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Stability Assessment of Reinforced Concrete Building Using Outrigger and Truss Belt System

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Abstract: For the study, we have considered ten test models, out of which one model is not having shear wall. This model is called bare frame. From the bare frame model other nine test models with shear wall is compared in order to define the optimum location of shear wall for L shaped building. Dynamic Analysis is done for the comparative study of the models. We have used standard software package of CSI ETABS ver. 16.0.0 for the modeling and analysis of the structure. Under dynamic analysis, we have limited ourselves to RSA & THA Both of these analyses are done under elastic limit. For Response Spectrum Method, we have considered the graph for Seismic Zone V with medium soil for a damping ration of 5% and importance factor as '1'. The RS Analysis has been carried out according to IS 1893 (Part-1):2016 by using CSI ETABS ver. 16.0.0. For Time History Analysis, we have used the time history data of Array Recording Station, El Centro, USA. The data is under the software package. We have determined the suitable configuration of shear wall in building, on various ground of comparison which is defined in the thesis.
Index Terms: Equivalent static method, Framed structure, Lateral loads, Maximum story drift, Response spectrum method, Seismic force, ETABS, PMM ratio.

I. INTRODUCTION

According to the code forms by Indian Government to decide the specifications for urban construction any building has its total height more than or equal to 22.5 m comes under the class of high rise building. In the design of single or two or three storey building only the self-weight and the weight of persons living or using that place is considered but for designing such high rise buildings some other important loads like wind forces and accident load is to be considered along with the ordinary loads. This make the design part critical for the civil engineers so now a day the focus of the structural engineers is to make the deign safe and economical as well. For this some advance techniques like retrofitting or strengthening are being widely adopted in the urban sector. It is quite simple to study that any geometric figure or body having symmetric arrangement will have its center of mass and gravity at its center of geometry but the problem faced during design of irregular or asymmetric structure like L, T and other shapes. Here it is very essential to check whether the eccentricity is within limits or not. Same problem occurs when some open space or free space is provided at the center or any other place in the plan that is simple known as discontinuity of the structure. These hollow gaps effect the performance of the structure in terms of lower design values and higher values of stresses and deflection hence need specific attention during the calculation of forces and other parameters. In our analysis we have tried identify the best suitable position where structural wall system can give better performance as retrofitting. Earthquake is unexpected, quick vibration of the ground Clause by the liberate of the power stored in the rocks. Power released basis of trouble, inside the earth is transferred to neighbouring land/water to shake. It affect on the entire built upbringing. . It damages the structure which is indirectly kills peoples. We are heavily needy upon the public facilities or life lines like water supply, electric power supply, drainage. It disturbs civic amenities in a major way. Lifeline amenities like hospital, health care centres have a major role in natural catastrophe like earthquake. Hence additional care while designing such structures is needed. Damage of tradition buildings can make us root less. A severe earthquake can have very damaging penalty upon a reign's development and economy.

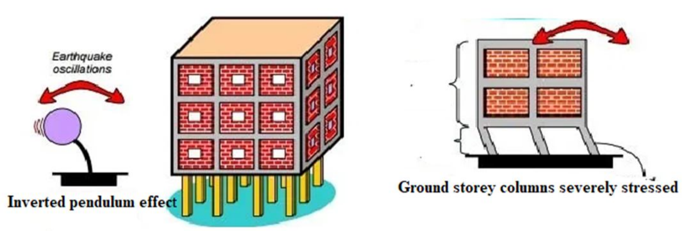

Figure 1: Behaviour of a soft Story during earthquake

RC buildings are of two types one is framed buildings and other is load bearing structure, in today's era load bearing buildings are rare to watch most of the structures are of frame type just because of its simplicity and advance load transfer mechanism. The framed building have some problems also , one of them is the load transfer only done by beams and columns , walls are not considered as a load bearing members here, so that the strength of the building may get reduced for long term.

Originally a nautical phenomenon, outriggers have been used for millennia as extended floats attached to canoes to provide stability and so avoid overturning. The same principle has been used since the 1950s in construction to provide lateral stability to tall, narrow buildings.

The outrigger and belt truss system is one of the lateral loads resisting system in which the external columns are tied to the central core wall with very stiff outriggers and belt truss at one or more levels. The belt truss tied the peripheral column of building while the outriggers engage them with main or central shear wall. The aim of this method is to reduce obstructed space compared to the conventional method.

Outriggers are typically horizontal structures (usually trusses or reinforced concrete walls) inserted into buildings at various levels to tie the concrete core to the outer (or perimeter) structural framework. They can be tied to the core and combined with exterior columns, or may be connected to a super- or mega-column.

Outriggers add strength and stiffness to a structure that is far in excess of what may be available at specific locations throughout the building's height. There is no one-size fits all and so the design of outriggers will usually be unique to suit the specific application.

The structural efficacy of outriggers will depend on their distribution through the building's height, the number of outrigger levels, their configuration on plan, the depth of the outrigger truss or wall, the materials used and other considerations. But the effect of constructing an outrigger and thereby connecting the core with perimeter columns creates a unified lateral load-resisting system that can reduce the overturning moment at the core by up 40% to 60% in tall and super-tall buildings respectively.

Tall or slender buildings, such as 432 Park Avenue, New York, or 22 Bishopsgate, London, will often feature a core and outrigger system to resist lateral loads. In such cases, the overturning moment is large compared to the shear, and the flexural deformations of the building contribute greatly to lateral deflection e.g drift. Outriggers provide increased stiffness and so can reduce building drift (the sway experienced at the top of very tall buildings), thereby reducing the building accelerations during strong winds which might otherwise cause discomfort to occupants.

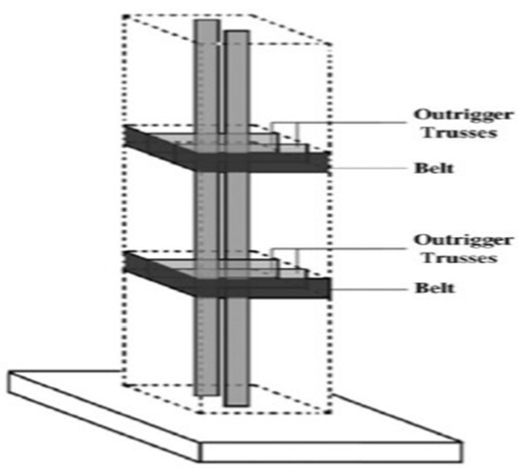

Figure2: outrigger beams with truss belt system

II. OBJECTIVES OF THE STUDY

The determination of stability of outrigger beams with truss belt system will consist of following objectives –

1) To review the comparison of lateral Displacement of various floor levels and storey displacement of bare frame models and other test models due to application of extreme response as per RSA.
2) To the compare Shear force at selected floor beam member of conventional structure model with implemented structures on application of extreme response as per dynamic earthquake loading.
3) Comparison of Base Force, overturning movement of conventional structure frame model with various new structure on application of extreme response as per RSA Method.
4) To study the suitability of outrigger beams with truss belt system in High Rise RC structure.

III. METHODOLOGY

This project work is carried out using ETABS that is a very powerful tool which is widely used for design and analysis of multistory buildings. It is used to evaluate basic and advanced systems under static or dynamic conditions. For a refined assessment of seismic performance, modal and direct integration time-history analysis, may couple with p-delta and large displacement effects. The modeling of various regular and building is very easy in ETABS.

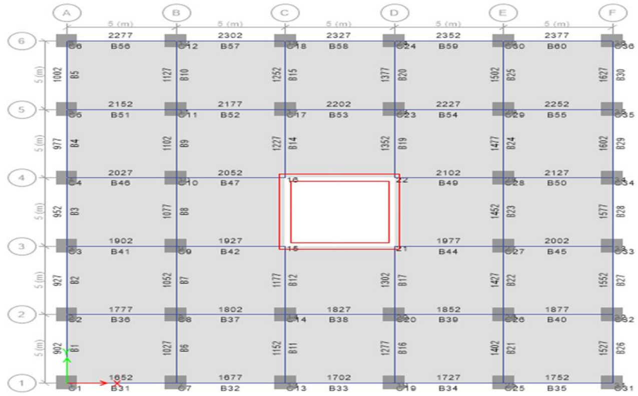

Figure 3: Plan view of the structure

Table 1: Cases Considered for the Study

Specifications	Data
Typical Storey Height	3 m
Base Storey Height	3.0 m
No. of bays along_X-Direction	5
No. of bays along_Y-Direction	5
Bay Length along_X-Direction	5 m
Bay Length along_Y-Direction	5 m
Concrete Grade	M-40
Density of R.C.C.	25 KN/m3
Density of Masonry	20 KN/m3
Columns (perimeter)	800_mm_x_800mm
Beams_	600 mm x 300 mm
Slab Thickness	160 mm
Bottom Support Conditions	Fixed
Live Load- Roof Rest of the structure	 2 KN/m2 3 KN/m2
Soil Conditions	Type_2_Soil (medium)
Damping Ratio	5%, as per IS-1893: 2016 (Part-I)
Poisson Ratio	0.2
Response Reduction Factor	1_
Importance Factor	_1_
Zone Factor	0.36 As per IS1893- 2016_(Part- I) for _Seismic Zone V
Shear Wall Thickness	250
Box/ Tube Section	IS 500X500X70

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IV. RESULTS

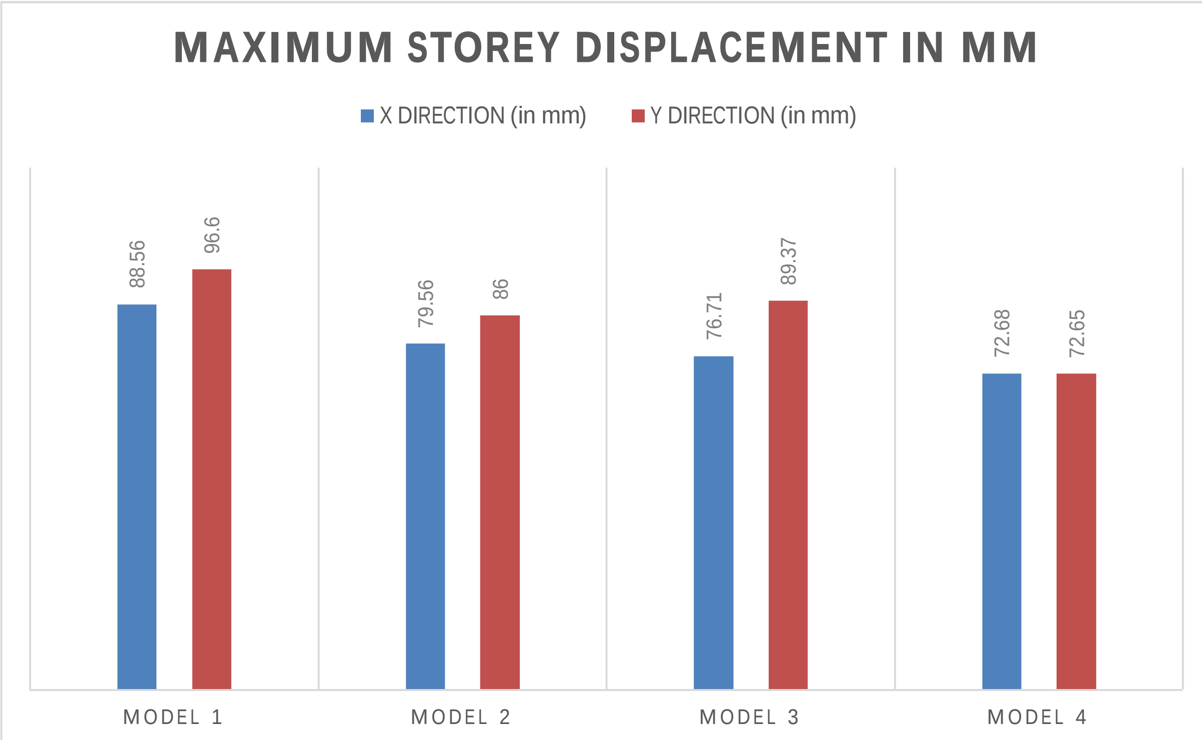

Figure 4: comparison of max. Storey displacement from response spectrum method

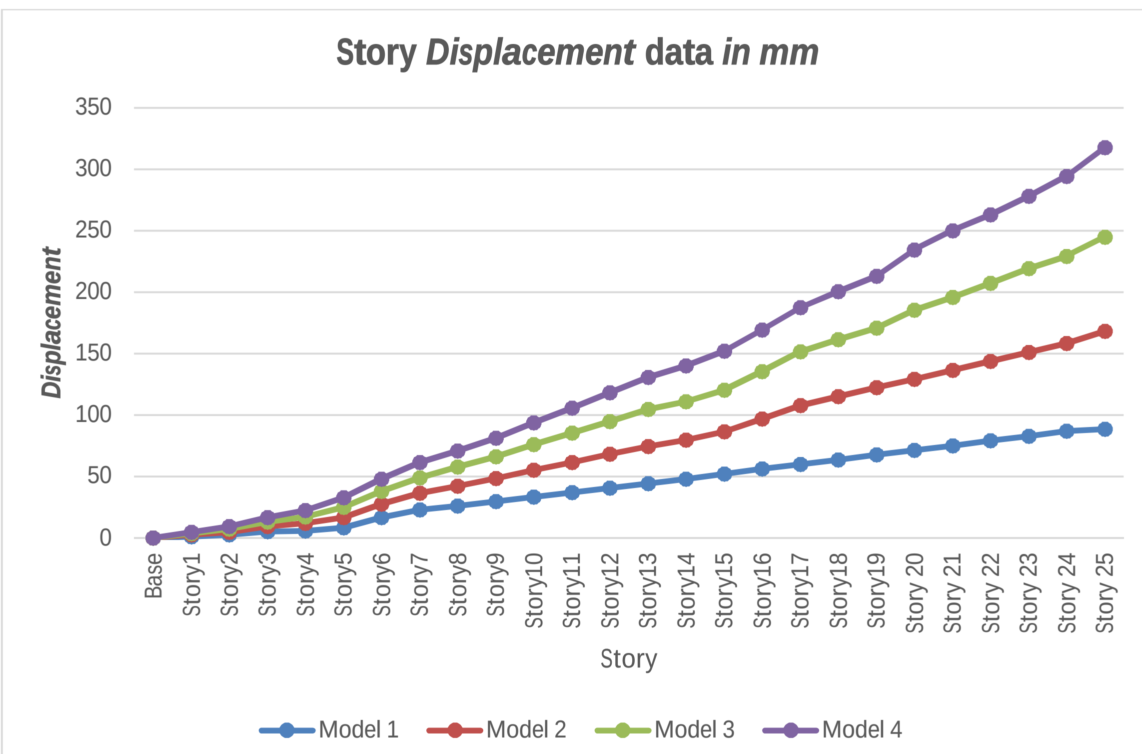

Figure 5: representation of Storey Displacement

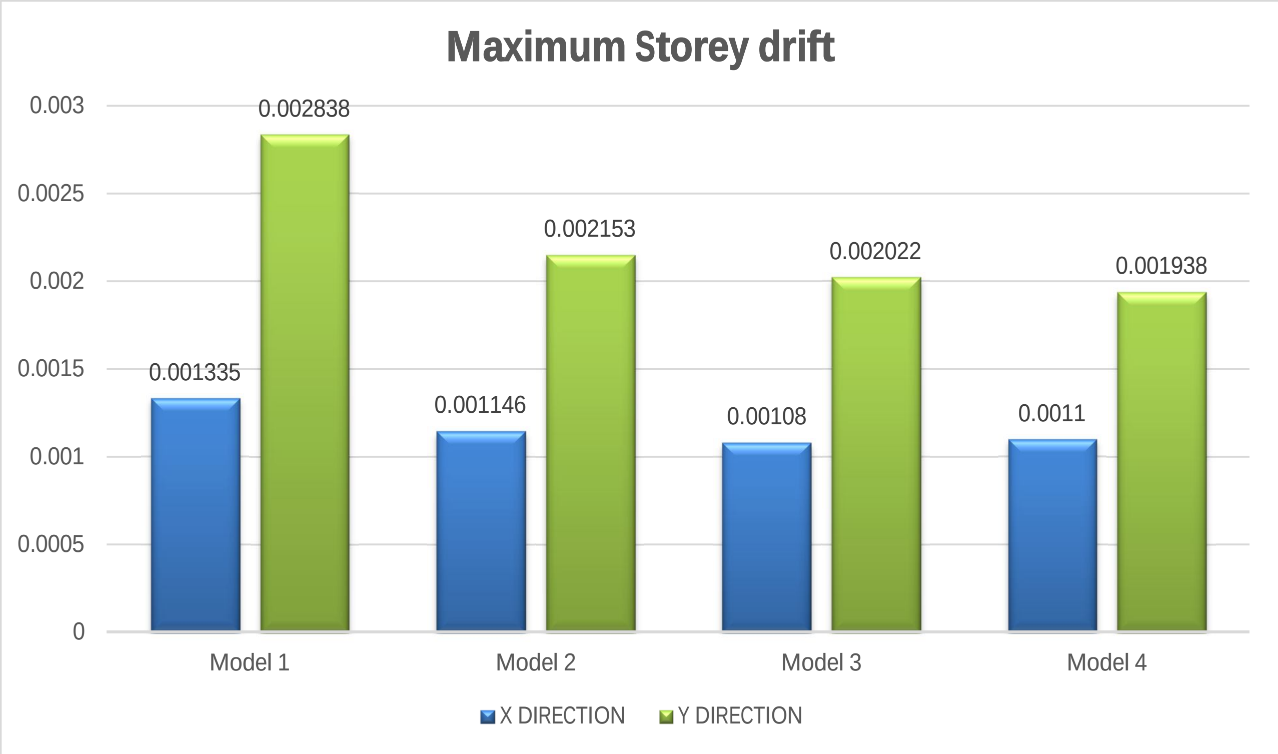

Figure 6: Comparison of max. Storey Drift from Response Spectrum Method

V. CONCLUSIONS

The different arrangement of outrigger are beneficial to reduce bending moment. it is found that implementation of outrigger with truss belt system is one of the important factor of earthquake design. From the test models, M-4 {Structure with outrigger beams with truss belt system} was considered as the model with optimum usage of outrigger. The optimum usage of outrigger is based on minimum story displacement, also lesser values of story drift. The dimensions of structural members are considered the same for both the structures, the effectiveness of Outriggers-Belt truss structures posed substantial resistance against the load conditions. The Outriggers belt truss system resisted the gravity loads without any interior columns, thus making the structure economical and cost-efficient. The Outrigger-Belt truss system strongly supports the earthquake design philosophy of Strong Column and Weak Beam which maximizes the efficiency of the structure.

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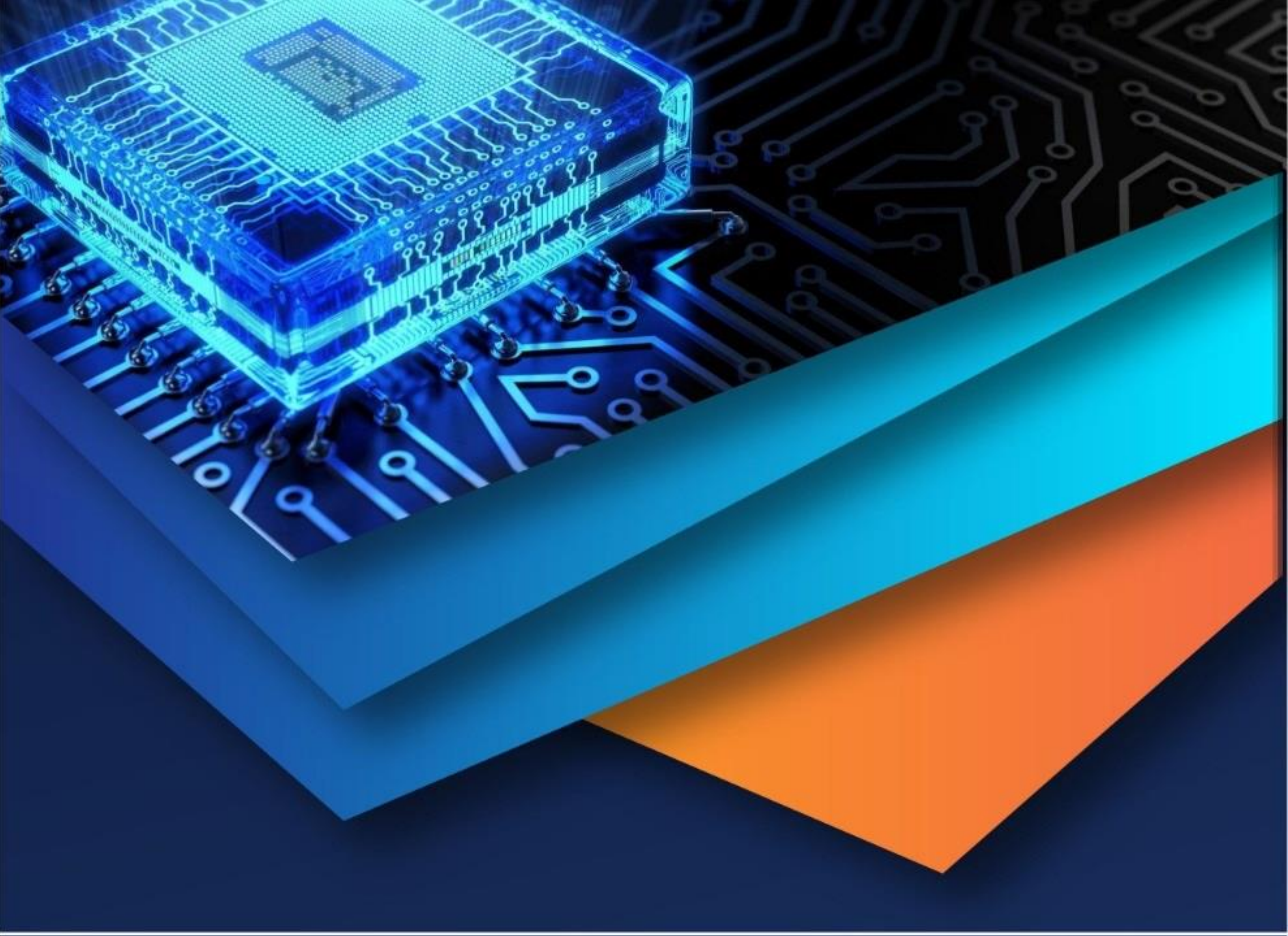

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