Proceedings of the 12th International Conference on Civil Structural and Transportation Engineering (ICCSTE 2027)
June, 2027 | Paris, France
DOI: 10.11159/iccste27.002

Shape Memory Alloys in Concrete Structures: From Self-Centring Behaviour to a Buildable Connection

Maged A. Youssef, Ph.D., P.Eng.
Professor, Department of Civil and Environmental Engineering
Western University, London, Ontario, Canada
youssef@uwo.ca

Abstract

Superelastic shape memory alloys (SMAs) recover large strains on unloading, offering reinforced concrete structures something conventional steel cannot — the ability to return to plumb after a design-level earthquake.

Two decades of analytical and experimental work have now established this behaviour across elements and systems: beams, beam-column joints, shear walls, core walls, precast diaphragm connectors, and modular steel frames using SMA bolts. The evidence consistently shows substantial reductions in residual drift, with implications for post-earthquake functionality and repair cost that go well beyond conventional life-safety design.

Adoption, however, has remained limited. The barriers are not behavioural but practical: material cost, the difficulty of anchoring and splicing SMA bars, the absence of design provisions, and the constructability penalties that follow from treating SMA as a direct substitute for steel reinforcement.

This keynote traces that research trajectory and then turns to the connection problem as the decisive obstacle.

It presents a mechanical rebar coupler that combines a collapsible chamber with a replaceable solid core, confines SMA to the plastic hinge region as a modular fuse, eliminates on-site welding, and permits post-event replacement of the dissipating element. The talk discusses experimental validation, finite element modelling, and the current commercialization pathway, along with what remains to be resolved before self-centring systems can enter design codes.