ME632: Problem Set-1

Q.1: A material exhibits the following crack growth resistance behavior:

$$R = 6.95(a - a_0)^{0.5}$$

where a_0 is the initial crack size. R has units of kJ/m^2 and crack size is in millimeters. The elastic modulus of this material is 207 GPa. Consider a wide plate with a through crack ($a << W$) that is made from this material.

(a) If this plate fractures at 138 MPa, compute the following:

(i) The half crack size at failure (a_c)

(ii) The amount of stable crack growth (at each crack tip) that precedes failure ($a_c - a_0$)

(b) If this plate has an initial crack length ($2a_0$) of 50.8 mm and the plate is loaded to failure, compute the following:

(i) The stress at failure

(ii) The half crack size at failure

(iii) The stable crack growth at each crack tip

Q.2: Suppose that a double cantilever beam specimen (DCB) (shown in Fig.1) is fabricated from the same material considered in Q.1. Calculate the load at failure and the amount of stable crack growth. The specimen dimensions are as follows:

$B = 25.4$ mm; $h = 12.7$ mm ; $a_0 = 152$ mm.

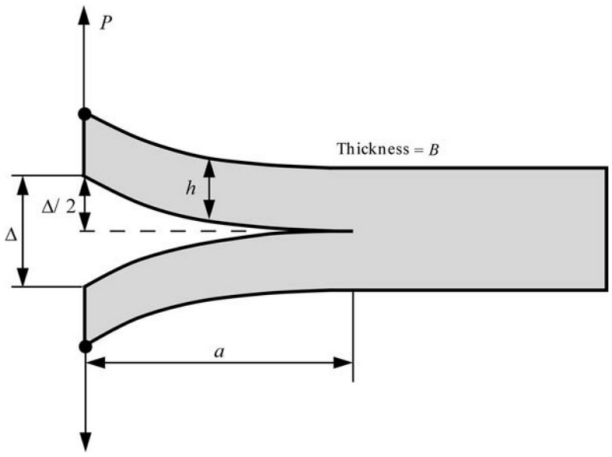

Fig.1

Q.3: Consider a nominally linear elastic material with a rising R curve (e.g., Q.1). Suppose that one test is performed on wide plate with a through crack (Fig. 2) and a second test on the same material is performed on a DCB specimen (Fig. 1). If both tests are conducted in load control, would the G_c values at instability be the same? If not, which geometry would result in a higher G_c ? Explain.

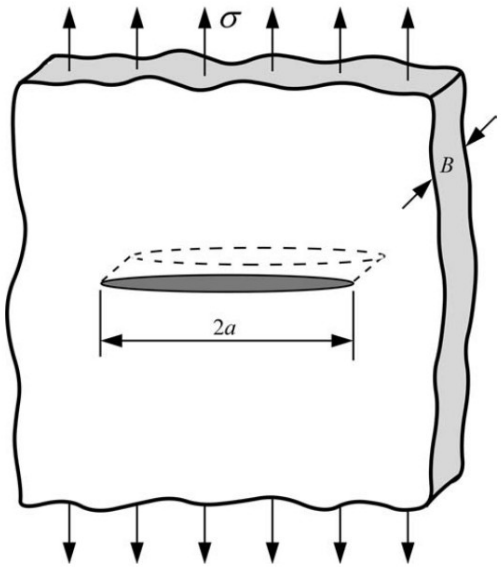

Fig. 2

Q.4: Determine the energy release rate, using elementary beam analysis, for the configurations shown in Fig. 3.

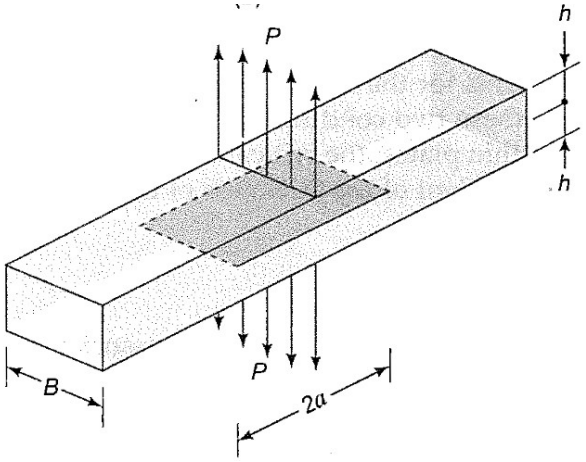

Fig. 3