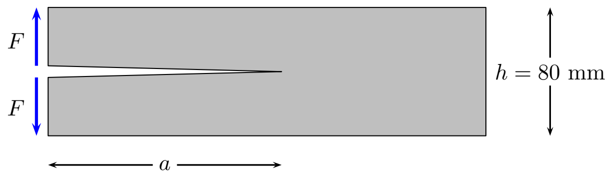
RAK-33060 Fracture mechanics and fatigue

6. Exercise, elasto-plastic fracture mechanics

1. A DCB-specimen shown in the figure below is loaded by the force $P = 50$ kN. For the material $J_{\mathrm{Ic}} = 100$ kN/m and the yield strength is $\sigma_{\mathrm{y}} = 400$ MPa. Compute the critical crack length a_{cr} using the model of (a) Irvin and (b) Dugdale. The Young's modulus of the specimen is $E = 200$ GPa and the Poisson's ratio is $\nu = 0.3$. Thickness of the specimen is 50 mm.



2. A large steel plate of an elastic, perfectly plastic material with yield strength of $\sigma_{\mathrm{y}} = 500$ MPa contains a through-the-thickness crack with a length of 50 mm which is oriented perpendicularly to the uniform remotely applied tensile stress σ_∞. During increased loading the crack starts to grow when $\sigma_\infty = 300$ MPa. The Dugdale model can be assumed to be applicable to the present problem.

   (a) At which stress should a 150 mm long crack start to grow if initiation of crowth occurs when the crack surface opening at the rear end of the plastic zone reaches a critical level?

   (b) Calculate the size of the plastic zones at initiation of growth for the two initial crack lengths.

3. A long strip ($h \ll a, h \ll b$) is subjected to constant vertical displacements $\pm v_0$ along the horizontal boundaries. The boundaries are supported so that no shear stress is transferred. The crack tip region can ne modelled by the Dugdale model, i.e. a constant stress σ_{y} is assumed to act between the cracl surfaces in the cohesive region. Fracture is assumed to occur when the crack opening of the rear end of the zone reaches the critical value δ_{c}. Calculate with aid of the J-integral the value v_0 at which fracture occurs. A plane stress state is assumed. The elastic constants are E and ν.