

Analytical mechanics solution for measuring the deflection of strengthened RC beams using FRP plates

ABSTRACT

Partial-interaction due to sliding between the steel bars, adhesively attached FRP plates and their bordering concrete surface, accompanied with the detachment of the FRP plates due to intermediate crack (IC) debonding make the deflection of strengthened RC beams difficult to anticipate. Previous research and design rules on determining the deflection of strengthened RC beams using FRP plates have opted for a full-interaction moment-curvature design technique where the deflection was measured by either deriving average effective moment of inertia and using elastic deflection equations or integrating the curvature along the beam's length. Therefore, IC debonding of the plate and the slip resulting from the formation and broadening of new cracks were not directly considered. In this study, a partial-interaction moment-rotation analysis of an adhesively plated beam segment was used to derive analytical equations for the rotation of individual crack faces. The analytical expressions were used to compute the rotation at a crack for a given moment; subsequently, the influence of each crack to the midspan deflection of the RC beams was calculated. As for the uncracked region of the beam, the deflection contribution was measured by integrating the curvature over the uncracked span. The deflection results from the mechanics solution seem to compare well with experimental results. The analytical mechanics solution accounts for the partial-interaction between the steel bars, externally bonded FRP plate and their bordering concrete surface, and also the detachment of the external plate through IC debonding. Further, due to its generic nature and non-reliance on empirical data, the mechanics solution can be adopted to forecast the deflection of strengthened RC beams with novel types of reinforcement materials.

Keyword: FRP strengthened beams; Intermediate crack debonding; Partial-interaction; Moment-rotation; Analytical solutions; Serviceability deflection