Fatigue life evaluation model for high-strength steel wire considering different levels of corrosion

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Abstract

Corrosion of steel wires is one of the most severe causes in the deterioration of cables for cable-supported bridges. This paper studies the quantitative influences of corrosion on the fatigue life of high-strength steel wires, considering a wide variation in the degree of corrosion. First, the multi-parameter Weibull model for corrosion-stress-life (C-S-N) proposed by the authors of this paper is introduced briefly, and the Goodman relation is employed to deal with the dependences of stress ranges on positive stress ratios for tension-tension fatigue. Fatigue data for high-strength steel wires are collected from the literature for three groups with different ultimate tensile strengths and the degree of corrosion ranging from 0.18% to 18.67%. This data is then used to estimate the parameters of the Weibull model; subsequently, quantitative influences of corrosion on fatigue life for steel wires with a wide range in the degree of corrosion are illustrate and discussed in detail. The results indicate that the influence of ultimate tensile strengths on fatigue life for corroded high-strength steel wire can be ignored, because corrosion causes crack nucleation more quickly, especially at lower stress ranges. The fatigue life decreases more quickly with the increase in the corrosion, and reduction on fatigue life caused by corrosion is more pronounced under a lower stress range, which indicates that the fatigue life is more sensitive to corrosion at lower stress ranges. Negative correlation of fatigue life and corrosion increases as the stress range decreases, which further confirms that corrosion has a higher influence at lower stress ranges. The proposed Weibull model for C-S-N can provide quantitative evaluation of the survival probability of high-strength steel wires, defined in terms of their fatigue life, considering a wide range in the degree of corrosion; these results can be used by engineering designers to ensure the safety for cable-supported bridges during their lifetime.

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