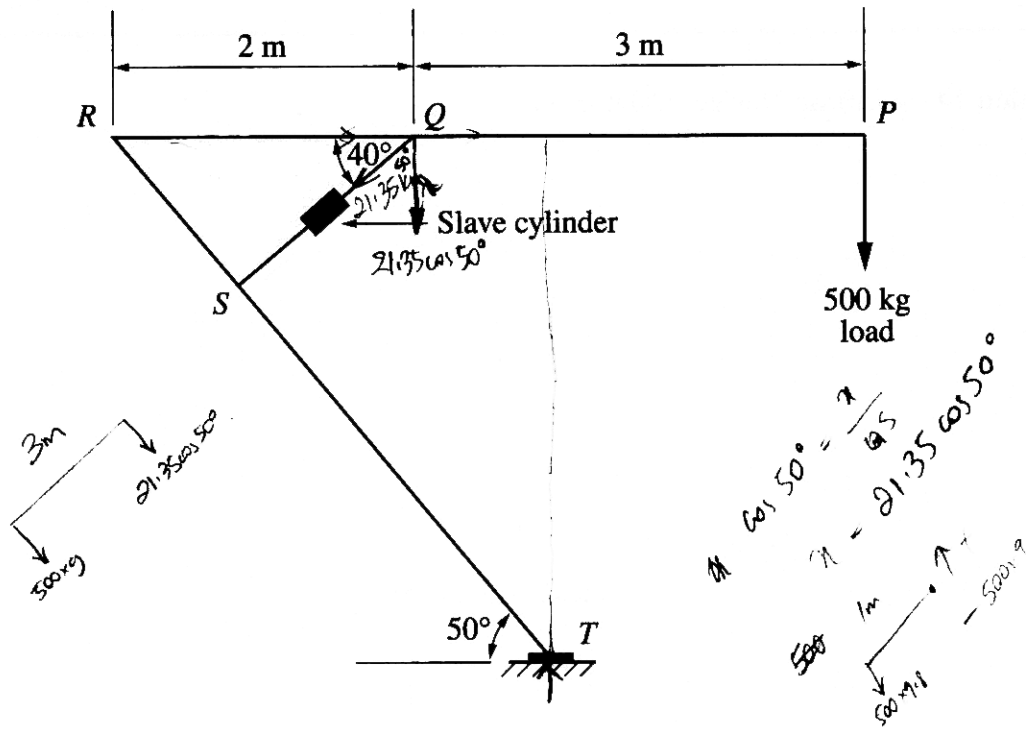


Question 14 — Lifting Devices (10 marks)

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

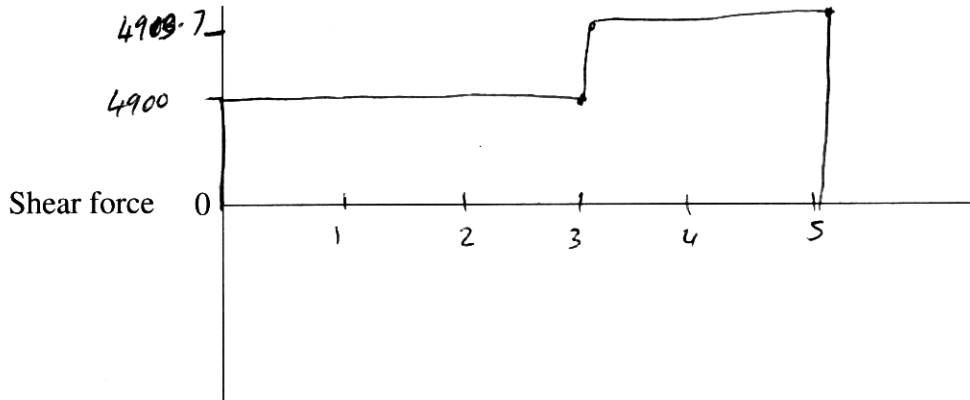
Minimum force =

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 mm². 3

$$MA = \frac{\text{Load}}{\text{Effort}}$$

$$3 = \frac{500}{\text{Effort}}$$

$$\text{Effort} = \frac{500}{3}$$

$$P = \frac{F}{A}$$

$$P = \frac{21.35}{2800}$$

$$\text{Effort} = \frac{F}{A}$$

$$\frac{500}{3} = \frac{F}{A}$$

$$MA = \frac{\text{Load}}{\text{effort}}$$

$$3 = \frac{\text{load}}{P}$$

$$\therefore MA = 3$$

$$3P = \frac{21 \times 35}{\pi \times 2800} \times 3$$

$$\text{Area} = 2800 \times 3 = \pi r^2$$

$$8400 = \pi r^2$$

$$r^2 = 51.708 \dots$$

Diameter =103.42 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.

..... Forging the gears allows grainflow to follow the shape of the gear giving it strength, ~~however~~ ^{where as} powder-forming ~~it~~ creates no grainflow which makes it weak in comparison.

..... However powderforming allows the addition of metals that usually do not alloy together which can increase some properties.

..... Powderforming can increase density where as forging doesn't allow that.

End of Question 14

Volume decreases, pressure increases.