Steel beams strengthened with prestressed CFRP laminate: is there a need for laminate prestressing?

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**ABSTRACT:** Strengthening structural members using Carbon Fiber Reinforced Polymer (CFRP) laminate is an effective method to increase their strength. Prestressing the CRFP laminate prior to attaching them to a steel beam can delay the common premature debonding, which is the predominant failure mode when loading such composite elements in flexure. Following a previously published experimental investigation, this paper presents the results of a finite element simulation of steel I-beams strengthened with bonded and mechanically anchored prestressed CFRP laminate subjected to flexural loading. The numerical analysis adopts a Cohesive Zone Model (CZM) technique to simulate the separation between the CFRP laminate and the steel beam in order to model the debonding failure mode. The accuracy of the finite element model is verified by comparing its results to those of the previously published experimental investigation, which was carried out on steel I-beams strengthened with prestressed CFRP laminate in different configurations. The numerical model is then used to evaluate the effect of changing the level of the prestressing force on the strengthened beams performance. It is found that the CFRP prestressing enhances the yield and ultimate load carrying capacity of the beams and delays the typical premature debonding failure up to a certain level of laminate prestressing.