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Comparative Study OF RCC Frame Structure with and Without Outrigger System

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Abstract: *With increased demand of high-rise structure in recent scenario of increasing population .It has been a mandatory need to study about the proficient methods for safe and adroitly serviceable structure. On of such method is Outrigger method, which is eventually a stiffening method with a central core connecting to outer columns with the help of bracing laid horizontally. This kind of structure can be very corroborative by preventing the overturning of structure hence reducing the storey drift making the core of stout nature. Another important determinant in choosing the outrigger format of structure is that since the system is quite rigid in comparison to conventional vertical cantilever system hence the foundation part is required to be designed much burly.*

Keywords: *Outrigger, High Rise Building, Wind load,Earthquake load, Storey Drift.*

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I. INTRODUCTION

In this ongoing era of civil engineering, a trend of high rise buildings has acquired the entire construction industry and now skyscrapers have become the vital part of the civilization. It is a challenge not only to the architects but also to the structural engineers to provide a strong design base to the high rise structures so as to make them sustainable to all kinds of loads and combinations of loads. High rise buildings are subjected to huge amount of lateral wind load than an earthquake load. Considering the probability of wind and earthquake loads, it is obvious that, in case of high rise buildings wind load is a major factor that affects the design criteria than the earthquake load. Therefore, along with the gravity loads, wind load and earthquake load (where earthquake load is equally effective) are also considered in the structural design of the high rise buildings. The huge amount of lateral forces causes lateral deflection and drift of the structure, which may exceed the allowable values provided in IS codes. Excess deflection and drift may cause failure of structure if not restricted to the allowable limit.

II. LITERATURE REVIEW

A. 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.

B. Smith and Coull:

Made a hypothetical assumption that the outriggers are flexural 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.

C. O Seng Kian and Frits Torang Siahaan:

The use of outrigger and belt truss system in high-rise concrete buildings of 40 and 60 storeys 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.

D. J. R. Wu and Q. S. Li:

Presented designs of multi outriggers in tall buildings and also gave an elaborate description of the structural performance of outrigger braced frame-core structures. The paper presents numerical equations for analysis of multi-outrigger systems subjected to uniformly distributed load, horizontal load and triangular load.

E. Z. Bayati:
Gave light on the use of optimum number of outrigger systems in a building using a 80 storey model and investigating on drift reduction. The results imply that optimized use of multi-outrigger system effectively reduces the seismic response of a building.

F. N. Herath
Reviewed the behavior of outrigger beams in high rise buildings under the influence of seismic loads. The optimum outrigger location is determined at 0.44-0.48 times the height of the building.

G. S. Fawzia, et al:
Studied the effects of cyclonic winds on 28, 42 and 47 storey buildings of L – shaped layout. The results show that the plan dimensions have vital impact on structural heights. Also, increase in height with same plan dimensions leads to reduction in lateral rigidity.

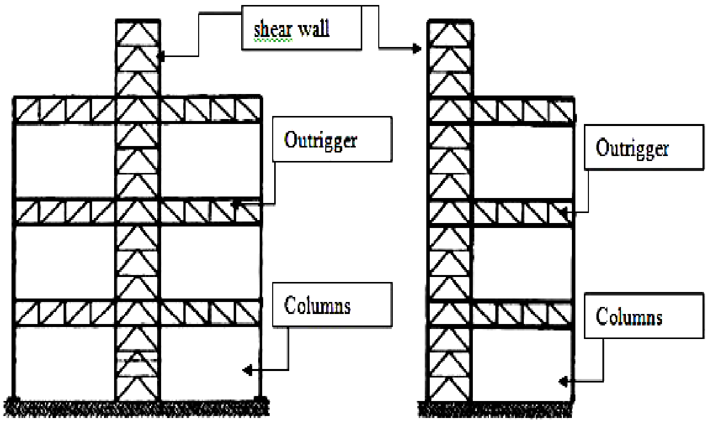
H. Hi Sun Choi and Leonard Joseph:
Outlined a detailed approach for design considerations in outrigger system. It gives design guidelines for conventional and virtual outrigger system. It explains factors like structural aspects, load transfer paths, optimum location of outrigger, diaphragm floors, stiffness reduction, differential shortening of columns and thermal impact

III. CONCEPT

Introduction
We know that, magnitude of lateral load action is increases in an accelerating rate with respect to the height of the building. Buildings having lightweight skeletons undergoes uncomfortable horizontal movements for occupants even during the smaller magnitude earthquake.

Outrigger system provides much stiffer structural system which is capable enough to cater with the high magnitude earthquakes and this system effectively reduces the structural deflections during the earthquake vibrations. A conventional outrigger consists of following two components;

Core-wall system
A very effective and efficient structural system used in reducing the drift due to lateral load. However, as and when the height of the building increases, the core does not have the adequate stiffness to keep the wind drift down to acceptable limits.



Outriggers
They are deep, stiff beam which connects the central core to the exterior most columns which helps in keeping the columns in their position in turn reducing the sway.

1. Advantages and Disadvantages
Advantages:-

- Base Reaction – Maximum base reactions of structural systems with outrigger bracing gives nearly 6% lesser values as compared to the structural system without outrigger bracing & with outriggers. Similarly, maximum base moments of structural systems with outrigger bracing gives 8.5% lesser values as compared to the structural system without outrigger bracing & with outrigger bracing.
- Displacement – Displacement of top story is lesser for structural system with outrigger bracing at 8th, 16th & 25th floor, which gives nearly 18% lesser displacement as compared to the normal building structure without outrigger bracing.

- Story Drift – Story drifts are lesser for the structural system with outriggers at 8th, 16th & 25th floor as compared to other systems. Outriggers give least values but not much considerable as compared to normal building.
- Acceleration – Accelerations are lesser for the structural system with outriggers at 8th, 16th & 25h floor as compared to other systems. Outriggers give least values but not much considerable as compared to normal building.
- RC framed building with 03 level outrigger system gives minimum base reaction and minimum story displacement, also lesser values of story drift & acceleration. It can be effectively used in Earthquake prone areas as an Earthquake resisting structural system.

Disadvantages:-

- Outrigger systems intrude with the engage and rentable space
- The costly and thorough work should be there for connection at the interface between core and foundation
- To resist overturning moments costly foundations are required.
- Outrigger system has elements that are in vertical plane, which affects the floor area or say obstruction free area.

IV. CONCLUSION

The various methods and techniques are used to reduce the displacement and overturning in the high rise buildings.It is found that location of outrigger system is one of the important factor of this study.So different locations of outrigger shows the different result,but most beneficial locations are top to reduce wind load ,bottom to reduce overturning and middle to reduce bending moment.

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