Concrete structures strengthening by iron-based shape memory alloys: an experimental demonstration

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Abstract

Shape memory alloys (SMAs) have the special property of returning to their initial shape if they are deformed and then heated. This effect is called shape memory effect. Iron-based SMAs (Fe-SMAs) show promising properties with regard to potential applications in civil engineering. The costs of Fe-SMAs can compete with other strengthening methods. In this paper an investigation is presented, where ribbed Fe-SMA bars were produced and used for strengthening and prestressing of real scale RC beams. RC beams strengthened by Fe-SMA or normal steel bars embedded in a shotcrete layer were experimentally examined to investigate their flexural behavior and to demonstrate the application of this strengthening method. The behavior of the beams at serviceability stage was significantly improved by the prestressed Fe-SMA bars. The results show that the application of Fe-SMA bars embedded in a newly applied shotcrete layer was successful.

Keywords: iron based shape memory alloy (Fe-SMA), ribbed Fe-SMA bars, shotcrete strengthening, RC structures, and prestressing

1 Introduction

Many existing concrete structures must be strengthened due to aging or adapting to increase their load capacity. Additionally, wide-span and slender load-bearing structures are increasingly more demanded in the field of civil engineering. A popular strengthening technique currently is the application of fiber reinforced polymer (FRP) strips or fabrics by means of epoxy adhesives on a concrete surface [1]. A popular strengthening technique currently is the application of fiber reinforced polymer (FRP) strips or fabrics, as 'strengthening elements', by means of epoxy adhesives on a concrete surface. In addition to the application of 'strengthening elements' on the surface, another technique exists, where the 'strengthening elements' are inserted and glued into grooves in the concrete cover, which is called near-surface mounted (NSM) strengthening technique. This method, which is more used for negative bending-moment strengthening, requires cutting grooves in the concrete cover, and no surface preparation work is needed afterwards. The advantages that are associated with NSM strengthening compared to the externally bonded technique are its ability to significantly reduce the probability of harm that results from corrosion, fire, acts of vandalism, mechanical damage, and aging effects. Furthermore, better bonding behavior due to a confining effect in the grooves can be expected. A third strengthening method is shotcreting which is more used for positive bending-moment strengthening or for walls

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