

Influence of Vertical Floor Accelerations on the Seismic Performance of Building Non-Structural Elements

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Abstract. Based on recent events, the structural engineering community has developed awareness that damage to building non-structural elements (NSEs) and contents can dominate losses incurred in frequent to moderately-large earthquakes in regions with modern building codes. In reality, all ground shaking is spatial or multi-directional; however, the vertical component of shaking is not understood to be a significant source of damage and can generally be accommodated by the structural gravity system. In contrast, acceleration-sensitive NSEs are sensitive to both horizontal and vertical accelerations. Nonetheless, the influence of vertical shaking on NSE damage is difficult to quantify, and it has not yet been the focus of much research.

The NEES TIPS/E-Defense test program on innovative isolation systems conducted in 2011 provided a first hand opportunity to observe and systematically evaluate the influence of vertical shaking on NSEs. The vertical structural acceleration demands and the correlation of NSE damage states to both horizontal and vertical shaking intensity during NEES TIPS/E-Defense were carefully evaluated. Several examples of NSE damage and failure states were attributed specifically to vertical shaking. Other evidence, in reconnaissance observations, experimental and analytical studies, can be found to corroborate the notion that some types of NSE damage are caused by vertical shaking. The ongoing large scale NHERI TallWood shake table experiment provides another opportunity to observe and quantify 2D versus 3D shaking demands and associated damage states to a varied class of NSEs, and evaluate next steps to advance practice.