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Predicting Bond Behavior of HB FRP Strengthened Concrete Structures Subjected to Different Confining Effects

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Abstract: This paper presents an analytical model to predict the bond behavior of hybrid bonded (HB) fiber reinforced polymer (FRP) strengthened concrete structures considering different confining effects. The bond strength of HB-strengthened concrete structures subjected to uniaxial loading is attributed to the friction-type bond from steel plate and the chemical bond provided by epoxy-based resin. The friction-type bond is assumed to develop before any interfacial slip occurs, and remain constant when the interfacial slip is nonzero; for the chemical bond between FRP and concrete, a tri-linear bond-slip relation is adopted. The loading process of HB-strengthened structures consists of three stages, and the stage-wise solution to slip, bond stress, and axial force of HB FRP are derived based on a governing ordinary differential equation (ODE). In this study, the experimental program includes twelve HB-strengthened concrete specimens, using different confining effects (twisting moments on the steel bolts). Test results indicated that the ultimate pullout strength increases and the failure mode switches from debonding to FRP rupture as the twisting moment increases. Moreover, by comparison to three series of experimental results, the proposed model can precisely predict failure mode, ultimate strength, load-slip relation and bond stress distribution. The twisting moment on bolts is found to have the most significant improvement on the ultimate tensile strength. Finally, the critical twisting moment without yielding FRP rupture is derived.

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