



High-Rise Buildings with Transfer Floors: Drift Calculations

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Summary

In many high-rise buildings, architectural requirements may result in a variable configuration for the vertical structural elements between the stories of the building. To accommodate such vertical elements' discontinuity, a "transfer" floor conveying vertical and lateral loads between upper and lower stories must be introduced. A drawback of the transfer floor is the sudden change in the building's lateral stiffness at its level: the structure becomes susceptible to the formation of a soft-story mechanism under moderate to severe earthquakes. These buildings generally showed conventional elastic behaviour for frequent earthquake but suffer extensive crack in the vicinity of transfer floors for rare earthquake. However, for design purposes current numerical modeling of high-rise building adopts reduced stiffness for the vertical elements for strength analysis and full stiffness for serviceability and drift analysis: a tradition that needs to be verified. A 3-D numerical model is built-up for a high-rise building with such vertical irregularities and analyzed using elastic response spectrum and nonlinear time-history analysis techniques. The effect of transfer floors on the buildings' drift is investigated where judgment for adopting a full or reduced stiffness for the vertical elements is scrutinized.

Keywords: drift, response spectrum, stiffness, seismic loads, time history, transfer floor.

1. Introduction

Recently, innovative architectural design merged with the advanced and powerful structural numerical analysis stimulated a new generation of "super-tall" and "mega-tall" buildings. Furthermore, discontinued vertical elements (columns and shear walls) within high-rise buildings are no more considered as a sin. Consequently, architectural demands for high-rise buildings in which columns may have different arrangement in a certain level(s) become familiar. Many high-rise buildings are currently constructed with this kind of vertical irregularity where "transfer" floors are provided to account for the discontinuous vertical element (columns and/or shear walls) in order to accommodate the functions (Figures 1 and 2).

Transfer floor is the floor system supporting the vertical and lateral load resisting elements and transfer their straining actions to a different underneath system. Different structural systems could be used for such buildings as the resisting system below the transfer floor may be moment-resisting frames and/or core walls while the floors above may be supported by structural walls. The transfer structures could be in form of transfer girders or slabs.



Fig. 1: High-rise building with a transfer slab.