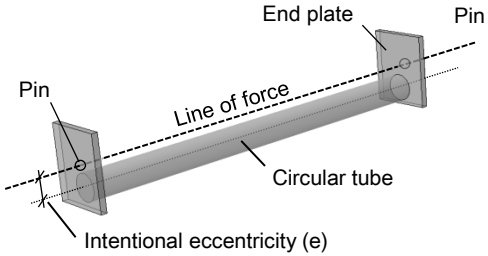
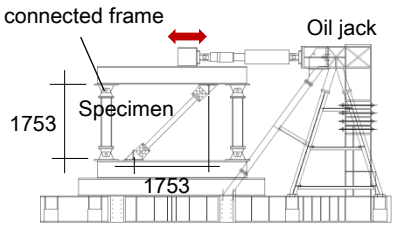
Development and Experimental Investigation of Brace with Intentional Eccentricity

Background: Conventional buckling braces (CBBs) are the most commonly used steel braces but appear some weaknesses. (1) Large stiffness is provided together with the strength demand which increases the base shear and acceleration in structures; (2) Very limited post-yielding stiffness is provided which increases rapidly the inelastic deformation beyond the brace yielding; (3) Intense local mid-length buckling occurs that leads to unstable energy dissipation and early fracture. This research proposes a new steel brace scenarios, named Brace with Intentional Eccentricity (BIE), aiming to overcome the aforementioned deficiencies and improve further the seismic performance of steel braced frames. The BIE is installed with intentional eccentricity along the member's length and deforms with a novel mechanism.
Methodology: BIE specimens manufactured by circular steel tube were subjected to cyclic loading up to high story drifts. Eccentricity of 60mm was applied using end plate connections. The behavior of BIE was compared with that of a CBB having the same cross-section.

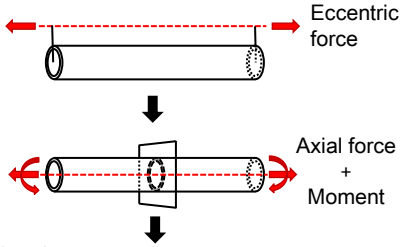


Configuration of BIE



Loading system

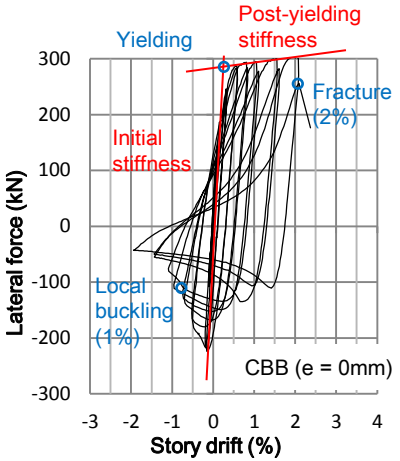
External force acting on BIE

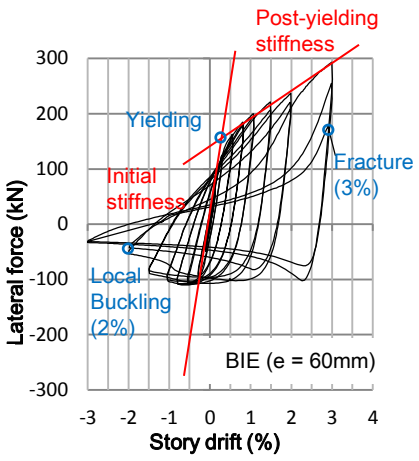



CBB (e = 0mm)

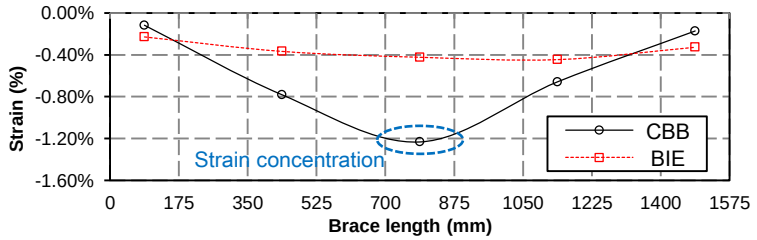

BIE (e = 60mm)

Deformation shape in compression (1.5% story drift)





Hysteresis loop of CBB and BIE



Strain distribution along the brace length (0.5% story drift)

Conclusion: Owing to the eccentrically applied axial force, BIE undergo overall bending from small story drifts and display tri-linear behavior under tension. Compared with the CBB, the BIE appeared: (1) 54% reduced initial stiffness and identical maximum tensile strength; (2) Larger post-yielding stiffness of almost 18% of the initial stiffness; (3) Enhanced ductility due to the appreciable delay of the occurrence of local buckling and fracture. The inherent moment in BIE distributes more uniformly the stresses along the brace length, thus delaying the strain concentration.