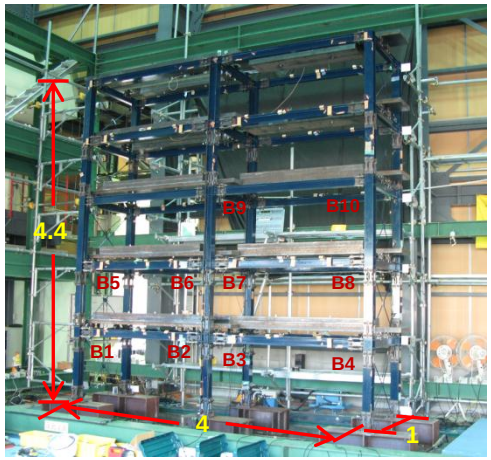
Piezoelectric sensing-based local damage detection for steel frame buildings

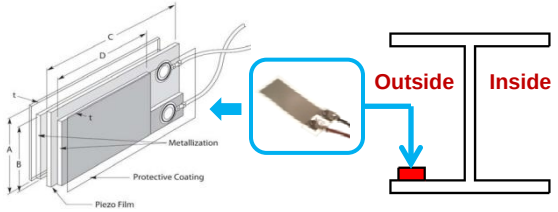
Background: Local damage in structural elements are difficult to detect by visual inspection due to building finishing, while the damage may exert critical influences on the normal operation of buildings. However, conventional structural health monitoring system based on floor acceleration responses is not necessarily capable of identifying the location and degree of local damage.
Objective: This research tries to develop quick and effective seismic damage detection techniques that can quantitatively identify local damage in structural elements.
Methodology: The polyvinylidene fluoride (PVDF) piezo film is adopted as a dynamic strain sensor for detecting local damage in a 1/3.75-scale steel frame testbed constructed in the laboratory of DPRI. The PVDF film is characterized by high sensitivity, excellent flexibility, wide-range frequency, and direct bonding with structural surface.



1/3.75-scale steel frame (unit:m)

Column damage

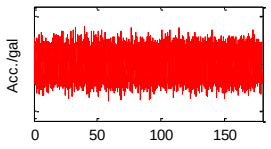
Beam damage



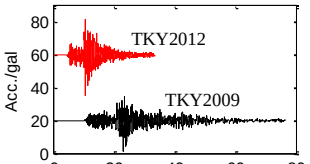
PVDF film attached to outside beam flange

Damage levels on beam

Level	Description
L1_i	Inside link of flange is removed
L1_o	Outside link of flange is removed
L2	All links on flange are removed
L3	All links on flange and web are removed

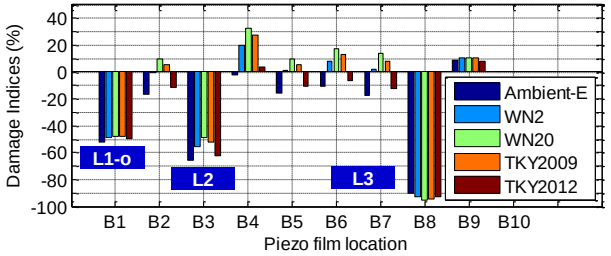


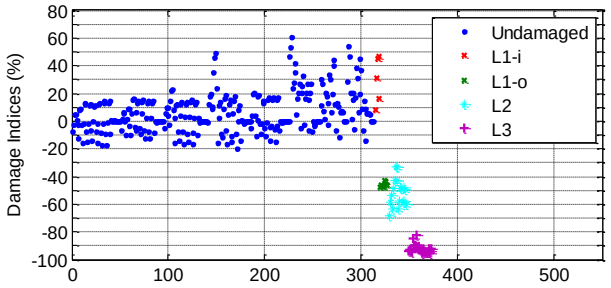
White noise: RMS=2gal, 20gal



Aftershock

Loading input for shaking table test





Level	Damage Indices (%)
L1_i	Non-detected
L1_o	30-70
L2	30-70
L3	>80

Conclusion: The normalized standard deviation of signals measured from piezo film sensors can be used as a damage index (damage-related feature) to detect the existence, location, and severity of local damage such as fractures at beam-to-column connections that are simulated in the steel frame testbed under small amplitude loadings including minor earthquakes and ambient excitations.