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A REVIEW ON DYNAMIC BEHAVIOUR OF RC STRUCTURE WITH LOAD TRANSFER PLATE

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Abstract*— With the rapid growth of population and due to high land value, high rise building are constructed at an increasing rate. The building which has car parking or commercial area at lower level and apartment and office area at upper level often lead to situation where different grid arrangement in the same building this requires the use of transfer system such as transfer plate, transfer beam or transfer girder. Transfer floor is a floor system which supports a vertical as well as lateral load resisting system and transfer it's loading to different underneath system. Transfer floor distribute the load from closely spaced column to column with long span. In the present study an attempt has been made to study the various research papers related to transfer plate. Also, the paper introducing behaviour of high rise building with transfer plate system under wind and seismic loading have been studied

***Keywords*— Transfer plate, Structural behaviour, Seismic, Wind, Software, Finite element**

I. INTRODUCTION

When considering present situation of the country, the land become a scare resource. So every bit of land is very important and it is used for some important purpose. Thus, high rise apartment buildings are in demand[1]. Lower floors are conventionally used as parking zone, shopping malls, assembly halls or open spaces for different functional requirements, while higher floors accommodate apartments, offices or hotel rooms. Such diversity in architectural functional demands forces the vertical structural elements, such as columns, walls and cores, within podium floors not to be vertically aligned with those belonging to the tower floors. This, in turn, leads to the need for utilizing structural transfer system to transmit the heavy loads from towers vertical structural elements to podium vertical structural elements[2]. Different structural transfer system are used for this purpose but one of these transfer system that are recently becoming common and sometimes even inevitable in modern building developments is the transfer plate system. The transfer floor is commonly used in multi storey building and they are major structural elements carrying number of floors. Normally the entire building 10 to 15 floor is carried by transfer slab. Transfer plate is usually very large and heavy in weight, sometime it is quiet difficult and time-consuming to construct. The depth of transfer plate is commonly defined under a preliminary estimation under engineering judgment, structure efficiency of the transfer plate stills not fully utilized in normal. Transfer plate is generally provided at set back level. A substantial portion of the world, including many highly populated urban cities in coastal areas, can be classified as regions of moderate seismicity but subjected to strong wind. High-rise buildings in these regions, for example, Hong Kong, Singapore, Bangkok, South Korea, Australia, and New York, are often designed without seismic resistance provisions. Rather, they are designed for combinations of very strong wind and gravity loads, which is thought to be able to resist low to moderate seismic excitation. But effect of wind loading and earthquake loading is different so that sometimes it is necessary to consider earthquake loading specially for high seismicity region.

Fig 1.Delhi one Building at Delhi

Fig 2. Residential Buildings in West Kowloon near Olympic Station

II. LITERATURE REVIEW

Many buildings are constructed with vertical irregularities. In this situation transfer floor is provided between these two column arrangements. A drawback of the transfer floor is the sudden change in the building's lateral stiffness.
Yoshimura M.,[5]concluded that the sudden change in lateral stiffness at transfer floor level create a weak storey mechanism and violates design concept of strong column weak beam.
Yong L., Tassios T.P., Zhang G.F., and Vintzileou E.,[6] recommended that if irregularity is not consider during analysis, then this irregularity become major source of building damage during strong earthquake.
Y.M. Abdlebasset[7] concluded that irregularity in upper stories would have a little effect on the floor displacements while irregularity in lower stories would have a significant effect on a floor displacement along building height.

1) **P. S. Lande, Parikshit Takale, "Analysis of High Rise Building with Transfer Floor",International Research Journal of Engineering and Technology, May-2018**
Prof. P. S. Lande, parikshit takle[3]studied a seismic behavior of high rise building with transfer floor. The model was analyzed using structural software for building analysis ETABS 2016 software. The building had the floor plan of 28 m x 48 m and the building plan was selected biaxially symmetric to eliminate torsional effect. Transfer slab with 1m thickness was provided. Numbers of proto type model of high rise building were analyzed using linear response spectrum analysis. Five different model of 10 storey building had studied by providing a transfer slab at different floor level such as first floor, second floor, third floor, fourth floor and fifth floor of the building.

Fig 3. Transfer slab at 4th floor

From this study they concluded that increase in storey shear in x and y direction is observed in building with lowest transfer slab located at 10% of total height of building. Storey moment is more for transfer slab provided at higher level. From storey displacement graph they concluded that every building has flexural mode up to transfer floor level and then displacement goes on increase above the transfer level. Transfer slab provided at 20-30% of the total height of building from its foundation is better than having it in a higher location.

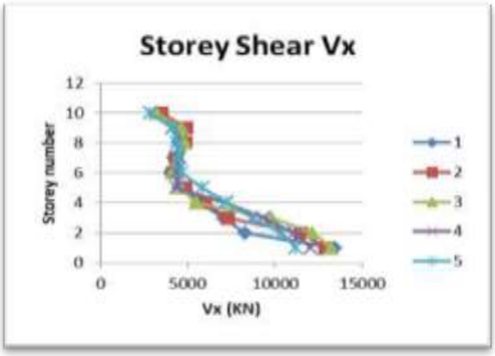

Figure 4. Storey shear distribution in X direction

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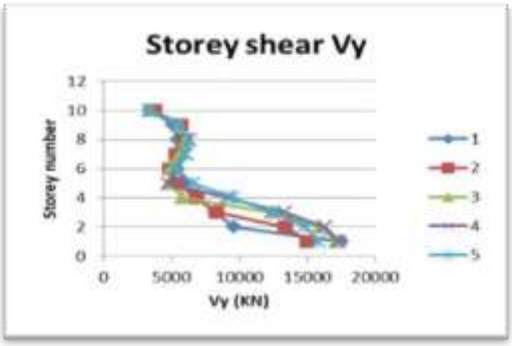

Figure 5. Storey shear distribution in Y direction

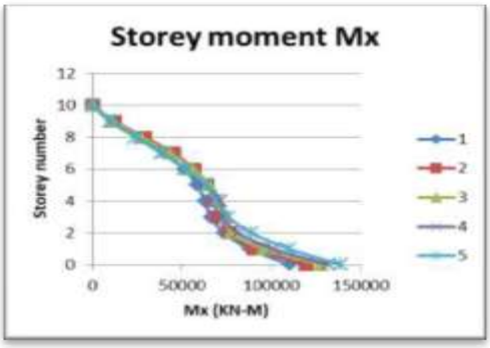

Figure 6. Storey moment distribution in X direction

Figure 7. Storey moment distribution in Y direction

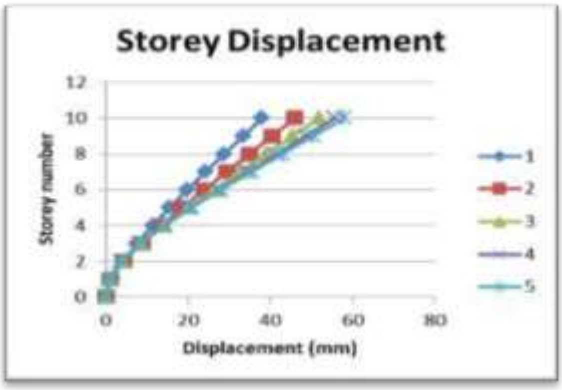

Figure 8. Storey displacement

2) S. S. Balasuriya, K. M. K. Bandara, S. D. Ekanayake, M. T. R. Jayasinghe, "The Influence of Trans1fer Plates on the Lateral Behaviour of Apartment Buildings",The Institution of Engineers, Sri Lanka,2007

S. S. Balasuriya, K. M. K. Bandara, S. D. Ekanayake, M. T. R. Jayasinghe[1] described the behavior of transfer plate which was used in tall building under wind which induced acceleration. The analysis was done based on a finite element model in SAP 2000. The model having parking layout and apartment layout. In this software three model was created,

first model A having a coarse mesh in the transfer plate, second model B having a finer mesh and third model C was created with only same apartment no parking was provided. So model C have not transfer plate. Case study of 30 storey apartment building having transfer plate of thickness 1m was used as transfer member and concrete grade of M40 was used in the model.

When comparing model A and model C they concluded that the transfer plate is effective because it reduce lateral deflection. Lateral deflection of transfer plate is zero. Acceleration also reduce due to outrigger action of thick plate. When transfer plate is provided the apartment structure behave effectively because it is supported on a rigid foundation at the level of transfer plate. There was no major difference between finer mesh and coarse mesh but advantage of finer mesh will be with accuracy of the force and moment in transfer plate.

3) Xiangming Zhou, Y L Xu, "Multi-hazard performance assessment of a transfer-plate high-rise building", EARTHQUAKE ENGINEERING AND ENGINEERING VIBRATION, December, 2007

Xiangming Zhou, Y L Xu[4] studied in this paper structural performance of a 35 storey transfer plate high rise building located in a typical region of moderate seismicity and subjected to strong wind. Various design wind code were used for wind analysis. Equivalent static load analysis(ESLA), response spectrum analysis(RSA), pushover analysis(POA), linear and non linear time history analysis(LTHA and NTHA) were used for the seismic performance of building when subjected to frequent earthquake, design based earthquake(DBE) and maximum credible earthquake(MCE). The effect of design wind and seismic action with common 50 year return period were also compared. The transfer plate high rise building was modelled by ETABS nonlinear version for elastic and inelastic responses under various seismic and non seismic load combinations.

From this study they concluded that under wind load lateral story drift and inter story drift ratio are larger in y direction compare to x direction. Under frequent earthquake with a 50 year return period the ESLA normally result in larger deformation while LTHA has least. The building satisfies the seismic performance objective specified in GB 50011-2001 in terms of deformation while inter story drift could not satisfied above transfer plate. Under design base earthquake with 475 year return period the building meets the performance objective of FEMA 273 in terms of inter story drift ratio. Under maximum credible earthquake with 2500 year return period the POA result in greater top drift than NTHA. The building fulfils the performance required of GB 50011-2001 and FEMA in terms of inter storey drift ratio.THA is most appropriate seismic assessment method. While NTHA is time consuming. So application of NTHA is very limited.

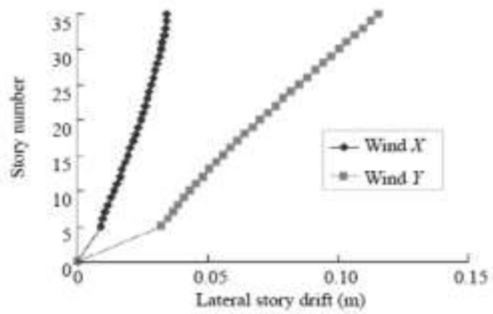

Figure 9. Deflection distribution of the building under wind

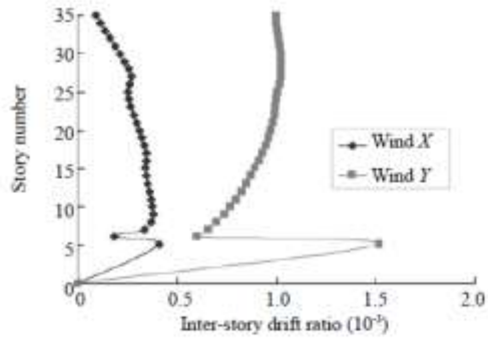

Figure 10. Deflection distribution of the building under wind

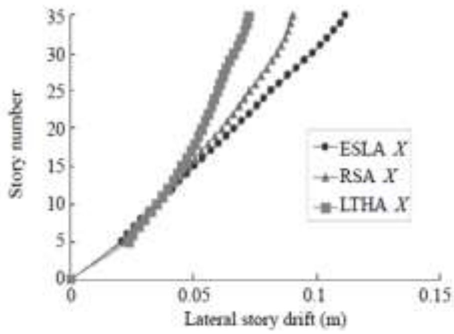

Figure 11. Later story drift in the X-direction under frequent earthquakes

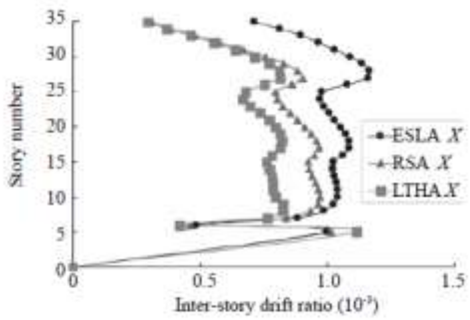

Figure 12. Inter-story drift ratio under frequent earthquakes

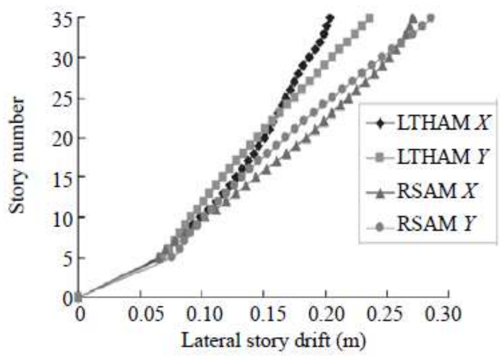

Figure 13. Later story drift under DBE

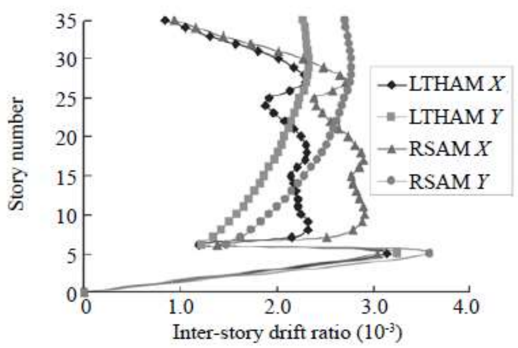

Figure 14. Inter-story drift ratio under DBE

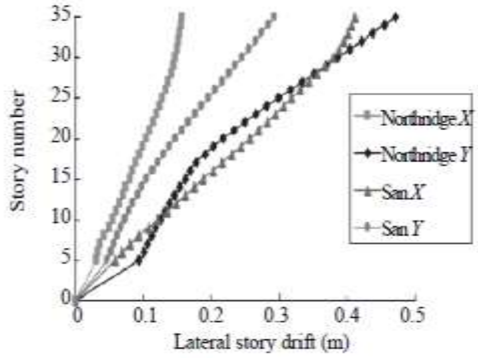

Figure 15 Later story drift under MCE

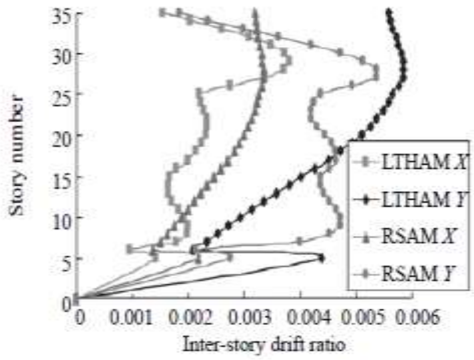

Figure 16. Inter-story drift ratio under MCE

III. CONCLUSION

- Architectural requirement may result in a variable configuration for the vertical structural elements between the stories of building so that transfer floor is provided for conveying vertical and lateral loads between upper and lower stories.
- Structure with transfer plate is effective than structure without transfer plate because it will reduce lateral deflection.
- Transfer plate is provided at lower level as possible because when transfer plate is provided at higher level it will increase base shear so transfer system is located at 10% height of total building.
- Buildings without transfer plates perform better against earthquakes due to the regularity of its mass distribution as against that of buildings with transfer plates.
- The buildings with transfer plates can perform better under wind because it will reduce acceleration and it will provide outrigger behavior.

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