5th World Congress on Civil, Structural, and Environmental Engineering (CSEE'20)
~~Lisbon, Portugal~~ Virtual Conference – October 2020
Paper No. ICSECT 117
DOI: 10.11159/icsect20.117

Superelastic Cyclic Properties of Cu-Al-Mn and Ni-Ti Shape Memory Alloys for Seismic Mitigation

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Abstract - Shape memory alloys (SMAs) have been getting much attention by many researchers in a variety of application areas due to their unique properties of superelasticity (SE) and shape memory effect (SME). They have the ability to recover large inelastic deformations upon heating (SME) and stress removal (SE). In recent years, structural engineers have been dealing with these smart materials to incorporate into civil engineering applications such as rebar in the reinforcement of concrete structures, repairing, retrofitting, base isolation system, dampers for vibrational control, etc. To overcome and mitigate the possible seismic risk of the structure under consideration, understanding the material characteristics of SMAs under various loading conditions is one of the critical steps. In this study, the mechanical properties of two popular SE SMAs, i.e. copper-aluminum-manganese (Cu-Al-Mn) and nickel-titanium (Ni-Ti), were investigated in detail. Moreover, the mechanical properties of the conventional rebar steel were also identified for comparison purposes. Room temperature monotonic and incremental cyclic tests were applied on dog-bone shaped Steel, Cu-Al-Mn and Ni-Ti tensile coupon specimens the obtain and compare their mechanical characteristics. The results showed that Cu-Al-Mn and Ni-Ti materials exhibited a significant re-centering ability upon unloading with negligible and comparable residual deformations whereas the Steel experienced higher permanent plastic deformations with almost 3% recovery at the same amount of deformation. In addition, the decrease in the amount of dissipated energy for Cu-Al-Mn and Ni-Ti for consecutive cyclic motion is much less than conventional steel. Test results were also evaluated in terms of cyclic performance of materials, residual strain, recovery capacity, dissipated energy and equivalent viscous damping. Experimental outcomes highlighted the potential usage of SMAs in seismic applications and supply basis information for continued research.

***Keywords*:** Shape memory alloys; Material testing; Cyclic tensile behavior; Seismic recovery; Residual deformation.