"RETROFITTING OF HIGH RISE BUILDING IN COASTAL AREAS USING SHEAR WALL IN ETABS SOFTWARE"

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Abstract: **High rise building in coastal zones areas are strained to environment force such as high wind pressure, stroms , cyclons , seismic activities. The combination of these factor may lead to the deteriotion of the structural members loss in strength, stability issue , durability .And Retrofitting as become more effective to improve the strength, durability and the performance of the structures. Various retrofitting technique like using shear walls is considered as main effective methods to enhance the strength , different loads resistance of tall structure. Shear walls is a vertical structure element which provides the stiffness and strength against the lateral loads like wind and earth quake forces, and it will improve the overall stability and safety of the building. And this methods will reduce the building sway and torsional and storey drifts. By using the ETABS Software it is more useful in analyse, evaluate the nature of the retrofitted tall structure by using the shear walls under various load condition. This is the platform to withstand the wind, seismic and gravity loads to assess the building response before and after the retrofitting. In the coastal zones, the building are affected to corrosion and environment effect. the retrofitting of high rise buildings with the shear walls will improve the strength and the long-term life of the structure, and reduces the maintenance coast and must ensure the compliance with the design codes and safety standards.**

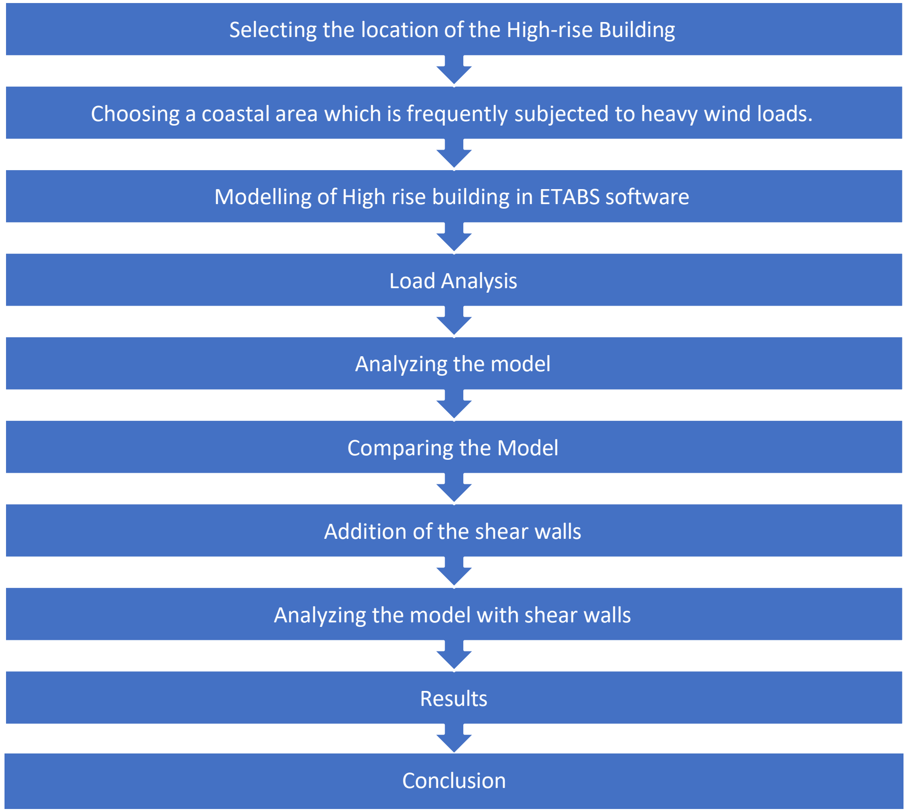
Keywords; **Structural performance, Durability, Building Safety.**

1. INTRODUCTION: The rapid urbanization of coastal cities around the world has led to the widespread construction of high-rise buildings to meet residential and commercial demands. The high rise structure are damaged and affected to environment condition in coastal region the wind, temperature ,rain and seismic activities ,etc.And in some area the structural elements like, reinforced concrete and steel,structure ,are facing difficult for the building safety measure like durability, lateral stability. And in coastal zones the building faces many damages like chloride attack corrosion of steel members. Due to the salt water in the ocean the concrete shrink and corrosion takes place and steel bars expand and it will crack and spoil the concrete members. More wind from the coastal sides and cyclones it may affect the lateral loads of building and may lead it the building instability. And more over the building must with stand the earthquake forces. The process of retrofitting in the high-rise building is to improve the structure strength, durability and to with stand the load which it is carrying and also the safety measure.The retrofitting method, by replacing the shear wall has been successful in most effectively manner in improving the stability, durability ,stiffness of the structure. And the shear walls are the longitudinal members which are made up of reinforced concrete and it acts as to with stand the beams of horizontal force.

11. OBJECTIVES OF THIS STUDY

- To evaluate the structural performance of existing high-rise buildings in coastal areas subjected to environmental deterioration and seismic loads.
- To analyze the damage of structural components exposed to aggressive marine environments (e.g., corrosion due to salt-laden air).
- To aim of retrofitting using shear walls customized to high-rise building located in coastal regions.
- To analyze a comparative study between retrofitted and non-retrofitted models in terms of strength, ductility, and displacement under dynamic loading conditions.
- To enhance the safety and serviceability of old high-rise buildings through cost-effective and sustainable retrofitting techniques.
- To formulate design recommendations for future retrofitting projects in similar coastal environments.

111.METHODOLOGY



PROJECT DETAILS:

Table 1.Building Parameter

Number of floors	10
Story height	5m
Support condition	Fixed at base
Slab thickness	200mm
Shear Wall thickness	200mm
COLUMN SIZE	
Storey 1-5	600mm X 600mm
Story 6-10	500mm X 500mm
BEAM SIZE	
Storey 1-5	450mm X 450mm
Storey 6-10	400mm X 400mm
Materials Characteristics	
Fck	M40
Steel-Grade	Fe 500 & Fe 250
Loads	
Live load	3 kN/m^2
Floor finishes	1 kN/m^2
Live load on roof	1.5 kN/m^2
Floor finish on roof	0.5 kN/m^2

Zone factor, Z	Zone 5 (0.36)
Soil type	II (Medium)
Importance factor, I	1
Response reduction factor, R	5
Damping ratio	5%
Eccentric ratio	0.05

EARTH QUAKE DATA(IS 1893 part 1: 2016)

Table 2: Earthquake parameters (IS 1893 part 1: 2016)

IV.MODEL DEVELOPMENT AND DESIGN

- Model 1:To design a symmetrical high rise building of G+9 in ETABS Software .And to make sure that building design complies with IS Codes and Standard (IS:456,1893:2015 ,IS875:2016)
- Model 1, will be used to identify the failure points and assess the structural behaviour under increased load.
- And the Model 1 will be retrofitted by using shear walls.

2. Analysis Methods

- 1.Equivalent Static Analysis.
- 2.Response Spectrum Analysis.

3. Performance Evaluation.

- To Evaluate the Model 2 and identify the failure members.
- To Evaluate the Retrofitted model with Shear walls.

4. Comparision and Analysis.

5. Reporting and documentation.

- Result presentation
- Discussion.

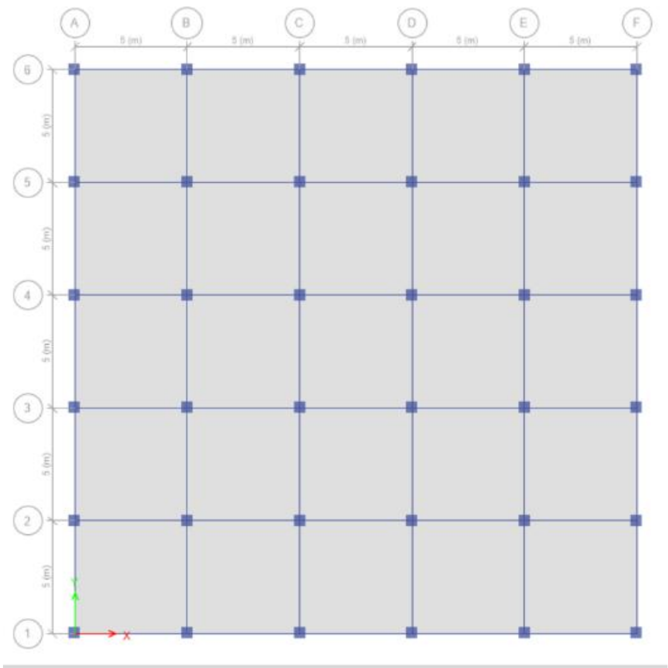


Fig 1.Plan of Model 1

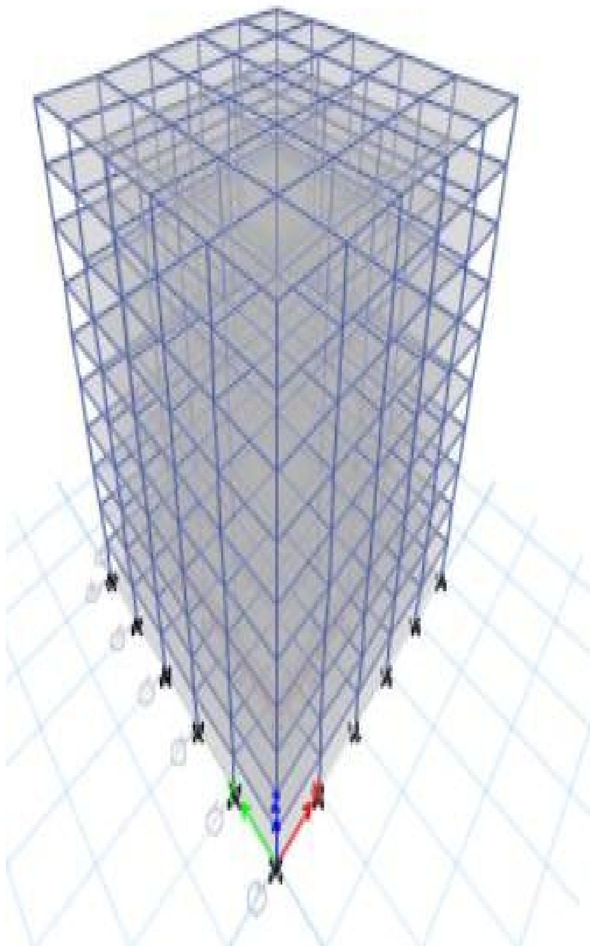


Fig.2 3-D View of Model

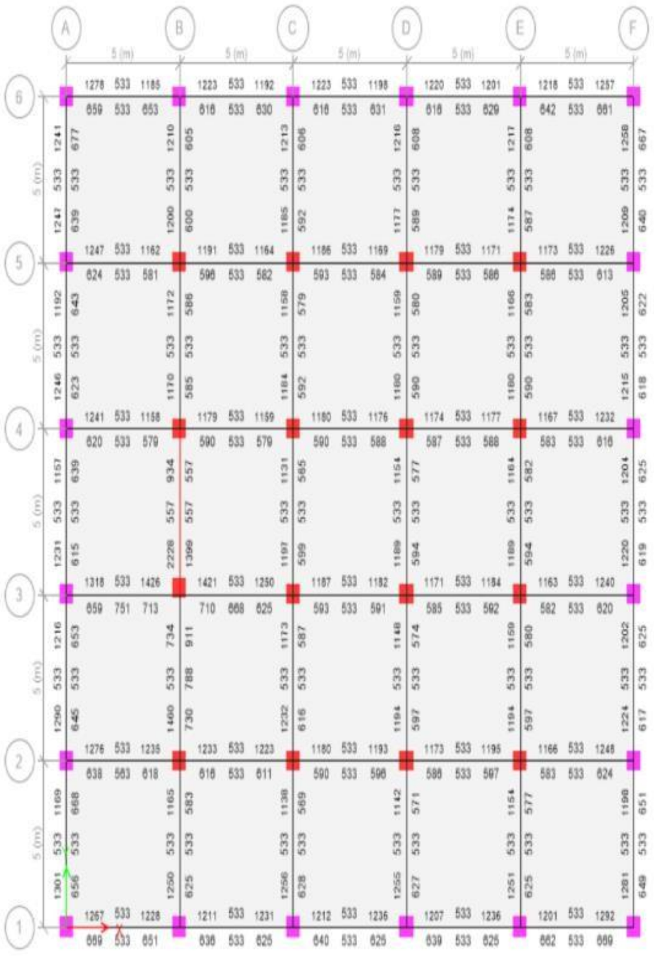


Fig 3.Design check of Model

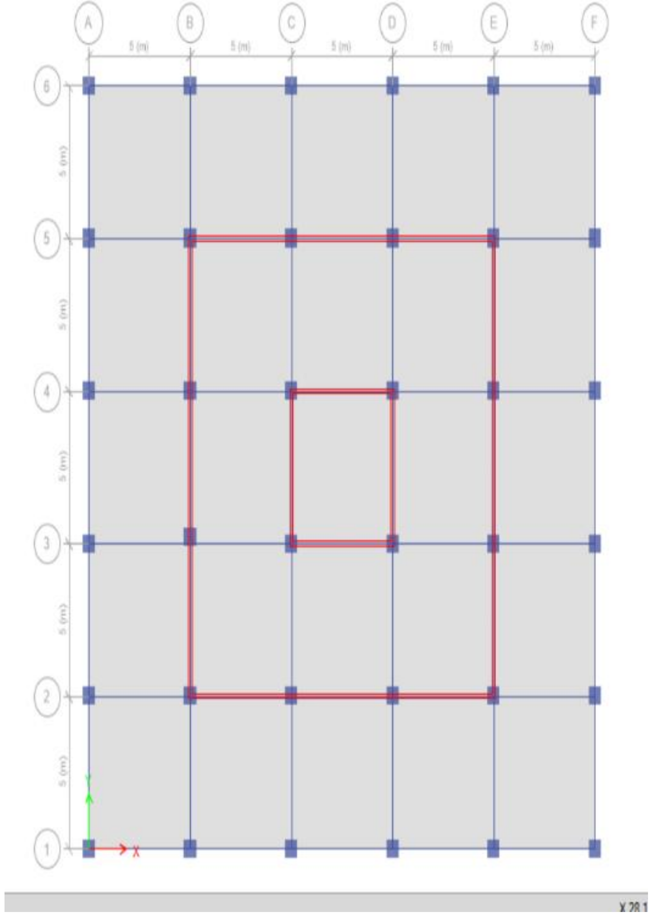


Fig 4. Plan view of Model 1 with shear wall

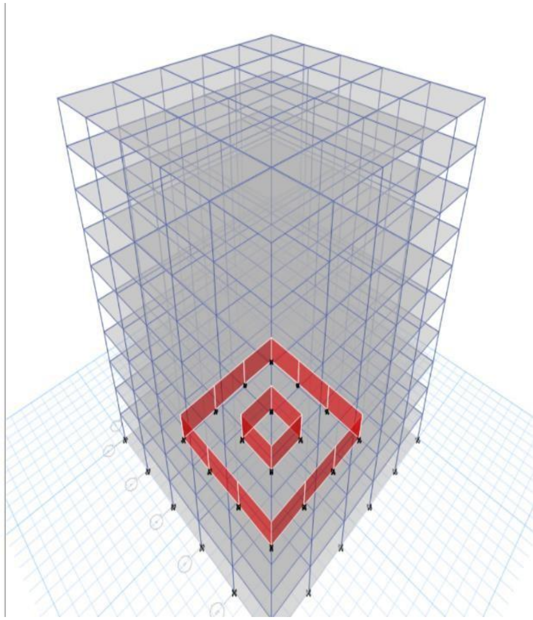


Fig 5. 3D view of Model 1 with shear wall

V.RESULTS

1. Method of Analysis :

These methods of analysis was carried on existing building (Model 1) and Model 2 symmetric and asymmetric model was analysed using both the static, and dynamic methods and equivalent static analysis. the models were retrofitted by using shear walls and also both static and dynamic analysis was carried out.

2. Equivalent static analysis:

The design under seismic load are consider under the static and dynamic analysis.Equivalent static analysis can perform for low to medium buildings without any torsional modes .the only first modes will be consider ,building like more than 75m second and higher modes can be consider ,building with torsional effect are suitable for this method and more complex method are to be used in this.

3. Response Spectrum Analysis;

Response spectrum analysis is suitable for which the modes other the fundamental affect the response of the structure. This method the response of multi degree of freedom system is expressed as the super position of modal response ,being determined from the spectral analysis of single degree of freedom system ,which is combined to compute the total response.Many combination methods are presented among them like SRSS(Square-root-sum-of-squares) and CQC(Complete quadratic combination) are the two most common modal combination techniques.

VI. Results and Discussion:

1 Base Shear

Base shear refers the sum of the lateral force that a structure should resist at ots base due to the wind loads and seismic activities.It is to be calculated by applying seismic or wind force coefficients to the building.and it also represents the sum of the horizontal forces which is distributed across the structure. Base shear is important for designing foundations and structural systems to make ensure stability and prevents collapse during lateral loads

Table.3.MAX BASE SHEAR (Equivalent static analysis)

Model	BASE SHEAR (kN)	
	EQX	EQY
Model- 1	8028.13742	8028.13742

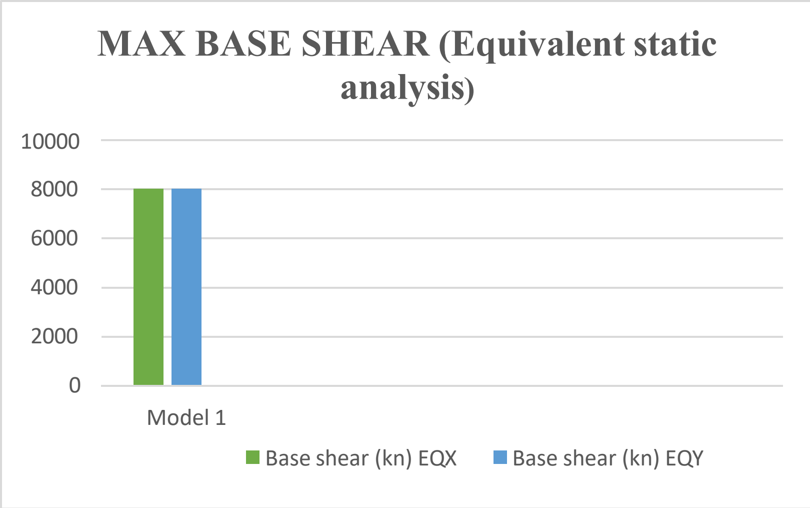
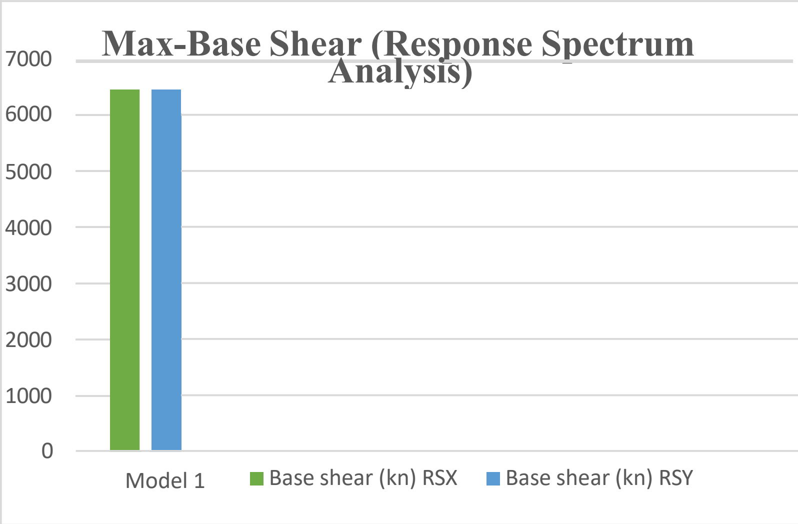


Fig 6 Max Base Shear (Equivalent static Analysis)

Table.4 MAX-BASE SHEAR (Response Spectrum Analysis)

Model	BASE SHEAR (kN)	
	RSX	RSY
Model- 1	6455.47555	6455.47555



2. Maximum Storey Drift

Maximum-storey drift is lateral displacement between the floors due to the lateral loads like wind or seismic forces. It is for evaluating structural deformation to make sure it obeys safe limits to prevent damage and maintain safety. More drift csn signal design issues and it can lead to damage of non-structural elements.

Table .5.Max- Storey Drift (Equivalentstatic analysis)

Model	Max-Storey Drift	
	EQX	EQY
Model-1	0.0097	0.0097

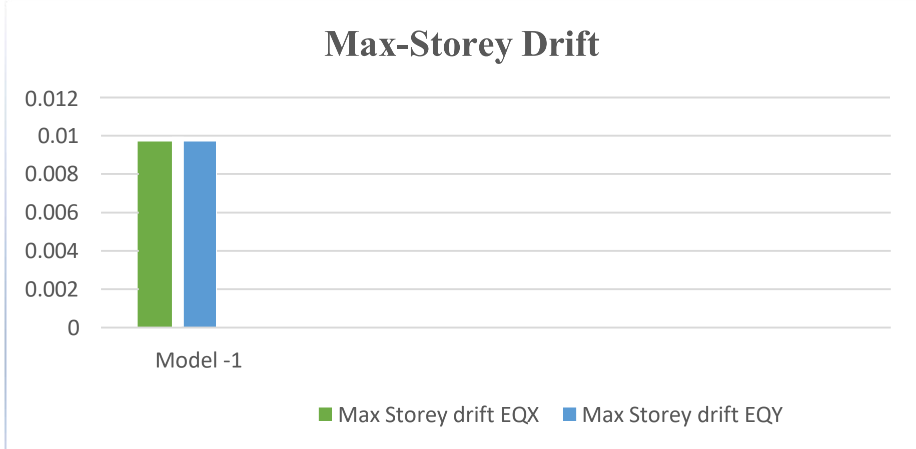


Fig 8 Max- Storey Drift (Equivalent static analysis)

Table 6. Max- Storey Drift (Response spectrum Analysis)

Model	Max-Storey Drift	
	RSX	RSY
Model- 1	0.001066	0.001066

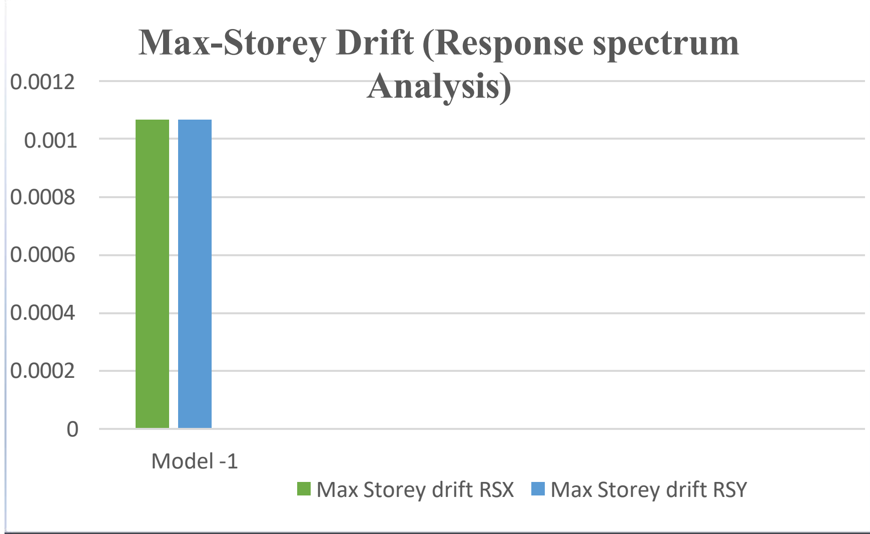


Fig 9 Max- Storey Drift (Response spectrum Analysis)

3. Maximum-Storey Displacement

Maximum-storey displacement is the biggest vertical movements of the floor of a building to its relative building position under its loads ,like a seismic activities it also measure how much a floors as to shift overall stability of the buildings.

Table 7. Max-Storey Displacement (equivalent static analysis)

Model	Max-Storey Displacement (mm)	
	EQX	EQY
Model-1	28.387	29.198

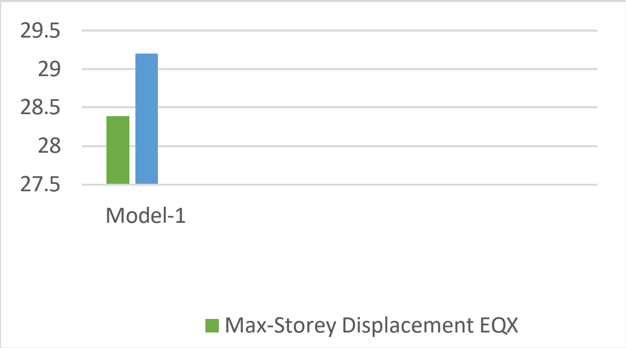


Fig.10. Max-Storey Displacement (equivalent static analysis)

Table 8. Max-Storey Displacement (Response spectrum analysis)

Model	Max-Storey Displacement (mm)	
	RSX	RSY
Model-1	21.615	21.615

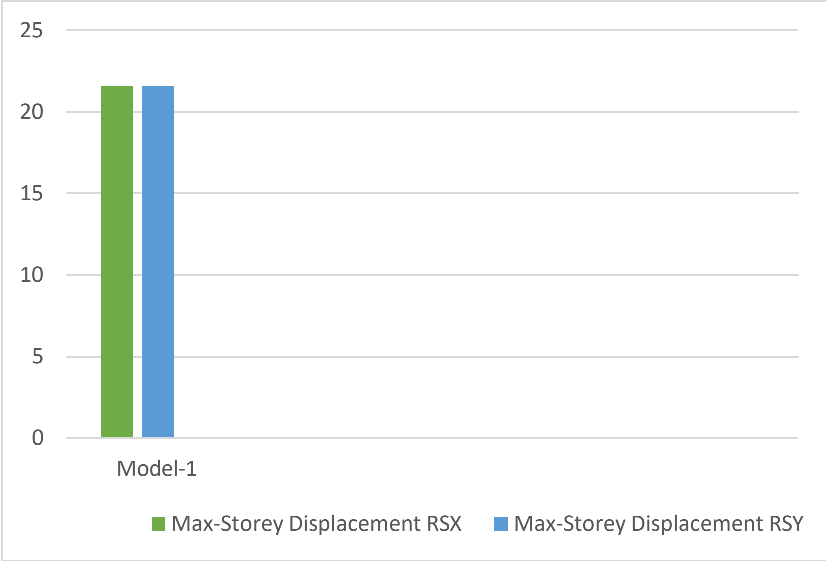


Fig.11. Max-Storey Displacement (Response spectrum analysis)

Table 9.Max-Storey stiffness(Equivalent static analysis)

Model	Max-Storey Stiffness (mm)	
	EQX	EQY
Model-1	1066142.166	16086142.079

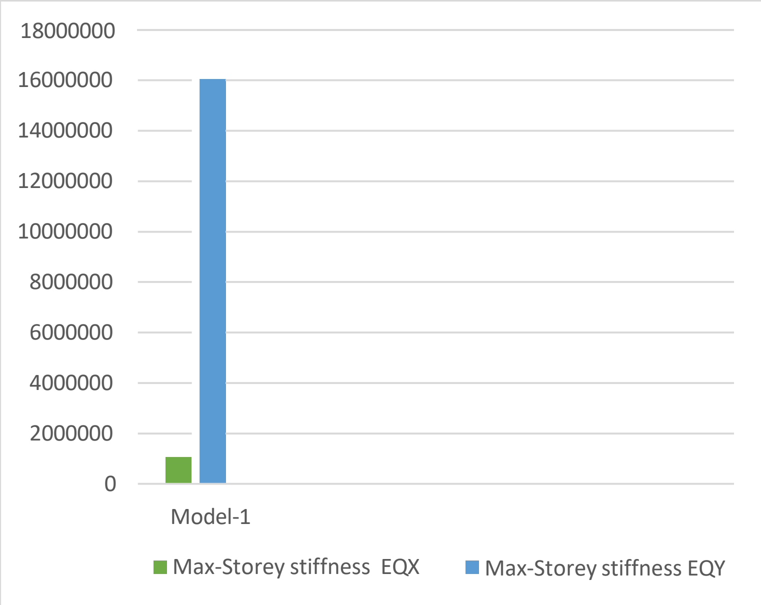


Fig.12 Max-Storey Stiffness (Equivalent static analysis)

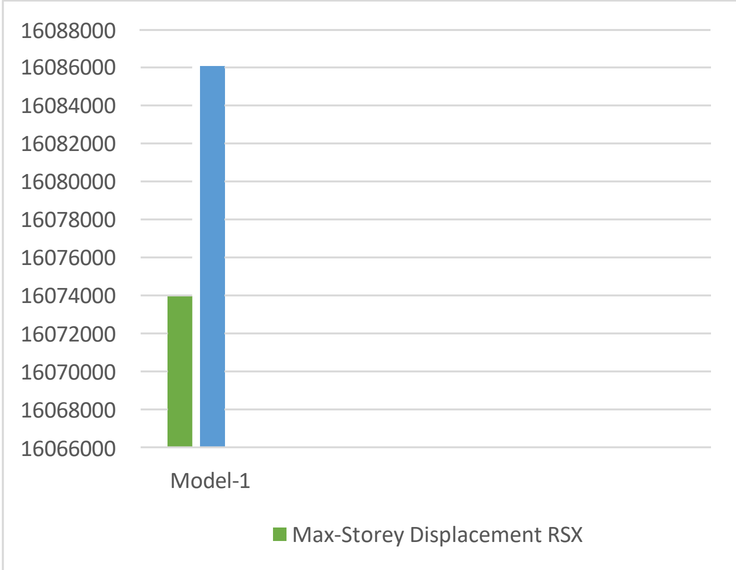
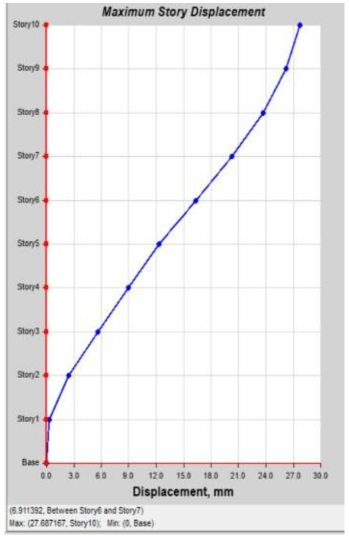


Fig.13. Max-Storey Stiffness (response spectrum analysis)

Table 10. Max-Storey Stiffness (response spectrum analysis)

Model	Max-Storey Stiffness (mm)	
	RSX	RSY
Model-1	16073692.669	16086142.079

Storey Response plot for Max- Displacements:



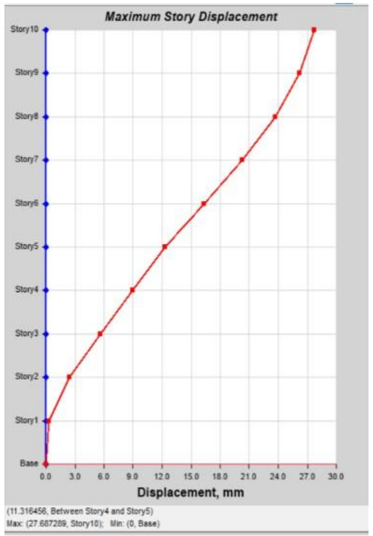


Fig 14. Max- Storey displacement for Model 1 (EQX and EQY)

4 Storey Stiffness: Storey stiffness is the measurement of a building storey of the lateral displacement which are caused by seismic forces. And it will be determined as the proportion of the lateral force which is used in lateral displacement which is experienced by the storey. More storey stiffness indicates a stiffer floor which resist the lateral movements more effectively. which improve the overall structural stability and also reduces the deformation. Storey stiffness can lead to increase displacements, potential damage, and noncompliance with IS design codes.

Table.11 Storey stiffness values Model- 1 (Equivalent static analysis)

Story	X-Direction	Y-Direction
Story -10	55982.101	559892.81
Story- 9	628486.146	628486.782
Story- 8	638778.453	638778.968
Story- 7	652476.108	652476.494
Story -6	720347.272	720347.859
Story -5	956645.079	956646.773
Story -4	998789.632	998794.483
Story -3	1081038.566	1081060.731
Story -2	1562497.584	1562728.088
Story -1	16073692.366	16086141.985
Base	0	0

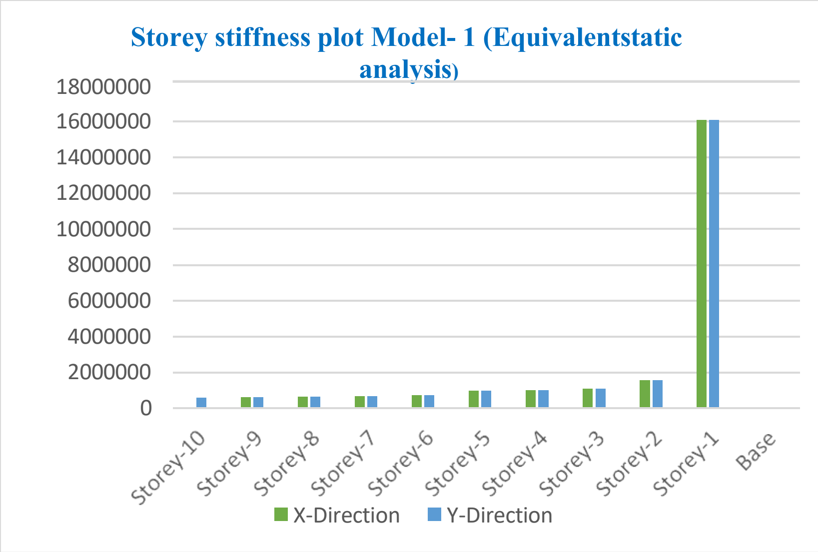


Fig.17..Storey stiffness Model-1(Equivalent static analysis)

Table.12 Storey stiffness values Model- 1

Story	X-Direction	Y-Direction
Story -10	559892.101	559892.811
Story- 9	628486.146	628486.782
Story- 8	638778.453	638778.968
Story- 7	652476.108	652476.494
Story -6	720347.272	720347.859
Story -5	956645.079	956646.773
Story -4	998789.632	998794.483
Story -3	1081038.566	1081060.731
Story -2	1562497.584	1562728.088
Story -1	16073692.366	16086141.985
Base	0	0

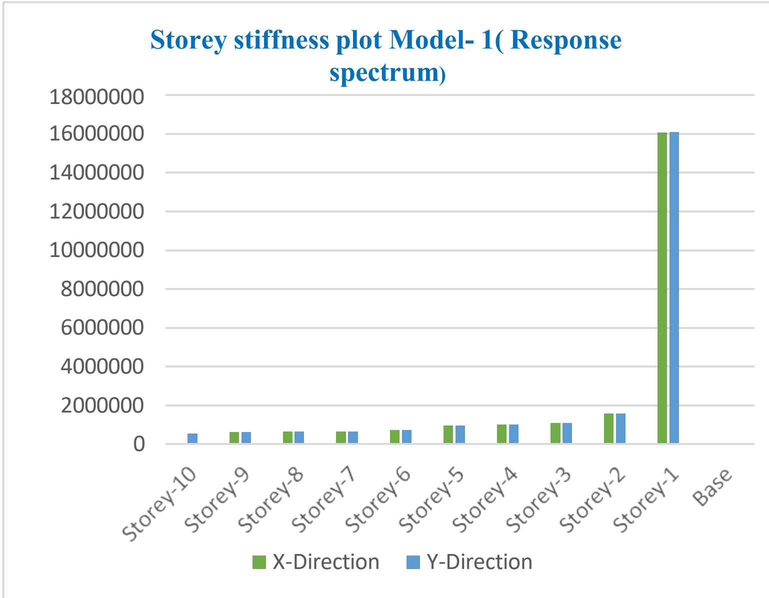


Fig.18. Storey stiffness Model-1

Table.13..Storey stiffness plot Model- 1 (Response spectrum)

Story	X-Direction	Y-Direction
Story -10	397853.384	397855.267
Story- 9	585689.143	585690.59
Story- 8	618055.848	618056.739
Story- 7	640829.376	640830.003
Story -6	714465.222	714465.884
Story -5	947629.331	947631.123
Story -4	992265.886	992271.137
Story -3	1081981.723	1082005.629
Story -2	1609342.118	1609575.942
Story -1	16151148.335	16163783.988
Base	0	0

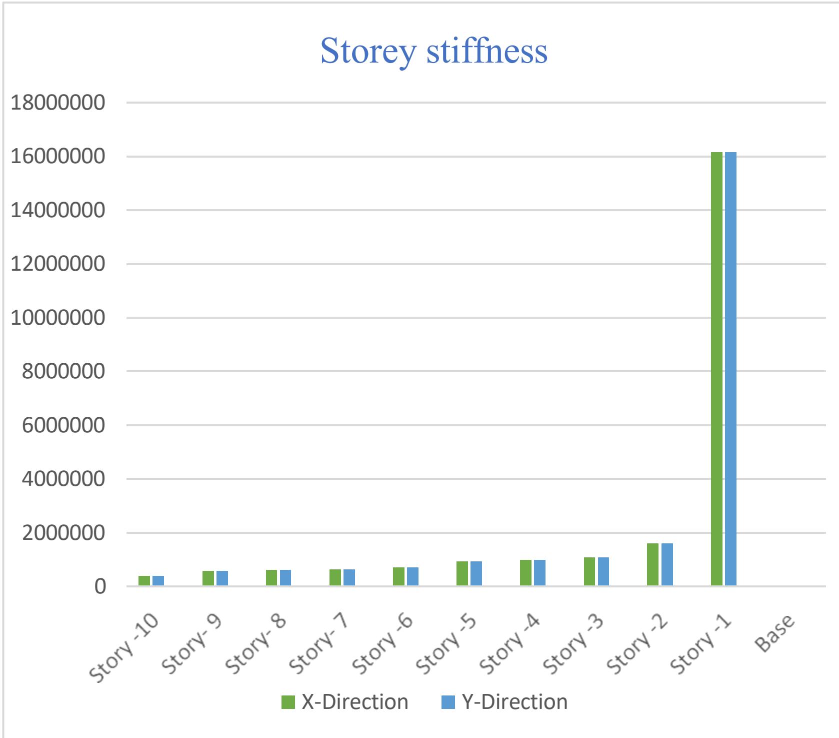


Fig.19 Storey stiffness Model-1

Model 2:Table 14. Building Parameters

Number of floors	10
Story height	5m
Support condition	Fixed at base
Slab thickness	200mm
Shear Wall thickness	200mm
COLUMN SIZE	
Storey 1-5	600mm X 600mm
Story 6-10	500mm X 500mm
BEAM SIZE	
Storey 1-5	450mm X 450mm
Storey 6-10	400mm X 400mm
Materials Characteristics	
Fck	M40
Steel-Grade	Fe 500 & Fe 250
Loads	
Live load	3 kN/m^2
Floor finishes	1 kN/m^2
Live load on roof	1.5 kN/m^2
Floor finish on roof	0.5 kN/m^2

EARTH QUAKE DATA (IS 1893 part 1: 2016)

Table 15: Earthquake parameters (IS 1893 part 1: 2016)

Zone factor, Z	Zone 5 (0.36)
Soil type	II (Medium)
Importance factor, I	1
Response reduction factor, R	5
Damping ratio	5%
Eccentric ratio	0.05

MODEL DEVELOPMENT AND DESIGN:

- Model 2:To design a Asymmetrical high rise building (T-Section) of G+9 in ETABS Software .And to make sure that building design complies with IS Codes and Standard (IS:456,1893:2015 ,IS875:2016)
- Model 2, will be used to identify the failure points and assess the structural behaviour under increased load.
- And the Model 2 will be retrofitted by using shear walls.

2. Analysis Methods

- 1.Equivalent Static Analysis.
- 2.Response Spectrum Analysis.

3. Performance Evaluation.

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4. Comparision and Analysis.

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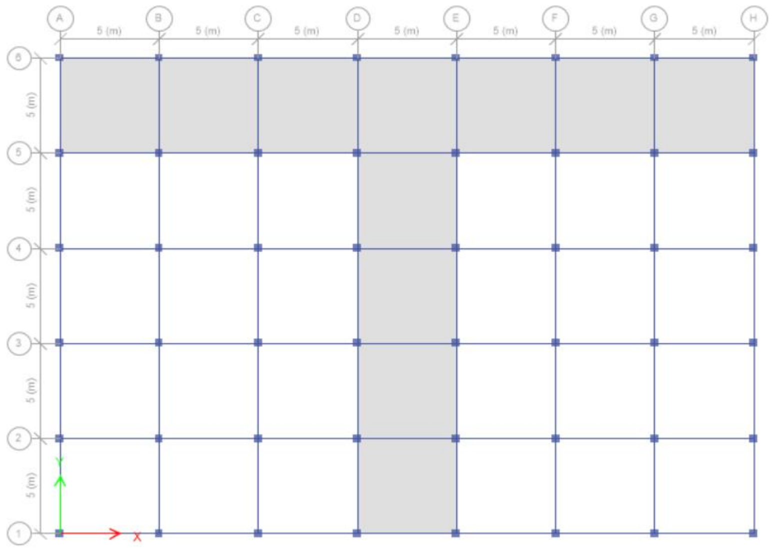


Fig 20.Plan view of Model 2

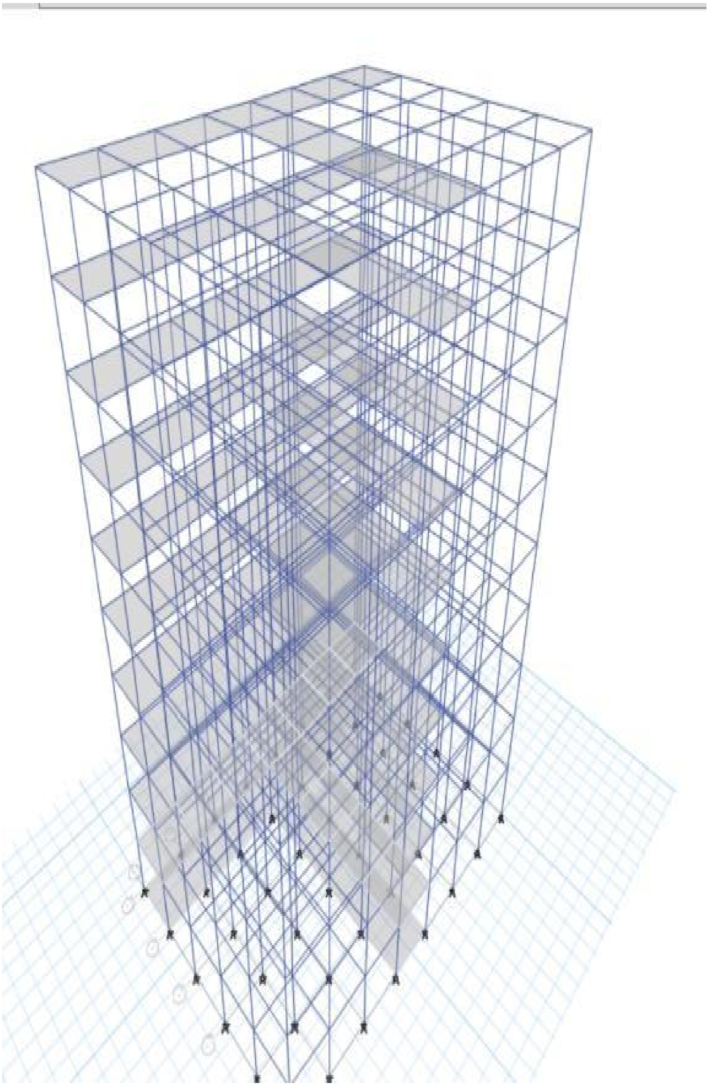


Fig.21. 3D View of Model 2

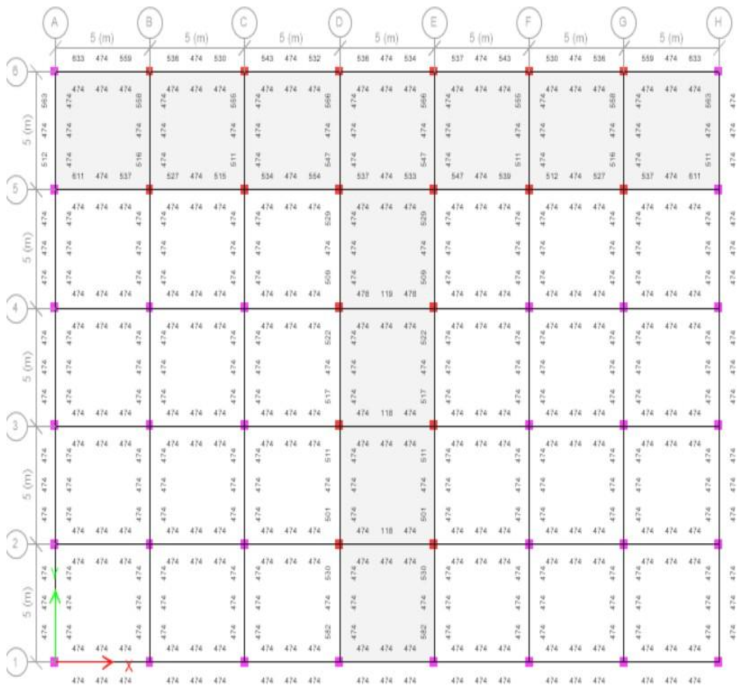


Fig.22 .Design Check Model 2.

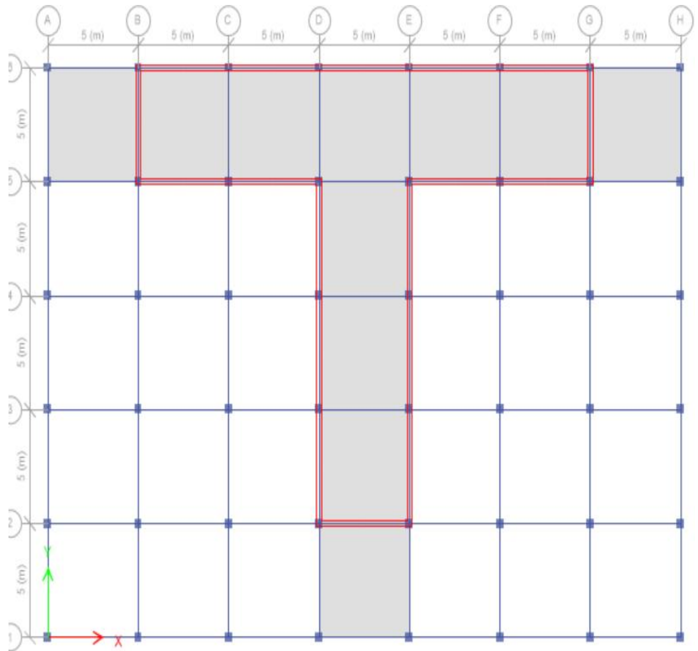


Fig.23.Plan view of Model 2 with Shear walls

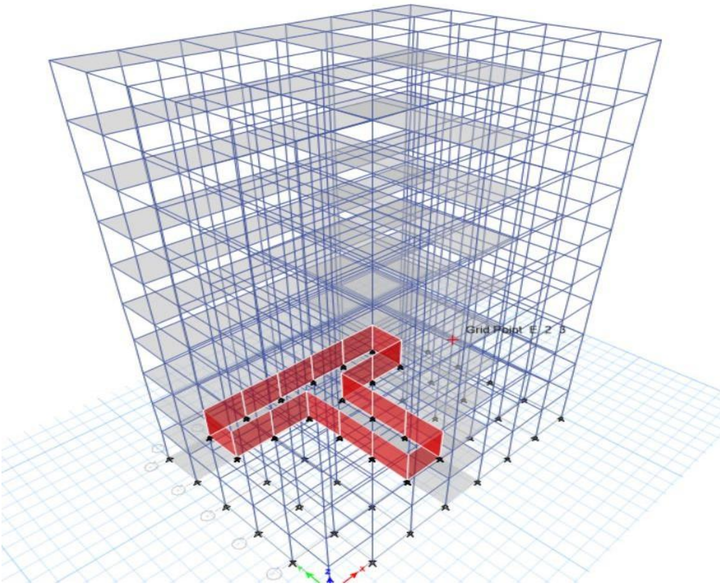


Fig.24. 3D View of Model 2 with shear walls

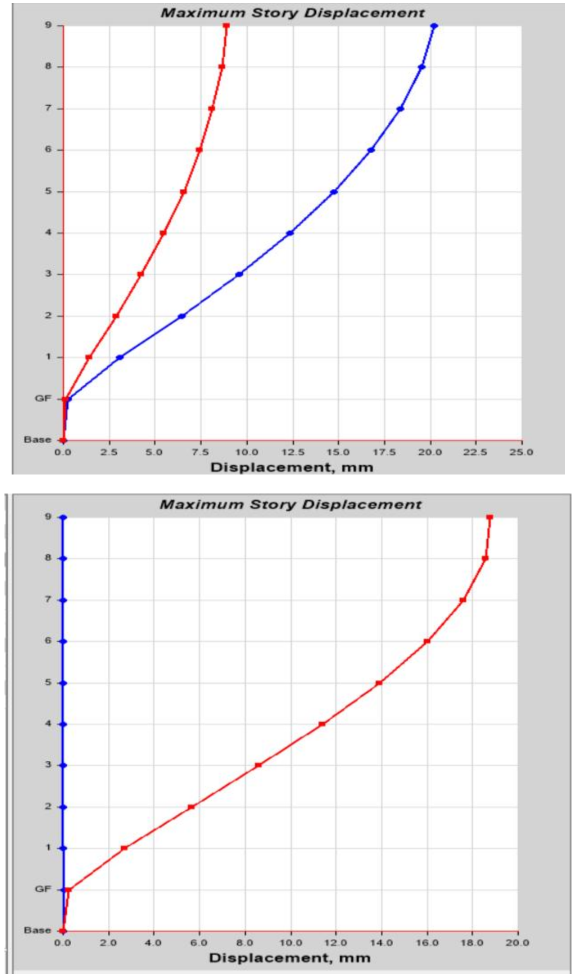
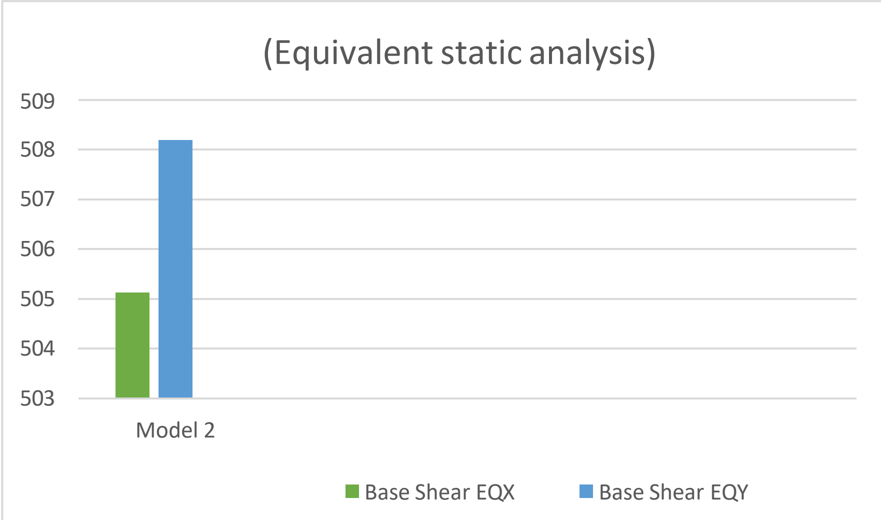


Fig.25.Max-Storey displacement for Model 2 (EQX & EQY)

Model	BASE SHEAR in (kN)	
	EQX	EQY
Model- 2	505.1264	508.1867

Table 16 Max Base Shear



Model	Max Storey Drift	
	EQX	EQY
Model- 2	0.000586	0.000565

Table.17 Max Storey Drift

Table 18. Max Base Shear(Response Spectrum Analysis)

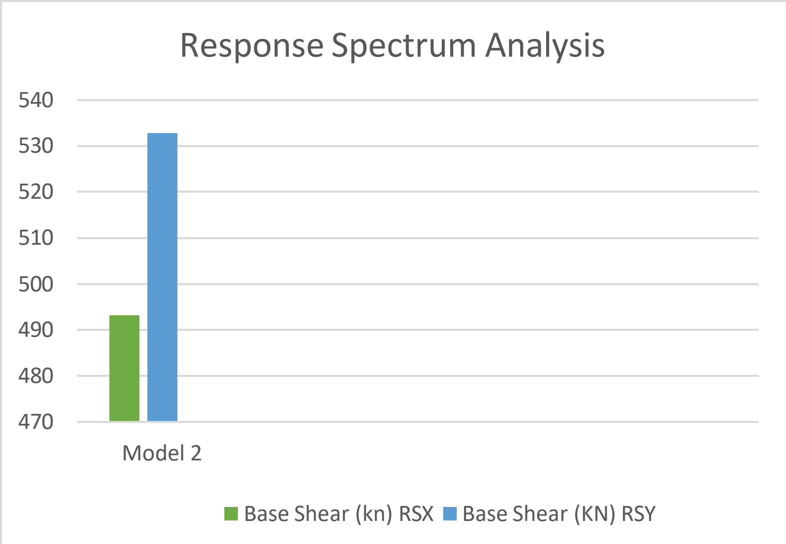


Fig :26 .Max Base shear (Response Spectrum Analysis

Table.19 Max Storey Displacement

Model	Max Storey Displacement (mm)	
	EQX	EQY
Model- 2	19.516	18.921

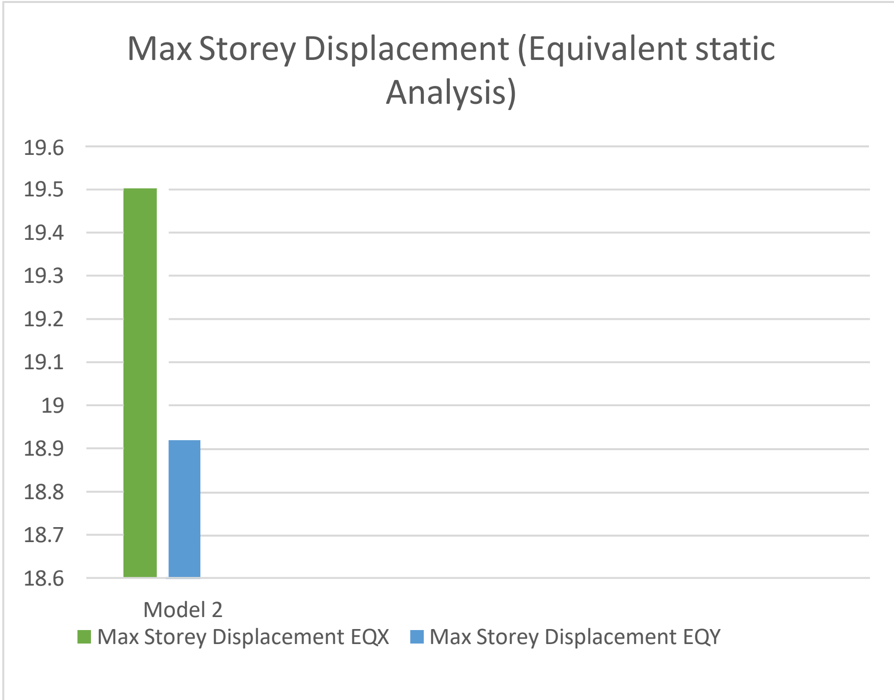


Fig :27.Max Storey Displacement (Equivalent static analysis)

Table.20.Max Storey Displacement (Response Spectrum Analysis)

Model	Max Storey Displacement (mm)	
	RSX	RSY
Model- 2	20.211	18.344

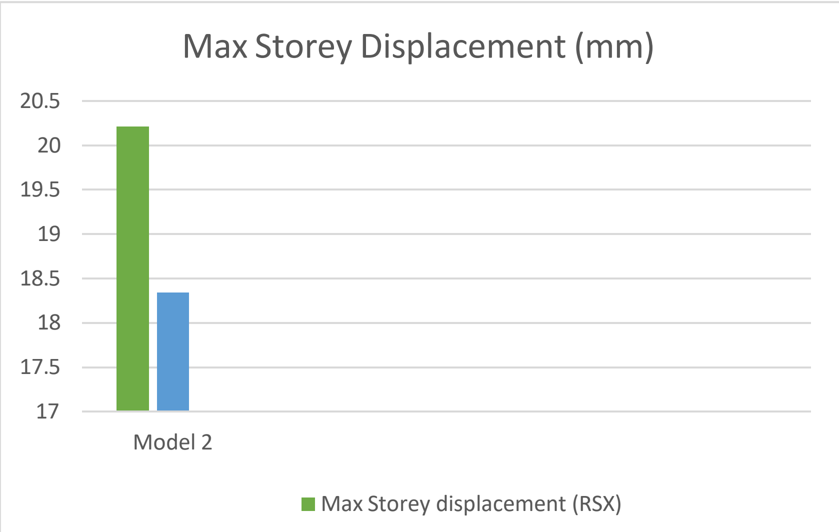


Fig :28.Max Storey Displacement (Response Spectrum analysis)

Story	X-Direction	Y-Direction
Story -10	1.16205	1.03105
Story- 9	162376.474	152290.257
Story- 8	169990.154	162352.654
Story- 7	172032.067	165482.143
Story -6	169553.235	163816.973
Story -5	167024.905	161860.129
Story -4	167793.946	163030.758
Story -3	170196.251	165946.285
Story -2	200469.066	197905.537
Story -1	4668169.401	4314336.38
Base	0	0

Table 21.Storey stiffness values Model- 2 (Equivalent static analysis)

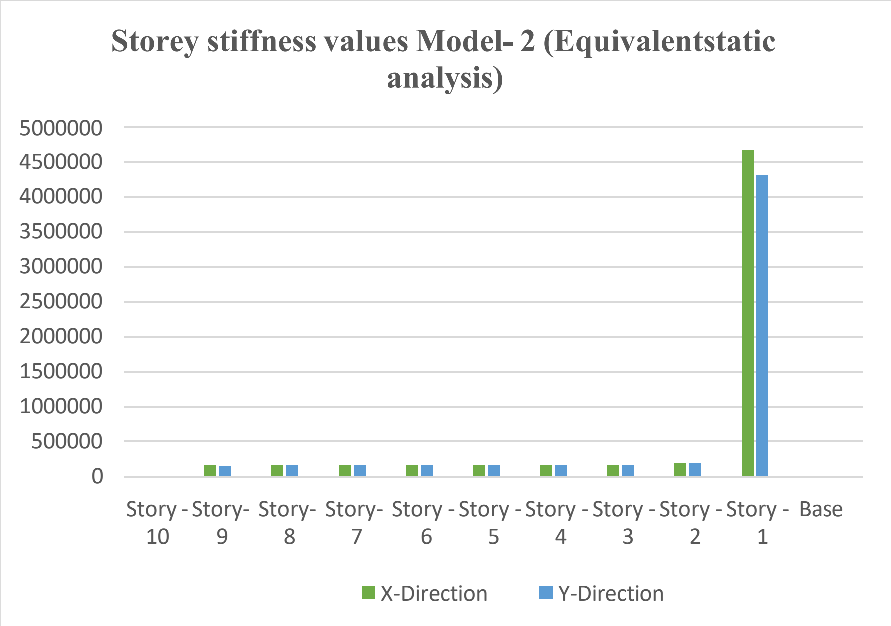


Fig :29.Max Storey Stiffness (Equivalent Static analysis)

Table 22.Storey stiffness plot Model- 2 (Response-spectrum analysis)

Story	X-Direction	Y-Direction
Story -10	150717.858	148310.651
Story- 9	161449.896	162680.943
Story- 8	162616.433	164881.802
Story- 7	163107.855	166023.989
Story -6	160259.853	163701.942
Story -5	157971.819	161924.297
Story -4	158956.027	163541.817
Story -3	161696.065	167120.518
Story -2	190850.609	199834.147
Story -1	4832729.811	4328124.539
Base	0	0

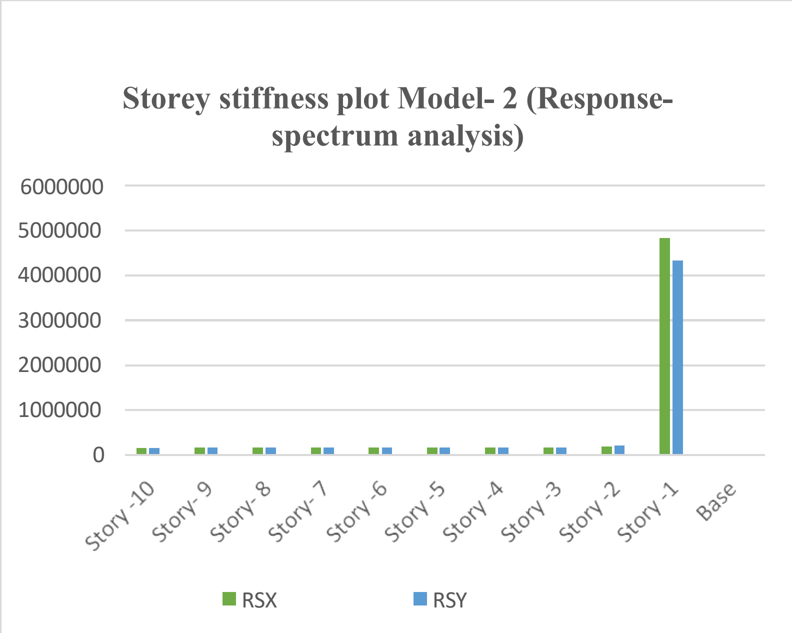


Fig :30.Max Storey Stiffness (Response Spectrum analysis)

CONCLUSION

- This analysis compares the seismic activities of the high rise building before and after retrofitting with shear wall.
- The both models (symmetric and asymmetric) were analysed and evaluated using the Static and dynamic methods.
- The symmetric high rise building retrofitted with shear walls will give more strength and improve the stability of the structure.
- In this study symmetric high rise building retrofitted with shear walls the distribution of loads will be uniform in which it gives increase in max base shear (20-50% increases), storey stiffness (40-75% increases) and decrease in storey displacement (30-60% decreases) and storey drift (30-60% decreases)..
- The Asymmetrical high rise building retrofitted with shear walls it does not have stability compared to symmetric, it shows torsional irregularities and non-uniform stiffness.
- In this study symmetric high rise building retrofitted with shear walls the distribution of loads will be uniform in which it gives increase in max base shear(30-60% increases) ,storey stiffness (50-80% increases) and decrease in storey

displacement (40-70% decreases) and storey drift(40-70% decreases).

- Asymmetrical high rise building after retrofitting shows more improve in strength and stability, but still it does not show stability as compared to the symmetric.
- But in constructing the high rise building in coastal areas a symmetric method is the best method retrofitting with using shear walls

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5. **Rahman A.S** :Seismic Response of vertically irregular RC Frames with stiffness irregularities.
6. **Anuj Chandra and Ganesh Jaiswal:** Retrofitting of structure using composite material FRP
7. **Moreno J:** Tall building system and their concept.
8. **Council on Tall Building and urban Habitat:** Structural system for tall buildings.
9. **Neville A:**Creep of concrete and Behaviour of structures.
10. **Vinay V.Gupta:** Performance based on design of RC Structures which is subjected to seismic loads using retrofitting method with steel bracing