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Optimization of Outriggers System in Highrise Buildings

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Abstract— In High rise buildings, lateral loads induced by wind & earthquake are often resisted by a shear walls. But as height of building increases , the stiffness of the structure is note as more important and introduction of outrigger beams connect to the central core walls and external columns. It is provide sufficient lateral stiffness to the structure. In this paper, analysis of High rise building is carried out to find the optimizing position of outrigger system by using lateral loads. The model is analyzed in ETABS. The objective of this paper was to optimize the outrigger location. Comparing when Two , Three & Four no. of outriggers located in the structure. From the analysis, To find out result that the performance of the outrigger was efficient and three optimum position of outrigger has been found i.e. at mid height of building, second at Ht/3 and third at Ht/4 of building. In which one outrigger fixed at terrace floor.

Index Terms— RCC + Steel Structure building, Control stiffness, storey Drift & Displacement, Optimum Outrigger

1 INTRODUCTION

The major factor that affects the design of High-rise structures is its sensitivity to the lateral load. One of the important criteria for the design of High-rise buildings is lateral drift at top. Structural system like moment resisting frame & shear wall gives primary need of building but as building as height increases there lateral load i.e. wind and earthquake effects on building structure. Two categories of structural system i.e. Interior structures and Exterior structures. When the maximum part of the lateral load resisting system is located within the internal in perimeter of the building it is called as interior structure and if the maximum part of the lateral load resisting system is located at the building perimeter, a system is categorized as an exterior structure. Recently, belt truss and outrigger system is widely used to reduce lateral drift & displacement. The placement of outrigger trusses increases the effective depth of the structure and significantly improves the lateral stiffness under lateral load.

The outrigger structural systems not only pro-efficient in controlling the top displacements but also plays good role in reducing the drift of stories. The outrigger systems can produce in any combination of steel members, concrete , Concrete core and composite construction. Outrigger trusses increases the effective depth and significantly improves the lateral stiffness under lateral load. Outrigger may connected to all side of central core to peripheral columns of building.

Objectives:
1) To obtain the optimized location of outrigger to reduce lateral drift.
2) To obtain the optimized location of outrigger to reduce lateral displacement.
3) To compare building with or without outrigger system.

2 WORK CARRIED OUTN

A Basement + 2Parking + 40Floors + Terrace reinforced concrete building was analysed using ETABS software. The lateral loads to be applied on the buildings were based on the Indian Standard. Building was analysed under wind and earthquake loads as per the recommendation of IS: 875 (Part III) 1987 & IS 1893 (Part I) 2002 resp. The building was analysed for Pune city considering its respective seismic zone III wind speed. To improve the performance of building in lateral load outrigger trusses are provided. The analysis was carried out for building with central core connected by outrigger with peripheral outrigger connected of 300mm thick concrete wall upto 10th floor & upto Terrace 450mm thick concrete wall provided at each floor from bottom to top respectively.

After running analysis for without outrigger system the maximum deflection & drift of building were calculated. To find the position of outrigger system, two number of outrigger system were located at top & center of building & it is analyzed that maximum deflection & drift reduction at level of outrigger system provided.

Then to find second position of outrigger first outrigger were fixed at its position and second outrigger were provided at each floor from bottom to top respectively and maximum deflection reduction were calculated. Same procedure were followed for minimizing displacement & drift by providing different position of outrigger system where outrigger provided by dividing building equally by three & four parts respectively. Comparative graphs have been plotted for building with and without outrigger.

Modelling:

Building consists of reinforced concrete flat slab model without drop and column head. The model is regular shaped symmetrical plan with dimensions 45m x 45m and Basement + 2Parking + 40Floors + Terrace. The plan has centrally located concrete core of size 9m x 9m. The storey height is assumed to be 3m. The three dimensional analysis for the model is carried out. After performing the wind and seismic analysis on building model deflection and drift result where evaluated. To control deflection and drift outrigger were provided in the building and their positions were calculated for maximum deflection reduction.

Sr. No.	Description	Parameter
1	Plan Of Building	45M X 45M
2	Height Of Building	138.4m
3	No. Of stories	45
4	Floor to Floor height	3m
5	Seismic Zone	III
6	Basic Wind Speed	44m/ s
7	Steel Section Size	
	Angular	ISMB350
	Horizontal	ISMB450
8	Column Size	
	Base to 10th	C600 X 1200
	11th to 20th	C500 X 1200
	21st to 30th	C450 X 1200
	31st to Terrrace	C400 X 1200
9	Core Beam Size	B300 X 600
10	Core Wall width	
	Base to 10th	450mm
	11th to Above	300mm
11	Thickness of Slab	200mm
12	Type Of main steel	Fe500
13	Type Of distribution steel	Fe415
14	Grade Of Concrete	
	Column	M50
	Beam	M40
	Slab	M35

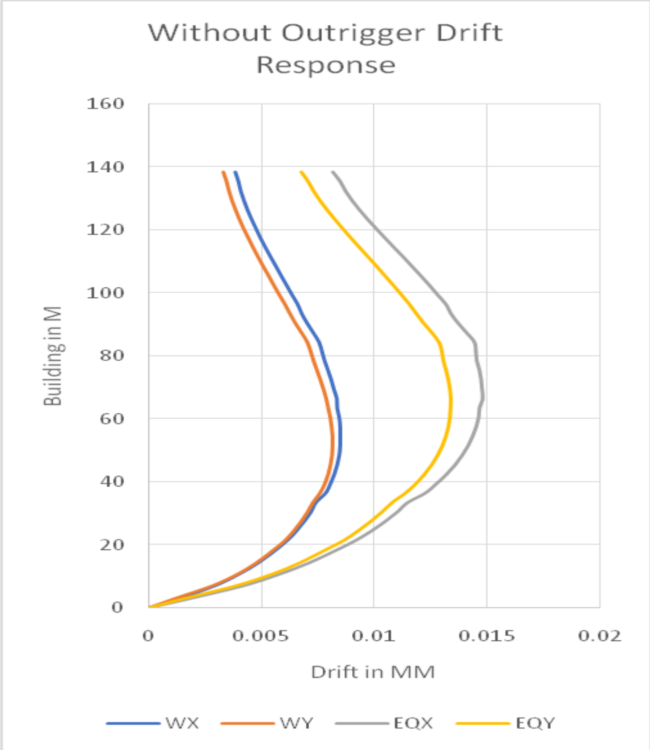
Project Description

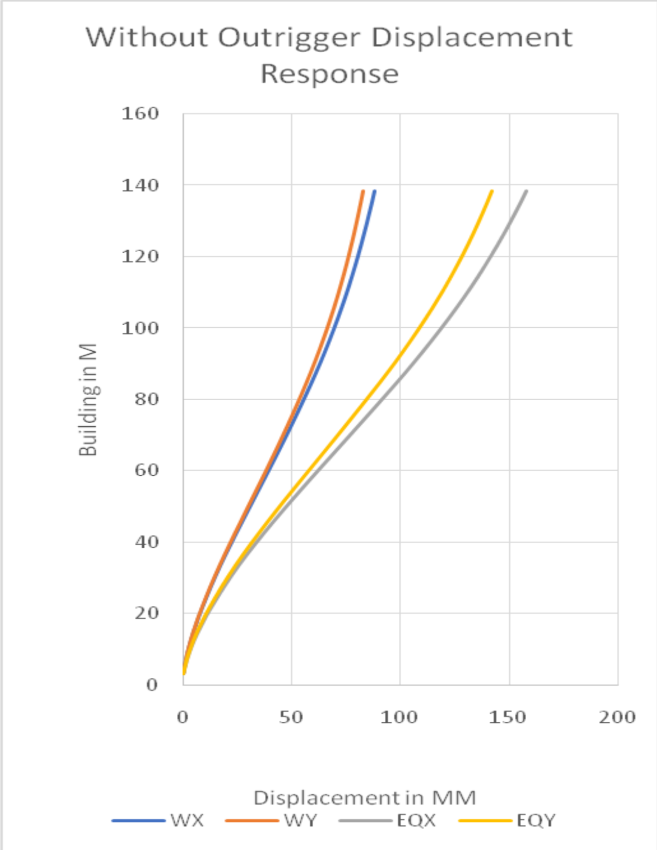
RESULTS:

Building deflection has been studied for various load cases for building without outrigger and building with outrigger system using ETABS software. The objective of this paper is to see the variation of load-displacement and storey drift graph and check the displacement of the building. The results obtained from analysis are compared and discussed as follows.

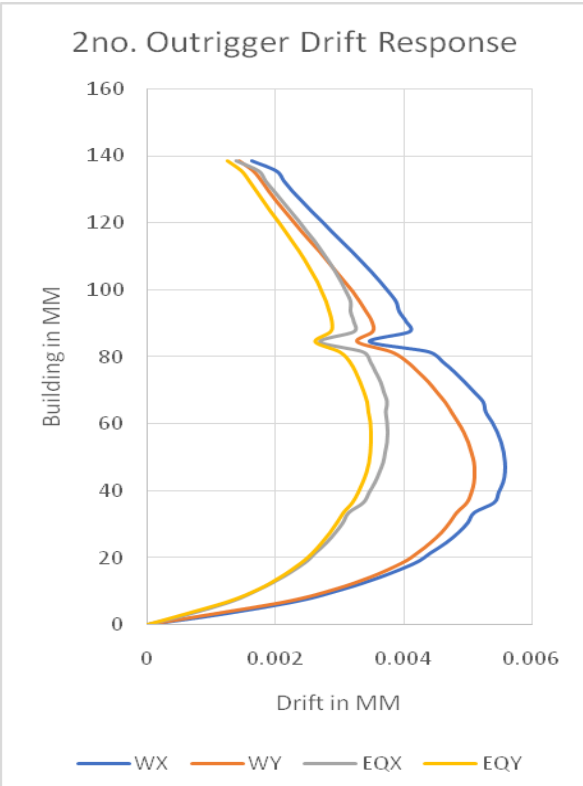
A.MAXIMUM DISPLACEMENT & DRIFT IN WINDX,

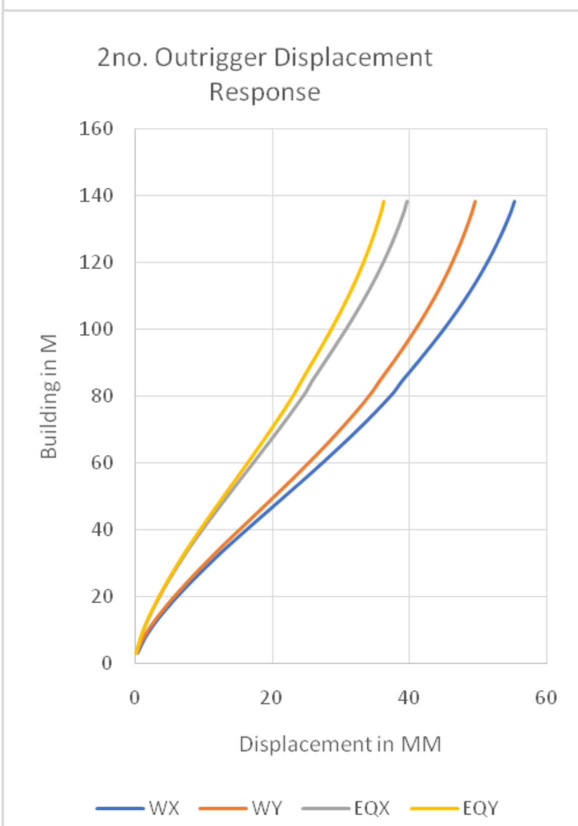
WINDY & EQX, EQY FOR WITHOUT OUTRIGGER SYSTEM



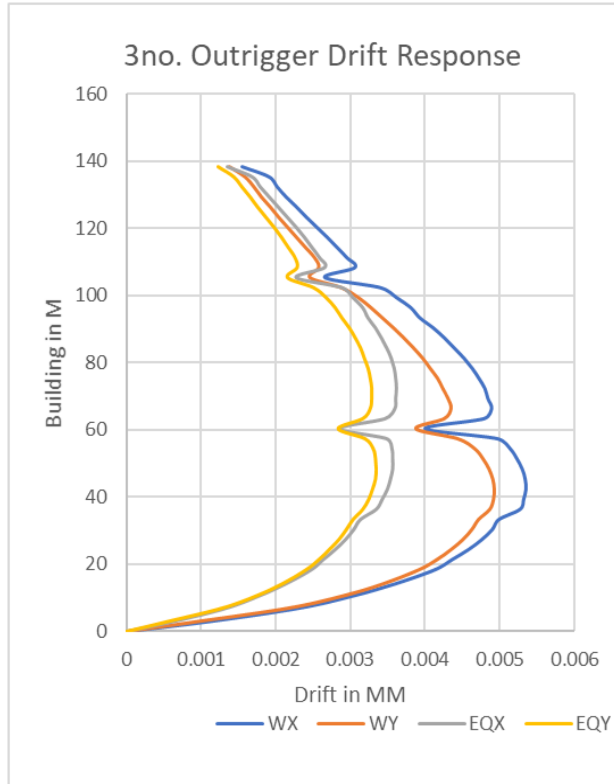


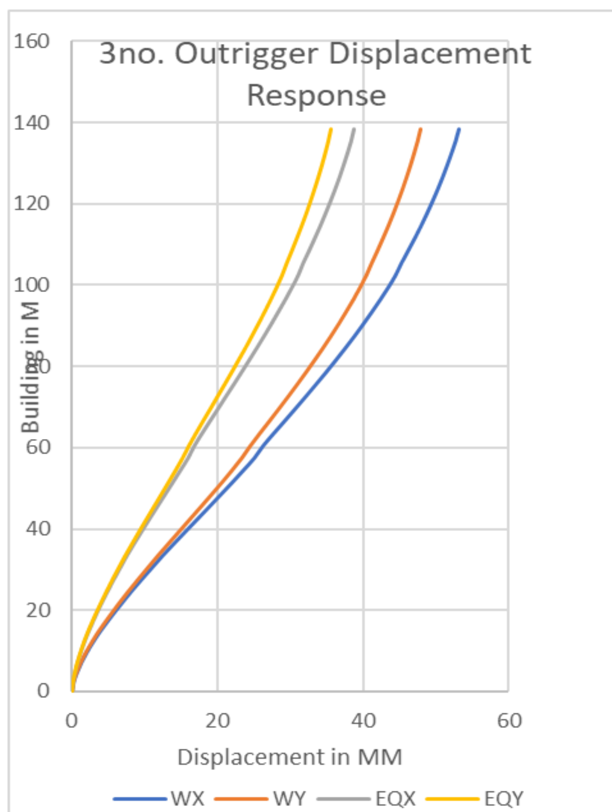
B. MAXIMUM DISPLACEMENT & DRIFT IN WINDX, WINDY & EQX, EQY FOR 2NOS OUTRIGGER SYSTEM



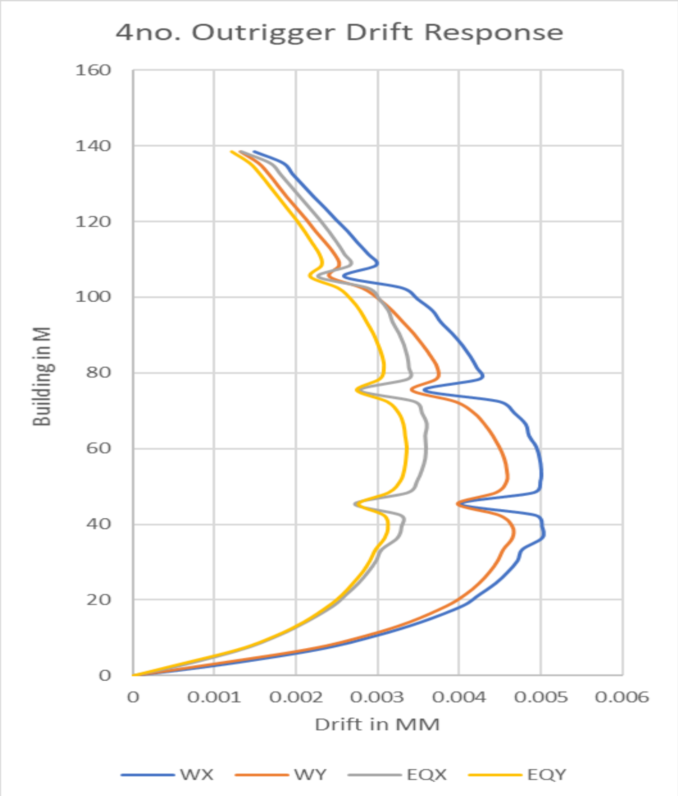


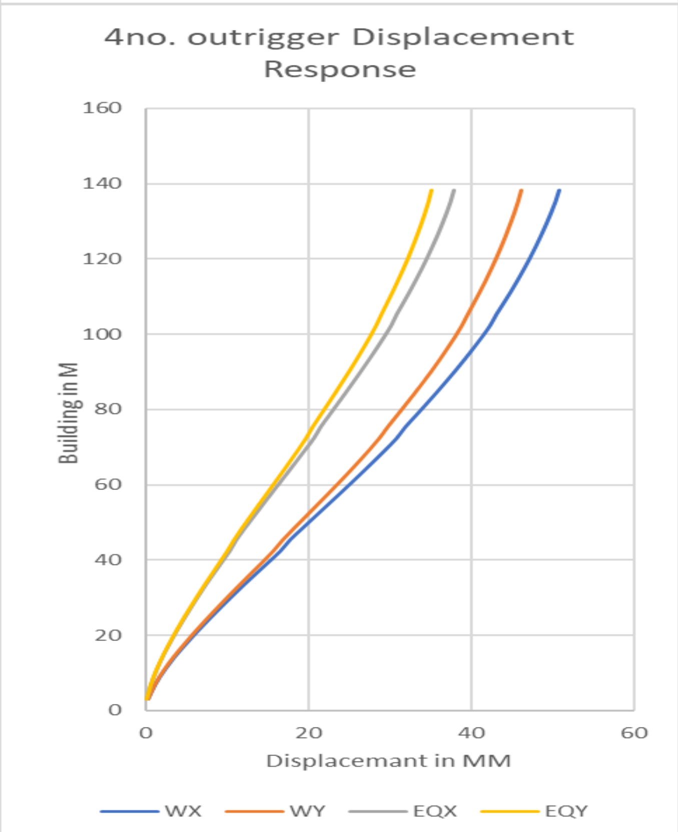
C. MAXIMUM DISPLACEMENT IN WINDX,WINDY &EQX,EQY FOR 3 NOS OUTRIGGER SYSTEM





D. MAXIMUM DISPLACEMENT & DRIFT IN WINDX, WINDY & EQX, EQY FOR 4 NOS OUTRIGGER SYSTEM





Conclusion

1. The maximum deflection at the top of structure when only flat slab with core is employed is around 625.7mm and this is reduces up to 411.18mm by providing first outrigger at mid height of structure i.e. 29.45% deflection reduction occurs for first position of outrigger.
2. The maximum deflection at top of structure reduces up to 335.15mm by providing second outrigger at 3/ 4th height of structure i.e. 43.94% deflection reduction occurs for second position of outrigger.
3. The maximum deflection at top of structure reduces up to 272.77mm by providing third outrigger at 1/ 3rd height of structure i.e. 54.98 % deflection reduction occurs for third position of outrigger. The Axial force goes on decreasing as infill wall with different openings like corner and centre are provided.
4. The use of outrigger structural systems in high-rise buildings increases the stiffness and makes the structural form efficient under lateral load.
5. Outrigger system is not only proficient in controlling the overall lateral displacement but also very capable of reducing the inter-storey drifts in tall building.

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