UHPC-PINN-parallel micro element system for the local bond stress-slip model subjected to monotonic loading

ABSTRACT

The bond stress between Ultra-High-Performance Concrete (UHPC) and steel bars is an essential issue in designing reinforced UHPC structures. Although, to date, considerable studies have been directed on the Local Bond Stress-Slip (LBSS) relationship, not enough progress has been achieved in the parametric investigation of the Parallel Micro Element System (PMES) on the LBSS relationship at the steel bar-UHPC interface. Therefore, the presented research applied the two-parameter Weibull Cumulative Distribution Function (WCDF) and conducted a series of monotonic pullout tests on 144 specimens considering the most influential parameters on the LBSS, such as concrete cover (c), UHPC compressive strength (f'_{UHPC}), steel bar diameter (d_b), and bond length (l_b). The Finite Element Method (FEM), ABAQUS, calibrated the experimental results to provide a reliable database. The Genetic Algorithm (GA) and the Physics-Informed Neural Network (PINN) were adopted to solve the inverse problem of this research, predict the results, and check the accuracy of the PMES. It can be concluded that PINN's application, compared to GA, leads to more precise results. Observing the specimens R16C1L2F155 and R18C1L3F155, for instance, PINN provided more consistent values for the friction coefficient (β) [0.2549, 0.8165] and the LBSS relationship stiffness (G) [453.1250, 249.9757], while GA failed to acquire not only β and G but also the hyper-parameters of (a) $[\ 0.3016, 0.3088]$ and $(m)[0.3035, 0.3635]$, respectively. This research developed the application of GA and PINN to solve an inverse problem in structural engineering.