iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 8 **Issue:** VII **Month of publication:** July 2020

**DOI:** http://doi.org/10.22214/ijraset.2020.7036

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 8 Issue VII July 2020- Available at www.ijraset.com*

# Comparative Study on Design & Analysis of Hypothetical G+20 RCC & Composite Structure

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***Abstract:*** ***Now a day the eager for construction of Multi-storey structures are growing rapidly. The main moto behind the growth competition in the present world and also to make for more economical and spacious in all directions. Theoretical calculations for Multi-storey structures are very crucial and hence the demand for rapid and quick softwares is growing faster. This study Report basically utilises the system programs like Staad.ProV8i and ETABS16 for Multi-storey building design and analysis of 2 forms. The standard codal provision of Indian code is used. The structure considered of the two forms are RCC and Composite structure with G+20 storey. In this two cases of Multi-storey buildings we are performing the design and analyze and comparison among the structures. STAAD. Pro V8i & ETABS 16 both are utilised for the concrete design, time history analysis, response spectrum analysis and p-delta analysis. The weight of Composite structure is 94.45% that of RCC structure. The P-Delta analysis result for both the structures are visualized the storey drift is about 0.041667% for the composite structure which is higher that the RCC structure however it can be visualized that the deflection is within the middle third of the columns. The Modal mass participation ratio in case of Response Spectrum analysis is greater than 90% which is the minimum required participation ration as per IS1893:2002. The Base shear ratio of linear and non linear case is approx. 91% which is greater than 85% of the desired ratio as per IS1893:2002.***
***Keywords: comparative study, Rcc structure, composite structure.***

## I. INTRODUCTION

The history behind Multi-storey structures or buildings were inspired by the tall temples built by Romans. The Romans architectural design was often known. Around 4000 years back, old designing was drawn closer and allowed multi-story structures to the development the run of the mill models would be found from found from right of South Europe to Central Asia. However moving towards the fluctuated significantly, the outcome was same in all cases whether it was 2 or 3 story houses/royal residences and so forth were made. The inspirational trend to the structures built by romans now the modern architecture can never come to the competence of the old style of the buildings. Nowadays the designers and modern architectures are moving towards the development of different multi-story structures of reinforced concrete structural system, steel and composite structure to make them as a practical, roomy and furthermore to build the designing advancements and arrangements.

The classification of Muilt-storey buildings as follows

1) *Low - rise:* These are the structures or a buildings which are not so tall enough which are of *1- 4 storey building* which are not classified under high-rise structure.
2) *Mid - rise:* These are the structures or a buildings which consists of 5-10 storey, which are installed with elevators.
3) *High - rise:* These are the structures or the buildings which consists of more than 7 to 10 storey, which are installed with couple of elevators.
4) *Skyscraper:* The name Skyscraper tells about the tallness of the structure which are of about 11-40 storeys or more which are equipped with the rapid elevators and much more.
5) *Supertall:* The structure or Skyscraper whose elevation exceeding the 300m, which are equipped with the rapid elevators and much more.
6) *Megatall:* The structure or Skyscraper whose elevation exceeding the 600m, which are equipped with the rapid elevators and much more.

Some of the familiar structural types are framed structure, propped structure, suspended structure, cantilever structure, braced structure, shear wall structure, hull core structure and composite structure. These classified structures are built in the view of economical , reliability & the future credit ratings of the buildings. But the following research paper discuss only about the RC framed structure and Composite structure only. Some of the most successful RC framed and composite structures are The Ingalls Building. 1903. Cincinnati OH. The worlds first reinforced concrete skyscraper. Prestige Trade Towers, Bangalore, India composite construction proved to be successful.

### *A. Intention Behind Comparative Design And Analysis Of High- Rise Reinforced Concrete & Composite Structure*

With the improvement of advancements around the globe, new and complex structures are being built and planned. Presentation of software in the market has now made it simpler to go for various formed structures, likewise the work gets quicker. So with the assistance of Staad.ProV8i and Etabs my point is to design and analyse the multi-story reinforced concrete structural system and composite structure and afterward contrast with make them progressively stable, spacious, seismic resistant and safe.

### *B. Design & Analysis Of High-Rise Reinforced Concrete Structural System And Composite Structure.*

The expectation of relative designing and analysis of a speculative 20 story structure is being analysed on Staad.ProV8i and Etabs with the different examination like P-Delta analysis, time history analysis, Response range examination, and so forth are being finished.

### *C. Benefits And Advantages*

As the area of land is diminishing step by step the prerequisite of Multi-story structures is getting higher. So the advantage of Multi-story building is that increasingly more space can be secured with it. Likewise it fills in as headway in the advanced time of new innovation and shows the step by step development of the country. The Reinforced concrete structure is a familiar and most suitable for all types of structures. RC framed structures takes the gravity loads only for the seismic resistance either steel bracings or monolithic shear walls to be used for the resistance due to tectonic lateral loads. Composite structures help decrease the measures of steel sections (in this way taking into consideration more headroom) and furthermore give expanded basic solidness. Concrete is good in overtaking the compression loads and steel is exceptionally good at overtaing the tension loads. This blend brings about a financially effective, rapid and truly stable construction. However the steel bracings are used for the openings of the structural members add-ons to the seismic or lateral resistance to the structure. Likewise the principle preferred position of Multi-story building is to serve it as official just as private reason both and make it spacious, stable, safe and economical.

## II. OBJECTIVE OF STUDY

*A.* To study the concrete design of structure for two structural types.
*B.* To locate the center of gravity of the structures from Staad.pro.
*C.* To find out the storey drift using P-Delta analysis for two different structures.
*D.* To find out the frequencies of the structure using time history analysis in Etabs
*E.* To perform the response spectrum analysis for both cases.
*F.* To find out the most economical and safe structure amongst the two different structures.

## III. DESIGN & ANALYSIS

Design and analysis considerations are listed below for the study of the structures.

| S# | Reinforced Concrete Structural System | Composite Structural System |
|---|---|---|
| 1 | Total weight of Structure | Total weight of structure |
| 2 | P delta analysis | P delta analysis |
| 3 | Time history analysis | Time history analysis |
| 4 | Response Spectrum analysis | Response Spectrum analysis |
| 5 | Locating C.G. | - |

Table.1 : Structural Details

Various designs and analysis have been carried out

| S# | Particulars | Dimension/Value/ Size |
|---|---|---|
| 1 | Plan(up to 5 floors) | 32m x 32m |
| 2 | Plan(up to 15 floors) | 40m x 40m |
| 3 | Plan(up to 20 floors) | 44m x 44m |
| 4 | Floor height | 4m |
| 5 | Column size | 0.60m x 0.60m |
| 6 | Beam size | 0.40m x 0.40m |
| 7 | Foundation depth | 10m |
| 8 | Type of soil | HARD |
| 9 | Zone type | 3 |
| 10 | Grade of concrete | M25 |
| 11 | Grade of steel | Fe415 |

Table.2 : Design and Analysis Details

*A. P-Delta Analysis*

When a structure is loaded, there is a deflection in the members of structure and it causes secondary moments and due to these members in the end may not be in vertical in deflected position. To overcome these effects number of iterations is done for the each storey drifting and thus these process is known as P-Delta Analysis. P-Delta Analysis is done by STAAD-PROV8i (For reinforced concrete structural system) & ETABS Software (For both) by number of iterations.

*B. Time History Analysis*

Time History Analysis is based on Realistic earthquake data which occurred in past and then the response of the structure is determined.

Time History Analysis is done by STAAD.PROV8i (For reinforced concrete structural system frequency & Period) & ETABS software (For reinforced concrete structural system & Composite Base Fx & Time-period) by inserting the previous seismic data of Imperial valley-02, El Centro station is considered as a standard time series for the analysis of the structural system.

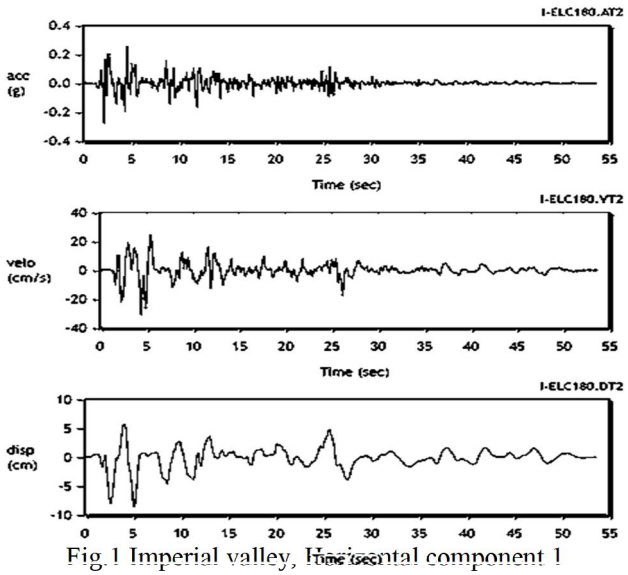


Fig.1 Imperial valley, Horizontal component 1

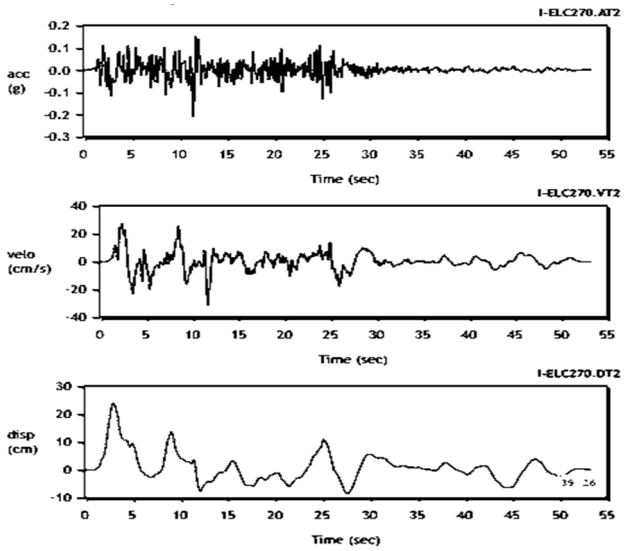


Fig.2 Imperial valley, Horizontal component 2

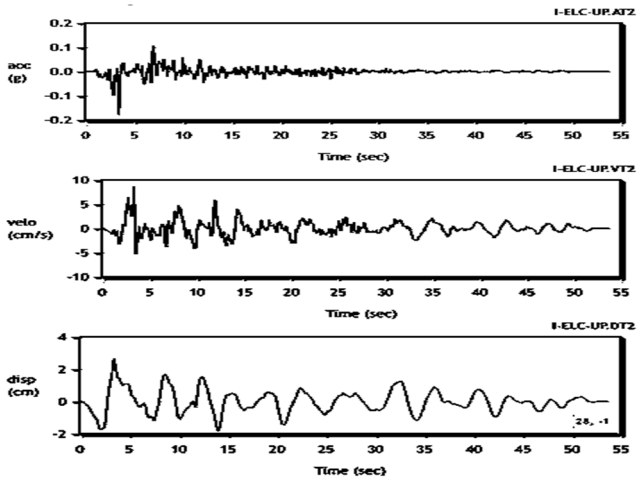


Fig.3 Imperial valley, Vertical component

### *C. Response Spectrum Analysis*

Response Spectrum Analysis is a kind of linear analysis which contains graph of Period Vs Acceleration or Period Vs Displacement. Based on the Earthquake data the response of the structure is obtained. Response spectrum Analysis is done by ETABS Software.

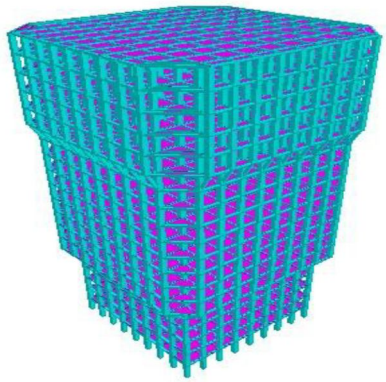

Fig.4 3D view of hypothetical model

## IV. RESULT AND DISCUSSIONS

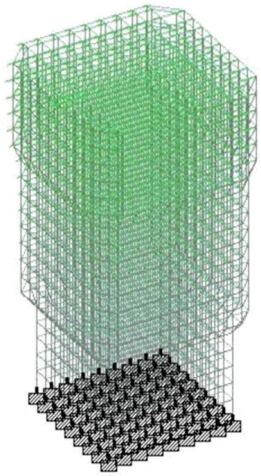

Fig .5 Stadd Pro model analysis

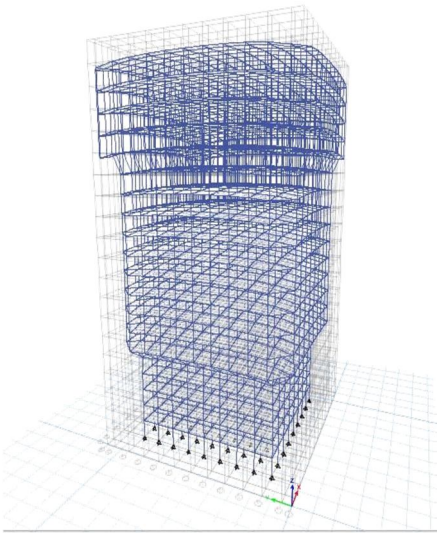

Fig .6 Deformed shape , Etabs model

*A. Comparison Graph for Maximum Storey Displacement*

We are comparing RCC and Composite Storey displacement for 20 story and it is found that Composite structure is having the more displacement value and line graph. Horizontal axis represents story and Vertical axis represents Displacement in mm.

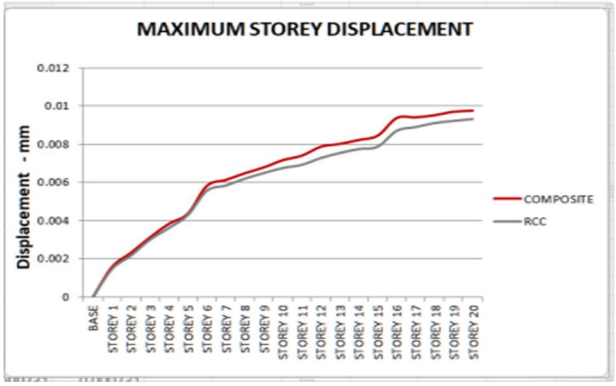


Fig.7 Maximum Storey Displacement

*B. Comparison Graph for Maximum Storey Drift*

We are comparing RCC and Composite modal plot for 20 story and it is found that Composite structure is having the more displacement value hence the storey drift values exceeding the RCC Storey drift and line graph. Horizontal axis represents story and Vertical axis represents Maximum Displacement mm.

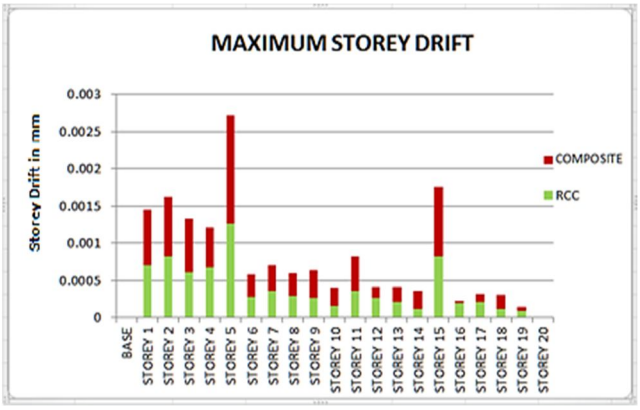


Fig.8 Maximum Storey Drift

*C. Comparison Graph for Response Plot from Response Spectrum Analysis*

We are comparing RCC and Composite response plot for $5^{th}$,$10^{th}$, $15^{th}$&$20^{th}$ story and it is found that RCC structure is having the more displacement value and line graph. Horizontal axis represents story and Vertical axis represents Displacement in E+3 mm.

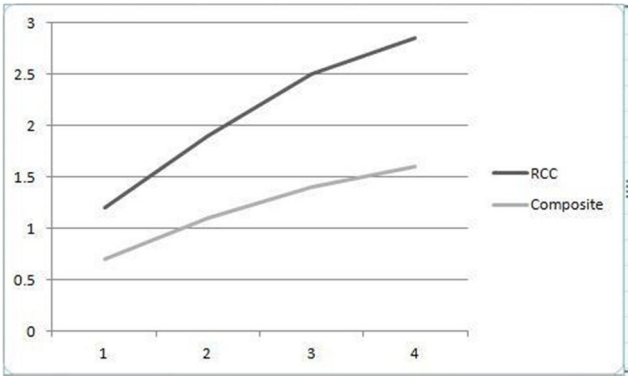


Fig.9 Response plot comparison graph

*D. Comparison Graph for Time history Analysis*

We are comparing RCC and Composite Structures for first 10 seconds and it is found that RCC structure is having the more Base Fx value as the time is increasing. Horizontal axis represents time in sec and Vertical axis represents Base fx in E-3 KN.

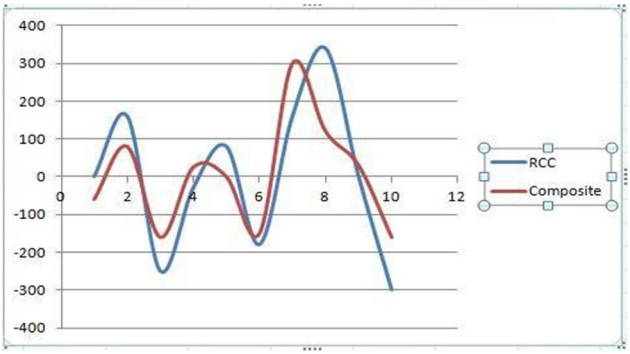


Fig.10 Time history plot comparison graph

*E. Comparison Graph for Maximum Displacement /Story Drifting from P- delta Analysis*

We are comparing RCC and Composite modal plot for 5th,10th,15th&20th story and it is found that Composite structure is having the more displacement value and line graph. Horizontal axis represents story and Vertical axis represents Maximum Displacement in E-3 mm.

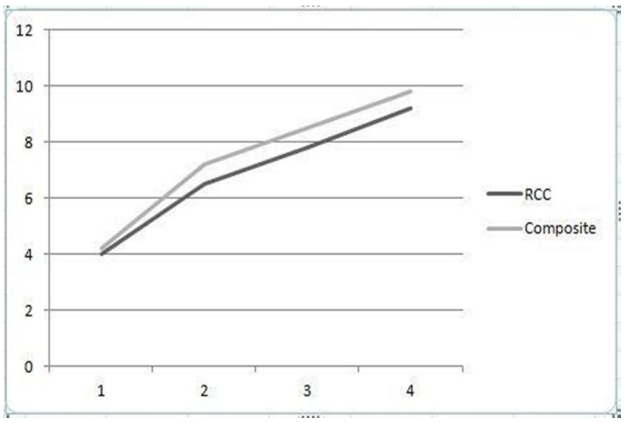


Fig.11 P-delta comparison graph

*F. Comparison Graph for Performance of RCC and Composite Structure*

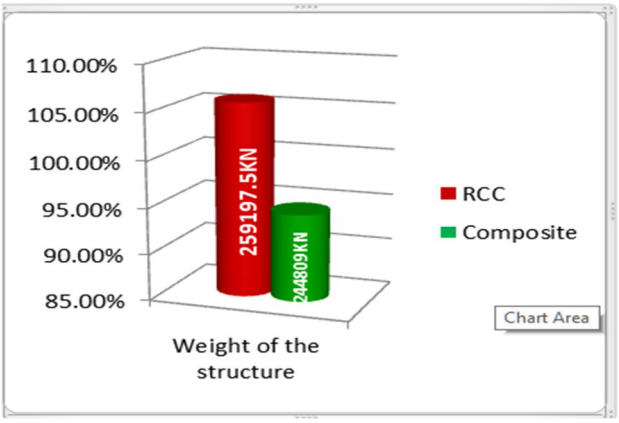


Fig.12 Weight comparison graph

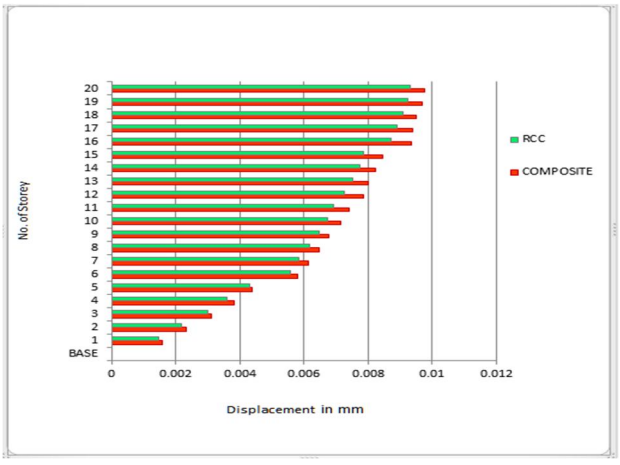


Fig.13 Displacement comparison graph

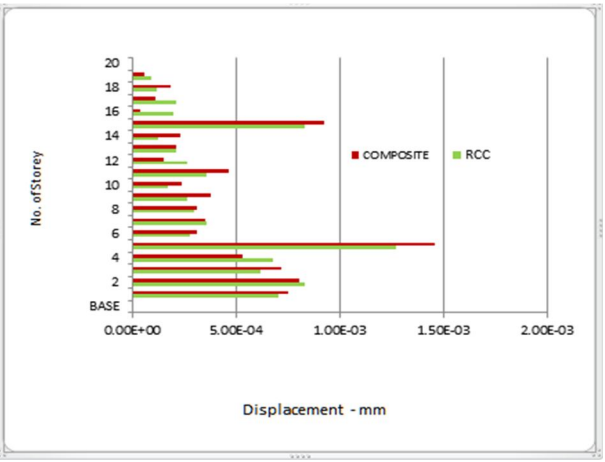


Fig.14 Storey Drift comparison graph

The following graphs represent performance of Reinforced concrete structure and Composite structure whrere in each graph red colour indicates the low performance and the green colour indicates the better performance.

## V. CONCLUSION

Following conclusions can be derived from the analytical results obtained till now :-

*A.* From the concrete design obtained, it can be concluded that the quantity of reinforcement & concrete requirement for RCC is in permissible limit but for composite structures we will conclude in future Also the construction of 20 floor Multi-storey building is feasible.

*B.* The p-delta analysis of the columns showed that the structure is safe and storey drift is within the permissible limit. From the P-Delta analysis result for both the structures it can be seen that storey drift for composite structure is 0.041667% higher that the RCC structure however it can be seen that the deflection is within the middle third of the columns.

*C.* Weight of RCC structure is 259197.5KN & of Composite structure is 244809KN as per Etabs result. The weight of Composite structure is 94.45% that of RCC structure.

*D.* Base shear of RCC structure is more than that of composite structure as per Etabs results for the Time history analysis. The Base shear ratio of linear and non linear case is approx. 91% which is greater than 85% of the desired ratio as per IS1893:2002.

*E.* The Modal mass participation ratio in case of Response Spectrum analysis is greater than 90% which is the minimum required participation ration as per IS1893:2002

*F.* From the various analysis performed and the results obtained it can be seen that the Composite structure is better in terms of self weight however in case of storey drift the Composite structure if inferior than RCC structure due to the Tensile nature of the Steel members used in the Columns.

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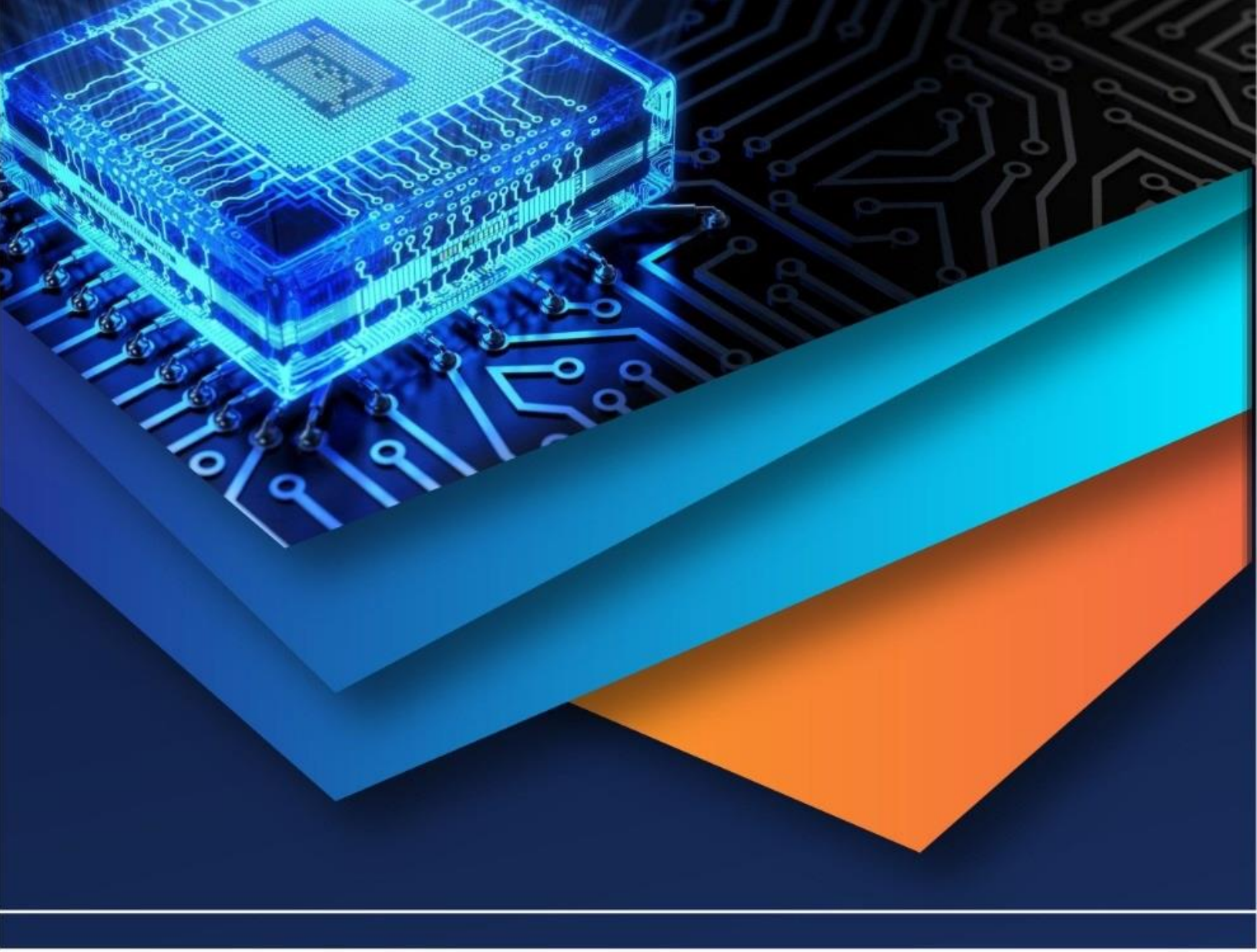

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