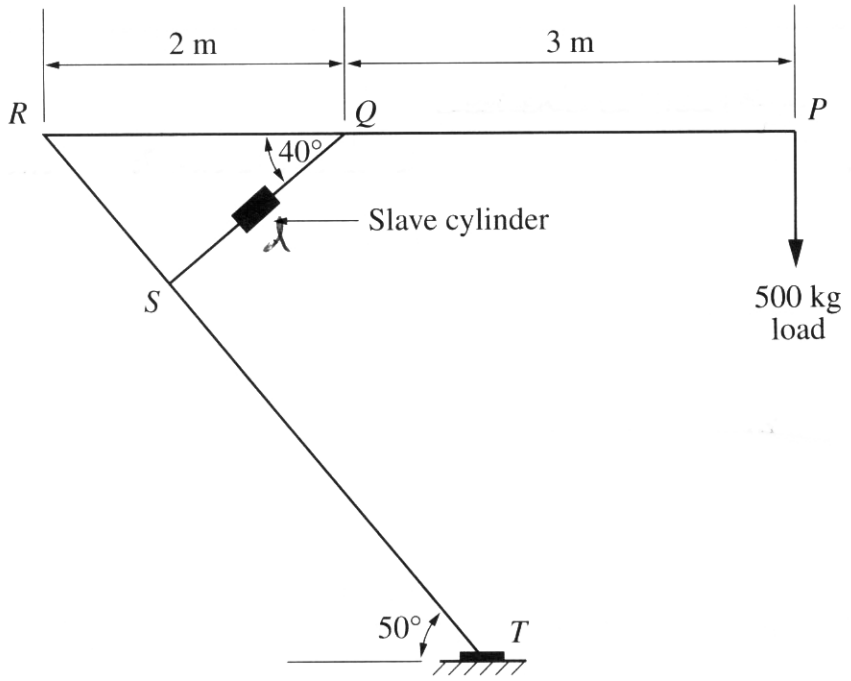
Marks

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**

$F_1 = ?$

$F_2 = 500 \times 9.8$

$= 4900$

$\cos 40 = \frac{SQ}{2}$

$2 \cos 40 = SQ$

$SQ = 1.532$

$= 1.53$

$\Sigma M = (4900 \times 3) - (F \times 1.53)$

$1.53F = 14700$

$F = \frac{14700}{1.53}$

$= 9594.74\ldots N$

$= 9.59\ kN$

Minimum force = 9.59 kN

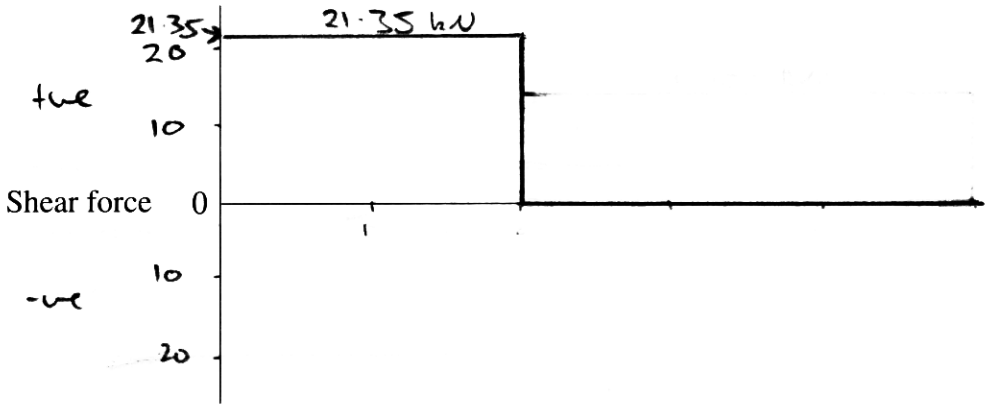
Question 14 continues on page 19

Marks

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^2. **3**

$A_1 = 2800$

$MA = 3$

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

$3 = \frac{4900}{E}$

$E = 1633.3\ N$

$F_2 = 9.59$ (slave)

$A_2 = 2800\ mm^2$

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

$2.09 \times 10^{-3} = \frac{\pi d^2}{4}$

$\frac{(2.09 \times 10^{-3})(4)}{\pi} = d^2$

$d = \sqrt{\frac{(2.09 \times 10^{-3})(4)}{\pi}}$

$= 0.05168...$

$= 0.05\ mm$

$\frac{F_2}{A_2} = \frac{F_1}{A_1}$

$\frac{9549}{2800} = \frac{1633.3}{A_2}$

$A_2 = \frac{9549}{2800} \times 1633.3$

$= 2.097976001 \times 10^{-3}$

Diameter = ...0·05 mm.....

Question 14 continues on page 20

Marks

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.

Another alternative is machining the gears. Machined gears compared to powder formed gears are more likely to chip, fracture or break as the grain flow does not conform to the shape which makes it weaker compared to powder formed gears ~~where grain flow~~ the sintered powders conforms to the shape of the gear giving it greater strength which makes it less likely to break, or fracture or fail when in use.

End of Question 14