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Prediction of fatigue crack initiation lives at elongated notch roots

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The notch sensitivity factor *q* used to quantify the influence of notches on fatigue strength has been associated with tiny non-propagating cracks at their roots, but the *q* plots used in practice are based on semi-empirical simplistic estimates which do not recognize such cracks. By modeling the influence of the notch tip stress gradient on the fatigue propagation of mechanically short cracks, it is shown that those traditional *q* plots are only applicable to semicircular notches, since elongated semi-elliptical slits, on the other hand, can have very different *q* values which depend on the notch shape, not only on its tip radius. These predictions are supported by a comprehensive experimental investigation where the fatigue crack re-initiation lives after drilling a hole at the tip of deep pre-cracks on modified SE(T) specimens, to force them to behave like an elongated notch, were carefully measured. Moreover, such results support the use of notch sensitivity modified fatigue stress concentration factors K_f instead of the classical linear elastic stress concentration factor K_t in Neuber's rule when using εN procedures to model the crack initiation process, providing the notch sensitivity is properly calculated as proposed in this work.

Keywords: notch sensitivity, short cracks, fatigue life prediction, non-propagating cracks, fatigue resistance of notched materials

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