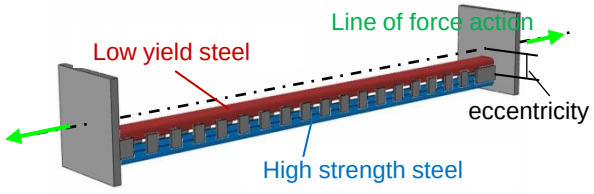
Development and Experimental Investigation of Naturally Buckling Steel Braces

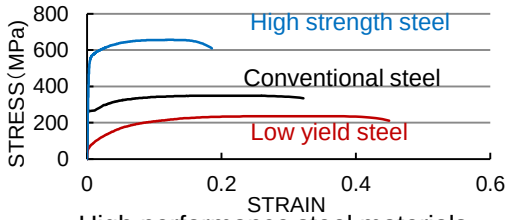
Background: Steel braced frame systems, including conventional buckling braced (CBB) and buckling restrained braced (BRB) frames, have been nowadays widely used as seismic resisting systems. However, the braced frames have inherent deficiencies limiting their seismic capability, such as providing no energy dissipation at small drift level, providing extremely small post-yield stiffness which would potentially cause the soft-story problem, and damage concentration due to local buckling of cross section in the CBBs which leads to early failure of the brace members and low ductility.

Objective: This research proposes an innovative design of braces, termed herein Naturally Buckling Braces (NBBs), to avoid the deficiencies mentioned above and to further promote the seismic capability and reliability of the steel braced frame.

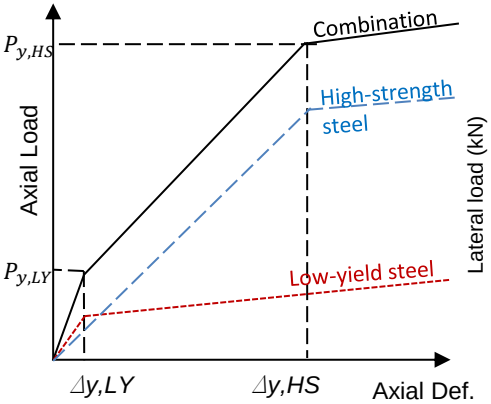
Methodology: The design combines the use of high-strength and low-yield steels with an intended initial eccentricity along the brace length. A number of NBB component tests were conducted to examine the design and hysteretic performance of NBBs.



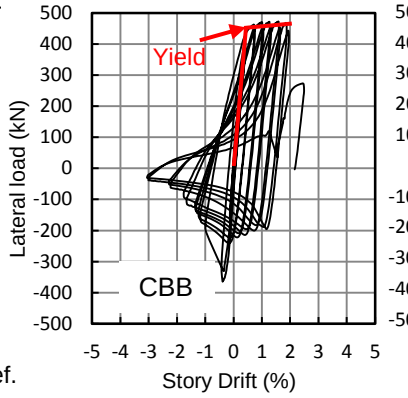
Configuration of NBB

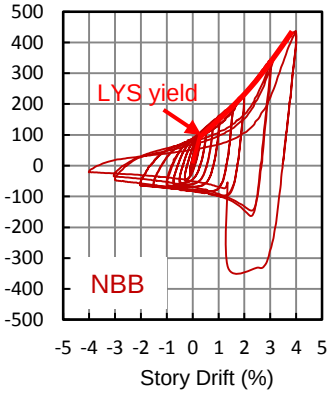


High performance steel materials

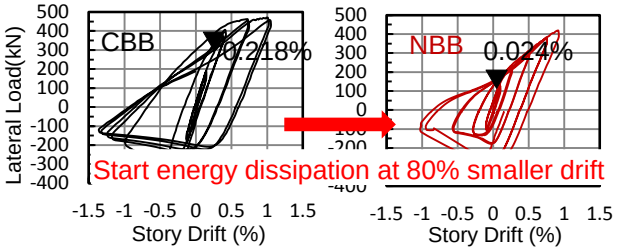


Combined system response of NBB



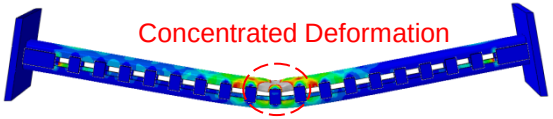


Comparison of post-yield stiffness



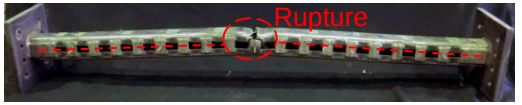
Comparison of yield drift

NBB in compression (2% story drift)



CBB in compression (2% story drift)

NBB (4% story drift)



CBB (2% story drift)

Conclusion: 1) With the proposed design configuration combining multiple high performance steels with appropriate initial eccentricity, NBBs enabled to achieve great ductility and provide considerable energy dissipation; 2) NBBs started providing hysteretic damping at drifts 80% smaller than those of CBBs; 3) NBBs provided significantly larger post-yield stiffness compared to the counterpart of the CBB; 4) NBBs effectively prevented strain concentration and early rupture at mid-span of the brace .