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Strengthening concrete structures using shape memory alloy

Shape Memory Alloy (SMA) has been attracting the researchers from different fields due to their superior properties. SMA is categorized as smart material with unique class of alloy for its ability to undergo large deformation as well as energy dissipation capacities while maintaining a superelastic response and returning to its original shape through stress removal (Super Elasticity) used for new construction or through heating (Shape Memory Effect "SME") used for strengthening applications. This presentation focuses on the use of SMA with the SME characteristics. The SME represents the ability of the SMA to recover its original shape after being deformed beyond the elastic limits through heating. The strain recovered in this transformation process can be utilized for prestressing applications. Therefore, by having the pre-strained SMA reinforcement (bars or strips) attached to the Reinforced Concrete (RC) members and then applying heat above the activation temperature the SMA will recover the inelastic strain and thus a presressing force will be developed in the RC member. In other words, the pre-strained SMA itself can be used as the supplementing prestressed reinforcement in flexural strengthening of RC beams/slabs by eliminating the use of specialized equipment such as hydraulic jacks. Another strengthening application is confining RC columns using SMA wires. This confinement technique relies on the recovery stress generated as the SMA wire transforms to its recovery (un-deformed) state. The confinement methodology simply involves wrapping a pre-strained SMA wire along the perimeter of the column. Then, heating the wire using an electrical current above a predefined transformation temperature would trigger the SME of the SMA that allows the wire to return to its original state while a reactive force is created by the wires producing an active confinement pressure. Findings from many researchers added a valuable knowledge to the field of strengthening RC structures and widened the potential applications of the SMA in the structural engineering field.

Speaker Biography

Raafat El-Hacha is a Professor of Structural Engineering at the University of Calgary in the Department of Civil Engineering. His pioneer research has been recognized as pushing the boundary of knowledge in using innovative and smart advanced materials for strengthening existing structures and for new construction, such as fibre reinforced polymers (FRP), shape memory alloy, and ultra-high performance concrete for hybrid structural systems in bridge applications and other structures. He published over 220 journal and conference papers, co-authored 3 refereed design guidelines. Supervised and graduated 42 PhD and MSc students. Served as guest editor for 3 journals and edited/co-edited 8 conference proceedings. He is a Fellow of the International Institute for FRP in Construction (IIFC) and the Canadian Society of Civil Engineers (CSCE). He is the recipient of several awards and fellowships including the CSCE Casimir Gzowski Gold Medal, CSCE Excellence in Innovation in Civil Engineering Award, IIFC President's Award, Killam Professorship Award, Erasmus Mundus International Fellowship (twice) and many others for his outstanding academic and professional achievements.

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