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Study on Behaviour of Outrigger System on High Rise Structure by Varying Outrigger Depth in Seismic Zones of India by Using Staad Pro

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Abstract: Tall building development is rapidly growing almost everywhere in the world acquainting new difficulties that need to be met with, through engineering evaluation. In tall buildings, lateral loads generated by earthquake or wind load are frequently resisted by providing coupled shear walls. But as the height increases, the building becomes taller and the efficiency of the tall building greatly depends on lateral stiffness and resistance capacity. So, a system called outrigger is introduced which improves overturning stiffness and strength by connecting shear wall core to outer columns. When the Structure is subjected to Lateral forces, the Outrigger and the columns resist the rotation of the core and thus significantly reduce the lateral deflection and base moment, which would have arisen in a free core. During the last three decades, numerous studies have been carried out on the analysis and behavior of outrigger structures. But this question is remained that how many outriggers system is needed in tall buildings. (Using Staad-Pro)

Index Terms - couple Shear wall core, outrigger depth, rotation, stiffness, strength lateral load

I. Introduction

The never ending human quest to reach the sky has developed far more from its historical advancements. Continuous research in the field of materials, construction technology and development of analysis soft-wares and operating systems has facilitated the construction of the modern marvels of the 21st century. These tall buildings have come to define human dominance and have essentially become a symbol of status and social & economic well-being of a country. Though fancy on the outward, high-rise buildings are a result of pioneering architecture, calculated engineering and shear hard-work. As the height of building increases, it is subjected to the action of lateral (horizontal) loads – seismic forces and wind forces. Intensity of seismic forces varies with the location of the building. Wind forces increase parabolically with the height of the building. Seismic forces are more intense in comparison to wind forces, but are shorter in duration. Apart from the vertical loads (dead and imposed loads), tall buildings are essentially designed to resist the lateral loads acting on these buildings.

OUTRIGGER STRUCTURAL SYSTEM:

The outrigger structural system is a lateral load resisting system in which the external peripheral columns are tied to the central core with very stiff outriggers and belt truss at or more levels. The belt trusses are tied to the peripheral columns of the building while the outriggers engage them with main or central shear wall. This structural system is commonly used as one of the structural systems to efficiently control excessive drift due to lateral load, so that during small or medium lateral load due to either wind or earthquake, the risk of structural and non-structural damage is minimized. The structural response of an outrigger system is based on tension-compression couple induced in the outer columns.

The outrigger acts as a stiff arm engaging outer columns and central core. The lateral load when induced in the central core is transferred to peripheral columns via outriggers and the overturning moment reduced. For high-rise buildings, particularly in seismically active zone or wind dominant regions, outrigger system is chosen to be appropriate structural system. Outrigger structural system is broadly classified into the following:

1] Conventional outrigger system: In this system, the outrigger trusses or girders are connected directly to shear walls or braced frames at the core and to the columns located at the periphery of the structure.

2] Offset outrigger system: In offset outrigger system, the outriggers are located elsewhere than in the planes of the core walls while retaining all the advantages and mitigating some of the disadvantages of the conventional outrigger system.

3] Virtual outrigger system: In virtual outrigger system the transfer of overturning moment from core to peripheral columns is achieved without a direct connection between the peripheral columns and the core. This is achieved using floor diaphragms which transfer overturning moment in the form of a horizontal couple from core to the outboard. A belt truss connecting the peripheral is also added.

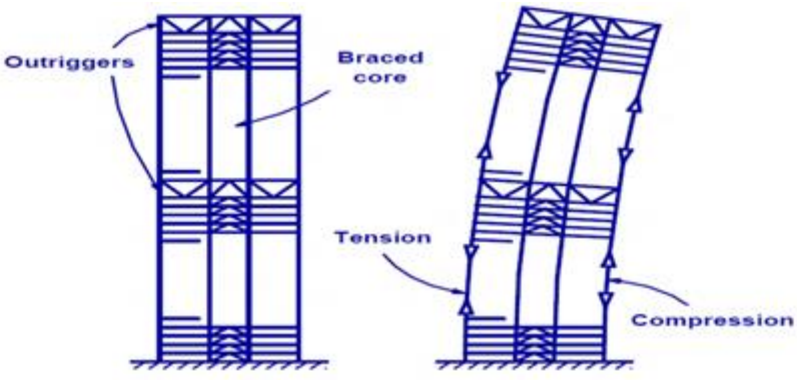

Figure1: Working of outrigger system

AIM AND OBJECTIVE

The objective is to study the behavior of outrigger, analyses of models for main governing factors like earthquake load and wind load with varying of outrigger depth, and optimization of outrigger depth.

In present study, Multi-storey 3D structures are modeled in STAAD-Pro software. The behaviour of the outrigger with static analysis of the outrigger with the varying depth of outrigger is studied. The structure with shear wall core and structure with outrigger system of varying outrigger depth are compared.

LIERATURE REVIEW

For the proper functioning of our project I have undergone various national and international papers published. The summary of some important papers gone through are as below.

Andrew J. Horton in 'Virtual Outriggers in Tall Buildings' has given an elaborate overview of conventional, offset and alternative offset outriggers. His paper concludes that virtual outriggers can be used with the same efficiency as conventional outriggers when efficiently proportioned perimeter belt truss and floor diaphragms are used.

Smith and Coull made a hypothetical assumption that the outriggers are flexrally rigid and devised for the optimum – the outriggers should be placed at 1/(n+1), 2/(n+1), up to the n/(n+1) height locations, i.e. for one-outrigger structure at approximately half-height, for two-outrigger structure at one-third and two-third height, for three-outrigger structure at one-quarter, one-half and three-quarter heights, and so on.

R Shankar Nair [1] explained the advantages of virtual outrigger system over the conventional type and explained the ways of using virtual outrigger system. The paper compared lateral displacement of 75 - storey model subjected to wind load for different structural designs.

Po Seng Kian and Frits TorangSiahaan[2] studied the use of outrigger and belt truss system in high-rise concrete buildings of 40 and 60 storey's subjected to wind and seismic load. The paper concluded that the use of outrigger and belt-truss system in high rise buildings increases the stiffness and made structural form efficient under lateral loads.

CONCLUSION

Following are the key observation of above literature review

Tall building case lateral load generated by earthquake or wind load this resisted by providing couple shear wall. It improve overturning stiffness and strength by connecting shear wall core to outer Colum so that lateral load induced in central core transferred to Colum through outrigger

After modeling in design load as per IS 875 and seismic forces as per Indian standard 1893 :(Part-1)-2016 is applied over the structure in Staad-Pro. Relative comparative study is done on the structures to understand its behavior in helping the reduction of lateral forces. The outrigger depth is reduced to 2/3rd, 1/3rd and half of the storey height along with the full storey height.

The study of lateral deflection and storey drift comparison for different outrigger depth will be made to get optimum height of outrigger

REFERENCES

[1] R Shankar Nair, Belt Trusses and Basements as Virtual Outriggers for Tall Buildings, Engineering Journal, Fourth Quarter, Page 140-146, 1998.

[2] PoSeng Kian & Frits Torang Siahaan, The Use of Outrigger and Belt Truss System for High-rise Concrete Structures, DimensiTeknikSipil, Volume: 0.33, Number: 01, Page 36-41, March 2001.

[3] J R Wu & Q S Li, Structural Performance of Multi-Outrigger-Braced Tall Buildings, The Structural Design of Tall and Special Buildings, Published online by Wiley INterScience, page 155-176, 2003.

[4] Z Bayati, M Mahdikhani& A Rahaei, Optimized use of Multi-Outrigger System to Stiffen Tall Buildings, The 14th World Conference on Earthquake Engineering, October 12-17, 2008, Beijing, China.

[5] N Herath, N Haritos, T Ngo & P Mendis, Behavious of Outrigger Beams in High rise Buildings under Earthquake Loads, Australian Earthquake Society Conference, 2009.

[6] S. Fawzia, A Nasir & T. Fatima, Study of Effectiveness of Outrigger System for High-Rise Buildings under Earthquake Loads, International Journal of Civil Environmental, Structural, Construction and Architectural, Volume: 05, Number: 12, Page 789-797, 2011.

[7] Hi Sun Choi & Leonard Joseph, Outrigger System Design Considerations, International Journal of High-rise Buildings, Volume: 01, Number: 03, Page 237-246, September 2012.