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Comparative Analysis of Outrigger Systems in High-Rise Building

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Abstract: ***The significant increase in the world population and emigration of human beings to the cities for amenities and employment opportunities, the land crisis has emerged as serious issues for humankind. For resolution structural engineer begin to build high-rise buildings to accommodate the current population. Height increase of building direct impact on increase of lateral forces on high buildings. The concept of illumination of outrigger structural systems is evaluated by comparing multiple X braced, N Braced, Inv V Braced outrigger system and shear wall system models types utilizing a 40-story reinforced concrete building using ETABS software.***
Keywords: High-rise structure, Outrigger system, displacement, base shear, time period.

I. INTRODUCTION

The rapid growth of the urban population and the consequent pressure on limited space have considerably influenced city residential development. The scarcity of space in urban areas has led to the development of vertical growth consisting of low-rise, medium-rise and tall buildings. Tall structures analysis and design needs appropriate analytical methods and precise design concepts to resist the lateral loads, so that the structure is safe.Developments of design in the tall building frames have ensured the importance of limiting the sideway under the action of lateral loads.

A. Core and Outrigger Structural system

Outriggers are rigid horizontal structures designed to improve building overturning stiffness and strength by connecting the building core or spine to distant columns. The explanation of building outrigger behavior is simple: because outriggers act as stiff arms engaging outer columns, when a central core tries to tilt, its rotation at the outrigger level induces a tension-compression couple in the outer columns acting in opposition to that movement. The result is a type of restoring moment acting on the core at that level.

Analysis and design of a complete core-and-outrigger system is not that simple: distribution of forces between the core and the outrigger system depends on the relative stiffness of each element. One cannot arbitrarily assign overturning forces to the core and the outrigger columns.

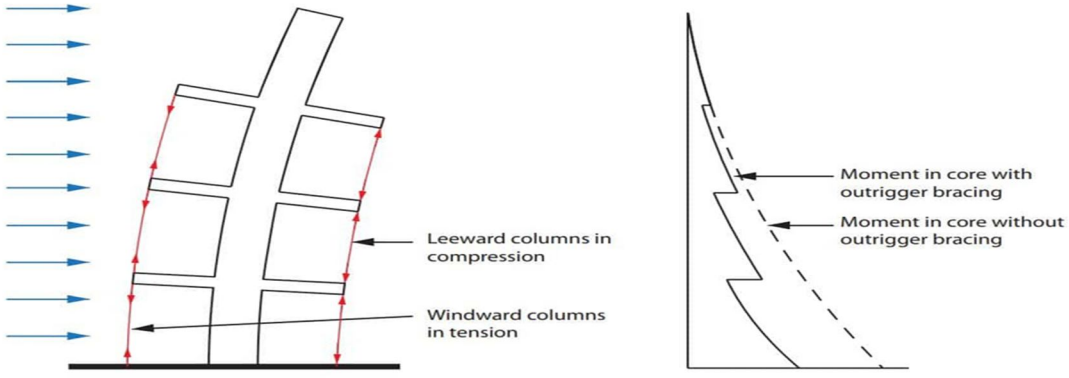


Figure 1.1 Structural behavior of an outrigger system and comparison of moment diagrams with and without outrigger bracings

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II. GENERAL CONSIDERATION

The frame selected for analysis is symmetrical in plan with plan size 20 mx20 m and floor to floor height is 3m. Here, 40 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	Grid Spacing	X and Y direction – 4 m
3	Total Dimension	20 m X 20 m Base dimension
4	Story Height Uniform	3 m
5	No. of Stories	40
6	Material Properties	Standard Values input in N-mm
7	Grade of Steel Outrigger	FE 345
8	Grade of Concrete Deck	M40
9	Column	1000 mm X 1000 mm
10	Beams	300 mm X 450 mm
11	Slab	200 mm
12	Wall load (DL)	5 KN/m
13	Dead Load(DL)	1.5 KN/m^2
14	Live load (LL)	2 KN/m^2
15	Reduction Factor (R)	5
16	Importance Factor (I)	1.5
17	Zone(z)	0.36 (V)
18	Soil type	II

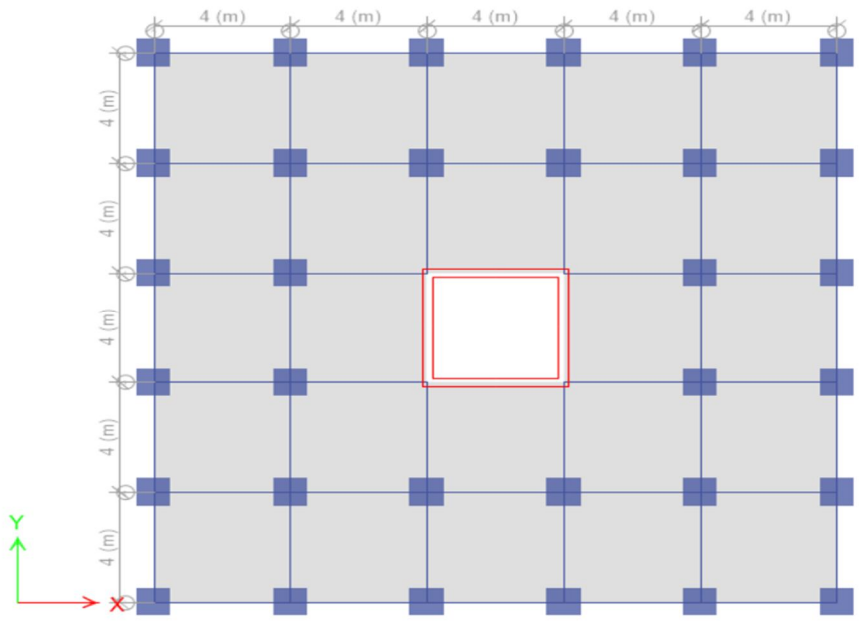


Figure 2.2 plan of model

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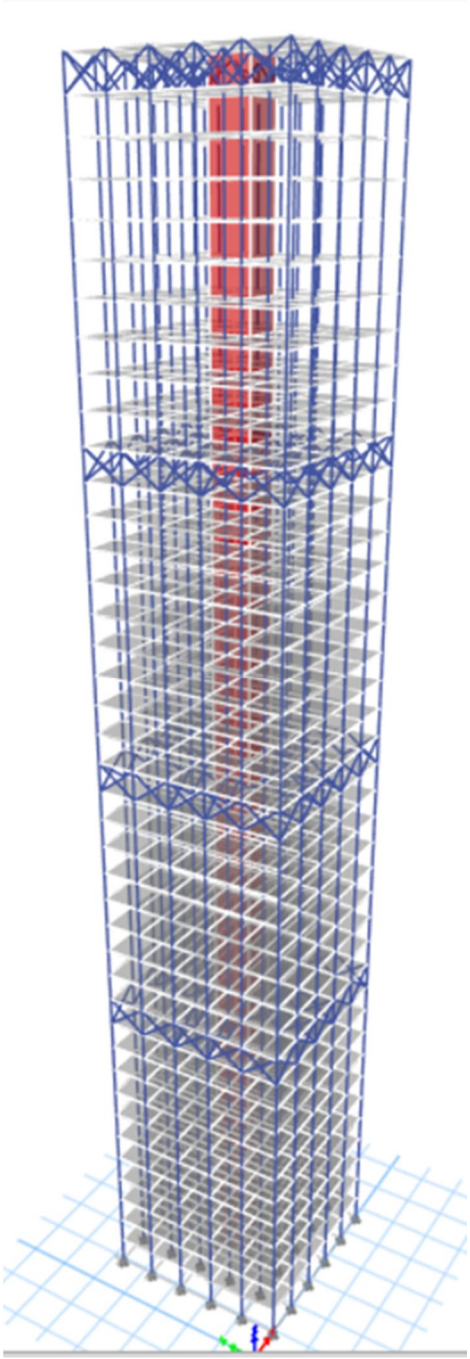


Figure 2.3 Outrigger at 12,20,30,40

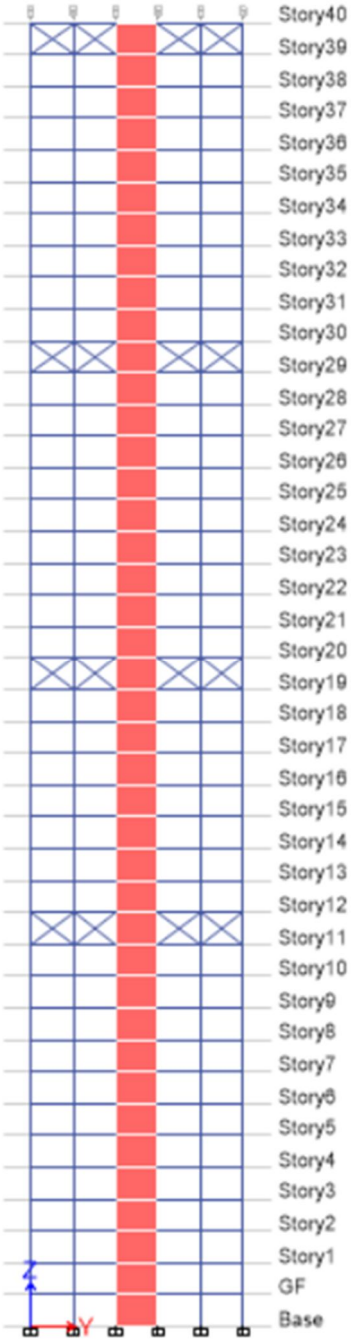


Figure 2.4 Elevation view Outrigger at 12,20,30,40

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 outrigger
2) X Bracing
3) Inverted V Bracing
4) N Bracing-

A. *Method of Analysis*

Response Spectrum Method

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

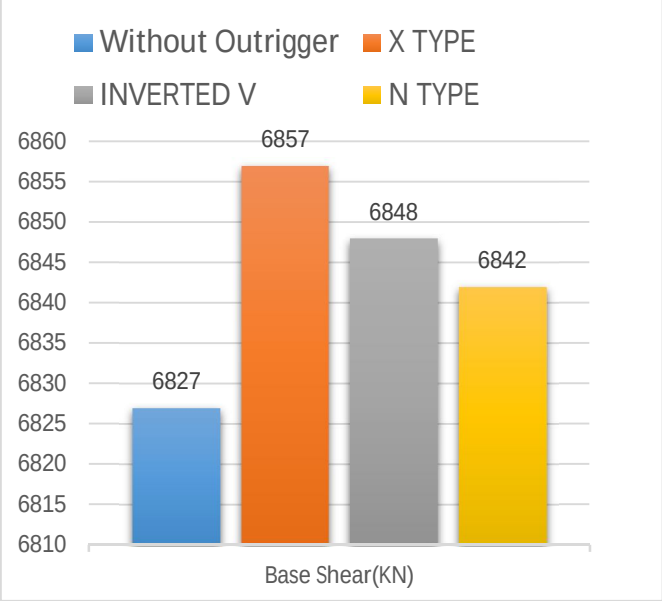


Figure.2.5 Base Shear Variation

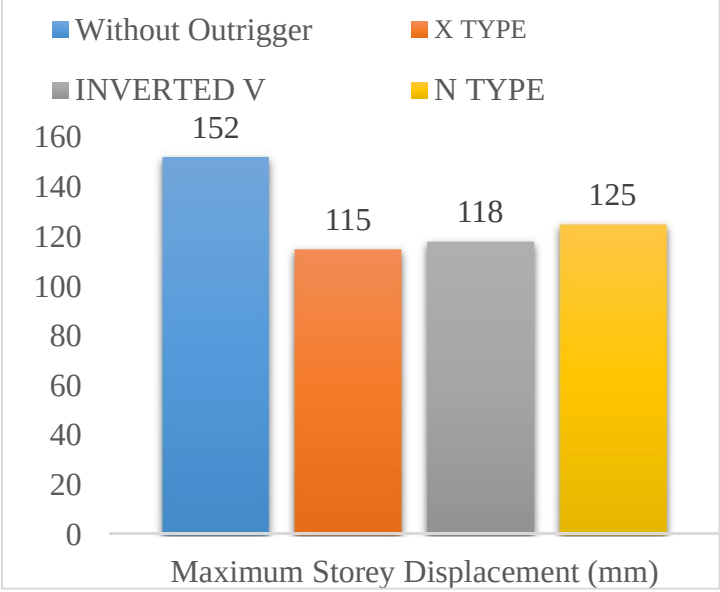


Figure.2.6 Maximum Storey Displacement

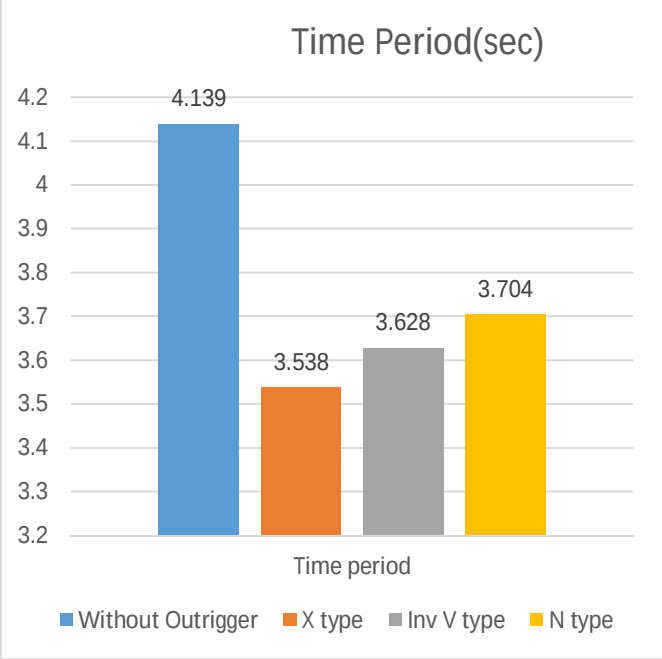


Figure.2.7 Time Period

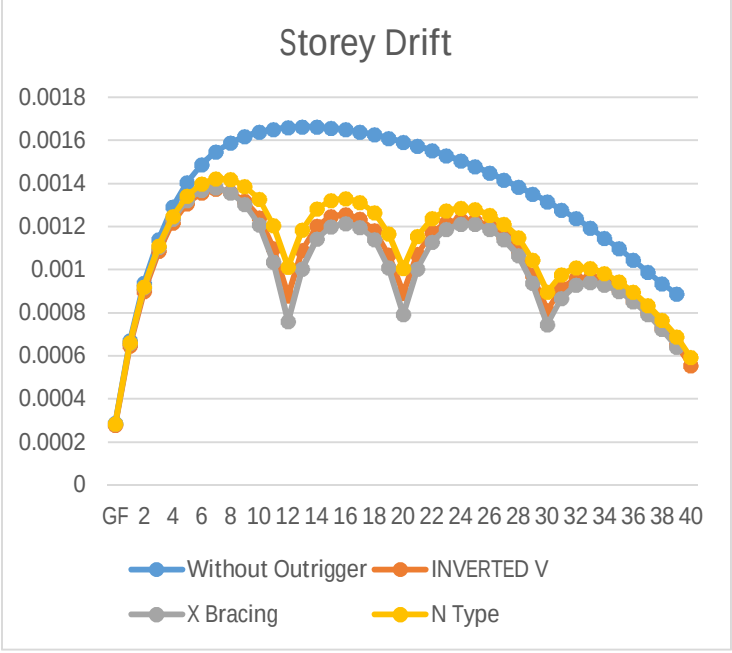


Figure.2.8 Story Drift

IV. RESULT AND DISCUSSION

This study compares the behaviour of multi outriggers, effect of belt truss on Building.

The increase in the no. of outriggers, performance of the building also increases and use of belt trusses with core shear wall is more effective than only outriggers.

Maximum Story Displacement conclusion For Earthquake Load X Bracing combined with 4 outriggers is most effective as maximum story displacement decreases by 24 %.

For Earthquake Load X Bracing combined with 4 outriggers is most effective as Story Shears increases by 30 KN with belt truss.

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.

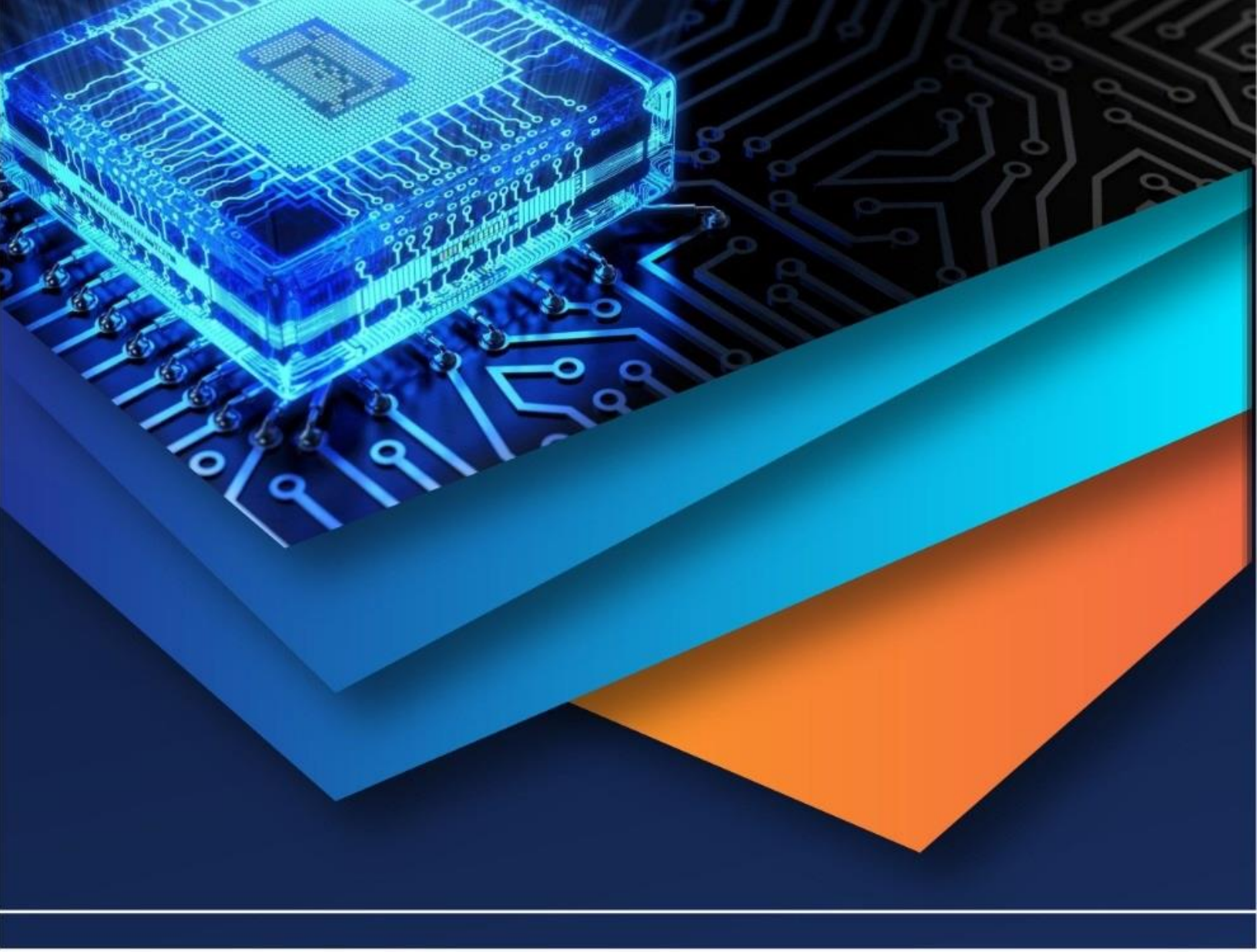
3) As the height of building increases then necessity of new structural system arises Outrigger structural system depends on number and its position throughout the height of the building.

4) The best performing model for dynamic assessment subjected to earthquake and wind load cases in a 40-storey Building when we use steel X type Bracing.

5) Outrigger performs well compared to rigid frame and core system.

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