

Research on Numerical Simulation of Microscopic Damage Evolution of Steel Wire for Cable of Bridge Under the Coupling of Corrosion and Fatigue

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Abstract: In order to explore the failure mechanism of high-strength steel wire for cable of bridge under the coupling interactions of environment corrosion and fatigue load, a numerical simulation method for microscopic damage evolution and failure process for steel wire of bridge cable is proposed in this paper. Firstly, based on pitting accelerated crack nucleation mechanism and continuum damage mechanics theory, fatigue damage model and corrosion-fatigue damage model for steel wire were established, and an algorithm of user-defined material subroutine (UMAT) based on Fortran language and commercial finite element software- ABAQUS was written to describe the above two models. And then, In numerical analysis software- MATLAB, by using of three- dimensional cellular automata technique, the shape and position of random initial pitting defects on the surface of steel wire could be obtained, then the above initial point defect data were input into AUTOCAD, RHINO, ABAQUS software in turn to produce a finite element model of pre-corroded steel wire with initial damage. Finally, according to the birth and death element method and adaptive modeling technology, the fatigue damage evolution process and corrosion-fatigue damage evolution process of steel wire were simulated, and the fatigue life and corrosion-fatigue coupling life of pre-corroded steel wire were studied. At the same time, the effects of the number of pitting pits, stress level and corrosion degree on the corrosion fatigue life of steel wire were studied by using the proposed simulation method. The results show that the proposed strategy and algorithm can be used to effectively predict the fatigue life of pre-corroded steel wire, and the simulated results are in good agreement with the experimental data from the literature, while in the coupling interaction of corrosion and fatigue load, the error between the simulated results and the experimental data will increase with the decrease of stress range due to the difference of the initial defect morphology.

Keywords: continuum damage mechanics, damage evolution, pre-corroded steel wire, the coupling interaction of corrosion and fatigue