The study of effectiveness of Outrigger system on Vertical Irregularity

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Abstract: Lateral forces are the most important factors to be considered when it comes to controlling lateral deflection of the building. And for that several lateral load resisting systems have been implemented in the field since years. Outrigger system has been found to be one of the most effective system and hence are used worldwide. In present study, G+60, G+70, G+80 story studied with different location of outrigger i.e. 0.2H+0.4H, 0.4H+0.6H,0.4H+0.8H, 0.4H+1.0H in Zone V and Medium Soil with Regular and Irregular (Vertical) Structure. Dynamic wind analysis and Response Spectrum analysis was carried out. Parameters to be considered Maximum storey displacement and Base Shear. Modelling and Analysis was done using ETABS 2016.

***Index Terms* - Outrigger and belt truss system, Shear wall, Gust Factor, Response Structure Analysis.**

I. INTRODUCTION

In Outrigger structural system encompass of a central core wall either shear wall or braced frames with outrigger truss connecting between core and the peripheral columns. These are the horizontal members designed to control overturning moment and stiffens the building by fastening the core to the exterior column through stiff horizontal members referred as a outrigger member, whereas core acts a single redundant cantilever beam for lateral forces and hence battle the rotation at the top by stretching and shortening action results in tensile and compressive action consequentially restoring couple by combating twisting of core thus cap truss be positioned as a restraining spring at the apex which considerable reduces the lateral deflection and base moments. The Victoria office tower (1965) is the first outrigger structural system designed by Nervi and Morerri. These outrigger systems are very popular among tall structures.

In the conventional outrigger system, the outrigger trusses or girders are connected directly to shear walls or braced frames at the core and to columns located outboard of the core. Generally, but not necessarily, the columns are at the outer edges of the building. The number of outriggers over the height of the building can vary from one to three or more. The outrigger trusses, which are connected to the core and to columns outboard of the core, restrain rotation of the core and convert part of the moment in the core into a vertical couple at the columns. Shortening and elongation of the columns and deformation of the trusses will allow some rotation of the core at the outrigger. In most designs, the rotation is small enough that the core undergoes reverse curvature below the outrigger.

In the virtual outrigger also knows as belt truss system, outrigger trusses connected directly to the core and to outboard columns are eliminated and outrigger trusses are connected between peripheral column of building to use floor diaphragms, which are typically very stiff and strong in their own plane, to transfer moment in the form of a horizontal couple from the core to trusses or walls that are not connected directly to the core.

II. OBJECTIVES

- To find Response of structure under seismic load. (Response Spectrum Analysis)
- To find Response of structure under dynamic wind load. (Gust Factor)
- To find Optimum location of the single Outrigger from 0.2H, 0.4H, 0.6H, 0.8H and 1.0H.
- To analysis (Parameter - Maximum Storey Displacement, Base Shear) the Structure with Double outrigger system for regular and Irregular (Vertical irregularity) Structure.

III. LITERATURE REVIEW

[2]Errol Dsouza, Dileep Kumar, investigated that the outriggers which are X shaped braced showed lesser displacement when compared to that V shaped braced outriggers. The drift of the structure was reduced up to 30% when provided with outrigger system.

[5]Prajyot A. Kakde, Ravindra Desai investigated that This paper depicts that the top story deflection by wind analysis of the outrigger at 0.2H, 0.4H, 0.6H & 0.8H has resulted in 25.99 % (For Concrete Outrigger) & 29.71 % (For Steel Outrigger) reduction in displacement.

[9]Sreelekshmi. S, Shilpa Sara Kurian, investigated that Structure provided with concrete outrigger and belt truss structural system shows significant variation in lateral displacement for L shaped structured with reduction of 19.41 % in Y direction provided with concrete outrigger at the mid height of the structure than the steel outrigger.

[7]Shivacharan K, Chandrakala S, Narayana G, Karthik N. M, investigated that 29.8% and 36.9% of the deflection and drift is controlled by providing outrigger at 0.67 height compared to bare frame.

IV. METHODOLOGY

In present work the analysis of following structure with different location of outrigger system has been carried out.

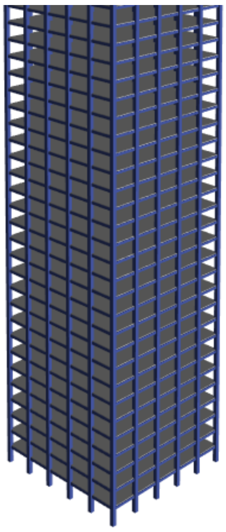
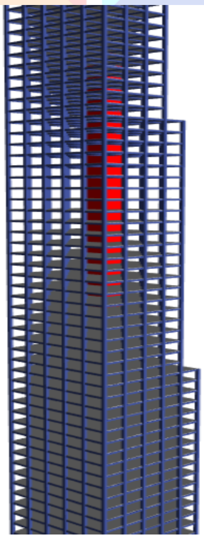
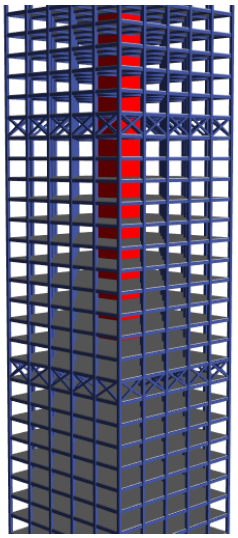
i) Bare Frame (Regular structure and Vertical Irregular Structure)
ii) Regular Structure with Outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H
iii) Vertical Irregular Structure with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H

The plan areas of the all structures are same for the analysis; also, the beam and column dimensions are same. The materials such as Poisson ratio, Density of RCC, Density of Masonry, Young's modulus, compressive strength of steel and concrete etc. are kept constant in all buildings.

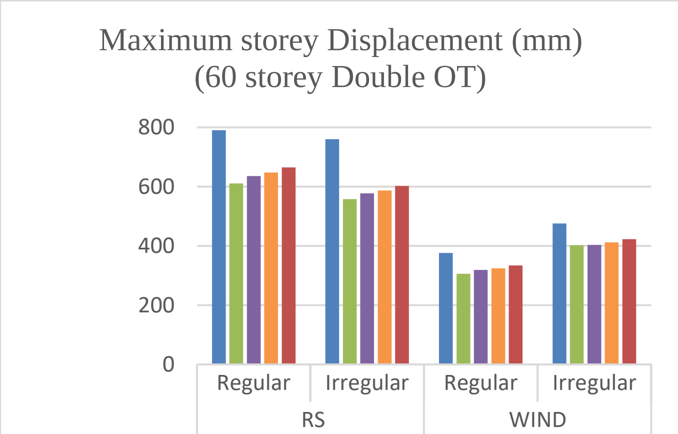
Comparison of the parameters considered in the study of regular as well as the irregular type structures.

- Dynamic wind analysis is carried out for soil condition II.
- The Response spectrum analysis for Zone V and soil II.
- The result parameter includes the Base Shear, Displacement

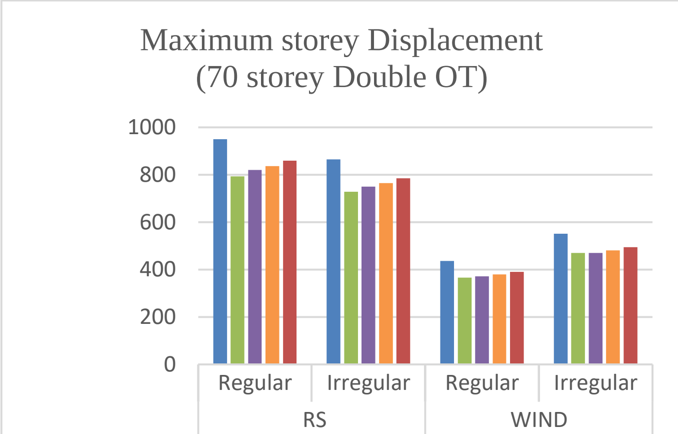
	60 Storey	**70 Storey**	**80 Storey**
Column	500mm X 500mm	700mm X 700mm	900mm X 900mm
Beam	230mm X 450mm	230mm X 450mm	300mm X 550mm
Outrigger Section	300mm X 300mm	300mm X 300mm	300mm X 300mm
Slab Thickness	150 mm	150 mm	150 mm
Wall Thickness	230 mm	230 mm	300 mm
Concrete Grade	M30	M30	M30
Steel	Fe500	Fe500	Fe500
Wind Load :			
City	Bhuj	Bhuj	Bhuj
Design Speed	50 m/s	50 m/s	50 m/s
Terrein Category	3	3	3
Class	B	B	B
Earthquake Load :			
Earthquake Zone	V (0.36)	V (0.36)	V (0.36)
Importance Factor	1	1	1
Type Of Soil	Medium	Medium	Medium
Reduction Factor	5	5	5
live Load	3 kN/m^2	3 kN/m^2	3 kN/m^2
Floor finish Load	1.5 kN/m^2	1.5 KN/M2	1.5 kN/m^2

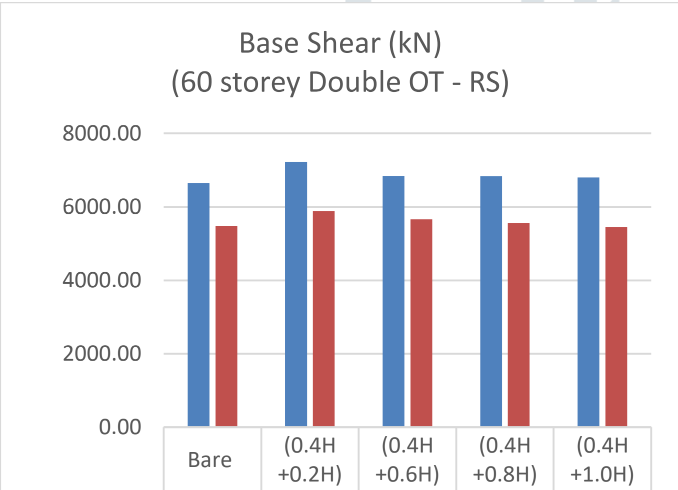
V. Results



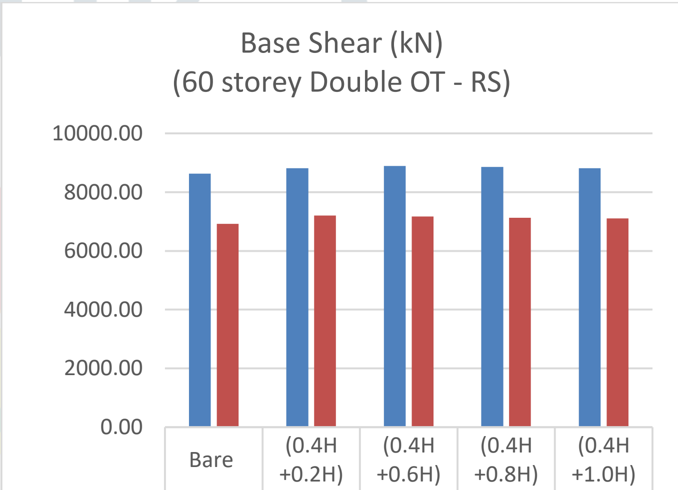
	RS Regular	RS Irregular	WIND Regular	WIND Irregular
Bare	790.43	760.89	376.140	475.640
(0.4H+0.2H)	611.1	558.03	306.098	402.640
(0.4H+0.6H)	635.77	577.58	318.843	403.6
(0.4H+0.8H)	647.55	587.6	325.29	412.28
(0.4H+1.0H)	665.44	602.16	334.39	423.474



	RS Regular	RS Irregular	WIND Regular	WIND Irregular
Bare	950.61	865.00	437.150	552.470
(0.4H+0.2H)	794.38	729.4	367.230	470.890
(0.4H+0.6H)	820.53	751.1	372	470.26
(0.4H+0.8H)	836.78	765.55	380.24	481.49
(0.4H+1.0H)	859.83	785.03	390.97	495.16



	Bare	(0.4H +0.2H)	(0.4H +0.6H)	(0.4H +0.8H)	(0.4H +1.0H)
Regular	6655.46	7232.07	6845.40	6832.31	6804.67
Irregular	5489.92	5887.63	5657.00	5560.47	5449.92



	Bare	(0.4H +0.2H)	(0.4H +0.6H)	(0.4H +0.8H)	(0.4H +1.0H)
Regular	8636.06	8817.00	8892.93	8865.90	8821.56
Irregular	6920.35	7210.99	7174.74	7130.18	7104.99

VI. Conclusion

- It is found that result of displacement in regular building is 22.69%. 19.57%, 18.08%, 15.81% for 60 storey will be lower in case of building with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H respectively for response spectrum.
- It is found that result of displacement in regular building is 16.48%. 13.68%, 11.97%, 9.55% for 70 storey will be lower in case of building with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H respectively for response spectrum.
- It is found that result of displacement in irregular building is 26.66%. 24.09%, 22.77%, 20.86% for 60 storey will be lower in case of building with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H respectively for response spectrum.
- It is found that result of displacement in irregular building is 15.68%. 13.17%, 11.50%, 9.25% for 70 storey will be lower in case of building with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H respectively for response spectrum.
- It is found that result of displacement in regular building is 18.62%. 15.23%, 13.52%, 11.10% for 60 storey will be lower in case of building with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H respectively for dynamic wind analysis.
- It is found that result of displacement in regular building is 15.99%. 14.90%, 13.02%, 10.56% for 70 storey will be lower in case of building with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H respectively for dynamic wind analysis.
- It is found that result of displacement in irregular building is 15.35%. 15.15%, 13.32%, 10.97% for 60 storey will be lower in case of building with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H respectively for dynamic wind analysis.
- It is found that result of displacement in irregular building is 14.77%. 14.88%, 12.85%, 10.37% for 70 storey will be lower in case of building with outrigger at 0.4H+0.2H, 0.4H+0.6H, 0.4H+0.8H, 0.4H+1.0H respectively for dynamic wind analysis.

REFERENCES

1. Abdul Karim Mulla and Srinivasan B. N (2015). "A Study on Outrigger System in tall R. C Structure with Steel Bracing" International Journal of Engineering Research and Technology ISSN 2778-0181 Volume: 04 Issue: 07
2. Errol Dsouza and Dileep Kumar (2017). "A Study on Outrigger System in Seismic Response of Tall Structures Non-Linear Analysis". International Journal of Innovative Research in Science, Engineering and Technology, ISSN 2347-6710 Vol.6 No.8.
3. Goman wai-Ming Ho and Arup (2016)." The Evolution of Outrigger System in Tall Buildings" International Journal of High-Rise Building, Vol.5 No.1.
4. Pradeep K M and M.R. Suresh (2015). "Influence of Outrigger System in RC Structures for Different Seismic Zones." International Journal for Scientific Research & Development, ISSN 2321-0613 Vol.3 No.5.
5. Prajyot A. Kakde and Ravindra Desai. (2017). "Comparative Study of Outrigger and Belt Truss Structural System for Steel and Concrete Material". International Research Journal of Engineering and Technology, ISSN 2395-0072 Vol.4 No.5.
6. Raksha M. N. and Shilpa B. S. (2016). "Study of Outrigger RC Frame with Plan Irregularities Subjected to Seismic Loading" International Research Journal of Engineering and Technology, ISSN 2395-0072 Vol.3 No.7.
7. Shivacharan K, Chandrakala S, Narayana G and Karthik N. M. (2015). "Analysis of Outrigger System for Tall Vertical Irregularities Structure Subjected to Lateral Load." International Journal of Research in Engineering Research and Technology, ISSN 2321-7308 Vol.4 No.5.
8. Shruti B. Sukhdeve (2016). "Optimum Position of Outrigger in G+40 RC Building" International Journal of Science, Technology and Engineering, ISSN 2349-784X Vol.2 No.10.
9. Sreelekshmi. S and Shilpa Sara Kurian (2016). "Study of Outrigger System for High Rise Buildings." International Journal of Innovative Research in Science, Engineering and Technology, ISSN 2347-6710 Vol.5 No.8.
10. Suresh, Bhanupriya and Ramakrishnaiah (2017). "Influence of concrete and steel Outrigger and belt truss in high rise moment resisting frames" International Research Journal of Engineering and Technology, ISSN 2395-0072 Vol.4 No.11.