iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** XI **Month of publication:** November 2023

DOI: https://doi.org/10.22214/ijraset.2023.56889

Effect of Eccentricity of Connection on Design of RC Columns

Swaranjali Kashyap[1], Umesh Pendharkar[2]
[1]*M.Tech Student, Ujjain engineering college, Ujjain, M.P., India*
[2]*Professor, department of civil engineering, Ujjain engineering college, Ujjain, M.P., India*

Abstract: This study investigates the influence of eccentricity on the behaviour of reinforced concrete (RC) beam-column connections, with a particular focus on moment distribution, and structural analysis conducted on 5 story buildings of different eccentricity using STAAD Pro. The study employed computational simulations to assess how different levels of eccentricity affect the moment distribution within the connection region. STAAD Pro was used for numerical modelling and analysis. The outcomes of this research are expected to enhance the understanding of the complex behaviour of RC beam-column connections and serve as a valuable resource for structural engineers and designers. Ultimately, this knowledge can be utilized to optimize the design and construction of structures to ensure they meet safety and performance standards, particularly when eccentric loading is a design consideration.
Keywords: **Eccentricity, Moment distribution, STAAD pro software. RC (reinforced concrete)**

I. INTRODUCTION

Reinforced concrete (RC) structures are fundamental components of our modern built environment, offering strength, durability, and versatility. Within these structures, the connections between beams and columns play a pivotal role in transferring loads and ensuring structural integrity. These connections must withstand various forces, including gravity loads, lateral loads, and moments induced by eccentricities in loading or geometry. Among these, the effect of eccentricity on RC beam-column connections has garnered significant attention in structural engineering. The connection between reinforced concrete (RC) beams and columns plays a pivotal role in ensuring the structural integrity and safety of a building. The eccentricity of this connection, which refers to the misalignment of the applied loads with the centreline of the column, has been a subject of significant interest in the field of structural engineering. Understanding the effects of eccentricity on these connections is crucial, as it can impact a structure's overall performance, load-carrying capacity, and, ultimately, its resilience to various external forces.

The purpose of this study work is to delve into the complex world of eccentricity in RC beam-column couplings. We will investigate the fundamental concerns surrounding this crucial part of structural design using STAAD Pro and moment distribution analysis. The key goals of this research are as follows:

Examine the effect of eccentricity on the structural behaviour of RC beam-column connections, paying special attention to load distribution, stress patterns, and deformation properties.

Examine the effects of variable eccentricity, such as lateral offsets, on the capacity of the connection to sustain applied loads.

II. LITERATURE REVIEW

1) Ayad Zeki Saber Agha1 and Mereen Hassan Fahmi Rashid (2018) investigates to assess the influence of load eccentricity on reinforced concrete column strength while accounting for the variables: amount of eccentricity ratio (e/h=0.1 and 1.0); amount of longitudinal reinforcement %=1% to 8%; concrete compressive strength ()'21, 28,35, 42,63 84 ; c f = and MPa steel yielding strength (f and MPa y=414 525 ;) steel reinforcement distance ratio loading condition (uniaxial and biaxial bending); cross section shape (rectangular and circular); and finally reinforcement distribution on two opposed sides and on four sides. Also, the results demonstrate that the load eccentricity ratio (e/h) and bending condition (uniaxial and biaxial) have a significant effect on column strength reduction. When the reinforcement is distributed on two opposite sides, the upper limit results and maximum column strength are obtained, as opposed to when the reinforcement is distributed on four sides and a rectangular section with circular reinforcement distribution, while circular columns yield lower limit results and minimum column strength when compared to the other cases mentioned above.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XI Nov 2023- Available at www.ijraset.com

2) Salih Cengiz, Abdulkadir Solak, Alptug Unal, Mehmet Kamanli (2022) studied the effect of eccentricity by modelling a five-storey reinforced concrete building with the IdeCAD V10 program, and the internal force changes in the columns were examined by creating different eccentricity states. The centre of stiffness was relocated away from the centre of mass while producing the eccentricity by modifying the size of one of the corner columns. The corner, edge and interior columns on the ground, third and fifth levels of the structure are being tested for internal strength. According to the analysis, the bending moment and shear force values are highest in the bottom level columns, whereas the torsional moment values are highest on the third story.
3) Takashi kashiwazaki and Hiroshi Noguchi (2004) investigated the effect of eccentricity on degradation of shear strength, stiffness and deformation capacity of beam column joints, nonlinear analysis using a three-dimensional finite element method (3-D FEM). This 3-D FEM analysis used reference specimens from the previous experimental work. In the tests, reference specimens failed in joint shear failure after beam flexural yielding. On the maximum story shear forces and failure modes, the FEM results accord well with the test data. The maximum narrative shear forces did not rise when the beam flexural yielding occurred. Furthermore, the internal stress fluxes of both concentric and eccentric joints acquired from analytical results were used to better understand the shear transfer mechanisms in an eccentric beam-column joint.
4) Ellobody and Young [2] studied the influence of different slenderness ratios, concrete strength, and steel yield stress on the strength and behaviour of pin-ended axially loaded concrete encased steel composite columns. The results of their 3D nonlinear finite element analysis have been confirmed against real test results. Because of the flexural buckling failure mode, the effect of increasing steel yield stress on composite strength for thin columns is less noticeable.

III. METHODOLOGY

To study the effect of eccentricity of connection on design of RC columns using STAAD Pro we will follow a systematic methodology. Here's an overview of the steps we will take:

1) *Model Creation:* We will create a detailed 3D model of structure in STAAD Pro, incorporating all the necessary geometric and material properties. This will include defined building dimensions, column and beam layout, and assigning column and beam properties.
2) *Load Assignments:* We will apply dead loads and live loads to the structure based on the specific IS code, these loads will reflect forces that the structure may encounter.
3) *Analysis Setup:* In STAAD Pro, we will establish the analysis settings, selecting the suitable analysis type and defining the requirements.
4) *Eccentricity Projection Modelling:* We will appropriately simulate the structure's eccentric projection on top floor of the building.
5) *Analysis:* We will run an analysis in STAAD Pro using the provided model and load allocations. This research will replicate the structure's response to eccentricity. The structural reaction will be examined in terms of moment, displacement, and deformations.
6) *Result Evaluations:* We will analyse and assess the findings of the analysis. This will include investigating the structure's behaviour with various types and configurations of eccentricity projections. We will analyse the response of structures with and without eccentricity to discover any significant changes in performance and develop conclusions.
7) *Interpretation and Conclusion:* We will evaluate the findings and draw conclusions about the behaviour of structures with varying eccentricity projections on the top level based on the analysis results. We will examine the possible effects of the findings and offer suggestions for the design and construction of similar structures.

IV. MODELING AND ANALYSIS

A. Building Parameters

Number of structures	4
Number of stories	5 story
Plan dimension	18m X 18m
Total height of building	15m
Height of each story	3m
Size of beam	450mm X 300mm
Size of column	600mm X 600mm
Thickness of slab	150mm
Eccentricity	150mm, 100mm, 50mm, 0

B. Loads Considered

Sr no.	LOADS	MEMBERS	CALCULATED LOADS
1	Dead Load (DL)	Column	0.60 X 0.60 X 25 = 9 kN/m^2
		Beam	0.45 X 0.30 X 25 = 3.37 kN/m^2
		Slab	0.15 X 25 = 3.75 kN/m^2
		Walls	0.12 X 20 X 3 = 7.2 kN/m^2 (internal wall) 0.23 x 20 x 3 = 13.8 kN/m^2 (main wall) 0.1 X 20 X 1.2 = 2.4 kN/m^2 (parapet wall)
2	Live load (LL)		2.5 kN/m^2
3	Floor load		1 kN/m^2

C. Load Combinations

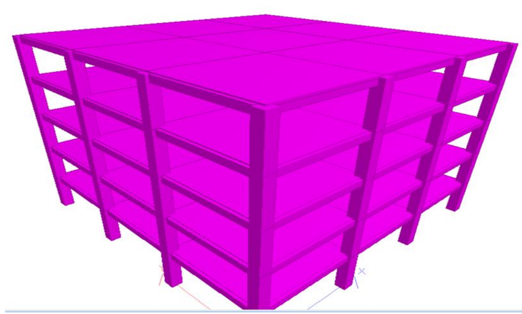
1) 1 DL
2) 1.5 DL
3) 1 (DL + LL)
4) 1.5 (DL +LL)

D. Eccentricity Provided

structure	Structure 1	Structure 2	Structure 3	Structure 4
eccentricity	150mm	100mm	50mm	centric

E. Structural Analysis

1) Top view of all four structures with different eccentricities on top floor



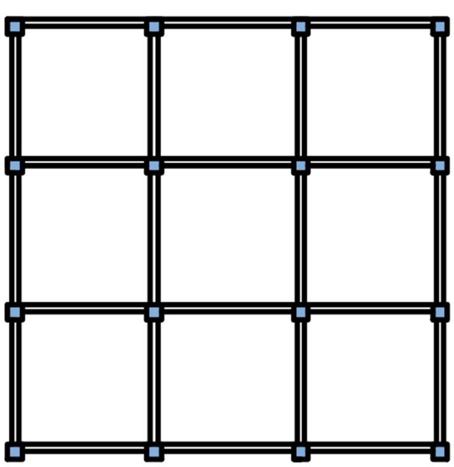


Fig 1. Eccentricity 150mm

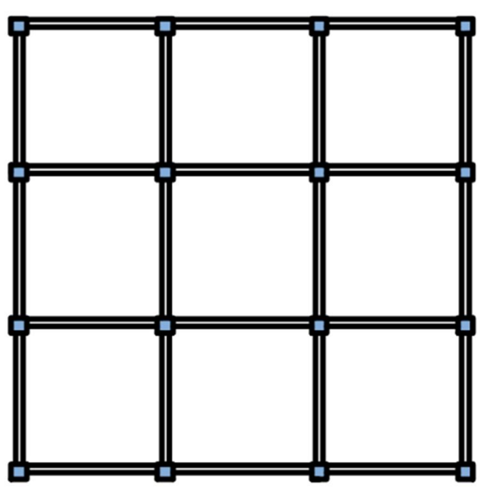


Fig 2. eccentricity 100mm

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XI Nov 2023- Available at www.ijraset.com

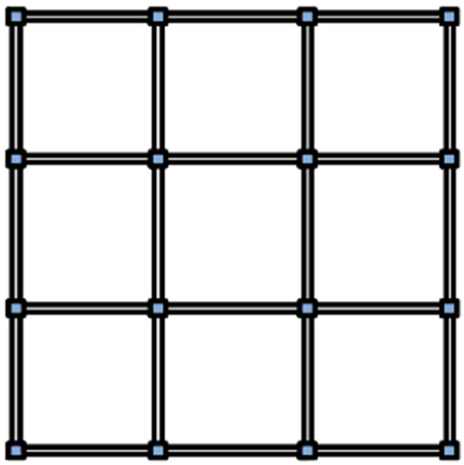


Fig 4. Centric connection

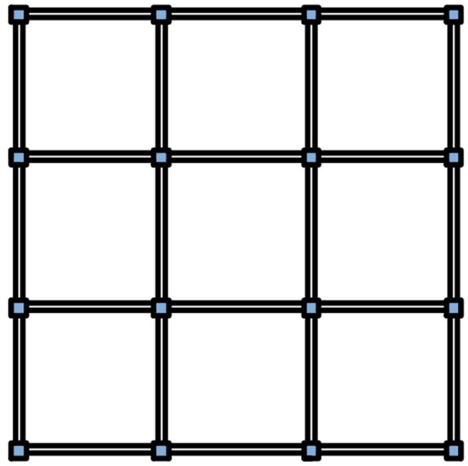


Fig 5. Eccentricity 50mm

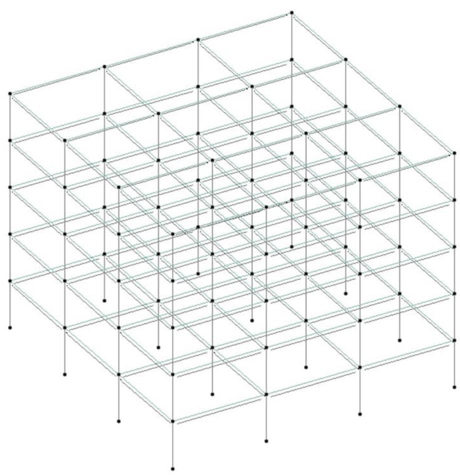


Fig 5. 3-D view of 5 story structure

V. RESULT AND DISCUSSION

A. Bending and Displacement in X and Y Direction.

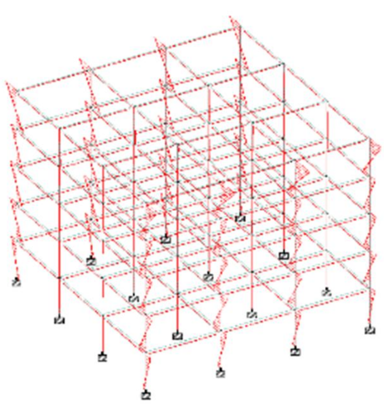


Fig 6. Bending in Z direction

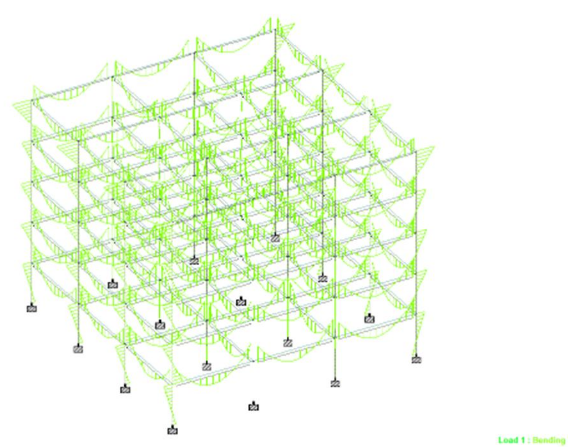


Fig 7. Bending in Y direction

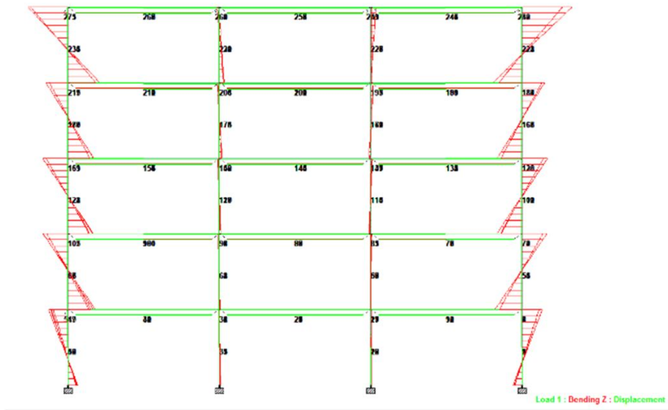


Fig 8. Bending and displacement in Z direction

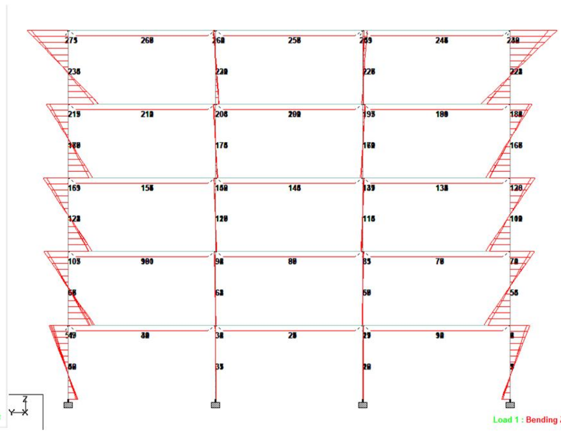


Fig 9. Bending in Z direction front view

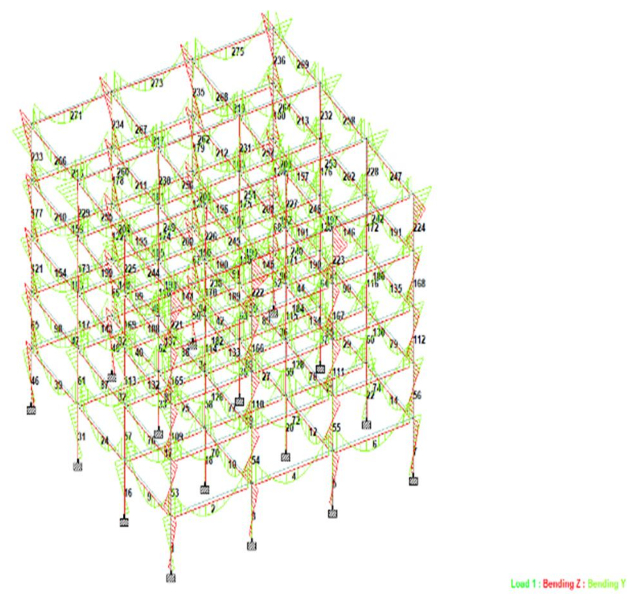


Fig 10. Bending in Y and Z direction

B. *Moment Distribution in Z Direction on Each Floor*

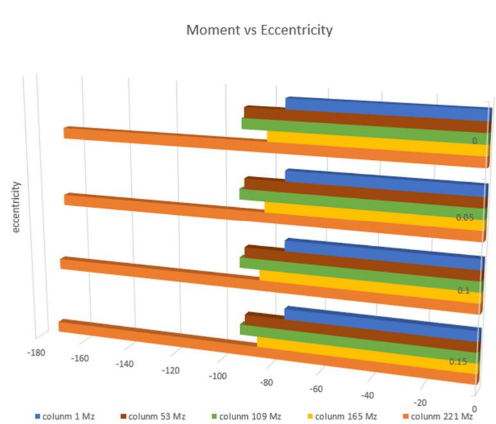


Fig 11. Corner column from top to bottom floor

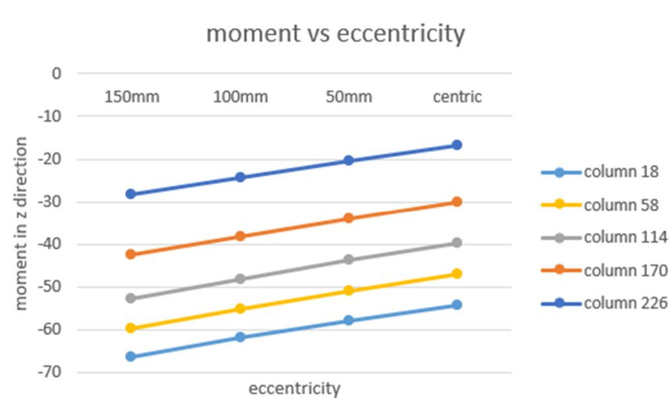


Fig 12. Centre columns from top to bottom floor

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XI Nov 2023- Available at www.ijraset.com

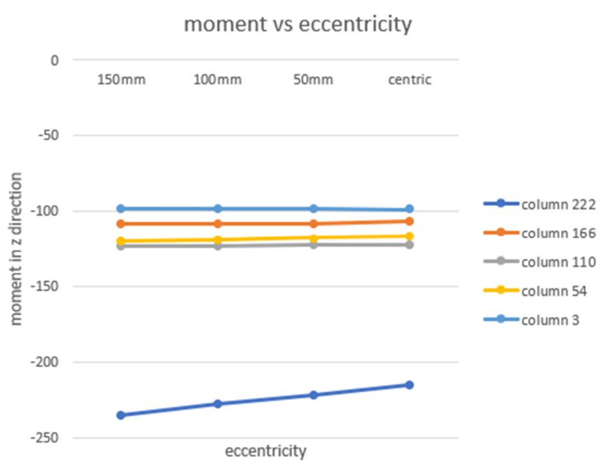


Fig 13. Front edge columns from top to bottom floor

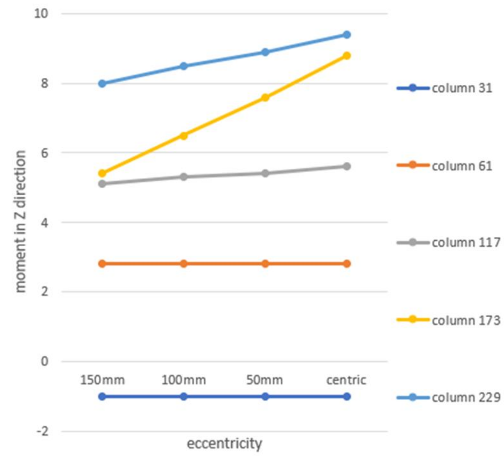


Fig 14. Side edge column from top to bottom floor

VI. CONCLUSIONS

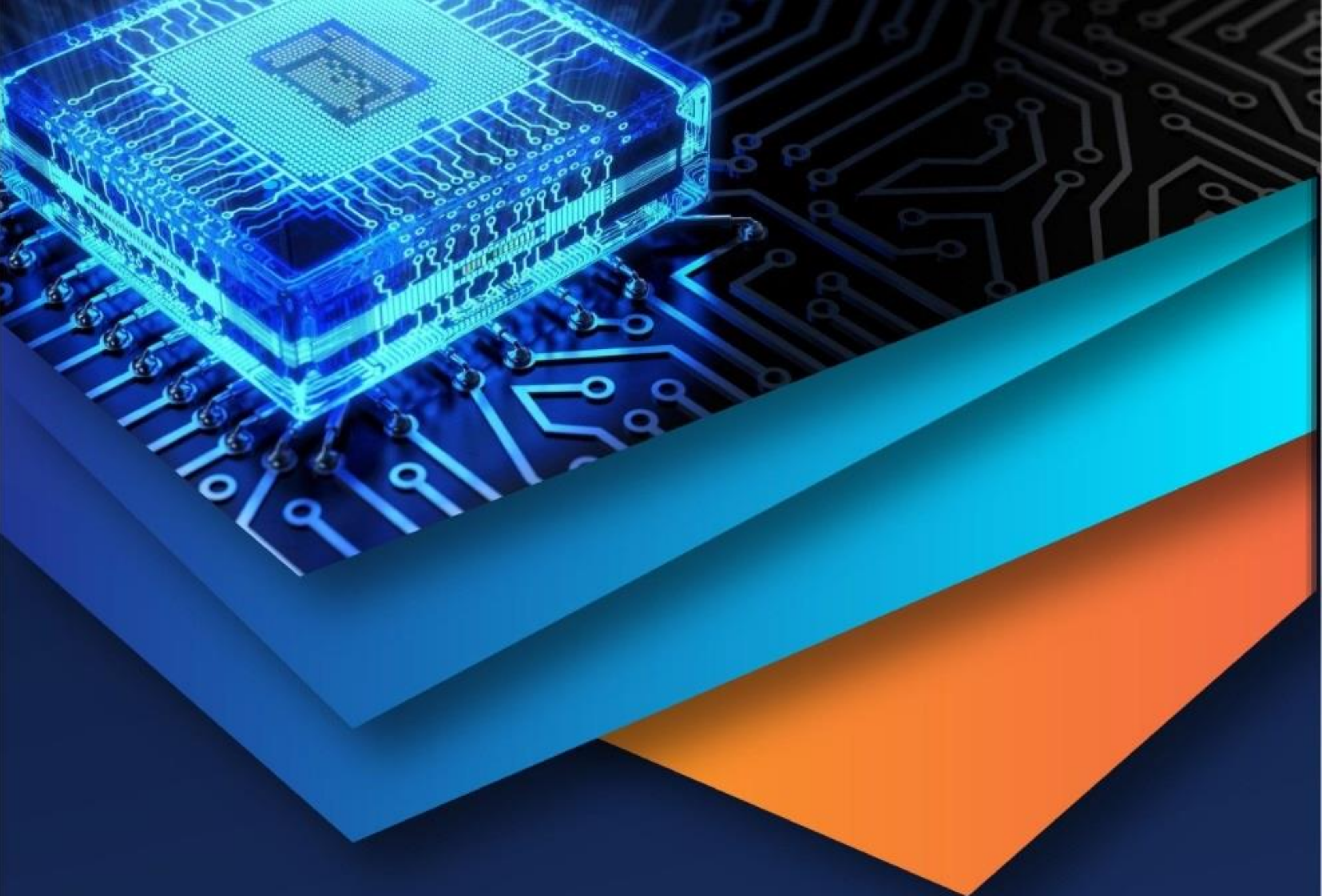
1) The effect of eccentricity on the topmost floor is carried to the next floor only it has no effect on the lower floors.
2) Moment in the Z direction increases with a decrease in eccentricity.
3) Moment in the Y direction decreases with a decrease in eccentricity.
4) The change of moment in centre columns is less as compared to corner columns.
5) Moments in front and rear edge columns are higher than side edge columns.
6) The difference between changes in the value of moments is greater in centre columns than in corner columns, but moments in corner columns are much higher as compared to centre and edge columns.

VII. ACKNOWLEDGMENT

I'm thankful to my guide, Dr Umesh pendharkar in civil engineering department for his constant encouragement and constant guidance. Also I thank my parents, friends etc. for their continuous support in making this work complete.

REFERENCES

[1] TBDY, Türkiye Bina Deprem Yönetmeliği, Türkiye Bina Deprem Yönetmeliği. Afet ve Acil Durum Yönetimi Başkanlığı, Ankara, 2018.
[2] Sezen, H., et al., Performance of reinforced concrete buildings during the August 17, 1999 Kocaeli, Turkey earthquake, and seismic design and construction practise in Turkey. 2003. 25(1): p. 103-114.
[3] Erdem, H., Burulma Düzensizliğinin Betonarme Kirişler Ve Kolonlar Üzerine Etkileri. Ömer Halisdemir Üniversitesi Mühendislik Bilimleri Dergisi, 2016. 5: p. 148-156.
[4] Doğangün, A., Performance of reinforced concrete buildings during the May 1, 2003 Bingöl Earthquake in Turkey. Engineering Structures, 2004. 26(6): p. 841-856.
[5] Abdel Raheem, S.E., et al., Evaluation of plan configuration irregularity effects on seismic response demands of L-shaped MRF buildings. Bulletin of Earthquake Engineering, 2018. 16(9): p. 3845-3869.
[6] Özmen, G.J.T.M.H.D., Rijitlik Dağılımının Burulma Düzensizliğine Etkisi. 2001. 411(1): p. 37-40.
[7] Nasıroğlu, S., Farklı zemin kat yüksekliklerinde yerleştirilen perde duvarların yerinin burulma düzensizliğine etkisi/Effect of position share walls placed on di?fferent ground storeys heights to torsional irregularity. 2018.
[8] Döndüren, M.S., et al., Yapılarda Burulma Düzensizliği. Selcuk University Journal of Engineering Sciences, 2007. 6(1): p. 42-52.
[9] Akçaer, G., N. Banu, and A. Soyluk. Earthquake resistant building design education and architecture. in Third national conference on earthquake engineering and seismology (3TDMSK), Dokuz Eylul University (DEU), İzmir. 2015.
[10] Beheshti-Aval, S.B. and S. Keshani, A Phenomenological Study on Inelastic Torsion Caused By Nonlinear Behavior Changes during Earthquake Excitations %J Civil Engineering Infrastructures Journal. 2014. 47(2): p. 273-290
[11] Erdem, H., Burulma Düzensizliğinin Betonarme Kirişler Ve Kolonlar Üzerine Etkileri. Ömer Halisdemir Üniversitesi Mühendislik Bilimleri Dergisi, 2016. 5: p. 148-156.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY