# NOTCH SENSITIVITY IN ENVIRONMENTALLY ASSISTED CRACKING (EAC): TEST METHODOLOGY

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Semi-empirical notch sensitivity factors $q$ have been used for a long time to quantify notch effects in fatigue design. The notch sensitivity has been associated with the generation of non-propagating short cracks at the notch tips in fatigue tests when $S_L(R)/K_t < \sigma_n < S_L(R)/K_f$, where $S_L(R)$ is the fatigue limit of the material measured at a given $R = \sigma_{min}/\sigma_{max}$ ratio; $K_t = \sigma_{max}/\sigma_n$ is the stress concentration factor (SCF) of the notch; $\sigma_n$ is the amplitude of the nominal stress that loads it; $\sigma_{max}$ is the maximum stress at the notch tip; and $K_f = 1 + q(K_t - 1)$ is the (effective) fatigue SCF, which quantifies the actual notch effect on the fatigue strength of the notched component. This old concept has been recently modeled using sound mechanical principles to properly quantify the influence of the stress gradient around the notch tip on the fatigue behavior of such non-propagating short cracks. This model predictions have been validated by proper tests, and based on this experimental evidence a criterion to accept tolerable short cracks has been proposed.

The mechanical principles used to develop this criterion are extended to account for notch effects in environmentally assisted cracking problems. The chemical effects are quantified by the material resistance to EAC cracking, $S_{EAC}$, and by its crack propagation threshold under EAC conditions, $K_{IEAC}$, both measured in the aggressive environment in question by standard procedures. Like in the fatigue case, this model predicts the existence of a notch sensitivity $q_{EAC}$ in EAC problems as well, when $S_{EAC}/K_t < \sigma_{max} < S_{EAC}/[1 + q_{EAC}(Kt - 1)]$, which can be quantified by the same stress analysis techniques successfully used to quantify $q$ in fatigue.

The purpose of this work is to verify the possible influence of the testing specimen geometry on the experimental results used to verify the behavior of notched components under EAC conditions. This precaution is necessary to avoid possible misinterpretations of the experimental results obtained with such specimens. First two simplified methodologies are used to calculate $q_{EAC}$ values from the basic EAC materials strength, $S_{EAC}$ and $K_{IEAC}$. These simplified models are based on Creager and Paris and on Inglis approximations for the notch stress concentration factors. The results of such simple estimates are compared with more elaborated stress analyses made using Finite Element techniques, applied to detailed numerical models which consider all the characteristics of the notch geometry and of the loading applied on four common standard test specimens. The notch sensitivity is not much affected by the specimen geometry, but the size of the non-propagating crack is. Moreover, although $q_{EAC}$ may be reasonably estimated by the simplified methodologies in the simpler specimens, the more elaborated numerical models are needed to evaluate the errors associated to them.

[1] Castro,JTP; Landim,RV; Leite,JCC; Meggiolaro,MA “Prediction of Notch Sensitivity Effects in Fatigue and EAC”, Fatigue and Fracture of Engineering Materials and Structures, in print, 2014.
[2] Castro,JTP; Leite,JCC “Does notch sensibility exist in environmentally assisted cracking (EAC)?”, Journal of Materials Research and Technology v.2, p.288-295, doi:10.1016/j.jmrt. 2013.02.010, 2013.