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Study on the Buckling Behaviour of Cold Formed Steel Lipped and Unlipped Column

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Abstract: In steel construction, cold-formed structural members are becoming more popular and have growing importance. Its growing popularity in building construction is due to its advantages over other construction materials such as lightness and consequent ease of erection and installation, the economy in transportation and handling. They are mostly used in the construction field as both primary and secondary structural members due to their advantageous features such as high strength to weight ratio, easy handling, fast construction, etc. Cold-formed steel is the common term for steel products shaped by cold working processes carried out near room temperature. The objective of this study is to examine the performance of CFS column subjected to loading. Numerical investigations are carried out by using finite element analysis software ANSYS. Using the ANSYS software the bucking behavior of CFS lipped and unlipped columns with different configurations are examined.
Keywords: Cold formed steel, Lipped column, Unlipped column, Buckling, Deformation

I. INTRODUCTION

Now a day, cold-formed steel section, has been widely used in civil engineering as structural elements, all over the world. Cold-formed steel products are the structural members made of thin sheet steel through pressing or rolling at room temperature. Stock bars and sheets of cold-rolled steel are commonly used in all areas of manufacturing. They are mostly used in the construction field as both primary and secondary structural members due to their advantageous features such as high strength-to-weight ratio, easy handling, fast construction, etc. In recent years, there has been a rapid increase in using cold-formed steel in various construction engineering applications for easier fabrication techniques of complex profiles, easier connection and construction with a high capacity to weight ratio, and high strength and stiffness of steel. Cold-formed steel structural members can lead to a more economical design than hot-rolled members. Cold forming procedures are used to create a vast variety of items with a huge variety of shapes, sizes, and applications from steel. In the building sector, cold-formed steel, particularly in the form of thin gauge sheets, is frequently used for structural and non-structural elements such as columns, beams, joists, studs, floor decking, built-up sections, and other parts. Cold-formed steel members have also been used in building structures, transportation machinery, bridges, storage racks, grain bins, car bodies, railway coaches, highway products, transmission towers, transmission poles, drainage facilities, firearms various types of equipment, and others.

Cold-formed steel elements are quality-assured materials that are suitable for mass construction. It exhibits a versatile nature which allows for the forming of almost any section geometry. It exhibits a versatile nature which allows for the forming of almost any section geometry. These sections are usually thinner and can be subject to different modes of failure and deformation and therefore extensive testing is required to provide a guideline for the design of cold-formed thin-walled structural members. Most of the codes of practice for usage of cold-formed steel sections in structural applications, deal only with static conditions of loading. In this paper, the performance of CFS column subjected to loading is evaluated. Numerical investigations are carried out by using finite element analysis software ANSYS 18.1. The analysis is done for lipped and unlipped columns in different configurations to find the deformation, maximum loading and also tho find the buckling behavior of columns. Cold-formed steel beams and columns exhibit complicated buckling behavior. Local buckling, distortional buckling, and overall buckling are the three generic forms of buckling. These forms often have different wavelengths and are limited to certain span ranges. Design regulations use either an effective width or an effective thickness for the plate element under consideration in order to account for the impact of buckling.

II. OBJECTIVE OF PRESENT STUDY

1) To analyse the load carrying capacity and deformation behaviour of CFS lipped and unlipped column in different configuration.
2) To investigate on the buckling behaviour of CFS lipped and unlipped column in different configuration.
3) To determine the best configuration of CFS column.

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III. STAGES INVOLVED IN FINITE ELEMENT MODELLING

A. Engineering Data

The material properties of cold formed steel section are explained here.

TABLE I

Youngs modulus	207 GPa
Yield strength	559 MPa
Poisons ratio	0.3
Density	$7850kg/m^3$

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B. Geometry

The sectional details of cold formed steel column are explained here.

TABLE III

DIMENSIONAL DETAILS OF LIPPED SPECIMEN

Specimen	Web dw (mm)	Flange bf (mm)	Lip C (mm)	Length L (mm)	Radius R (mm)	Thickness t (mm)
1	80	40	20	1000	4.73	3.15

TABLE IV

DIMENSIONAL DETAILS OF UNLIPPED SPECIMEN

Specimen	Web dw (mm)	Flange bf (mm)	Length L (mm)	Radius R (mm)	Thickness t (mm)
1	80	40	1000	4.73	3.15

TABLE V

WELDING DETAILS

Material	Thickness t (mm)
Structural steel	3

C. Modelling

The models are created using the ANSYS 18.1 software. Four columns with different configurations such as front to front and back to back are used in this study. This configuration is done by means of welding with structural steel material of 3mm thickness.

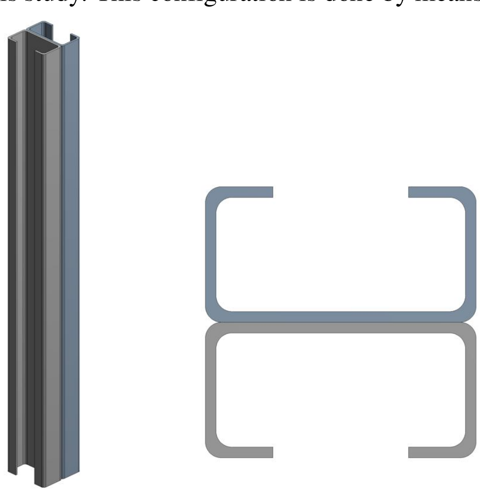

Fig: 1 Model of lipped column with back to back configuration

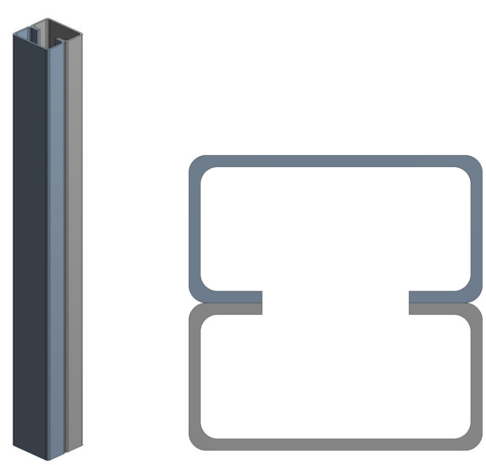

Fig: 2 Model of lipped column with front to front configuration

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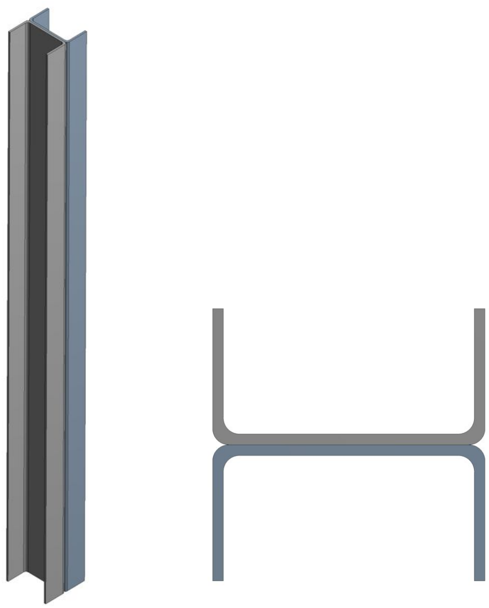

Fig: 3 Model of unlipped column with back to back configuration

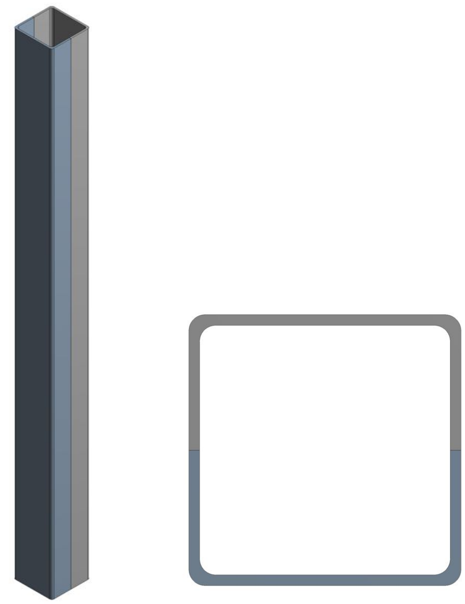

Fig: 4 Model of unlipped column with front to front configuration

D. Meshing

Meshing is done to reduce the amount of time and effort spent to get to accurate results. Since meshing typically consumes a significant portion of the time it takes to get simulation results, Ansys helps by making better and more automated meshing tools. Here the model is divided into number of Finite elements. A mesh size of 10mm is provided for all the sections.

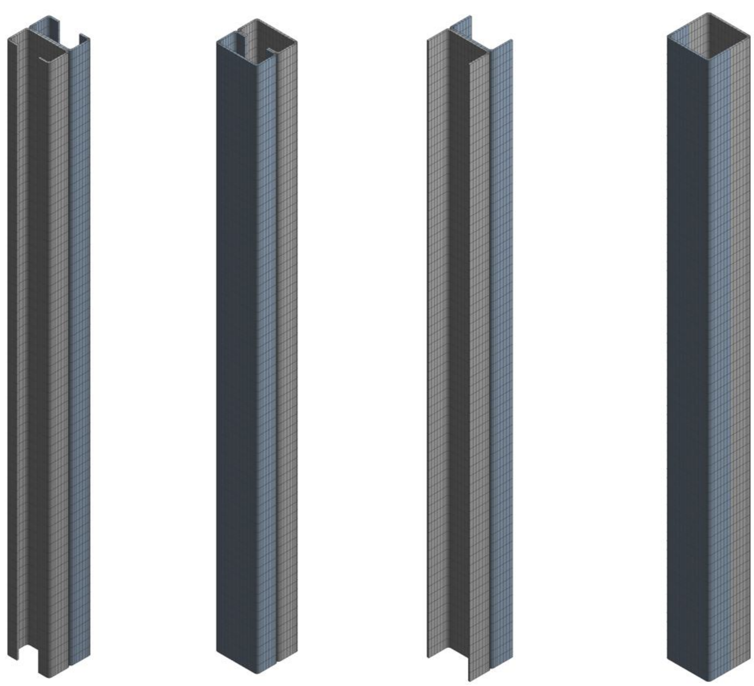

Fig: 5 Finite element meshing of columns

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E. Setup

In this case load and boundary conditions are applied to the ANSYS model. A displacement controlled vertical loading was applied on a reference point (Fig: 7). On the column Bottom support is kept as fixed support (Fig : 6) in which one of the rotation components is kept free and load is provided on the top support.

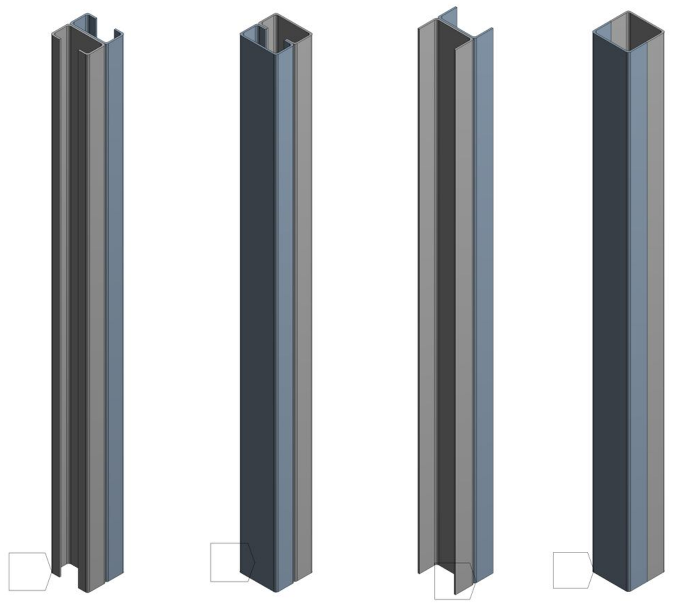

Fig: 6 Fixed support at the bottom of columns

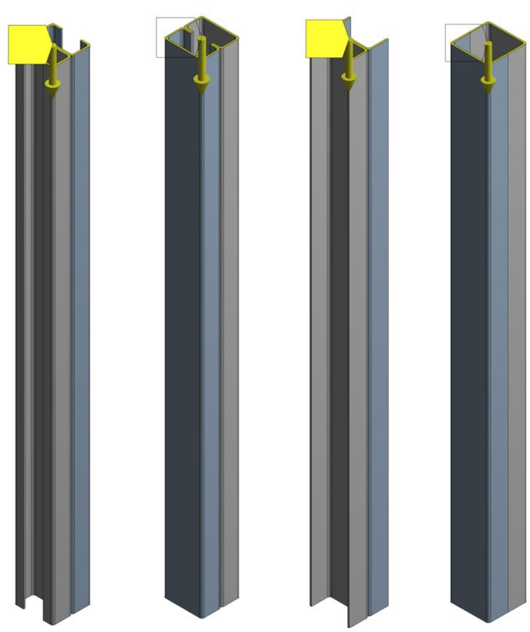

Fig: 7 Remote displacements at the top of columns

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F. Solution

Here results are obtained. The maximum deformation and maximum load are analyzed. The buckling behavior of the columns is also understood from the ANSYS 18.1 shown in Fig: 8.

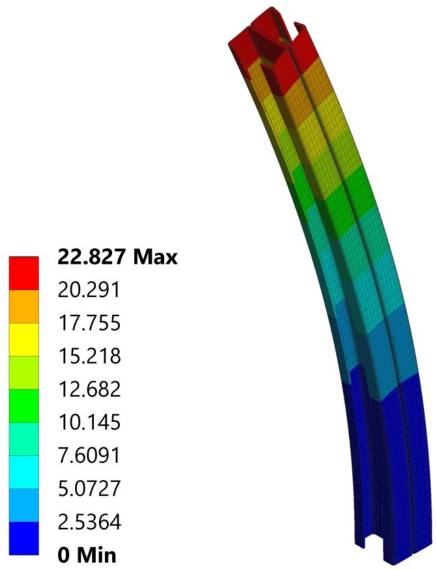

Fig:8a. Buckling behavior of lipped back to back column

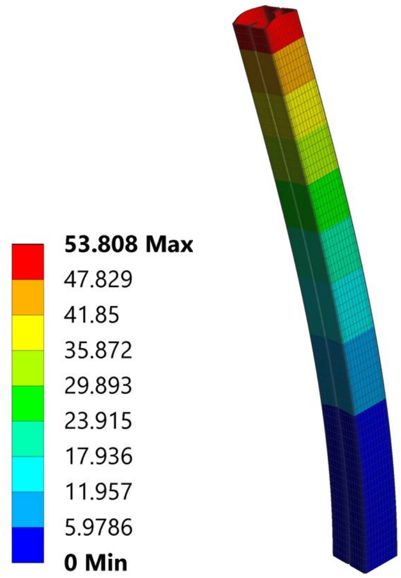

Fig:8b. Buckling behavior of lipped front to front column

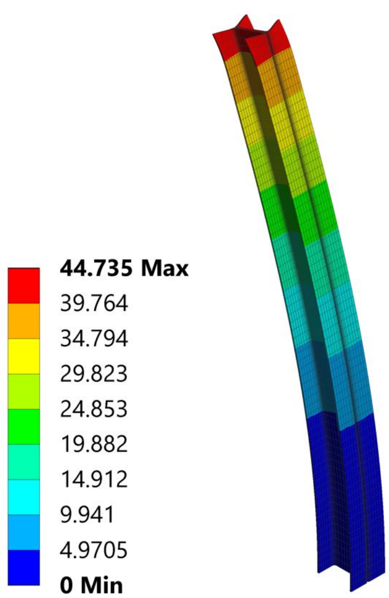

Fig:8c. Buckling behavior of unlipped back to back column

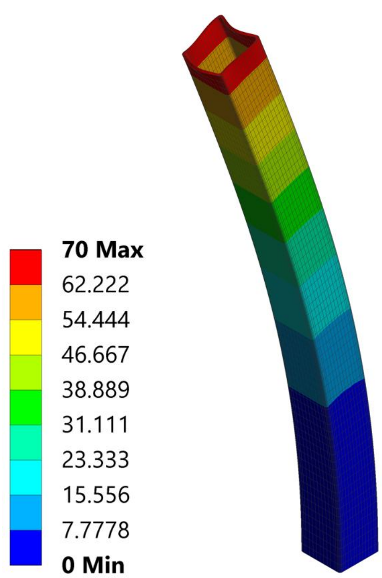

Fig:8d. Buckling behavior of lipped front to front column

G. Results and Discussion

After the analysis it is understood that the column under goes global buckling on loading. Global buckling is a buckling mode where the member deforms with no deformation in its cross-sectional shape. The load versus deformation graph is shown below. From the analysis it is understood the lipped column with back to back shows less maximum deformation on the loading and also it has the smaller deformation at maximum load comparing to other configurations of column.

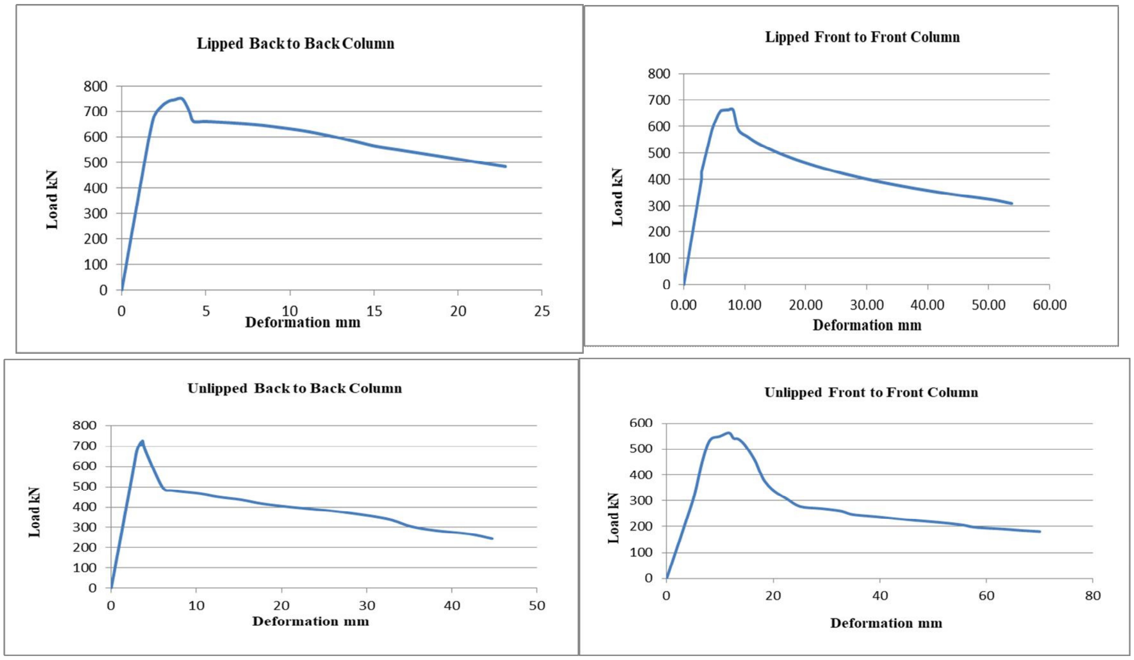

Fig:9 Load versus defamation graph of columns

TABLE VI
COMPASION OF COLUMN

Configuration	Load (kN)	Deformation(mm)
Lipped Column (Front to front)	8.08	662.22
Lipped column (Back to back)	3.6	749.16
Configuration	Load (kN)	Deformation(mm)
Uipped Column (Front to front)	11.70	562.23
Uipped column (Back to back)	3.7022	725.69

IV. CONCLUSIONS

This work deals with the numerical investigation concerning the behaviour of cold-formed steel lipped and unlipped columns. The study and review helped in better understanding of the buckling modes, deformation and maximum load cariying capacity.

1) From the analysis it can conclude that lipped back to back configuration column shows greater result compared to other configurations.
2) The lipped and unlipped back to back connection has the greatest load carrying capacity compared to front to front connections.
3) The back to back configuration column shows low deformation during the maximum load.
4) The global buckling behavior is shown in all columns. The

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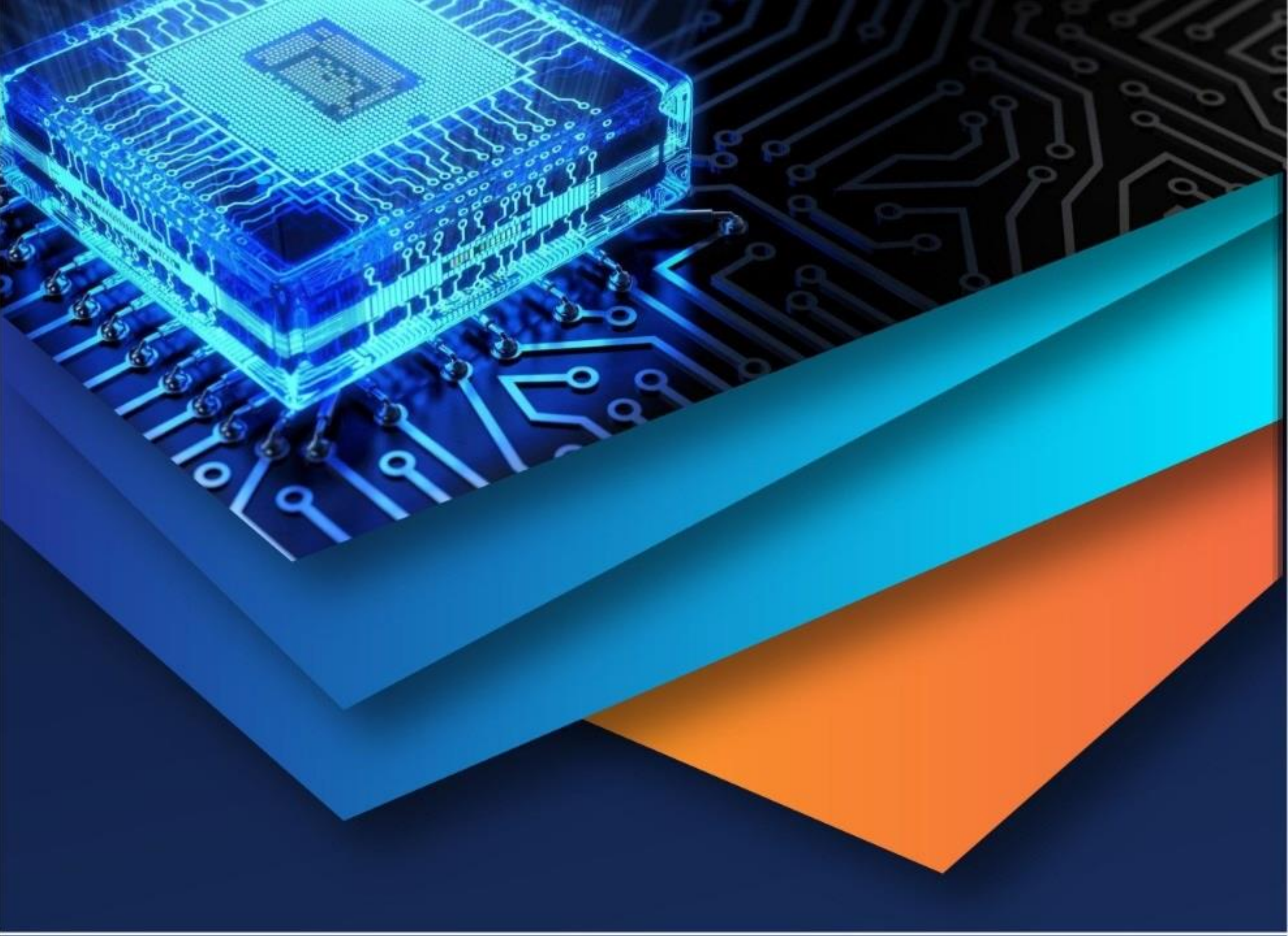

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