Optimum Outrigger Location of High-Rise RC Building for Lateral Loading

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Abstract-*In seismic active zone, structural performance of conventional RC building is poor, which shows increasing time period and excessive drifts when subjected to lateral forces. This issues can be solved by providing lateral load resisting element such as outrigger system at different height of building. In this present work, a twenty storied RC building without outrigger and with outrigger at the top and at different storeys were analysed. Results shows the fundamental time period and storey displacement reduces where as stiffness increases in case of outrigger system.*

Keywords-Outrigger, Wind load, Earthquake load, Lateral displacement.

I. INTRODUCTION

In tall buildings, lateral loads induced by wind or earthquake forces are often resisted by a system of multi-outriggers. An outrigger is a stiff beam that connects the shear walls to exterior columns. When the structure is subjected to lateral forces, the outrigger and the columns resist the rotation of the core and thus significantly reduce the lateral deflection and base moment, which would have arisen in a free core. During the last three decades, numerous studies have been carried out on the analysis and behaviour of outrigger structures. But this question is remained that how many outriggers system is needed in tall buildings. The outrigger system is commonly used as one of the structural system to effectively control the excessive drift due to lateral loads, so that the risk of structural and non-structural damage can be minimized. For high-rise buildings, particularly in seismic active zone or wind load dominant, this system can be chosen for safe guard of structure. The outrigger systems may be formed in any combination of steel, concrete and composite construction because of the many functional benefits of outrigger systems and the advantages.

II. METHODOLOGY

2.1 Modelling

Five models of twenty storey RC structure, square in plan having dimension 25 m x 25 m in plan with 5m bay spacing and 3 m floor height is modelled in ETABS 2016 software package. Five types of models were analysed:

Model 1: Structural Model without Outrigger
Model 2: Structural Model with One Outrigger at the top floor
Model 3: Structural Model with One Outrigger at the top floor and another at 3/4th height of the building.
Model 4: Structural Model with One Outrigger at the top floor and another at mid height of the building.
Model 5: Structural Model with One Outrigger at the top floor and another at 1/4th height of the building

The properties of structural elements are shown in Table 1.

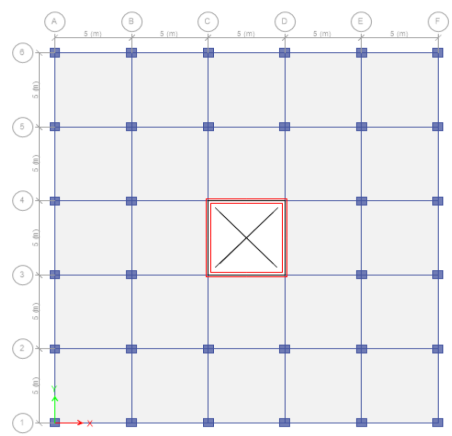

Figure 1 . Plan of Structure

2.2 Analysis

All the models with and without outrigger system were analysed by static analysis method in ETABS 2016 for seismic zone III and basic wind speed 44 m/s as per IS 1893 (part I):2002 and IS 875 (part III):1984. The earthquake and wind load data is shown in table 2 and table 3.

The analysis is done for fundamental time period of vibration, storey displacement, storey drift and stiffness of structure. The results of analysis are shown in figure 3, figure 4, figure 5 and figure 6.

Table 1. Specification of Structure

Slab	120 mm
Beam	230 mm x 600 mm
Column	600 mm x 600 mm
Outrigger	ISLB 300
Shear wall	300 mm

Table 2. Wind Load Data

Wind speed, Vb	44 m/s
Terrain category	3
Structure class	c
Risk factor	1
Topography	0.1
Cp	-0.5

Table 3. Earthquake Load Data

Response reduction factor, R	5
Seismic zone factor, Z	0.16
Soil type	II
Importance factor	1

III. RESULTS AND DISCUSSION

The results of static analysis for fundamental time period of vibration, storey displacement, storey drift, storey stiffness of structure are shown in figure 3, figure 4, figure 5 and figure 6. From the results, it is observed that;

1. In the core and outrigger structures storey displacement is about 40% - 50% less than conventional frame structure.
2. It is seen that storey drift value for conventional building is much higher as compared to building having core and outrigger.
3. Stiffness is higher for structure having core and outrigger than the conventional frame structure.

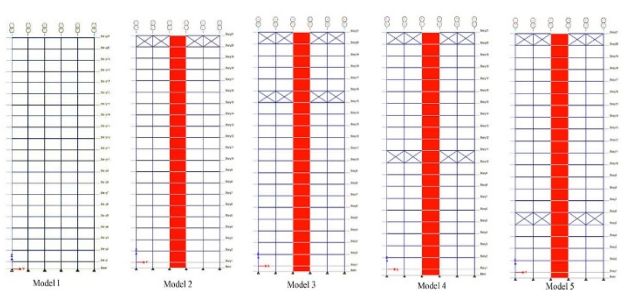

Figure 2 Outrigger Locations along Building Height

4. As compared to conventional frame structure the time period is reduces for the structure having core and outrigger system.
5. From figure 3 it is concluded that 47% storey displacement is reduces by providing outrigger at 1/2th height of building and also reduces 64% time period at same height, so the optimum location of outrigger is one at top and other is at 1/2th height of structure.

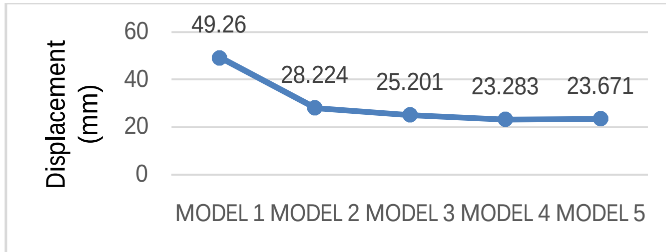

Figure 3. Storey Displacement

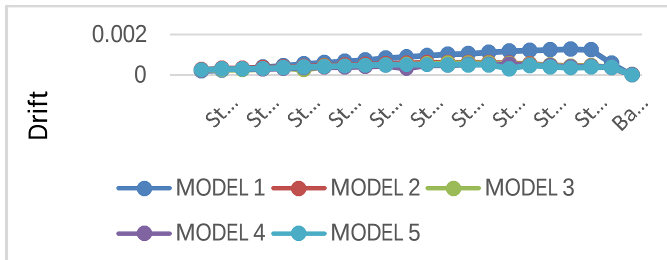

Figure 4. Storey Drift

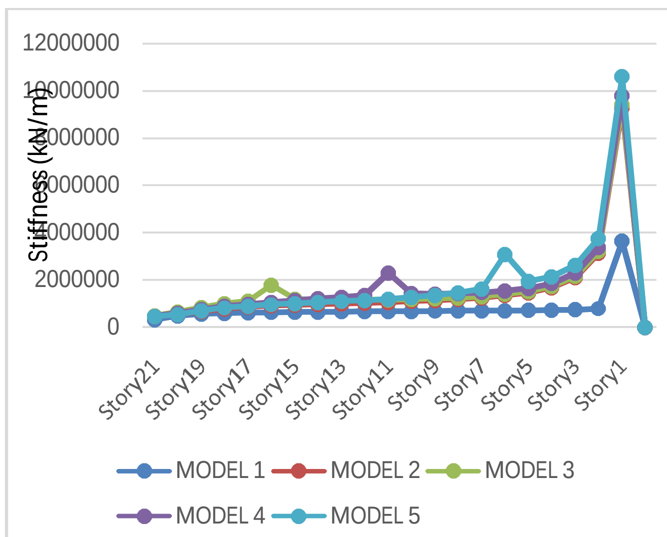

Figure 5. Storey Stiffness

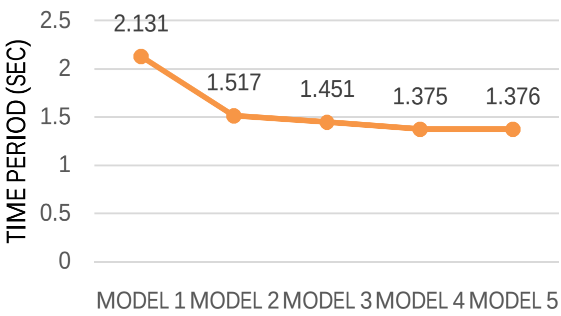

Figure 6. Fundamental Time Period

V. COCLUSION

1. Storey displacement at top storey corresponds to ground storey is minimum in Model 4. However, storey drift is limited in all outrigger system Models.
2. Storey stiffness is found to be more at the outrigger location. The maximum value of storey stiffness is noted in Model 4 and Model 5 as when compared to other.
3. Time period is observed to be less in Model 4.

It is found that the location of outrigger in Model 4 optimum location to counteract parameter such as storey displacement, storey drift and time period and to increase stiffness of structure.

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