Tutorial Session 39 – T73S03 (R5V4/5/7)
Definition and Relevance of C(t) and C*

Mentor Guide questions

(1.0) Define the creep fracture parameters C* and C(t) and explain their relevance

(1.1) State the contour integral definition of the creep fracture C(t), including suitable contours to employ in its evaluation.

(1.2) Draw a typical graph of C(t) versus time for: (a)primary loading only; (b)secondary loading only; (c)combined primary plus secondary loading.

(1.3) Describe algebraically, using the contour integral definition of J, why C(t) is not in general equal to dJ/dt.

(1.4) State the contour integral definition of the creep fracture parameter C*, and hence show that C* = dJ/dt. Discuss the implications of this for the possible contours to employ in a finite element calculation of C* and contrast with C(t).

(1.5) State the form of the crack tip stress and strain fields for power-law creeping materials in terms of C(t) (assuming a stationary crack and no plasticity).

(1.6) State the expression for C(t) in terms of J, and hence K, for sufficiently early times.

(2) A crack on plant has been present from fabrication but only incubates (i.e., starts to grow) after 10,000 hours service. It has K = 20 MPa√m and E = 160 GPa. Assuming no plasticity, no secondary stresses and purely secondary creep, evaluate C(t) assuming the short time expression is valid and that the material has a creep exponent of $n = 4$. If the creep crack growth law is $\frac{da}{dt} = A.C(t)^q$ with A = 0.221 and q = 0.891, where the units are MPa, metres and hours, find the initial rate of crack growth in mm/year.