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Analysis of Seismic Behaviour of RC Frame Structure with and without Bracing System

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Abstract: RC Building In recent decades, the building industry has relied heavily on RC structures for the most practical content. Seismic design is primarily used to provide strength, stability, and adaptability. It is necessary to build a structure that can withstand seismic loads. The system's structural bracing component has a significant impact on how the structure behaves during earthquakes. Massive steel-framed buildings' bracing patterns can alter how the worldwide seismic activity behaves. In this study, a G+11-story RC frame building with a varied bracing system arrangement is subjected to linear static analysis. The dimensions of the beam (450 x 600 mm), the columns (450 x 700 mm), the thickness of the slab (180 mm), the density of RCC (25 KN/m3), the density of the masonry (20 KN/m3), the thickness of the wall (230 mm), the height of the parapet wall (1 m), the height of each floor (3.2 m), the live load on a typical floor (4.0 KN/m2), and the live load seismic calculation (0.75) are some of the parameters used in this work. Bracings are compared using different section types, such as ISMB350 sections. Steel buildings are analysed using the Staad Pro software program, which compares several parameters. The section's properties are employed in accordance with IS: 456:2007 and IS 800:2007, which analysed several bracing types, such as X, V, and without bracing, and compare the performance of each frame using the linear static method. In this research, a G+11 with a square building plan measuring 20 m by 28 m, with 3.2 m for each level, is modelled. The structure is constructed using the linear static method in Staad Pro software, and an earthquake analysis of the structure is conducted in seismic zones III with medium soil conditions.
Keywords: Seismic zone, Soil type, G+11 Multistory Steel Building, different type Bracing, Software etc.

I. INTRODUCTION

The earth's crust produces earthquakes, which are a natural occurrence. In typically, earthquakes last anywhere from a few seconds to a minute or longer. However, thousands of people are killed by earthquakes in various places of the world. A major loss would be the collapse of a building or damage from ground motion during an earthquake. Experience has shown that high frequency vibrations in the building cause inertial forces on the structure and its constituent parts during an earthquake. Even though the building is rising from the earth below, it is still in its original place because of the force of the tendency to stay at rest. In order to accurately predict the seismic reactions of non-deterministic characteristics, it is necessary to assess the seismic sensitivity of structures and seismic activity levels beyond standard linear behavior. This is a very complex subject. Bracing systems are the primary determinant of stable performance. One more plastic deformation bracing system that can absorb more energy during an earthquake should be installed before it is destroyed. A subset of the earthquake response of a building's structure is determined via seismic and structural analysis. The procedure includes structural engineering, structural design, seismic assessment, and retrofit locations where earthquakes are common. Strengthening, stabilizing, and adapting are the main goals of seismic design.

A. Bracing System

The main purpose of a braced frame structural system is to withstand seismic and wind stresses. Like a truss, the members of a braced frame are made to function in both tension and compression. Steel members are nearly usually used to make braced frames. Moment resisting and concentrically braced frames, two popular lateral force resisting systems, typically offer cost-effective solutions for one of the two needs but not both. For example, while concentrically braced frames are stiff and have a limited capacity for energy dissipation, moment resisting frames are ductile and frequently too flexible to economically meet drift control requirements. Eccentrically braced frames have recently been promoted as a cost-effective way to address the seismic design issue. An eccentrically braced frame is a type of generalized framing system where shear and bending in a section of the beam transfer the axial forces generated in the braces to a column or another brace. The term "active link" or just "link" refers to this crucial beam portion, which will be identified in this context by its length e. Through material yielding, these linkages work to disperse the significant quantities of input energy from a strong seismic event.

B. Objective of study

The objective of the study comprises of the following:

1) Comparative study of the behavior of different type of bracing structures such as with and without braced, inverted V-braced.
2) To perform the Linear Static Analysis on steel structures.
3) To compare the different bracing steel structures such as with & without bracing.

II. LITRATURE REVIEW

An easy way to comply with IJRASET paper formatting requirements is to use this document as a template and simply type your text into it.

1) Jagdeesh Bommisetty, Dr**.** G, Rajesh Kumar etc**.** al**.** **(**2019**):-** Seismic analysis of steel-framed buildings in earthquake zone V with medium soil conditions (without bracing and with various bracing systems). Using the response spectrum method in SAP2000 V16 software, they compared and analyzed the structure with two bracing systems—global and concentric—as well as a moment-resisting frame. They took into account a number of parameters, including the fundamental time period of vibration, storey drift, and storey displacement for different building heights (20, 60, and 100 meters). They found that while all bracing systems improved earthquake performance, the global bracing system significantly improved, followed by the K bracing and X bracing frame.
2) K**.** M**.** Bajoria, K**.** K**.**Sangle, etc**.**al**.** **(**2012**):-** They investigated the seismic analysis of steel-framed high-rise buildings with and without bracing systems. A structural system's bracing element is crucial to how the structure behaves during an earthquake. The bracing pattern can significantly alter the framed steel building's overall seismic performance. In order to prepare for the Northridge earthquake, he included a linear time history study of high-rise steel buildings with various bracing system patterns. Various bracing system patterns are used to compute natural frequencies, fundamental time periods, mode shapes, inter story drift, and base shear. To determine the best kind of bracing pattern, more optimization was done while maintaining the inter story drift, total lateral displacement, and stress level within acceptable bounds. According to his observations, bracing elements will significantly impact how a structure behaves during an earthquake. According to the data, base shear might increase by up to 38% as a result of bracings in both directions. With varying bracing styles, the building's roof level displacements decrease from 43% to 60%. Additionally, the modal time period is shortened by 65%. The diagonal brace is a very cost-effective and efficient bracing design.
3) K**.** S**.** K**.** Karthik Reddy etc al **-** He investigated the relative seismic behavior of a multistory steel building with a G+15 plan measuring 25 m by 25 m, six bays oriented in X and Z directions, member load of 10 kN/m, dead load of 3 kN/m2, live load of 2 kN/m2, response reduction factor 3, importance factor 1, depth of foundation of 3 m, and damping ratio of 5% with various racing types and configurations. Lateral stiffness was taken into consideration when designing the steel tall building frame since the steel structure is prone to lateral or torsional effects when subjected to lateral loads. He investigated the relative seismic behavior of a multistory steel building with a G+15 plan measuring 25 m by 25 m, six bays oriented in X and Z directions, member load of 10 kN/m, dead load of 3 kN/m2, live load of 2 kN/m2, response reduction factor 3, importance factor 1, depth of foundation of 3 m, and damping ratio of 5% with various racing types and configurations. Lateral stiffness was taken into consideration when designing the steel tall building frame since the steel structure is prone to lateral or torsional effects when subjected to lateral loads.
4) Kartik Prashar, Jagdeep Singh Gahir **(**2018**) :-** He investigated the seismic analysis of the structure utilizing various bracing systems, such as diagonal, V, inverted, and K types, which are used in column members to withstand lateral loads. Using Etab software, the structure in seismic zone V was analyzed and compared to bare-framed and bracing system-framed structures. He found that the bracing system decreased shear stress and bending moment in columns, and that the displacement of the structure and structures with various types of bracing decreased storey drift.
5) Krishnaraj R**.** Chavan, H**.** S**.** Jadhav **(**2014**):-** They examined RC G+6 framed buildings with various steel bracing system configurations, including diagonal, V, inverted V, and X types. According to Indiana Standard Code IS 1893:2001, the building was studied using the linear static approach in Staad Pro software in seismic zone III with a medium soil site and importance factor 1, among other factors. In contrast to previous bracing systems, he found that the X type of steel bracing system expressively increases the stiffness and lowers the maximum interstory drift of RC building structures.
6) Ms Deepika C**.** Hiwrale etc al **-** Using equivalent static analysis in Staad Pro structural software, she examined and designed high-rise steel building frame structures with and without steel plate shear walls. According to IS:1893-2002, the steel moment-resisting building frame of a G+6 story building situated in earthquake zone III was examined. He found that the steel plate

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shear wall had a significant impact on the structure during an earthquake, that the infill plate increased the structure's stiffness, that the deflection in the frame without SPSW was much greater than that in the frame with SPSW, and that the building frame's bending moment, shear force, and column deflection were all reduced with SPSW, making the steel building frame structure more cost-effective than it would have been without SPSW.

7) Prof**.** G.D. Dhawale, Prof**.** N**.** P**.** Shende, Amol V**.** Gowardhan **(**2016**):-** Using SAP2000 software with sections like ISMB, ISMC, and ISA, they examined the residential steel building frame structure of G+15 without bracing and with various bracing systems, including diagonal, K, inverted V, and K type bracing, along with the gravity load structure. They compared the same bracing system pattern with different bracing system positions in earthquake zone III. They discovered that, in comparison to a frame structure without bracing, the steel bracing system decreased flexure and shear on beams and columns, al force rose in comparison to the building structure without bracing.

III.MATHODOLOGY

The seismic performance i.e., analysis of steel structures is attempt in the current project. For this, the proposed methodology is as follows:

1) An extensive survey of the literature on the response of steel structures to seismic loading is performed.
2) Different type of steel structure are taken and analyzed by Linear Static Analysis.
3) Different type of steel bracing system of RC structures are taken and analyzed by different ground motion with the help of Staad Pro Software.
4) Calculate the different results of RC structure i.e. without bracing and with Steel bracing.

The current effort attempts to analyze steel constructions' seismic performance. The following is the suggested methodology for this:

- The literature on how steel structures react to seismic loads is thoroughly reviewed.
- Linear Static Analysis is used to examine various steel construction types.
- Using Staad Pro software, several steel bracing systems for RC constructions are taken and examined by various ground motions.
- Determine the differences between the RC structure's outcomes with and without steel bracing.

a) Making use of Staad Pro.
b) Developing the structure's building plan.
c) Using structural properties such as beam, column, slab dimension, and support.
d) Using loads such as dead, live, seismic, and combination loads in accordance with IS code.
e) Obtaining outcomes in the form of maximum axial force, maximum story displacement, maximum bending moments, maximum story shears, etc.
f) Results Analysis: A visual analysis using Max Story Shears and Max Bending Moments. Maximum Axial Force, Maximum Story Displacement, etc.
g) Discussion of the Conclusion and Future Prospects.

A. Building Geometry

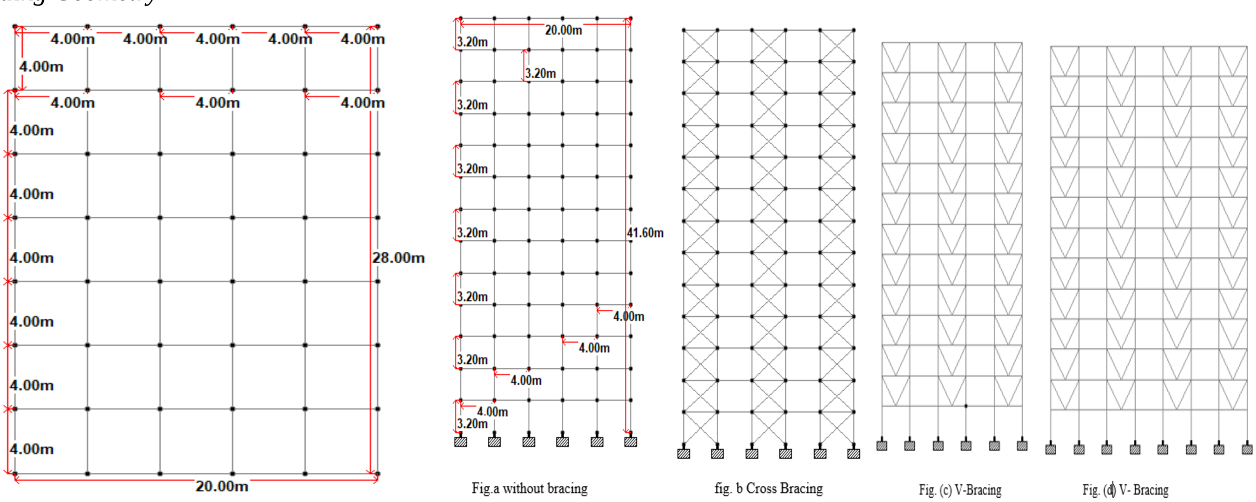

Fig.3.1 Building Plan configuration

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IV. MODELLING AND PROBLEM FORMULATION

A. Modelling Of Building Frames

Etabs is a general-purpose application used to analysed structures in seismic zone III and medium soil conditions. To accomplish that purpose, the following three tasks must be completed:

- creating a model with Staad Pro software.
- The computations used to get the analytical findings
- The tools in the system's graphical environment all encourage result checking.

1) Parameter Using

Type of Building: RC Framed Structure with & Without bracing System
Number of Floor: G+11 (Rectangular Shape Building)
Section Property: ISMB

2) Seismic Parameter

Seismic Zone- III
Soil Type- Medium Soil
Damping = 5% (as per table-3 clause 6.4.2), Zone factor for zone III, Z=0.24)
Importance Factor I=1.5 (Important structure as per Table-6)
Response Reduction Factor R=5 for Special steel moment resisting frame Table-7)
Sa/g= Average acceleration coefficient (depend on Natural fundamental period)

B. Geometry And Modelling

Grade of concrete is considered M25
Grade of Rebar is considered Fe-415
Grade of Steel –Fe-345

Description**:**

Table: Structural modeling specification of G+11 Buildings

Type of Structure	Without bracing	With bracing
Bay Width in longitudinal direction	20m	20m
Bay Width in Transverse direction	28m	28m
Total Height	41.60 m	41.60 m
Live Load	3.0 KN/m2	3.0 KN/m2
Floor Finishing	0.75KN/m²	0.75KN/m²
Wall Load	14.75 KN/m	14.75 KN/m
Grade of concrete	M-25	M-25
Type of Rebar	Fe-415	Fe-415
Type of steel	Fe-345	Fe-345
Each column height	3.2 m	3.2m
Support condition	Fixed	Fixed

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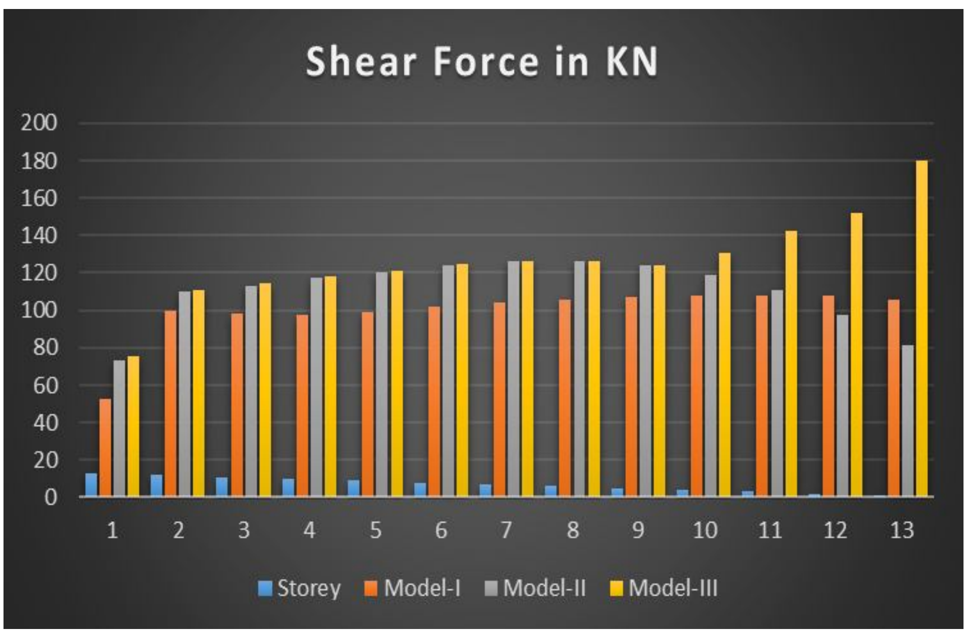
V. RESULTS & ANALYSIS

A. *Comparative Maximum Storey Shear*

Table 5.3.4: Storey Shear (KN)

Maximum Shear Force (KN)			
Storey	**Model-I**	**Model-II**	**Model-III**
13	**52.336**	**73.338**	**75.333**
12	**99.887**	**110.167**	**110.671**
11	**98.43**	**113.102**	**114.274**
10	**97.809**	**117.058**	**118.103**
9	**99.112**	**120.433**	**121.245**
8	**101.665**	**124.027**	**124.395**
7	**103.945**	**126.13**	**126.222**
6	**105.896**	**126.268**	**126.116**
5	**107.397**	**124.037**	**123.742**
4	**108.097**	**118.975**	**130.778**
3	**108.159**	**110.493**	**142.058**
2	**107.58**	**97.686**	**151.974**
1	**105.417**	**80.993**	**180.275**



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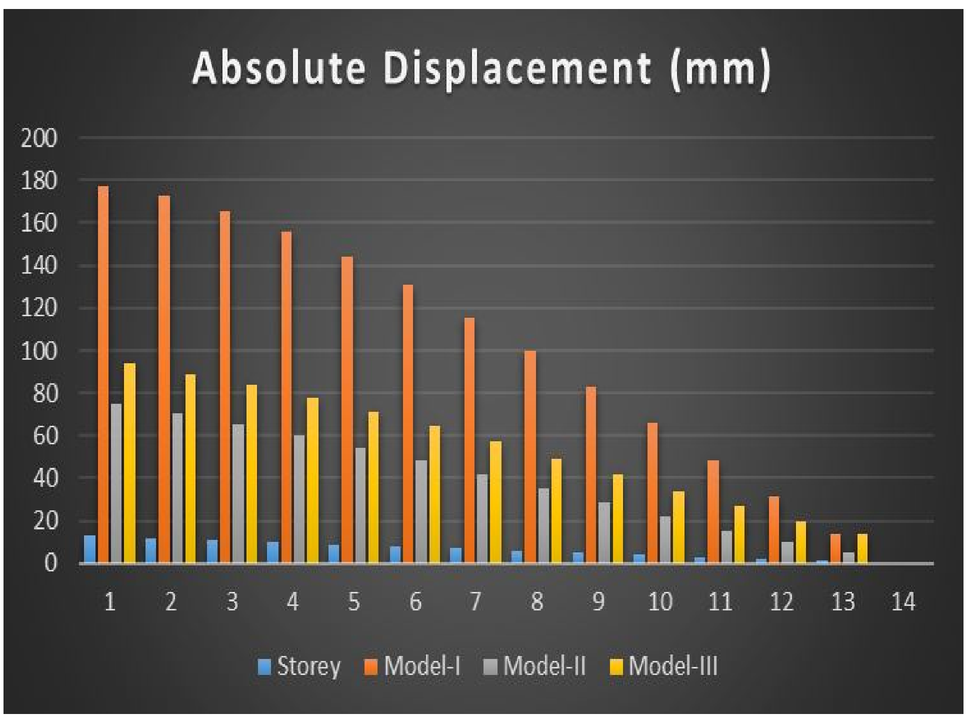
B. Comparative Maximum Absolute Displacement

Table 5.4.4: Comparative Maximum Absolute Displacement

Maximum Absolute Displacement (mm)				
Storey	**Node**	**Model-I**	**Model-II**	**Model-III**
13	**79**	**177.205**	**74.957**	**94.028**
12	**73**	**173.027**	**70.563**	**89.293**
11	**67**	**165.864**	**65.676**	**83.925**
10	**61**	**156.127**	**60.29**	**77.946**
9	**55**	**144.267**	**54.44**	**71.407**
8	**49**	**130.695**	**48.201**	**64.391**
7	**43**	**115.784**	**41.683**	**57.011**
6	**37**	**99.867**	**35.016**	**49.402**
5	**31**	**83.235**	**28.35**	**41.711**
4	**25**	**66.141**	**21.847**	**34.1**
3	**19**	**48.793**	**15.671**	**26.747**
2	**13**	**31.37**	**9.965**	**19.881**
1	**7**	**14.097**	**4.798**	**13.739**
0	**1**	**0**	**0**	**0**



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VI. CONCLUSIONS

A. *Shear Force*

1) It can be observed that the top floor has a minimum shear force of 52.159 KN and the third floor has a maximum of 108.159 KN. Additionally, it was discovered that the shear force gradually grew from the base to the third floor, reduced from the fourth to the tenth storey, then increased in the eleventh and twelfth storeys without bracing.
2) It is evident that the top floor has a minimum shear force of 73.388 KN and the sixth floor has a maximum of 126.268 KN. Additionally, it was discovered that in an X-type bracing structure, the shear force gradually increased from the base to the sixth storey and gradually dropped from the seventh to the top storey.
3) It is evident that the base floor's maximum storey shear force is 180.00 KN, whereas the top floor's is 75.333 KN. Additionally, it was discovered that the shear force gradually dropped from the base to the fifth storey and increased in the seventh storey. Additionally, the shear force gradually declined in the V type bracing structure from the seventh level to the top storey.

In general, the Model-III with V type bracing system had a maximum storey shear force of 180 KN, while the Model-I without bracing system had a minimum shear force of 52.159 KN.

B. *Absolute Displacement*

1) It can be observed that the structure's 13th storey top has the largest absolute displacement, measuring 177.205 mm. Additionally, the displacement decreases in order as the structure's storey height decreases, while the base of the structure, which is devoid of bracing, has zero displacement.
2) It can be observed that the structure's 13th storey top has the largest absolute displacement, measuring 74.957 mm. Additionally, the displacement decreases in order as the structure's storey height decreases, whereas the base of the structure, which has an X-type bracing system, has zero displacement.
3) The structure's 13th storey top has the most absolute displacement, measuring 94.028 mm. The displacement decreases in order as the structure's storey height decreases, while the base of the V-type bracing structure has zero displacement.
4) As a whole. The Model-I without bracing structure has the most absolute displacement of 177.205 mm, while the Model-II with X type bracing structure has the smallest absolute displacement of 74.957 mm.
5) It indicates that when we raised the floor of the constructions, the displacement progressively grew as a result of the structure's growing forces.

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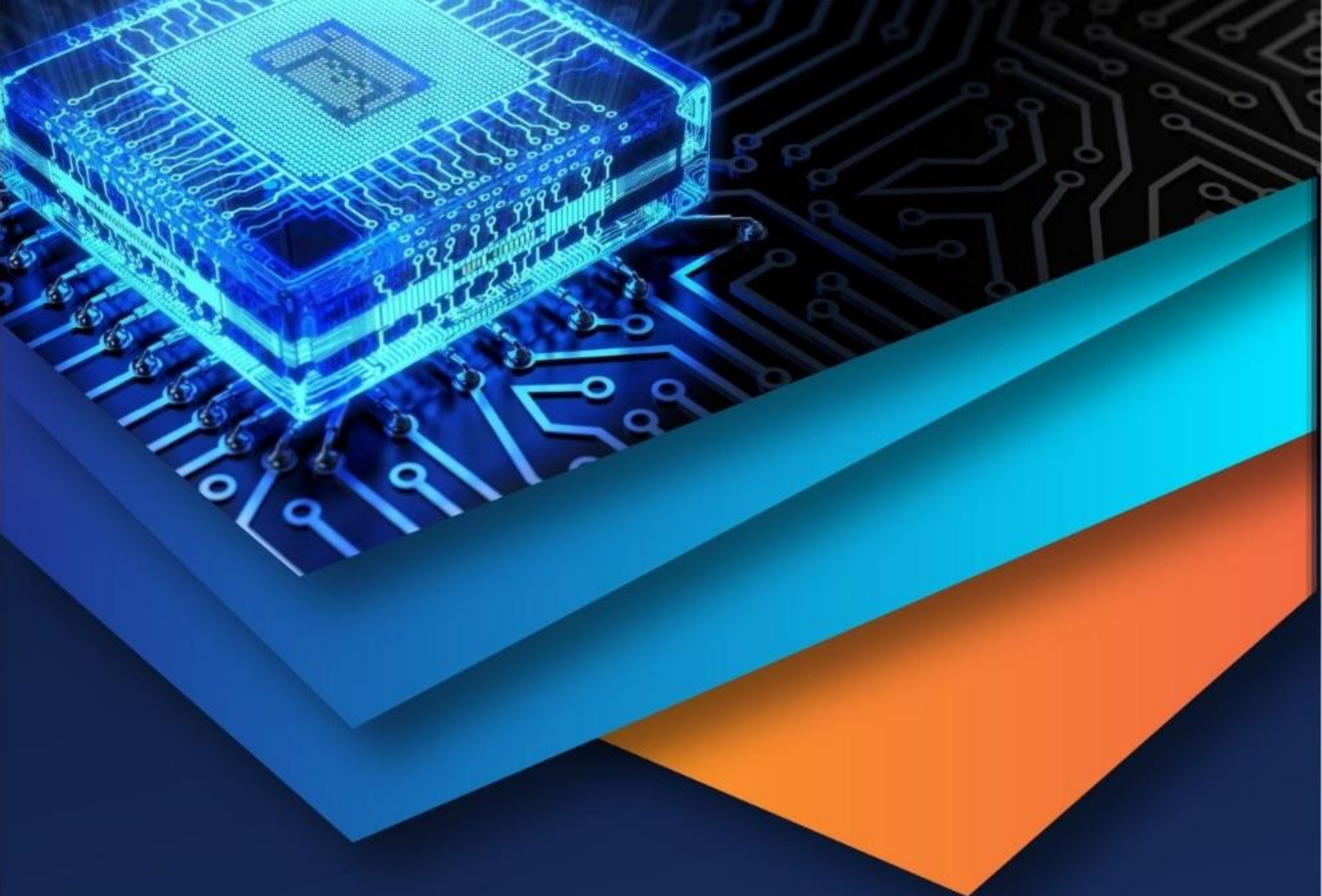

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