# A discrete crack approach for the study of concrete beams with externally bonded pre-stressed CFRP reinforcement

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Several research studies and applications along the years have provided important contributions for a better understanding of bond behaviour between concrete and a composite material, such as CFRP. The search for the optimization of the use of the composite can be seen as a consequence of those advances. In this paper, the use of prestressed FRP is studied. This technique presents the advantages of better crack control and decreased deformation. The behaviour of concrete beams reinforced with pre-stressed CFRP is analysed by using the finite element method. Several nonlinear material models are defined, considering the following situations: i) concrete under compression; ii) concrete under tension; iii) steel reinforced bars; iv) interface between the concrete and the steel reinforced bars; v) interface between the concrete and the pre-stressed CFRP. Simple elasto-plastic models are adopted for describing the behaviour of both concrete under compression and steel reinforced bars. Cracking in concrete is numerically simulated using the discrete crack approach, based on Non-Linear Fracture Mechanics, in which the Discrete Strong Discontinuity Approach (DSDA) is used. In this case the fictitious cracks are embedded within the finite elements. For the interface between the concrete and the steel reinforced bars a bond-slip relationship is adopted based on the Model Code 1990. The behaviour of the interface between the concrete and the pre-stressed CFRP is modelled by means of the mode-II fracture law presented in [1]. Considering the non-linearity of the behaviour of concrete beams reinforced with pre-stressed CFRP, the Non-Iterative Energy based Method (NIEM) is used to overcome convergence difficulties occurring with traditional iterative methods. The behaviour of the anchorage zone, and its importance is also analysed. The aim of the present study is to contribute for a better understanding of the behaviour of this type of technique.

[1] P. Neto, J. Alfaiate, J.R. Almeida and E.B. Pires, Comput. Struc., 82, 1495 (2004).