6. Assuming that plane strain toughness is being measured, the minimum thickness, from (28) is

$b_0 = 2.5(K_{Ic}/S_y)^2 = 2.5(140/700)^2 \times 10^3 = 100$ mm

The width must be twice this ($w = 200$ mm) and the length four times this again ($L = 800$ mm). The specimen's mass must therefore be at least:

$m = 0.1 \times 0.2 \times 0.8 \times 7.9 (t/m^3) = 126$ kg.

– and the specimen is obviously large. Assuming fracture occurs when $\alpha \approx 0.5$, then corresponding configuration factor, case (e) is $Y = 1.42$ and the failure load, P_c is given by:

$K_I \to K_{Ic} = (6P_c/bw)Y\sqrt{\pi a}$

or $P_c = 140 \times 100 \times 200/6 \times 1.42\sqrt{\pi \times 0.5 \times 0.1} = 585$ kN

So the size of specimens of tough materials may exceed testing machine capabilities.

7. ELASTIC $K_{Ic} = \sigma_E Y\sqrt{\pi a}$

where $Y = (\cos \pi\alpha/2)^{-\frac{1}{2}}$

$\therefore \sigma_E = K_{Ic}((\cos \pi\alpha/2)/\pi w\alpha)^{\frac{1}{2}}$

$= 564 (\cos \pi\alpha/2 / \alpha)^{\frac{1}{2}}$

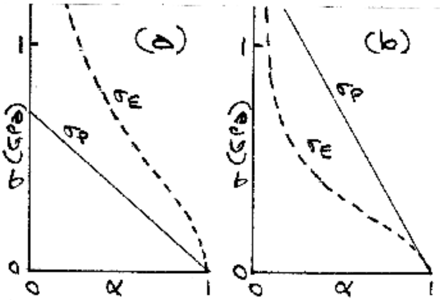
for (a) – for (b) the constant is halved.

PLASTIC $\sigma_p = (1-\alpha)S_y$

$\therefore \sigma_p = 700 (1-\alpha)$

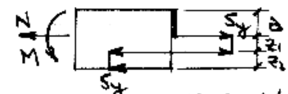
for (a) – for (b) the constant is doubled

These are plotted :–



Note how properties dictate that (a) will fail mainly through the plastic collapse mechanism, while crack instability is the main danger in (b).

8 At plastic collapse, the yield stress must extend right across the ligament – partly tension & partly compression, to equilibrate both N & M. Let z_1 & z_2 be extent of tension & compression zones. Then



$\leftarrow \Sigma F = N + (z_2 - z_1) b S_y = 0 \quad \therefore z_1 - z_2 = nW$

& from geometry $z_1 + z_2 = W - a = (1-\alpha)W$

Solving for z_1 & z_2 yields

$z_1 = (1-\alpha+n)W/2 \quad ; \quad z_2 = (1-\alpha-n)W/2$

Now for moment equilibrium

$\circlearrowright \Sigma M_{LH\ centre} = M + bz_1 S_y \left(a + \frac{z_1}{2} - \frac{W}{2}\right) - bz_2 S_y\left(W - \frac{z_2}{2} - \frac{W}{2}\right) = 0$

Substituting from above for z_1 & z_2 yields, after