Performance of steel beams strengthened with prestressed CFRP laminate

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ABSTRACT: Prestressed Carbon Fibre Reinforced Polymer (CFRP) system is generally used for strengthening reinforced concrete beams where CFRP laminate can improve both the strength and serviceability behaviour of reinforced concrete beams via increasing the overall member stiffness. However, the applicability of this technique to strengthening steel structures is still lagging behind its application to concrete structures. In this study, the flexural behaviour of steel I-beams strengthened with prestressed CFRP laminate using a mechanical anchorage system is experimentally investigated. A total of nine steel beams subjected to flexural loading are tested in various conditions to evaluate the effectiveness of the proposed strengthening system. The experimental investigation confirmed that CFRP prestressing increases the ultimate load of the strengthened steel beams and moderately delays the premature debonding failure of the CFRP laminate. Even with low level of CFRP prestressing, significant enhancement in the ultimate load of the strengthened beam was recorded. Beams strengthened using non-prestressed CFRP laminate mainly failed due to premature debonding of the laminate with a slight increase in the failure load. Mechanical end anchorages maintain the CFRP laminate prestress after releasing the jacking force without encountering any debonding of the CFRP laminate till final failure of the strengthened steel beam. The results of the experimental programme and its outcomes are presented and discussed.