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PERFORMANCE OF DIFFERENT OUTRIGGER STRUCTURAL SYSTEMS

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Abstract - *The development of tall building has been rapidly increasing worldwide. In typical structural design practice, the performance of lateral-load-resisting systems is the main focus of lateral analysis. The outrigger structural systems are one of the lateral load resisting systems that can provide significant drift control for tall buildings. The study is conducted on a 30-storied high-rise core wall building. A regular floor plan of 38.5m x 38.5m is considered for the analysis. Two types of analysis is carried out namely time history analysis and push over analysis. For obtaining the results the parameter – maximum storey displacement is considered. In this paper, the performances of different outrigger structural systems were analyzed using ETABS software.*

Key Words: Outrigger, Structural systems, Lateral load resisting systems, Drift control, Time history analysis, Pushover analysis

1. INTRODUCTION

The outrigger structural system is one of the horizontal load resisting systems. In this system the belt truss ties all the external columns on the periphery of the structure and the outriggers connect these belt trusses to the central core of the structure thus restraining the exterior columns from rotation. This system is functionally efficient as there is a free floor space between the central core and the exterior columns.

The outrigger and belt truss system is commonly used as one of the structural system to effectively control the excessive drift due to lateral load, so that during small or medium lateral load due to either wind or earthquake load, 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 as an appropriate structure.

The structural arrangement for this system consists of a main core connected to exterior columns by relatively stiff horizontal members such as a one or two storey deep walls commonly referred to as outriggers. The core may be centrally located with outriggers extending on both, or it may be located on one side of the building with outriggers extending to the building columns on one side.

The basic concept of finite element method is discretization of a structure into finite number of elements, connected at finite number of points called nodes. The material properties and the governing relationships are considered over these elements and expressed in terms of nodal displacement at nodes. ETABS is a general purpose finite element modelling package for numerically solving a wide variety of problems which include static/dynamic structural analysis, heat transfer and fluid problems, as well as acoustic and electro-magnetic problems. The mechanical and thermal buckling have been analyzed using a finite element (FE) model in ETABS. Analysis is carried out for outriggers such as flat slabs at central core and by comparing with conventional buildings.

1.1 Objective

Outrigger structural system increases the stiffness and makes the structural form very efficient under lateral loading. The objective of this thesis is to study the use of outrigger at various locations in a 30 storied building. The location of outrigger for reducing core moments, storey drift and lateral displacement. To find the performance of outriggers at various storeys with various types of bracings.

The work is to be carried out by conducting:

- Modelling of all the building frames.
- To analyse all the models using ETABS software.

- Analysis is done by two methods – time history analysis and push over analysis.
- To obtain the response in terms of parameter-storey displacement.
- To study the performance of outrigger structural system.

1.2 Scope of the Study

- The scope of the project mainly focuses on analyzing the performance of the outrigger structures with conventional structures and to make it economical.
- To effectively control the excessive drift due to lateral load.
- To evaluate the efficiency of outrigger in different stories of the high rise building.

2. MODELING AND ANALYSIS

The model considered for the analysis is a 30 storied building which is 90m high rise reinforced concrete building frame. The plan area of the structure is 38.5m x 38.5m with columns spaced at 5.5m from centre to centre. The height of each storey is 3m and all the floors is considered as typical floors. Material of the concrete and steel is M_{20} grade and Fe 415 is used. The size of beam is 230mm x 600mm and that of column is 600mm x 600mm. The thickness of slab considered is 200mm thick. Two types of analysis were carried out in the study namely time history analysis and push over analysis. A total of nine models were considered. Three models are considered by placing outriggers at 10, 20,30 storeys. Other three models are considered by placing outriggers at 15,30 storeys. And other three models are considered by placing outriggers at 29,30 storeys. The models are considered with X, V and eccen forward types.

The plan and elevation of one model is as shown in Fig.1 and Fig. 2.

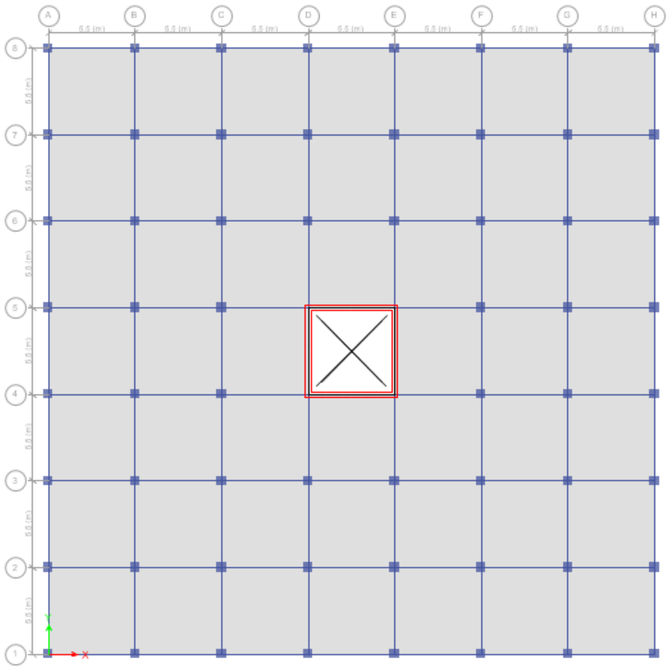

Fig-1. Plan of the model

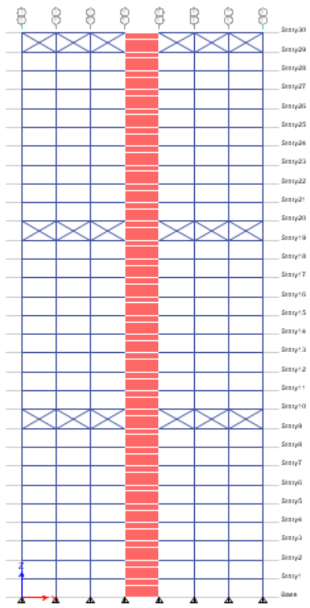

Fig-2. Elevation

3. RESULTS AND DISCUSSIONS

Based on the study, the following results were obtained. To achieve the results, the maximum storey displacements for the nine models were considered.

3.1 Maximum Storey Displacement

The following charts shows the storey displacement for various models.

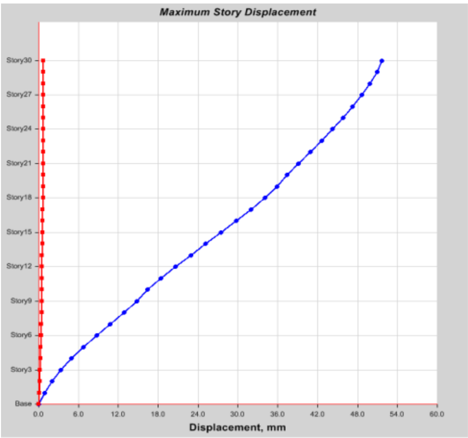

Chart-1. Storey displacement for outrigger at 10,20,30 storeys with X type

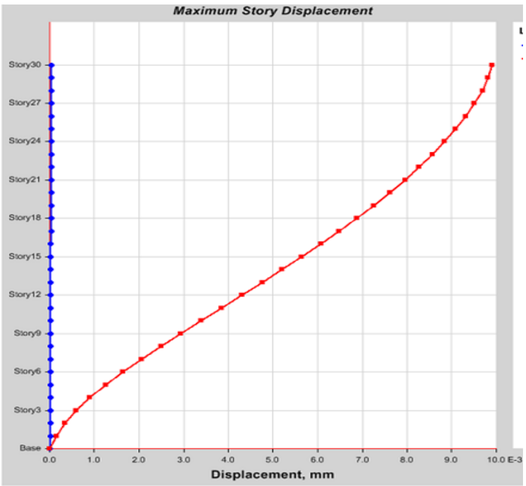

Chart-2. Storey displacement for outrigger at 10,20,30 storeys with V type

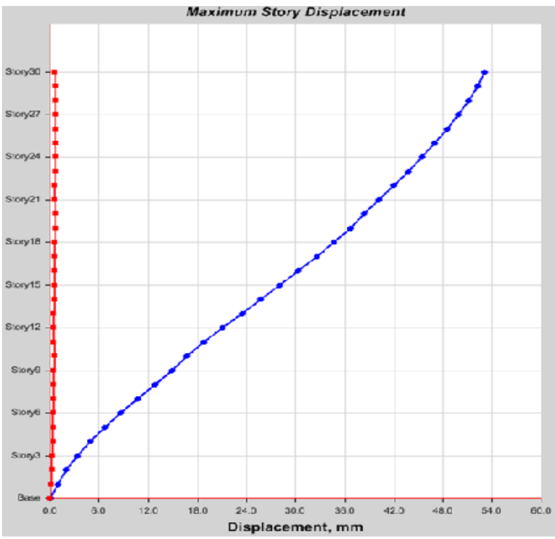

Chart-3. Storey displacement for outrigger at 10,20,30 storeys with eccen forward type

Chart-1, Chart-2 and Chart-3 represent the maximum storey displacements for outriggers located at 10, 20, 30 storeys with X type, V type and eccen forward type bracings. The trend of lateral displacements is observed to be increases as the storey height increases.

3. CONCLUSIONS

Based on the study carried out in the work, the following conclusions were made:

- The performance of different outrigger systems are analyzed in a 30 storied building.
- The optimum position of the outrigger at various levels are analyzed.
- The outrigger structural system for tall building substantially increases stiffness and stability against lateral loads.
- The outriggers located at 10,20,30 storeys is better than the other two models.

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