iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** XI **Month of publication:** November 2022

DOI: https://doi.org/10.22214/ijraset.2022.47672

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XI Nov 2022- Available at www.ijraset.com

Analysis of Stability of Tall Building by the Use of Efficient Outrigger and Wall Belt System under Earthquake Response: A Review

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Abstract: Every Structure needs a table to withstand a system of resisting other forces caused by wind or strong earthquakes. One of the best programs is outrigger. Outriggers of structural elements support the formation of lateral loads together. When the complexity of the height of the buildings is increased they become larger as well as the addition of tempting additions to resist systems such as truss consists of belt and outriggers are needed. Utilisation of structural regulation adds structural strength by connecting the main building with the remote colony and making the whole body function as a single unit in resistance to the burden.

The current review articles deals with the research based on the Outrigger Wall and Wall Belt Supported System by different researchers. The observation includes based on the reviews in that inputs of Outrigger Wall and Wall Belt increase the performance of building in terms of stability, stiffness, strength & cost. It also concluded that this performance are vary with variation is occurs in the location and dimensions parameters such height, depth and plan areas. The research also impact on the system is used as per the guidelines provided.

Keywords: Outrigger Wall and Wall Belt Supported System, stability, stiffness, strength.

I. INTRODUCTION

We are living in that world where the voracity for taller structure will be increasing day by day. Although the requirement of high rise building is in demand but the structural safety is always a matter of concern because we would not take risk with human life. As the structural safety is primary concern but the frugality of project is also important so we must have to maintain the poise in economy of project along with structural safety. So for making our structure safer, various structural arrangement have been developed with the increasing demand and necessity some of them are shear wall, bracing etc.

For buildings taller than 15 to 20 stories, pure rigid frame system is not adequate because it does not provide the required lateral stiffness and causes excessive deflection of the building. These requirements are satisfied by two ways. Firstly, by increasing the members size above the requirements of strength but this approach has its limitation and secondly, by changing the structural form into more stable and rigid to restrict deformation. This increases the structure's stability and rigidity and also restricts the deformation requirement.

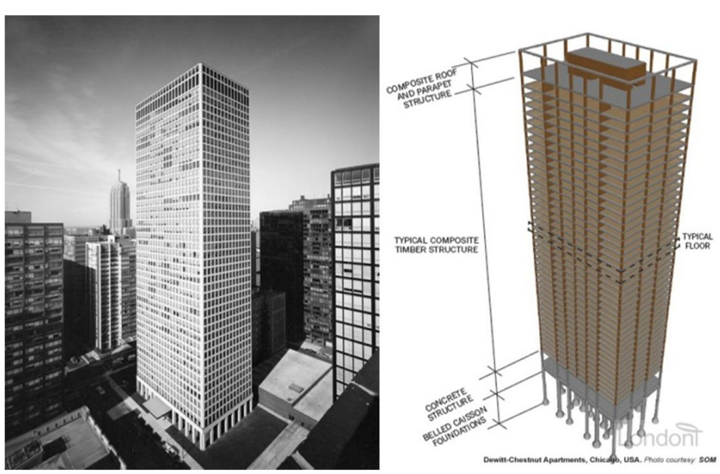

Fig 1: Example: DeWitt-Chestnut building in Chicago

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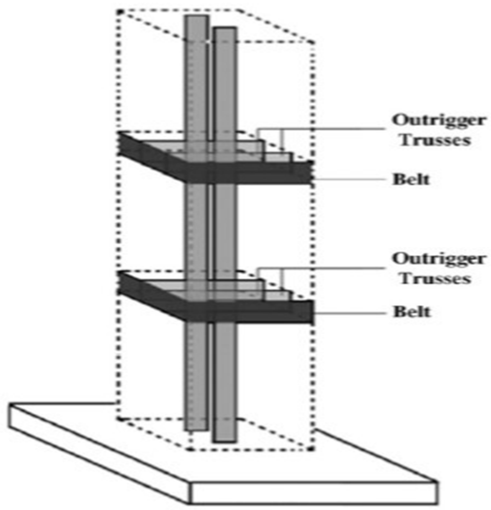

Fig. 2: Outrigger System in a Typical Multistoried Building

Belt supported system: The best technique used in huge-story houses is to maintain the body whether it is a bar belt or a truss belt system. It representatives to the structural nodal points & communicate through it. They are termed as belt support systems the reason is the belt is usually made of trusses or bolts, connecting the structure line. The load departs from each member being distributed equally housing. In order to adapt to the force of the wave and to maintain the stability of the structure, the outer straps and straps are used. The Policy is that the outer poles are fitted with the centre of the bar with the braces and straps in one or more positions. The truss straps are attached to the outside pillar of the house while the outside holds them to the main or central vertical wall. The reason behind is this approach due to reduction value is occurs in interference structure with respect to the conventional method.

II. LITERATURE REVIEW

1) Wael Alhaddad ,Yahia Halabi ,Hu Xu , and Hong Gang Lei (2022)

This article is the second part of the series of the comprehensive review which is related to the outrigger and belt-truss system design for tall buildings. In this part, by presenting and analyzing as much relevant excellent resources as possible, a guideline for optimum topology and size design of the outrigger system is provided. -is guideline will give an explanation and description for the used theories, assumptions, concepts, and methods in the reviewed articles for optimum topology and size design. Finally, this part ended up with a summary for the findings of the reviewed studies, which is useful to understand how different parameters influence the optimum topology and size design of a tall building with outrigger and belt-truss system

2) Wael Alhaddad ,Yahia Halabi , Hu Xu & Hong Gang Lei (2020)

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3) Kashif Salman, Dookie Kim, Ataullah Maher & Abdul Latif (2020)

This paper considers the static and dynamic analysis of a high-rise structure under the lateral loads. Firstly, the static analysis was carried out for four different structural systems (i.e. moment-resisting frame, building frame, and outrigger braced frame (OBF) system). Under the same static loading, it was found that the outrigger braced system provides an optimal control to high-rise structure. To earn these results, an analytical procedure was carried out that manifests the efficiency induced by the bracing system. Secondly, dynamic analysis was considered to evaluate the vibration response of a tall building.

To this end, the outrigger system was compared with the Pendulum tuned mass dampers (PTMD). The parametric analysis investigates that the outrigger system provides an optimal reduction of 33% for one and 60% for two outriggers in the top displacement and drift response of the structure. This alteration in the response was verified using an analytical solution for the top and middle of the structure. The acceleration reduction capacity of outriggers was found to be 40% and PTMD with 35% respectively. Based on the comparative static and dynamic analysis OBF was found to be an effective addition to the sway frame.

4) V. Swamy Nadh, B. Hema Sumanth, K. Vasugi, and Manish.R. Shirwadkar (2020)

Nowadays many techniques have been developed to make buildings taller and more efficient. Moreover, if unsymmetrical tall buildings are considered, the stability of structure plays a vital role and these are majorly effected by the lateral loads like wind and earthquake. In order to resist from lateral loads, different structural systems have been followed practically like bracing system, outrigger system, diagrid, hexagrid systems. This paper deals with the use of outrigger system for unsymmetrical tall building of 30 storey and its Comparison with the same building without outrigger system.

This paper also emphases on determining the exact position of outrigger in tall buildings. Also, in the second case, keeping the height of the building same as that of the conventional building the floor areas are increased by reducing the number of interior columns with and without outrigger system and the stability is checked. The results reveal the ideal position of outrigger at top position and other at 0.5 times the height of the building. and with the use of outrigger system the displacement is reduced to 26.69% which improves the stiffness and efficiency of unsymmetrical building.)

5) Nadh V.S., Sumanth B.H. (2020)

This article discusses the use of the stabilizer system for 30-story high-rise concrete buildings and its comparison with the same building without stabilizer systems. This article emphasizes the exact identification of the status of stabilizers in high-rise buildings. In the second case, the maintenance of the height of the building is the same as that of the normal building, the floor surface is increased by reducing the number of interior posts and without a stabilizer system and stability is checked. The results show the quality of the stabilizers on top and others at 0.5 times the height of the building. With the use of the stabilizer system, the change has been reduced by 26.69%

6) Alhaddad W., Halabi Y. & et. al.(2020)

The articles are based on the study of the design of beam and beam systems for tall buildings. The primary focus is provided on optimal topology and outrigger system size design. The guide will provide an explanation and description of the theories, assumptions, concepts, and methods used in the reviewed articles for optimal topology and size design. The review obtained is useful to understand how different parameters influence the optimal topology and size design of a tall building with truss and truss system. The system meets the initial and final design stages. The codal approach is also adopted by composing a standard or special code for designing tall buildings.

7) Salman K. , Kim D. & et. al. (2020)

This article examines the rigid and specific foundation of high-level structures under load. First, a static analysis was performed for four different system structures (such as weather-resistant body, fence, and outrigger body structure (OBF) systems). Under the same static load, the stabilizer reinforcement system was found to provide better control over the high-altitude structure. To obtain these results, a detailed analysis was performed to show how well the immune system was stimulated. Second, detailed analyzes were evaluated to assess the vibration response of a high-rise building. For this reason, the stabilizer system was compared to pendulum-tuned mass dampers (PTMD). The analytical model simulates the supply of the stabilizer decreasing even further by 33% for one and 60% for the solution for the two at the top of the transition. This change in response was confirmed by a detailed solution for the top and middle of the building. The potential reduction rates of the stabilizers received 40% with PTMD and 35% respectively. Based on comparative statistics and solid OBF details, it was found to be a useful addition to the rolling frame.

8) V.D. Sawant, V.M. Bogar (2019)

During the last few decades, several buildings have been built utilizing belt truss and outrigger system for the lateral loads' transfer (throughout the world). In conjunction with the composite structures, this system is very effective when used especially in tall buildings. Parameter comparison of high rise RCC structure with steel outriggers and belt truss system provided at various positions along with the height of structure using

Linear and Non- Linear Analysis is the main scope of this research. The key parameters discussed in this paper include lateral deflection, story drifts and, base shear. Nine different models are prepared for different positions of the outrigger system and results have been compared. Seismic loads are considered as per IS 1893- 2016 part -1. The modeling and analysis is performed using finite element software ETABS 15.2.2-2016

9) Reihaneh Tavakoli, Reza Kamgar Reza, Rahgozar (2019)

The focus of this study is to investigate the seismic behavior of outrigger-braced building considering the soil–structure interaction based on finding the best location of outrigger and belt truss system. For this purpose, a central outrigger-braced frame of a steel tall building is considered. A layered soil deposit underlined this frame and the resulting soil–structure system is subjected to seismic excitation. To analyze this system, direct method is employed in Open Sees. Also, elastic and in-elastic analyses are both considered and a comparison is made between current results and the results related to the system with fixed base. The best location of outrigger–belt truss system is determined by considering the maximum roof displacement, base moment and base shear with and without soil–structure interaction. It is shown that considering SSI affects the location of outrigger–belt truss system. Elastic analysis of both systems, namely with fixed base and with soil–structure interaction, showed that locating the belt truss at higher stories caused lower amounts of roof displacement.

10) Tae-Sung Eom, Hiubalt Murm and Weijian Yi (2019)

A new lateral force-resisting structural system for concrete high-rise buildings, distributed belt wall system, is proposed. Unlike conventional belt structures, the belt walls inflling the space between perimeter columns are distributed separately along the overall building height. In this study, the force transfer mechanism and performance of the distributed belt walls, acting as virtual outriggers under lateral load, are investigated. For the reinforcement of the belt walls subjected to high shear demand, a reinforcing method using high-strength prestressing strands (i.e. PSC belt wall) is suggested, and the shear strength of the PSC belt walls is estimated based on the compression feld theory. By performing nonlinear fnite element analysis, the shear behavior of the PSC belt walls, including cracking and yield strengths, is investigated in detail. Based on these investigations, recommendations for the shear design of the belt walls reinforced by high strength prestressing strands are given.

11) Tavakoli R. , Kamgar R. (Feb.-2019)

The study examines the concept of outdoor storage and considers the layout of the soils. For this reason, a central pull-wall belt of a high-rise steel building is considered. The storage of clay soil under this framework and what is happening to the soil - is subject to soil stimulation.

When studying this system, the correct methods are used in Open Sees. In addition, an analysis of an action and decision is made between these decisions and the decisions associated with the system and the policy. Optimised location of outrigger-strap truss system is based on the consideration of the top roof substitute, time base and partition structure and with no interaction of ground-structure. The outputs showed that SSI infection affects the location of the outside of the seat-belts. A detailed analysis of all the data, such as the structural and structural correlation of the soils, showed that the availability of the bond at high altitudes resulted in a lower roof thickness.

12) Patel N. & Jamle S.(Aug.-2019)

The researcher's patel & jamle worked on outrigger system is made for details because of the fact that the best system is available for high-rise buildings and on the skies. In this system, the outer lines are connected to the main inward or outward path by strong loads on different floors against the shock and moderate action of the main parent should be seismic and windy. In this paper various papers presenting this subject are reviewed to perform a great deal of work done in this first field. On reviewed the research, it comes about the proven result that drives the development of our research.

It also faces the multi-story building to do details for the 13 floors. A total of 13 cases are shown in twin towers with different floor sizes and the best conditions are notoriously resistant to movement.

The tower is being considered for zone 4 against dirt roads. Studies have been completed against different segments of seismic, there is an increase in the pit & it is on the roof. Preliminary results of more than one case and the various cases are recommended with the help of statistical data and analysis Staad-pro. The main component of the welding plate is a flexible part of the welding wall, its width and thickness.

13) Mathew M., (June-2017)

The work involves outdoor frames and fence posts that are widely used to reduce drift. Three-dimensional models for the G + 45 concrete structure are being developed and the results are detailed for themselves. For the conflict of zones specific to zone 2 and the method described in IS: 1893 (part1) -2002. Therefore the analysis of wind load can be taken from IS: 875 (section 3) -1987 Finally, a comparison of the periodic studies on the energy generated and used the system "ETABSvr.16". Regulation of changes such as back-to-back, treadmill baths, time connection and optimum condition are associated with outrigger and brake pads.

14) Soni P., Tamrakar P.L. & et. al.(Feb.-2016)

A list of articles being made for the study of the improvement of spinal cord and their behaviour towards emergency loads. While vertical walls resist large areas of lateral load on the basement of the building and lateral load supported framed on the building consist upper part which is suitable for weak high-rise buildings, buildings are similar in nature built in India, as per India habituation concept floors are utilised as a parking and garages or offices and the upper floors places.

This result of the G + 10 structural velocity project reduces the importance of von-misses reinforcement and structural changes in site 1 compared to site 2. Similarly the result is in G + 20 wall-to-wall structures have less significant fracture sites in site 2 compared to site 1.

The end of the G + 26 floor structure was concluded to reduce the importance of von-misses sites and less inconvenience to the structure in place 1 compared to place 2..

15) N.K., Gore N.G (June-2016)

The researchers of this paper summarize in detail the Outriggers integration and the current practice of integrating Outriggers into high-rise buildings. Back to this various issues related to the Outriggers have also been discussed. Detailed descriptions of the articles available in the field of Outrigger system are in place and the summaries and opportunities encountered in the study are listed in this document. A new Virtual Outrigger concept is introduced in this paper. It is utilise for the the seat belt in the house for increment in the performance of the house under the load force being studied. Emphasizes the greater benefits of hiring Virtual Outriggers than usual. It is also shown in the affected paper ideas under the Virtual Outrigger.

16) Kogilgeri S. , Shanthapriya B. (July-2015)

An attempt is being made to investigate the inconsistency and behaviour of the regulatory environment on by reduction in the depth of the exit & to provide steel structure. The steel and central structures and the steel structure and the layout of the foundations vary in the depth of the exterior. The reduction in the depth of the outrigger is taken as 2/3 and 1/3 of the maximum height with the full maximum height. Equivalent depth is taken for both belt-truss & a normal story and remained the same throughout the day. Key terms include accidental mixing and slipping. From the analysis of the results obtained, the comparison of the outrigger movements with the upper floor depth and the depth reduction reveals a significant difference under load. Shah

17) Fawzia S., Nasir A. & et. al. (2011)

This work is based on the effects of hurricanes and the evacuations of people outside of the 28, G+42and G+57 are being studied. There are some decisions have been made that will prohibit the opportunity to worked on upcoming area for the researchers. The civil engineer. The results of the demonstrations have significant implications for the higher structures. The increase is high but the same strategy is in place to reduce the complexity. To meet the maximum tensile need bracings are added and also the addition of additional resistance resistors for example truss straps & outriggers is required.

18) Herath N., Haritos N. & et. al. (2009)

This study is needed to identify the best location outside of high-rise influence of seismic conditions.. The storey consist 50 floors buildings surveyed and the levels having a highest peak in 3 levels of ground acceleration on the velocity of the points in each segment of the earthquake data were combined to provide a similar level of roadmap.

The analysis of the response and behaviour of the building was considered with regard to the legalization of responses such as relocation and safety on the premises.

This study showed that the standard deviation of the setting when the external level is 22-24 is higher. Thus it can be concluded that the optimal location are obtained in the range of 0.44-0.48 times its maximum location.

19) Bayati Z, M. Mahdikhani & et.al.(Oct.-2008)

The results of the researchers Bayati Z,, M. Mahdikhani is on decrement in tension in the ligament with strong stimulants, by the analytical approach adopted for structural model built in Tehran Vanan Park. The results show that proper use of the multi-outriggers system can reduce home volatility. Other than this the outcomes consist of that the structure which having the multi-outriggers system reduced the elements and bases from the structure.

III. CONCLUSIONS

Based on the different researchers study on Outrigger Wall and Wall Belt Supported System

Based on the different researchers study on Outrigger Wall and Wall Belt Supported System the following conclusions are to be made. The points out conclusions are as follows:

1) The belt truss & outrigger system most accepted method for withstanding under lateral loads.
2) The maximum research is based on the optimum height, shear wall location and height, variations in outrigger depth etc.
3) The main aim of the researchers is to increases the Stability of the building used, hence increment is observed by different researchers.
4) The structural form used by the Outrigger System for High-Rise, Composite Structure ,Multi-Outriggers System, Unsymmetrical Tall Buildings, Steel Structure & braced frame system by different analysis. The bracing & Outriggers System is more priority in it and reduces the effect of laterals loads.
5) The checks made by different researches are Seismic performance, Impact in the Cyclonic Region, Guideline adopted under for Optimum Topology concept and Design consideration under sizes.
6) Under the behaviour of the soil–structure interaction, the systems consist fixed base, location consist of the belt truss at the higher stories imparts the lesser amounts displacement.
7) Difficult connection due to the core is removed & with outrigger system, the structural materials can be applied effectively by utilizing the axial strength and stiffness of exterior columns.
8) The systems minimize hindered space compared to the traditional method. The floor space does not contain any columns and remains among the core and the external columns; as a consequence, increment in the functional efficiency of the building occurs.

IV. FUTURE SCOPE

The following future worked as carried out to get the knowledge of truss belt and wall in the structure and to find deeper concept and new considerable idea through it. There are as follows

1) Locations based assessment of the structure to get optimises location for earthquake resisting building.
2) Use of different types of structural form such steel, bundled tube, bracing etc and comparisons between them.
3) Dimensional analysis: variations in the depth, size of the belt truss and wall.
4) Earthquake approach comparison such as RSA & THA.
5) Use of different type's base isolation in the truss belt and outriggers system.
6) Dynamic wind analysis such as CFD analysis or wind tunnel.
7) Different software such as midas, sofistik etc in new upcoming era.
8) Outputs based on the efficiency of outrigger.

V. ACKNOWLEDGEMENT

I extend my deepest gratitude to R.K. Grover, Associate Professor, Department of Civil Engineering, Jabalpur Engineering College, Jabalpur, and Madhya Pradesh. for providing all the required data's related to the project, learning of software tools and guidance to do successful completion of this work

REFERENCES

[1] Wael Alhaddad ,Yahia Halabi ,Hu Xu , and Hong Gang Lei (2022) Outrigger and Belt-Truss System Design for High-Rise Buildings: A Comprehensive Review Part II—Guideline for Optimum Topology and Size Design, Hindawi Advances in Civil Engineering Volume 2020, Article ID 2589735, Pp1- 30 https://doi.org/10.1155/2020/2589735

[2] Wael Alhaddad ,Yahia Halabi , Hu Xu , and HongGang Lei (2020) "Outrigger and Belt-Truss System Design for High-Rise Buildings: A Comprehensive Review Part II—Guideline for Optimum Topology and Size Design" Hindawi Advances in Civil Engineering Volume 2020, Article ID 2589735, Pp-30 https://doi.org/10.1155/2020/2589735

[3] Kashif Salman, Dookie Kim, Ataullah Maher & Abdul Latif (2020) Optimal control on structural response using outrigger braced frame system under lateral loads, Journal of Structural Integrity and Maintenance, 5:1, 40-50, DOI: 10.1080/24705314.2019.1701799

[4] V. Swamy Nadh, B. Hema Sumanth, K. Vasugi, and Manish.R. Shirwadkar (2020) International Journal Of Scientific & Technology Research Volume 9, Issue 02, February 2020 Issn 2277-8616 2917 Ijstr©2020 Ideal Location Of Outrigger System And Its Efficiency For Unsymmetrical Tall Buildings Under Lateral Loadings.

[5] Nadh V.S., Sumanth B.H. (Feb.- 2020) Ideal Location Of Outrigger System And Its Efficiency For Unsymmetrical Tall Buildings Under Lateral Loadings, International Journal Of Scientific & Technology Research volume 9, ISSUE 02, ISSN 2277-8616, Pp 2917-2920.

[6] Alhaddad W., Halabi Y., & et.al. (Feb.-2020) "Outrigger and Belt-Truss System Design for High-Rise Buildings: A Comprehensive Review Part II—Guideline for Optimum Topology and Size Design" Hindawi Advances in Civil Engineering, Volume 2020, Article ID 2589735, pp 1-30, https://doi.org/10.1155/2020/2589735-

[7] V.D. Sawant, V.M. Bogar (2019) International Journal of Engineering Trends and Technology (IJETT) – Volume 67 Issue 7- July 2019 ISSN: 2231-5381 http://www.ijettjournal.org Page 15 Parameters Comparison of High Rise RCC Structure with Steel Outrigger and Belt truss by Linear and Non-linear Analysis

[8] Reihaneh Tavakoli·, Reza Kamgar· Reza Rahgozar (2019) Seismic performance of outrigger–belt truss system considering soil–structure interaction International Journal of Advanced Structural Engineering (2019) 11:45–54 https://doi.org/10.1007/s40091-019-0215-7 , Pp 45-54.

[9] Tae-Sung Eom1, Hiubalt Murmu and Weijian Yi (2019) Behavior and Design of Distributed Belt Walls as Virtual Outriggers for Concrete High-Rise Buildings Eom et al. Int J Concr Struct Mater 13:1, International Journal of Concrete Structures and Materials https://doi.org/10.1186/s40069-018-0311-2

[10] Patel N. & Jamle S. (Aug.-2019) "Use of Shear Wall Belt at Optimum Height to Increase Lateral Load Handling Capacity in Multi-story Building: A Review" International Journal of Advanced Engineering Research and Science (IJAERS), Vol-6, Issue-4,Apr-2019,ISSN:2349-6495(P),2456-1908(O),pp310-314. https://dx.doi.org/10.22161/ijaers.6.4.36,

[11] Tavakoli R. , Kamgar R. (Feb.-2019) "Seismic performance of outrigger–belt truss system considering soil–structure interaction" International Journal of Advanced Structural Engineering, pp 45-54, https://doi.org/10.1007/s40091-019-0215-7

[12] Soni P., Tamrakar P.L. & et. al. (Feb.-2016) "Structural Analysis of Multi-story Building of Different shear Walls Location and Heights" International Journal of Engineering Trends and Technology (IJETT) ,Volume 32, Number 1- ISSN: 2231-5381, pp 50-57.

[13] Gadkari A.P. , Gore N. G. (2016) "Review on Behaviour of Outrigger Structural System in High-Rise Building" IJEDR 2016 , Volume 4, Issue 2, ISSN: 2321 -9939

[14] Kogilgeri S. , Shanthapriya B. (July-2015) "A Study On Behaviour Of Outrigger System On High Rise Steel Structure By Varying Outrigger Depth Srinivas" International Journal of Research in Engineering and Technology Volume-04 Issue: 07, e ISSN: 2319-1163, p ISSN: 2321-7308, pp 434-438.

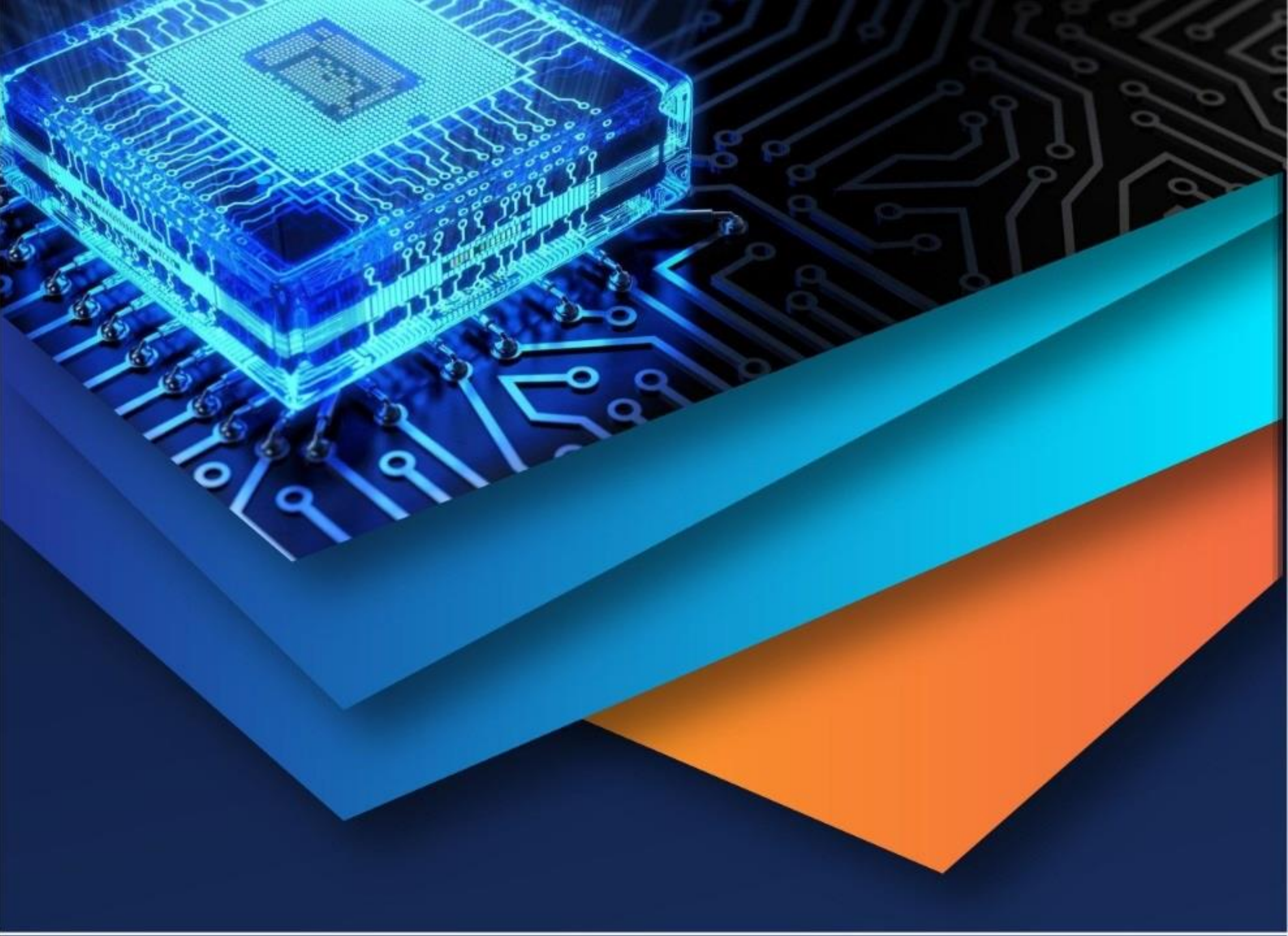
[15] Shah N.K., Gore N.G (June-2016) "Review on Behaviour of Outrigger System in High Rise Building" International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395 -0056, Volume-03, Issue-06, p-ISSN: 2395-0072, Pp 2803-2809.

[16] Ddd Fawzia S. , Nasir A. & et. al. (2011)Study of the Effectiveness of Outrigger System for High-Rise Composite Buildings for Cyclonic Region, World Academy of Science, Engineering and Technology 60 , pp 937-943

[17] Mathew M., (June-2017) Optimum Position of Outrigger with Belt Wall International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 6, June 2017, ISSN(Online) : 2319-8753, ISSN (Print) : 2347-6710, pp 10376-10372, DOI:10.15680/IJIRSET.2017.0606033

[18] Herath N., Haritos N. & et. al. (2009) "Behaviour of Outrigger Beams in High rise Buildings under Earthquake Loads" Australian Earthquake Engineering Society 2009 Conference

[19] Bayati Z,, M. Mahdikhani & et.al.(Oct.-2008) "Optimized Use Of Multi-Outriggers System To Stiffen Tall Buildings" The 14th World Conference on Earthquake Engineering Beijing, China , pp- 12-17, 2008,



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