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Retrofitting of Deteriorated with Carbon Wrapping & Steel Plate Jacketing

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Abstract: ***The pre-fiasco readiness plot takes to fix/retrofitting of the strengthened solid structure to guarantee satisfactory execution during tremors. The fix can prompt an expansion in firmness quality and disappointment distortion. There is a need to quality the presentation of the structure after a fix has been completing. These are adequated in specific cases and may not be fulfilled in others. Structures get broken down with time for which fixes are not possible. A few structures can't be saved shut for longer vacation required for reproduction. Retrofitting is a proficient strategy that can be unexplored to repudiate every one of these insubordinations. The article supplement relative examination of rate increment in quality later receiving steel plate jacketing and carbon wrapping is resolved and looked at. The examination will be convenient to assist the auxiliary specialist in deciding which strategy for retrofitting ought to be embraced for procuring the necessary increment in quality.***

Keywords: Axially loaded column, Ductility, Carbon wrapping, Steel plate jacketing, Retrofitting, Seismic Performance, Epoxy resign.

I. INTRODUCTION

The fortify and improved of the presentation a lacking basic component or the structure similarly an entire be alluded to similarly retrofitting. Retrofitting is expressions of the human experience of change of present structure to do them increasingly unaffected expense be successful and strategy to a circumstance. Retrofitting focus on basic reinforce of a structure later or prior a seismic tremor to predefined execution. It is, subsequently, suggest that the current lacking structure is retrofitting to better their exhibition to the occasions of a tremor and to evade huge scope harm to life and property. Jacketing of section comprises of incorporate to the concrete with longitudinal and transversal fortress about the current segment. This sort of strengthens upgrades the hub and shear quality of the segment while the flexural solidarity to the bar section of joint continues as before. Sections jacketing is that it better to the laterals loads limit of the build and in this manner avoid the concentrated of solidness similarly on account of the shears divider. Jacketing improves to the general seismic exhibitions of the structures a ways create parallel solidarity to the hub load transport limit, the pliability and shear limit a structure part. Carbon wrapping is created methods to build the quality and malleability of the harm or under-plan fortify the solid structure. Carbon wrapping gives useful isolation to touchable accomplishing a critical resurgence in malleability. Similarly totally substitutions or reproductions of the basic will be financially savvy, fortify or retrofitting is a viable method to reinforce the equivalent. Via carbon wrapping, retrofitting of solid structure gracefully an increasingly financial and in fact better option than the customary strategy in any circumstance since it offers high quality, low weight, erosion opposition, high weariness obstruction, effectively and rapids establishment and insignificant changes internal basic geometry.

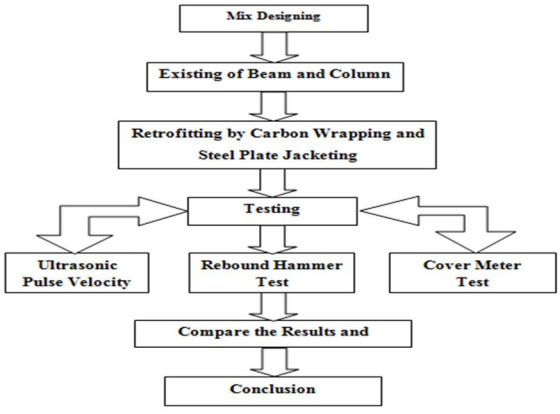

Fig. 1 Flow Chart

A. *Need Of Retrofitting*

Complete redoing would be an extravagant, of incredible worth be significant. The total recover (redevelopment) of the structure would relinquish a lot higher than the retrofitting cost. Memorable landmarks must be kept up in their unique structure with well being.

II. METHODS OF RETROFITTING

There are various strategies for retrofitting accessible. Besides there a couple of up and coming techniques for retrofitting similarly well. Be that as it may, the most liked, compelling, and rehearsed techniques are Reinforced Concrete Jacketing and Fiber Reinforced Polymer Wrapping. The jacketing of the column be completed by the various techniques.

A. *Carbon Wrapping*

The procedure of the carbon wrapping or fiber wrapping sections or shaft utilizes structure carbon fiber. Carbon FRP concrete has improved burdens conveying points and an upgraded administration life and sturdiness. Carbon fiber fortifies cement to be additionally used to reinforce the solid structure.

1) *Carbon Wrapping Properties*

a) High solidarity to weight proportion.
b) Inflexibility.
c) Consumptions obstruction.
d) Electricals conductivity.
e) Weakness obstruction.
f) Great elasticity yet weak.
g) Imperviousness to fire/Not combustible.
h) High warm conductivity in certain structures.

Fig. 1.3.1. Carbon Wrapping

The rate increments in the quality of the part later carbon wrapping to be resolved as per the rules gave in IS 15988: 2013. The midmost quality of the segments wrapped with detail wrapping to be determined dependent on the condition with the substitution of fck by compressive quality of bound cement f'cc.

$$Pu' = 0.4 \times f'cc \times Ac + 0.67 \times fy \times Asc$$

$$f'cc = fck(1 + \alpha pc\ \omega w)$$

Where,
αpc = performance coefficient for circular columns
ωw = ratio's of ultimated confinement stress due to concrete strength
Fck= Characteristics compressive strengths of the concrete.
Ac = Areas of concrete.
Fy= Characteristics strengths of compressive reinforcement.
Asc= Areas of longitudinal reinforcement for column.
Compute the percentage increase in the strengthed of the column after carbon wrapping.

$$\text{Increase in strength} = \{(Pu'-Pu) / Pu\} \times 100$$

B. Steel Plate Jacketing

Steel plate jacketing developments technique: A development strategy wherein steel plates are set consistently around the whole outskirts of the current section part. That has lacking burden conveying themes clinging to the current part to shape a composite design so as to unfasten the steel plate jacketing. There are a few choices for coats of cement. Out of them, most favored one which is normally received to be coat concrete with longitudinal steel in the types of strengthened and ties or welded wires. The accompanying advances are followed to decide the increments in quality.

Fig. 1.3.2. Steel Plate Jacketing

1) Step 1 - Determine the strengths of the columns from the following equation with respects to IS 800:2007.

Pu = 0.4 x *fck* x Ac + 0.67 x *fy* x Asc

Where,

Fck= Characteristics compressive strengths of the concrete.

Ac = Areas of the concrete.

Fy= Characteristics strengths of compressive reinforcements.

Asc= Areas of longitudinal reinforcement for columns.

The deteriorated strengths of the concrete and steel is consider during the calculation of strength of column.

2) Step 2 - Compute the news Area of concrete (Ac') and news area of steel (Asc') later steel jacketing the column

3) Step 3 - Calculate the new strengths of column later increase in areas of steel and concrete after steel jacketing by using equation.

Pu' = 0.4 x *fck* x Ac' + 0.67 x *fy* x Asc'

Where,

Pu'= Strengths of column after steel jacketing.

4) Step 4:- Compute the percentages increase in the strengths of the column after steel jacketing.

Increasing in strength = (Pu'-Pu)

Increase in strength = {(Pu'-Pu) / Pu} × 100

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III. DETERMINATION OF LOADS CARRYING CAPACITY

A. Load Carrying Capacity (Pu) when Constructed

For a column of size 230×350mm with 1% steel reinforcement,

Ag = 230×350 = 80500mm^2

Asc = 805mm2

Ac = 80500-805 =79695mm^2

Pu = 0.4×25×79695 + 0.67×415×805

Pu = 1020.78 kN

B. Loads Carrying Capacity (Pu) after Deterioration

Pu = 0.4×18.4×79695 + 0.67×415×805×0.3

(fck = 18.4 (deteriorated & 70% corrosion))

Pu' = 653.704 kN

IV. COMPARATIVE STUDY OF PERCENTAGE INCREASE IN STRENGTH

A. Percentages Increase in strength after Carbon Wrapping.

1) For 2 layer of carbon wrapping.

a) For Minimum condition - (α= 0.67)

Pu = ϕc×α×f'cc×(Ag – Ast) + ϕs×fy×Ast

= 1×0.67×24.657×(80500-805) + 1×0.3×415×805

Pu = 1416.79 KN

Percentage increase in strength (× original)

= {(1416.79 – 1020.78)/1020.78} ×100

= 38.79%

Percentage increase in strength (× original) = 38.79%

Percentage increase in strength (×deteriorated)

= {(1416.79 – 653.704)/ 653.704 } ×100

Percentage increase in strength (deteriorated) = 116.73%

b) For Maximum condition- (α= 0.67)

Pu = 1770.506 KN

Percentage increase in strength (× original)

= {(1770.506 – 1020.78)/1020.78} ×100

Percentage increase in strength (original) = 73.45%

Percentage increase in strength (×deteriorated)

= {(1770.506 – 653.704)/ 653.704} ×100

Percentage increase in strength (deteriorated) = 170.84%

2) For 1 layer of carbon wrapping.

a) For minimum condition - (α= 0.85)

Pu = 1249.724 KN

Percentage increase in strength (× original)

= {(1249.724 – 1020.78)/1020.78} ×100

Percentage increase in strength (original) = 22.42%

Percentage increase in strength (×deteriorated)

= {(1249.724 – 653.704)/ 653.704 } ×100

Percentage increase in strength (deteriorated) = 91.17%

b) For Maximum Condition - (α= 0.85)

Pu = 1558.545 KN

Percentage increase in strength (× original)
= {(1558.545 – 1020.78)/1020.78} ×100
Percentage increase in strength (original) = 52.68%
Percentage increase in strength (×deteriorated)
= {(1558.545 – 653.704)/ 653.704 } ×100
Percentage increase in strength (deteriorated) = 138.42%

B. Percentage Increase in Strength after Jacketing

1) For Maximum condition - (0.04% steel)

Providing 100mm jacketing on all sides
Area of jacket = (550×430) – (230×350) = 156000mm2
As = 0.04 % of Ag
= 0.04%×156000 = 62.4 mm2
Ac = 156000 - 62.4 = 155937.6mm2
Pu" = Pu + Pu'
= 653.704×103 + { (0.4×25×155937.6) + (0.67×415×62.4) }
Pu" = 2230.43 KN
Percentage increase in strength (original)
= { (2230.43 – 1020.78)/1020.78 } × 100
Percentage increase in strength (original) = 118.5%
Percentage increase in strength (deteriorated)
= { (2230.43 – 653.704)/ 653.704} × 100
Percentage increase in strength (deteriorated) = 241.19%

2) For Minimum condition – (0.015% steel)

Area of jacket = 156000mm2
As = 0.015%×156000 = 23.4mm2
Ac = 156000 - 23.4 = 155976.6mm2
Pu" = Pu + Pu'
= 653.704×103 + { (0.4×25×155976.6) + (0.67×415×23.4) }
Pu" = 2219.976 KN
Percentage increase in strength (original)
= {(2219.976 – 1020.78) / 1020.78} × 100
Percentage increase in strength (original) = 117.478%
Percentage increase in strength (deteriorated)
= {(2219.976 – 653.704) / 653.704} × 100
Percentage increase in strength (deteriorated) = 239.59 %

Methods	Minimum Condition		Maximum Condition	
	Original	Deteriorated	Original	Deteriorated
Carbon Wrapping (with 2 layer)	α = 0.67		α = 0.85	
	38.79%	116.73%	73.45%	170.84%
Carbon Wrapping (with 1 layer)	α = 0.67		α = 0.85	
	22.42%	91.17%	52.68%	138.42%
Steel Plate Jacketing	(0.015% steel in jacket)		(0.04% steel in jacket)	
	117.5%	239.59%	118.5%	241.19%

Table 1 Clearly demonstrate show that increments in quality of segment later Steel Jacketing be a lot more noteworthy than carbon wrapping for the two essentials and maximums conditions

The two bar graphs beneath the display that increments in quality of segment later steel jacketing and carbon enveloping by parts of both least and the most extreme condition are especially more for a segment with weakened quality than a section with unique quality.

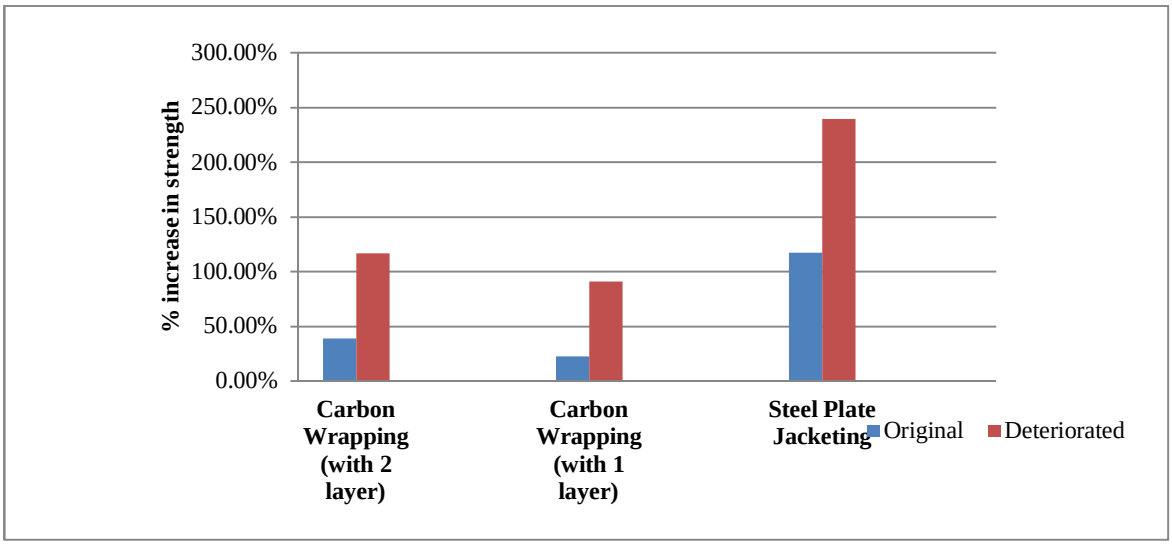

Figure 3.1 Graph for minimum condition.

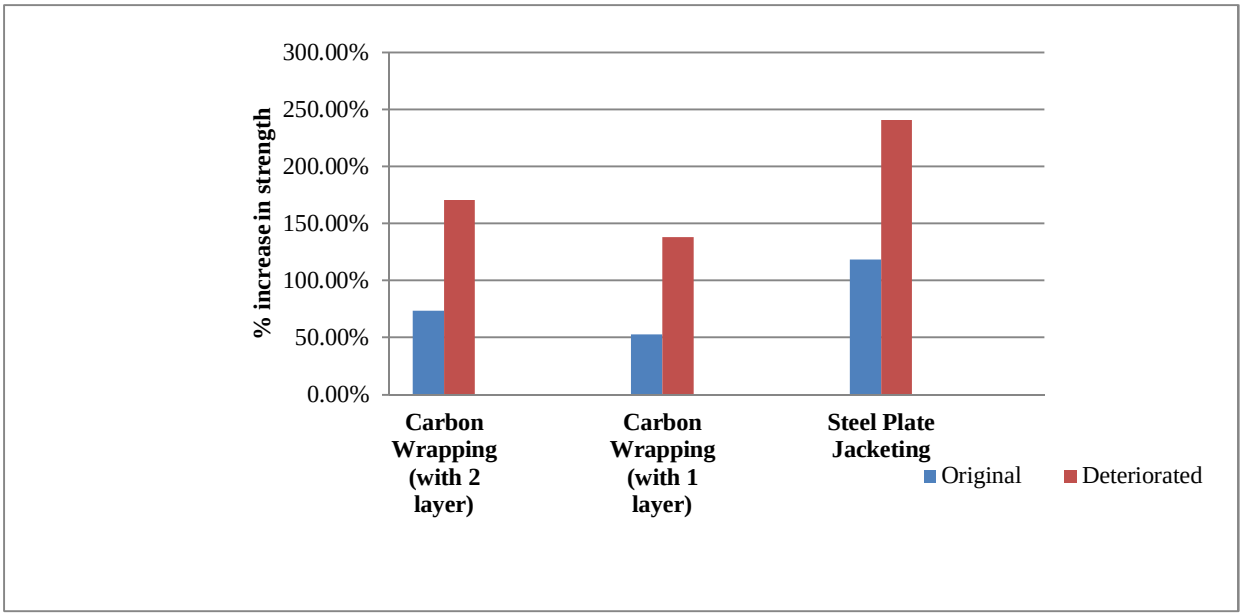

Figure 3.2 Graph for maximum condition.

V. METHODOLOGY

A. Study of Architectural and structural drawings, design criteria old existing structure.
B. Visual Inspection.
C. Non Destructive Testing.
D. Ultrasonic pulse velocity.
E. Rebounds hammer test.
F. Half cell test Cover meter.

Preparation of structural assessment and audit report.
Post structural assessment and audit.

VI. RESULT

A. *Ultrasonic Pulse Velocity Test for Result*

Sr. No.	Member	Distance (mm)	Time (us)	Velocity (m/sec)	Method
1	C1	310	97.5	3.179	D
2		310	98.4	3.150	D
3		310	91.1	3.403	D
4	C2	310	98.2	3.157	D
5		310	96.7	3.206	D
6		310	103.5	2.996	D
7	C3	300	117.9	2.545	I
8		300	146.6	2.046	I
9		300	119.6	2.508	I
10	B1	300	97.1	3.090	D
11		300	90.9	3.300	D
12		300	91.7	3.271	D
13	B2	310	105.2	2.946	D
14		310	106.1	2.923	D
15		310	104.8	2.957	D
16	B3	300	72.6	4.132	I
17		300	84.0	3.572	I
18	S1	300	73.5	4.080	I
19		300	75.3	3.982	I
20		300	72.9	4.113	I
21		300	81.8	3.669	I
22		300	83.8	3.579	I
23	C1	300	94.1	3.188	D
24		300	101.8	2.948	D
25		300	96.4	3.111	D
26	C2	300	85.7	3.499	D
27		300	93.6	3.206	D
28		300	91.2	3.29	D
29	C3	300	95.6	3.138	D
30		300	83.1	3.61	D
31	C4	310	101.4	3.057	D
32		310	87.2	3.556	D
33		310	105.8	2.931	D
34	B1	300	90.7	3.308	D
35		300	83.2	3.605	D
36		300	90.7	3.306	D
37	B2	310	88.0	3.523	D
38		310	104.1	2.979	D
39	B2	310	98.4	3.150	D
40		310	101.3	3.060	D
41		310	85.4	3.630	D
42	B3	310	100.2	3.093	D
43		310	95.9	3.234	D

Pulse Velocity in KM/sec.	Concrete Quality	No. of Readings
Above 4.5	Excellent	0
3.5 - 4.5	Good	20
3.0 - 3.5	Doubtful	23
Below 3.0	Poor	10

Table No. 1 U.P.V (km/sec) as per Quality of Concrete.

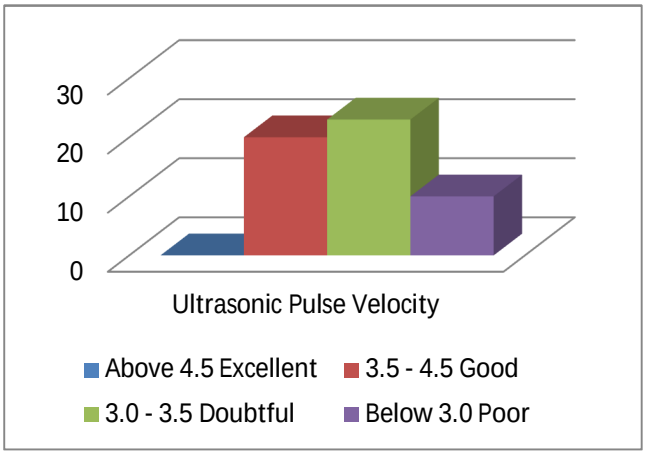

Figure 4.1 Graph for Ultrasonic Pulse Velocity.

Ultrasonic Pulse Velocity results with direct and indirect method indicate the maximum readings between **2.046 m/sec to 4.132 m/sec.** The quality of concrete maximum locations and good at few locations.

B. Rebound Hammer Test Result

Sr. No.	Description	Rebound no.
	First Floor	
1	Beam-1 East West Side	30,36,38,34,42,40
2	Beam-2 North South Side	30,32,36,34,40,38
3	Beam-3 East West Side	30,28,30,24,26,24
4	Column-1 North South Side	30,34,36,32,38,42
5	Column-2 East West Side	30,28,34,32,28,30
6	Column-3 East West Side	34,36,40,38,36,42
7	Slab-1 First Floor	26,28,30,32,26,22
8	Slab-2 First Floor	28,32,30,34,30,32
	Ground Floor	
9	Beam-1 West East Side	30,38,32,34,30,32
10	Beam-2 West East Side	36,40,42,38,34,38
11	Beam-3 South North Side	38,32,28,24,26,24
12	Beam-4 South North Side	38,32,36,30,34,40
13	Column-1 North South Side	32,34,36,28,24,30
14	Column-2 East West Side	30,32,28,30,36,26
15	Column-3 East West Side	32,38,32,30,28,24
16	Column-4 South North Side	32,28,30,26,28,34
17	Slab-1 Ground Floor	26,28,30,22,28,30
18	Slab-2 Ground Floor	26,24,22,30,38,42
19	Slab-3 Ground Floor	32,30,28,32,30,24

Rebound No.	Concrete Quality	No. of Readings
Above 60	Excellent	0
40 – 60	Good	10
20 – 40	Doubtful	114
Below 20	Poor	0

Table No. 1 Rebound Number as per Quality of Concrete.

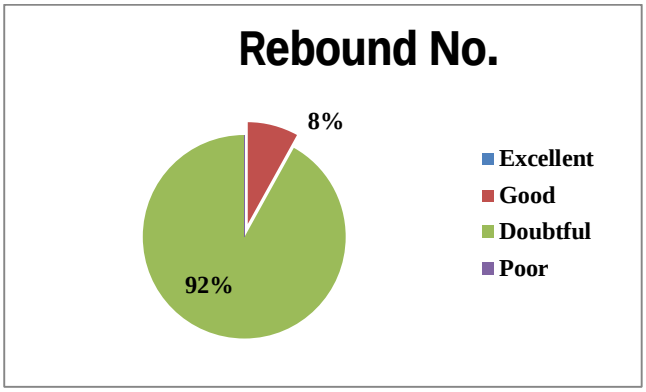

Figure 4.1 Graph for Rebound Hammer.

As per the Rebounds hammer test (refer IS 13311 part II 1992) all the readings are confirming M10 to M30 grade of concrete.

C. Cover Test Result

Sr. No.	Description	Cover to the reinforcement in (mm)
	First Floor	
1	Slab -1 Ground First Floor	28,34,48,52
2	Column-3 East West Side	48,49,54,58
3	Beam-3 East West Side	55,58,60,65
	Ground Floor	
4	Slab -1 Ground First Floor	28,40,45,52
5	Column-3 East West Side	50,52,58,62
6	Beam-3 East West Side	58,62,65,68

Cover Meter in MM.	Concrete Quality	No. of Readings
Above 90	Excellent	0
60 - 90	Good	6
30 - 60	Medium	18
Below 30	Doubtful	2

Table No. 1 Cover Meter as per Quality of Concrete.

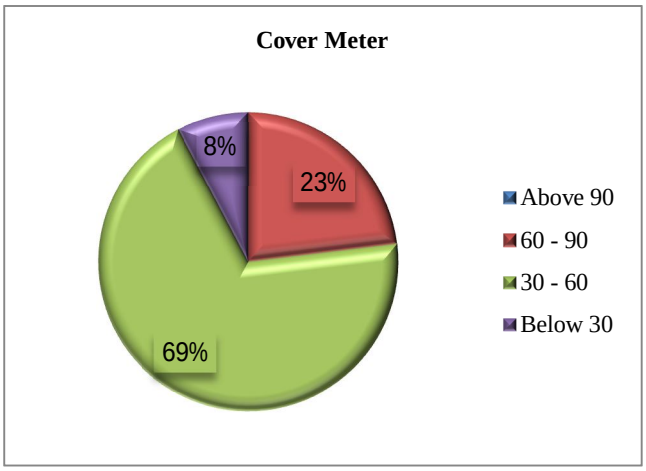

Figure 4.1 Graph for Rebound Hammer.

According to pH and carbonation test on solid, it is seen that the pH of spread cement is decreased and the detached layer over the fortification isn't flawless, carbonation profundity has crossed the support level at certain areas. According to cover meter tests, the front of cement is inside as far as possible.

VII. CONCLUSION

The structures require distinctive refreshing existing gear methods of doing things contingent on the sort and properties of the structure. Some require the way toward jacketing, though some require the procedure of Carbon wrapping to build the quality and lessen the moderate synthetic breakdown of something/rust, and so on demolition of steel and capacity to last of cement. This unit is beneficial to fixed-size the is directly for the two refreshing existing gear techniques for new parts strategies for made more vulnerable to do with structure portions of a gathering. The workspace will be effortlessly used to go to a choice about which cautious method of making augmentations of new parts ought to be taken in the mood for getting the required increment in quality. serving to look at least two things investigation of rate increment in quality spoke to that steel plate jacketing shows higher rates of increments in quality than carbon wrapping.

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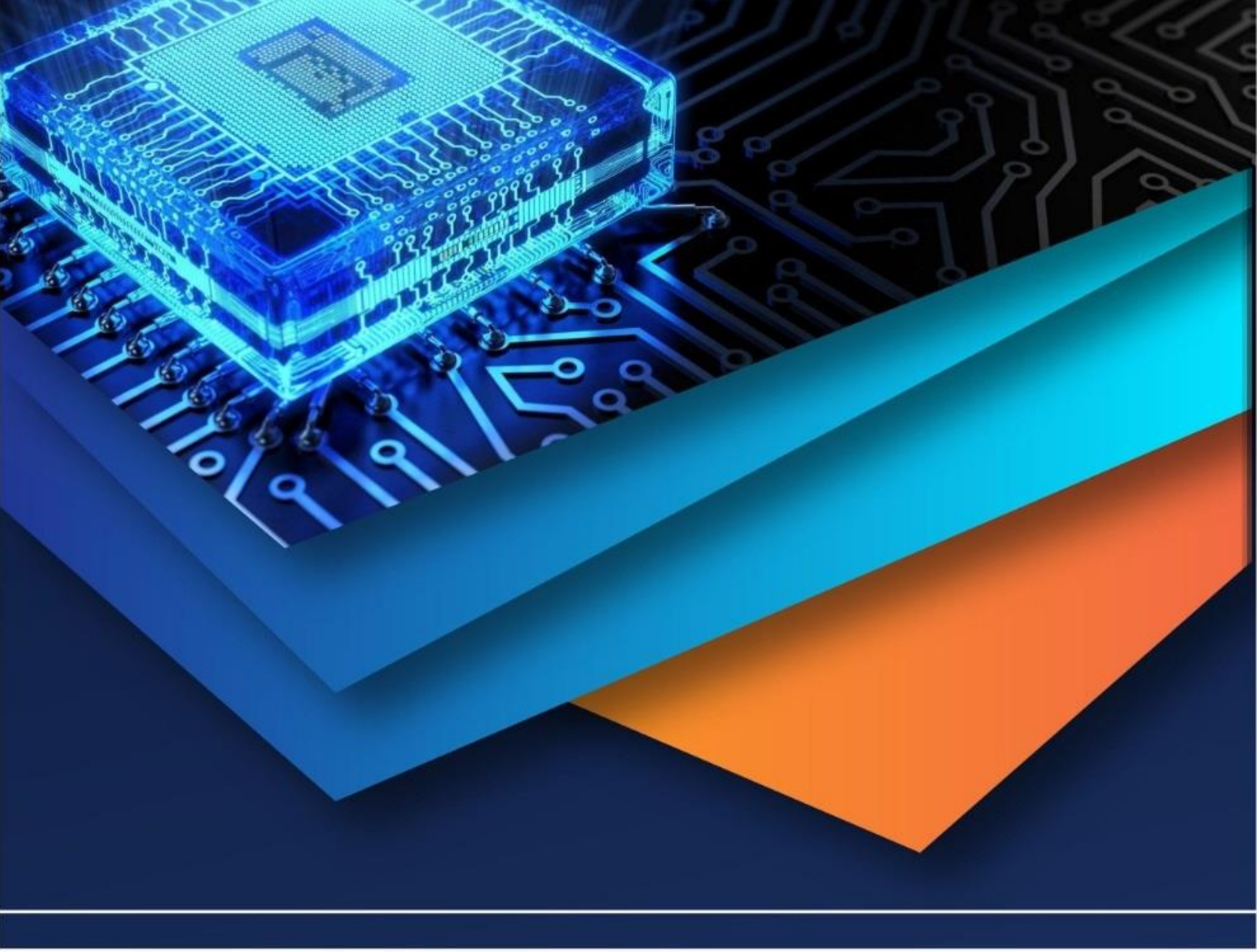

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