iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** VI **Month of publication:** June 2024

DOI: https://doi.org/10.22214/ijraset.2024.63321

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VI June 2024- Available at www.ijraset.com

Sesmic Comparitive Analysis for Isolated RCC Trapezoidal Footing resting over Black Cotton Soil

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***Abstract:** During earthquake soil deforms under influence of incident seismic waves and dynamically carries with it foundation and support structures. There are various types of soil and various types of footing Thus it becomes important to study the behaviour of footing during earthquake in different soil. The main objective of the study is to understand the effect of sesmic forces on Isolated RCC Trapezoidal Footing resting over Black Cotton soil. Also from various litreature review study shows the point which are helpful to overcome damage in footing construction by showing different method, loading combination, sesmic effect, footing stability, etc. Thus the aim of following study is to carry out Sesmic Comparitive study for Isolated RCC Trapezoidal Footing resting over black cotton soil. The Isolated RCC Trapezoidal footing resting over Black Cotton soil having external loading (sesmic loading) is analyzed and design, The observations and remark shows that for the same geographical region when the lateral forces are induced in the footing , the development of moments, torsion and twising are developed . This brings the necessity to change the design of footing for resisting earthquake forces even if we consider Zone II . Since, the footing is most important part of load transfer path the detaling and consideration of earthquake force is necessary.*
***Keywords:** Sesmic, Footing, Soil, Earthquake, Trapezoidal.*

I. INTRODUCTION

A. Aim

To Study Seismic comparitive analysis for Isolated RCC Trapezoidal footing resting over Black Cotton soil.

B. Objectives

1) To Study various Soil condition
2) To Study construction property of Black Cotton Soil
3) To Study Types and function of footing
4) To study Indian Seismology
5) To Study effect of earthquake on RCC structures
6) To Study Sesmic analysis for Isolated Trapezoidal footing resting over black cotton soil.

C. Need

Earthquake is one of the most destructive of natural hazards. It is the sudden movement of earth cause due to the release of strain energy. It may causes various damages to buildings, earth surface, environment and life of common man. Thus, to minimize the effect of earthquake, foundation of structure is considered as more strongest element of overall building. There can be different types of foundation failure on soil due to movement and settlement which can cause building collapse & stability of foundation is depend upon the soil type available at foundation site. Hence, it is necessary to study the seismic stability of footing on various underlying soil and provide the safety as well.

II. LITERATURE REVIEW

Sneharika S. Shirbhate, et. al (1) Studied about the behavior of building components during earthquake over hilly terrain area and seismic characteristics such as displacement, storey drift, time period, base shear, etc. In addition to this twisting, torsion, short column effect are also studied. Generally, 27 degree sloping ground is more suitable & provide better stability on hilly terrain as compared to other building types.

Nagaraju, et. al (2) Analyzing and designing the RC building with various load combination under very high seismic zone(i.e. zone 5) and also make the comparison between manual method & software method to find which method is more suitable to increase the design quality, accuracy and strength

S. Balachandar, et. al (3) Studied over analysis of self wt. of footing with reference to safe bearing capacity, analysis of depth v/s reinforcement & comparative analysis of concentric square footing, eccentric one way square footing, eccentric both ways square footing and concluded that, self wt. of footing & depth of footing is depend on safe bearing capacity of soil. If depth of footing increases the reinforcement is decreases and all the footings which were design having the same data but reinforcement is gradually increased.

Prof. S.C. Gupta et al. (4), studied the behavior of flexible foundation using STAAD. Pro software. The study was done using a real life foundation problem of a G+3 storey school building. This paper shows a comparison of plate raft and the beam-slab raft by method of subgrade reaction of flexible foundation

Tarun Tiwari et al. (5), Studied on the effect of soil type for evaluating the seismic performance of footing. By using software STAAD PRO, finding the better technique to make the sensitivity of footing rested on different soil type and finally stated that, soil type which are available at foundation site effects the stability of foundation when subjected to earthquake waves

III. LOADING COMBINATIONS

Load combinations provide the basic set of building load conditions that should be considered by the designer.Load combinations are provided as per IS 456-2000.

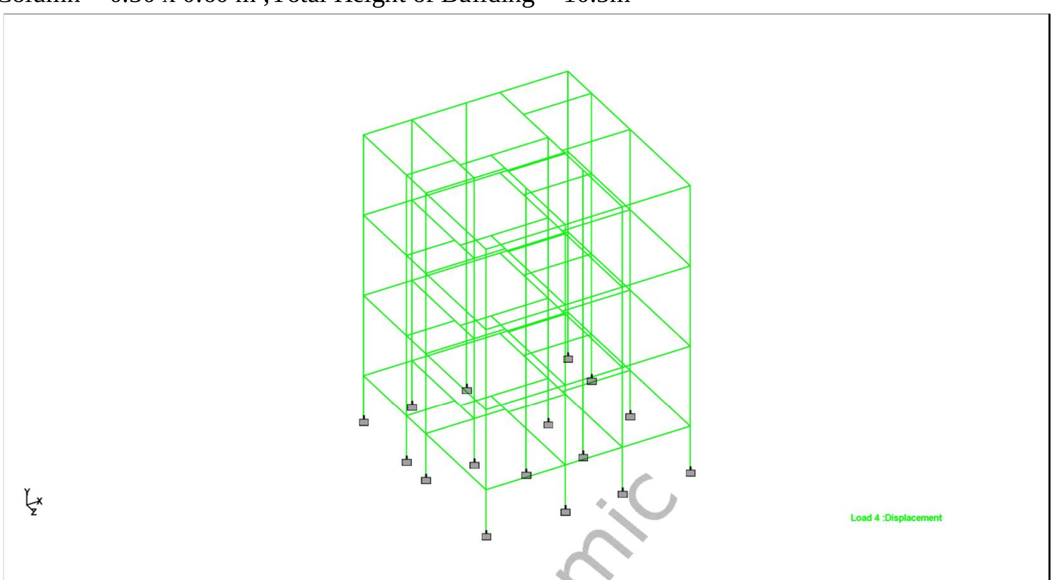
A. 1.5(DL+LL) ; B. 1.2(DL+LL+EQX) ; C. 1.2(DL+LL-EQX) ; D. 1.2(DL+LL+EQZ) ; E. 1.2(DL+LL-EQZ)
F. 1.5(DL+EQX) ; G. 1.5(DL-EQX) ; H. 1.5(DL+EQZ) ; I. 1.5(DL-EQZ) ; J. 0.9DL+1.5EQX ; K. 0.9DL-1.5EQX
L. 0.9DL+1.5EQZ ; M. 0.9DL-1.5EQZ

IV. CASE CONSIDERATION MODELLING AND ANALYSIS

The details of a structure considered for the analysis is as follows:

It is Three storied RCC frame structure comprising of rooms. The dimensions of respective 5 rooms are;

Living Room = 3.55 x 4.50 m ;Bed Room = 3.20 x 4.20 m ; Kitchen = 2.74 x 4.2 m ; Dinning = 2.74 x 2.7 m ; Sitout = 1.95 x 3.00 m ;Tiolet = 1.95 x 1.35 m ; Puja = 2.81 x 1.23 m ; Height of each floor = 4.5 m ;Depth of footing = 3.1 m ;Size of Beam = 0.23 x 0.45 m ; Size of Column = 0.30 x 0.60 m ;Total Height of Building = 10.5m



Whole Structure Displacements 1000mm:1m 4 1.5(DL+LL)

Footing Details when Sesmic load are considered

Grp. No.	Footing Mark	Column Mark	Footing Type	Material Property	Column Size (mm)	Footing Size (LxBxD) (mm)	Loss of contact (%)	Bottom @ L	Bottom @ B	Top @ L	Top @ B
1	FC1	C1	Sloped	M25 : Fe415	300 X 600	1850 x 1550 x 375 d=175	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
2	FC2	C2	Sloped	M25 : Fe415	300 X 600	2250 x 1950 x 450 d=200	0	T10 @ 280	T10 @ 285	T10 @ 300	T10 @ 300
3	FC3	C3	Sloped	M25 : Fe415	300 X 600	2350 x 2050 x 475 d=225	0	T10 @ 260	T10 @ 235	T10 @ 300	T10 @ 300
4	FC4	C4	Sloped	M25 : Fe415	300 X 600	2050 x 1750 x 400 d=200	0	T10 @ 295	T10 @ 295	T10 @ 300	T10 @ 300
5	FC5	C5	Sloped	M25 : Fe415	300 X 600	2150 x 1850 x 425 d=200	0	T10 @ 265	T10 @ 270	T10 @ 300	T10 @ 300
6	FC6	C6	Sloped	M25 : Fe415	300 X 600	2100 x 1800 x 425 d=200	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
7	FC7	C7	Sloped	M25 : Fe415	300 X 600	2850 x 2550 x 600 d=275	0	T10 @ 185	T10 @ 180	T10 @ 300	T10 @ 300
8	FC8	C8	Sloped	M25 : Fe415	300 X 600	2100 x 1800 x 425 d=200	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
9	FC9	C9	Sloped	M25 : Fe415	300 X 600	2650 x 2350 x 550 d=250	0	T10 @ 215	T10 @ 205	T10 @ 300	T10 @ 300
10	FC10	C10	Sloped	M25 : Fe415	300 X 600	2350 x 2050 x 475 d=225	0	T10 @ 230	T10 @ 235	T10 @ 300	T10 @ 300
11	FC11	C11	Sloped	M25 : Fe415	300 X 600	2200 x 1900 x 450 d=200	0	T10 @ 275	T10 @ 275	T10 @ 300	T10 @ 300
12	FC12	C12	Sloped	M25 : Fe415	300 X 600	2250 x 1950 x 450 d=225	0	T10 @ 245	T10 @ 250	T10 @ 300	T10 @ 300
13	FC13	C13	Sloped	M25 : Fe415	300 X 600	2100 x 1800 x 425 d=200	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
14	FC14	C14	Sloped	M25 : Fe415	300 X 600	2150 x 1850 x 450 d=200	0	T10 @ 300	T10 @ 270	T10 @ 300	T10 @ 300
15	FC15	C15	Sloped	M25 : Fe415	300 X 600	2100 x 1800 x 425 d=200	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
16	FC16	C16	Sloped	M25 : Fe415	300 X 600	2000 x 1700 x 400 d=200	0	T10 @ 300	T10 @ 290	T10 @ 300	T10 @ 300

Footing Details when Sesmic forces are not considered

Grp. No.	Footing Mark	Column Mark	Footing Type	Material Property	Column Size (mm)	Footing Size (LxBxD) (mm)	Loss of contact (%)	Bottom @ L	Bottom @ B	Top @ L	Top @ B
1	FC1	C1	Sloped	M25 : Fe415	300 X 600	1850 x 1550 x 375 d=175	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
2	FC2	C2	Sloped	M25 : Fe415	300 X 600	2150 x 1850 x 425 d=200	0	T10 @ 265	T10 @ 270	T10 @ 300	T10 @ 300
3	FC3	C3	Sloped	M25 : Fe415	300 X 600	2300 x 2000 x 475 d=225	0	T10 @ 290	T10 @ 260	T10 @ 300	T10 @ 300
4	FC4	C4	Sloped	M25 : Fe415	300 X 600	2000 x 1700 x 400 d=200	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
5	FC5	C5	Sloped	M25 : Fe415	300 X 600	2100 x 1800 x 425 d=200	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
6	FC6	C6	Sloped	M25 : Fe415	300 X 600	2050 x 1750 x 425 d=200	0	T10 @ 300	T10 @ 295	T10 @ 300	T10 @ 300
7	FC7	C7	Sloped	M25 : Fe415	300 X 600	2750 x 2450 x 575 d=275	0	T10 @ 190	T10 @ 185	T10 @ 300	T10 @ 300
8	FC8	C8	Sloped	M25 : Fe415	300 X 600	2050 x 1750 x 400 d=200	0	T10 @ 295	T10 @ 295	T10 @ 300	T10 @ 300
9	FC9	C9	Sloped	M25 : Fe415	300 X 600	2600 x 2300 x 525 d=250	0	T10 @ 210	T10 @ 200	T10 @ 300	T10 @ 300
10	FC10	C10	Sloped	M25 : Fe415	300 X 600	2300 x 2000 x 450 d=225	0	T10 @ 250	T10 @ 230	T10 @ 300	T10 @ 300
11	FC11	C11	Sloped	M25 : Fe415	300 X 600	2100 x 1800 x 425 d=200	0	T10 @ 300	T10 @ 265	T10 @ 300	T10 @ 300
12	FC12	C12	Sloped	M25 : Fe415	300 X 600	2150 x 1850 x 450 d=200	0	T10 @ 300	T10 @ 270	T10 @ 300	T10 @ 300
13	FC13	C13	Sloped	M25 : Fe415	300 X 600	2050 x 1750 x 425 d=200	0	T10 @ 300	T10 @ 295	T10 @ 300	T10 @ 300
14	FC14	C14	Sloped	M25 : Fe415	300 X 600	2100 x 1800 x 425 d=200	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300
15	FC15	C15	Sloped	M25 : Fe415	300 X 600	2050 x 1750 x 400 d=200	0	T10 @ 295	T10 @ 295	T10 @ 300	T10 @ 300
16	FC16	C16	Sloped	M25 : Fe415	300 X 600	1950 x 1650 x 400 d=175	0	T10 @ 300	T10 @ 300	T10 @ 300	T10 @ 300

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From above two tables, we can consider one exterior footing (i.e. footing no.1) and one interior footing (i.e. footing no.7). On exterior footing,eccentricity is acting (eccentric footing) and on internal footing loads are coming from all directions (axial footing). So to observe the variations in result due to seismic forces and without sesmic forces, footing no.1 and footing no.7 is considered for further studies. The output of STAAD design for various cases are.

V. OBSERVATION AND REMARK

Reaction values over Supports when Sesmic load are considered:-

Support	Fx kN	Fy kN
1	3.014	8.229
2	-0.904	17.921
3	13.777	-7.353
4	1.395	10.895
5	11.529	-30.797
7	8.821	-16.349
8	-4.12	-6.671
9	1.044	-8.057
10	2.363	-6.801
11	-1.017	-4.753
12	-19.47	-9.201
18	-6.246	-16.141
19	-8.848	9.157
21	-16.516	2.376
23	-19.877	2.556
25	15.819	1.37

Reaction values over Supports when Sesmic load are not considered:-

Supports	Fx kN	Fz kN
1	2.838	7.582
2	-0.901	18.91
3	12.292	-6.661
4	1.476	11.398
5	8.007	-14.499
6	10.589	-27.619
7	-3.668	-5.487
9	2.124	-5.645
10	-5.74	-14.45
11	0.941	-8.102
12	-0.932	-4.95
14	-17.343	-7.644
17	-7.616	8.073
18	-14.502	2.16
19	-18.403	2.369
20	14.739	1.115

The study undertaken over here is related to comparitive analysis of footing subjected to normal forces and earthquake forces.For this the RCC multistorey structure G+2 is analysed using Stadd pro and RCDC software.For this two cases were modelled

Case 1:- Without Sesmic forces

Case 2:- With Sesmic forces

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The Support reaction values of both the cases are observed over here from which it can be seen that due to increase in earthquake forces the lateral direction forces over the footing is increased. Similarly the moment Mx and Mz shows reasonable growth.These values are responsible for development of torsion and twisting also these values are responsible for development of eccentric forces and thus the design of footing are changed Since the materials is kept constant there is change in volume and area.

Difference Between Design properties of Footing no.1 when sesmic load are considered versus when sesmic load are not considered.

	FC1 when sesmic load are not considered	FC1 when sesmic load are considered
Maximum Soil Pressure	170.33 KN	175.62 KN
Axial load ,Pu	336.52 KN	348.99 KN
Ast required at bottom reinforcement along length	342 sqmm	356sqmm
Ast required at top reinforcement along length	256 sqmm	256sqmm
Ast required at bottom reinforcement along width	414 sqmm	431 sqmm
Ast required at top reinforcement along width	305 sqmm	305 sqmm
One way shear along L Tv Tc	 0.29 KN/sqmm 0.33 KN/sqmm Tv<Tc	 0.30 KN/sqmm 0.34 KN/sqmm Tv<Tc
One way shear along B Tv Tc	0.28 KN/sqmm 0.30 KN/sqmm Tv<Tc	0.29 KN/sqmm 0.31 KN/sqmm Tv<Tc
Design for Punching shear Tv Tc	0.328 KN/sqmm 1.25 KN/sqmm Tv<Tc	0.34 KN/sqmm 1.25 KN/sqmm Tv<Tc
Load transfer Check Pu Concrete bearing capacity	336.52 KN 4050 As CBC > Pu Hence safe	348.99 KN 4050 As CBC > Pu Hence safe

Difference Between Design proprties of Footing no.7 when sesmic load are considered versus when sesmic load are considered.

	FC7 when sesmic load are not considered	FC1 when sesmic load are considered
Maximum Soil Pressure	176.57 KN	176.11 KN
Axial load ,Pu	871.92 KN	936.59 KN
Ast required at bottom reinforcement along length	1040 sqmm	1126 sqmm
Ast required at top reinforcement along length	625 sqmm	669 sqmm
Ast required at bottom reinforcement along width	1209 sqmm	1302 sqmm
Ast required at top reinforcement along width	701 sqmm	748 sqmm
One way shear along L Tv Tc	0.35 KN/sqmm 0.40 KN/sqmm Tv<Tc	0.35 KN/sqmm 0.40 KN/sqmm Tv<Tc
One way shear along B Tv Tc	 0.35 KN/sqmm 0.37 KN/sqmm Tv<Tc	 0.36 KN/sqmm 0.37 KN/sqmm Tv<Tc
Design for Punching shear Tv Tc	 0.439 KN/sqmm 1.25 KN/sqmm Tv<Tc	 0.442 KN/sqmm 1.25 KN/sqmm Tv<Tc
Load transfer Check Pu Concrete bearing capacity	871.92 KN 4050 KN As CBC > Pu Hence safe	348.99 KN 4050 KN As CBC > Pu Hence safe

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From the above tables we can conclude that when sesmic loads are considered there is increase in values of some of the design properties of footing and in some cases there is increase in depth of footing.

VI. CONCLUSION

The study done over here is related to effect of seismic forces over the footing. The observations and remark shows that for the same geographical region when the lateral forces are induced in the footing , the development of moments, torsion and twising are developed . This brings the necessity to change the design of footing for resisting earthquake forces even if we consider Zone II . Since, the footing is most important part of load transfer path the detaling and consideration of earthquake force is necessary.

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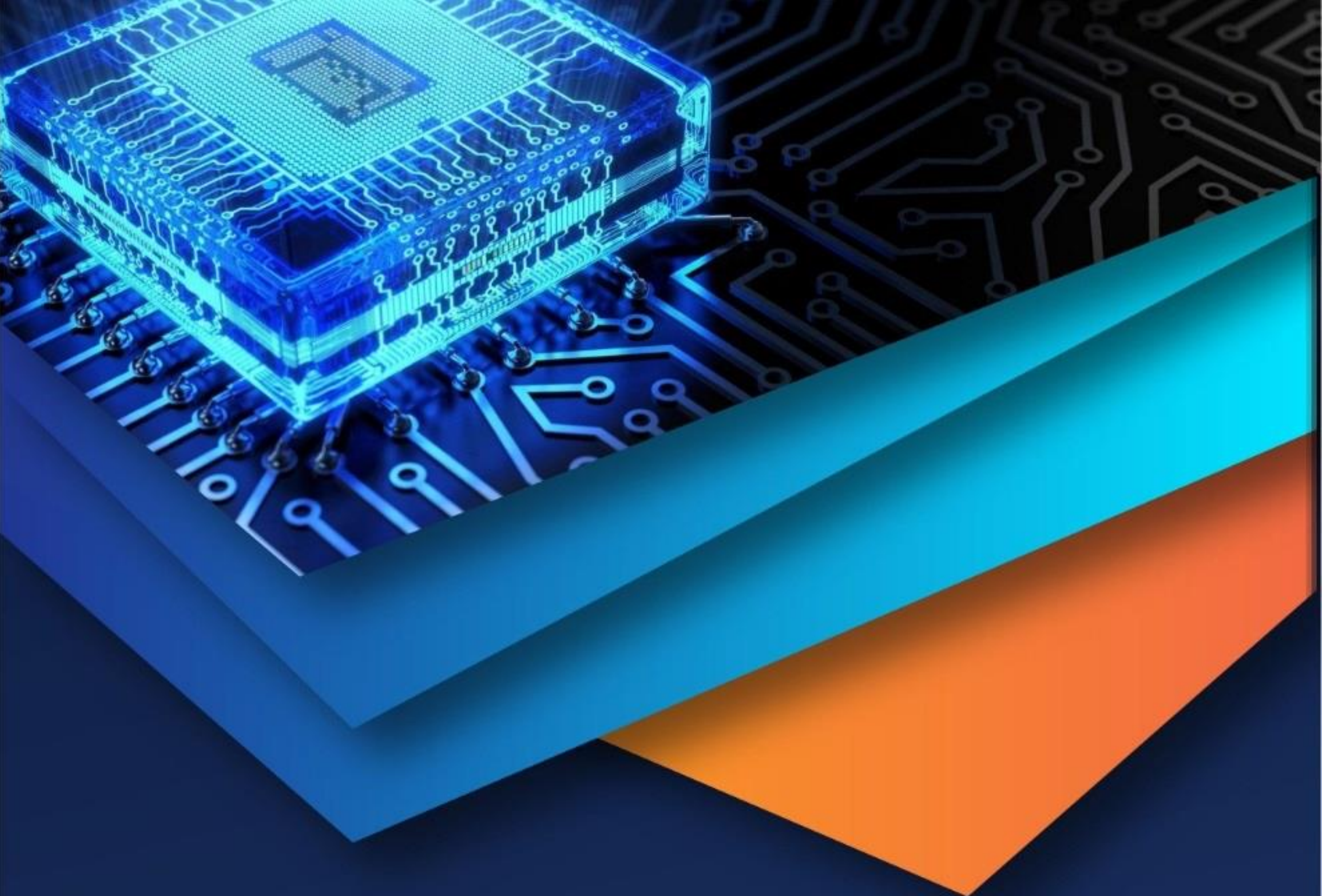

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