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Behaviour of RCC Column Strengthened using Steel Jacketing

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Abstract: Strengthening of existing reinforced Columns in old structures is turning into a noteworthy issue during repair and support. Reinforced sections in a structure get bothered because of different reasons like aging, decay of materials, corrosion of steel and unusual loading conditions like quake, fire, higher wind loads, shock loads and impacts, and so on. Retrofitting of existing structures to meet well-being necessities in seismic ranges where more established developments were not intended for earthquake activities. Other average utilization of retrofitting strategies can be discovered where the bearing limit must be expanded as a result of the adjustment in the utilization of structure, retrofitting further reduces destruction of historical structures, modern structures, urban transport structures, marine structures.

There are diverse techniques for retrofitting of existing structures. Jacketing is a standout amongst the most well known technique for columns. Steel jacket, reinforced concrete jacket, fiber reinforced polymer composite jacket, etc are most common examples of jacketing. Retrofitting of solid part with remotely connected steel and Ferro concrete is an acknowledged alternative for repair and restoration of structures, which will enhance the load carrying capacity together with ductile characteristics , required on account of seismic retrofit.

In the present thesis 6 columns are casted. 3 RC columns are considered as control column, 3 RC columns are strengthened using steel jacketing. The columns will be tested using axial load test and ultimate load test and are compared for different specimens. The same will be simulated in FEM based software such as, ANSYS and loading conditions were applied and the results were compared with the experimental results from the above obtained results the performance of two methods will be investigated.

Keywords: Retrofitting, Columns, Steel Jacketing. ANSYS

I. INTRODUCTION

Jacketing of columns comprises of included cement with longitudinal and transverse fortification around the existing columns. This kind of reinforcement enhances the axial and shear strength of columns while the flexural strength of column and strength of the beam-column joints remains the same. It is observed that the jacketing of columns is not suitable for enhancing the durability. A major advantage of column jacketing is that it improves the lateral load capacity of building and hence keeping away from the concentration of stiffness as in case of shear walls. In the addition of original function of building can be maintained and there will be no major changes of building with this technique. The jacketing of columns is carried out by different methods:

1) Reinforced Concrete Jacketing.
2) Steel Jacketing.
3) CFRP Jacketing(Carbon Fiber Reinforced Polymer

In this paper, economically reasonable material such as Steel angle sections are used for retrofitting a reinforced concrete Column and the behaviour of the Column under loading is observed. Installation of these angle sections is very easy and skilled labour is not required. The behaviour of 6 columns i.e. 3 normal columns and 3 columns retrofitted with steel angles sections under same loading are compared. The simulating models of these columns were generated in finite element based software ANSYS and the behaviour of these columns were observed under same loading and compared. The results of both experimental analysis and software analysis were also compared.

One of the strengthening method is steel coat in which steel edges/Plates are utilized for binding the section concrete with various arrangements like steel wrapping for roundabout column, Steel Plates and steel confining. Steel confining is one of least demanding and normal rendition among them, which comprises of four steel points, set at the edges of RC section and steel lashes/secures are utilized on a level plane, welded to the edges with a particular interim along the stature of the column The tiny gap between the solid and the confining is topped off with non-recoil bond mortar or epoxy grout. It is generally utilized reinforcing method of RC segments with rectangular or potentially square cross-segment. The strategy is for the most part viewed as sensible, quick and practical. Additionally, it improves overall seismic performance of the structure by developing lateral strength, axial load carrying capacity, the ductility and shear capacity of structural members. The technique is widely used in construction field.

Retrofitting refers to the addition of new technology or features to the older systems it may be increase the service ability at the deterioration or to increase the load carrying capacity of the existing structure to bare additional loads which is not anticipated during the time of design. It proves to be better economic considerations and immediate usage rather than replacement of the structure. In most countries of the world, the structures are ageing and need continuous maintenance or repair. Moreover, the majority of existing buildings are deficient as per current problem of structural deficiency of existing constructions is especially more in seismic regions since the concept of seismic design of structures is recent. The direct and indirect costs of demolition and reconstruction of structurally deficient constructions are often high; furthermore they cause a substantial waste of natural resources and energy. Therefore, structural retrofitting is becoming increasingly widespread throughout the world.

Jacketing is one of the most frequently & popularly used techniques to strengthen reinforced concrete (RC) columns. With this method, axial strength, bending strength, and stiffness of the original column are increased. Steel connectors are additionally once in a while connected. These means include specific workmanship, time, and cost. The most widely recognized sorts of coats are steel coat, strengthened solid coat, fibre fortified polymer composite coat, coat with high pressure materials like carbon fibre, glass fibre and so on. The primary motivations behind jacketing are, To build solid restriction by transverse fibre support, particularly for round cross-sectional segments, To build shear quality by transverse fibre support, To increment flexural quality by longitudinal fibre gives strength.

II. LITERATURE REVIEW

A. M.k. Elsamny, a.a. Hussein, a.m. Nafie and m.k. Abd-elhamed (2013)

An experimental study of Reinforced Concrete, RC, columns strengthened using a steel jacketing technique was conducted. The jacketing method comprised of four steel vertical points introduced at the sides of the section joined by even steel lashes keeping the segment remotely. Strain gages were introduced to screen the strains in the inner strengthening and also the outside jacketing framework. The adequacy of the jacketing procedure was illustrated, and the parameters influencing the strategy were contemplated.

B. N. ISLAM, m. M. Hoque*

This paper means to audit the fortifying systems of Reinforced Concrete (RC) section utilizing steel coat. Investigations were engaged to know the impact of fortifying setups on stack conveying limit, flexibility, horizontal quality and flexural quality by changing parameters like strip thickness, size and dividing, solid quality, edge size and thickness. Comparisons between the consequences of the exploratory examination and scientific conditions proposed by various specialists and configuration codes have been outlined. It has been found from the writing that heap conveying limit relies upon parameters. The test examinations directed by a few analysts uncover that there is a general increment in pivotal quality and parallel quality**.**

C. Ezz - ELDEEN, h. A(2016)

In the present investigation, the steel jacketing system with variable vertical edges estimate associated with level steel lashes is utilized to overhaul the heap conveying limit of rectangular strengthened solid sections under whimsical burdens. Seventeen fortified cement rectangular sections were stacked and tried under various whimsies until disappointment. Numerical examination utilizing the limited component system has been directed to re-enact the reaction of control and reinforced segments. A limited component business bundle "ANSYS rendition 15" is utilized. Every segment is reinforced to achieve the first section conveying limit. The comes about demonstrated that expanding the secured territory of the steel coat and in addition expanding cross sectional region of the steel points builds the heap conveying limit of the fortified segments.

D. K. Al-deen, i. Bsis (2005)

In this study, two strategies for retrofitting of short strengthened solid square sections were endeavored. Wire work mortar jacketing (WMM) and Steel Cage Mortar jacketing (SCM) were given to the fortified solid section. For investigation of test outcomes, a plain fortified section (CS) was tried. A sum of 9 section examples were tried following 28 days and results were broke down. The plan and the testing was done according to the Indian Standard. Results were broke down for SCM and WMM. Hypothetical limits of sections were figured and looked at. The solidness variety for different sections are exhibited. From the outcome investigation, it was watched that when contrasted with control example CS, WMM was 1.75 times more noteworthy, SCM was 2.28 times more noteworthy. The solidness of WMM was the most elevated esteem at first, 1.2 times higher that CS.

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E. Mustafa fakharifar s.

In this examination, a lightweight pre-focused on steel coat (PSJ) was proposed and created for quick and financially savvy repair of a seriously harmed round strengthened solid section. The extreme quality and uprooting malleability of the harmed segment were re-established to 115% and 140%, separately, of those of the as-manufactured segment. The starting solidness of the harmed section, nonetheless, was re-established to just 84% of that of the as-constructed segment on the grounds that the PSJ was intended to re-establish the quality and malleability as it were. By interfacing the harmed segment to its balance through secured dowel bars, the levels of rebuilding in extreme quality, beginning firmness, and dislodging flexibility were altogether expanded by no less than 20%

III. METHODOLOGY

This project is simplified into two modules to make the work easy. The first module is experimental analysis and the second module is software analysis. The first module i.e. experimental analysis includes applying axial loading of RCC Columns under Loading Frame Reinforced Concrete Columns are casted. The columns were casted in wood moulds by adopting proper mix design and allowed to cure for 28 days. Later the columns were allowed to dry and the surfaces of the columns were cleaned from dirt. The normal column i.e. the Control column is set in Loading Frame with axial load loading is applied uniformly on top of the Column and readings are recorded on monitor. The load vs. Deflection graph of the specimen is plotted and the ultimate load of the column is noted. In the same manner, the column retrofitted with steel jacketing is also tested in Loading Frame and the behaviour of the retrofitted column is also observed.. The ultimate loads of 6 columns are compared, so that we can get a clear idea that the additional load taken by the retrofitted columns when compared with the control column. Reinforced concrete beams which are casted and tested experimentally are now modelled in Ansys and their physical behaviour will be predicted at different load conditions

IV. EXPERIMENTAL STUDY

In order to investigate the effect of above mentioned parameters on the behavior of strengthened RC column, and experimental program was carried out to test six RC columns with concrete compressive strength.

A. Test specimens

All tested columns *were* 100 x 100 mm in cross section with 1000 mm height. The specimens were divided into two groups. The first group includes three control specimens without strengthening and second group includes three specimens strengthened with steel jacketing. Vertical steel elements such as angles were chosen throughout the height of the column.

B. Concrete mix and casting

The concrete mix was prepared from OPC, natural sand and crust natural dolomite aggregate with maximum nominal size of 20mm. the test specimens were vertical cast in wooden moulds stiffened by battens to maintain the form and shape.

Table 1

Cement	Water	Sand	Aggregate	W/C Ratio
338kgs	186litres	683.427	1212	0.55

C. Test procedure

The specimens were put on Loading Frame. The strain gauge, load cell and linear voltage displacement transducer (LVDT) were altogether associated with the information obtaining framework appended to the monitor. The load was monitored by the load cell and transmitted to the RC column. A controlled data acquisition system was utilized to ceaselessly record the readings of load cell, the dial gauge that measures the column even distortions in opposite ways, the fortification strain gauges and furthermore the steel coat were more restricted with steel edge areas and connected by flats. All the records were automatically saved on computer file for further data manipulation and plotting.

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D. Analytical work using Finite Element Model

The finite element package ANSYS was used to simulate the experimental testing by introducing a numerical model. The tested columns in the experimental work were modeled to determine the failure loads and strains in each specimen. Comparison of results between experimental and F.E was carried out.

Fig 1: Buckling Of A Column

Fig 2: Crack Pattern Showing Buckling

E. Strengthening details for specimen:

Fig.3: Steel Jacketing

Fig.4: Steel Jacketing Setup

Steel Type	Size
Angle	4L 20mm*20mm*3mm
Flats	24F 70mm*20mm*3mm

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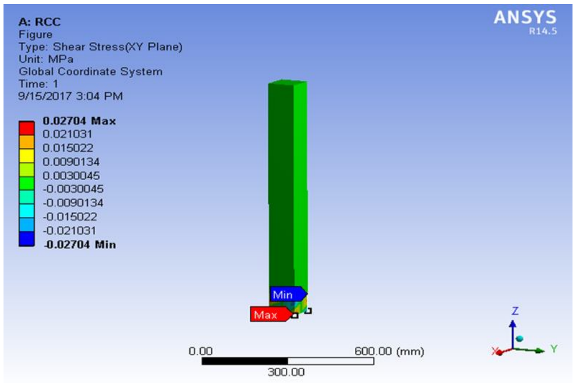

Fig.5: Testing Of Steel Jacketed Column

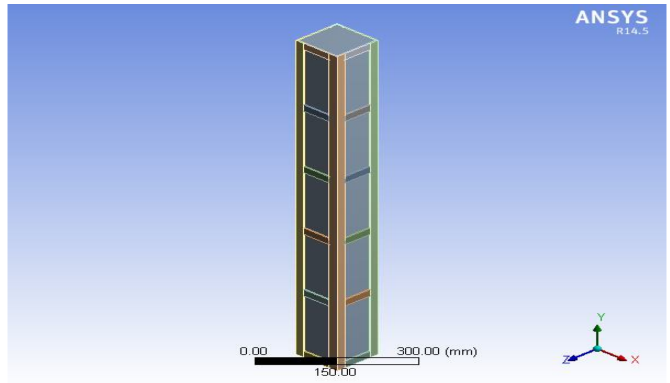

Fig.6: Column Under Buckling

F. Column Design Using Ansys

Fig.7: Model Of A Control Column With Axial Force

Fig.8 Total Deformation

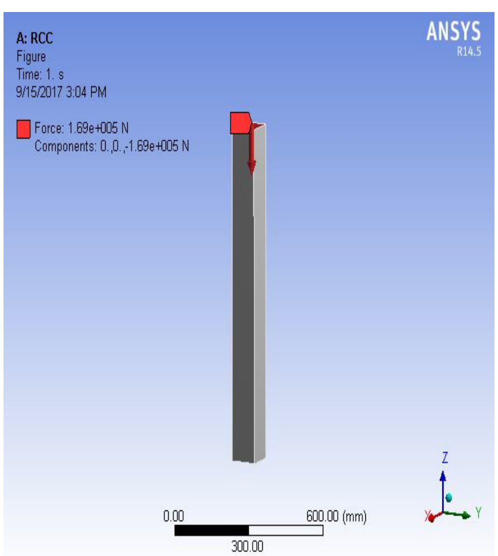

Fig.9: Shear Stresses In Xy Plane

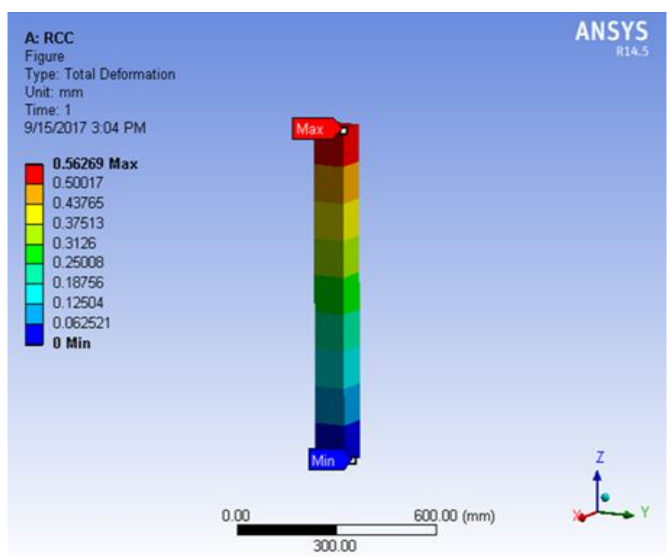

Fig.10: Steel Jacketed Model Showing Minimum & Maximum

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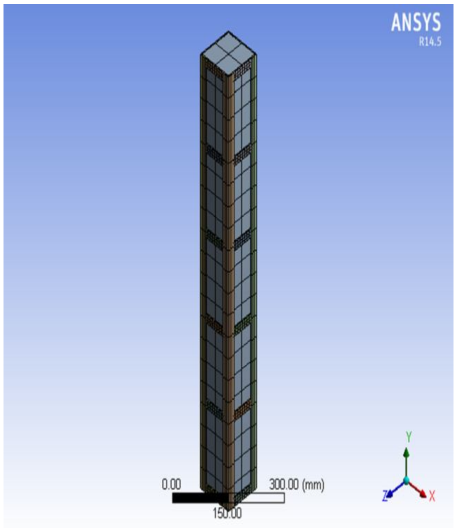

Fig.11: Model With Mesh

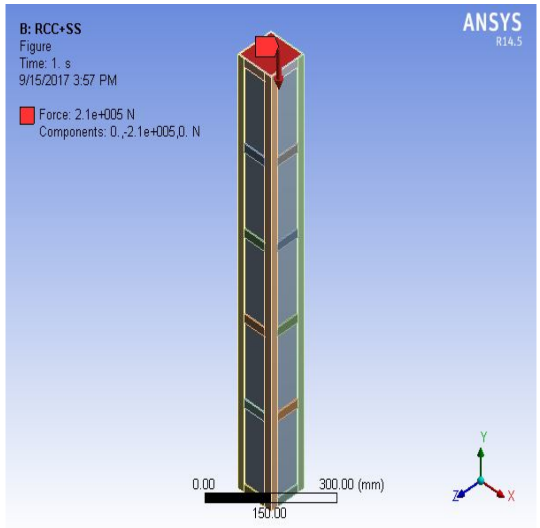

Fig.12: Loading Pattern

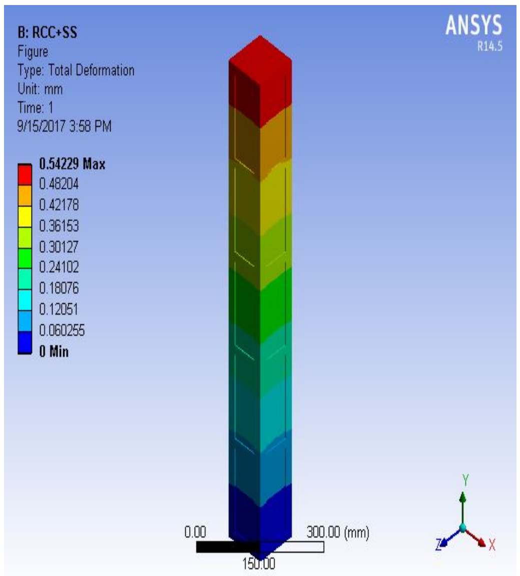

Fig.13: Deformation

V. RESULTS & DISCUSSIONS

A. Control column

MODEL	EXP. FAILURE LOAD(KN)	F.E. FAILURE LOAD(KN)	$P_{EXP}/P_{F.E}$	EXP DEFLECTION(mm)	F.E DEFLECTION(mm)	$D_{EXP}/D_{F.E}$
C 1	169	189	1.19	1.015	0.624	1.80
C 2	175	192	1.13	1.117	0.612	2.17
C 3	183	200	1.13	1.008	0.581	2.04

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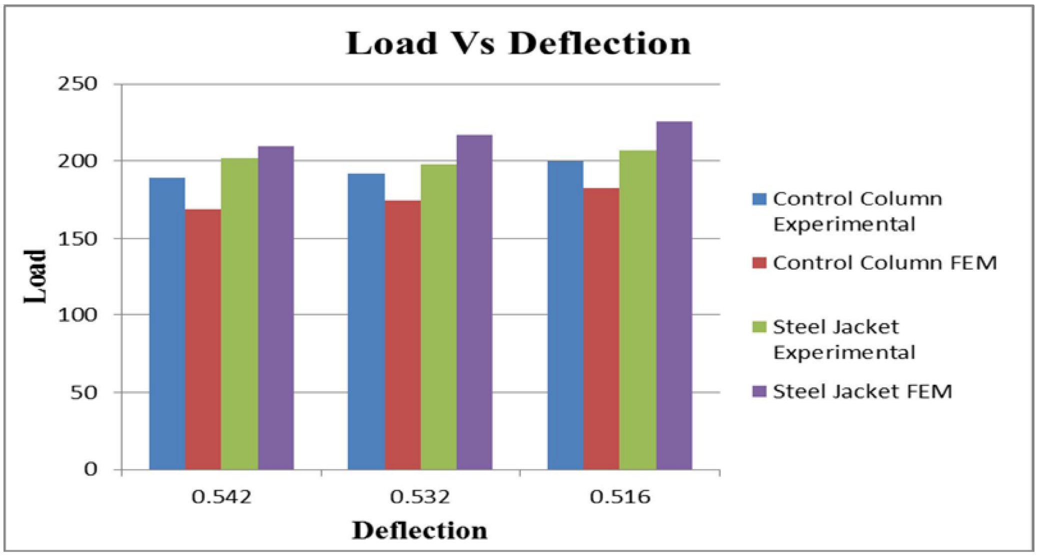
B. Steel Jacketing

MODEL	EXP. FAILURE LOAD(KN)	F.E. FAILURE LOAD(KN)	$P_{EXP}/P_{F.E}$	EXP DEFLECTION(mm)	F.E DEFLECTION(mm)	$D_{EXP}/D_{F.E}$
C 1	202	210	0.9	0.623	0.542	1.547
C 2	198	217	0.884	0.597	0.532	1.121
C 3	207	226	0.8849	0.576	0.516	1.114

Graph Showing Load Vs Deflection For Both Control And Steel Jacketed Columns



VI. CONCLUSIONS

A. Adopting steel jacketing strategy for reinforcing RCC section has been ended up being successful since it enhances the column ability to at least 20%.

B. The failure mode of control RCC column was brittle while strengthening with steel jacket changed failure mode to be more ductile

C. Specimen strengthened with angle segments recorded a higher failure load than control column.

D. 4L arrangement experienced less deformation than control column.

E. The simulation of strengthened RC section utilizing a F.E investigation in ANSYS program is great since method of failure, failure loads and displacements predicted very close to those measured during experimental testing.

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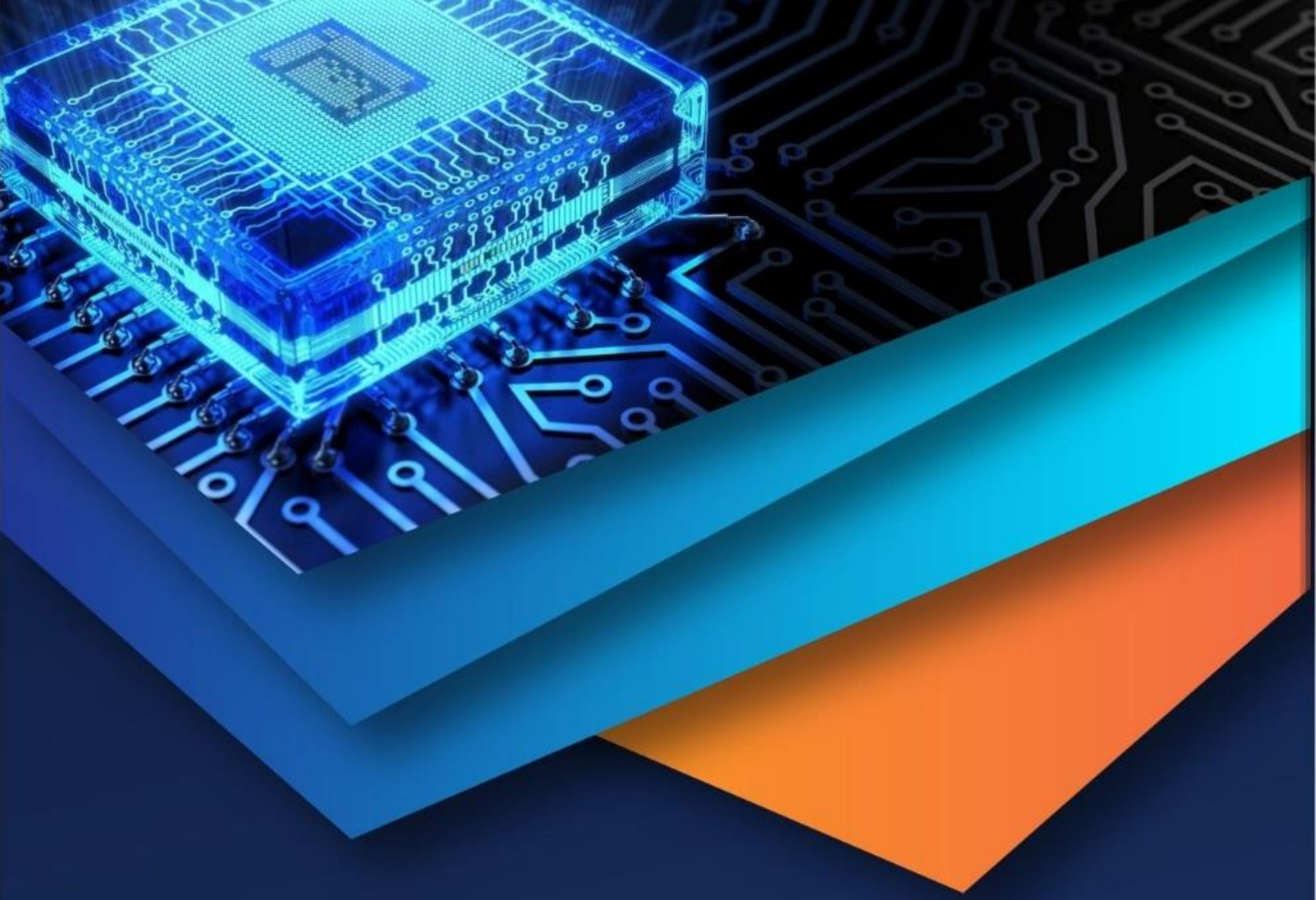

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