Defense Announcement

Strengthening Reinforced Concrete Members Using Iron-Based Shape Memory Alloys

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Location: Zoom, meeting ID: 922 0440 8346
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Maintaining the sustainability and integrity of existing structures constantly subjected to severe environments is an important aspect, where deterioration and strength deficiencies of members could lead to sudden and unpredictable failures. Addressing such issues requires the use and development of new technologies and sustainable systems which can effectively extend the lifespan of deteriorated structures. An increased interest have taken place in the use of so-called 'active strengthening' techniques. Such techniques apply initial stresses on the members upon installation which allows early engagement of the system without requiring further deformations. The presented research work aimed to study the feasibility of using iron-based shape memory alloys (Fe-SMA) as an active strengthening system for existing reinforced concrete (RC) structures.

The phenomenon known as the shape memory effect allows shape memory alloys to return to a predefined shape upon heating. Therefore, this phenomenon has been used for prestressing applications such as active strengthening of members. This research study focused on strengthening of shear deficient RC beams and confinement of RC columns due to the brittle failure mechanisms of these structures. Investigating such a novel technique relies on experimental testing to better understand the behavior and failure mechanisms. The experimental program presented in this dissertation involved material testing to identify the thermo-mechanical properties of the Fe-SMA, and testing small-scale and full-scale RC beams strengthened in shear and RC columns confined using Fe-SMA strips to understand the effect of this technique on the behavior of such members. Several parameters were investigated for each part of the experimental program.

The experimental results showed successful improvement of the shear behavior of the beams and the axial compressive behavior of the columns. The effect of the initial prestressing was captured from the results, where the shear cracking of the beams was delayed and occurred at higher load stages, in addition to the increase in shear strength attributed to the effective strengthening system. Moreover, it was also evident that the initial confinement applied on the columns allowed early engagement of the strengthening system in containing the crushed concrete, and resulted in significantly improved post peak behaviors as well as higher ultimate axial stresses and strains. An analytical model was developed based on the experimental results involving the shear strengthening of RC beams which included the shear contribution of the Fe-SMA strips and captured the effect of the initial vertical prestressing. Finally, the full proposed model conservatively predicted the shear strength of the beams compared to the experimental results.