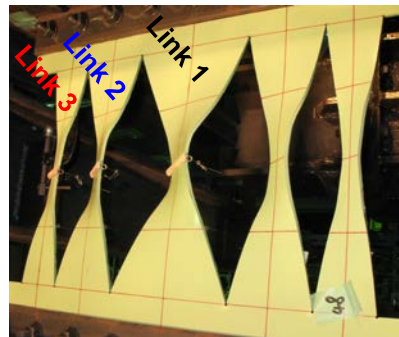
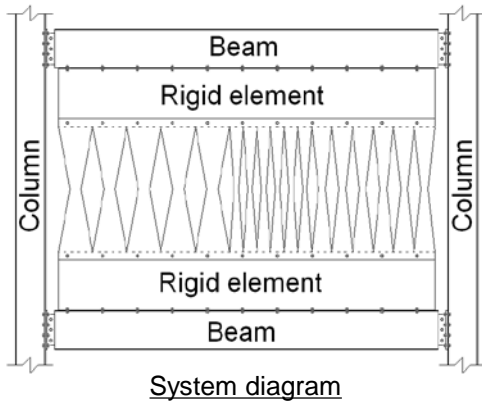


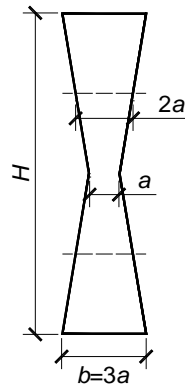
# Dual functional steel plate shear walls with X-shaped links

**Background:** Seismic application of structural health monitoring (SHM) to built structures are yet limited only to the most critical structures. Meanwhile, passive energy dissipation devices have gained popularity to improve seismic performance. If a certain device can function as SHM in addition to its own function of energy dissipation, the scope of applications can be significantly broadened.

**Methodology:** The steel plate shear wall with X-shaped links is considered as a potential device which can incorporate SHM. X-shaped links are adopted as they have a large out-of-plane tilting suitable for visual inspection. Another merit of X-shaped links is their fracture-free behavior, due to the large plasticity occurred at quarter height section instead of at link ends. The dual functions of energy dissipation and condition assessment are verified through a series of experimental tests.



A plate with X-shaped links of three different widths



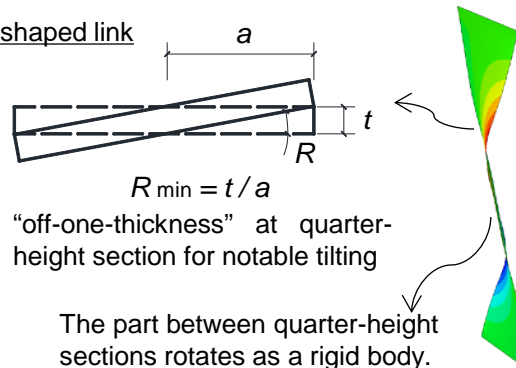
Width-thickness ratio:  $\lambda = 2a / t$

Aspect ratio:  $\beta = H / 2a$

Buckling is primarily controlled by width-thickness ratio, while little influenced by aspect ratio.

The wide link buckles earlier and the narrow link buckles latter. By identifying the narrowest link to buckle one could assess the peak drift ratio experienced.

An X-shaped link

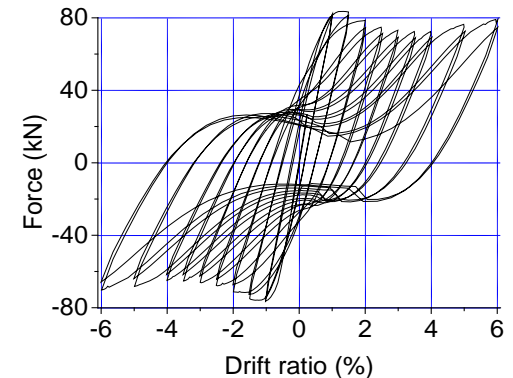
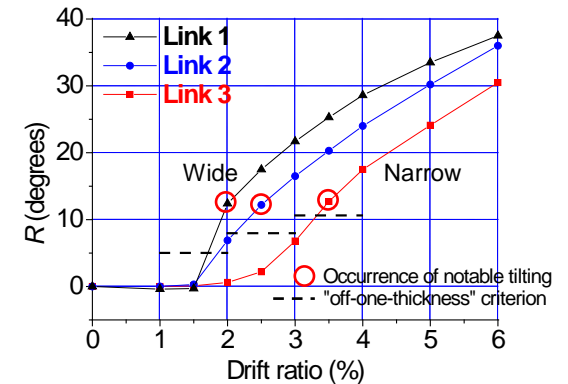


$$R_{\min} = t/a$$

"off-one-thickness" at quarter-height section for notable tilting

The part between quarter-height sections rotates as a rigid body.

Criterion of notable tilting



Angle of rotation and hysteresis

**Conclusion:** Under shear deformation, the X-shaped links buckle and tilt notably, which enables quick post-earthquake condition assessment through visual inspection. The buckling is mainly controlled by the width-thickness ratio, while little affected by the aspect ratio. Wide links buckle at smaller drift ratio and narrow links buckle at larger drift ratio. This enables a quick estimation of the peak drift ratio experienced by the story. By combining X-shaped links with different widths into one steel plate shear wall, the dual functions of energy dissipation and structural condition assessment can be achieved.