iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 Issue: XII Month of publication: December 2020

DOI: https://doi.org/10.22214/ijraset.2020.32574

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 XII Dec 2020- Available at www.ijraset.com

Response of Tall Structure with Soft Storey having Composite Column

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Abstract: Construction of multi storey buildings is must in developing countries like India in order to occupy space and also due to increase in population. These constructions of multi storey buildings often have soft stories due to requirement or needs of the occupants in the building. For example, open ground storey for the purpose of vehicle parking or for the commercial use such as showrooms etc. This soft storey due to lack of stiffness fail to resist the lateral loads due to Earthquake forces which may lead to the damage or collapse of the building. In this project, the study is made to know the behavior of single and multi soft storey at different levels of multi storey building for regular plan for G+14 stories using ETABS for seismic zone V in India during Earthquake and to find the optimum location of the soft storey using "Response Spectrum Method" by using IS 1893: 2002 part 1 codal provision with regards maximum storey displacement, Storey drift and storey base shear.
Keywords: Regular plan, G+14 multi storey building with soft storey, stiffness, Response Spectrum Method, IS 1893:2002 part 1 provisions, Etabs software.

I. INTRODUCTION

Immense evolution in the population of India among various factors is one of the foremost causes for the construction of tall structures in big places. This is the reason for the progress of the nation. A soft storey is defined as “If storey is lesser than 70% stiff than that of the storey just above or less than 80% stiff as the average of three storeys above (As per IS-1893:2002 (part I)) it is recognized as soft storey”. Reinforced concrete frame structure in present time has a distinctive role i.e. the ground storey is kept open for the need of parking, etc. These building are usually considered as open ground storey buildings or building on stilts. Such a storey is adopted in multi storied buildings based upon the desires of the occupants of the building.

Earthquake generates waves which influences the base of structure through vibrations in various etiquette and directions, due to this reason lateral forces is developed on structure as a result of which shearing of column or even buckling of the whole column occurs finally resulting in collapse of building.

Here an attempt was made to inspect the outcome of single soft storey and multiple soft storeys with conventional column and composite column in tall building by varying the position of them along the entire height of the structure having a regular plan. The modeling of G+14 storey building models will be done on the ETABS 2018 software. Post analyses of a building such as drift value, displacement value and base shear values are computed and then compared for structure having soft storey with composite column and soft storey with RCC column.

II. LITERATURE REVIEW

1) *Mohammed Hamaid Sayeed, , Prof Md Mansoor Ahmed , et al:* Building having G+25 is adopted for study. It is studied by taking into account the soft storey at 2nd, 7th, 12th, 17th, 22nd and top most stories. The project has six models belonging to zone 5 and method adopted is “Push over analysis” for analyzing of the building.1.In tall buildings the most suitable position of the soft storey is at higher level. 2. Soft storey at base level is found to yield maximum. 3. Building with soft storey at ground floor along with soft storey at upper floors is found to provide much safety. 4. Nonlinear analysis of the building can be easily explained by pushover analysis.
2) *Achyut S. Naphade, Prof. G. R. Patil:* The RCC symmetrical building having G+ 10 storey’s is considered for the project. The models are prepared for the project in SAP 2000 software. The models were analyzed having soft storey at ground, 2nd, 5th and 8th floor. Push over analysis was adopted to know the performance of the building along with retrofitting by the shear wall. Forming of plastic hinges are maximum due to soft stories although with the increase of base shear. 2. Yielding rate at the soft storey of the building is large. 3. Rate of yielding reduces as the position of soft storey goes to upper floors and after multiple number of pushover analyses the lesser value of hinges are formed. 4. From the pushover analysis and from spectrum curve as the location of soft storey goes to upper floor, the time period value is decreasing from 0.716sec to 0.446sec for 2nd and 8th floor soft storey respectively. This concludes that soft storey at upper floors is better from safer point of view.

3) *Rahiman G. Khan, Prof. M. R. Vyawahare:* The project main concept is to know the most suitable location or position of soft story in tall buildings. Now a days by the improvement in modern technology particularly in electronics field in the form of computer has led to adopt "PBSE (Performance based seismic engineering)" easily. PBSE considering non linear analysis is called to be "pushover analysis". In PBSE the seismic behavior of the structure is calculated by combining both the inelastic structural analysis and seismic hazard evaluation.

There is significant outcome that can be seen by using infill wall upon stiffness with lateral resistance in the frame.

III. OBJECTIVE OF THE STUDY

A. Determine the outcome of seismic loads upon the structure by using response spectrum method on buildings having soft storey at various levels with composite column.
B. Find out the best possible position of soft storey with composite column along the building height.
C. Find out the best possible position of multi soft storey with composite column along the building height.
D. Study the lateral story displacement, drift and base shear values for the structure.
E. Study the advantages of the structure with soft storey along with composite column over structure with soft storey with RCC column.

IV. METHODOLOGY

A. Response Spectrum Method

Response Spectrum method shows the illustration of dynamic response graphically of a number of cantilever pendulums which are increasing with the increase of natural period, this subjects with common lateral seismic motion of base. In engineering branch of seismology, spectrum is a term used for showing an aspect in the form of graph highlighting a building response with a wide range of period. The plot of graph represents the reaction of a considered motion of earthquake in the form of acceleration, deflection and velocity. This method can be even named as a linear dynamic method. In this method, the earthquake response or (Design spectrum) spectrum at the time of an earthquake directly gives the maximum reaction of an assembly. From structural point of view this method gives quite accurate results. Through the same method, several modes of building reaction at the time of an earthquake are obtained. Then on the basis of modal masses the reaction we get by the design spectrum for every mode. Then to finally achieve an estimate of reactions for complete building we unite the reactions for various modes. This can be achieved by means of number of modal methods like ABS called as 'Absolute sum' method, SRSS called as 'Square root of sum of square' method and CQC 'complete quadratic combination'

Building Category	Special RC Moment Resisting Frame (SMRF)
Stories	15 no's (G+14)
Floor to floor height	3m
Type of base support	Fixed
Type of structure	RCC framed structure
Concrete grade used	M30
Steel grade used	Fe500
Column dimension	C1=900mm x900mm
	C2=900mm x900mm encased with ISWB600
Beam dimension	300mm x750mm
Slab thickness	175 mm
Thickness of wall	300 mm
Live load	2 KN/M^2 and 3 KN/M^2
Flour finish load	1.2 KN/M2
Seismic zone	V (0.36)
Imp (I) factor	1.2
Reduction (R) factor	5
Soil classification	Type II (medium)

Plan Of Building Models

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
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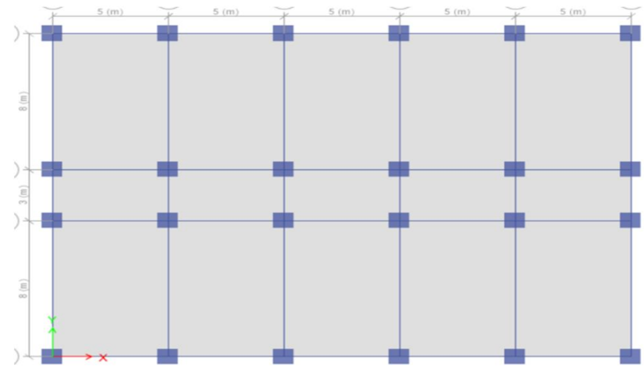
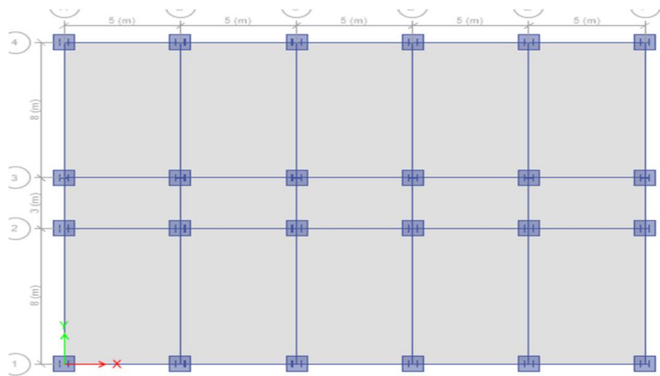


Building plan with RCC columns

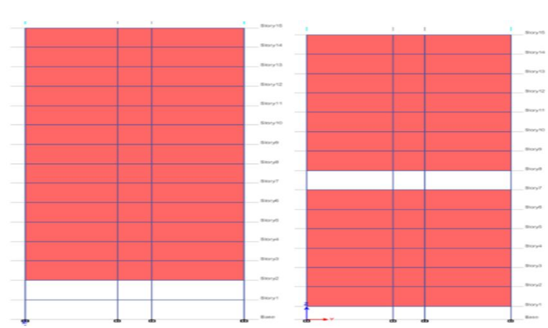


Building plan with composite columns at soft storey level

B. Description Of Models

1) *Model-1:* Soft storey at GF with RCC column.
2) *Model-2:* Soft storey at 8 th Floor with RCC column.
3) *Model-3:* Soft storey at 15 th Floor with RCC column.
4) *Model-4:* Soft storey at GF with Composite column.
5) *Model-5:* Soft storey at 8 th Floor with Composite column.
6) *Model-6:* Soft storey at 15 th Floor with Composite column.
7) *Model-7:* Soft storey at GF and at 8 th Floor with RCC column.
8) *Model-8:* Soft storey at 8 th Floor and at 15 th Floor with RCC column.
9) *Model-9:* Soft storey at GF and at 15 th Floor with RCC column.
10) *Model-10:* Soft storey at GF and at 8 th Floor with Composite column.
11) *Model-11:* Soft storey at 8 th Floor and at 15 th Floor with Composite column.
12) *Model-12:* Soft storey at GF and at 15 th Floor with Composite column.

C. Elevations Of Building Models



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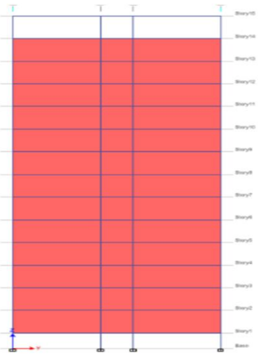

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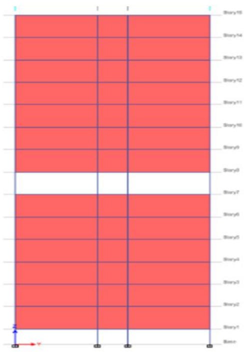

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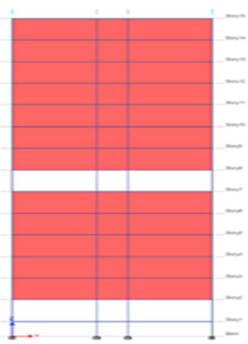

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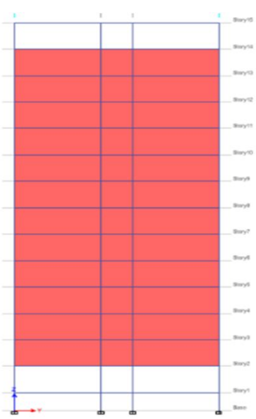

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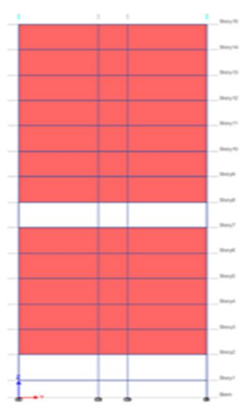

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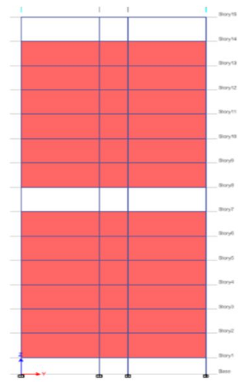

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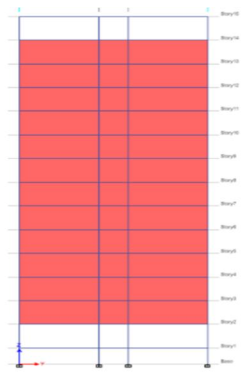

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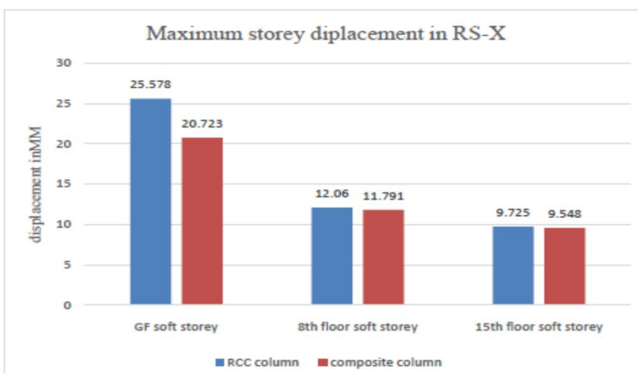
V. COMPARISION OF MODELS HAVING SINGLE SOFT STOREY:

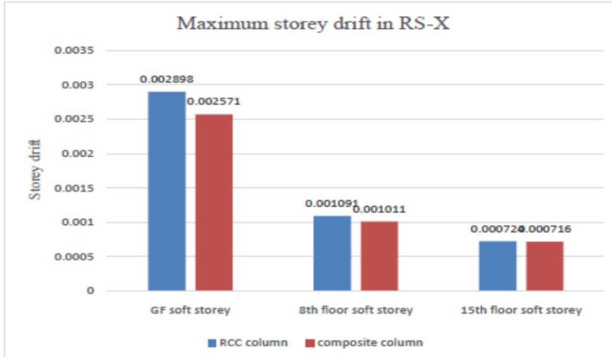
A. Maximum Storey Displacement Values

SL NO	MODEL	RCC COLUMN	COMPOSITE COLUMN
1	soft storey at GF	25.578	20.723
2	soft storey at 8th floor	12.060	11.791
3	soft storey at 15th floor	9.725	9.548



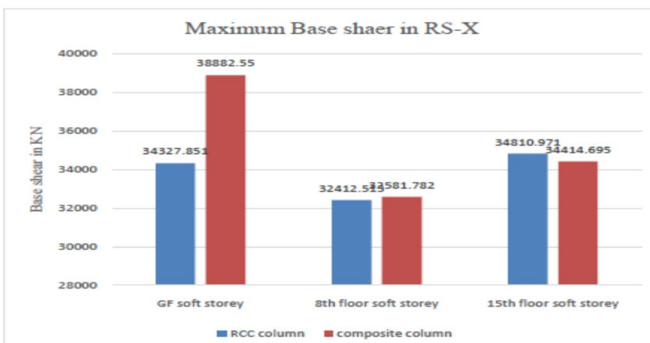
B. Maximum Value of Storey Drift

SL NO	MODEL	RCC COLUMN	COMPOSITE COLUMN
1	soft storey at GF	0.002898	0.002571
2	soft storey at 8th floor	0.001091	0.001011
3	soft storey at 15th floor	0.000724	0.000716



C. Maximum Base Shear Value

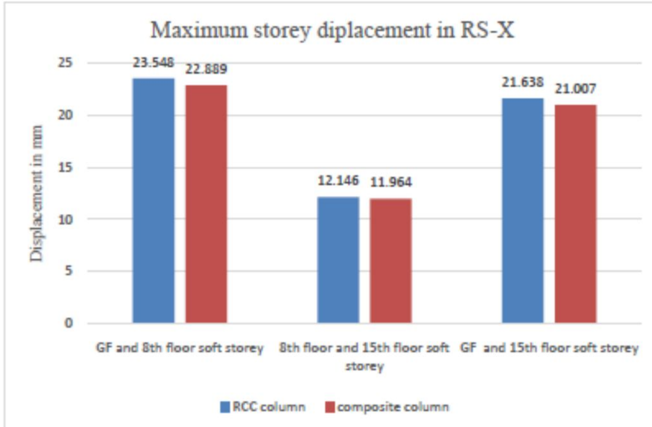
SL NO	MODEL	RCC COLUMN	COMPOSITE COLUMN
1	soft storey at GF	34327.851	38882.550
2	soft storey at 8th floor	32412.513	32581.782
3	soft storey at 15th floor	34810.971	34414.695



VI. COMPARISION OF MODELS HAVING MULTI SOFT STOREY

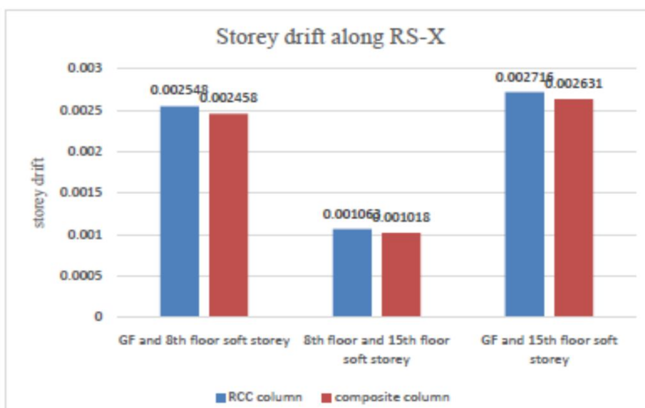
A. Maximum Displacement Values

SL NO	MODEL	RCC COLUMN	COMPOSITE COLUMN
1	soft storey at GF and 8th floor	23.548	22.889
2	soft storey at 8th floor and 15th floor	12.146	11.964
3	soft storey at GF 15th floor	21.638	21.007



B. Maximum Value of Storey Drift

SL NO	MODEL	RCC COLUMN	COMPOSITE COLUMN
1	soft storey at GF and 8th floor	0.002548	0.002458
2	soft storey at 8th floor and 15th floor	0.001063	0.001018
3	soft storey at GF and 15th	0.002716	0.002631



C. Maximum Base Shear Value

SL NO	MODEL	RCC COLUMN	COMPOSITE COLUMN
1	soft storey at GF and 8th floor	36234.696	36934.242
2	soft storey at 8th floor and 15th floor	32086.723	32221.115
3	soft storey at GF and 15th floor	38670.577	38720.483

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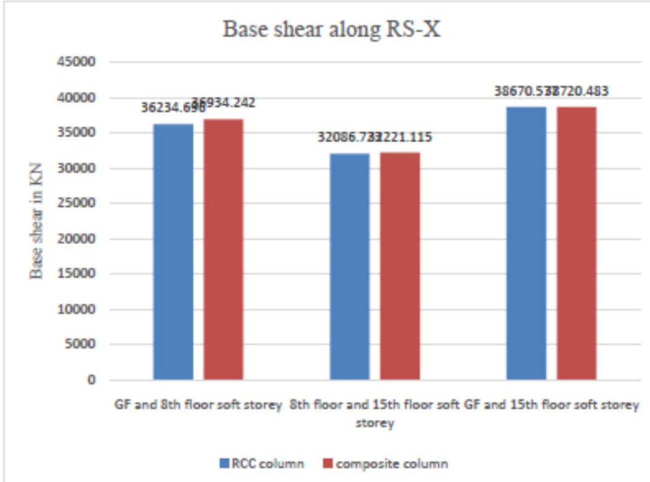

VII. CONCLUSION

A. It is observed that by providing composite column displacement and storey drift can be reduced.

B. It is observed that by providing composite column base shear is increased.

C. By the several analysis and their results, it has been found that provision of soft storey at a certain floor leads to increase in deflection.

D. Buildings made of completely RCC provided with soft storey at GF, chances of complete failure due to earthquake forces are more.

E. Value of drift known as lateral drift reduces with shifting of soft storey to higher level. Hence, using of composite column for soft storey at upper level is a better choice.

F. Comparison of soft storey at different locations with conventional column and composite column for model has done and conclusion came as that the chances of failure of building due to earthquake is large for model having soft storey with conventional column and less for model having soft storey with composite column. By the above statement it can be clearly said that, soft storey provided with composite column is capable of absorbing much energy. Due to this it is stronger for reduction of earthquake response.

G. Providing single soft storey with composite column at higher level is more suitable, as decrease in displacement is observed.

H. Proving multi soft storey with composite column at higher level i.e. above middle floor is more suitable, as decrease in displacement is observed.

I. Response of Building having soft storey with composite column is better than the building having soft storey with RCC column as decrease in storey displacement, storey drift and increase in base shears observed.

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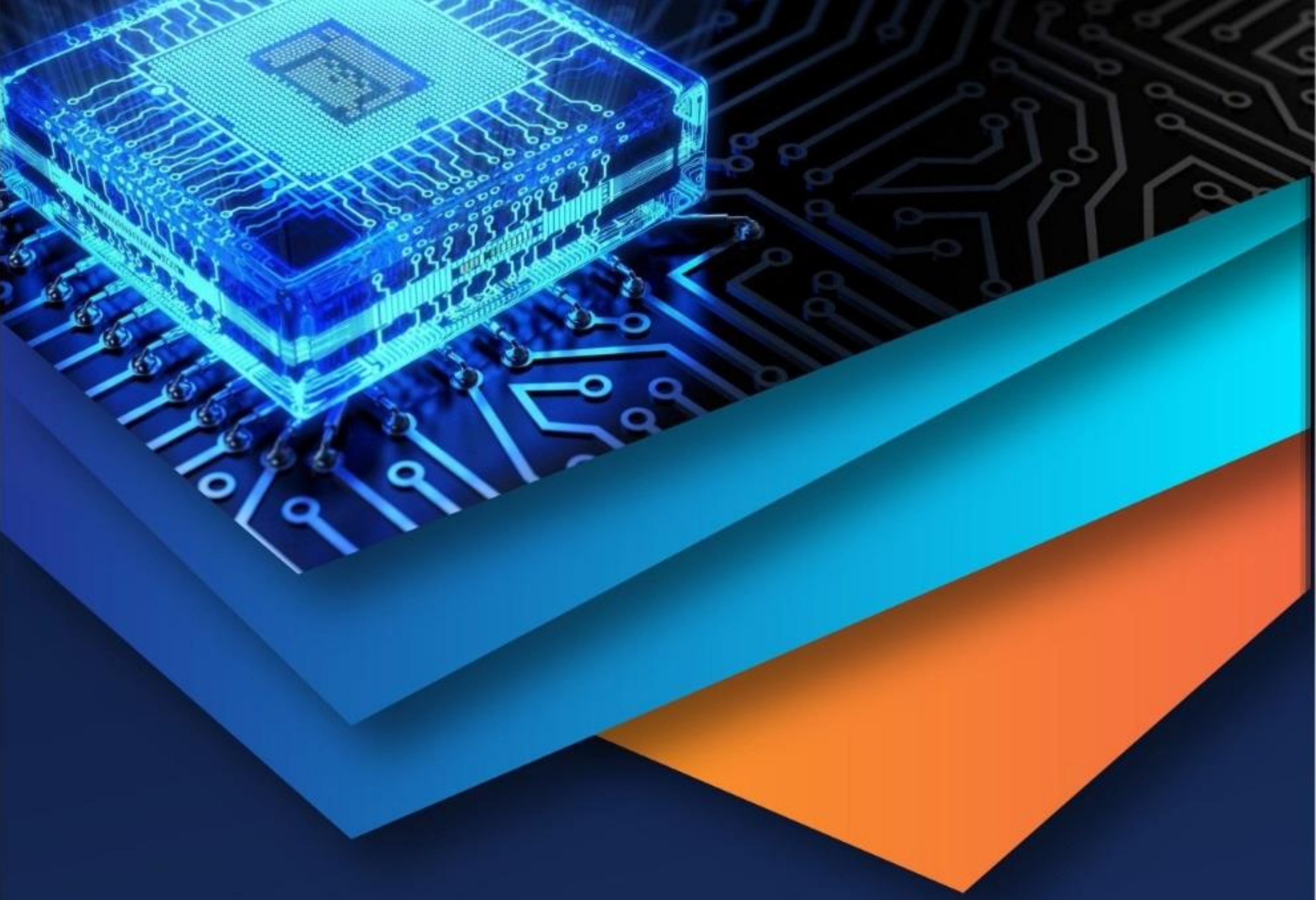

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