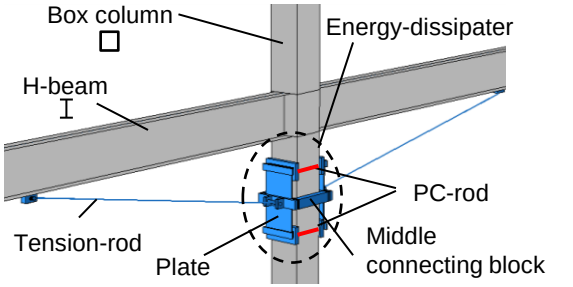
Development of resource-saving seismic rehabilitation using light steel members

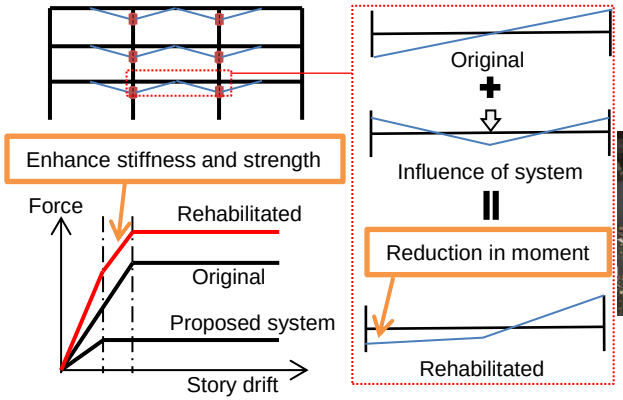
Background: Structurally-deficient steel frames require increasing their earthquake-resisting capacity. Current seismic rehabilitation techniques interrupt business and require their relocation. This increases the cost of rehabilitation projects significantly. In addition, installed systems often block users' view and influence building use plan.

Objectives: This research develops a tension-only bracing system for resource-saving seismic rehabilitation. The proposed system satisfies the following design requirements: (1) to reduce the tensile strains at critical sections such as the bottom flanges of beams near beam-column connections; (2) to increase the initial stiffness and strength of the original frames, and their energy-dissipation capacity; (3) to install the system without the need for welding and to occupy only the upper part of openings so as to keep visibility.

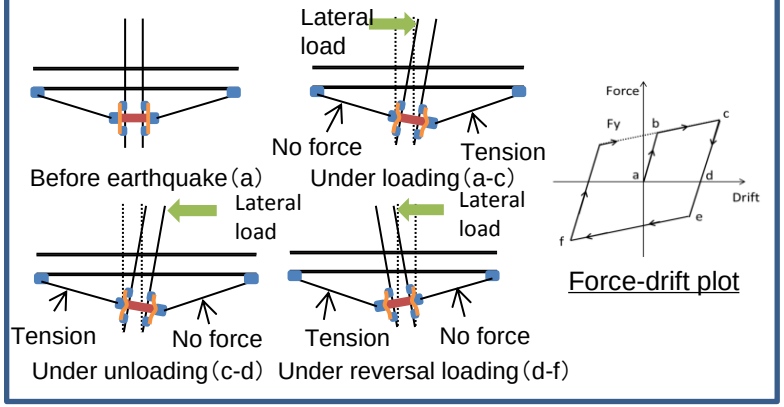
Methodology: Two levels of tests, a component test and a system application test, where conducted. The results were compared to FEM analysis. A design method aiming at the reduction of beam bending moment is developed and the efficiency of the system in real-scale frame will be examined in future test.



Scheme of proposed system



Mechanism of energy-dissipation by bending plates

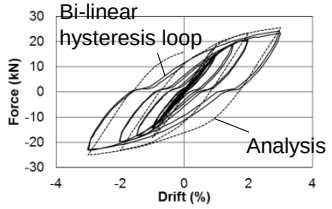


Force-drift plot

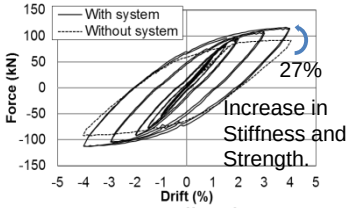
Component test, ½ scaled

System application test, ½ scaled

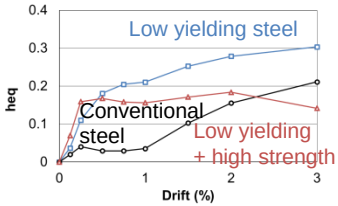
Two plates behaving similarly



Component test



System application test



Energy-dissipation

Conclusion: Through the experiment and numerical study, the expected bi-linear hysteresis loop was obtained. The high energy-dissipation capacity was achieved starting from small deformation by the use of the low yielding point steel. In the system application test, the initial stiffness and strength were enhanced by 30% for a cruciform beam-column connection and the reduction of tension strains at the bottom flange of the beam were 12%.