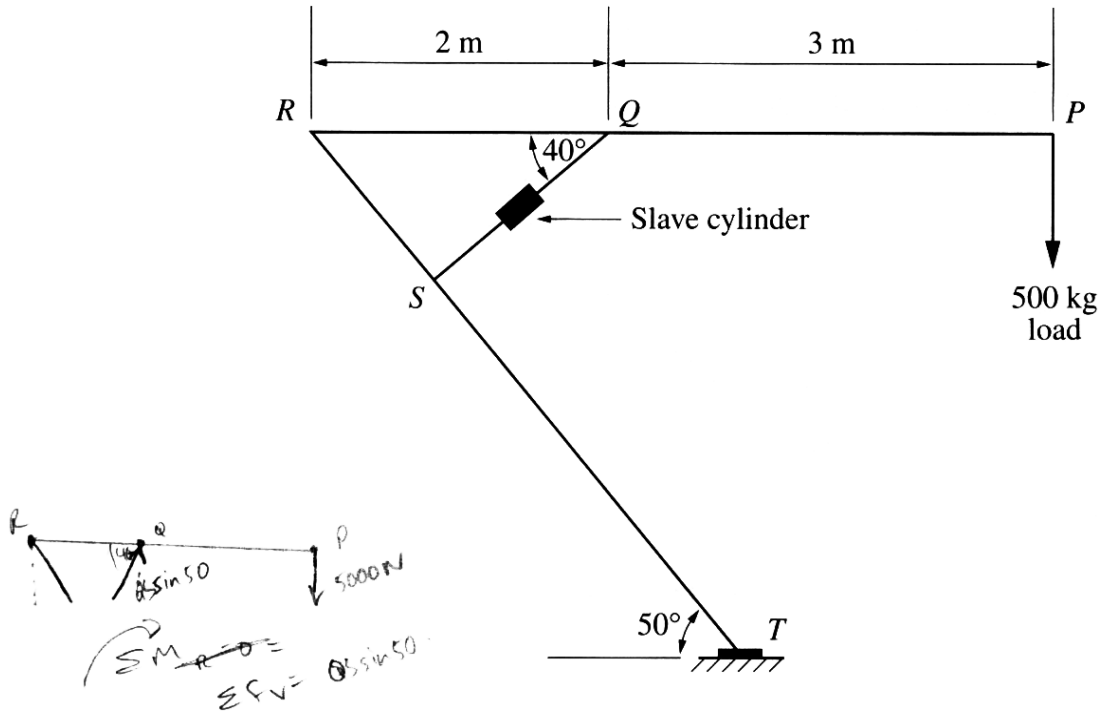


Question 14 — Lifting Devices (10 marks)

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

Minimum force = ~~5958.77 N~~ 16317.6 N

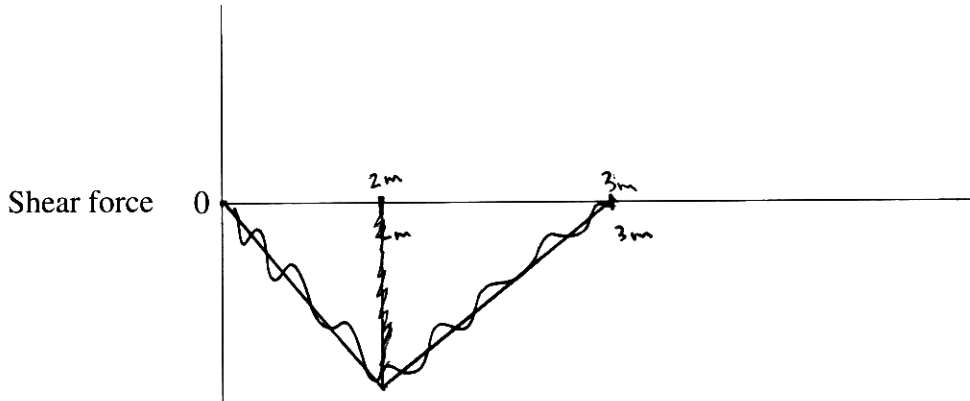
Question 14 continues on page 19

$2 \times QS \sin 50 = 25000$
 $\therefore QS = \frac{25000}{2 \times \sin 50} = 16317.6 \text{ N}$

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 mm². 3

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

$$A = \pi D$$

$$MA = 3$$

$$A = 2800 \text{ mm}^2 = 2.8 \text{ m}^2$$

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

$$2.8 = \frac{\pi D^2}{4}$$

$$\therefore 11.2 = \pi D^2$$

$$\therefore D^2 = \sqrt{\frac{11.2}{\pi}}$$

$$= 1.888 \text{ m}$$

Diameter = 1.888 m

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.

✦ Another manufacturing process that can be used is sand casting. ~~The~~ ^{Gears} are made ~~via~~ by first producing sand casts, this are then injected with the molten metal used to make the gears. When the metal cools, ~~it~~ ^{the} sand mold is then ~~left to~~ ^{take} broken off.

✦ Sand casting would tend to provide a rough surface but would provide a harder and tougher surface in contrast to powder forming methods which would result ~~it~~ in being more brittle.

End of Question 14