential Apartments in Staad Comparative Analysis The building's location should be as diverse as possible. Outriggers are rigid horizontal structures intended to increase strength and enhance overturning stiffness by attaching the core or spine to distant columns. An Outrigger system produces a total structural behavior that is significantly better than that of a component system by joining two structural systems—typically a perimeter system and a core system. The advantages of an outrigger system are that it reduces the overturning moments that cause building deformations, which, on the other hand, results in higher efficiency in resisting forces.

Keywords – outrigger, wall belt, Truss wall belt support, Core wall belt support, CSI-ETABS,multi-story

Introduction

Tall buildings' structural designs are governed by lateral stiffness, therefore their structural systems have developed to achieve higher lateral stiffness more effectively. The perimeter tubetype structures with diagonals, such as braced tubes and diagrids, are generally particularly effective among the numerous structural systems designed for tall buildings. This is because they support lateral loads through the axial actions of their main structural members, and the placement of the structural members along the building's perimeter maximizes the structural depth of the systems. The outrigger system is yet another popular structural design that is extremely effective. Outrigger trusses that are connected to perimeter mega-columns that have a shear wall-type core construction provide excellent resistance to overturning moments in outrigger structures.

Humanity has always been fascinated by height, and throughout history, we have continually strived to reach for the stars figuratively. From the ancient pyramids to the contemporary skyscraper, a culture has frequently demonstrated its power and wealth through impressive and gigantic constructions. The skyscraper is today's representation of economic might and leadership. Mankind's competitiveness to claim ownership of the tallest structure in the globe has rarelybeen seen. The building industry now has amazing potential thanks to this never-ending desire for height. The field of structural engineering has advanced significantly from the early moment frames frame incredibly efficient mega-braced constructions of today. Numerous structural and architecturally unique forms have been made possible by the most recent developments in finite element technology and structural analysis and design software. Increased reliance on computer analysis, however, is not the answer to the issues that the field will face in the future. The factors that will transform the way buildings are designed and constructed are a fundamental understanding of structural behavior and the use of computational technologies. Skyscraper designs are typically dictated by the lateral loads placed on the building. The structural engineer has faced growing challenges as buildings have grown taller and slenderer to date drift standards while reducing the architectural impact of the structure. The profession came up with a variety of lateral plans as a solution to this problem, and these are today found in towering structures all around the world.

Objectives of the project:

The comparative analysis of wall belt systems, shear core outrigger systems, and truss belt systems in residential apartments is the foundation of this study. According to the study, the employment of these types of concepts in structures appears to increase their ability to handle lateral loads. The following goals are adopted for this project:

• The most traditional way for withstanding seismic stresses is the shear core, truss belt support system, belt truss, and outrigger system.

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• The most thorough analysis is based on factors like the shear wall's position and height, differences in outrigger depth, etc.

• It prioritizes frequently used bracing and outrigger systems, which lessen the impact of lateral stresses.

• Growth is pragmatic by a variety of researchers because the major goal of the investigators is to raise the strength and longevity of the building used.

• Various studies have examined seismic performance and the effects of various support systems in high-rise structures with varying characteristics.

Modeling and Analysis:

The fem-based CSI-ETABS program is used to model the various cases of transverse direction with outrigger and wall belt-supported systems. The following are the cases' notations:

Results for the residential flat on the plane ground in Case RA1.

Results for the residential apartment shear core case RA2.

Apartment shear core and wall outriggers results for Case RA3.

Results for the wall belt support system and shear core outriggers in residential apartments under Case RA4.

Results for the truss belt support system and shear core outriggers in residential apartments under Case RA5.

Case RA6 -OTA Results for Optimised Truss Belt Support System and Shear Core Outriggers for Residential Apartments

Instance RA7 -OTB Optimised truss belt support system and shear core outriggers for residential apartments

Table 1 & Table 2 :shows the elementarylimitations used in the analysis of the structure.

Table 1. Structural Limitations

S. No.	Element Name	Description
1	Building Types	Residential
2	No. of Storey	G+10
3	Plinth Area	315 m2
4	Floor Height	3.66 GF & 3.66 on each floor
5	Dimensions of Beam	0.6 m. x0.35 m.
6	Dimensions of Column	0.50 m. x 0.50 m.
7	Slab Thickness	0.130 m.
8	Shear wall	0.230 m.
10	Grade of Concrete	M30
11	Steel Used	Fe 500
12	Period	1.006 Second
13	Analysis Software used	Staad Pro

Earthquake Parameters used in G+10 Storey:

Table 2. Earthquake Parameters

S. No.	Parameters	Description
1	Earthquake Code	IS 1893(Part 1):2016
2	Earthquake Zone	III
3	Response Factor (RF)	4
4	Importance Factor (IF)	1.2
5	Soil Types	Medium
6	Damping	0.05
7	Structural Type	RCC Framed Building
8	Earthquake method	Response Spectrum Method

Result & Discussions

The Subsequent results are to be obtained from the modeling and analysis of the Multi-story building G+10 Storey building in Staad Pro software. The results are as follows:

Maximum Displacement: As measured from its equilibrium position, it is the largest displacement or detachment that a point on a vibrating body or wave can move. Table 3 displays the maximum displacement in a G+10 Storey Building under various scenarios.

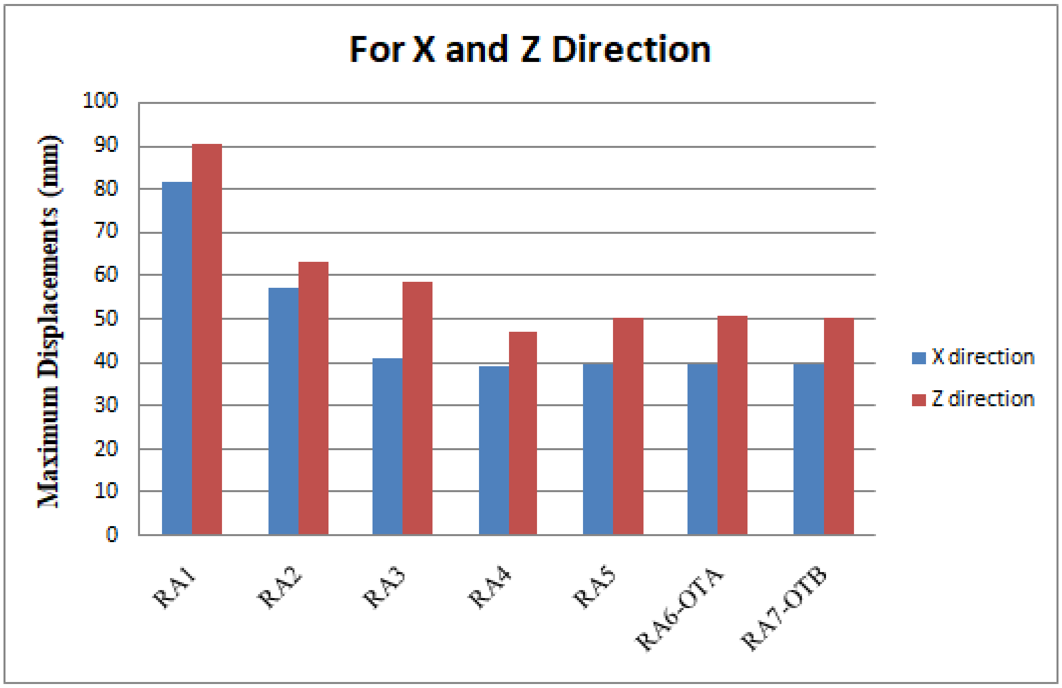

Figure 1: Bar chart of Max. Displacement

Story Drift*:* Story Driftis an approximation of the supremepredictable drift on the structure due to seismic action.

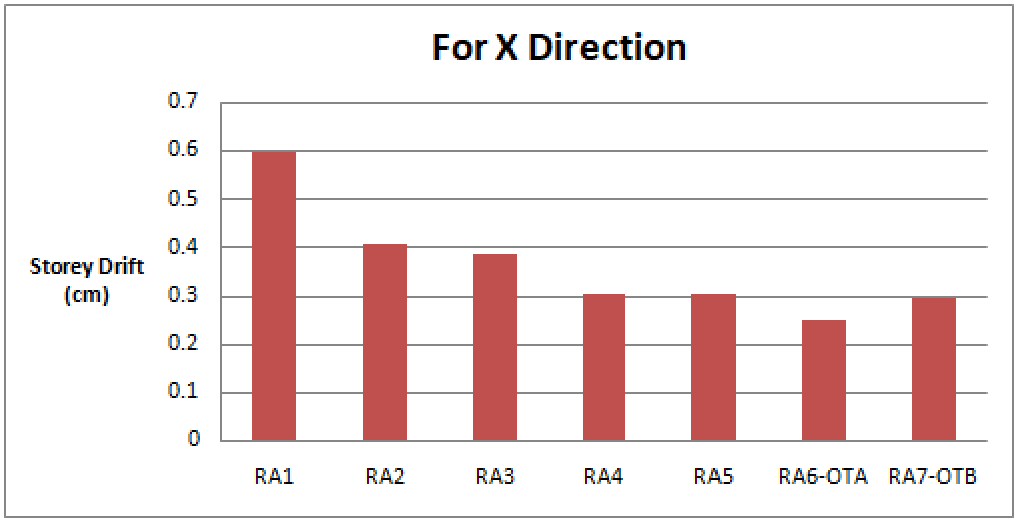

Figure 2: Bar chart of Story drift in X direction

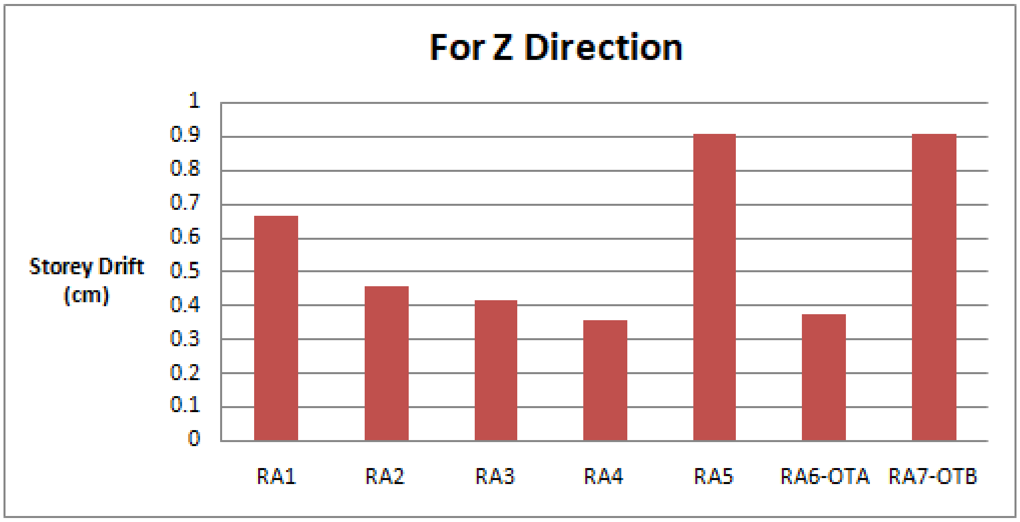

Figure 3: Bar chart of Story drift inthe Z direction

Baser Shear*:* Base shear is a measurement of the greatest predicted lateral stress from seismic activity on the base of the structure.

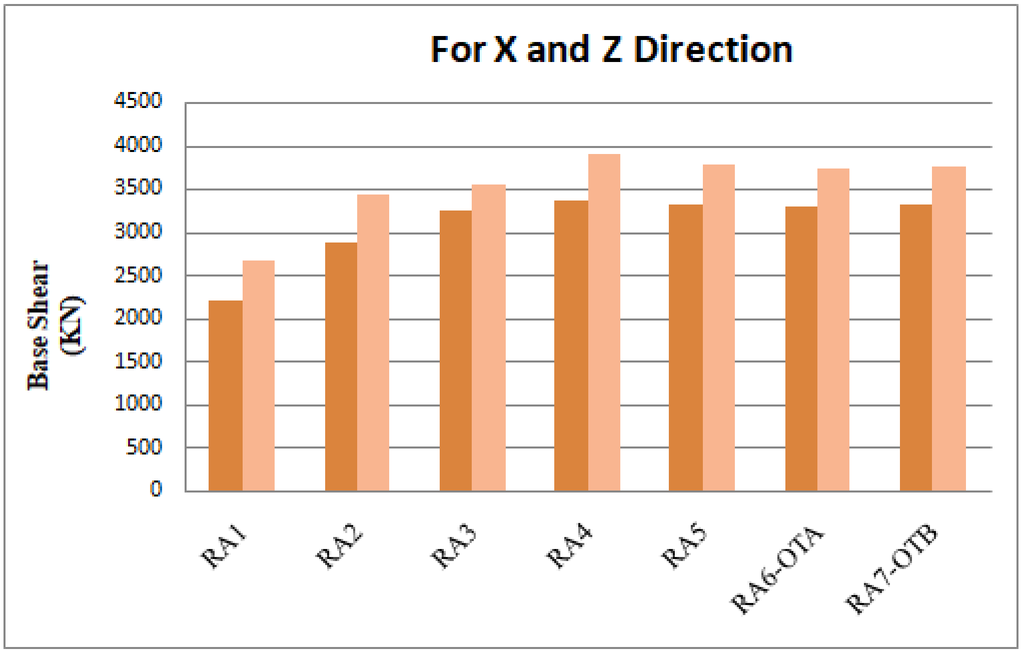

Figure 4: Bar chart of Max. Base Shear

Maximum Axial Forces:

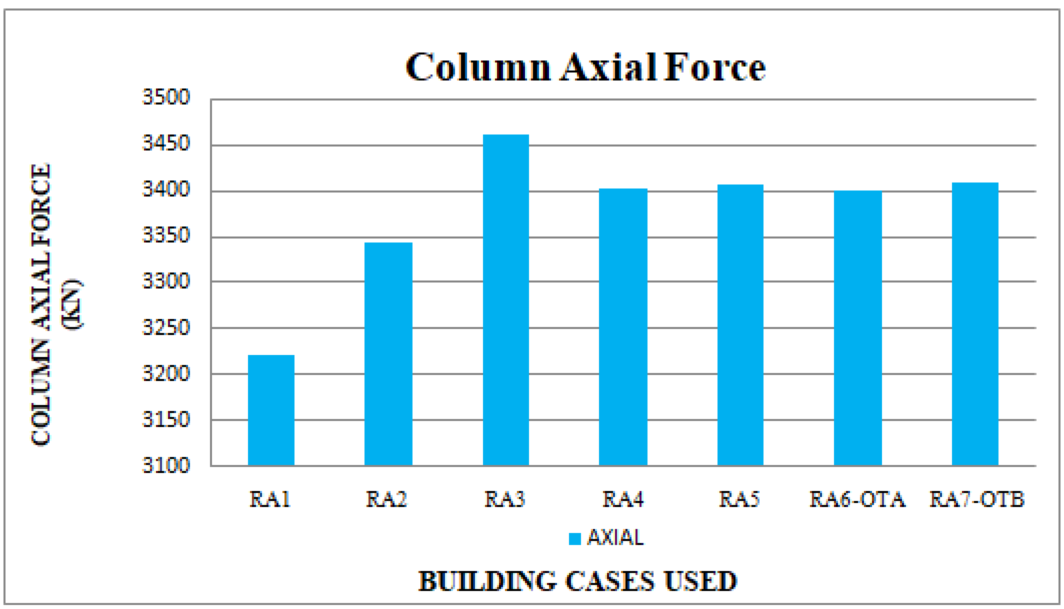

Figure 5: Bar chart of Max. Axial Forces

Maximum Shear Force in Column*:*

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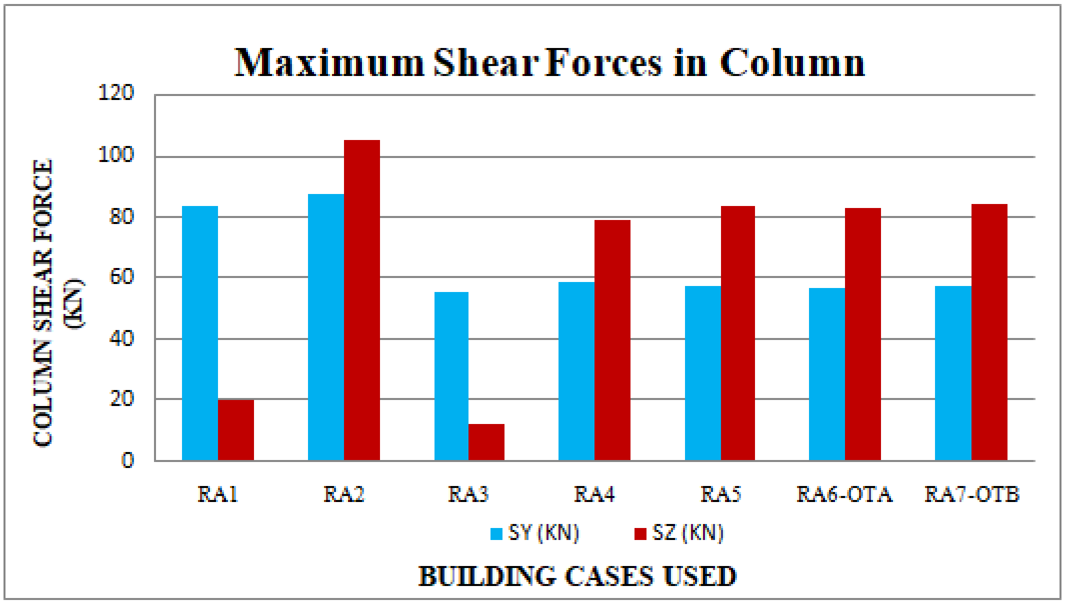

Figure 6: Bar chart of Max. column shear Forces

Maximum Bending Moment in Column: When an external force or moment is applied to a structural element, causing the element to bend, the element responds by experiencing a bending moment. The beam is the structural component that is bent the most frequently or simply. It demonstrates the maximum bending moment. Results for various scenarios in a G+20 Storey Building.

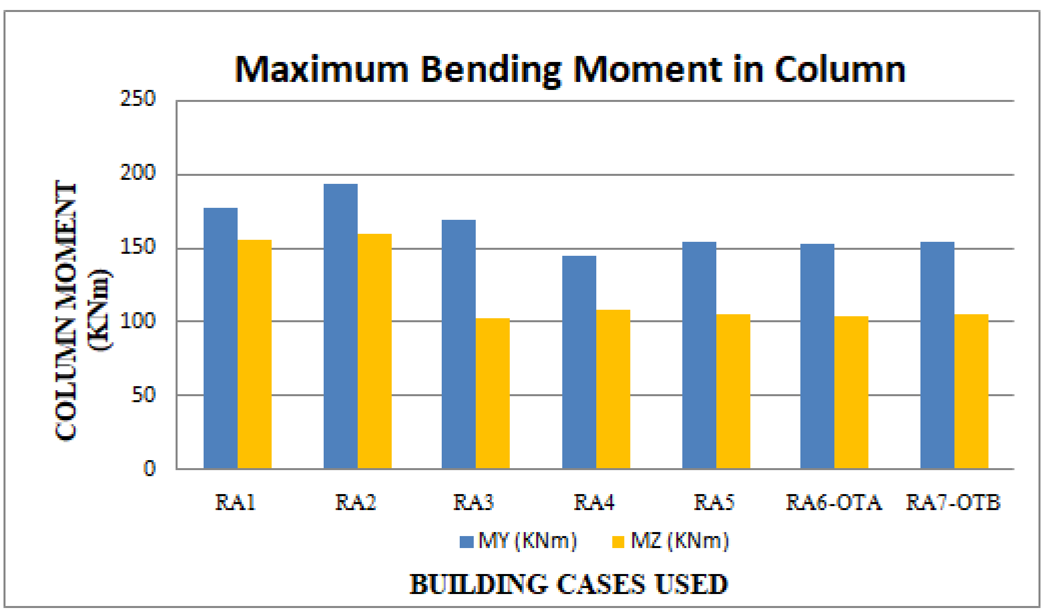

Figure 7: Bar chart of Max. Bending Moment in column

Maximum Shear Force in Beam*:* It demonstrates how, in various scenarios, the maximum bending moment leads to a G+10-story building.

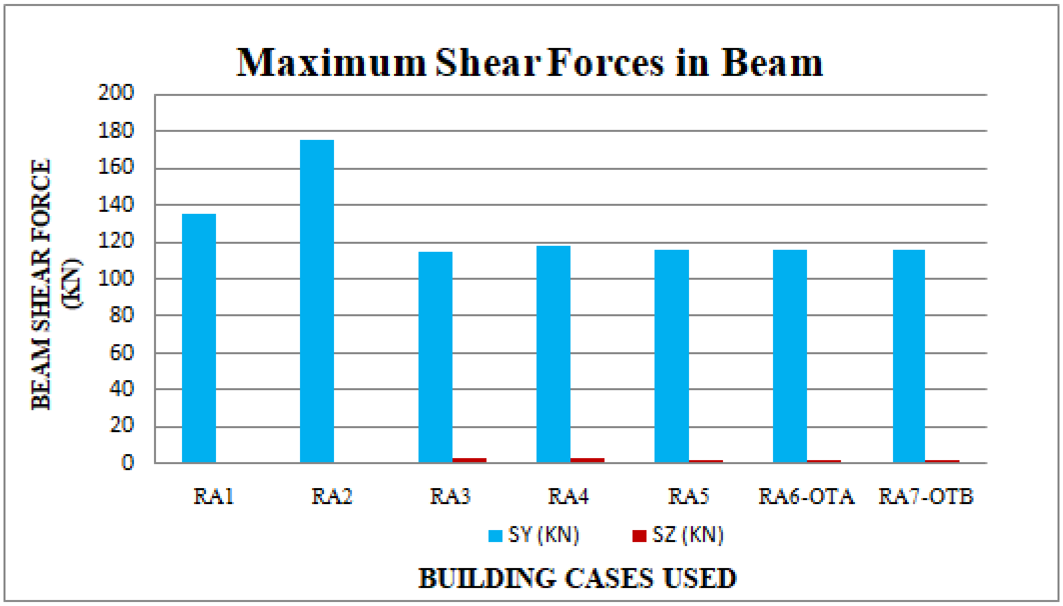

Figure 8: Bar chart of Max. shear force in the beam

Maximum Bending Moment in Beam:

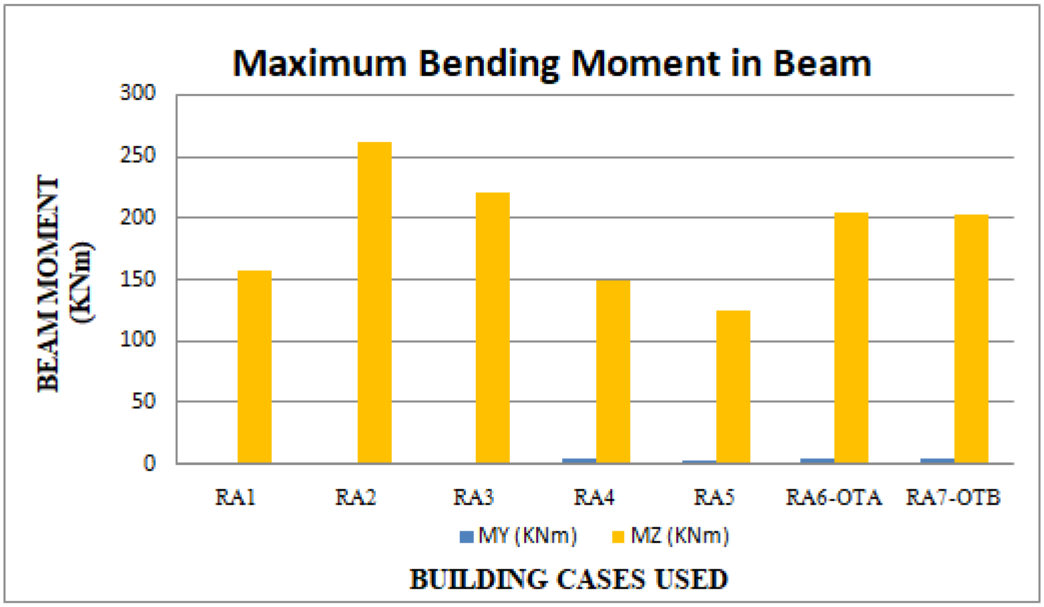

Figure 9: Bar chart of Max. Bending Moment in the beam

Maximum Torsional Moments in Beam & Column: The term "torsion," sometimes known as "torque," refers to a moment that is exerting force on an item about its axis.

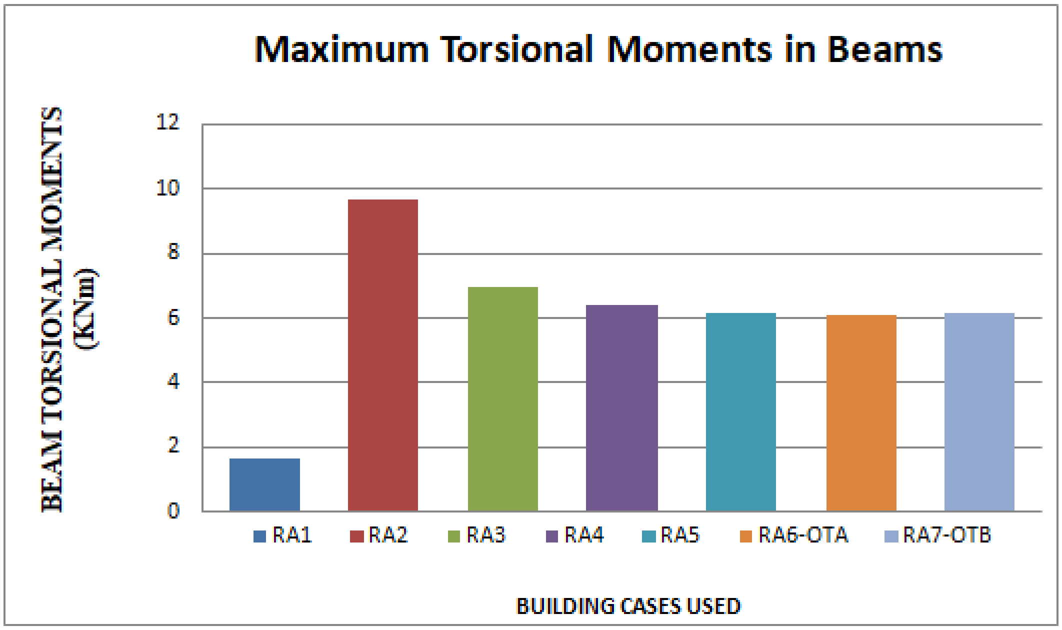

Figure 10: Bar chart of Torsional Moment in Beam

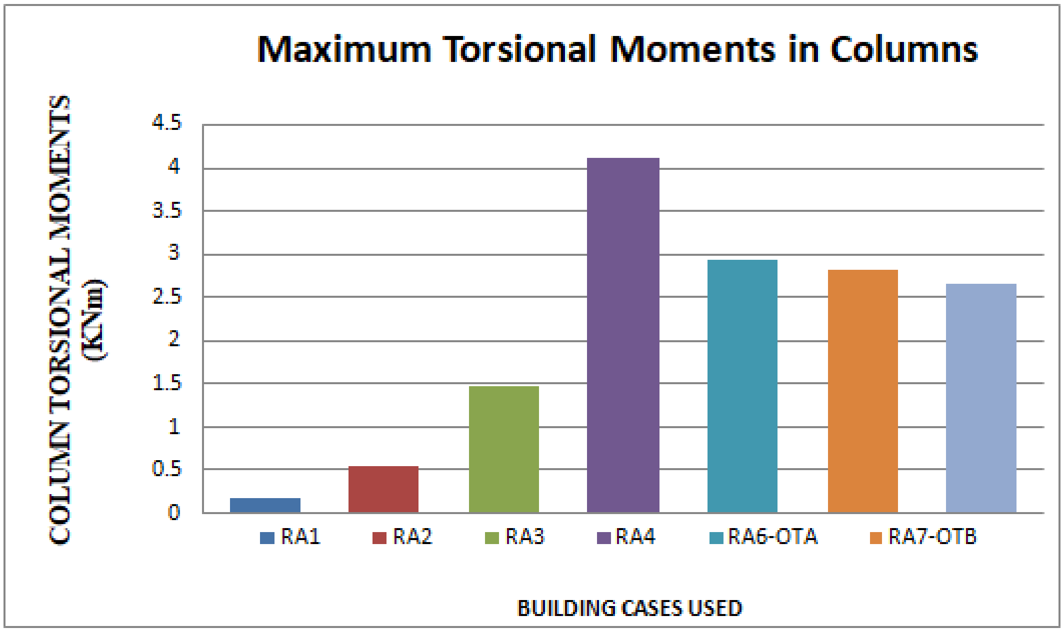

Figure 11: Bar chart of Torsional Moment in Column

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Conclusions

We will be examining seven unique Wall Belt Systems, Shear Core Outrigger Systems, and Truss Belt Systems on Residential Apartments in Staad Pro. This comparison analysis reveals the following conclusions in terms of the situations described.

1. It has been determined through comparison that the maximum displacement in the X direction and the maximum displacement in the Z direction were both attained for the effective case RA3.
2. Case RA6-OTA is shown to be the most effective when comparing the Story drift for all locations in the X direction.
3. Case RA4 is found to be the most effective when comparing the Story drift for every position in the Z direction.
4. Comparative results show that Case RA1 is the most effective case for base shear pressures in both the X and Z directions.
5. Case RA1 outperforms other cases in terms of comparing data for axial force.
6. RA3 is the best example when comparing the column shear force for all cases.
7. examples RA4 and RA3 are significantly more successful than other examples for the X and Z directions, respectively, according to comparison results in culture mn bending moment.
8. When comparing the beam shear force in both the X and Z directions for all examples, Case RA3 performs best.
9. Case RA1 is much more effective than other cases, according to comparing data for beam in X direction bending moment.
10. RA5 is much more successful than other situations, according to comparing data for beam in Z direction bending moment.
11. Case RA1 is particularly effective at assessing the torsional moment in beams and the torsional moment in columns.
12. According to the overall analysis, Case RA3 is the study's most effective case. It is regarded among all of these as the most appropriate configuration for construction.
13. As an alternative to using a shear wall, this particular project illustrates the use of truss belt support to maximize the usage of building materials. This means that the structure's stability and performance will be better if wall truss belt supports are used in shear wall arrangements.

Here, we provide two types of improved truss belt supports that work effectively in any situation…

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