iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 6 **Issue:** VI **Month of publication:** June 2018

**DOI:** http://doi.org/10.22214/ijraset.2018.6256

# Study on RC Jacketed Rectangular Column under Axial load

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***Abstract: One strategy for the jacketing of reinforced concrete column is to target the improvement of local vulnerabilities in columns related to inadequate strength (compressive & Flexural) or poor ductility. Theoretical analysis have been carried out in the present study for different column sections of jacket thickness of 75mm and 100mm for jacketed RC columns subjected to axial compressive loading for rectangular column. The axial load carrying capacity along the major axes has been carried out under balanced section condition. Linear static finite element analysis has been carried out for the jacketed RC columns to compare the confined concrete strength (fcc) of finite element analysis with that of theoretical analysis, to plot the variation of stresses at the central core concrete and at the interface of old and new concrete. The displacements at core with respect to both major and minor axis are also plotted. Considerations have been given for variations in the properties of different types concretes used in the jacket and the original column. In order to find out the increase in the confined capacity of jacketed columns due to strengthening with respect to original column, theoretical analysis has been carried out.***
***Keywords: axial load, NISA Display IV, Jacketing, confined compressive strength.***

## I. INTRODUCTION

Reinforced concrete is a composite in which steel reinforcement bars ("rebar's"), reinforcement grids, plates or fibers have been incorporated to strengthen the concrete. It was invented by French Joseph Monier in 1849 and patented in 1867. The term Ferro Concrete refers to concrete that is reinforced with iron or steel. Other materials used to reinforce concrete are organic and inorganic fibers as well as composites in different forms. Concrete is strong in compression, but weak in tension, thus adding reinforcement increases its strength in tension. In addition, the failure strain of concrete in tension is so low that the reinforcement has to hold the cracked sections together.

## II. OBJECTIVES OF THE PRESENT STUDY

*A. The Primary Objectives of the Present Study are*

1) To find the confined and unconfined capacity of the jacketed RC columns subjected to axial load using the method based on Sheikh and Usurer's model.
2) To obtain the strength gain factor K using the confined and unconfined capacity for Axial loaded columns for rectangular columns.

## III. METHODOLOGY

To study the variation of stresses at the central core concrete, at the interface of old and new concrete and at the column surface and lateral displacement along the length of the column, first theoretically calculate the axial compression convert it to the pressure and apply that load on the FEM model and execute it. Then plot the variation of stresses and displacement. Then also compare the increases in the confined capacity of jacketed columns with respect to the original column

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887*
*Volume 6 Issue VI, June 2018- Available at www.ijraset.com*

Table 1: Dimensions of rectangular columns for Axial load (Both Theoretical and F E M Analysis)

| Type of column | Column Dimension | Spacing | Percentage of steel | | Longitudinal Steel Provided | |
|---|---|---|---|---|---|---|
| | | | Original Column | Jacketed Column | Original column (number and diameter of main bars) | Jacketed column (number and diameter of main bars) |
| Rectangular Columns | 230x230 | 100 | 2% gross area of original column | 1% gross jacketed area | 8#20 | 8#16 |
| | 230x300 | 150 | | | | 4#16+8#12 |
| | 300x450 | 200 | | | | 12#12 |
| | 300x600 | 250 | | | | 16#25 |
| | 450x600 | 300 | | | | 12#25 |

### *A. Theoretical Analysis of Jacketed RC Axial Rectangular Columns*

The method based on Sheikh and Usurer's has been used for the theoretical analysis of jacketed RC column subjected to axial load. The grade of the original column concrete considered is 25MPa and that of jacket concrete are 30MPa. From below table it can be noticed that in case of rectangular columns of different dimensions the confined capacity of jacketed column, strength gain factor(k) and confined concrete strength (fcc) decreased considerably as the spacing of bars increased. In turn the unconfined capacity of jacket column remains constant irrespective of varied spacing and thickness of jacket.

Table 2: Comparison of axial compression component of original and jacketed column

| Column Dimension (mm) | Spacing (mm) | 100mm jacket, 16#25, fci=25, fco=30Mpa | | | Confined concrete Strength (fcc) in MPa |
|---|---|---|---|---|---|
| | | Confined capacity of Jacketed column (KN) | Unconfined capacity of Jacketed column(KN) | Strength gain factor (K) | |
| 230x300 | 100 | 10433.82 | 5806.55 | 1.79 | 39.98 |
| 230x300 | 150 | 10397.93 | 5806.55 | 1.79 | 38.98 |
| 230x300 | 200 | 10347.88 | 5806.55 | 1.78 | 37.59 |
| 230x300 | 250 | 10280.91 | 5806.55 | 1.77 | 35.73 |
| 230x300 | 300 | 10204.47 | 5806.55 | 1.75 | 33.61 |
| 230x450 | 100 | 12488.99 | 7569.05 | 1.65 | 40.36 |
| 230x450 | 150 | 12445.62 | 7569.05 | 1.64 | 39.63 |
| 230x450 | 200 | 12383.89 | 7569.05 | 1.63 | 38.58 |
| 230x450 | 250 | 12285.38 | 7569.05 | 1.63 | 36.95 |
| 230x450 | 300 | 12123.08 | 7569.05 | 1.60 | 34.23 |
| 300x450 | 100 | 14103.90 | 8776.55 | 1.60 | 40.83 |
| 300x450 | 150 | 14070.35 | 8776.55 | 1.60 | 40.44 |
| 300x450 | 200 | 14027.65 | 8776.55 | 1.59 | 39.95 |
| 300x450 | 250 | 13970.96 | 8776.55 | 1.59 | 39.29 |

| | | | | | |
|---|---|---|---|---|---|
| 300x450 | 300 | 13893.71 | 8776.55 | 1.58 | 38.39 |
| 300x600 | 100 | 16599.18 | 10801.55 | 1.53 | 40.95 |
| 300x600 | 150 | 16560.77 | 10801.55 | 1.53 | 40.63 |
| 300x600 | 200 | 16512.67 | 10801.55 | 1.52 | 40.23 |
| 300x600 | 250 | 16448.98 | 10801.55 | 1.52 | 39.70 |
| 300x600 | 300 | 16360.53 | 10801.55 | 1.51 | 38.96 |

### *B. Finite Element Modeling*

Finite element modelling is described as the representative of the geometrical model in terms of a finite number of elements and nodes, which are the building blocks of the numerical representation of the model. In addition to information about elements and nodes, model also contains information about material and other properties, loading and boundary conditions. The most important step in the finite element method of structural analysis is to generate, using finite number of discrete elements, a mathematical model which should be as near as possible equivalent to the actual continuum. Such a formation of a model is referred to as structural idealization or discretization.The geometrical and material properties of the jacketed RC columns considered for analysis are given in below table.

Table 3: Geometrical and material properties

| Original column dimensions (mm) | 230x230, 230x300, 230x450, 230x600, 300x300, 300x450, 300x600 |
|---|---|
| Column height (m) | 3 |
| Jacket thickness (mm) | 50, 75 and 100 |
| Original column concrete | |
| Modulus of Elasticity(MPa) | 22360, 25000 and 27386 |
| Poisson's ratio | 0.15 |
| Jacketing concrete | |
| Modulus of Elasticity(MPa) | 27386 and 31623 |
| Poisson's ratio | 0.15 |
| Longitudinal Reinforcement | |
| Modulus of Elasticity(MPa) | 200000 |
| Poisson's ratio | 0.3 |
| Stirrups | |
| Modulus of Elasticity(MPa) | 200000 |
| Poisson's ratio | 0.3 |

### *C. 3-d Models for Square and Rectangular column of Axial Loaded Column*

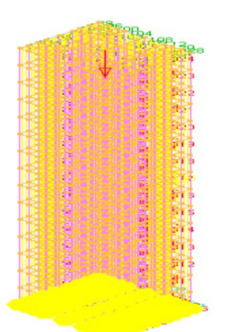


Fig 1: Modelling of jacketed RC column

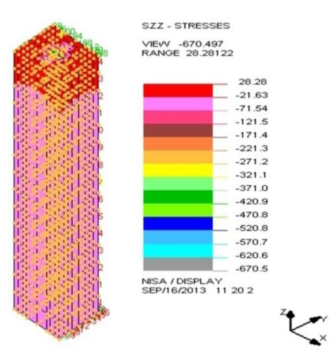



Fig 2: Isometric view of normal stress distribution in the jacketed RC column

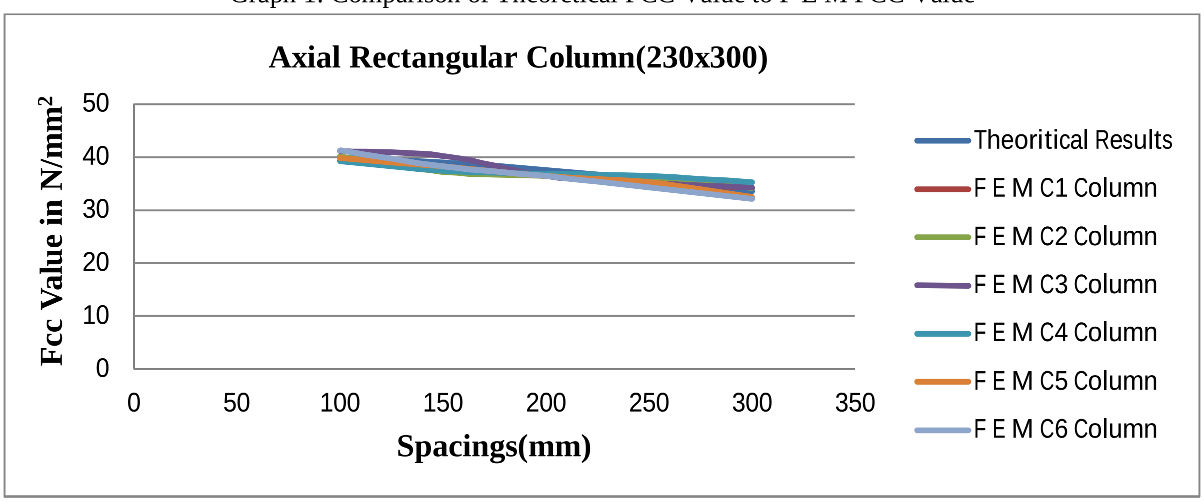
Table 4: FCC Results of Axial Loaded Rectangular Column

| Column Section | Spacing | Confined concrete strength (fcc) in MPa values |
|---|---|---|
| | | 100mm jacket, 16#25, fci=25, fco=30Mpa |
| 230x300 | 100 | 39.38 |
| 230x300 | 150 | 37.98 |
| 230x300 | 200 | 36.49 |
| 230x300 | 250 | 34.85 |
| 230x300 | 300 | 34.23 |
| 230x450 | 100 | 39.13 |
| 230x450 | 150 | 37.24 |
| 230x450 | 200 | 36.45 |
| 230x450 | 250 | 35.13 |
| 230x450 | 300 | 33.18 |
| 300x450 | 100 | 39.45 |
| 300x450 | 150 | 39.13 |
| 300x450 | 200 | 37.13 |
| 300x450 | 250 | 36.43 |
| 300x450 | 300 | 36.20 |
| 300x600 | 100 | 39.24 |
| 300x600 | 150 | 39.13 |
| 300x600 | 200 | 38.43 |
| 300x600 | 250 | 38.14 |
| 300x600 | 300 | 36.25 |

## IV. RESULTS AND DISCUSSION

Due to confinement of core concrete by both inner and outer sets of stirrups, its original strength gets increased. In order to validate the theoretical results, the same has been compared with that of the finite element analysis results. The theoretical and finite element results obtained for the different column sections having different spacing of outer stirrups has been taken up for the comparison. The theoretical results obtained from the analysis of jacketed column of different thickness and varying concrete strength have been considered. That the results of theoretical and finite element analysis are approximately matching with some percentage of errors. Comparative errors are as shown in below graphs for with respect to theoretical analysis.

Graph 1: Comparison of Theoretical FCC Value to F E M FCC Value



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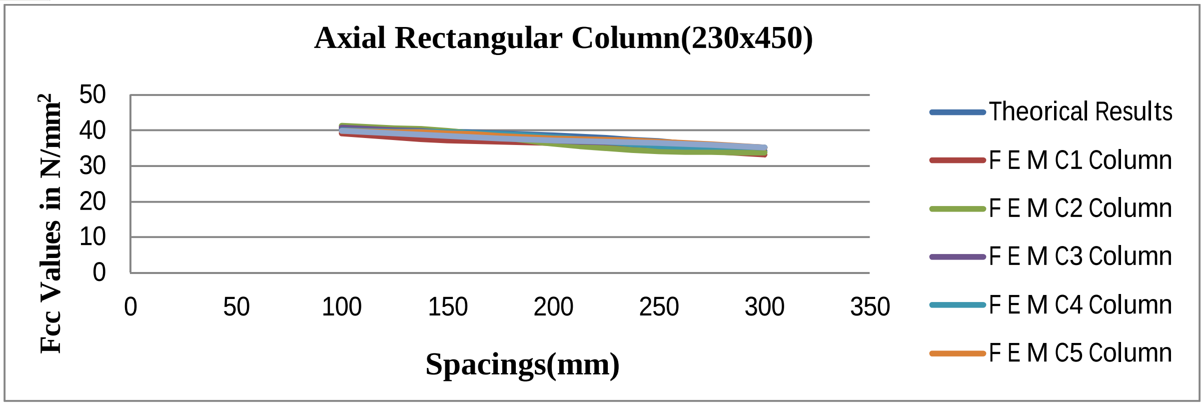
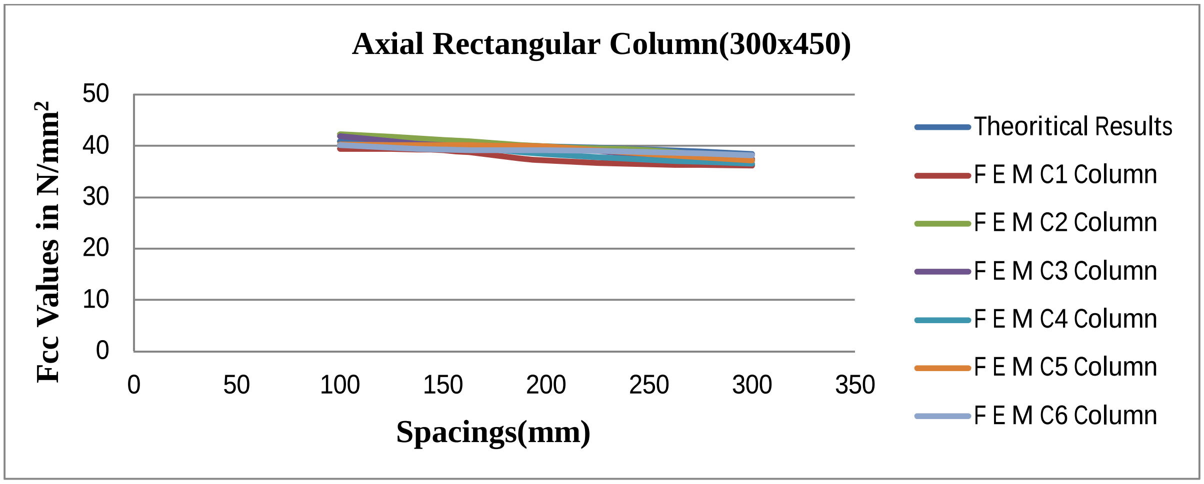
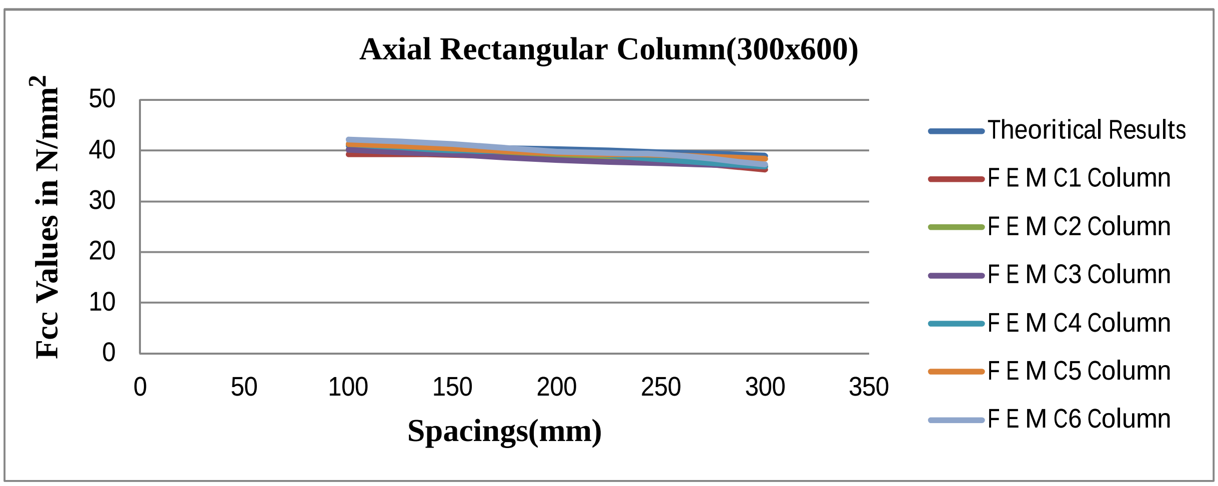



From the Above graph results of theoretical and finite element analysis are approximately matching with some percentage of errors. The percentage of errors is mentioned in the conclusion.

## V. CONCLUSIONS

The object of investigation is to study the confined and unconfined capacity of jacketed R.C column. In turn to compare confined concrete strength by theoretical and F E M analysis. The conclusions are discussed in the respective chapters with results for all the aspects considered for study.

*A.* R. C Jacketing can be considered for rehabilitation of column member. In which special design and construction techniques are not essential.

*B.* The K and fcc of axial loaded square and rectangle column will considerably decrease with increase in spacing of bars.

*C.* The theoretical and FEM analysis reveals that axial rectangular column the maximum error varied from positive 3.26 to negative 8.17.

## REFERENCES

[1] Sheikh,S.A., and Uzumeri,S.M.(1982)."Analytical model for concrete confinement in tied columns". Journal of the Structural Division.ASCE, 108(12), PP. 2703-2722

[2] J. B. Mander, M. J. N. Priestley, and R. Park: stress-strain model for concrete subjected to uniaxial compressive loading and confined by transverse reinforcement. ASCE, Journal of structural Engineering, Vol.114, No. 8, August, 1988

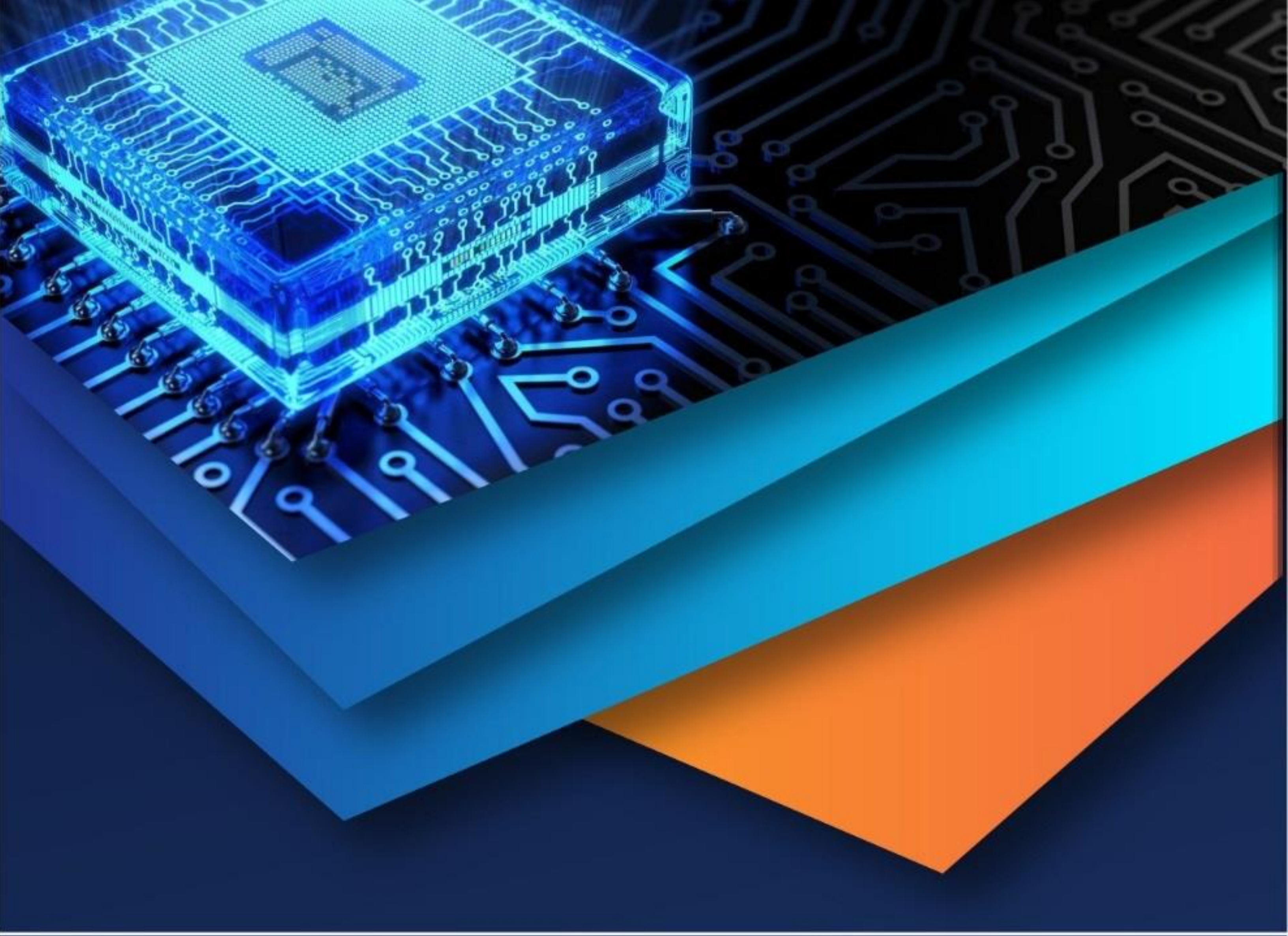
[3] Bett et al (1988) "the effectiveness of three different repair and / or strengthening techniques in enhancing the lateral load and response of reinforced concrete short columns"

[4] M.Frangou et al (1995) "Structural repair of RC columns construction and building materials,Vol.9 Jan 1995,PP.259-265.

[5] Husnii et al [1995] partially jacketed (Two, Three, Four sides) Reinforced Concrete Column Behaviour under Uni-Axial

[6] Indian standard Code of practice for plain and reinforced concrete (fourth revision), IS 456-2000, Bureau of Indian standard, July 2000, New Delh

[7] K.C.G. Ong, Y. C. Kog, C. H. Yu and A. P. V. Sreekanth,[2002] "Jacketing of reinforced concrete columns subjected to axial load". National University of Singapore; CPG Consultants.

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