Develop smart adaptable reinforced concrete slabs using iron based shape memory alloy

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In current design practice, structures are designed as passive structures. That is, they are designed to support the anticipated loads throughout their lifespan. This means, until the structure experiences the anticipated load, there is excess capacity. Smart structures are adaptive structures which have the ability to understand their condition or surroundings and react to changes in a beneficial manner using a sophisticated system of sensors, controllers and actuators. Compared to passive structures, smart structures are able to increase their capacity only when required, creating more efficient structures. Smart structures require a material that can change as required and shape memory alloy (SMA) is a potential candidate for this application. SMA has the ability to recover relatively large strains by either heating it (known as shape memory effect) or by releasing it after it's been loaded (known as pseudoelasticity). Originally discovered as a nickel-titanium (Ni-Ti) alloy in 1962; however, the special characteristics of SMA have recently been found in iron based alloys (Fe-SMA), which have significantly lower manufacturing costs than Ni-Ti making them suitable for the relatively larger structures prevalent in civil engineering. This research proposes to develop a smart concrete (RC) slab reinforced using SMA. The significance of smart slabs are that engineers can design more efficient and resilient structures. Currently, an inherent defect of RC slabs is their tendency to crack. Although it is possible to design RC structures that do not crack either with increased materials, material strength or by current prestressing techniques, this is highly impractical and results severely over designed structures. With smart slabs, the smart force can counteract loading throughout its lifespan and it would be possible to add smart force on demand before the concrete cracks. Uncracked concrete prevents moisture from contacting the internal reinforcement and is significantly more resilient to bending. The result could be more durable structures, less maintenance and strengthening and reduced need for expensive prestressing or strengthening operations potentially saving billions that would otherwise be used to repair or maintain the structure.

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