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Analysis of Outrigger System for Frame Structure Subjected to Lateral Loads

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Abstract - *Multistorey structures is one of the most used for the influence control of excessive drift, efficient and stiffness when subjected to lateral load is as the outrigger system. During the earthquake or wind load, the damage of non-structural and structural form can be minimized. This paper studies "ANALYSIS OF OUTRIGGER SYSTEM FOR FRAME STRUCTURE SUBJECTED TO LATERAL LOAD" is the three dimensional model of 32 storey building have to bring into existence for analysis and design using ETABS software. To study the effect of outrigger system varying with different storey height of the building is perform as one, two, three and four outrigger level. This analysis of model is using method of Linear Static Method (Equivalent Static Method) and Linear Dynamic Method (Response Spectrum Method). The characteristics of efficiency and stiffness is to calculate the lateral displacement, base shear, story drift, and fundamental natural time period for different types model with and without outrigger system. So this case the reduction of displacement and drift is to minimized as compared to model of without outrigger system*

Key Words: Frame Structure, Outrigger System, Seismic load, Lateral displacement, Storey drift.

1. INTRODUCTION

Tall building development is rapidly increasing around the world, posing new challenges that must be met through engineering judgement. Lateral loads induced by wind or earthquake are frequently resisted in modern tall buildings by a system of coupled shear walls. However, as the structure of building rises in height, the structure's stiffnes becomes increasingly significant, necessitating the adoption of a lateral load resisting system to give adequate lateral stiffnes. The dyanamic load resisting system effectively controls excess laterals load drift, lowering the risk of structural and non-structural damage caused by small or medium lateral loads caused by wind or earthquake. This system is chosen as an appropriate structure for high-rise buildings, especially those in seismically active zones or wind-load-dominant areas

From over course of the twentieth century, advances in concrete technology, including materials, structural systems, analyse, and constructions processes, made it feasible create concrete high structures. The primary needs of the building are met by structural systems. The influence of laterals load, such as wind & earthquake, on the structure of a buildings rises as it grows in height. Tall buildings are subjected to wind and seismic forces. become an essential design consideration. Tall structures' structural systems can be improved to regulate their dynamic response.

Building deflection is influenced by earthquakes and wind loads. A concrete core has been installed at the centre of the building to counteract lateral loads caused by earthquakes and wind. Concrete core is an extremely efficient and practical structural method for decreasing bending caused by seismic and wind stresses. The hybrid frame-concrete core wall structure has grown in popularity in recent years, with owners worried about its performance and cost savings.

The allowable limit of top deflection in high buildings for wind study is 1/500 of the structure height, Part III of Bureau of Indian Standards 875:1987. One of most essential requirements of selecting a structural system of a tall building is lateral drift at the top. However, as a building's height increases, the core wall's rigidity alone is insufficient to withstand wind and seismic forces. This issue necessitates the development of new modern structural systems. Tall structures are created with numerous braced tube, dia-grid, and outrigger systems are examples of structural systems, for each complicated form category.

1.1 OUTRIGGER STRUCTURAL SYSTEM

Outriggers area unit rigid horizontal structure i.e. truss or beam that connect core wall and outer column of building to enhance building strength and overturning stiffness. Outriggers are employed in tall building for nearly from century, however innovative style principle has been up its potency. stabilizer system is one style of structural system that is made from a cantilever formed horizontal member connected to structures inner core and outer columns. Through the association, the instant arm of the core are going to be enlarged that cause higher lateral stiffness of the system. Central core during a building act as cantilever, outriggers area unit provided to scale back overturning moment in core and to transfer moment from core to outer column by connecting the core and column. Wall frame stabilizer trusses is one amongst the foremost economical and economical structures in tall building, at outer finish they connected to the inspiration through exterior columns

When the structure is subjected to horizontal loading, the wall and stabilizer trusses can rotate, inflicting compression within the downwind column and tension in column on the upwind aspect, these axial forces can resist the rotation within the wall. once the structure is subjected to lateral forces, stabilizer and columns resist the rotation of the core and therefore considerably scale back the lateral deflection and base moment, which might have arisen in a very free core. stabilizer structural systems not solely practiced in dominant the highest displacements however additionally play substantial role in reducing the put down level drifts

1.2 METHODS OF SEISMIC ANALYSIS

The primary goal of seismic analysis is to make the structure earthquake resistant rather than earthquake proof. The structure specially designed for this purpose will withstand effects of shaking of ground, it donot fall during strong earthquakes. In another sense, the primary goal of seismic analysis is to assess forces that have evolved, their treatments, and the ability of structures and their elements to withstand these forces The seismic analysis methodologies used were as follows:

I) Linear Methods

a) Static linear analysis (Equivalent static method)

b) Analyses of linear dynamics (Response spectrum analysis)

The Response Spectrum and Equivalent Static Method approach is use to study 32- steel frame resistant to storey moments building in this study. The building's performance is measured in terms of lateral displacement, storey drift, base shear, and time period, and overturning moment.

2. ANALYTICAL MODELLING

The ETABS software system is used to form 3D model and to hold out the analysis. The software system is ready to predict the behavior of house frames below static or dynamic loadings, taking under consideration material in snap. The software system accepts static masses similarly as dynamic masses and has the flexibility to perform static and dynamic analysis.

The arrange layout of the RC SMRF building as shown in figure five.1. The elevation and 3D read of various building models also are shown on top of. during this study, the arrange is same for all the models. every building model is of thirty two constructions with storey height capable three.2m. the peak of bottom construction is unbroken as a pair of.5m for all the various building models. And seismal zone V is taken into account for the study. whereas scheming the seismal weight, precisely 0.5 (50%) of the ground loading is taken into account (IS 1893-2002, clause 7.3.1 and 7.3.2). The act knowledge given for all the various building models is given below.

Model Data Structure- SMRF
No. of stories- G+30
Storey height – 3.2m
Intensity of Live Load – 3Kn/m^2
Seismic zone – 5th (0.36)
Soil type – 2nd (medium)
Important factors – 1.5
Response reduction factors – 5
Concrete column 1– 0.75 x 1.0 m
Concrete column 2– 0.6 x 0.8 m
Concrete beam – 0.3 x 0.55 m
Grade of concrete – M30
Grade of steel – Fe 500
Steel Outrigger brace – ISA 200x200x12 mm Fe 345

The outrigger system are analysis for the different model structural forms as follows

FIG -1: PLAN LAYOUT

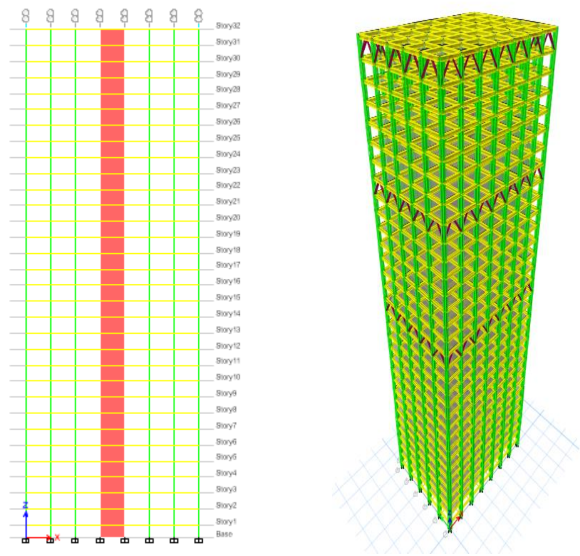

FIG -2: Sectional Elevation and 3D View of Building with Outriggers and Core Wall

3. RESULTS AND DISCUSSIONS

In this the results of the selected buildings are presented and discussed in detail. The results of base shear, lateral displacements, storey drifts, and natural period of vibration and overall performance for the different building models are presented and compared.

3.1 LATERAL DISPLACEMENT

This methods shown is for both the transverse & the longitudinal directions of that model. According to this, the displacement is maximum at highest top of the level structure and minimum at the base level. Thus the storey height increase with lateral displacement also increases. It observed that, the displacement values of model outrigger system are less than without outrigger system

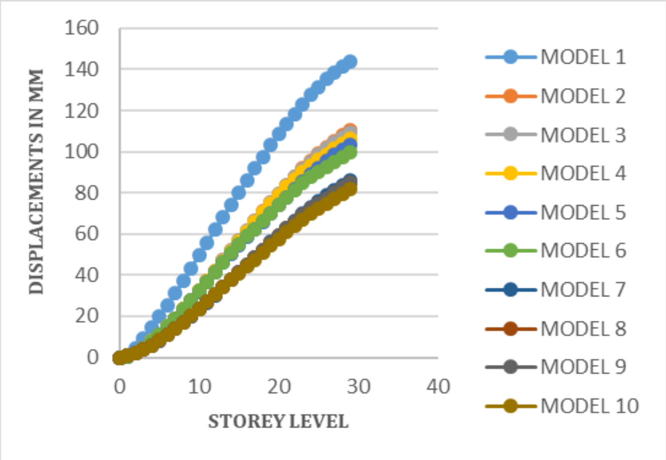

FIG-3: Lateral Displacement for various Models

Table-1: Top Storey Displacement for various Models

TOP STOREY DISPLACEMENT (mm)				
MODEL	Equivalent Static Method		Response spectrum method	
	EQX	EQY	RSX	RSY
1	148.821	162.333	112.797	112.797
2	116.951	128.632	80.544	84.192
3	114.95	127.071	79.028	83.032
4	112.103	124.704	77.683	82.033
5	109.851	122.847	75.984	80.754
6	104.729	118.07	72.993	77.907
7	92.159	97.14	62.858	63.884
8	91.399	96.576	62.818	63.885
9	91.933	96.941	63.515	64.35
10	87.366	93.741	63.016	64.894

3.2 STOREY DRIFT

Drift is mostly defined as comparative of lateral displacement of two floors. Drift is absolutely essential for control limit damage to interiors and exteriors part systems. According to INDIAN STANDARD 1893 (part 1) of 2002 consider that the allowable story drift is measured as 0.0004 times of one story height of structure

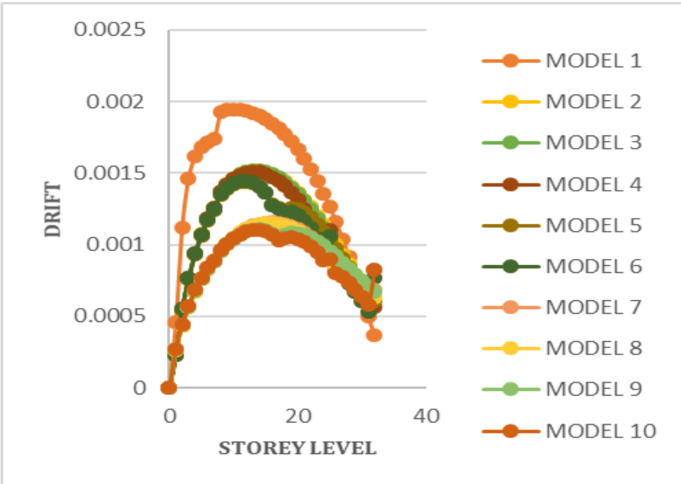

FIG-4: Storey Drift for various Models

MAX STOREY DRIFT				
MODEL	Equivalent Static Method		Response spectrum method	
	EQX	EQY	RSX	RSY
1	0.00194	0.00209	0.001655	0.00163
2	0.00152	0.00165	0.0011	0.00112
3	0.00151	0.00164	0.0011	0.00112
4	0.00151	0.00164	0.0011	0.00112
5	0.00144	0.00158	0.00107	0.00109
6	0.00144	0.00157	0.00107	0.00109
7	0.00115	0.00121	0.00081	0.00081
8	0.00115	0.00112	0.00081	0.00081
9	0.00108	0.00117	0.0008	0.0008
10	0.00105	0.00119	0.0082	0.00082

Table-2: Max Storey Drift for various models

3.3 BASE SHEAR

Base shear can be defined as the maximum lateral force which will occur at base of structure because of seismic ground motion. Base shear is the deformation of base in which parallel planes of structure during an earthquake waves. Base shear is an maximum lateral forces at the base of the building when subjected to seismic load or wind load.

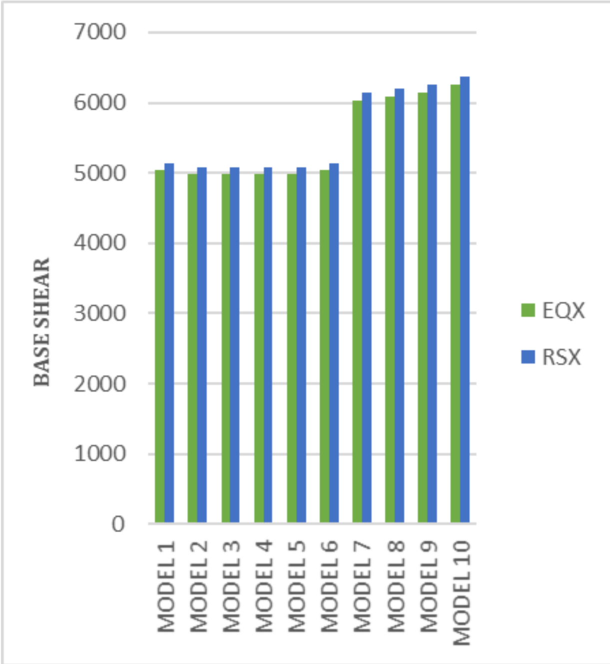

FIG-5: Base Shear for Different Models by Equivalent Static and Response Spectrum Method

3.3 TIME PERIOD

All objects including buildings and the ground have a natural period, i.e. the time it takes to swing back and forth, from point A to point B and back again. Seismic waves when travels under the ground it also moves at its natural period. It will pose a problem if the period of both ground an building resting on ground is same

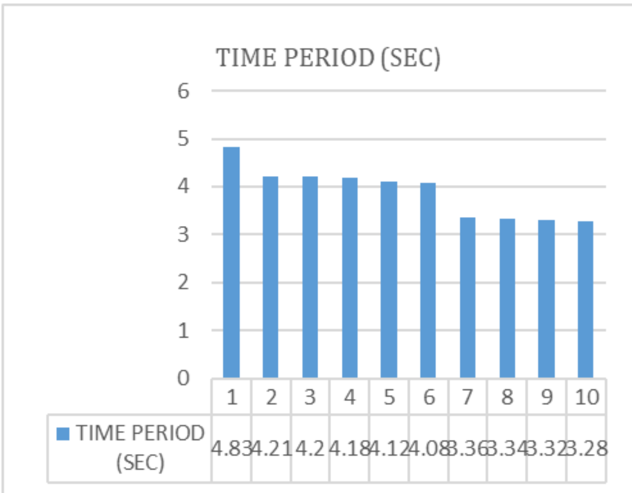

FIG-6: Time Period for Different Models

4. CONCLUSIONS

- The X-braced Outriggers are very effective because they have minimal lateral displacement

- When the outriggers system is used, the lateral deflection or displacement at the top level is much lower when the outriggers systems is not used.
- The maximum lateral displacement in 32-story structures subjected to earthquake lateral load is reduced by 29.73 percent, and storey drift is reduced by 25.77 percent
- The outrigger structure system can support up to a 50-story building
- Where the zone is extremely severe, this outrigger system or belt truss system of structures can be used.

REFERENCES

[1] Krunal Z. Mistry, Prof. Dhruti J. Dhyani, "Optimum outrigger location in outrigger structural system for high rise building" International Journal of Advance Engineering and Research Development Volume 2, Issue 5, May -2015.
[2] Akshay Khanorkar, Shruti Sukhdeve, S. V. Denge & S. P. Raut, "Outrigger and Belt Truss System for Tall Building to Control Deflection: A Review" GRD Journals- Global Research and Development Journal for Engineering | Volume 1 | Issue 6 | May 2016.
[3] B.S.Taranath, "Structural Analysis & Design of Tall Buildings", New York, McGraw Hill, 1998.
[4] . Iyengar Hal, Composite and Steel High Rise Systems, Habitat and the High- Rise, Tradition & Innovation. In Proceedings of the Fifth World Congress. 14-19 May 1995.Amsterdam, The Netherlands, Bethlehem, Council on Tall Building and Urban Habitat, Lehigh University
[5] Abdul Karim Mullah, Srinivas B. N, "A Study on Outrigger System in a Tall R.C Structure with Steel Bracing" International Journal of Engineering Research & Technology (IJERT), Vol. 4 Issue 07, July-2015