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Comparison between Manual and Different Software Approach towards Design of Transmission Line Tower

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Abstract: ***The metal structures which keep the cable off the bottom are power transmission towers. Earlier, transmission tower have been analyzed and designed by the manual calculation based on 2d stress analysis or stress diagram procedure which is very tedious and time taking process. In the present there is highly sophisticated software had been developed. Generally most of transmission tower are fabricated from hot-rolled steel angles.***
Emerging from the olden times when the utilization of manual calculations was predominant, the utilization of varied software's and learning of an equivalent has become much easier and important. Big construction firms and ventures have moved their approach and have started using them for design purposes This paper mainly considers upon the comparison of study obtained from the design of Transmission line Tower structures using these user friendly software's. In this paper, comparison of software's results with the manual calculations of a transmission tower designed as per IS 800:2007 using limit state method . In this paper the software STAAD Pro v8i and E Tab used.
Keywords: **Analysis of Structure, Design of structure, ETAB, Indian Standard Code, STAADPRO**

I. INTRODUCTION

India has a large population residing all over the country and the electricity supply basic of this population creates necessity of large transmission and distribution system. Also, the outlook of the first resources for electric power generation viz., coal, hydro potential is somewhat uneven, thus again adding to the transmission requirements.
They are designed and constructed in big variety of shapes, types, sizes, configuration and materials. Transmission line towers are modeled using different bracing patterns. Axial forces, deflection and weight of towers vary with bracing pattern. The structure types used in cable generally comes under one among the three categories: lattice, pole and guyed. In this paper, the comparative study of deflection calculation is carried out using both the software STAAD PRO V8i and E Tab. And also compare both the software with manual calculation is evaluated. In this paper transmission tower is designed using hot rolled steel angle section according to IS 800-2007.

A. Objective

The layout of transmission tower for optimizing maximum deflection the basic parameters are forced on the basis of electrical necessities.

1) Base width
2) Height of the tower
3) Outline of the tower

With the above necessities the study of maximum deflection of transmission tower with software and by manual calculation is carried out.
In this work comparison is carried out by taken simple tower of 10 m with same section and same parameter. Then by taking the reference of "D.B.Sonowal1 , J.D.Bharali2 M.K. Agarwalla3, N. Sarma4, P. Hazarika Analysis and Design of 220 kV Transmission Line Tower(A conventional method of analysis and Indian Code based Design) result of deflection manually and by software carried out.

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II. TRANSMISSION LINE TOWER

Transmission tower is considered in tall structures, a steel lattice tower, usually used to support an overhead transmission line. It is used for AC and DC high voltage systems, and available in a wide variety of shapes and sizes. Typical height ranges from 15 to 55 meters. Other than steel, the materials may be used, including concrete and wood.

The transmission towers can be categorized in four major category they are: suspension, terminal, tension, and transposition. Some transmission towers combine these basic functions. Transmission towers and supporting structure types usually used as a three categories names as: lattice, pole and guyed. To reduce the visual effect include undergrounding.

It is an integrated system it consist of conductor sub system, ground wire subsystem. the transmission tower is act as a single cantilever fixed at its base, in other hand the guyed mast is pin connected to its foundation and braced with guys or other element.

A. Types of Transmission Line Tower (According to Material)

According to type of material transmission line tower is classified as:

1) *Structures made up of wood*
a) Wood poles
b) Wood H- poles
2) *Structure made of concrete*
c) R.C.C. poles
d) Pre stressed concrete poles
3) *Structures made of structural steel*
e) Round or I-section steel poles
f) Fabricated steel poles
g) Flexible tower
h) Semi Flexible tower

B. Different designs of Transmission Tower

There are many different designs for transmission structure, two common types are-

1) *Lattice steel type (LST):* It is separate structural components of steel frame that are bolted or welded together.
2) *Tubular steel pole (TSP):* It is hollow steel poles made up by one piece or by several piece fitted together.

LSTs and TSPs designed to carry either one or two electrical circuits, mentioned to as single-circuit and double circuit structures. Double-circuit structures usually hold the conductors in a vertical or stacked configuration, whereas single-circuit structures usually hold the conductors horizontally. On lower voltage lines, structures rarely carry more than two circuits.

There are three phases in a single circuit alternating current. At low voltages, a phase usually involves of one conductor. Over 200 kV i.e. at high voltage, a phase can consist of multiple conductors separated by short spacers.

Dead-end towers are used where a cable ends; where the cable turns at an outsized angle; on all sides of a serious crossing like an outsized river, highway, or large valley; or at intervals along straight segments to supply additional support. A dead-end tower differs from a suspension tower therein it's built to be stronger, often features a wider base, and has stronger insulator strings.

C. Types of transmission towers based on structure type

1) *Waist type tower-* Waist type tower is usually use as a transmission tower. It is used for voltages ranging from 110 to 735 kV. Because this is easy in assembled, these towers are suitable for power lines that cross very uneven terrain.

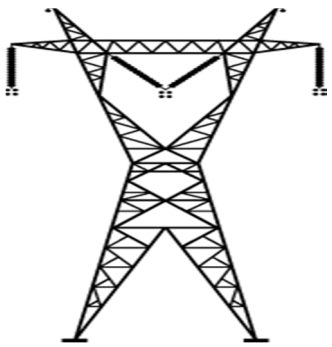

Fig.1 Waist type tower

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2) *Double circuit tower*- This type of towers is mainly used for voltages ranging from 110 to 315 kV. Its height varies from 25 to 60 meters.

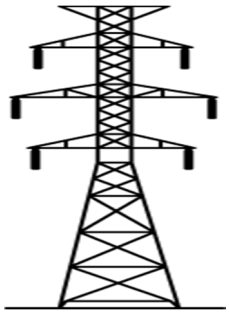

Fig.2 Double circuit tower

3) *Guyed V Tower*: This tower is designed for voltages ranging from 230 to 735 kV. It is used mainly for power lines.

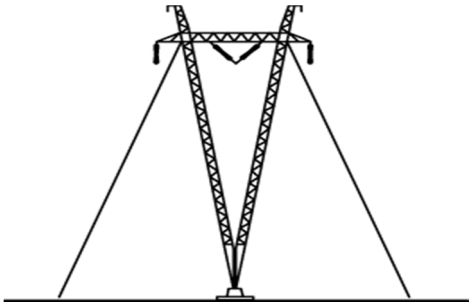

Fig.3 Guyed v tower

4) *Tubular Steel Pipe*: Featuring a streamlined, aesthetic shape, this structure is less massive than other towers, allowing it to blend easily into the environment. For this reason, it's being used more and more in urban centers.

III. FORCES IN TOWER

A. Methods to Find the Member Forces In tower

1) *Methods of section:* The method of joints is a method used to solve for the unknown forces acting on members of a truss. Since only two equations are involved, only two unknowns can be resolved for at a time. Therefore, you need to solve the joints in a definite order. That is, you must to work from the sides to the center of the truss. Since you need to work in a certain order, the Method of Sections (which will be covered below) can be more useful if you objective want to know the forces acting on a particular member adjacent to the center of the truss.

2) *Method of joints:* It is a method used to solve for the unknown forces acting on members of a truss. The method involves split the truss down into individual sections and evaluating each section as a separate rigid body. In the Method of Joints, we are deal with static equilibrium at a point. This limits the static equilibrium equations to take only two force equations. This permits solving for up to three unknown forces at atime.

3) *Tension coefficient:* Tension coefficient method is used to determine member forces in space trusses. The method of tension coefficients may be tabular technique of completing resolution in either two or three dimensions. It is preferably suitable to the analysis of pin-jointed space-frames. Consider an individual member from a pin-jointed plane-frame.

Take

AB = member of LAB, and it having TAB as a tensile force,

TAB Cos theta = tensile force in X direction

TAB sin theta= tensile force in Y direction

Tension Coefficient:

t = F/L

If t positive (tension),

if t negative (compression)

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IV. NEED AND ADVANTAGES OF SOFTWARES

Being a totally practical and site based study, the use of the software like STAADPRO and ETAB Become doubtful. But the civil engineering software use of a wide range of tools to help the civil engineers in all construction works. In all the stages of work namely drafting & documenting, designing, visualizing & analyzing, these tools can be helpful.

STAADPRO may be software which is employed for data analysis and design. It is popular due to its flexible modeling environment and wide range of design codes. The design of big projects like tunnels and bridges can be easily done by using it. STAADPRO has made it easy for the civil engineers to pan the structures according to the strain of their clients.

ETAB is used in the design of beams, slabs, columns, shear walls and bracings. The graphic input output and therefore the numerical solutions are very easy. We also obtain precision and accuracy in dimensions by using Snaps (end, perpendicular, middle etc.).There are multiple viewing windows present in the software.

A. About STAAD Pro

The full form of STAAD is STRUCTURAL AIDED ANALYSIS AND DESIGN, advanced features & fluent data collaboration. STAAD-PRO was born giant. It is the foremost popular software used now a days. Basically it is performing design works. There are four steps using STAAD-PRO to succeed in the goal.

1) Prepare the input file.
2) Analyze the input file.
3) Watch the results and verify them.
4) Refer the analysis result to steel design or concrete design engines for designing purpose.

B. About E TAB

ETAB or ETABS they mean an equivalent .its full form is extended three-Dimentional analysis of building system. Its a sort of software generally used for structural analysis of building or any structure . generally this software is employed by civil engineers at the present most of the industry adopt this software for analysis across the world .

From the beginning of design conception through the assembly of schematic drawings, ETABS integrates every aspect of the engineering design process. The modeling of structure is not be easy - instinctive drawing commands leave the rapid generation of floor and elevation framing.

V. LIMITATIONS OF HAND COMPUTATION METHODS

A. Applicable for small problem

The design of transmission tower manually is based on the 2 dimensional stress analysis procedure which is more time taking process so it is give accurate result for small problem.

B. Tedious for even medium sized problems

Analysis of transmission tower by manual method needs limitation to try out several permutations and combinations of tower geometry.

C. 3-d analysis almost impossible

There is no methods of calculation of transmission tower to solve the 3 D structure, for this we should we go with the software.

VI. TRANSMISSION LINE COMPONENTS

The transmission line component which is used in our problem are-

A. Transmission Line Voltage: 220 kV (A. / C.)
B. No. of Circuits: Single Circuit
C. Angle : 0 to 2 degrees
D. Bracing Pattern: Pratt system
E. Terrain Type Considered: Plain
F. Cross Arm: Pointed
G. Terrain Category: 2

H. Inclination of the tower legs: 70
I. Wind Zone: 5
J. Basic Wind Speed: 50 m/s
K. Design Wind Pressure: 793 N/sqm
L. Tower Type: Self-Supporting, Type "A"
M. Tower Geometry: Square Base Tower
N. Creep Effect: Not Considered

VII. GEOMETRICAL CONFIGURATION OF THE TRANSMISSION TOWER.

By the geometrical details of the 220kv transmission line tower, the model created in STAADPRO. & ETAB wind analysis is Performed for zone V The transmission tower is of height 30m and base width of the tower is 6m. The transmission tower was modeled using members 200x200x25, 100x100x8, 150x150x12.

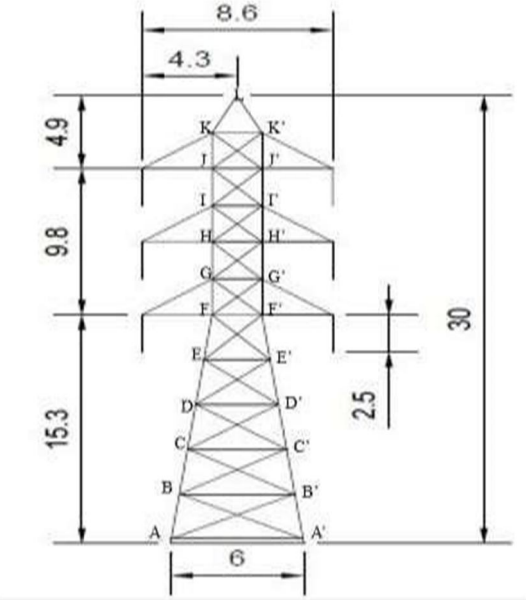

Fig.3 Guyed v tower

VIII. RESULTS

A. Maximum Deflection by STAAD PRO V8i

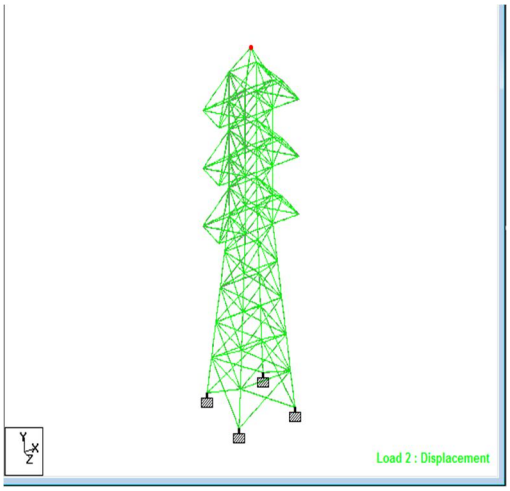

Fig.4 Max. deflection by STAAD PRO

B. Maximum Deflection By E TAB

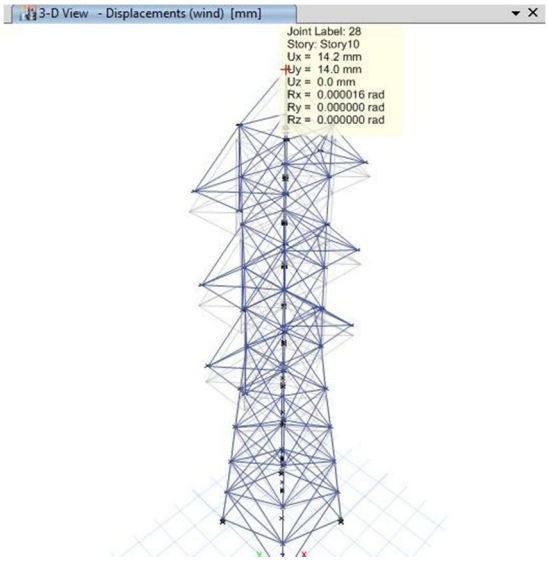

Fig.5 Max. deflection by E TAB

TABLE 1
Shows The Values Of Deflection

Description	Type of model	Max. deflection in X direction (mm)
HRS Transmission behavior with conventional method & both software	Model 1: Conventional model	24.508
	Model 2: HRS model in E TAB	14.2
	Model 3: HRS model in STAAD PRO	22.482

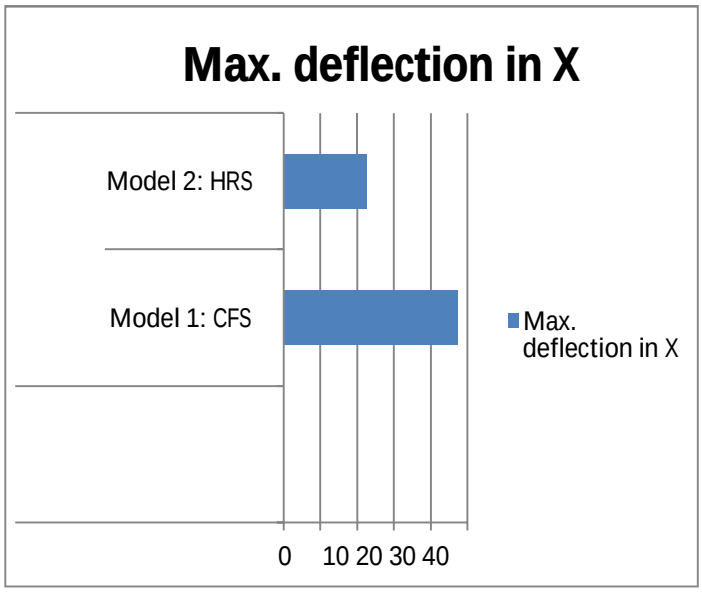

Fig.6 Bar Graph shows Transmission behaviour with different steel form by STAAD PRO

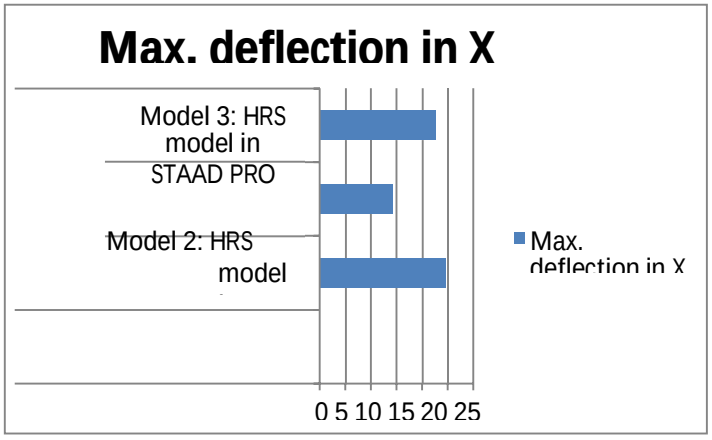

Fig. 4 Bar Graph shows HRS Transmission behaviour with conventional method & both software

IX. CONCLUSION

Our research work implies to reduce the manual calculation of tall structure by software. A rigorous analysis considering three dimensional space actions is sort of difficult. The development and application of computer analysis opened up a new and practically unlimited possibilities for the exact solution of these statically indeterminate structures with precise statically analysis of their three dimensional performance. In this paper we consider linear behavior with two dimensional approach and it will verified by software like STAAD Pro V8i and E Tab.The results coming with studies are-

A. It is seen that the section used in manual calculation is light than section used in STAAD PRO V8i software.
B. So we use higher section in STAAD PRO, then the deflection come in STAAD PRO is less as compare to manual analysis.
C. When we compare the E Tab and STAAD PRO then in E Tab it takes higher section as compare to section used in STAAD PRO. So we increase section.
D. In the E Tab the deflection has been seen less as compare to both STAAD PRO and manual analyzed structure.
E. As we know the result obtained from manual method is more accurate than software then the closest result among E TAB and STAAD PRO, Staad Pro gives nearly result to conventional method.

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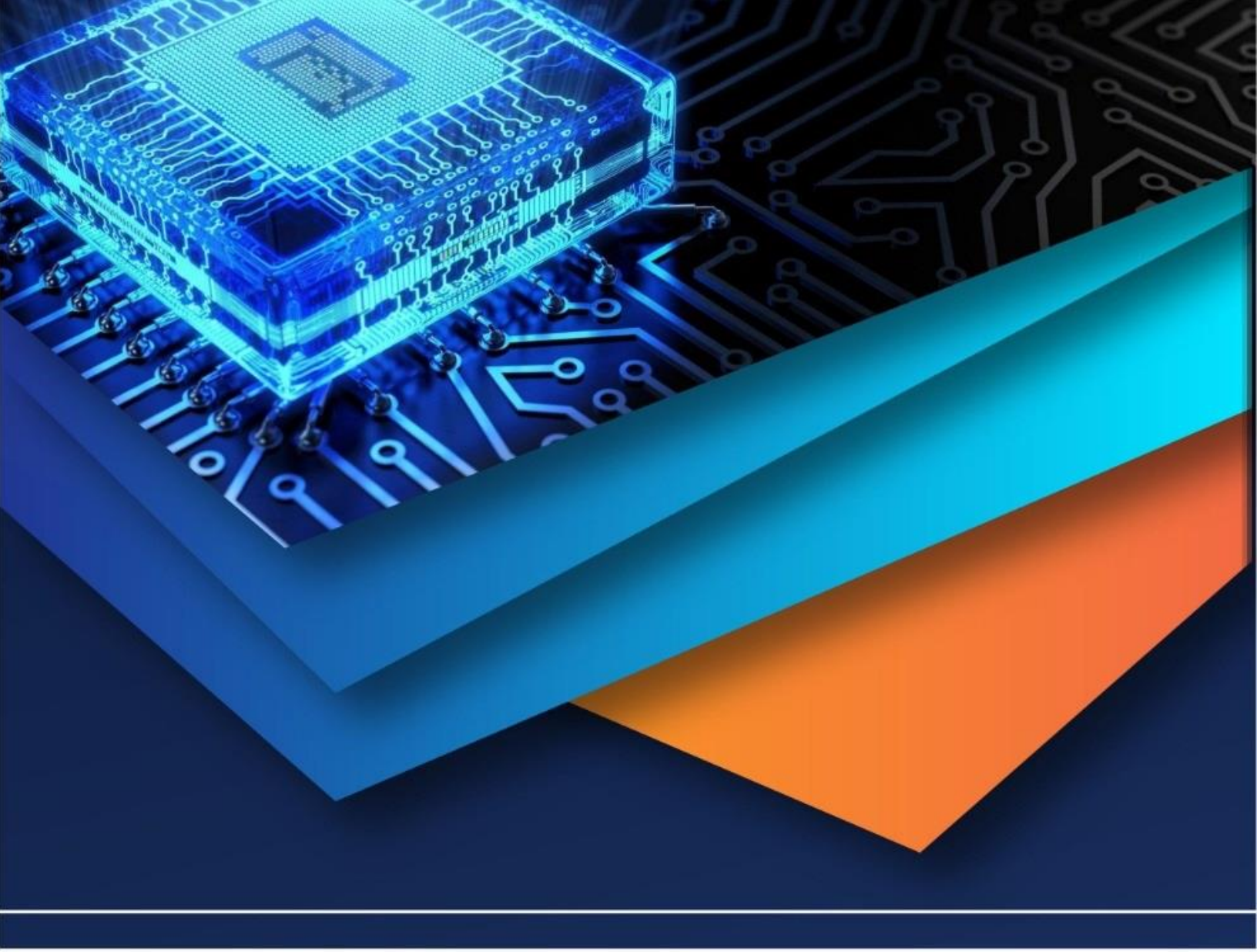

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