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Parametric Study on the Effect of Outrigger Location at Different Stories in High Rise Structure

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Abstract: Outrigger optimization is a significant challenge. The objective of this paper is to give a better understanding of outrigger location optimization and the efficiency of each outrigger when several outriggers are used in the structure. Results revealed that the inclusion of multiple outriggers significantly improved structural performance, particularly when positioned at strategic levels, typically at 0.25H, 0.5H, and 0.75H of the building height. The most effective configuration under and seismic conditions was a triple outrigger system placed at these levels.

I. INTRODUCTION

Urbanization causes a rapid concentration of people who are looking for work and a high quality of living. Vertical expansion is the sole option over horizontal one because land is scarce, its price is rising over time, and people are trying to live higher. Tall skyscrapers will eventually be built as a result of this. Reaching the sky-high level is making the new standard for the Structural Engineering. Land's shortage and rise in population, to necessitate the construction of tall buildings. Tall structures analysis and design require suitable analytical techniques and accurate design concepts to with stand the lateral loads, such that the structure is safe. Tall building frame development of design have ensured the importance of limiting the sideway under the action of lateral loads.

A. Core and Outrigger Structural system

The Outrigger structural system is a lateral load resisting system in which outer peripheral columns are tied to the central core at one or more levels throughout the height of the building. Outrigger acts as stiff horizontal member connected to the core and when lateral load acts upon core, it tries to resist its rotation. The various factors affecting the effectiveness of Outrigger are stiffness and location of the Outrigger truss system, geometry of the building, floor-to-floor height and shape of the tall building, type of outrigger, number of outriggers and it's positioning etc. The increment in height lead to the necessity of new structural system.

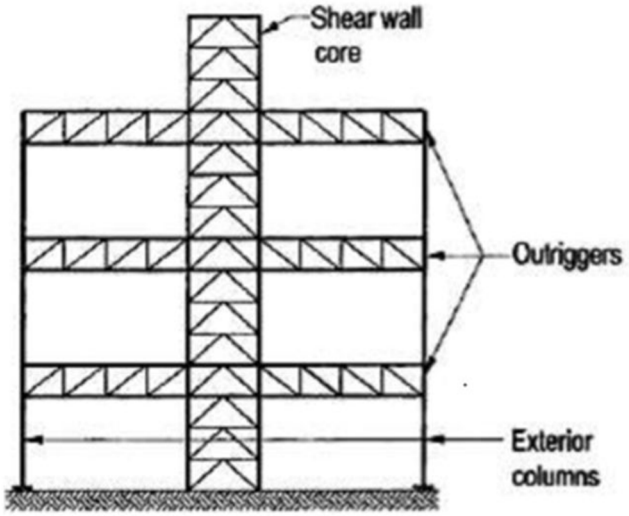


Figure I.1Modeling Details

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II. GENERAL CONSIDERATION

The frame selected for analysis is symmetrical in plan with plan size 30 mx30 m and floor to floor height is 3m. Here, 36 story models are analyzed for seismic zone V and soil type II. Centre to center spacing of columns is 5m. Story displacement, base shear, time periods are calculated for different floor of outrigger.

Table II-1Modeling Data

Sr no	Title	Details
1	Types of structure	RC frame with Concrete Outrigger Wall
2	Grade of Concrete Deck	M40
3	Column (1-15 storey)	1500 mm X 1500 mm
4	Column (16-30 storey)	1000 mm X 1000 mm
	Column (31-36 storey)	600 mm X 600 mm
5	Core Shear Wall	300 mm
6	Outrigger Wall	300 mm
7	Beams	300 mm X 450 mm
8	Slab	200 mm
9	Wall load (DL)	5 KN/m
10	Dead Load (DL)	1.5 KN/m^2
11	Live load (LL)	2 KN/m^2
	Seismic Data	Values as per IS 1893 Response
12	Reduction Factor (R)	5
13	Importance Factor (I)	1.5
14	Zone(z)	0.36 (V)
15	Soil type	II

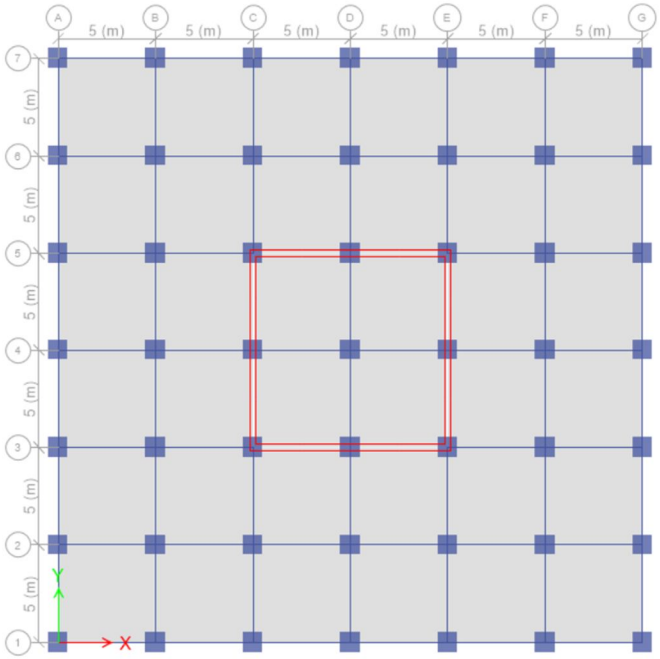


Figure II.1 Without Outrigger Frame

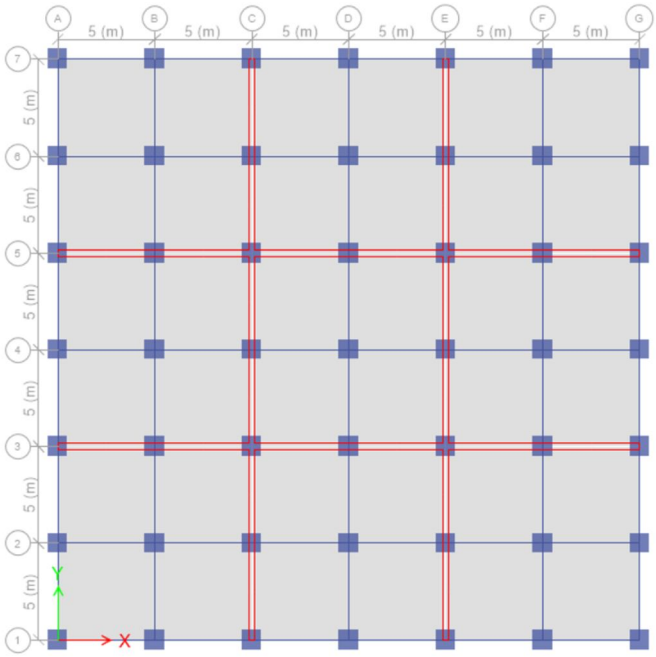


Figure II.2 With Outrigger Frame

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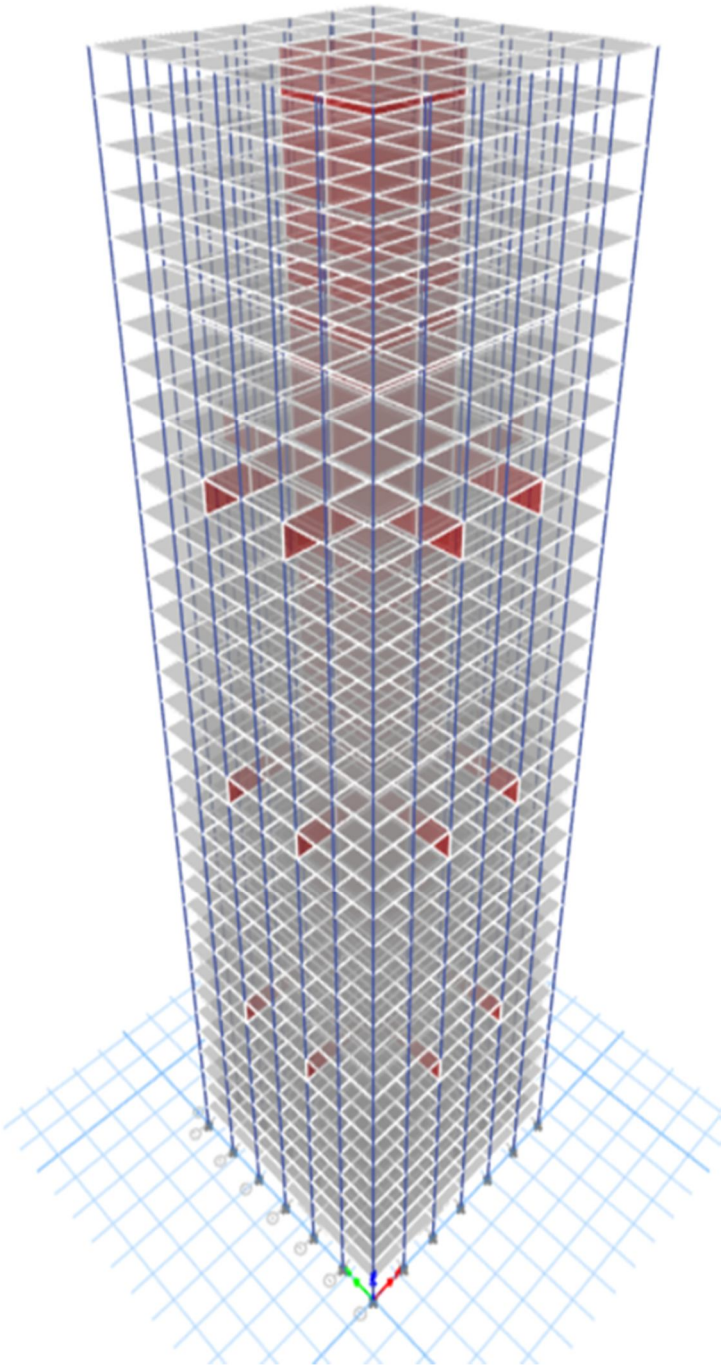


Figure II.3 Outrigger at 9,18,27

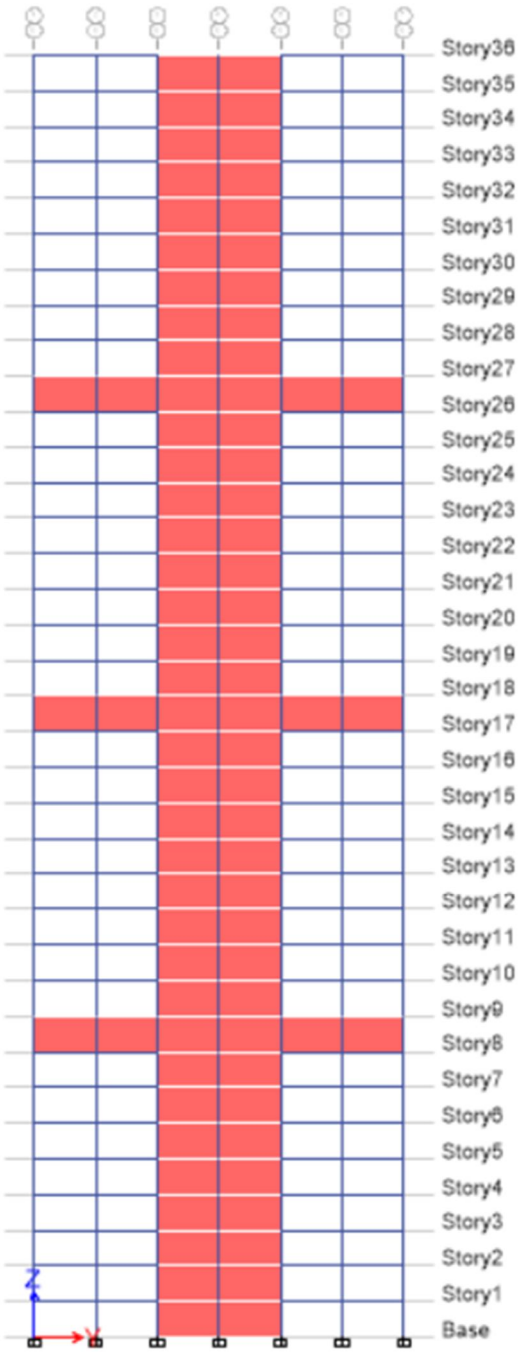


Figure II.4 Elevation view Outrigger at 9,18,27

B. Wall Load Calculation

We assume that the AAC Block Density is 10 KN/m^3
Floor Height=3m=3000 mm and Beam Depth 450 mm
So the AAC Block wall Height =3000-450=2550 mm
Thickness we take 200 mm=0.2 m
So Wall load=0.2 X2.55x10=5.1 KN/m
We apply 5 KN/m Load on each Beam.

III. MODEL INFORMATION

In this study models are classified as follow

1) Without shear wall-M1
2) Outrigger place at 7,17,30-M2
3) Outrigger place at 9,18,27-M3
4) Outrigger place at 12,24,36-M4

A. *Method of Analysis*

Response Spectrum Method

We find Displacement and Story Drift for Response Spectrum load case –RSX

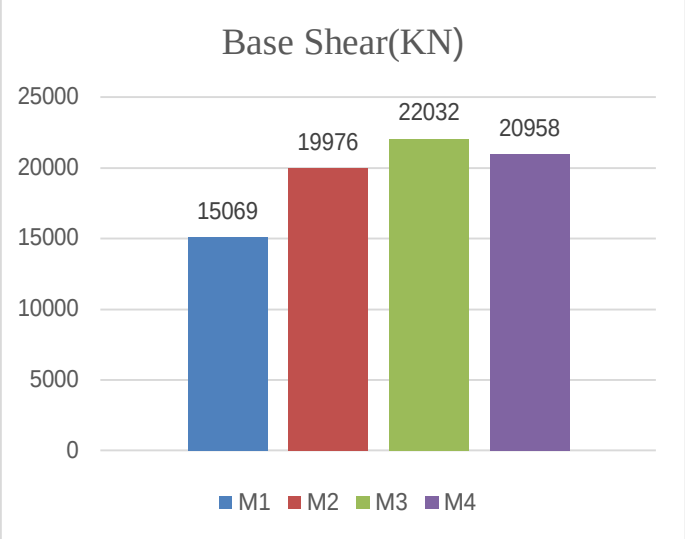


Figure.III.1 Base Shear Variation

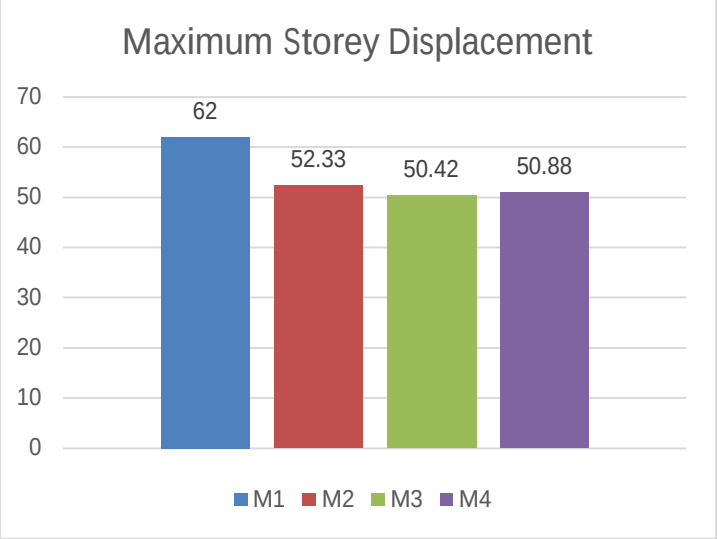


Figure.III.2 Maximum Storey Displacement

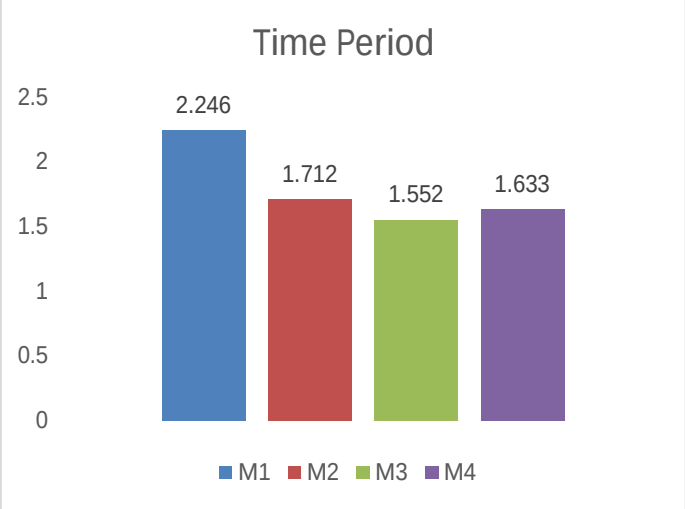


Figure.III.3 Time Period

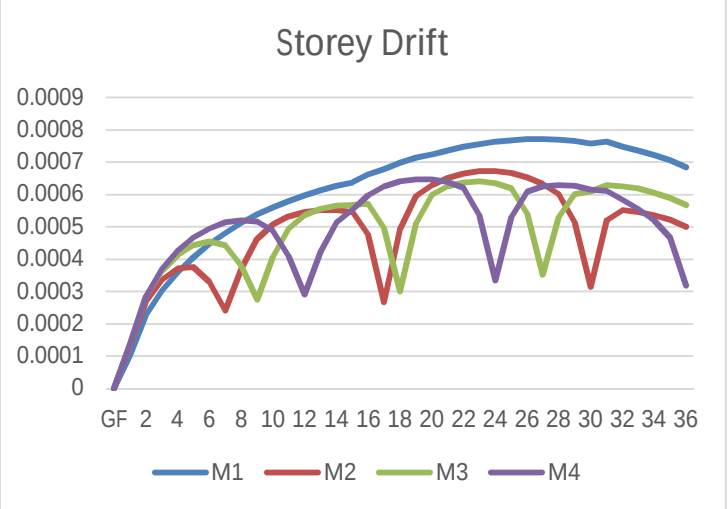


Figure.III.4 Story Drift

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IV. RESULT AND DISCUSSION

For the dynamic earthquake analysis of a 36-storey model using 3 level outriggers i.e., at 7th, 17th and 30th storey reduced the displacement by 15 % and time period had reduced by 23% and base shear is increased by 32%. For the dynamic earthquake analysis of a 36-storey model using 3 level outriggers i.e., at 9th, 18th and 27th storey reduced the displacement by 18% and time period had reduced by 30% and base shear is increased by 45%.

For the dynamic earthquake analysis of a 36-storey model using 3 level outriggers i.e., at 12th, 24th and 36th storey reduced the displacement by 18% and time period had reduced by 27.2% and base shear is increased by 40%.

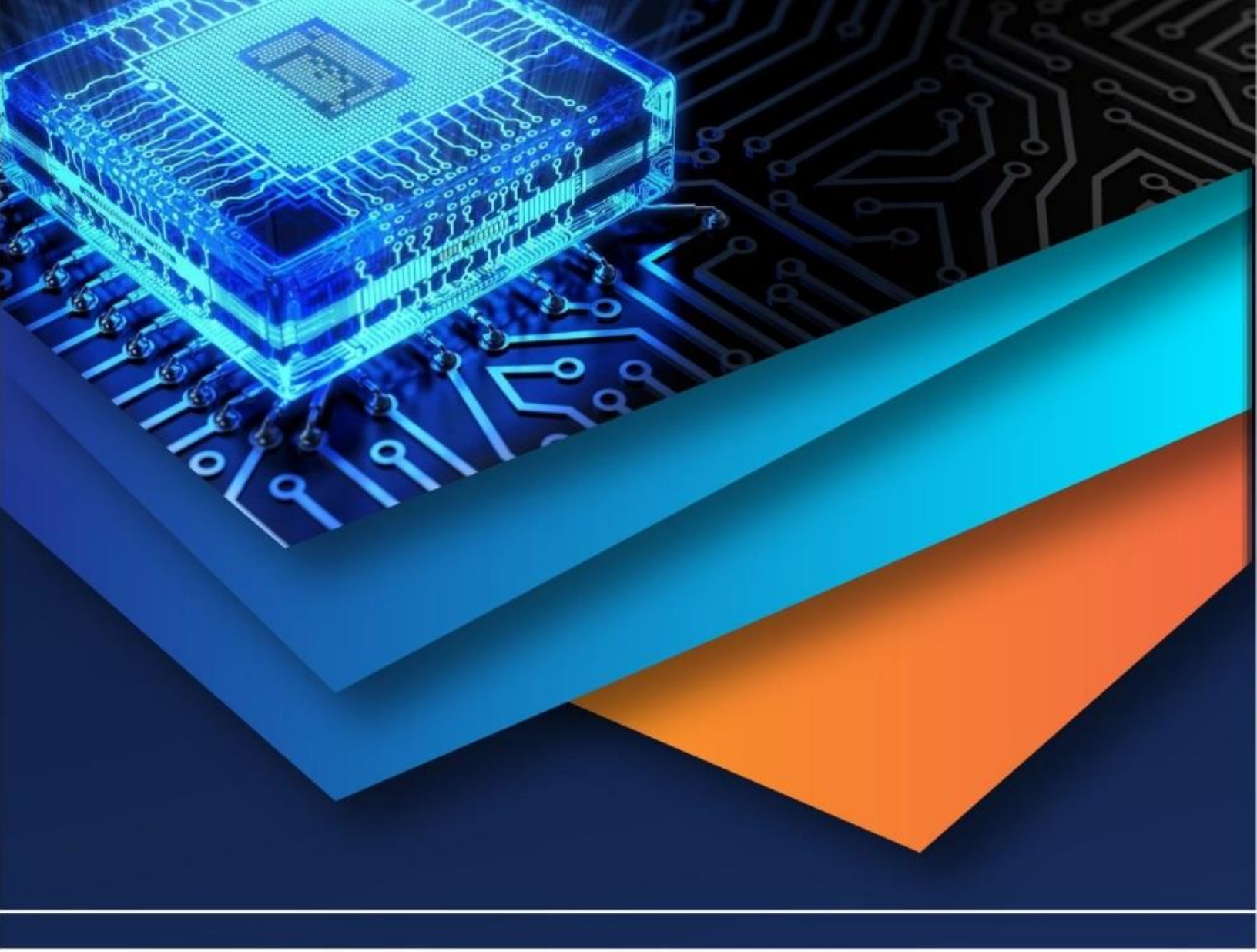
V. CONCLUSIONS

Based on the observations and the results obtained during this study, we can arrive at the following conclusions:

1) The use of outrigger system in high rise structure increases the stiffness and makes the structure more efficient under seismic.
2) It can be concluded from this study that the outrigger system provides reduction in displacement, drift and base moment and time period.
3) As the height of building increases then necessity of new structural system arises Outrigger structural system depends on number and its position throughout the height of the building.
4) The best performing model for dynamic assessment subjected to earthquake and wind load cases in a 36-storey Building when outrigger places at 0.25H, 0.5H, 0.75H.
5) Outrigger performs well compared to rigid frame and core system.

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