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Analysis Of Frame Structure Subjected To Lateral Load By Using Lateral Load Resisting Elements

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ABSTRACT

When it comes to controlling excessive drift, efficiency, and rigidity when exposed to lateral loads, multi-story constructions are among the most popular choices for the outrigger system. Both structural and non-structural forms may have their damage reduced in the event of an earthquake or wind stress. The purpose of this article is to examine the importance of creating a three-dimensional model of a 32-story building in order to conduct analyses and designs using the ETABS program. The model will be used to analyze the building's frame structure and determine the elements that will resist lateral loads. The purpose of this experiment is to determine the impact of an outrigger system at one, two, three, and four storeys in height. This model study makes use of the Wind Static Method, the Linear Dynamic Method (Response Spectrum Method), and the Linear Static Method (Equivalent Static Method). Determine the lateral displacement, base shear, and tale drift for various kinds of models with and without an outrigger system using the efficiency and stiffness parameters. Therefore, in this scenario, it is necessary to reduce displacement and drift in comparison to the model without the outrigger system.

Keywords: Base Shear, Storey Drift, Outrigger, Seismic Zone, Storey Displacement.

I. INTRODUCTION

1.1 General

More and more, tall buildings are going constructed all over the globe, which means that engineers will have to use their best judgment to deal with new problems. Modern skyscrapers often use a network of connected shear walls to counteract lateral stresses caused by earthquakes or wind. Nevertheless, a lateral load resisting system is required to provide sufficient lateral stiffness as building height increases, as the structure's stiffness becomes more important with growing building height. Reduced vulnerability to wind and earthquake-related small and medium lateral loads is a direct result of the dynamic load resisting system's ability to regulate excess lateral load drift. For high-rises, this method is the way to go, particularly in places prone to earthquakes or where wind is a major factor.

The development of concrete technology—encompassing new materials, structural systems, analyses, and construction processes—during the 1900s allowed for the possibility of constructing concrete tall buildings. Structural systems address the fundamental requirements of the structure. As a building climbs in height, the impact of lateral loads, such wind and earthquake, becomes more significant. Wind and seismic factors may cause significant damage to tall structures. rise to the level of a crucial factor in any design. It is possible to control the dynamic response of tall buildings by enhancing their structural systems.

Earthquakes and wind loads affect the amount that a building can deflect. The building's central concrete core acts as a barrier against earthquake and wind-induced lateral stresses. One of the most effective and widely utilized structural methods for reducing bending due to wind and seismic forces is the use of a concrete core. Owners are more concerned about the performance and cost savings of the hybrid frame-concrete core wall construction, which has seen a rise in popularity in recent years.

The maximum permissible top deflection for wind studies on tall structures is one-fifth of the building's height, according to Part III of Bureau of Indian Standards 875: 1987. When choosing a structural system for a tall structure, lateral drift at the top is one of the most important factors to consider. The core wall's stiffness is enough to resist wind and seismic stresses at lower building heights, but it becomes inadequate at higher ones. New, state-of-the-art structural solutions are required to address this problem. Each complex form category requires a unique structural system; for example, tall buildings often use many braced tubes, dia-grid, and outrigger systems.

1.2 Objectives of Study

- In order to learn how high-rises affected by dynamic loading fare after installing outriggers.
- Examine four-sided effects of the building's core wall and braced outriggers.
- Assessing building's total stiffness against lateral load allows researchers to examine how well each structural component performs.
- For the purpose of researching optimal outrigger placement in tall buildings.
- With the goal of learning how x-bracing affects outrigger
- In order to examine base shear, displacement, and storey drift.

II. LITERATURE REVIEW

2.1 General

Existing RC structures in high seismic zones and hilly terrains were subject of several research studies and tests worldwide in an effort to better understand and evaluate impact of seismic stresses. Idea of modeling & analytical approaches used to achieve this objective has developed over time in response to both new technological developments & accumulation of prior knowledge.

Shivancharan K, Chandrakala S, Narayan G, Karthik , (2015) (IJRET) "Analysis of Outrigger System for High Vertical Irregularities Structures Subjected to Lateral Load" is the title of their study. For zone V of IS 1893:2002, the author has used E-tabs to examine a G+30 story structure with vertical irregularity in this inquiry. The ground, air, and water pressures exerted by gravity can't break the three-dimensional framework. The next step is to examine the outriggers' drift and deflection after positioning them at a certain height. It all starts with fixing the outrigger position as the first outrigger position. Then, while examining the drift and deflection, you set the second outrigger position by adjusting its location. The author has computed the building's performance for lateral displacement and storey drift after analyzing it using the equivalent static approach for wind and earthquake.

The research found that 0.5H was the most suitable outrigger location, and that 0.67H was the best overall. One position outrigger at 0.67 height controls 36.9 percent of drift and 29.8 percent of deflection as compared to the bare frame, respectively. In comparison to the naked frame, outriggers with belt trusses mitigate 45.1% of deflection and 40% of drift. One may regulate the building's deflection by 13% and its drift by 14.64% by comparing the first and second locations of the outrigger systems. Positioning the outrigger between half of its heights is ideal.

M.R Suresh, Pradeep K.M, (2015) (IJSRD) "The Outrigger's Impact on Reinforced Concrete Structures in Various Seismic Zones" was conducted by. An RC-frame structure with 30 stories was the subject of this scholar's investigation. It is possible to think about the outriggers system at intervals of 0.25H, 0.5H, 0.75H, and 1H along the H-axis of the structure. For modeling and analysis, the Outrigger beam depths were raised from 1 to 5 in accordance with the do/d ratio using ETABS finite element software. The study takes into consideration loads in line with Indian requirements and uses the comparable static approach. Part 1 of IS: 875: 1987, Part 2 of IS: 875: 1987, and Part 1 of IS: 1893: 2002
A range of models with different outrigger depths were able to regulate the lateral displacement to within 65% to 60% throughout all seismic zones, as shown in the research. In Zone II, all of the models had drift control of 60% to 65%, while in Zones III, IV, and V, different models had drift control of 62% to 67%.

Abdul Kareem and Srinivas B,(2015) (IJERT) An Investigation on the Use of Outriggers in Steel-Braced High-Rise Reinforced Concrete Structures The researcher has used analysis approaches such as the Equivalent Static Method and the Response Spectrum Method to examine a G+20 story structure for all the zones specified in the regulation. This research compares two types of structures: regular and irregular. The regular buildings use steel bracings as outriggers, while the irregular buildings use a centrally stiff shear wall. Based on the findings, this study examines base shear and inter story drifts.
Researchers found that using the Equivalent Static Method, outriggers decreased lateral displacement by 20% for standard buildings and by 19% for irregular ones. According to the results of the Response Spectrum

Analysis, outriggers were able to limit the displacement of the top story by around 11% for regular buildings and 7% for irregular ones. Base shear is lower in both regular and irregular structures that do not have outriggers compared to those that do. using outriggers in the response spectrum approach by 10% and the corresponding static method by 20% across all seismic zones. Given these facts, it's safe to say that outriggers work better on regular buildings when it comes to limiting lateral displacement than on irregular ones.

Krunal Z. Mistry,(2016) (IJAERD) "The Optimal Position of the Outrigger in an Outrigger Structure for a Tall Building." The lateral displacement reduction related with the location of the outrigger and belt truss systems was determined by analyzing forty-story three-dimensional models of these systems that were exposed to wind and seismic loads. This research used IS 1893(part 1)-2002 to calculate the earthquake load and IS 875(part 3) to calculate the wind load.
In order to minimize displacement and shear force, it is optimal to put the first outrigger on the 20th storey, the second on the 10th floor, and the third on the 30th floor.

Prateekh N. Biradar & Mallikarjuna S. Bhandiwad (2015) (IRJET) A Performance-Based Investigation of the Static and Dynamic Behavior of an Outrigger Structural System for a Vertical Structure. A 40-story, three-dimensional building with an 8-by-7-meter core shear wall and three bays running in opposite directions was the object of this investigation. For the belt truss and outrigger bracing, we used ISLB 200 steel, and the dimensions of the outriggers are 0.5 m x 3.5 m. Belt trusses and outrigger bracing both have the shape of an X.
The models studied are

1. A structurally unsupported concrete core wall
2. You may create four different versions by switching up the positions of the two outriggers: one stays at the 40th story while the other moves to the 6, 10, 16, and 20th.
3. We created four more models by shifting the placement of the second outrigger from 20th to 26th, 30th, and 36th storeys while maintaining the 20th story location of the first outrigger. Modeling for outrigger bracing with belt truss also included 17 different models.

With a maximum percentage decrease of 15.02% for Earthquake load and 15.77% for Wind load, the research found that the model with outriggers positioned at the 20th and 26th proved to be effective in decreasing lateral displacement.

III. METHODOLOGY

3.1 Introduction

Most older buildings have reinforced concrete (RC) frames and are either medium- or low-rise, so they can survive earthquakes of varying intensities. These buildings are especially susceptible to earthquake damage because their designs sometimes ignore seismic stresses in favor of gravity loads. The goal is to lessen the impact of big earthquakes.
This study aims to study the effects of seismic and wind loads on an RC frame building, specifically its gravity load and lateral load analyses with outriggers supplied in compliance with zone V seismic codes and wind loads. The purpose of this modeling is to assess the building's seismic susceptibility. For both static and dynamic analysis, ETABS is the program of choice.

3.2 Method of Modelling

We utilize the ETABS program to build the 3D model and do the analysis. The program can foretell the behavior of space frames by considering the material's elasticity and either static or dynamic loads. ETABS is capable of static and dynamic analysis in addition to handling static load.

3.2.1 Model Geometry

NO of Storey	No of bay X direction	Bays width in X direction	No of bay Y direction	Bay widthin Y direction	Storey height Bottom	Height of the storey
32	7.0	5.0	5.0	5.0	2.5	3.2

The models that were use for this study are listed below;

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3.2.2 Models

- Model 1- A Bare frame
- Model 2- A Bare frame with central core wall
- Model 3- A Bare frame with central core wall & Outrigger at Top
- Model 4 A Bare frame with central core wall & Outrigger at 3/4 Height
- Model 5- A Bare frame with central core wall & Outrigger at Mid
- Model 6- A Bare frame with central core wall & Outrigger at Top, 3/4 and Mid
- Model 7- A Bare frame with central core wall & Outrigger at Top + X Bracing
- Modell 8- A Bare frame with central core wall & Outrigger at 3/4 Height + X Bracing
- Model 9- A Bare frame with central core wall & Outrigger at Mid + X Bracing
- Modell 10- A Bare frame with central core wall & Outrigger at Top, 3/4 and Mid + X Bracing

IV. RESULTS AND DISCUSSION

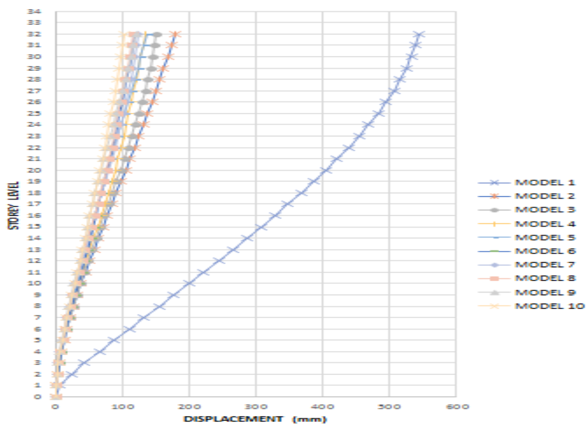
4.1 General

The outcomes of the selected buildings are presented and discussed in detail in this chapter. The results of shear, laterals displacements, storey drifts, & natural period and overall performance of different building model have presented and compared.
In these study, attempt has made to evaluate the seismic performance RC with central core wall both with and without outriggers
The outriggers are placed in different positions to evaluate their effectiveness in reducing lateral displacements and other parameters. Also Braced core wall is used in the study, and theefficiency is observed.

4.2 Seismic Analysis

4.2.1 Lateral Displacement

Following the study, the displacement values were illustrated in charts using analysis of linear static and linear dynamic systems methods. This method is applicable to the model's Y and X-Directions. The displacement is greatest at the top of the level structure and lowest at the bottom, according to this. When a result, as lateral displacement increases, so does the storey height. It was discovered that the model outrigger system's displacement values are lower than those of the outrigger system without the outrigger`



Graph 1: Comparison of Lateral Displacement for Various Models alongX-Direction by Equivalent

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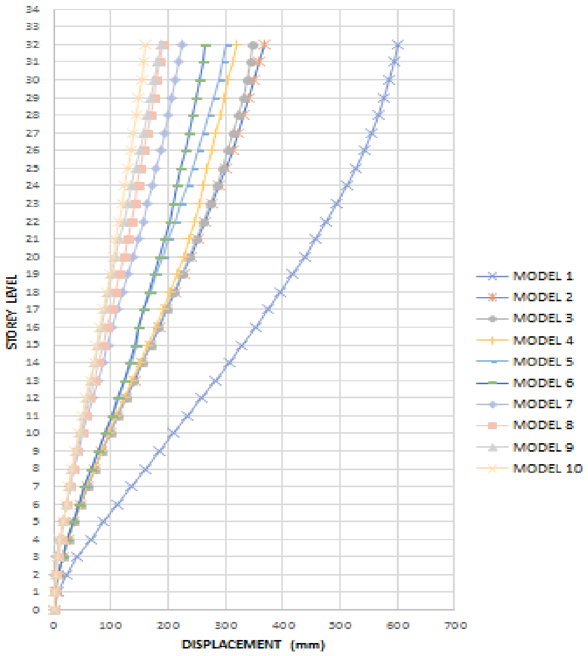
Static Method

Graph 1 shows the Comparison of Lateral Displacement for Various Models along X-Direction by Equivalent Static Method.

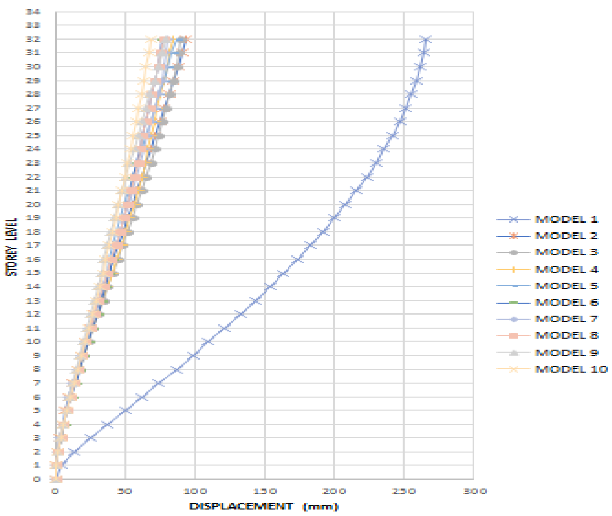
It shows that the displacement is greatest at the top of the level structure and lowest at the bottom, according to this. When a result, as lateral displacement increases, so does the storey height. Variation illustrated in graph 1 shows variation displacement in X-Direction for all building model.



Graph 2: Comparison of Lateral Displacement for Various Models along Y-Direction by Equivalent Static Method

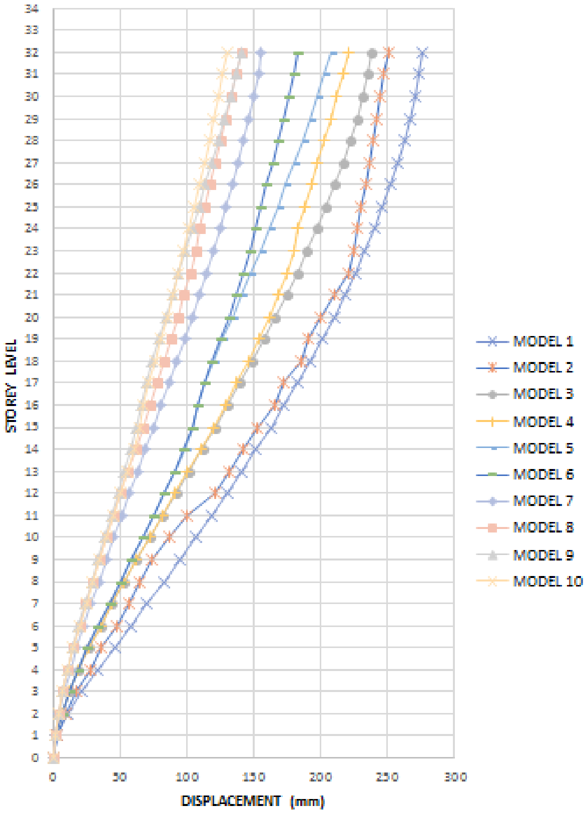
Graph 2 shows the Comparison of Lateral Displacement for Various Models along Y- Direction by Equivalent Static Method.

It shows that the displacement is greatest at the top of the level structure and lowest at the bottom, according to this. When a result, as lateral displacement increases, so does the storey height. Variation illustrated in graph 2 shows variation displacement in Y- direction for all building model.



Graph 3: Comparison of Lateral Displacement for Various Models alongX-Direction by Response Spectrum Method

Graph 3shows the Comparison of Lateral Displacement for Various Models along X-Direction by Response Spectrum Method.
It shows that the displacement is greatest at the top of the level structure and lowest at the bottom, according to this. When a result, as lateral displacement increases, so does the storey height. Variation illustrated in graph 3 shows variation displacement in X-Direction for all building model.



Graph 4: Comparison of Lateral Displacement for Various Models along Y-Direction by Response Spectrum Method

Graph 4 shows the Comparison of Lateral Displacement for Various Models along Y- Direction by Response Spectrum Method.
It shows that the displacement is greatest at the top of the level structure and lowest at the bottom, according to this. When a result, as lateral displacement increases, so does the storey height. Variation illustrated in graph 4 shows variation displacement in Y- direction for all building model.

Table 1: Maximum Displacements (mm) By Equivalent Static Method and ResponseSpectrum Method along X and Y-Direction

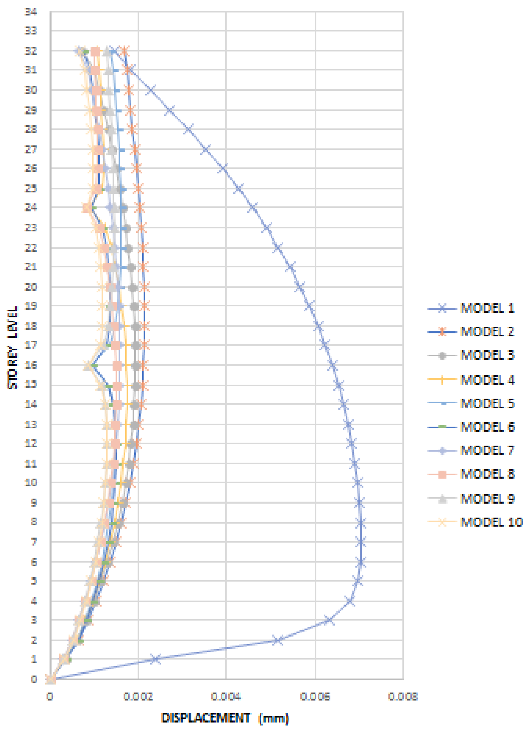
TOP STOREY DISPLACEMENT (mm)				
MODEL	Equivalent Static Method		Response Spectrum Method	
	EQX	EQY	RSX	RSY
1	542.463	600.56	265.93	275.978
2	178.568	366.88	93.711	250.423

3	150.844	346.613	89.9	237.863
4	134.764	318.19	84.54	220.804
5	136.99	302.09	86.68	207.105
6	118.365	264.6	76.915	182.285
7	124.384	222.96	81.008	155.717
8	117.196	190.021	77.841	140.989
9	121.521	186.359	78.961	141.215
10	102.8	161.155	68.123	129.641

The above Table 1 Shows Maximum Displacements (mm) By Equivalent Static Method and ResponseSpectrum Method along X and Y Direction

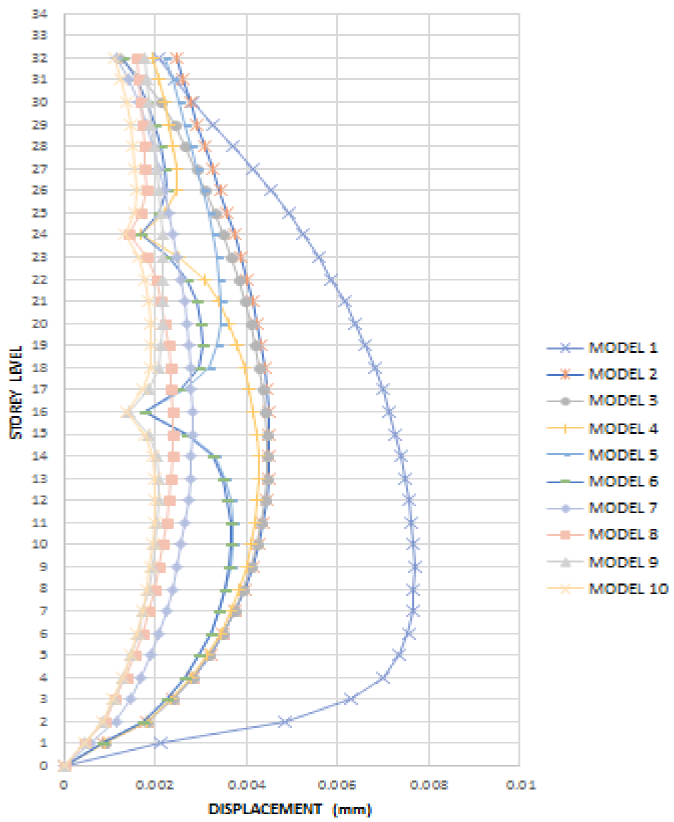
4.2.2 Storey Drift

Drift is mostly defined as comparative of lateral displacement of two floors. Drift is absolutely essential for control limit damage to interiors and exteriors part systems. According to INDIAN STANDARD 1893 (part 1) of 2016 consider that the allowable storey drift is measured as 0.0004 times of one storey height of structure. From the tale drifts motion, the drift is the least atthe bottom and top of the storey structure, and the most at the center. As a result of this method .When the outrigger system is at the storey height level, the drift is also minimal, as demonstrated in the graphs below.



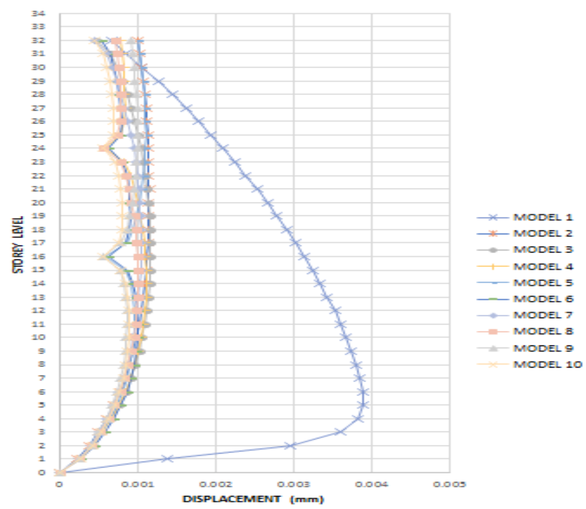
Graph 5: Comparison of Storey Drift for Various Models along X-Direction by Equivalent Static Method

Graph 5 shows the Comparison of Storey Drift for Various Models along X-Direction by Equivalent Static Method. It shows that the drift is greatest at the mid-level of the structure and lowest at the bottom, according to this, a result, as lateral displacement increases, so does the storey height. The variation illustrated in Graph 5 shows variation in drift in X-Direction for all building models.



Graph 6: Comparison of Storey Drift for Various Models along Y-Directionby Equivalent Static Method

Graph 6 shows the Comparison of Storey Drift for Various Models along Y-Direction by Equivalent Static Method. It shows that the drift is greatest at the mid level of the structure and lowest at the bottom, according to this, a result, as lateral displacement increases, so does the storey height. The variation illustrated in Graph 6 shows variation in drift in Y-Direction for all building models.



Graph 7: Comparison of Storey Drift for Various Models along X-Direction by Response Spectrum Method

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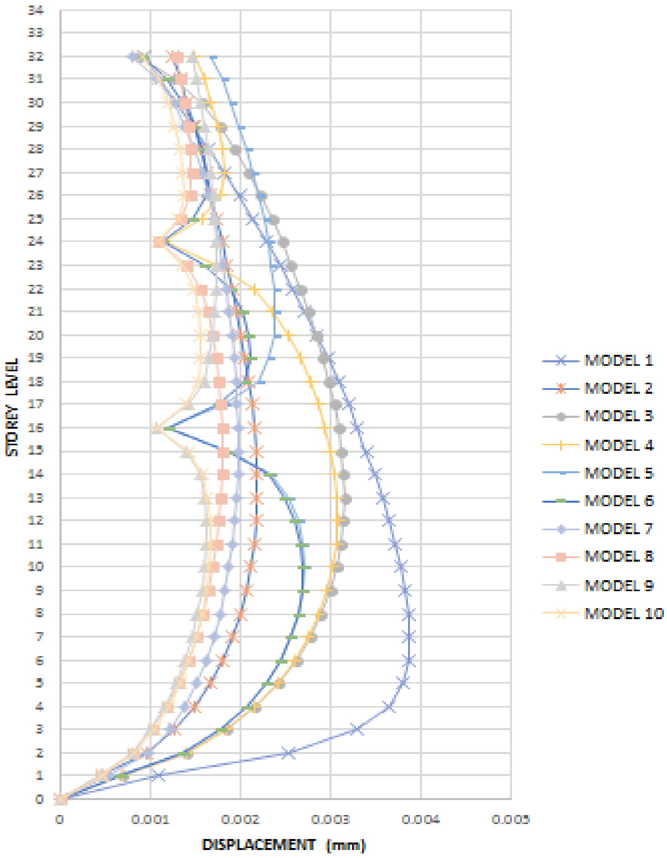
Graph 7 shows the Comparison of Storey Drift for Various Models along X-Direction by Response Spectrum

Method. It shows that the drift is greatest at the mid-level of the structure and lowest at the bottom, according to this, a result, as lateral displacement increases, so does the storey height. The variation illustrated in Graph 7 shows variation in drift in X-Direction for all building models.



Graph 8: Comparison of Storey Drift for Various Models along Y-Directionby Response Spectrum Method

Graph 8 shows the Comparison of Storey Drift for Various Models along Y-Direction by Response Spectrum Method. It shows that the drift is greatest at the mid-level of the structure and lowest at the bottom, according to this, a result, as lateral displacement increases, so does the storey height. The variation illustrated in Graph 8 shows variation in drift in Y-Direction for all building models.

Table 2: Maximum Storey Drifts by Equivalent Static Method and ResponseSpectrum Method along X and Y-Direction

MAXIMUM STOREY DRIFT				
MODEL	Equivalent Static Method		Response Spectrum Method	
	EQX	EQY	RSX	RSY
1	0.007047	0.007678	0.003891	0.003873
2	0.002142	0.004509	0.001168	0.003185

3	0.00193	0.004448	0.001149	0.003148
4	0.001737	0.004267	0.001111	0.003077
5	0.00162	0.003696	0.001105	0.002709
6	0.001489	0.003651	0.001006	0.002691
7	0.001583	0.002809	0.001046	0.001979
8	0.001494	0.002377	0.001008	0.001798
9	0.001449	0.002186	0.001004	0.001732
10	0.001288	0.001985	0.000892	0.001663

4.2.3 Base Shear
The max laterals forces that will occur as a result of seismic activity at a structure's foundation activity ground motion is known as base shear. During earthquake waves, base shear occurs when parallel planes of the structure deform. When a building is subjected to seismic or wind loads, the highest lateral forces at the building's base are called base shear.

Table 3: Base Shear by Equivalent Static Method and Response Spectrum Methodalong X and Traverse Direction

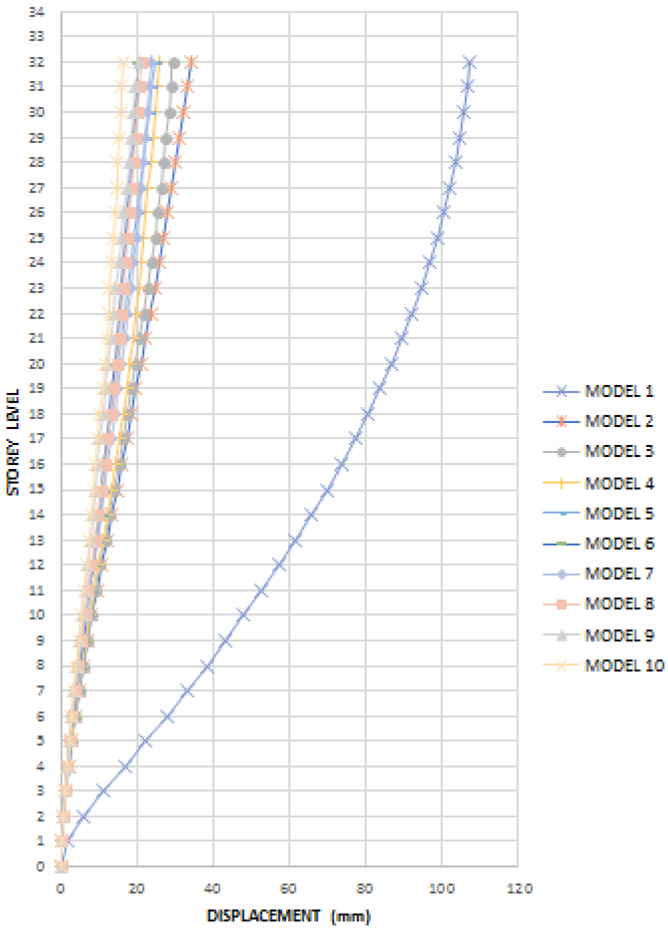
BASE SHEAR				
MODEL	Equivalent Static Method		Response Spectrum Method	
	EQX	EQY	RSX	RSY
1	13182.5	13182.5	8360.93	8289.77
2	12690.09	12690.09	11606.06	8675.08
3	12688.89	12688.89	12688.89	12688.89
4	12720.8	12720.8	12720.8	12720.8
5	13232.07	12720.8	13232.07	12720.8
6	14194.07	12782.22	14194.07	12782.22
7	13152.85	12740.35	14100.5	14093.31
8	13979.39	12784.62	14610.06	15289.53

9	14628.71	12784.62	14724.4	15456.29
10	15813.06	12846.04	15676.46	15962.94

4.3 Wind Static Analysis

Designing for wind-induced building motion is increasingly crucial as demand for larger, lighter, and more slender structures grows. Strong winds can cause tall structures to sway even if they comply with the code's lateral drift standards. Recent catastrophes brought on by hurricanes in the United States are more evidence that current structures are not completely wind-resistant. As a result, it is vital to review the computing methods that are currently being used to determine along wind load. Although it is anticipated that in the end, wind load assessment will be done by accounting for the random change in wind speed over time, the theoretical approaches currently available have not developed sufficiently for inclusion in the Indian standard code. For this reason, the current Indian Standard for Wind Loads on Buildings and Structures (IS-875 (part3):2015) uses the static wind technique of load estimate, which assumes a constant wind speed.

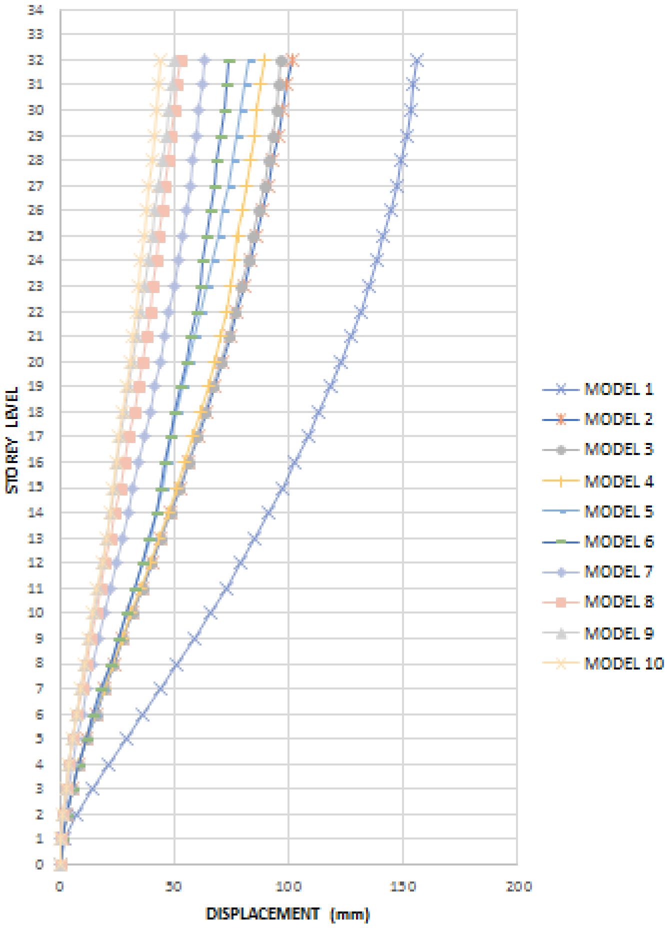
4.3.1 Lateral Displacement



Graph 9: Comparison of Lateral Displacement for Various Models alongX-Direction by Wind Static Method

Graph 9 shows the Comparison of Lateral Displacement for Various Models along X-Direction by Wind Static Method.

It shows that the displacement is greatest at the top of the level structure and lowest at the bottom, according to this. When a result, as lateral displacement increases, so does the storey height. Variation illustrated in graph 9 shows variation displacement in X-Direction for all building model.



Graph 10: Comparison of Lateral Displacement for Various Models along Y-Direction by Wind Static Method

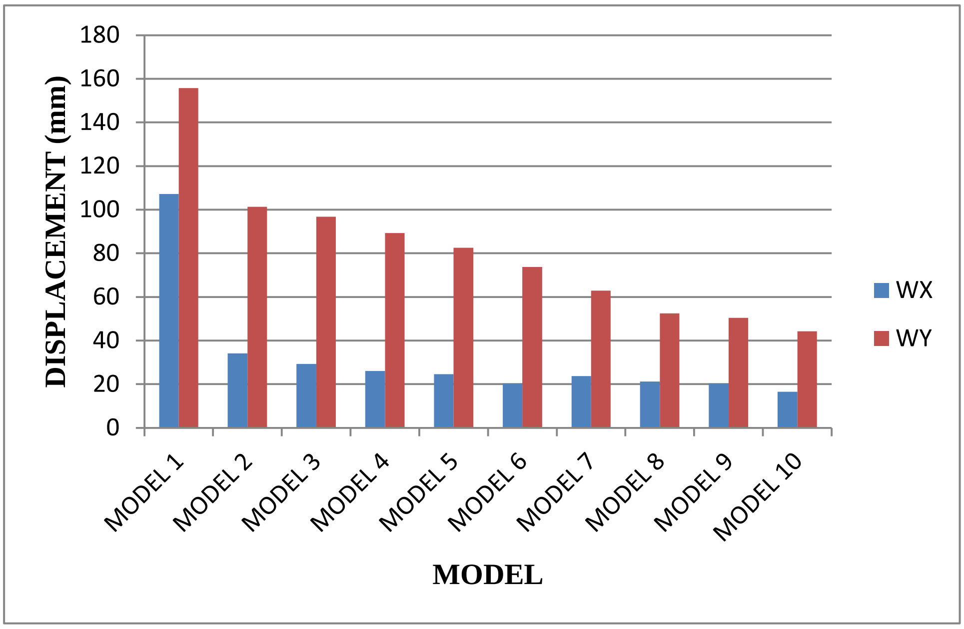
Graph 10 shows the Comparison of Lateral Displacement for Various Models along Y-Direction by Wind Static Method.

It shows that the displacement is greatest at the top of the level structure and lowest at the bottom, according to this. When a result, as lateral displacement increases, so does the storey height. Variation illustrated in graph 10 shows variation displacement in Y-Direction for all building model.

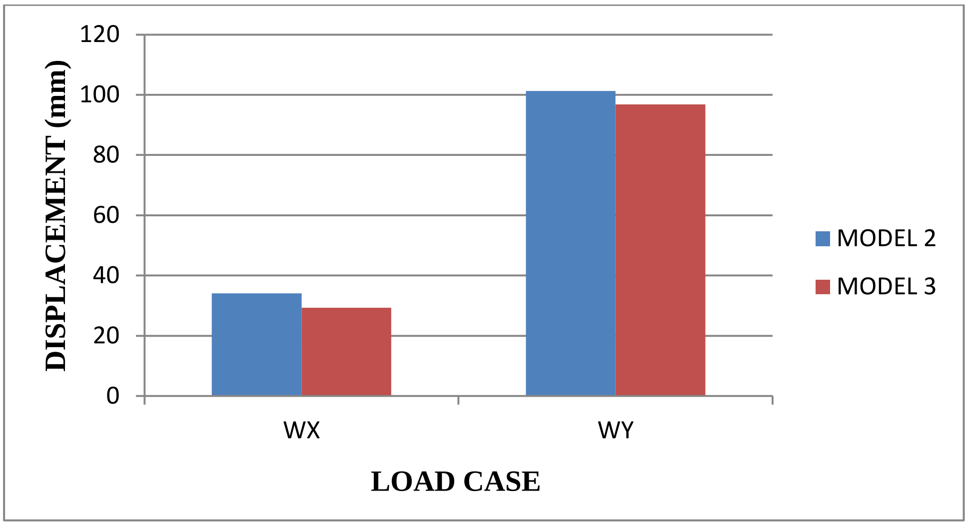
Table 4: Maximum Displacements (mm) By Wind Static Method and along X and Y-Direction

TOP STOREY DISPLACEMENT (mm)		
MODEL	Wind static	
	WX	WY
MODEL 1	107.133	155.773
MODEL 2	34.154	101.316

MODEL 3	29.285	96.808
MODEL 4	26.097	89.293
MODEL 5	24.614	82.55
MODEL 6	20.305	73.775
MODEL 7	23.745	62.904
MODEL 8	21.244	52.43
MODEL 9	20.38	50.373
MODEL 10	16.462	44.258

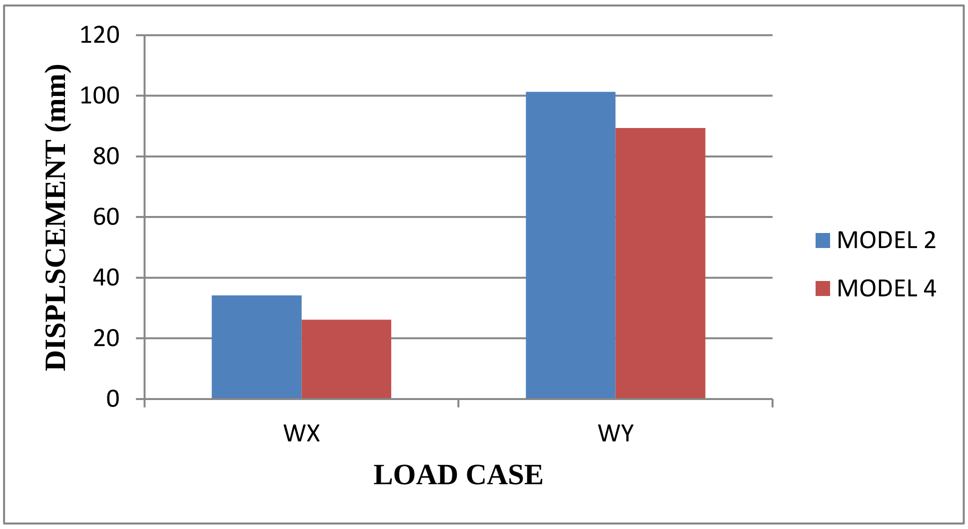


Graph 11: Comparison of Top Storey Displacement by Wind Static Methodalong X and Y-Direction



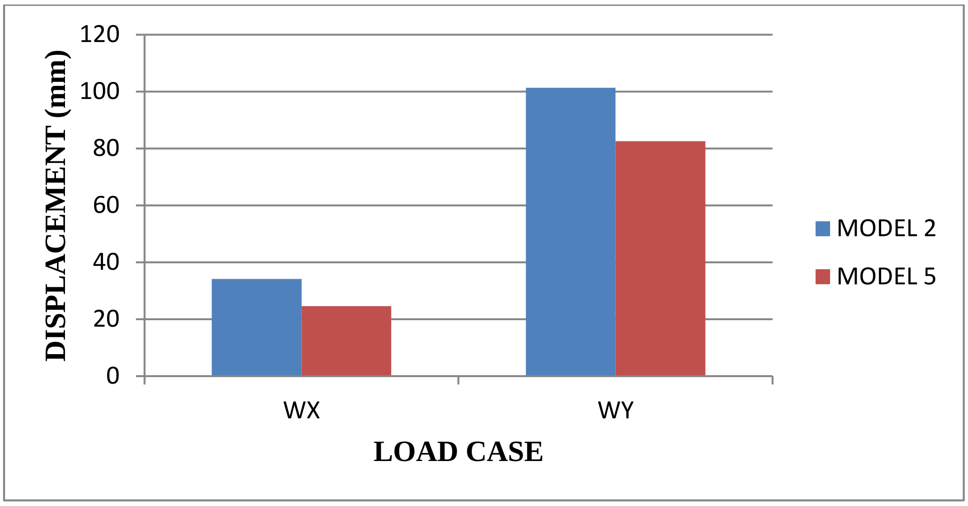
Graph 12: Model 2 and Model 3 Maximum Storey Displacement Comparison

Graph 12 show that the use of the Outrigger system at Top of building resulted in the reduction of displacement in the structure. The displacement is reduced up to 15.35% due to Outrigger. The Outrigger Model 3 showed less displacement in X-direction, which is 28.285 mm, than the other model 2.



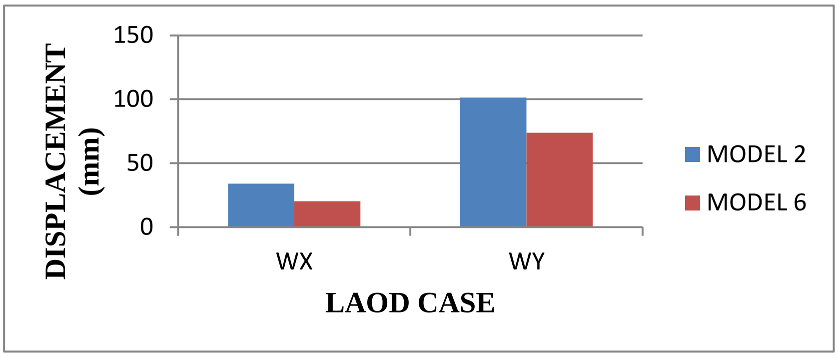
Graph 13: Model 2 and Model 4 Maximum Storey Displacement Comparison

Graph 13 show that the use of the Outrigger system at 3/4 height of building resulted in the reduction of displacement in the structure. The displacement is reduced up to 26.744% due to Outrigger. The Outrigger Model 4 showed less displacement in X-direction, which is 26.097 mm, than the other model 2.



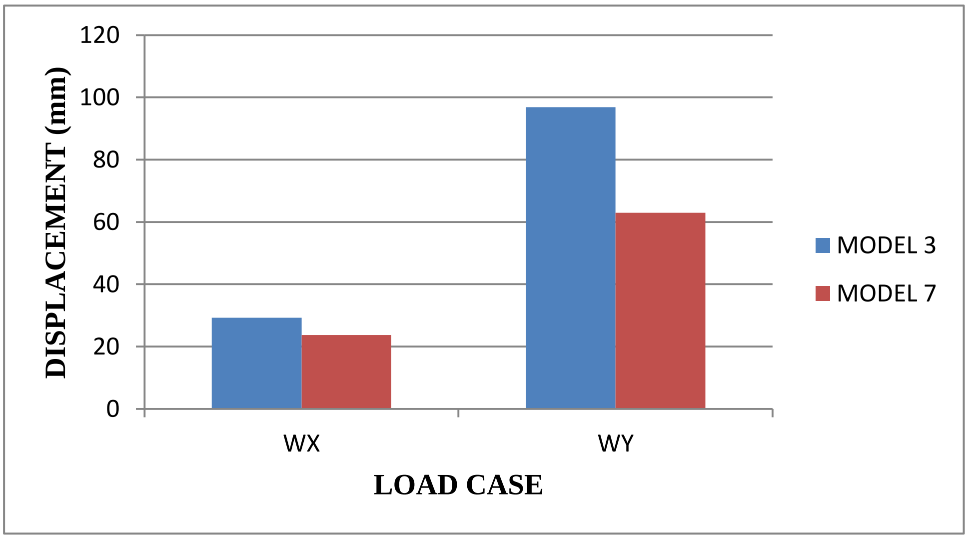
Graph 14: Model 2 and Model 5 Maximum Storey Displacement Comparison

Graph 14 show that the use of the Outrigger system at 1/2 height of building resulted in the reduction of displacement in the structure. The displacement is reduced up to 32.46% due to Outrigger. The Outrigger Model 5 showed less displacement in X-direction, which is 24.614 mm, than the other model 2.



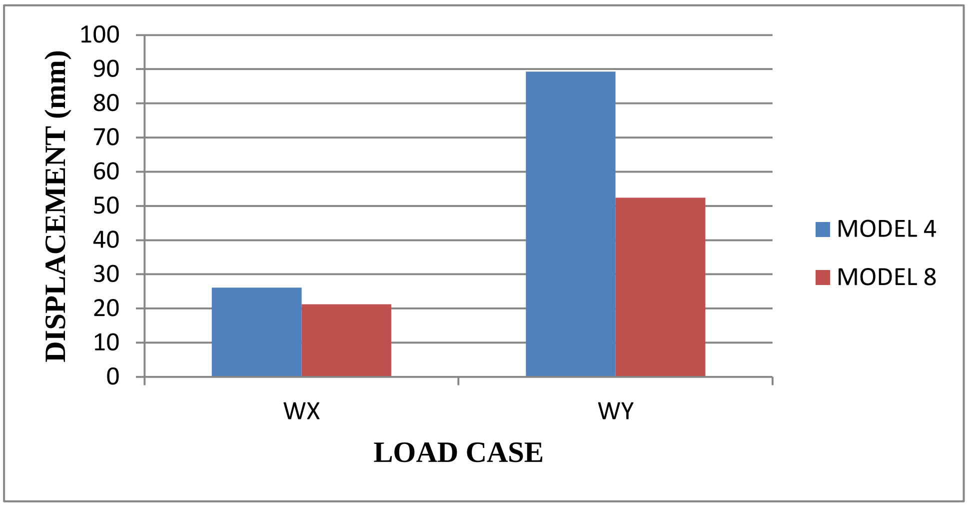
Graph 15 : Model 2 and Model 6 Maximum Storey Displacement Comparison

Graph 15 show that the use of the Outrigger system at Top,3/4 and 1/2 height of building resulted in the reduction of displacement in the structure. The displacement is reduced up to 50.86% due to Outrigger. The Outrigger Model 6 showed less displacement in X-direction, which is 20.305 mm, than the other model 2.



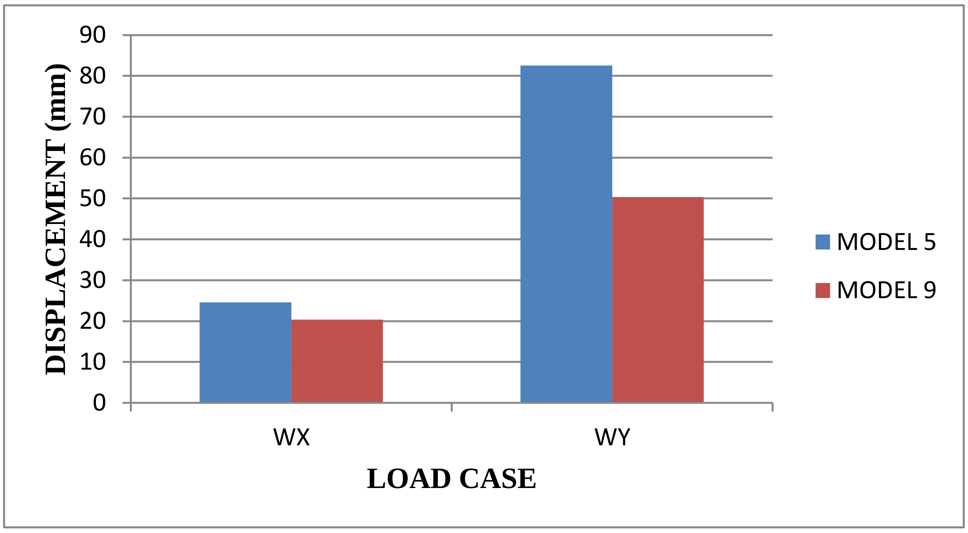
Graph 16: Model 3 and Model 7 Maximum Storey Displacement Comparison

Graph 16 show that the use of the Outrigger system at top of building and X-bracing resulted in the reduction of displacement in the structure. The displacement is reduced up to 20.89% due to Outrigger. The Outrigger Model 7 showed less displacement in X-direction, which is 23.745 mm, than the other model 3.



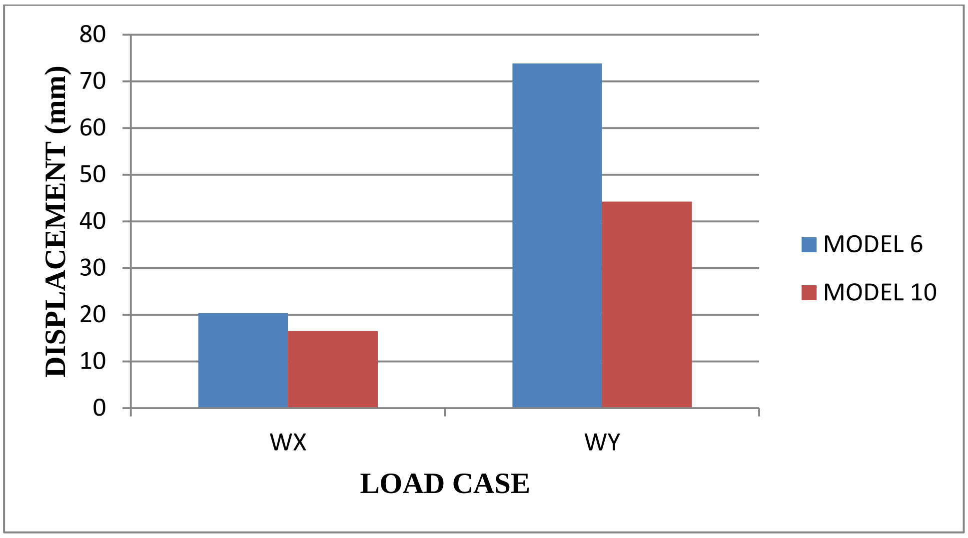
Graph 17: Model 4 and Model 8 Maximum Storey Displacement Comparison

Graph 17 show that the use of the Outrigger system at 3/4 height of building and X-bracing resulted in the reduction of displacement in the structure. The displacement is reduced up to 20.50% due to Outrigger. The Outrigger Model 8 showed less displacement in X-direction, which is 21.244 mm, than the other model 4.



Graph 18: Model 5 and Model 9 Maximum Storey Displacement Comparison

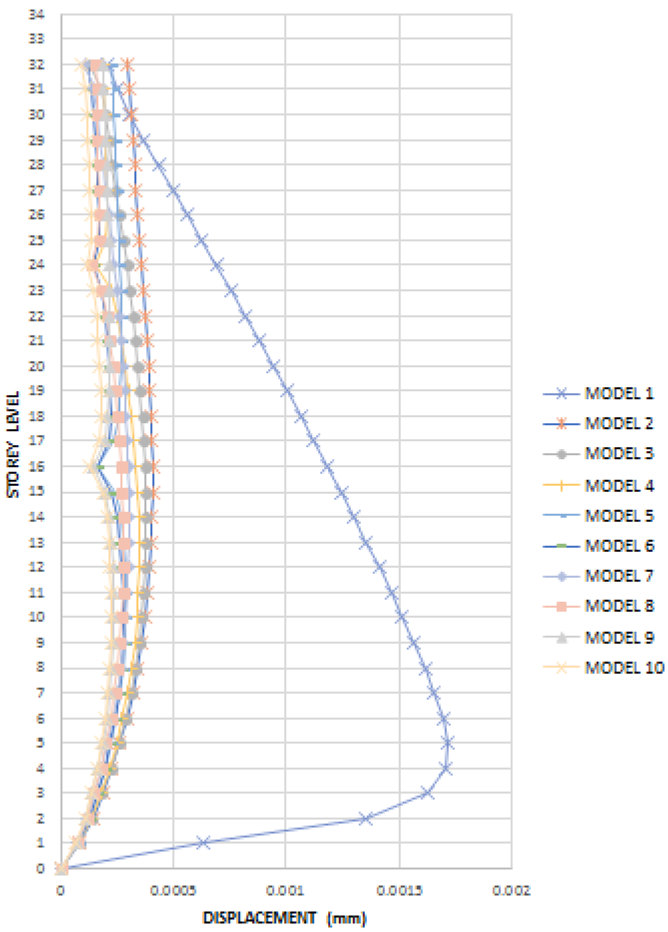
Graph18 show that the use of the Outrigger system at 1/2 height of building and X-bracing resulted in the reduction of displacement in the structure. The displacement is reduced up to 18.82% due to Outrigger. The Outrigger Model 9 showed less displacement in X-direction, which is 20.38 mm, than the other model 5.



Graph 19: Model 6 and Model 10 Maximum Storey Displacement comparison

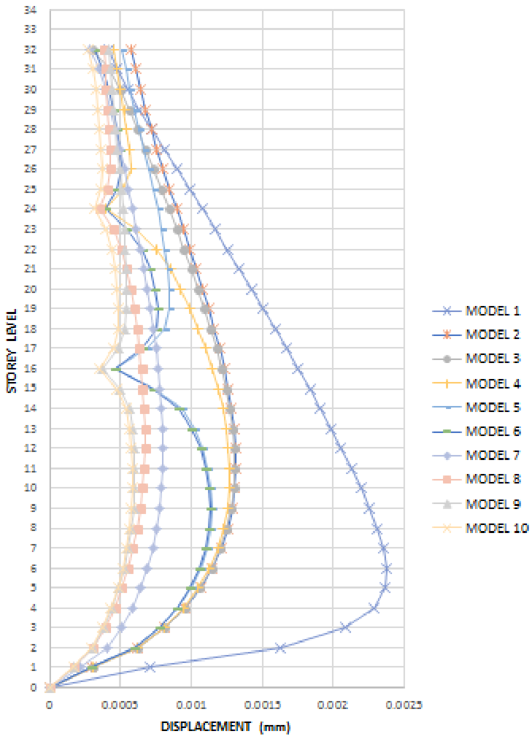
Graph 19 show that the use of the Outrigger system at Top,3/4 and 1/2 height of building resulted in the reduction of displacement in the structure. The displacement is reduced up to 20.90% due to Outrigger. The Outrigger Model 10 showed less displacement in X-direction, which is 16.462 mm, than the other model 6.

4.3.2 Storey Drift



Graph 20: Comparison of Storey Drift for Various Models along X Direction by Wind Static Method

Graph 20 shows the Comparison of Storey Drift for Various Models along X-Direction by Wind Static Method. It shows that the drift is greatest at the mid-level of the structure and lowest at the bottom, according to this, a result, as lateral displacement increases, so does the storey height. The variation illustrated in Graph 20 shows variation in drift in X-Direction for all building models.



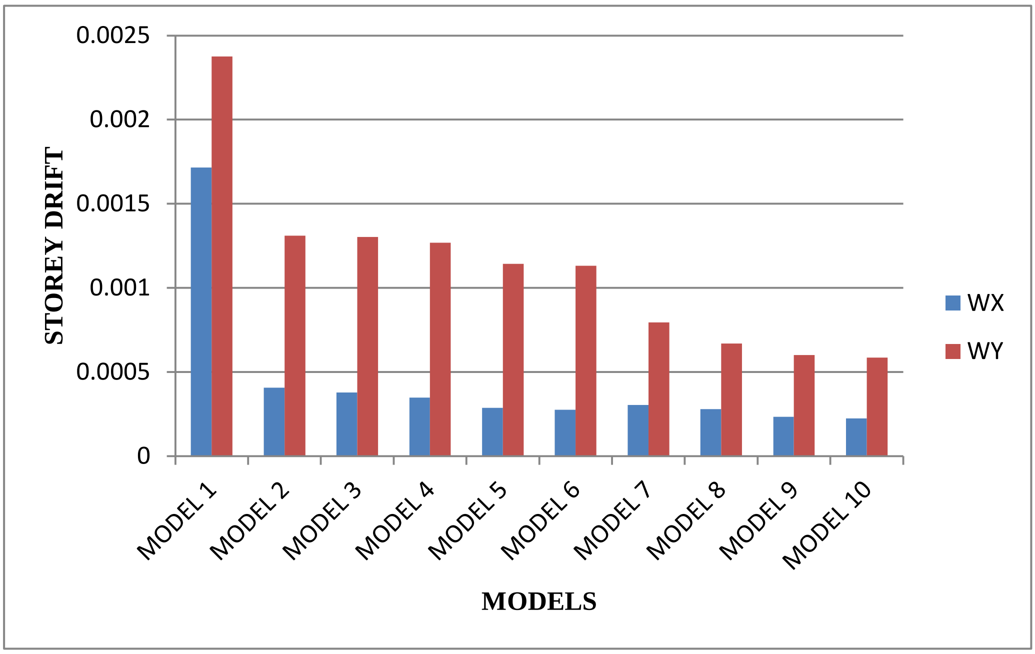
Graph 21: Comparison of Storey Drift for Various Models along Y-Direction by Wind Static Method

Graph 21 shows the Comparison of Storey Drift for Various Models along Y-Direction by Wind Static Method. It shows that the drift is greatest at the mid-level of the structure and lowest at the bottom, according to this, a result, as lateral displacement increases, so does the storey height. The variation illustrated in Graph 21 shows variation in drift in Y-Direction for all building models.

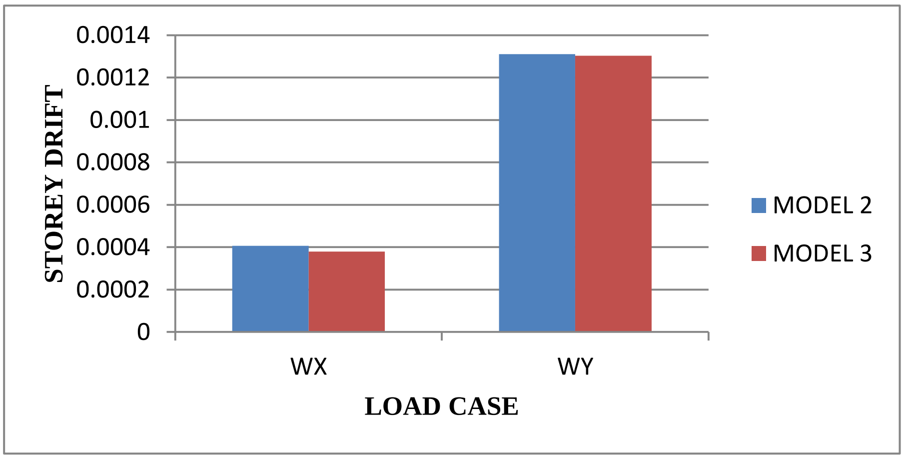
Table 5: Maximum Storey Drift By Wind Static Method and along X and Y-Direction

MODEL	Wind Static Method	
	WX	WY
MODEL 1	0.001715	0.002375
MODEL 2	0.000407	0.001311
MODEL 3	0.000379	0.001302
MODEL 4	0.000348	0.001269
MODEL 5	0.000287	0.001144

MODEL 6	0.000276	0.001132
MODEL 7	0.000304	0.000796
MODEL 8	0.000279	0.00067
MODEL 9	0.000235	0.000602
MODEL 10	0.000224	0.000585

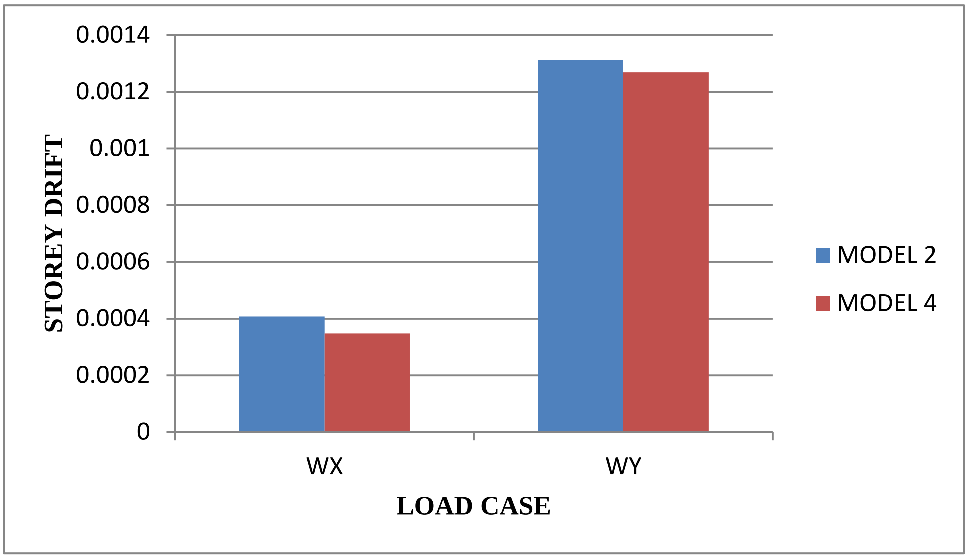


Graph 22: Comparison of Top Storey Drift by Wind Static Methodalong X and Y-Direction



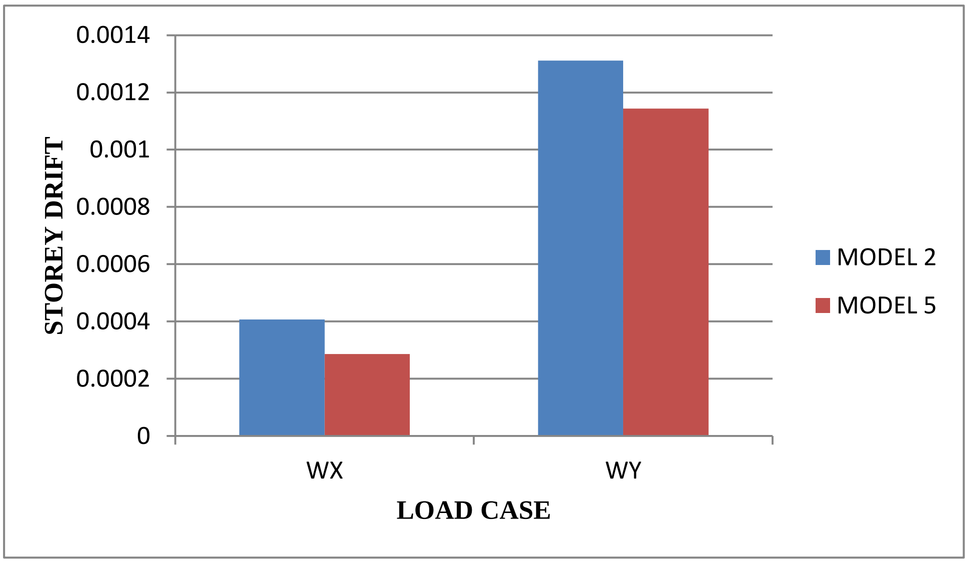
Graph 23: Model 2 and Model 3 Maximum Storey Drift Comparison

Graph 23 shows that the use of the Outrigger system at top of building resulted in the reduction of drift in the structure. The drift is reduced by 7.12% due to Outrigger. The Outrigger Model 3 showed less Story Drift in X and Y-direction, which is 0.000379 than the Model 2.



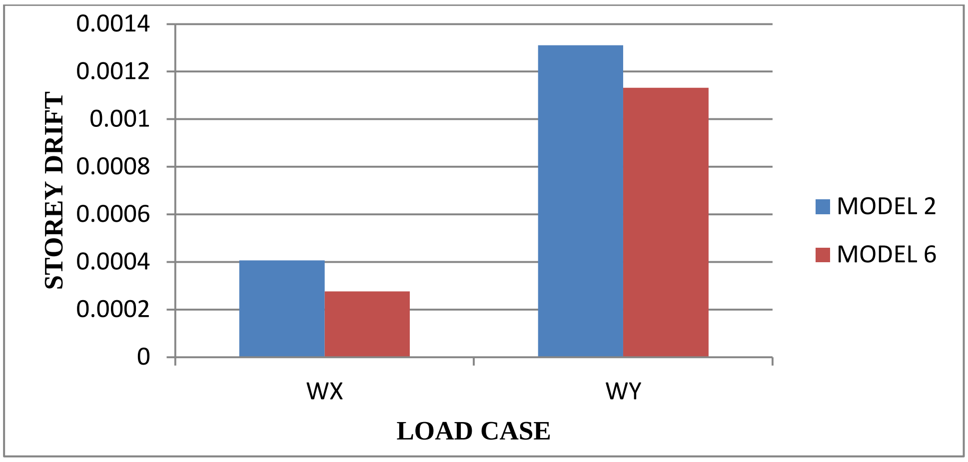
Graph 24: Model 2 and Model 4 Maximum Storey Drift Comparison

Graph 24 shows that the use of the Outrigger system at 3/4 height of building resulted in the reduction of drift in the structure. The drift is reduced by 15.62% due to Outrigger. The Outrigger Model 4 showed less Story Drift in X and Y-direction, which is 0.000348 than the Model 2.



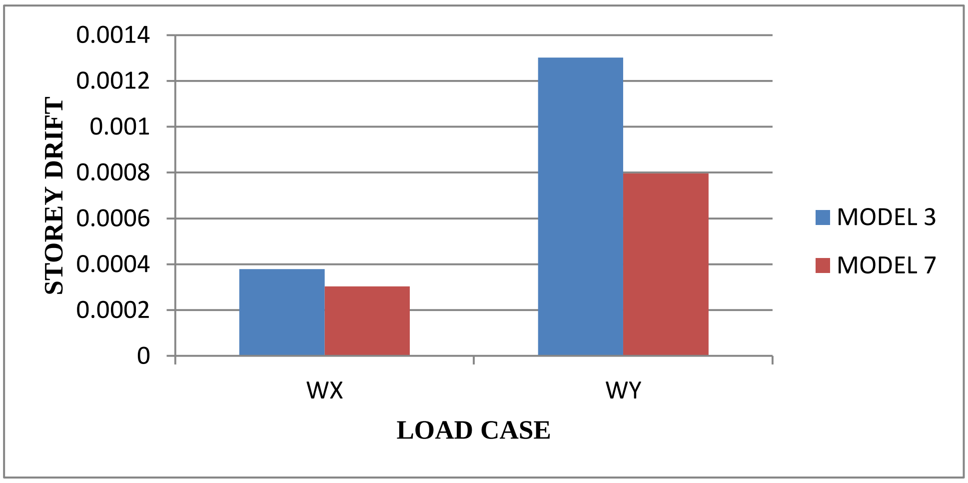
Graph 25: Model 2 and Model 5 Maximum Storey Drift Comparison

Graph 25 shows that the use of the Outrigger system at 1/2 height of building resulted in the reduction of drift in the structure. The drift is reduced by 34.58% due to Outrigger. The Outrigger Model 5 showed less Story Drift in X and Y-direction, which is 0.000287 than the Model 2.



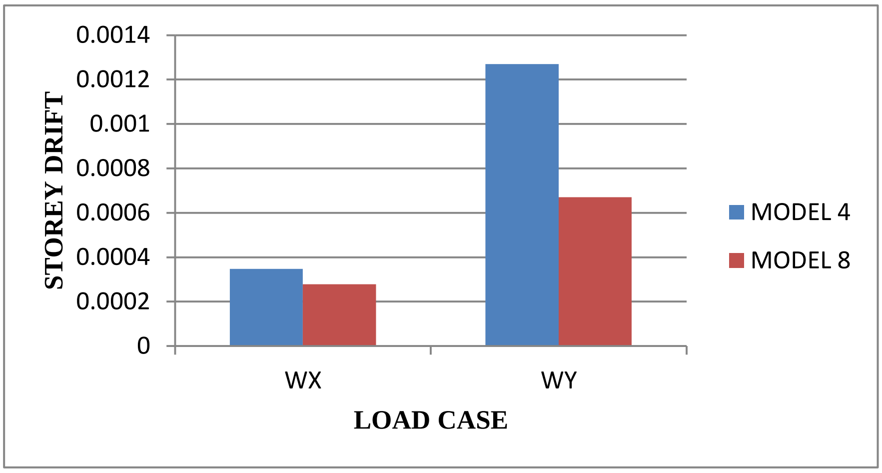
Graph 26: Model 2 and Model 6 Maximum Storey Drift Comparison

Graph 26 shows that the use of the Outrigger system at Top,3/4 and 1/2 height of building resulted in the reduction of drift in the structure. The drift is reduced by 38.36% due to Outrigger. The Outrigger Model 6 showed less Story Drift in X and Y-direction, which is 0.000276 than the Model 2.



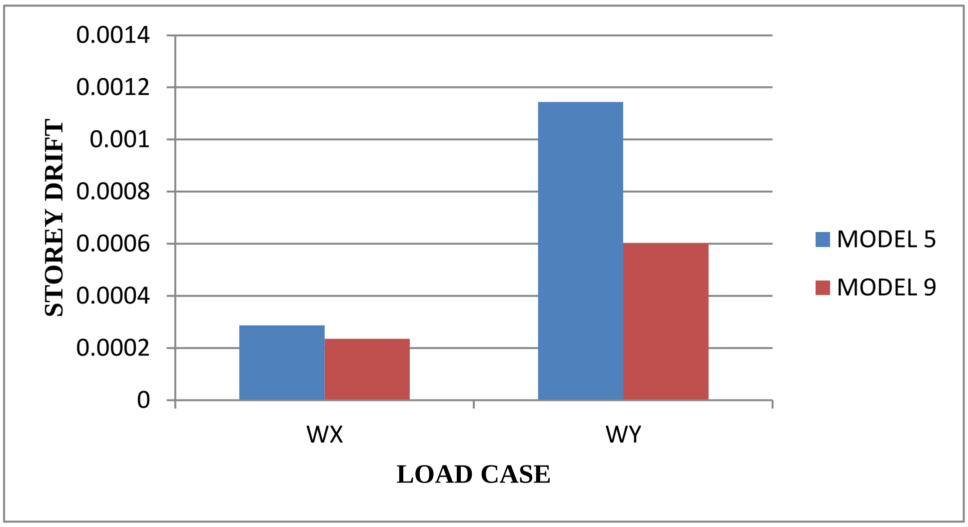
Graph 27: Model 3 and Model 7 Maximum Storey Drift Comparison

Graph 27 shows that the use of the Outrigger system at Top of building and X-bracing resulted in the reduction of drift in the structure. The drift is reduced by 21.96% due to Outrigger. The Outrigger and X-bracing Model 7 showed less Story Drift in X and Y-direction, which is 0.000304 than the Model 3.



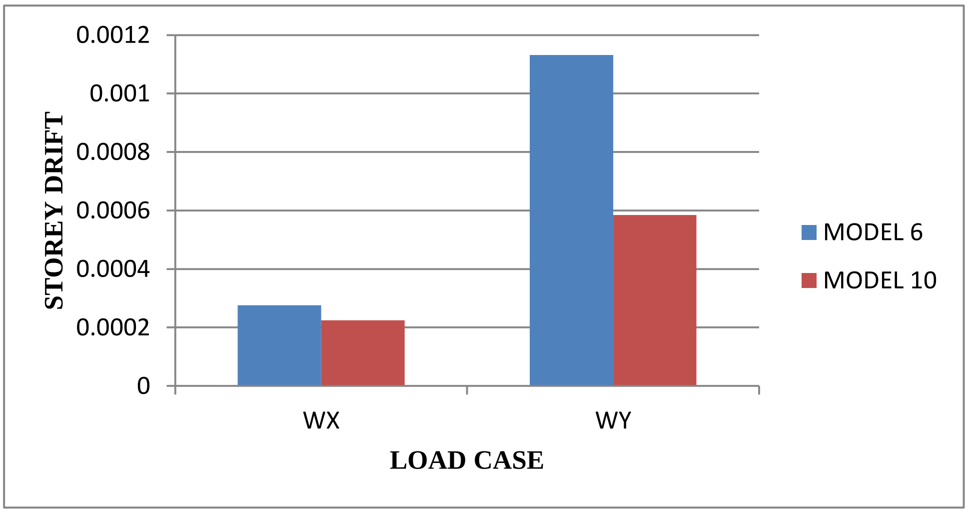
Graph 28: Model 4 and Model 8 Maximum Storey Drift Comparison

Graph 28 shows that the use of the Outrigger system at 3/4 height of building and X-bracing resulted in the reduction of drift in the structure. The drift is reduced by 23.07% due to Outrigger. The Outrigger and X-bracing Model 8 showed less Story Drift in X and Y-direction, which is 0.000276 than the Model 4.



Graph 29: Model 5 and Model 9 Maximum Storey Drift Comparison

Graph 29 shows that the use of the Outrigger system at 1/2 height of building and X-bracing resulted in the reduction of drift in the structure. The drift is reduced by 19.92% due to Outrigger and bracing. The Outrigger and X-bracing Model 9 showed less Story Drift in X and Y-direction, which is 0.000276 than the Model 5.



Graph 30: Model 6 and Model 10 Maximum Storey Drift Comparison

Graph 30 shows that the use of the Outrigger system at Top, 3/4 and 1/2 height of building resulted in the reduction of drift in the structure. The drift is reduced by 20.8% due to Outrigger. The Outrigger Model 10 showed less Story Drift in X and Y-direction, which is 0.000224 than the Model 6.

V. SUMMARY AND CONCLUSION

5.1 Conclusions

From the above study, an attempt to investigate the buildings seismic and wind response in zone V and of wind speed 39ms^{-1} region, with outriggers and braces. Different models are compared and analyzed. The model of a braced core wall is compared to the model of a solid concrete core wall. An impact of the core wall and the X bracing is also compared. Response spectrum analysis is used to compare seismic base shear, storey deflections, and storey drift. The findings of the study are as follows:

1. It has been observed that for Model 2 displacement was 366.88 mm and for Model 3 it is 346.613 mm which got reduced by 5.68%, for Model 4 reduction is 14.21% , for Model 5 reduction is 19.37% and model 6 is

32.39%. From the above lateral displacement, it can be concluded that Model 6 Outrigger position is yielding more optimized results when compared to other positions.

2. It has been observed that for Model M2 drift was 0.003185 and for Model 3 it is 0.003148 which got reduced by 1.16%, for Model 4 reduction is 3.44% for Model 5 reduction is 16.15% and model 6 is 16.81%. From the above drift, it can be concluded that Model 6 Outrigger position is resisting more in drift when compared to other outrigger positions.
3. It has been observed that for Model M6 Base Shear was 14194 kN and for Model 5 it is 13232 kN which got reduced by 7.3%, for Model 4 reduction is 11.6% and model 3 is 11.86%. From the above Base Shear, it can be concluded that Model 6 Outrigger position is though having more Base Shear it is resisting more in Displacement and Drift when compared to other outrigger positions.
4. It has been observed that for Model 7 displacement was 222.96mm and for Model 8 it is 190mm which got reduced by 15.96%, for Model 9 reduction is 17.88% and model 10 is 32.18%. From the above lateral displacement, it can be concluded that Model 10 Outrigger position with Bracing is yielding more optimized results when compared to other positions.
5. It has been observed that for Model 7 drift was 0.001979 and for Model 8 it is 0.001798 which got reduced by 9.58%, for Model 9 reduction is 13.31% and model 10 is 17.35%. From the above drift, it can be concluded that Model 10 Outrigger position with bracing is resisting more in drift when compared to other outrigger positions.
6. It has been observed that for Model M10 Base Shear was 15813 kN and for Model 9 it is 14268 kN which got reduced by 10%, for Model 8 reduction is 13% and model 7 is 20%. From the above Base Shear, it can be concluded that Model 10 Outrigger position with Bracing is though having more Base Shear it is resisting more in Displacement and Drift when compared to other outrigger positions with bracing

5.2 Recommendations for Future Work

Further research can be carried out to study the following aspects:

- Buildings with irregular geometries and located on sloping grounds need to be studied.
- Inspect in case the put forward technique clarifies is relevancy for Performance Based Seismic Design and Analysis of Transfer Structure.
- Construction Sequence Analysis can be done in order to assessment of exponential changes in load pattern in Outrigger Bracing.
- Secondary effects like the temperature change, shrinkage, creep, stress concentrations etc., may interest area of investigation.

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