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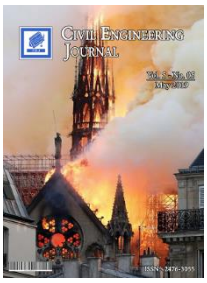

Serviceability Assessment of Continuous Beams Strengthened by SMA Strands under Cyclic Loading

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Abstract

Since the wide cracks or large deflections can have a significant effect on the appearance of concrete elements and may cause some uncommon behavior, therefore, serviceability of concrete structures requires investigation. The main objective of this paper is to study experimentally the serviceability of continuous reinforced concrete (RC) beams strengthened by Ni-Ti strands. In addition, some building code provisions were used to calculate crack width and deflection. The current study presents the experimental results to verify the accuracy of building codes' provisions for continuous RC beams strengthened by SMA strands. Although a pattern of smaller width cracks was monitored for strengthened beams, more than 50% of the crack widths were recovered because of super elastic SMA strands. The performance of crack width provisions illustrates an overestimated crack width for SMA RC beams. Moreover, the predicted values for immediate deflections based on building codes provided a good agreement, although the effective reinforcement ratio (steel reinforcement and SMA strands) had a significant effect on immediate deflections of reinforced concrete beams strengthened by SMA strands under service loads.

Keywords: Serviceability; Continuous Beam; Cyclic Loads; Strengthening by Nitinol Strands; Building Codes.

1. Introduction

Nowadays, concrete structures are one of the favorable alternatives in the construction industry and they are considered to satisfy the main criteria of limit states. Well-detailed and properly-erected structures designed by the limit state method will have acceptable probabilities that they will not reach a limit state, will not become unfit for their purpose by collapse and buckling (ultimate limit states), deformation and cracking (serviceability limit states), and therefore, the structure will be durable under environmental conditions over its design life. Some researchers have studied the serviceability requirements, crack width and deflection. Ramos et al. developed and validated a finite element model to study the static and dynamic behavior of a reinforced concrete beam during cracking. A nonlinear behavior was expected at the loading cycle because of cracking. However, upon secondary analysis, when it was loaded again up to the same level, the concrete behaved linearly and so it did not suffer more degradation [1]. Allam et al. investigated building codes formulas and different effective factors for crack width calculations in RC flexural members. Standard codes provisions predicted various values, while Egyptian code underestimated crack width, especially in sections with low reinforcement ratio [2]. Desayi and Ganesan considered a concrete member with a reinforcement bar under tension loading and proposed a new method to calculate crack width. The proposed equation overestimated crack width by 5.1%, while the BS8110 provision underestimated crack width by 18.3% [3]. Rakoczy and Deak theoretically

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