It is well recognized that crack length has significant effects on both the monotonic failure stress and cyclic threshold stress conditions. Existing experimental data indicates that LEFM predicts correctly the failure and threshold stresses only for relatively long cracks. For small/short cracks, the LEFM overestimates both the failure and threshold stresses. Usually, an argument has been made that LEFM is violated in terms of a crack length with respect to the crack-tip plastic zone that results in overestimating the failure stress for small cracks. On the other hand, the Kitagawa diagram has been used to experimentally illustrate the connection between the observed threshold stresses for very small cracks and predictions from LEFM analysis.

To understand the failure stress diagram for small/short cracks, we introduce a plasticity correction in calculation of the effective critical stress intensity factor (KC eff). Earlier analysis showed that Irwin’s correction of KC eff underestimates whereas the conventional Dugdale - Barenblatt yield-strip model overestimates the effects of the crack-tip plasticity on the failure stress for relatively small/short cracks. The rationale of a plasticity correction utilized in the failure stress diagram is extended to understand the Kitagawa diagram in terms of the observed threshold stress versus a crack size. This plasticity correction also explains the associated physics behind experimental observations in contrast to El Haddad’s phenomenological curve fitting approach. Both type of diagrams demonstrate an analogy which governs interrelation between stress, crack/defect size and fracture mechanics analysis. Using the existing data from the literature, the proposed analysis of small cracks effects is discussed with relevance to monotonic and cyclic loading conditions, under inert and corrosion environments.