Analysis of plane strain upset forging of rectangular billet

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1.Quiz - Key:

1. Plane strain compression is carried out on a rectangular billet of initial height of 30 mm, width of 70 mm and depth of 20 mm. The height if the work gets reduced to 20 mm during the operation. What is the forging load being applied at the reduced height, if the yield strength of the material is 450 MPa. Assume sticking friction condition.

Solution:
We know that the average forging pressure for plane strain upsetting is
$\bar{p} = \bar{Y}'[1 + \frac{a}{2h}]$
And plane strain yield strength = $\frac{2}{\sqrt{3}}Y = \bar{Y}'$ = 519.61 MPa
Applying the volume constancy
We get the width of the billet after compression as followed:
aoho = ah

a = 105 mm

Therefore, the average forging pressure is = 1883.59 MPa

Forging load = pressure X area = 3.96 MN

2. For the case of combined sticking and sliding friction in plane strain compression forging determine the distance x at which the transition from sliding to sticking friction occurs, in terms of μ, h-height and a which is half width of the rectangular bar.

At the point of transition the forging pressure should be equal to shear yield strength [k], because, with sticking friction, the shear stress can not exceed the shear strength of the material.

Therefore,
$\tau = k = \mu p = \mu Y' e^{\frac{2\mu(a-x)}{h}}$
Here we take k = $Y'/\sqrt{3}$

Solving for x

x= a - $\frac{h}{\mu\sqrt{3}} \ln [\frac{1}{\mu\sqrt{3}}]$