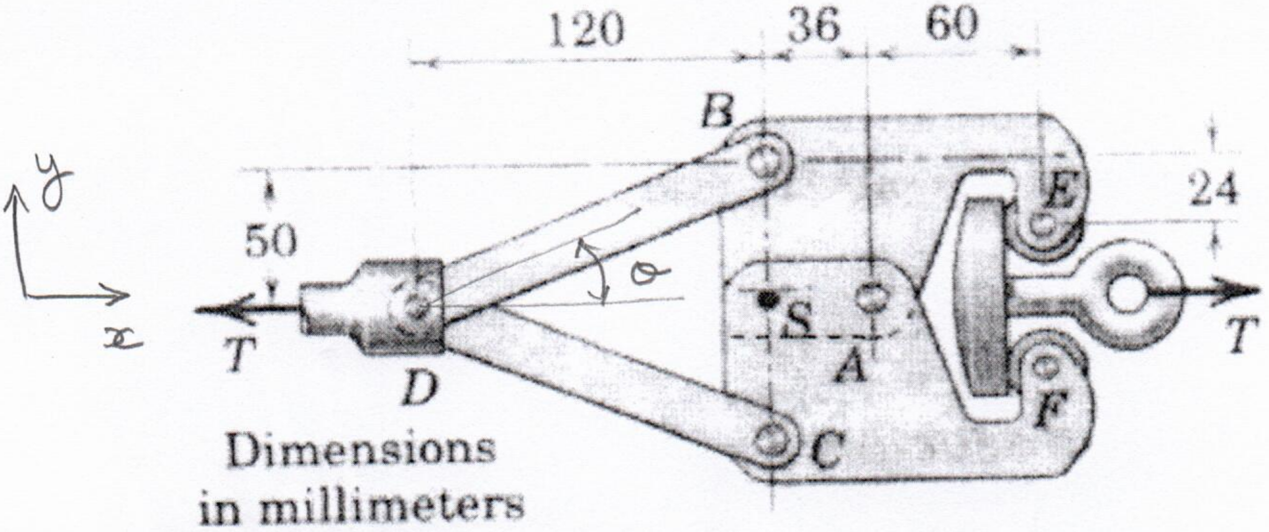
# Problem #1




## Problem Statement

Given that max shear force on pin S = 800N, what is the maximum T?

We solve the static problem just as the shear force @ pin S reaches 800N.

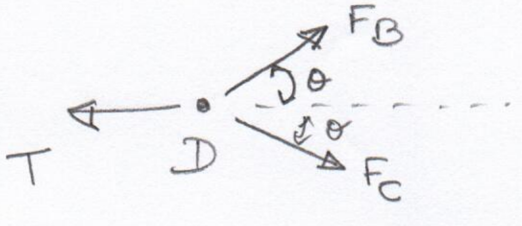
Breaking down the problem into its parts: 2

$\tan\theta = \frac{BS}{SD} = \frac{5}{12}$

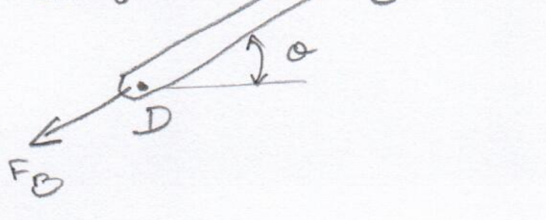
$\cos\theta = 12/13$

$\sin\theta = 5/13$

① FBD of joint D

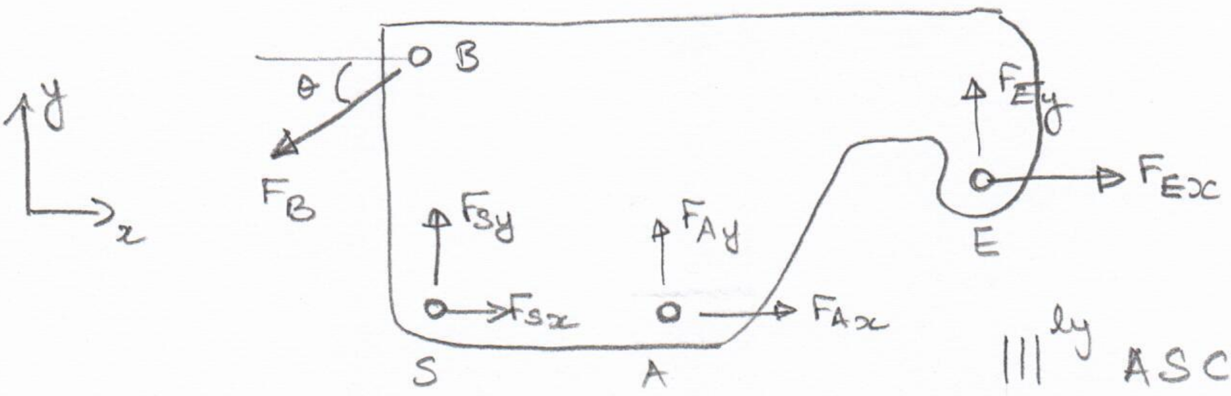



② FBD of element BD




$\parallel^{ly}$ element CD due to symmetry.

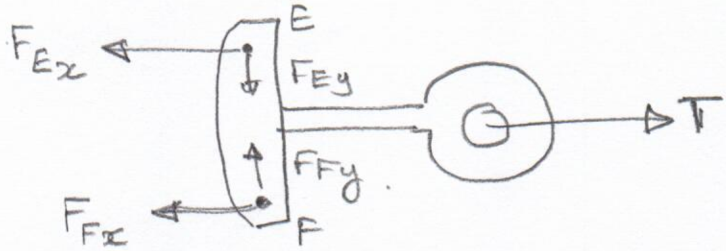
③ FBD of ASBE




5

$|||^{ly}$ ASCF due to symmetry.

④ FBD of Eyebolt.




Solving the individual FBDs.

① FBD of joint D.

$\Sigma F_x = 0 \Rightarrow F_B \cos\theta + F_C \cos\theta - T = 0$

$\Sigma F_y = 0 \Rightarrow F_B \sin\theta - F_C \sin\theta = 0$

2

$$\boxed{F_B = F_C = \frac{T}{2\cos\theta}} \quad \text{———} \quad (1)$$

④ FBD of Eyebolt.

$\Sigma F_x = 0 \Rightarrow T - F_{Ex} - F_{Fx} = 0$

$\Sigma F_y = 0 \qquad -F_{Ey} + F_{Fy} = 0$

From consideration of symmetry or using $\Sigma M|_{eye} = 0$ we get

$$\boxed{F_{Ex} = F_{Fx} = \frac{T}{2}} \qquad \text{———— (2)} \qquad \boxed{2}$$

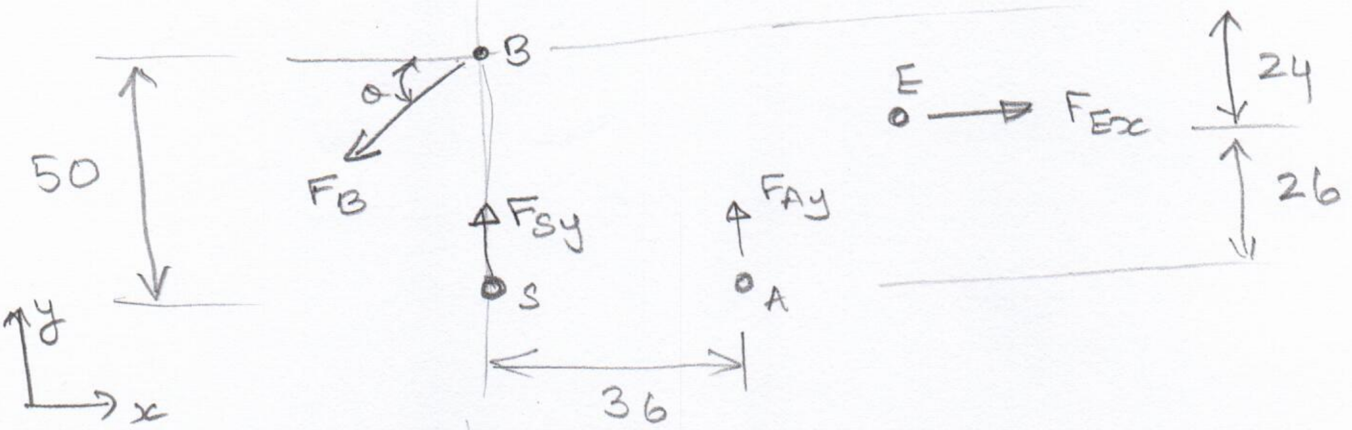
$$F_{Ey} = F_{Fy} = 0$$

3 FBD of ASBE

∴ From considerations of symmetry, we can say

$$F_{Sx} = F_{Ax} = 0$$

So, the FBD is as below.




$$\left.\sum M = 0\right|_{\text{point } A} \Rightarrow \qquad \boxed{3}$$

$$-F_{Sy} \cdot 36 + F_B \cos\theta \cdot 50 + F_B \sin\theta \cdot 36 - F_{Ex} \cdot 26 = 0$$

Substituting for $F_B$, $F_{Ex}$, we get

$$-F_{Sy} \cdot 36 + \frac{T}{2\cos\theta} \cdot \cos\theta \cdot 50 + \frac{T}{2\cos\theta} \cdot \sin\theta \cdot 36 - \frac{T}{2} \cdot 26 = 0$$

$$\Rightarrow \quad F_{Sy} \cdot 36 = 25T + \frac{T}{2} \cdot \frac{5}{12} \cdot 36 - 13T$$

$$= \frac{39}{2} T$$

$$\Rightarrow \quad \boxed{F_{sy} = \frac{39}{72} T}$$

At the time of failure (breaking of shear pin at S)

$$|F_{sy}| = 800 \text{ N}$$

Note that direction of $F_{sy}$ assumed is an arbitrary one. However if $F_{sy} = -800$, we get negative T which is a completely different mechanism. Hence $F_{sy} = 800$ N (+)ve.

Thus if $F_{sy} = 800$,

$$\max T = \frac{72 * 800}{39}$$

$$\Rightarrow \quad \boxed{T = 1476.92 \text{ N}}$$

2

To find the shear force on the pin @ A, we could use $\Sigma F_y = 0$

$$\Rightarrow \quad -F_B \sin\theta + F_{sy} + F_{Ay} = 0$$

2

$$\Rightarrow \quad -\frac{T \sin\theta}{2\cos\theta} + 800 + F_{Ay} = 0$$

$$\Rightarrow \quad F_{Ay} = \frac{1476.92}{2} \cdot \frac{5}{12} - 800$$

$$\Rightarrow \quad \boxed{F_{Ay} = -492.31 \text{ N}}$$

2

So the shear force at point A acts downward on upper plate

The result for $F_{Ay}$ could also have been obtained by using $\sum M = 0 \Big|_{\text{point } S}$

$$\Rightarrow \quad F_B \cos\theta \cdot 50 + F_{Ay} \cdot 36 - F_{Ex} \cdot 26 = 0$$

Substituting for $F_B$ & $F_{Ex}$,

$$\frac{T}{2\cos\theta} \cdot \cos\theta \cdot 50 + F_{Ay} \cdot 36 - \frac{T}{2} \cdot 26 = 0$$

$$\Rightarrow \quad F_{Ay} \cdot 36 = -12T$$

$$\Rightarrow \quad F_{Ay} = -T/3$$

if $T = 1476.92\text{ N}$,

$$\boxed{F_{Ay} = -492.31\text{ N}}$$

which is the same as the earlier result.