EXPERIMENTAL INVESTIGATION OF CONCRETE COLUMNS WRAPPED WITH SHAPE MEMORY ALLOY SPIRALS

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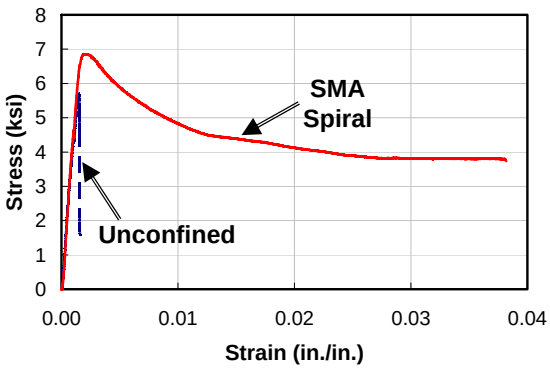
ABSTRACT:

This experimental work focuses on enhancing the seismic performance of reinforced concrete (RC) bridge piers by using innovative active confinement technique. Steel jackets and fiber composite wraps are currently being used to provide extra passive confinement for RC bridge columns in order to enhance their ductility and shear capacities. Although the passive confinement approach has been widely accepted and used, research has shown that better results could be obtained by applying external confining pressure on the concrete element; a technique that has been widely known as active confinement. Previous attempts to apply active confinement on bridge piers using conventional materials had failed due to several problems related to the method of applying the confining pressure. The approach proposed in this paper is based on using spirals made of Shape Memory Alloys (SMAs) to provide the active confining pressure. In this study, experiments are conducted to assess the cyclic behavior of reinforced concrete columns retrofitted with external prestressed SMA spirals. Three 10in diameter-6ft long columns are tested under quasi-static cyclic loading. One of the columns is wrapped with prestressed SMA spirals, while another column is wrapped with glass fiber reinforced polymer (GFRP) wraps. The third column is tested in the unretrofitted condition for comparison. The recovery stress of the SMAs is utilized to apply the prestressing force in the spirals, which, in turn applies large active confining pressure on the column. The active confinement pressure provided by the SMA spirals and the passive confinement pressure provided by the GFRP wraps are chosen to be the same for comparison. Post-tensioned strands are used to apply axial compression on the tested columns. The three columns are tested under displacement-controlled cyclic loading, which is applied at the tip of the column. The columns force versus drift results show a significant increase in the load-carrying capacity, energy dissipation, and residual stiffness of the column that is actively confined with SMA spirals compared to the unretrofitted and GFRP wrapped columns. This enhancement in the column's cyclic behavior is primarily attributed to the superior effect of active confinement in increasing the concrete strength and ultimate strain compared to passive confinement.



Uniaxial stress-strain results from a test conducted on concrete cylinders wrapped with 0.08in-dia. SMA spiral.