STUDY ON SEISMIC BEHAVIOUR OF REINFORCED CONCRETE TALL BUILDINGS WITH OUTRIGGER

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Abstract - *The expansion of high rise building has been quickly increasing these days, create more challenges to the engineers. As tallness of the building increases, the stiffness of structure is reduced. Outrigger system has become the one of the most effective lateral load resisting system in tall buildings. Outriggers are the structural method which increases the stiffness of the structure by huge amount.*

In this study dynamic non-linear behavior of the reinforced concrete regular building 9x9 bays 24 storey building. The purpose of this paper is to study, the performance of outrigger structural system in 24 storey RC Building subjected to seismic load. Story drift is another problem for the collapse of building constructed in seismic areas. Another objective of this study is to reduce the story drift to permissible value. The competence of the structure is measured in terms of drift index, lateral displacement, base shear etc.

***Key Words*: Outrigger, Lateral displacement, ETABS, Storey drift, Base shear, Stiffness**

1.INTRODUCTION

1.1 General

Tall towers and buildings have astonished us from early times itself. However, the growth of tall buildings for commercial and residential purposes began in 1880s. The rapid growth of urban population and the resultant pressure on the limited space have influenced city residential spaces. The increase in the land cost, desire to avoid a continuous urban sprawl, and the need to preserve important agricultural production have all contributed to drive residential buildings upwards. And, in some cases, like in the cities of Hong Kong and Rio de Janeiro the topographical features make only the tall buildings as feasible housing systems.

The amount of the available materials, the level of construction technology and the state of development services needed for the use of the building decides the feasibility and desirability of high rise structures. So, as time passed away, many new improvements have occurred with the finding of new materials, construction facility or form of service. In the early stages of planning a building, the entire design team should collaborate to agree on a form of structure to satisfy their respective requirements of function, safety and serviceability and servicing. Very often, there will be a compromise between conflicting demands. And, in very tall buildings, the structure arrangement will be subservient to the architectural requirements of space arrangements and aesthetics.

The primary types of vertical load resisting elements of tall buildings are columns and walls. their function is to resist the gravity loading from the weight of the building and its contents. As the height of the building increases, the weight of the columns per unit area also increases. But, rarely, the worst possible effects of lateral forces may occur in the life of the building, it is important to minimize the penalty for height to achieve an optimum design. And, the stiffness of building depends on height of the structure. That is if the height is increases, stiffness reduces. So, the construction of efficient, economic and stiffened building is a challenge. The constant search for more efficient solutions led to develop a suitable system for resisting lateral forces, the engineers devised stiff horizontal interconnections between various vertical components to form composite assemblies having lateral stiffness's many times greater than that of the individual components.

Outrigger is one such system which is a just a beam that connects between shear wall and to the exterior column. It may be steel or concrete. It helps to stiffen the structure and reduce the lateral displacement and story drift to permissible limit. Not only has the number of outrigger used in a structure depended on the story drift and stiffness of building but also the position of outrigger.

Story drift is the main problem for the collapse of building that constructed in seismic areas. IS 456 provides permissible story drift for high rise structure. So, we need to change the story drift to permissible limit. The outrigger system helps to reduce the story drift to permissible limit.

1.2 Objective

- The objective of present study is the usage of outrigger in regular building under earthquake forces
- 24 storey reinforced concrete framed building is considered in this study
- The rc building with and without outrigger are compared.
- Estimation of inter storey drifts and its distribution along the height.
- Determination of storey displacements.
- The results of different parameters such as displacement, drift, base shear are studied.

2. METHODOLOGY

2.1. Modelling of Structures

ETABS is one of the best tool to structural engineers for designing buildings, whether they are working on one-story building or the tallest commercial high-rises. Models is rendered realistically, and all results can be easily interpreted.

2.2 Building plan and dimension details

The models which have been used for study are G+23 storeyed buildings. Spacing between the building are 6 m along y direction and 5m along x direction. Outrigger are provided in 1/3rd and 2/3rd height of the building Following data is used in the analysis of RC building models.

Structure OMRF
No of stories G+23
Type Regular
Story Height 3 m
Grade of concrete M25,M30, M60
Grade of Steel Fe500, Fe550
Beam Size 0.3 x 0.6m
Column Size 0.4 x 0.8m
Seismic Location- Imperial Valley earthquake in United States
Seismic Intensity- 6.9
Importance Factor 1
Reduction Factor 5
LL 3 kN/m^2
Shear wall 0.3m width, M60
Concrete outrigger 0.3m width

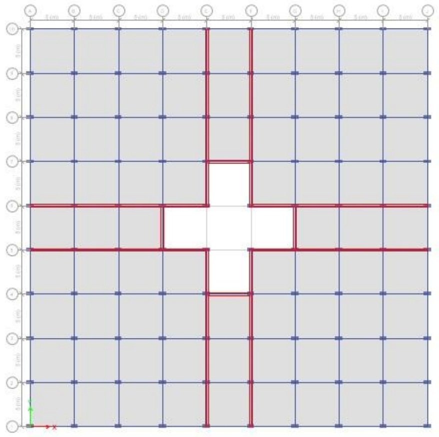


Fig -1: Plan

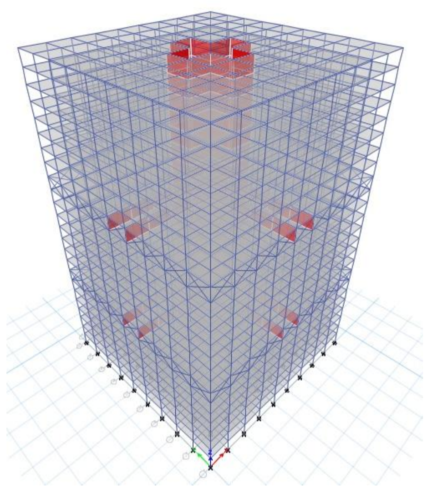


Fig -2: 3d view

The analysis of the building is carried out by following methods of analysis

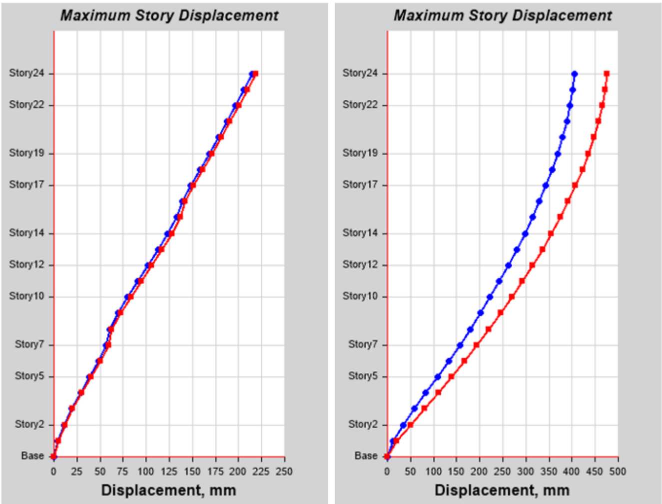
1. Equivalent Static Analysis Method
2. Dynamic Analysis Method
   a) Response spectrum analysis
   b) Time history analysis

Equivalent Static Analysis Method: The equivalent static lateral force method is a simple technique to substitute the effect of dynamic loading of an expected earthquake by a static force distributed laterally on a structure for design purposes. The concept is a dynamic analysis into partly dynamic and partly static analyses for finding the maximum displacement. It is restricted only to a single mode of vibration of the structure.

Response Spectrum Method: Response spectrum method of analysis shall be performed using the design spectrum specified in Clause 6.4.2 or by a site-specific design, spectrum mentioned in Clause 6.4.6 of IS 1893 (2002)

Time History Method: Time history method of analysis, when used, shall be based on an appropriate ground motion and shall be performed using accepted principles of dynamics.

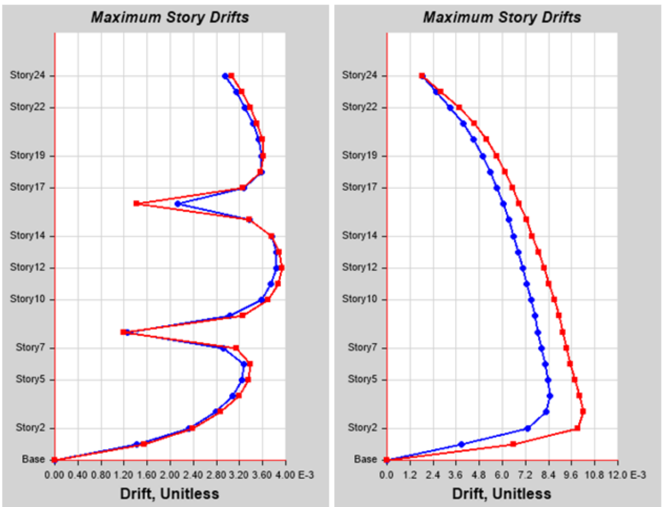
Result and Discussion



With outrigger without outrigger

Fig -3: Story Displacement

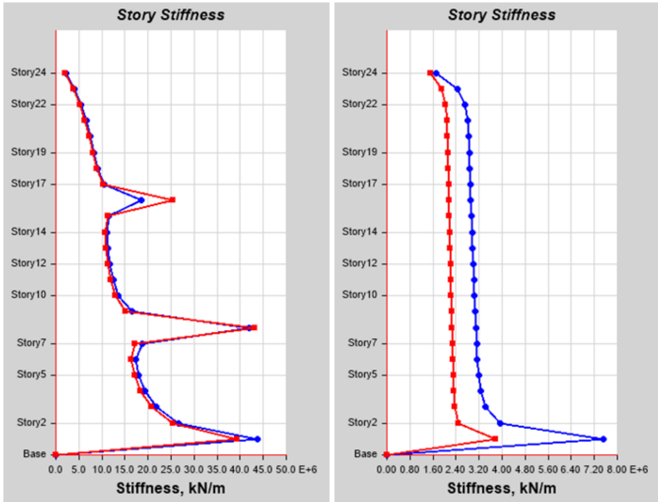
From the above graph the displacement of building with outrigger is less compared to without buildings in both x and y direction. The percentage of reduction in the values found to be in x and y direction is 55% and 47% for regular building with concrete outrigger from dynamic analysis. When outrigger is provided the overall displacement of building is minimized.



With outrigger without outrigger

Fig -4: Story Drift

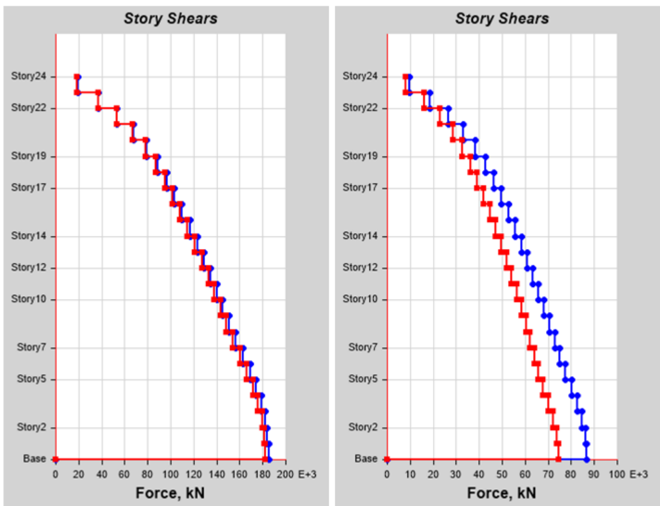
From the above graph the story drift of building with outrigger is less compared to without buildings in both x and y direction. The percentage of reduction in the drift values found to be in x and y direction is 61% and 55% for regular building with concrete outrigger from dynamic analysis.



With outrigger without outrigger

Fig -5: Story Stiffness

Max story stiffness is at the bottom story and the maximum story stiffness is almost same for all these three building. The stiffness reduces, the height of the story increases. The stiffness increases the at the outrigger story in large quantity. From the graph we can observe that the story stiffness of outrigger building is 6 to 7 times the without outrigger building. If the stiffness increase, the rigidity of structure increases. This reduces the story displacement and drift.



With outrigger without outrigger

Fig -6: Story Shear

The max story shear of outrigger building is 185x10^3 kN and without outrigger building is 88x10^3 kN. i.e. max story shear of outrigger building is double the without outrigger building.

3. CONCLUSIONS

The outrigger plays a vital role in increasing structural flexural stiffness by reducing base shear under the action of seismic loads.

- The outrigger system in the building increases the efficiency of the building when compared to building without outrigger.
- The introduction of outrigger in the tall building system will lead to minimization of inter storey drift.
- The outrigger is more efficient in reducing the lateral storey displacement.
- The outriggers can be used in high seismicity locations.
- The outrigger increases stiffness of building

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