

6. In design, the Computation of Fracture characteristics must be possible for specimens of arbitrary shape.

For a specimen of finite width (w) with a centre crack of length ($2a$), The Applied Force develops σ -

$\sigma = \left(\frac{F}{wB} \right)$; The value of σ at which crack begins to grow is σ_F ;
(The Case is thick plate with finite width);

$$K_{Ic} = \sigma_F \left[w \tan \left(\frac{\pi a}{w} \right) \right]^{1/2}$$

The value of K_I for the specimen under stress (σ) is

$$K_I = \sigma \left[w \tan \left(\frac{\pi a}{w} \right) \right]^{1/2}$$

Example: A plate of polystyrene of width (w) = 100mm

contains a central sharp crack of length $2a = 40$ mm,

The crack is found to propagate at $\sigma_F = 3.91$ MPa.

(1) Find K_{Ic} (2) Will a central crack of length 14mm in

an identical plate propagate under $\sigma = 9$ MPa? (3) Will

a crack of length 3mm in an infinitely wide polystyrene

plate propagate under a stress of 10 MPa?

7
 Solution: (1) $K_{Ic} = \sigma_F \left[W \tan \left(\frac{\pi a}{W} \right) \right]^{1/2}$

$$= 3.91 \left[100 * 10^{-3} * \tan \left(18^\circ * \frac{20}{100} \right) \right]^{1/2}$$

$$= 1.05 \text{ Mpa} \cdot \text{m}^{0.5}$$

(2) $K_I = \sigma \left[W \tan \left(\frac{\pi a}{W} \right) \right]^{1/2}$

$$= 9 \left[100 * 10^{-3} * \tan \left(18^\circ * \frac{7}{100} \right) \right]^{1/2}$$

$$= 1.35 \text{ Mpa} \cdot \text{m}^{0.5}$$

$K_I > K_{Ic}$, plate will fracture.

(3) For a plane of infinite width:

$$K_I = \sigma (\pi a)^{1/2} = 10 \left(\pi * \frac{3}{2} * 10^{-3} \right)^{1/2}$$

$$= 0.686 \text{ Mpa} \cdot \text{m}^{0.5}$$

$K_I < K_{Ic}$, plate will not fracture.

For fracture mechanics tests on plastics most widely

used test pieces are:-

1. The Compact tension (CT) Specimen.

2. The ~~edge~~ Single-edge-notched bend Specimen (SENB)

(The Crack tip should be sharp and grow in stable

manner). These are the test specimen geometries used to determine K_{Ic}

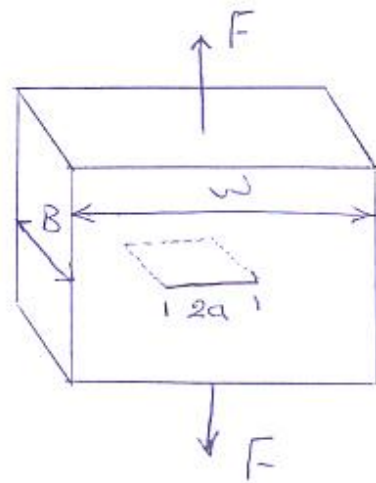


Fig.(1)

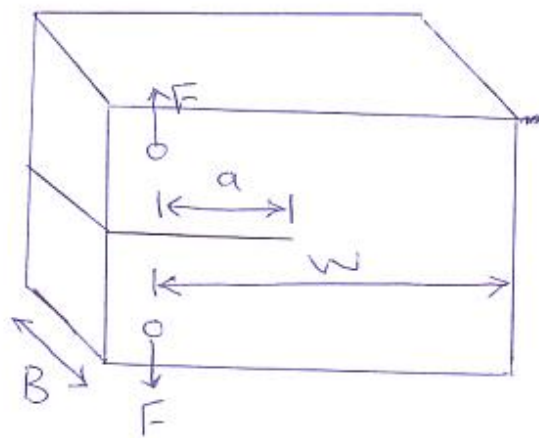


Fig 2. (a) (CT Specimen)
Compact tension specimen

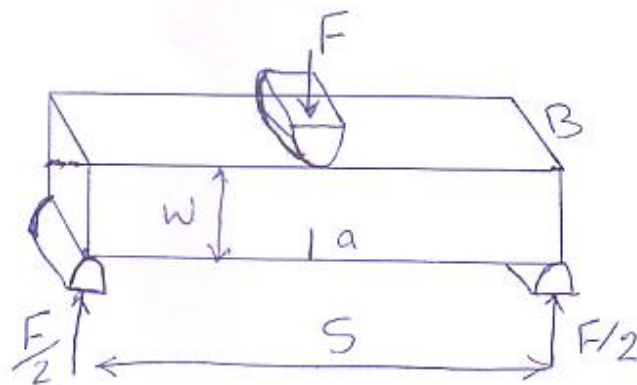


Fig. 2(b) SENB specimen
single edge notch Bend specimen