Defense Announcement

Rehabilitation and strengthening of reinforced concrete columns with iron-based shape memory alloys

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Location: Zoom **Meeting ID:** 988 3225 6261 **PIN:** Please email dfvieira@uh.edu

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The demand for rehabilitation and strengthening of deteriorating concrete structures has promoted the evolution of applications of smart materials. Smart material such as Shape Memory Alloys (SMA) have been used as solution methods to tackle such concerns, as a more efficient and durable form of strengthening method when compared to traditional methods. However, the research carried on this material for structural applications is still in its early stages. Therefore, it is imperative that systematic studies on the structural application of this material are continued to be carried out.

In strengthening applications, such as confinement of concrete columns, the property of the SMA known as shape memory effect (SME) allows the application of an initial active confining pressure. Such technique does not require expansion to occur for the confining system to engage, hence it can delay the generation of cracks in the concrete element and increase the deformation capability and load capacity.

The research work done in this dissertation focus on the use of iron-based shape memory alloys (Fe-SMA) for strengthening and rehabilitations of existing reinforced concrete (RC) columns, by taking advantage of the material's unique SME property for initial confining pressure. The main objective of this study is to evaluate the responses of full-scale circular RC columns externally confined with Fe-SMA subjected to concentric axial loading, while assessing the variables that influence the enhancement in the load-deformation behavior and mode of failure. The results obtained of the experimental tests showed significant improvement on the columns' axial compressive behavior, which indicates the feasibility of using such confinement system for strengthening of larger scale members. The initial active confinement applied on the columns, generated an early engagement of the external SMA reinforcement, and delayed the contribution of the internal transverse steel reinforcement in restraining lateral deformations. Moreover, the technique also showed to be efficient in rehabilitating damaged columns and in containing the crushing of the concrete core in the post-peak region. The results showed that the use of the technique can produce almost the same load carrying capacity as an undamaged strengthened column. In addition, numerical models were also developed to predict the responses of the strengthened and rehabilitated columns, using an empirical based approach and a finite element implementation. For both cases, the predictions were validated with the experimental results, and showed to be accurate in generating the load-axial deformation responses obtained in the experimental test. Finally, a parametric study was conducted using the finite element model to evaluate the influence of different parameters and scenarios not included in the experimental program on the overall behavior of the SMA confined columns.