iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 7 **Issue:** IV **Month of publication:** April 2019

**DOI:** https://doi.org/10.22214/ijraset.2019.4587

# Outrigger Structural System in High Rise Building to Control Deflection: A Review

Navnita C. Ragite[1], Prof. V. N. Mendhe[2]
[1]PG Student, [2]Assistant Professor Department of civil Engineering, Department of civil Engineering, Yeshwantrao chavan college of Engineering Nagpur-441110

***Abstract:** People are migrating from urban area to rural area therefore the requirement of land has drastically increased hence high rise building has become more convenient option for office and residential housing. As the height of the building increased the stiffness of the building reduces. That's way using lateral load resisting system that can provide significant drift control for high rise building .the introduction of outrigger and belt truss is one of the latest method to be used for later load resisting system. This review approaches the design and analysis of outrigger to reducing deflection, storey drift.*
***Keywords:** outrigger, lateral displacement, storey drift, high-rise building.*

## I. INTRODUCTION

Urbanization has rapidly increased now a day therefore to overcome this problem multistory building is efficient solution. As the height of the building increased the chances of deflection has also being increased also the risk of earthquake
Force and wind effect has also been increased.
Recently outrigger system is widely used to reduce lateral drift. While designing self weight, earthquake force along with wind force should be considered.

### *A. Lateral load Resisting System*

Various are the lateral load resisting system which can be used in tall building to control storey drift, deflection,etc .
1) Outrigger system
2) Braced frame system
3) Shear wall frame system
4) Rigid frame system

### *B. Structural Concepts*

Outrigger is one of the lateral load resisting system in which external column are tied to the central core wall at one various level.
Outrigger is use to control the excessive drift, deflection so that during medium and high lateral load due to wind or earthquake load the risk of non structural and structural damage is minimum. It is made up of steel bracing. Various analysis is carried out on building by using ETABS software.
The central core is of may be of steel frame or reinforced concrete shear wall, the outrigger may be concrete or steel brace..

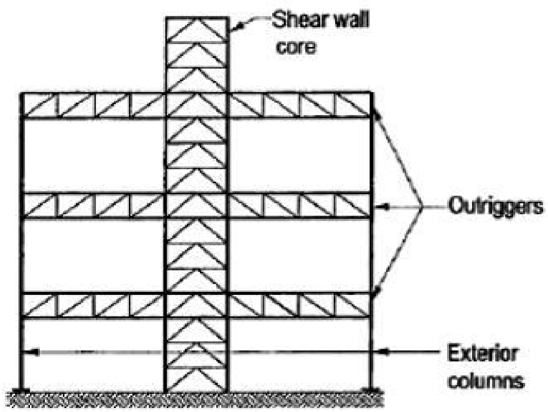



Figure 1.2. Outrigger with core wall

There are two type of outrigger system, they are

1) Conventional outrigger concept
2) Virtual outrigger concept

### C. Virtual Outrigger Concept

"In virtual outrigger concept without direct connection between outrigger truss and core the same transfer of overturning moment from the core to elements outboard of the core is achieved. The basic idea behind the virtual outrigger concept is to use floor diaphragms, which are typically very stiff and strong in their own plane to transfer moment in the form of horizontal couple from the core to trusses or walls that are not connected directly to the core. Basement wall and belt truss are good suited to use as a virtual outrigger truss".

## II. ADVANTAGE OF OUTRIGGER SYSTEM

A. Outrigger system can effectively reduce lateral forces.
B. Outrigger system is the combination of steel, concrete, or composite construction.
C. It can potentially increase the effective depth of the structural system from the core.
D. Maximum deflection due to various effect such as earthquake and wind force can be control after providing outrigger.

## III. LITERATURE REVIEW

### A. Brief Literature Survey

PRATEEK N. BIRADAR, MALLIKARJUN S. BHANDIWAD (AUGUST-2015)[1]. " This paper study on performance of multi-outrigger structural system. Static and dynamic behaviour of 40 storey building for various models were examined using ETABS software for concrete outrigger with central shear wall and without outrigger and outrigger bracing with belt truss in replacement with concrete outrigger. Time history analysis for ground motion data of Bhuj earthquake was carried out. The analysis include Lateral displacement, storey drift and base shear for static and dynamic loading and also time period variation of different buildings. From the results obtained the effective performance of building with outriggers at 20th and 26th storeys was found to be more effective".

Kiran Kamath, N. Divya, Asha U Rao (December 2012)[2]. "In this paper an investigation has been performed to examine the behaviour of various alternative 3D models using ETABS software for reinforced concrete structure with central core wall with outrigger and without outrigger by varying the relative flexural rigidity from 0.25 to 2.0 with step of 0.25. Also the position of outrigger has been varied along the height of the building by considering a parameter relative height of outrigger from 0.975 to 0.4. The parameters discussed in this paper include variation of bending moments, shear force, lateral deflection, peak acceleration of the core; inter-storey drifts for static and dynamic analysis for a 3-dimensional model for various values of relative rigidity and relative height. From the analysis of the results obtained it has been found that performance of the outrigger is most efficient for relative height of the outrigger equal to 0.5".

Srinivas B. N, Abdul Karim Mulla (July-2015)[3]. "As the height of the building increases the stiffness of the building reduces. Therefore to improve the performance of the building under seismic loading, outrigger system is proposed in the present study of work. In the present work, contains a comparative study on regular building with and without outrigger and irregular building with and without outrigger with centrally rigid shear wall and steel bracings as outrigger. The modeling of the structure is done using "ETABS" program. The analysis of the model is carried out by equivalent static method and response spectrum method. The stiffness and efficiency characteristics of the structure is measured in terms of lateral displacement, drift, base shear and fundamental natural period for different types of buildings to provide stiffness against static and dynamic loads. The parameters should be minimized to prevent damage to the buildings".

Ajinkya Prashant Gadkari, N. G. Gore (2016)[4]. "In this paper outrigger and belt trussed system is use as one of the lateral load resisting systems that can provide significant drift control for tall buildings. Thus, to improve the performance of the building under seismic loading, this system can prove to be very effective. The outrigger and belt truss system is commonly used as one of the structural system to effectively control the excessive drift due to lateral load, so that, during small or medium lateral load due to either wind or earthquake load, the risk of structural and non-structural damage can be minimized. For high-rise buildings, particularly in seismic active zone or wind load dominant, this system can be chosen as an appropriate structure. The objective of this paper is to study, the performance of outrigger structural system in high-rise RC Building subjected to seismic load and Wind Load. Study of the literature is reviewed in this paper on various aspects of outrigger structural system as; Behaviour of outrigger structural system in High-Rise RC building, Behaviour of Outrigger structural system in High-Rise Steel and composite Building, Behaviour of outrigger structural system in vertically irregular structures and Effect of seismicity on irregular shaped structure".

Deepa Telang Ajinkya Dhone (2016)[5]. "In these paper, analysis has been done to determine optimum position of deep-beam outrigger at different position of shear wall for G+15 storey building by using STAAD-PRO V8i. Model with three different position of outrigger i.e.at 5th floor, 10th floor, and 15th floor separately with two different position of shear wall are analyzed by linear static analysis method for seismic zone III. As result coming out from above models shows the performance of the deep-beam outrigger at 10th floor with shear wall 2 position is better than other combination. So, additional combination of outrigger at 5th, 10th, 15th floor with shear wall 2 position is analyzed. Which shows minimum lateral displacement as compared to other combination".

Shruti Badami M. R. Suresh (July – 2014)[6]. "In this paper an investigation has been carried out to examine the most common structural systems that are used for reinforced concrete tall buildings under the action of gravity and wind loads. These systems include "Rigid Frame", "Shear Wall/Central Core", "Wall-Frame Interaction", and "Outrigger". The basic modeling technique and assumptions are made by "ETABS" Program, in 3-D modeling. Design considerations are made according to Indian Standards. This comparative analysis has been aimed to select the optimal structural system for a certain building height. The structural efficiency is measured by the time period, storey displacement, drift, lateral displacement, base shear values and core moments. The recommendations for each structural are based upon limiting the wind drift of the structure, and increasing the lateral stiffness. The achievement of structural system for tall buildings is not an easy task. Whereas building height increases the importance of lateral loads action rises in an accelerating rate. There are two types of lateral loads, wind and seismic loads. Wind load presents the most critical lateral loading for modern tall buildings, which have lightweight skeletons that cause uncomfortable horizontal movements for occupants. Also, wind is not constant either with height or with time and is not uniform over the sides of a building. So, windy weather creates a variety of problems in tall buildings, causing concern for buildings owner and engineers alike. Where, excessive vibration due to this load is a major obstacle in design and construction of a modern tall building. It should be limited to prevent both structural and non-structural damage".

S. Fawzia and T. Fatima (2010)[7]. "The design of high-rise building is more often dictated by its serviceability rather than strength. Structural Engineers are always striving to overcome challenge of controlling lateral deflection and storey drifts as well as self weight of structure
imposed on foundation. One of the most effective techniques is the use of outrigger and belt truss system in Composite structures that can astutely solve the above two issues in High-rise constructions. This paper investigates deflection control by effective utilization of belt truss and outrigger system on a 60-storey composite building subjected to wind loads. A three dimensional Finite Element Analysis is performed with one, two and three outrigger levels. The reductions in lateral deflection are 34%, 42% and 51% respectively as compared to a model without any outrigger system. There is an appreciable decline in the storey drifts with the introduction of these stiffer arrangements".

### *B. Literaturer Summary*

On the basis of literature review the relevance of objective to my project work is-

1) To study the use of outrigger in a regular building under earthquake force.
2) The outrigger is introduced in various level in building.
3) To investigate the influence of outrigger in reducing storey drift and storey displacement for core eccentric building.
4) To carry out earthquake analysis of core eccentric building with and without outrigger.
5) To determine various parameter like lateral displacement, storey drift, stiffness.
6) Analysis is carried out using response spectrum method as per IS 1893:2016.

## IV. CONCLUSION

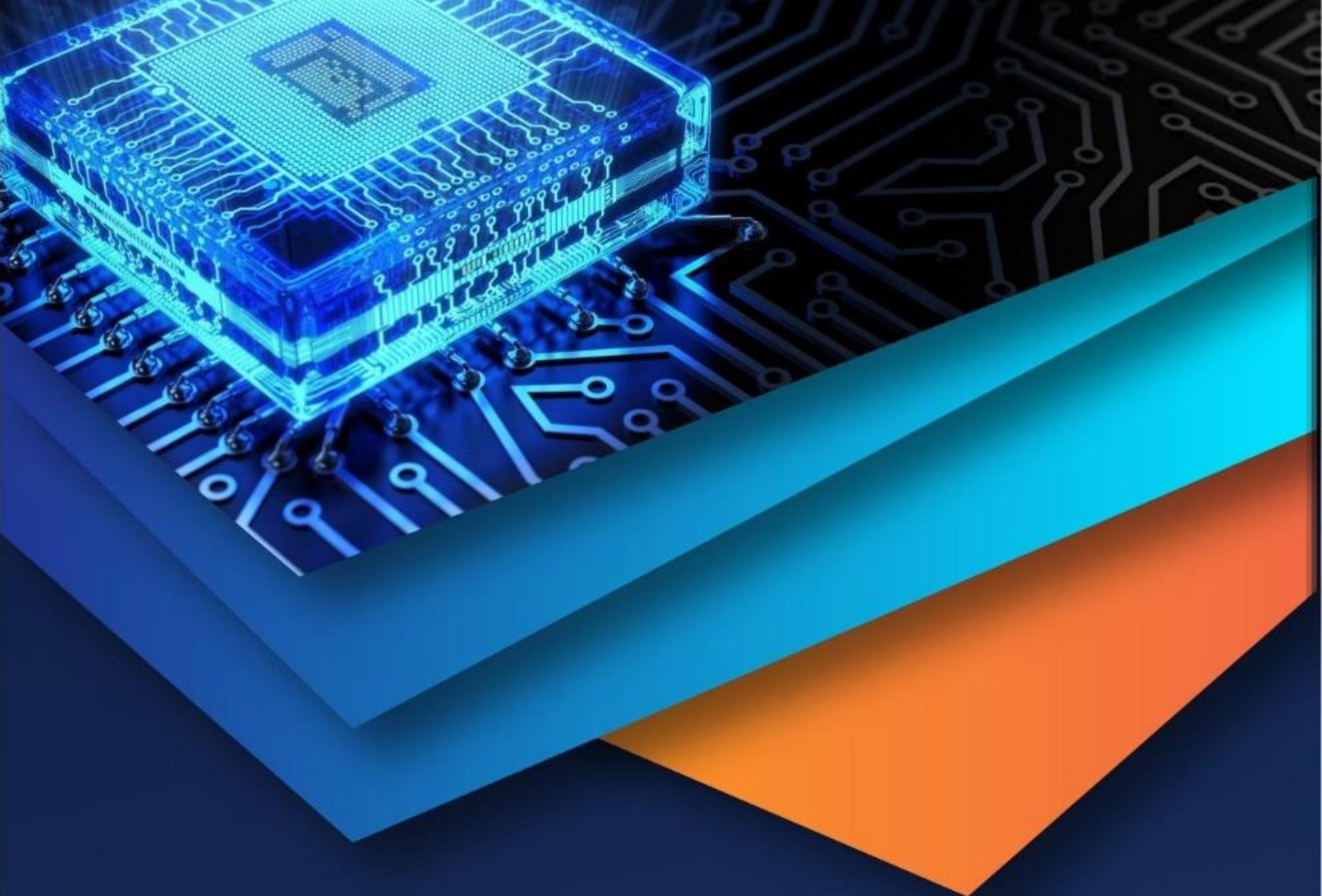
After discussing various methods to control lateral deflection outrigger and belt truss is one of the effective method. Research found that proper position of core wall and placing of outrigger at different interval of building it get much effective result in reducing deflection and also storey drift.

In this study from the observation it can be conclude that maximum deflection occur at top of the storey as per design criteria.

Belt truss and outrigger is cost effective structure.

## REFERENCES

[1] Ajinkya Prashant Gadkari, N. G. Gore, "Review on Behaviour of Outrigger Structural System in High-Rise Building" International Journal of Engineering Development and Research, (September 2016)
[2] Kiran Kamath, N. Divya, Asha U Rao , " A Study on Static and Dynamic Behavior of Outrigger Structural System for Tall Buildings" , International Journal of Industrial Engineering and Management Science, (December 2012)
[3] Takehiko Asai , Chia-Ming Chang, Brian M. Phillips, B.F. Spencer., "Real-time hybrid simulation of a smart outrigger damping system for high-rise buildings" , ISET Journal of Earthquake Technology, (December 2006)
[4] Mohammad AlHamaydeh, Sherif Yehia, Nader Aly, Ammar Douba, and Layane Hamzeh, "Design Alternatives for Lateral Force-Resisting Systems of Tall Buildings in Dubai," International Scholarly and Scientific Research & Innovation ,( 2012)
[5] Chethan Patel , Kiran Kuldeep K N, "The study on behavior of outriggers for tall buildings Subjected to lateral load, International Research Journal of Engineering and Technology (IRJET), (July -2017)
[6] Deepa Telang Ajinkya Dhone , " Optimum Position of Deep Beam Outrigger for Different Position of Shear Wall in High Rise Structure" , International Journal for Scientific Research & Development, (2016)
[7] Reza Kamgar , Mohammad Mehdi Saadatpour,"A simple mathematical model for free vibration analysis of combined system consisting of framed tube, shear core, belt truss and outrigger system with geometrical discontinuities", Applied Mathematical Modeling,(2016)
[8] Huanjun Jiang , Shurong Li, Yulong Zhu, "Seismic performance of high-rise buildings with energy-dissipation outriggers" , Journal of Constructional Steel Research 134, (2017)
[9] Kiran Kamath, N. Divya, Asha U Rao, "A Study on Static and Dynamic Behavior of Outrigger Structural System for Tall Buildings", Bonfring International Journal of Industrial Engineering and Management Science, Vol. 2, No. 4,9 December 2012
[10] Shruti Sukhdeve, S. P. Raut, Akshay Khanorkar, "Outrigger and Belt Truss System for Tall Building to Control Deflection: A Review", Global Research and Development Journal for Engineering Volume 1 Issue 6 ( May 2016)




10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429


# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY