Rocking frame reinforced with superelastic Nickel-Titanium shape memory alloy

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Conventional seismic design systems rely on the inelastic behaviour of certain members to dissipate the seismic energy. This research takes a deeper look into retrofitting steel structures using the rocking structures method. This is an innovative technique where the designer is allowing for the structure to rock back and forth with the seismic loading, taking advantage of the weakening of the structure. Rocking columns reduce the strength of the structure causing it to yield sooner, thus reducing the maximum structural accelerations. However, though the maximum acceleration due to ground excitations is reduced, the rocking increases the inter-storey displacements. Shape Memory Alloys (SMA) has been attracting researchers from different fields, it is a unique class of alloy with the ability to undergo large deformations (up to 8%) and return to its original shape through stress removal. The main objective of this research is to investigate the effectiveness and feasibility of active techniques for seismic retrofitting of steel braced frames using the rocking structures combined with pseudoelastic (PE) nickel-titanium (Ni-Ti) SMA wires. To observe the behaviour of the retrofitted steel braced frame a free vibration test to determine the natural frequency of the system and a cyclic test were performed to demonstrate the effects of a rocking structure with PE Ni-Ti SMA wires to dissipate and recenter the structure when subject to an earthquake. The use of the rocking columns combined with the shape memory alloys proposed in this research not only controls where the damage occurs but limits it to be very insignificant, where no structural elements would need replacing. Results from the free vibrations test suggest that the stiffness of the system is dependent on the rigidity of the column-foundation connection than the rigidity of the cross bracing. The in-plane cyclic tests found that the Ni-Ti wires have significant pseudoelastic properties that had almost zero residual strain at 4% drift and the potential for moderate energy dissipation. Findings of this research are expected to add valuable knowledge to the field of seismic retrofitting of RC structures and widen the potential applications of the SMA in the structural engineering field.

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