Quasi-static test data analysis

This document describes the data analysis techniques used to produce the data for the quasi-static tests that is contained in this data set.

Force, displacement, and crack length

Force and displacement were measured by the fatigue machine. Crack length was determined from photographs taken during the test using a camera aimed at the side of the specimen.

Compliance

Compliance was determined by dividing displacement by force.

Strain energy release rate (SERR)

The file 'Series A Data.csv' gives three different SERR values, corresponding to the different methods presented in ASTM standard D5528-01

Modified beam theory (MBT)

$$G = \frac{3Pd}{2b\left(a + \Delta\right)}$$

Where *P* is the force, *d* is the displacement, *b* is the specimen width, *a* is the crack length and *Δ* is a crack length correction term found by extending a least squares fit of the cube root of the compliance ($C^{1/3}$) versus *a*.

Compliance Calibration (CC)

$$G = \frac{nPd}{2ba}$$

Where *n* is a calibration parameter, equal to the slope of log (C) versus log(a)

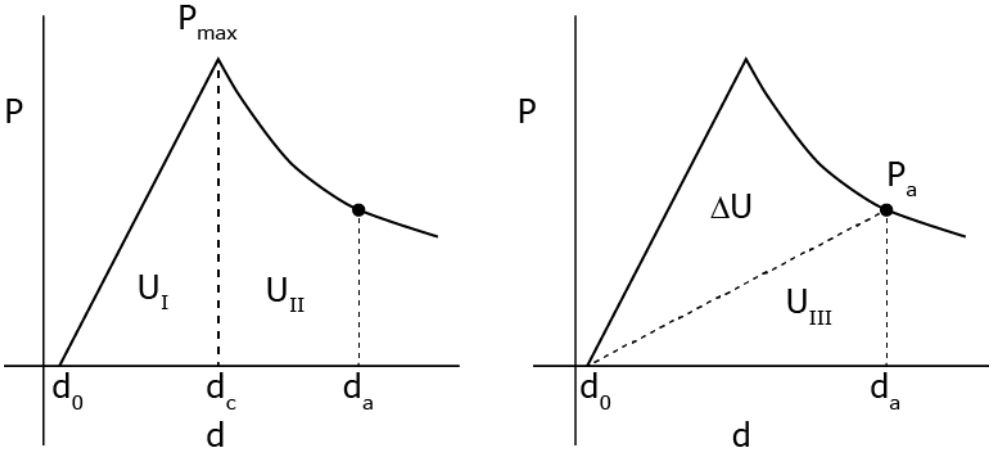
Modified Compliance Calibration (MMC)

$$G = \frac{3P^2C^{2/3}}{2A_1bh}$$

Where h is the specimen thickness, and A_1 is the slope of a/h versus $C^{1/3}$

In the files 'AXXX-Energy.csv', only the CC value for the SERR is given.

Dissipated energy



The method for calculating the energy dissipation ΔU, is illustrated in the figure above, where d_0 is the displacement where the force is zero, d_c is the displacement for maximum force, and d_a and P_a are the displacement and force at a crack length of a.

The area U_I is found by assuming linear elastic behaviour of the specimen for $d < d_c$.
The area U_{II} is found by integrating a 4th order polynomial fit through the data for $d > d_c$.
The area U_{III} is found by drawing a straight line from $(d_0,0)$ to (d_a,P_a).

ΔU(a) is thus given by

$$U_I = \frac{1}{2} P_{\max} \left(d_c - d_0 \right)$$

$$U_{II} = \int_{d_c}^{d_a} P \mathrm{d}d$$

$$U_{III} = \frac{1}{2} P_a \left(d_a - d_0 \right)$$

$$\Delta U \left(a \right) = U_I + U_{II} - U_{III}$$

In the files 'AXXX-Energy.csv' the values for ΔU are given along with the crack extension $a-a_0$, where a_0 is the crack length for $d = d_c$.