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Strain monitoring on pre-stressed CFRP laminates through computer vision

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1 Abstract

Strengthening reinforced concrete (RC) members with Carbon Fiber Reinforced Polymer (CFRP) solutions is currently a widespread technique. The success in increasing the strength and/or in controlling the deformation of structural members using CFRPs has been recognized worldwide, and most relevant aspects have been thoroughly studied and published. For large-span beams and slabs, the method is much more effective if pre-stressed CFRP laminates are adopted. Therefore, onsite measurements of the applied strain state, as well as of its evolution with time due to pre-stress losses, are mandatory to ensure a correct operation and to monitor the time-dependent behavior. Presently, the former is assessed only indirectly, through load control when pre-stress is applied, and the latter simply is not conducted since there is no budget to comply with.

In this paper a first step of a vision-based method to measure the strain level in CFRP laminates during the strengthening operations, as well as during periodic inspections later on, is presented. The method uses computer vision and was applied and validated in computational simulations. The results achieved allowed to establish the limits of validation of the algorithms developed and implemented. The contactless method proposed will represent a major added value for the already widespread technique of reinforcement of RC members with pre-stressed CFRP laminates.

Keywords: computer vision; CFRP laminates; strengthening RC; strain monitoring.

2 Introduction

The reinforcement interventions that use the pre-stressed CFRP laminates are mostly performed without effective control of the tension installed in the laminates, when applying the pre-stress. In the reinforcement design project, after computing the pre-stress to be installed, the corresponding stress and strain to be applied in the laminates is estimated to reach that pre-stress level. For onsite applications, the stress is usually applied through hydraulic jacks, controlling the applied force. A load cell is sometimes used as a control. In special reinforcement works and/or in scientific research, also deflectometers and/or strain gauges glued to the laminates are used, which allow to obtain a direct measurement of the strain during onsite applications or laboratorial tests. Regarding the

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