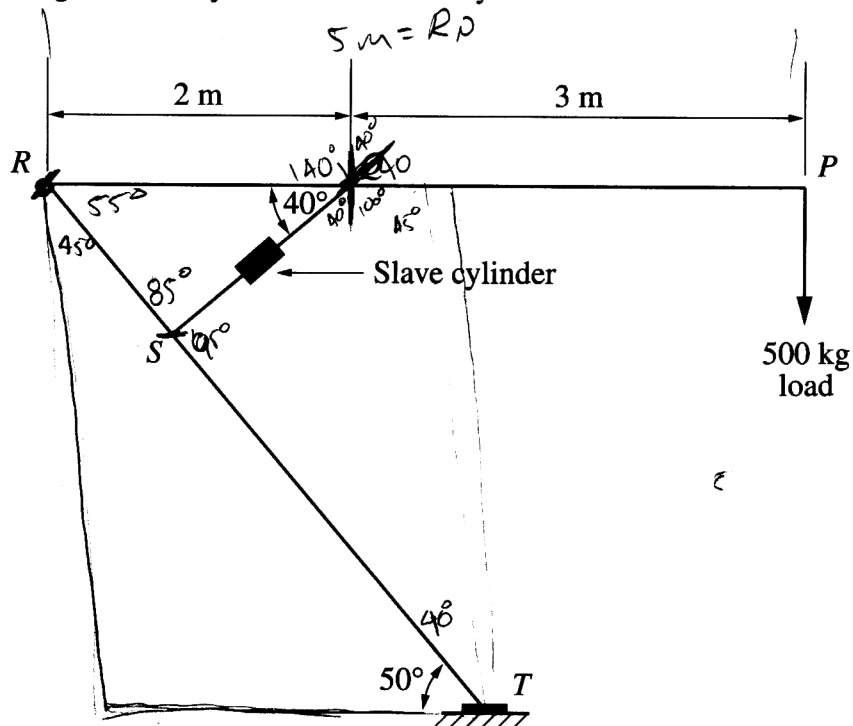


Question 14 — Lifting Devices (10 marks)

The diagram shows a lifting device. Arm  $RP$  is raised or lowered by a hydraulic system comprising a master cylinder and a slave cylinder.



- (a) The lifting device is required to hold a load of 500 kg. Determine the minimum force required in member  $QS$  to keep arm  $RP$  horizontal. 2

$500 \text{ kg} = 5000 \text{ N}$

$M_Q^R = Fd$   
 $= 3 \times 5000$   
 $= 15000 \text{ Nm}$

$RQ = 10000 \text{ N}$

$\sin 40 = \frac{25}{10000}$

$10000 \times \sin 40$

=



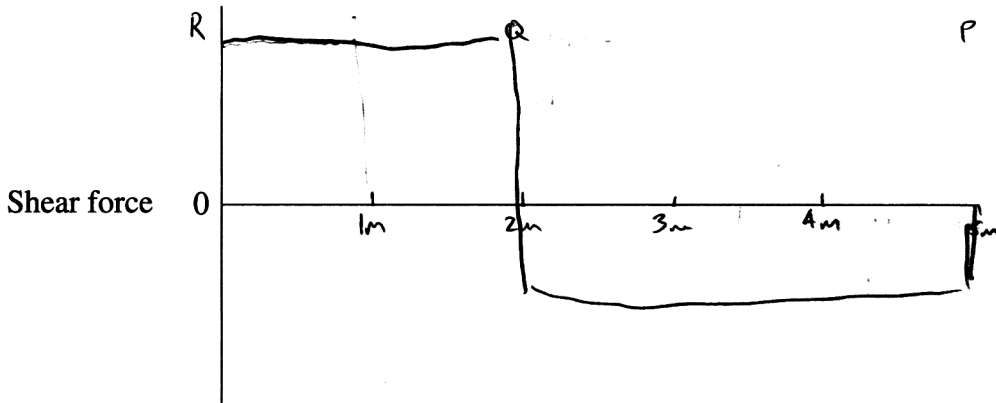
Minimum force =  $\dots 6427.9 \text{ N} \dots$   
 $= 6.4279 \text{ kN}$

Question 14 continues on page 19

Question 14 (continued)

(b) For another set of conditions, the force in member QS was found to be 21.35 kN.

- (i) Draw the shear-force diagram for the arm RP. Label the values on the diagram. The mass of the arm should not be considered. 2



- (ii) Determine the diameter of the master cylinder if the mechanical advantage of the hydraulic system is 3. The slave cylinder has a cross-sectional area of 2800 mm<sup>2</sup>. 3

$$MA = \frac{L}{E}$$

$$VR = \frac{dE}{1L}$$

$$\eta = \frac{MA}{VR}$$

$$\frac{1}{3} = \frac{2800}{x}$$

$$x = 8400$$

$$\frac{\pi d^2}{4} = 8400$$

$$\pi d^2 = 2100$$

$$\pi d = \sqrt{2100}$$

$$d = \frac{\sqrt{2100}}{\pi}$$

$$=$$

$$A = \frac{\pi d^2}{4}$$

$$\frac{2800}{9} = \pi d^2$$

$$\sqrt{700} = \pi d$$

$$\frac{\sqrt{700}}{\pi} = d$$

$$d = 8.42$$

slave

Diameter = .....14.59 mm.....

Question 14 continues on page 20

Question 14 (continued)

- (c) Gears used in lifting devices can be manufactured by powder-forming or by a variety of other processes. 3

Identify an alternative manufacturing process, and contrast the properties of gears formed by this process with the properties of the powder-formed gears.

Gears can be drop forged, which means they are  
manufactured by applying force until the correct  
shape is achieved, this allows the gears to have more  
~~stress~~ stress free grains than powder forming, which  
will leave grains that are independent and hence  
quite brittle.

End of Question 14