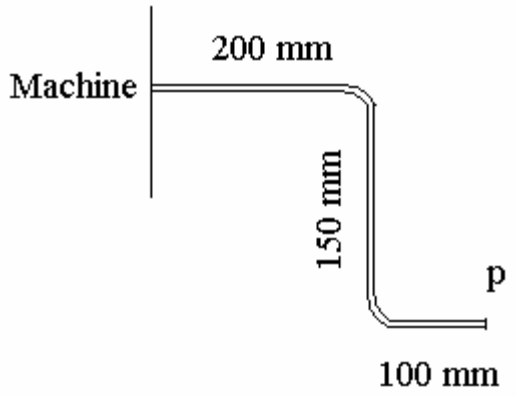
2 The diagram shows a crank handle for turning a machine. It is made from solid round bar 15 mm diameter.



(a) Calculate the force required at point P so that a torque of 50 Nm is exerted on the machine.

SOLUTION

The force has a turning arm of 150 mm so the torque is T = 50 = F x 0.15 F = 50/0.15 = 333.3 N

(b) Calculate the maximum principal stress produced in the handle by this force ignoring stress concentrations.

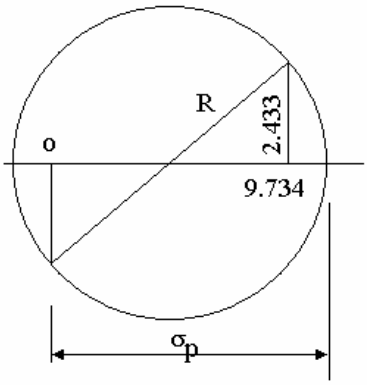
SOLUTION

At the point where the handle is connected to the machine the bending moment is a maximum and the torque is a maximum so this point will be used.

T = 50 N m M = 333.3 x 0.3 m = 100 Nm
BENDING STRESS
$\sigma = My/I$ $y = 7.5 \times 10^{-3}$ m $I = \pi \times (15 \times 10^{-3})^4/64 = 7.705 \times 10^{-8}$ m^4
$\sigma = 100 \times 7.5 \times 10^{-3} / 7.705 \times 10^{-8} = 9.734 \times 10^6$ N/m^2

TORSIONAL STRESS
$\tau = TR/J$ R = 0.15 J = 2I
$\tau = 50 \times 0.15/1.541 \times 10^{-7} = 2.433 \times 10^6$ N/m^2

Constructing Mohr's circle of stress we get



The greatest principal stress is $\sigma_p = 9.734/2 + \sqrt{[2.433^2 + (9.734/2)^2]} = 31$ MPa