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Analysis of different Outrigger Structural System for Tall Building

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Abstract: Construction of high buildings is growing rapidly worldwide. Tall buildings are a mankind-induced lateral force like wind and seismic loads. In high buildings, the parameter rigidity plays an important role. By increasing the height of the building, stiffness decreases.

The introduction of a Outrigger system can be used to achieve reduced drift and deviations due to lateral loads. This study explored the seismic behavior of various structural configurations of the Outrigger structural system. As one of the structural systems for effective management of excessive drift due to lateral loads, the Outrigger with the belt farm is used. This way, it will increase productivity, preventing structural and non-structural damage of the building during seismic load and wind load. The aim is to explore the structural systems of the Outrigger high lift RC building under the action from lateral loads such as seismic load and wind

Keywords: outrigger, tall buildings, storey shear, storey drift and displacement

I. INTRODUCTION

The tall house as Skyscraper has always been a vision of dreams and technological advances with new types of equipment leading to the construction progress in the world. Nowadays, the high House has become a more convenient option for residential and commercial housing due to the rapid growth of urbanization. High buildings are designed for residential and office use. This is the primary reaction to the rapid growth of urban population and the demand for entrepreneurship. Much of our country is prone to damaging seismic hazards due to earthquake, hence the need to take into account seismic load for the design of high-altitude structure.

Various lateral load resistance systems are used in high-rise buildings. These lateral forces can produce critical stresses in structural and non-structural members in construction, causing undesirable tension in the structure, and undesirable vibrations or causing excessive lateral effects of the structure.

In past years, structural members of the building were assumed to carry primarily the severity of loads. Today, however, by advancement in structural systems and high strength materials, the building mass has shrunk, in turn, an increase in slenderness, which requires taking into account, taking into account lateral loads such as wind and earthquake.

Especially for tall buildings like slenderness, stiffness and flexibility are important parameters as buildings are severely affected by lateral loads resulting from wind loads and earthquake load. Thus, it is becoming increasingly important to determine the correct structural system for lateral-load resistance depending on the height of the building. There are many types of structural systems that can be used for lateral resistance of tall buildings.

The aim of the present work is to study the static characteristics of multistoried RCC frames with single bay & to arrive at the optimum outrigger position.

The objectives are as follows:

A. To analyze three models with different configurations for outrigger system.
B. To observe the response in both the static and dynamic analysis.
C. To analyze the important structural response parameters such as base shear, lateral displacement, storey drift and time period.
D. To identify the possible efficient outrigger system among the different outriggers approach.
E. To compare Bare Frame, Outrigger System & Outrigger System with central truss core

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II. REVIEW OF LITERATURE

The study observed that: 1) there is a maximum reduction of side displacement of 31.18% when the Outrigger is provided on the 10th floor due to wind load. 2) of the storey result drift concluded that there is a 42.59% reduction when the Outrigger is placed on the 40th storey ie the top of the building. 3) The use of Outrigger does not show any significant changes in the baseline offset, as the overall force that operates on the structure does not change with the addition of Outrigger. 4) Thus, it can be concluded that the UTRICERNYH are effective in the management of a floor shift, storey drift. Using the Outrigger system in high-altitude buildings increases stiffness and makes structural forms effective under lateral load (Preeti. M. Nagargoje, et al 2017).

In the implementation of Outrigger systems, factors such as baseline shift, shift and history of drift structures during the earthquake are reduced and therefore construction should only be designed for wind and gravity loads. Hence, the size of structural elements decreases, leading to economic construction. The location of the Outrigger beam has a critical effect on the side behavior of the structure under lateral loads and the optimum locations of the Outrigger appear to be 0.75 times the height of the building along with the roof rafters at a condition of three floors of depth. The numerical study was conducted on a 40 storey structure of steel, providing the Outrigger at the top, one fourth, the middle and three four heights of the building, and the Outrigger of three-quarters along with the lid of the farm was found among three in terms of drift, offset and baseline offset because it confirmed the security restrictions described in 1893-2002. (Sreelekshmi. S et al 2016).

Analysis of the response spectrum gives smaller results compared to static analysis, there is a reduction of about 24% in values. This is refined, ESA gives higher results and safe, which will be sufficient when analyzing buildings of low elevation and less value. The value of the storey shear will always match the offset values. Higher drift values are labeled in Model 1 and lower in case of Model 3. It may notice several punctures in the graph indicating the presence of rigidity elements, the system of Outrigger element. Model time span 1 is high due to the flexibility in structure. However, the Model 3 behaves tougher, hence the time period less. These buildings demonstrate rigidity and flexibility and will also show the best performance in the direction of seismic analysis. Base offset values are almost identical in all models. Base offset depends on the weight, height and dynamics of the building. However, it can watch is almost equal weight and height of the building, not so markedly difference in models. Thus, it can be concluded that ensuring the Ouspuskovogo system will not change in the basic cost of shear, as it is purely dependent on the mass, height and dynamics of the building (DEEPTHI M et al 2018).

III. MODELING

The following table gives the analysis data for the building considered for the work carried out in the present study. The different parameters are as explained in the table.

Table No.1: Analysis data for building

Plane dimensions	20x15 m
Total height of building	97.5 m
Height of each storey	3.2m
Height of parapet	1m
Depth of foundation	1.5m
Size of beams	300x500mm
Size of X brace (Outrigger)	300x450mm
Thk of shear wall (Outrigger)	230mm
size of columns	350x750mm
Thickness of slab	150 mm
Thickness of external walls	230 mm
Thickness of shear wall	230mm
Seismic zone	IV
Soil condition	Hard
Response reduction factor	5
Importance factor	1.2
Partition Wall Load	2.0 kN/m^2
Floor finishes	1.5 kN/m^2
Live load at all floors	3 kN/m^2
Grade of Concrete	M25
Grade of Steel	Fe500
Density of Concrete	25 kN/m^3
Density of brick masonry	20 kN/m^3

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The different models are analyzed in the present work and it is considered as in the following table, the particulars are explained as follows

Table No.2: Particulars of Models

Model No	Particulars
Model I	Building without any Outrigger system
Model II	Building with X Bracing Outrigger system is connected with Core at 1/3rd height i.e. at 10th storey
Model III	Building with X Bracing Outrigger system is connected with Core at mid height i.e. at 20th storey
Model IV	Building with X Bracing Outrigger system is connected with Core at top i.e. at 30th storey
Model V	Building with Shear Walls Outrigger system is connected with Core at 1/3rd height i.e. at 10th storey
Model VI	Building with Shear Walls Outrigger system is connected with Core at mid height i.e. at 20th storey
Model VII	Building with Shear Walls Outrigger system is connected with Core at top i.e. at 30th storey

IV. RESULTS

A. Lateral Displacement-X

The lateral displacement in the X direction is presented for all the storey and all the models as follows, the lateral displacement is more for storey 30

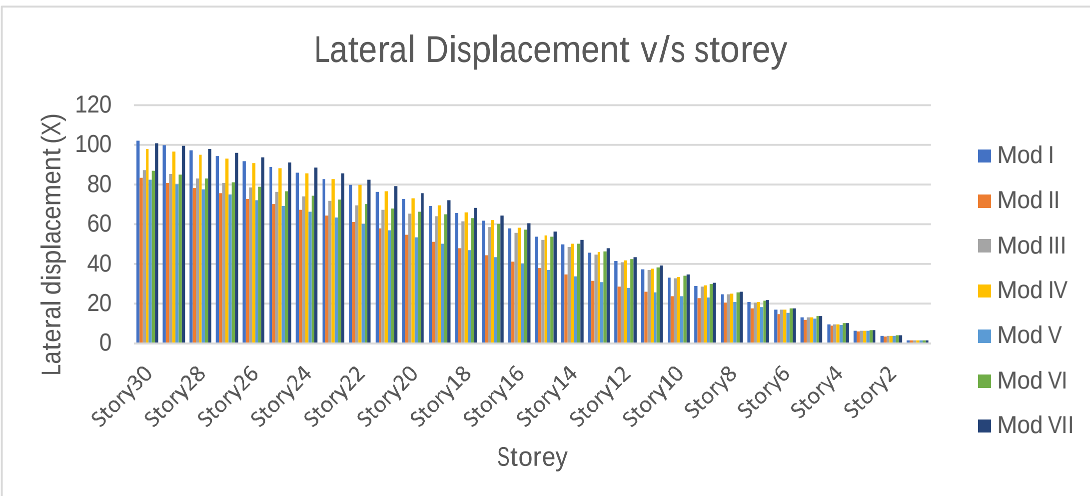

Fig.1:Lateral Displacement v/s storey

B. Lateral Displacement-Y

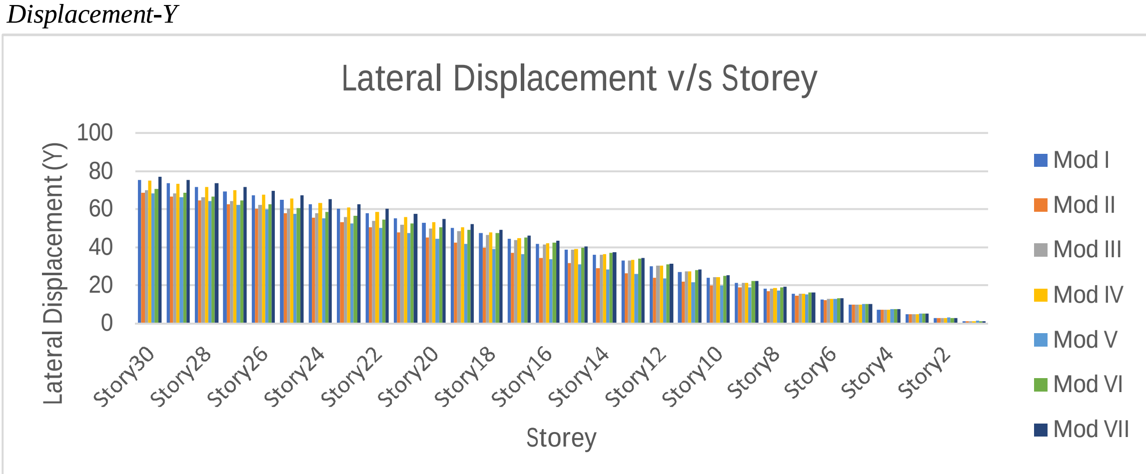

Fig.2:Lateral Displacement v/s storey in Y-direction

C. Storey Drift-X

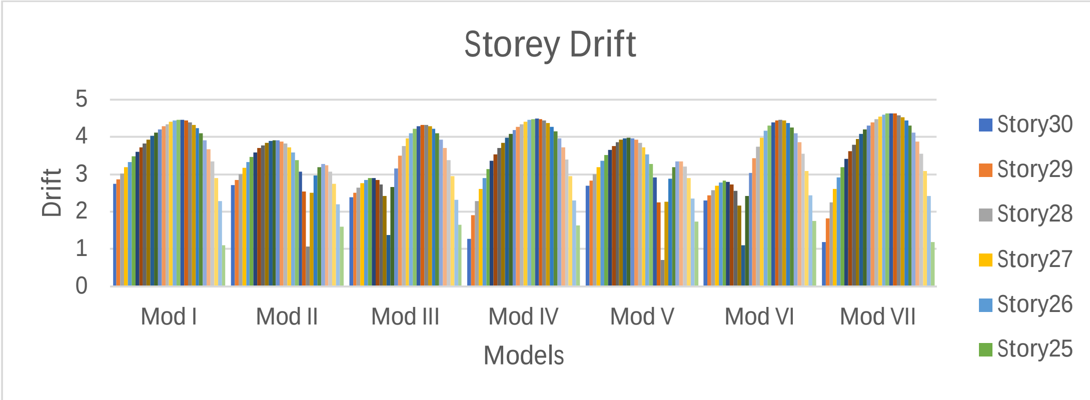

Fig.3:Storey Drift for all models

The storey drift for all the models are presented in X-direction in the above graph, the model-VII gives the maximum value as compared to other models.

D. Storey Drift-Y

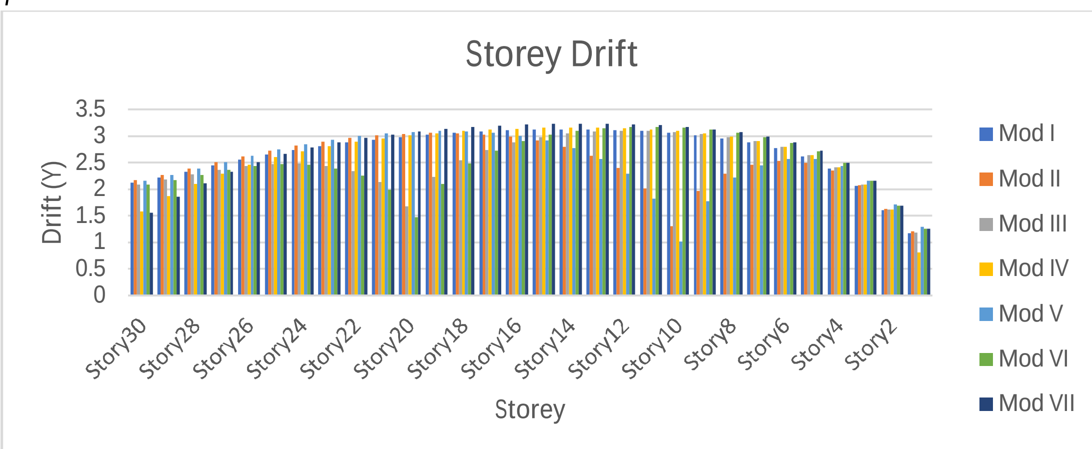

Fig.4:Storey Drift for all models

The storey drift for all the models are presented in Y-direction in the above graph.

E. Time Period

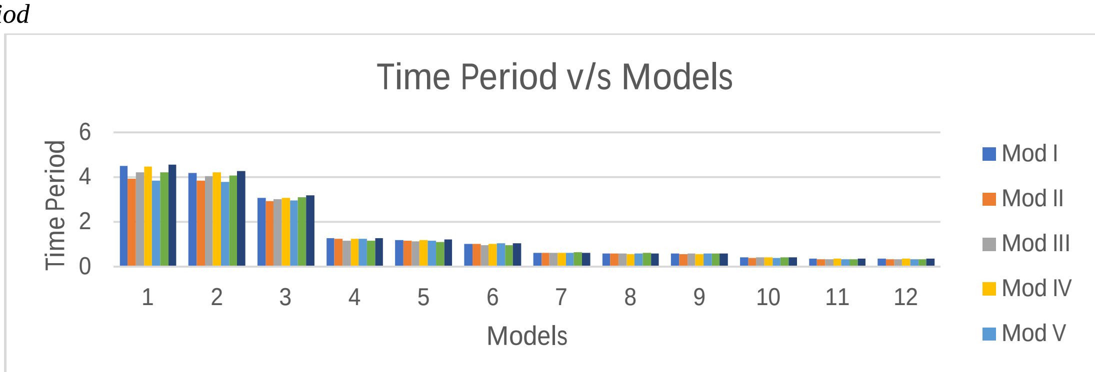

Fig. 5:Time Period v/s all models

Time period for storey 1 gives the maximum time as compared to the other storey while the model VII in storey 1 gives the maximum time period.

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F. Storey Shear-X

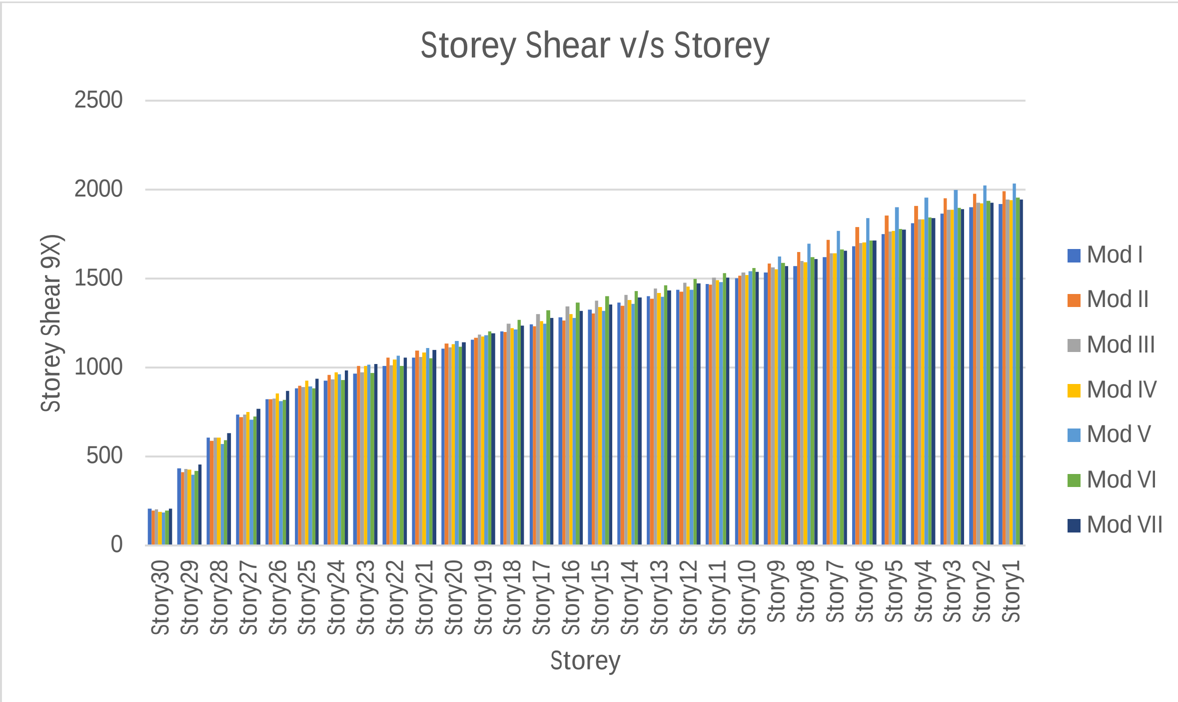

Fig. 6: Storey Shear v/s Storey

Storey shear for storey 30 gives the minimum results as compared to other storey as presented in the above graph.

G. Storey Shear-Y

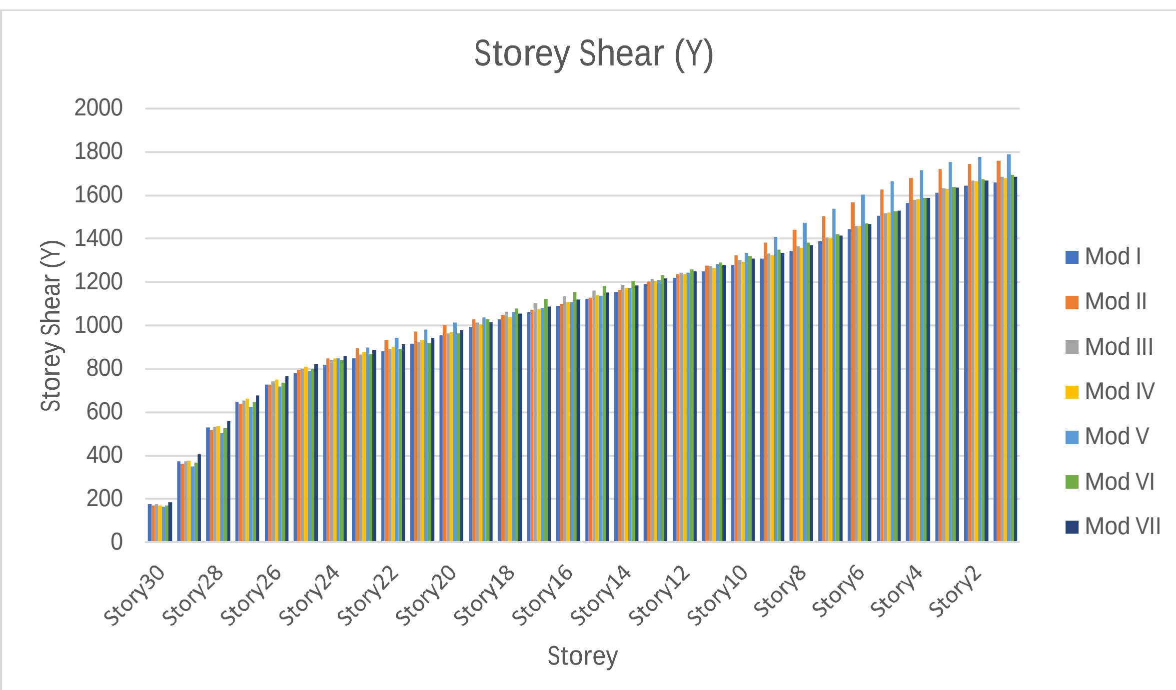

Fig. 7: Storey Shear (Y) for all models

From the above graph it is clear that the storey shear is maximum in storey 1 as compared to the other stories. The model V gives the maximum results as compared to the other models.

V. CONCLUSION

It is observed that the time period of vibration is more for Model I (Building without any Outrigger system). While it is considerably reduced for models II, III, IV, V, VI and VII. Period of vibration is found to be minimum for Model VII.

There is no considerable change in Base shear of model II , model III , model IV, model V. Model VI has base shear is reduce to 8% of model I (Building without any Outrigger system).

Large displacement occurs in case of without outrigger system building (Model I). It is seen that the use of X bracing at 12th & 24th Storey (Model II), use of peripheral shear walls at 12th & 24th Storey (Model III) and use ofperipheral shear walls at 8th, 16th & 24th Storey (Model IV) reduces the displacement up to 4.3%. The building with use of External X Brace at 8th, 16th &24th Storey (Model V) reduces the displacement up to9.5%.

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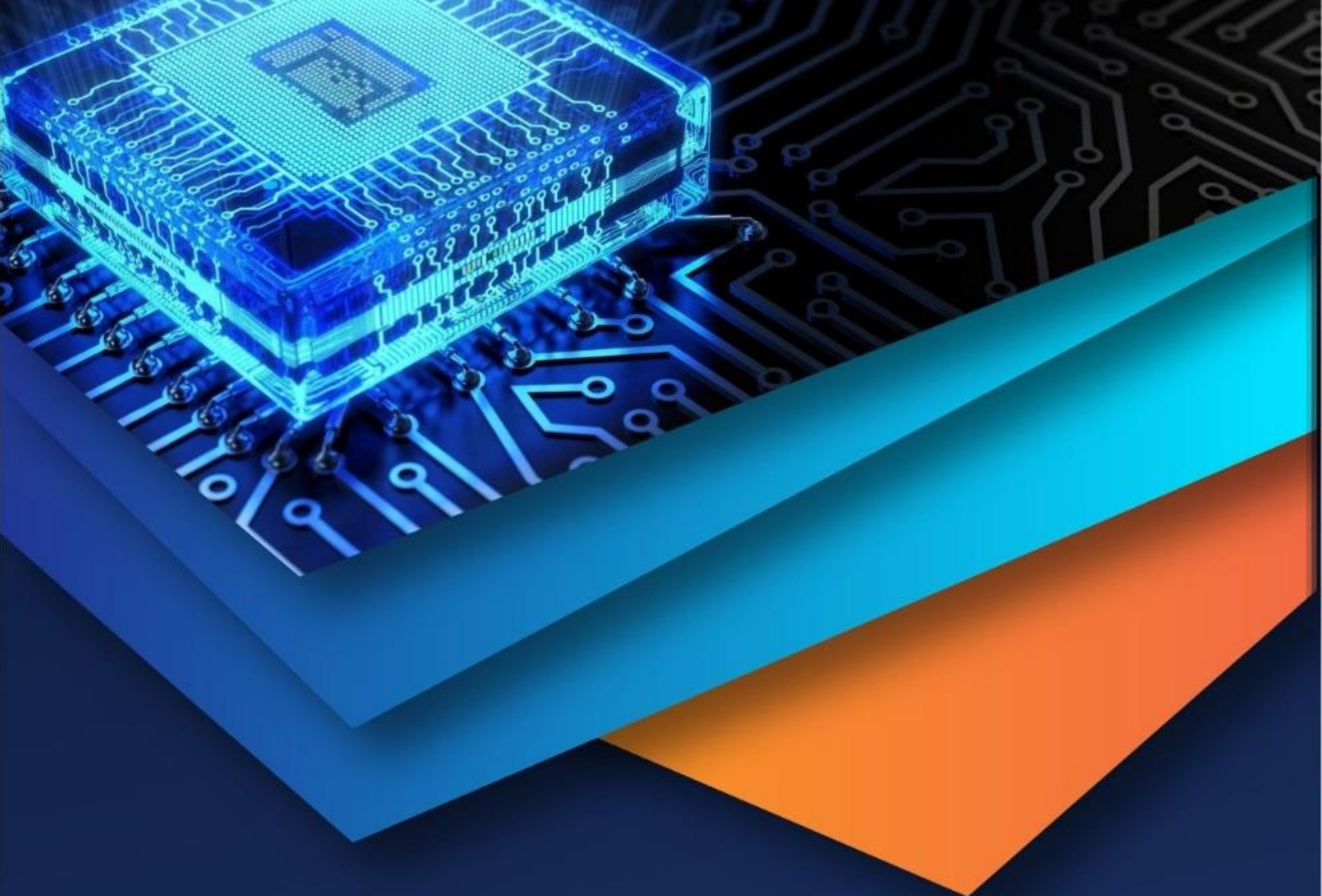

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