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Modelling & Comparative Analysis of Cable Stayed & Girder Bridges using SAP2000

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Abstract: A bridge is a structure which is built over some physical obstacles such as a body of water, valley, road and railway, its purpose is to provide crossing over that obstacle. Numerous bridges are in exist namely Arch Bridge, Girder Bridge, Suspension bridge, Cable stayed Bridge, etc. Design of bridges varies depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the funds available to build it. Structural analysis is a process to analyze a structural system to predict its responses and behaviour by using physical laws and mathematical equations. The main objective of structural analysis is to determine internal forces, stresses and deformation of structure under various load effects. In the present study, Girder Bridge and Cable stayed bridge are modelled and comparative analysis is carried out for dynamically loading conditions. A comparison is made between the bridges for dead load, live load and combined load.
Keywords: Cable stayed bridge, Girder Bridge, Dynamic analysis of bridges, SAP2000.

I. INTRODUCTION

A bridge is a structure built to span physical obstacles without closing the way underneath such as a body of water, valley, railway or road, for the purpose of providing passage over the obstacle. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the material used to make it, and the funds available to build it.

A. Types of bridges

There are various types of bridges classified based on span, materials, types of bridge structures, functions, utility and position etc.

1) Bridges by Structure
a) Girder bridge
b) Cable stayed bridge
c) Arch bridge
d) Suspension bridge
2) *Girder Bridge:* In Girder Bridge the deck slab is supported by means of girders. The girder may be of rolled steel girder or plate girder or box girder. In case of Girder Bridge, the deck slab is supported by means of girders. The girder may be of rolled steel girder or plate girder or box girder. Load coming from the deck are taken by girder and transferred them to the piers and abutments. A beam may be made of concrete or steel. Many shorter bridges, especially in rural areas where they may be exposed to water overtopping and corrosion, utilize concrete box beams. The term "girder" is typically used to refer to a steel beam. In a beam or girder bridge, the beams themselves are the primary support for the deck, and are responsible for transferring the load down to the foundation. Material type, shape, and weight all affect how much weight a beam can hold. Due to the properties of inertia, the height of a girder is the most significant factor to affect its load capacity. Longer spans, more traffic, or wider spacing of the beams will all directly result in a deeper beam. In truss and arch-style bridges, the girders are still the main support for the deck, but the load is transferred through the truss or arch to the foundation. These designs allow bridges to span larger distances without requiring the depth of the beam to increase beyond what is practical. However, with the inclusion of a truss or arch the bridge is no longer a true girder bridge. The girder bridge is shown in Figure1.

Fig-1: Girder Bridge

B. Cable Stayed Bridge

A cable-stayed bridge has one or more towers (or pylons), from which cables support the bridge deck. A distinctive feature is the cables which run directly from the tower to the deck, normally forming a fan-like pattern or a series of parallel lines. This is in contrast to the modern suspension bridge, where the cables supporting the deck are suspended vertically from the main cable, anchored at both ends of the bridge and running between the towers. The cable-stayed bridge is optimal for spans longer than cantilever bridges and shorter than suspension bridges. This is the range where cantilever bridges would rapidly grow heavier if the span were lengthened, while suspension bridge cabling would not be more economical if the span were shortened. The cable stayed bridge is shown in Figure2.

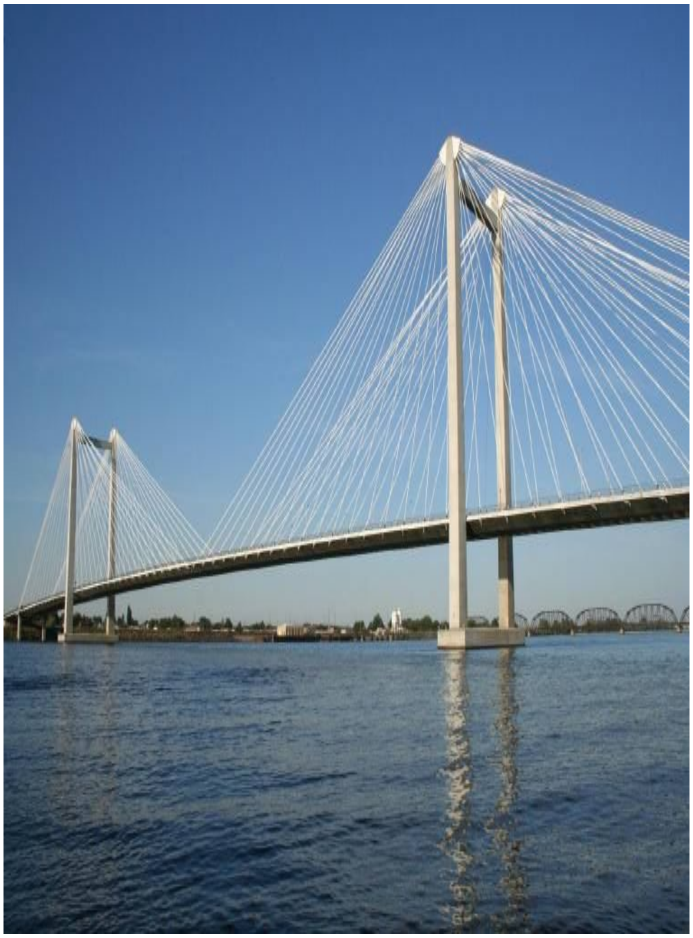

Fig-2: Cable stayed Bridge

II. METHODOLOGY

The methodology of the project is shown in the flowchart given below.

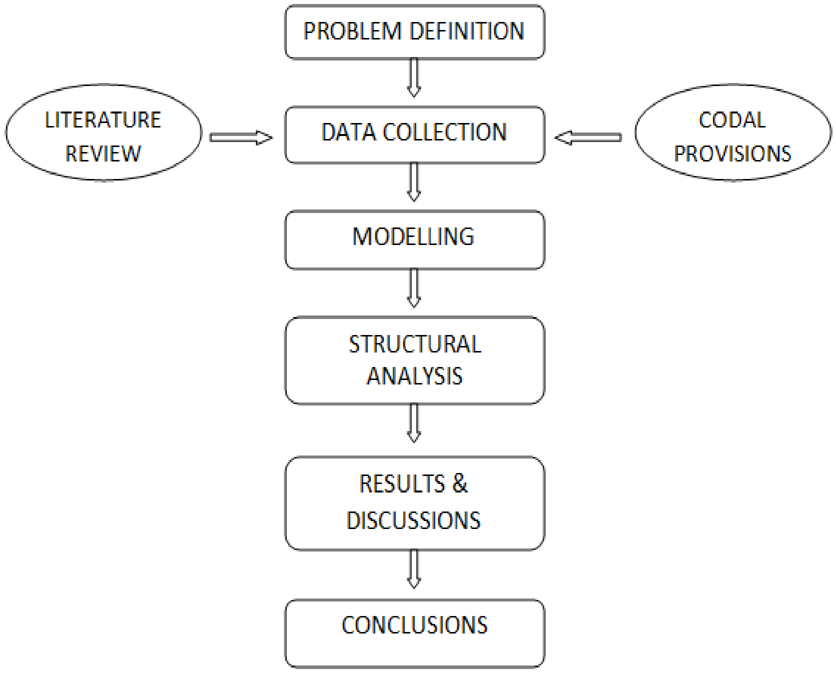

Fig-3: Methodology

A. Problem definition

The type of bridge to be adopted depends on the requirements of the location. Relevant Bridges as to be selected before proceeding for the Design and Construction. The structural analysis of bridges for dynamic loading conditions will give us deformations and shear force values. In the present study Cable stayed Bridge and Girder Bridge are modeled and comparative analysis is made to find out magnitude of deformations

B. Data Collection

The data used for the modeling of the Bridges are shown in Table1.

Table1.
Design input Parameters

Sl no	Parameters	For Suspension Bridge	For Girder Bridge
1	Length	4m	4m
2	Width	1.6m	1.6m
3	Height of the pylon	2.3m	0
4	Girder type	Precast concrete U girder	Precast concrete U girder

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C. Modeling

The modeling is done in SAP2000; the modeling procedure is shown in Figure-4:

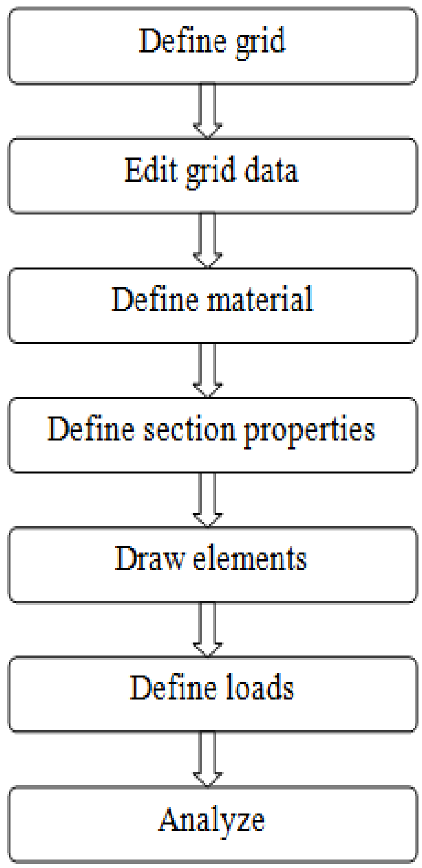

Fig-4: Steps in Modeling

D. D Model In Sap 2000

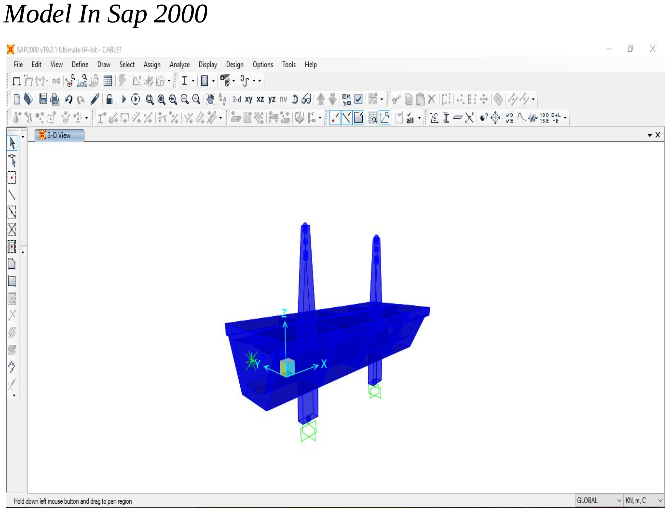

Fig-5: Cable stayed Bridge 3D- Model

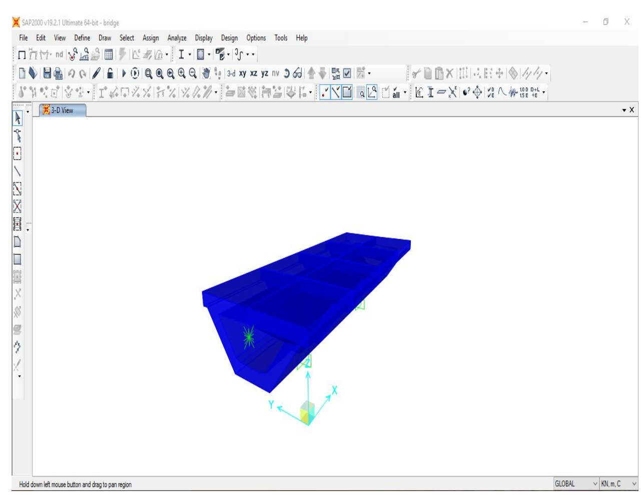

Fig-6: Girder Bridge 3D- Model

E. 2D Model in sap2000

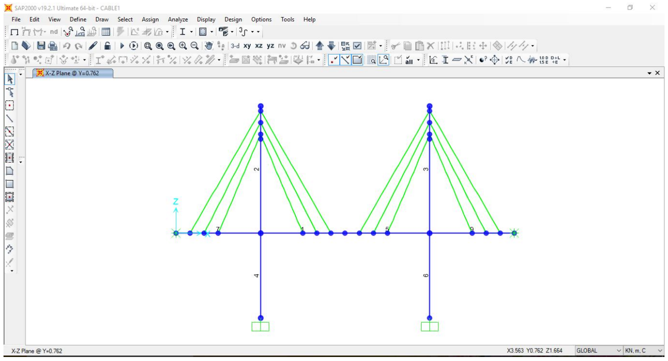

Fig-7: Cable stayed Bridge 2D- Model (X-Z) Axis

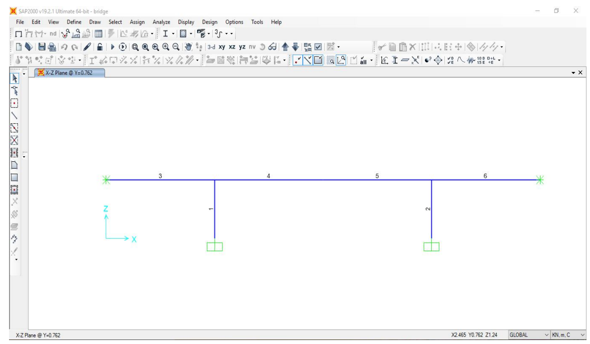

Fig-8: Girder Bridge 2D- Model (X-Z) Axis

F. Results and Discussions.

A. Shear Force Results

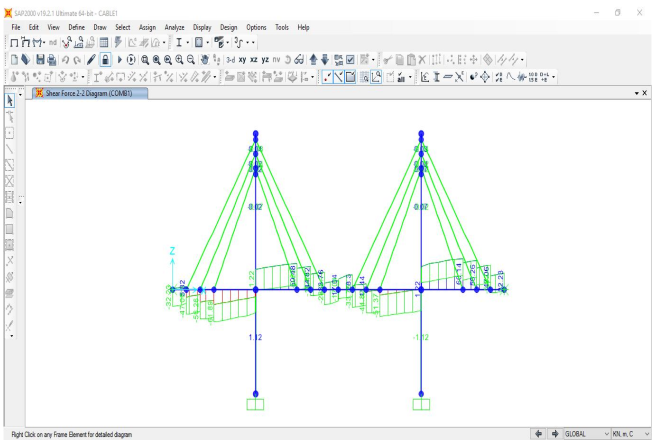

Fig-9: Shear force of Cable stayed Bridge Combination Load (Dead Load & Moving Load)

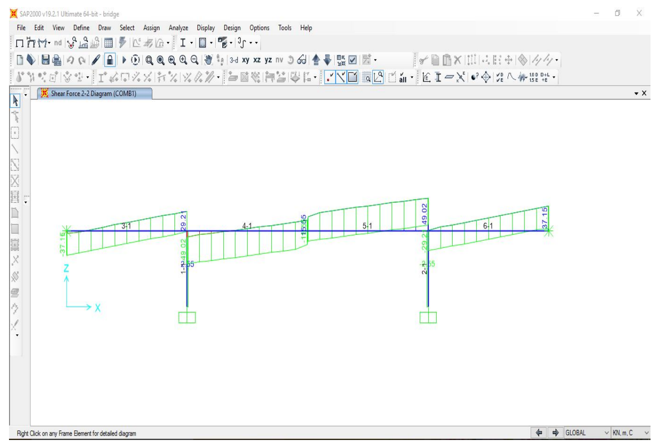

Fig-10: Shear force of Girder Bridge Combination Load (Dead Load & Moving Load)

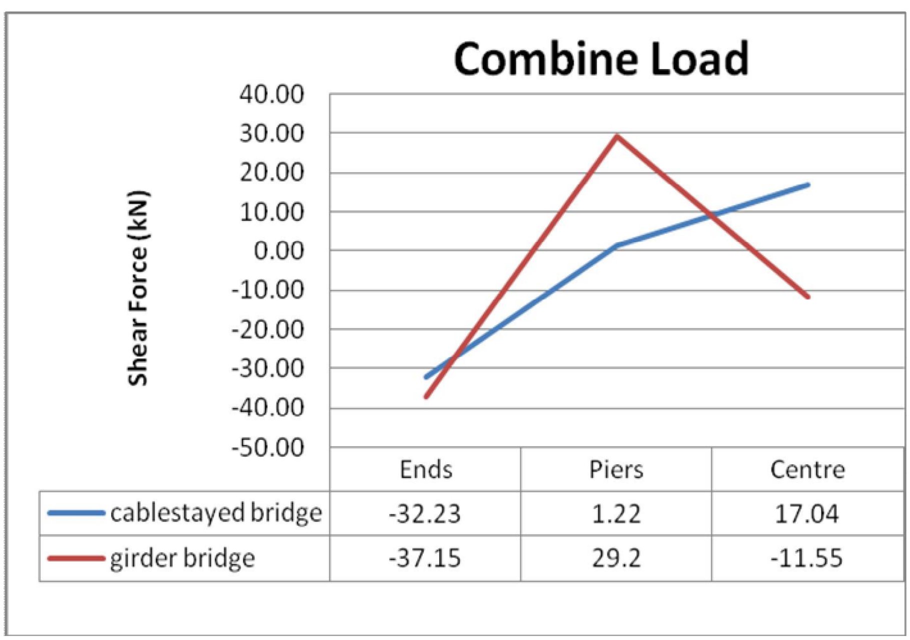

Fig-11: Comparision graph of shear force

It is observed that for the same loading conditions and design input parameters, Girder Bridge is giving Higher Shear force than Cable stayed Bridge at piers.

B. Bending Moment

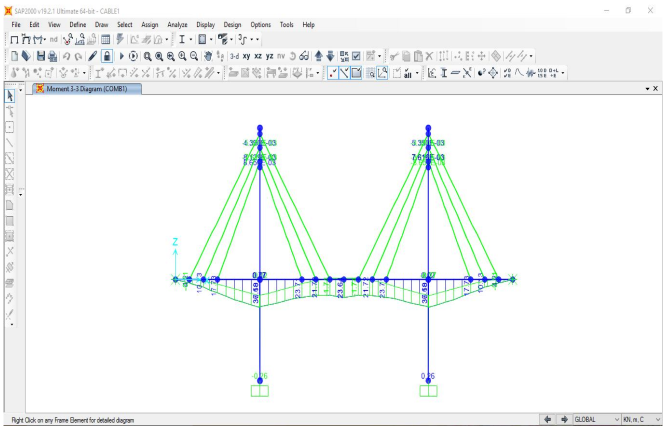

Fig-12: Bending moment of Cable stayed Bridge Combination Load (Dead Load & Moving Load)

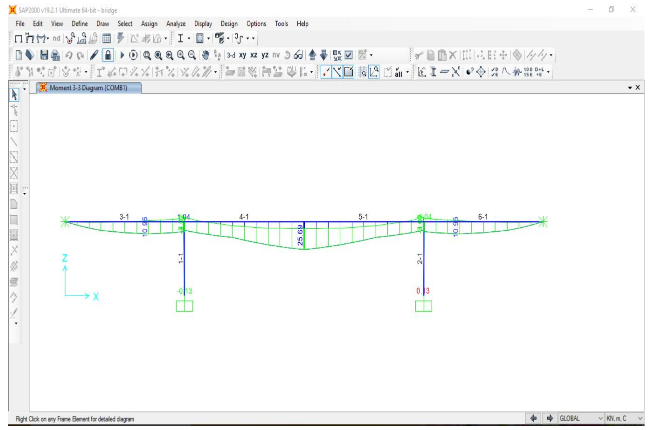

Fig-13: Bending moment of Girder Bridge Combination Load (Dead Load & Moving Load)

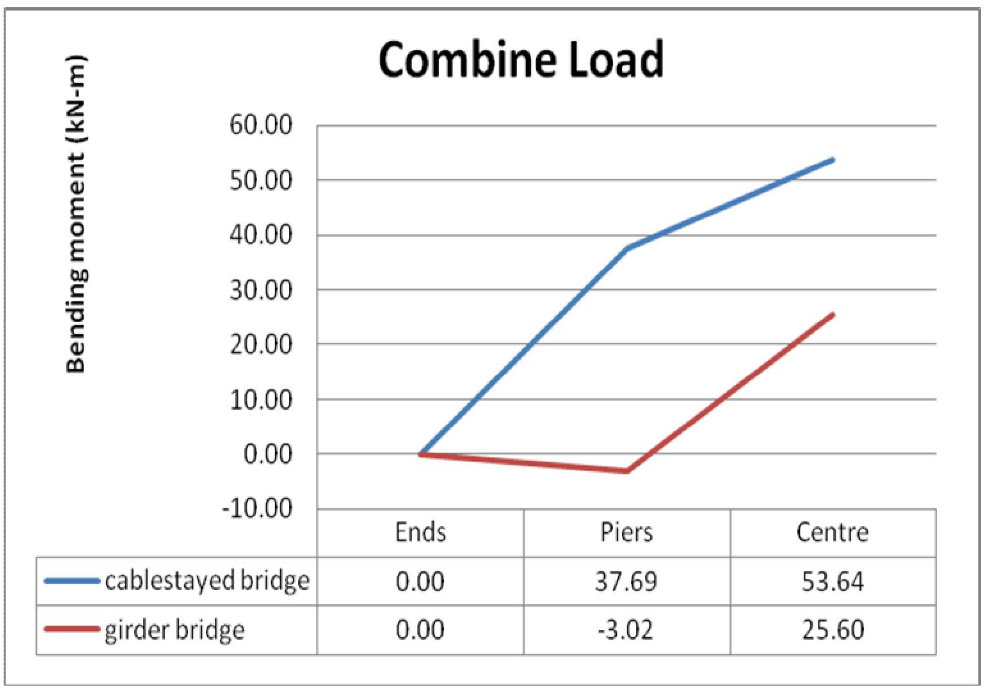

Fig-14: Comparision graph of Bending moment

It is observed that for the same loading conditions and design input parameters, Girder Bridge is giving lesser deformations than Cable stayed Bridge.

III. CONCLUSIONS

A. Based on the results, the following conclusions are drawn.,

1) It is found out that Girder Bridge is giving minimum deformations than Cable stayed Bridge.
2) It is found out that Cable stayed Bridge is giving minimum Shear force than Girder Bridge at the piers.
3) Deformation values are decreased by 47.72% for Girder Bridge compared to Cable stayed Bridge.
4) Shear force values are increased by 70% for Girder Bridge compared to Cable stayed Bridge.

IV. ACKNOWLEDGEMENT

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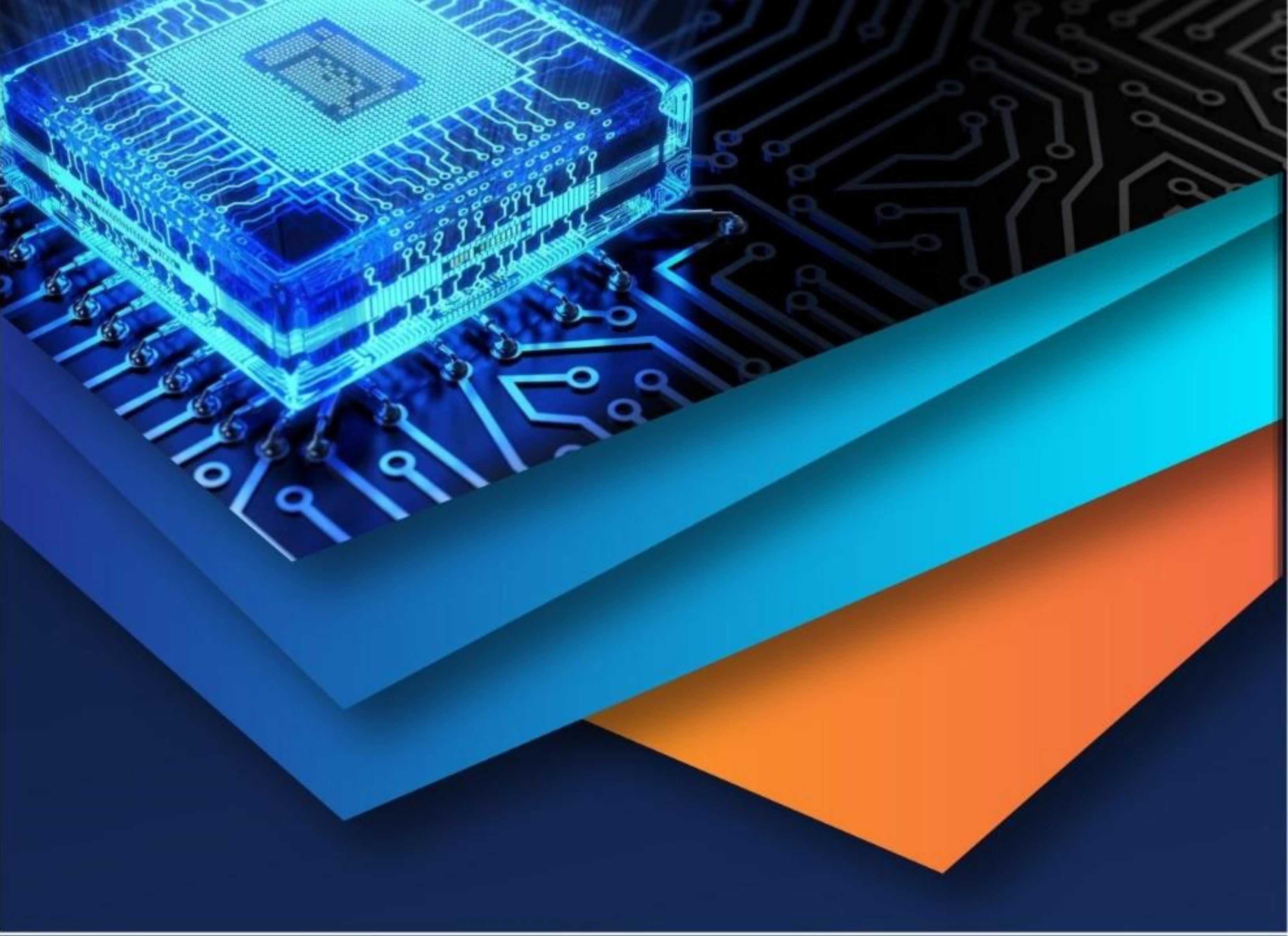

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