Accidental torsion due to overturning in nominally symmetric structures isolated with the FPS

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Abstract

Overturning of a structure causes variations in the normal loads of the isolators supporting that structure. For frictional isolators, such variation leads to changes in the frictional forces developed and, hence, in the strength distribution in plan. For frictional pendulum system (FPS) isolators, it also causes changes in the pendular action, i.e. in the stiffness distribution of the isolation interface. Therefore, although the structure is nominally symmetric it develops lateral–torsional coupling when it is subjected to two horizontal components of ground motion. This coupling is denoted herein as accidental torsion due to overturning, and its effect in the earthquake response of nominally symmetric structures is evaluated. Several parameters are identified to control this coupling, but the most important are the slenderness of the structure and the aspect ratio of the building plan. Results are presented in terms of the torsional amplification of the deformations of the isolation base and the interstorey deformations of the superstructure. The FPS system is modelled accurately by including true large deformations and the potential uplift and impact of the isolators. Impulsive as well as subduction-type ground motions are considered in the analysis, but results show small differences between them. An upper bound for the mean-plus-one standard deviation values of the torsional amplifications for the base due to this accidental torsion is 5%. This implies that for design purposes of the isolation system such increase in deformations could probably be neglected. However, the same amplification for the interstorey deformations may be as large as 50%, depending on the torsional stiffness and slenderness of the superstructure, and should be considered in design. In general, such amplification of deformations decreases for torsionally stiffer structures and smaller height-to-base aspect ratios.