

Elasto-damage fatigue modeling of RC beams strengthened by CFRP

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Abstract

The repair of understrengthened or damaged reinforced concrete (RC) members by external plate bonding of carbon fiber reinforced plastics (CFRP) laminates or plates is becoming increasingly popular in the construction industry. Prominent modes of failure in strengthened RC beams reported in literature are concrete crushing in compression, CFRP plate rupturing in tension and peeling of the CFRP plate due to high interfacial shear and peeling stresses at the plate cut-off point.

In this study the fatigue behavior of RC beams strengthened by CFRP is modeled using continuum damage mechanics. Modeling of the overall system of strengthened RC beams requires individual modeling of the components that ultimately leads to failure i.e., concrete, CFRP and concrete-CFRP interface.

Component elasto-damage constitutive models are developed for concrete subjected to monotonic multiaxial and cyclic uniaxial tensile loading and concrete-CFRP interface subjected to monotonic and cyclic shear and peeling stresses using the data available in literature or derived during the course of the study.

Concrete-CFRP interface is characterized experimentally by testing reinforced concrete blocks in shear and peeling, and the static and fatigue behavior of strengthened RC beams with or without end anchorages is investigated by testing strengthened RC beams in flexure.

Numerical models are implemented in FORTRAN codes EDMON3D, EDMON3DS and EDCYC3D to predict the static and fatigue behavior of concrete, CFRP, concrete-CFRP interface and strengthened RC beams. Predictions are in good agreement with the experimental results available in literature or derived during the course of the study.