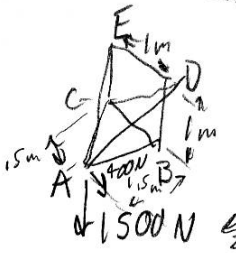
P.S. 7 solutions

① 

reactions at B: F_{Bx}, F_{By}, F_{Bz}

at C, D, E: F_{Cy}, F_{Dz}, F_{Ez}

for body: $\Sigma M_{Bx} = 0 = (F_{Ez} + F_{Dz})(1.00m) + 1.50kN(1.50m)$

$\Sigma M_{Bz} = 0 = 1.50kN(0.5m) - F_{Cy}(1.00m)$

$\rightarrow F_{Cy} = 750N$

$\Sigma M_{By} = 0 = 400N(1.50m) + F_{Ez}(1.00m)$

$\rightarrow F_{Ez} = -600N \longrightarrow F_{Dz} = -1650N$

$\Sigma F_z = 0 = F_{Ez} + F_{Dz} + F_{Bz} \rightarrow F_{Bz} = 2250N$

$\Sigma F_x = 0 = F_{Bx} + 400N \rightarrow F_{Bx} = -400N$

$\Sigma F_y = 0 = F_{Cy} + F_{By} - 1.50kN \rightarrow F_{By} = 750N$

at D: $\Sigma F_z = 0 = DA\left(\frac{1.50}{\sqrt{3.50}}\right) + F_{Dz} \rightarrow$ $DA = 1.10\cancel{3.50}\,kN$ $(2.06kN)$

at B: $\Sigma F_y = 0 = F_{By} + BD \rightarrow$ $BD = -750N$

$\Sigma F_z = 0 = F_{Bz} + AB\left(\frac{1.50}{\sqrt{2.50}}\right) \rightarrow$ $AB = -1.50\sqrt{2.5}\,kN$ $(-2.37kN)$

$\Sigma F_x = 0 = BC + F_{Bx}$

$\rightarrow$ $BC = 400N$

at E: $\Sigma F_z = 0 = AE\left(\frac{1.50}{\sqrt{3.50}}\right) + F_{Ez} \rightarrow$ $AE = 400\sqrt{3.5}\,N$ $(748N)$

$\Sigma F_y = 0 = EC + \left(\frac{1.00}{\sqrt{3.50}}\right)AE \rightarrow$ $EC = -400\,N$

$\Sigma F_x = 0 = ED + \frac{0.50}{\sqrt{3.50}}AE \rightarrow$ $ED = -200\,N$

① (cont.) at C: $\Sigma F_z = 0 = AC\left(\frac{1.50}{\sqrt{2.50}}\right) \rightarrow$ **AC = 0 force**

$$\Sigma F_x = 0 = BC + \left(\frac{1}{\sqrt{2}}\right)CD + \frac{0.5}{\sqrt{2.5}}\cancel{AC}^{0}$$

$$\rightarrow \boxed{CD = 400\sqrt{2}\,N}$$

check at A:

$$\Sigma F_z = 0 = \frac{-1.5}{\sqrt{3.5}}AD - \frac{1.5}{\sqrt{3.5}}AE - \frac{1.5}{\sqrt{2.5}}AB - \frac{1}{\sqrt{2.5}}\cancel{AC}^{0}$$

$$= -1650N - 600N + 2250N$$

$$= 0 \checkmark$$

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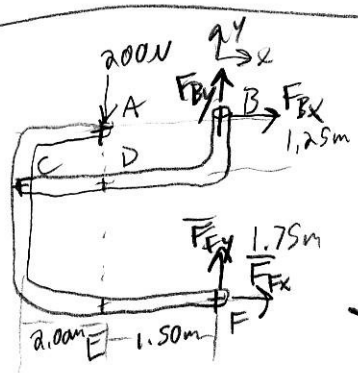
②



(a) 200N·m applied at D

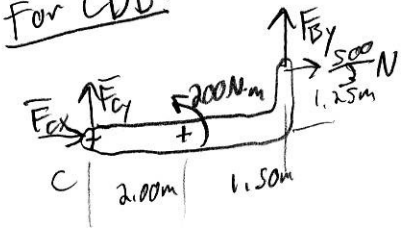
reactions at B, F?

body: $\Sigma M_B = 0 = 200N(1.50m) + 200N\cdot m + F_{Fx}(3.00m)$

$$\rightarrow \boxed{F_{Fx} = -\frac{500}{3}N}$$

$$\Sigma F_x = 0 = -\frac{500}{3}N + F_{Bx} \rightarrow \boxed{F_{Bx} = \frac{500}{3}N}$$

For CDB:



$$\Sigma M_C = 0 = 200N\cdot m + F_{By}(3.50m) - \frac{500}{3}N(1.25m)$$

$$\boxed{F_{By} = \frac{100}{42}N = 2.381N}$$

body: $\Sigma F_y = 0 = \frac{100}{42}N + F_{Fy} - 200N$

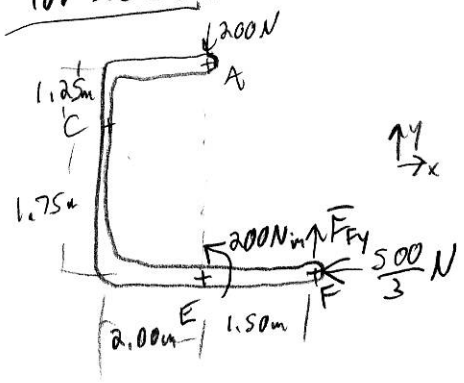
$$\rightarrow \boxed{F_{Fy} = 197.6N \quad (198N)}$$

(2.6) 200 N·m applied at E

for body, $\Sigma M_B = 0$ yields $\boxed{F_{Fx} = \frac{-500}{3} N}$, same as prev.

so $\boxed{F_{Bx} = \frac{500}{3} N}$ also.

for ACEF:



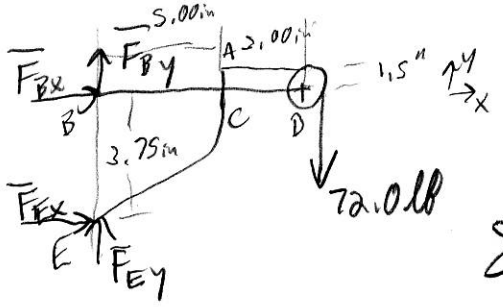
$\Sigma M_C = 0 = -200\,N(2.00m) + 200\,N\cdot m + F_{Fy}(3.50m) - \frac{500}{3}N(1.75m)$

$\rightarrow \boxed{F_{Fy} = 140.5\,N}$

body: $\Sigma F_y = 0 = 140.5\,N - 200\,N + F_{By}$

$\rightarrow \boxed{F_{By} = 59.5\,N}$

(3) For body:

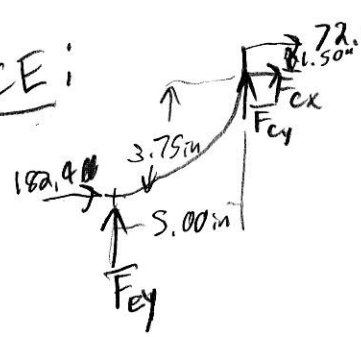


$\Sigma M_B = 0 = F_{EX}(3.75\text{in}) - 72.0\text{lb}(9.50\text{in})$

$\rightarrow \boxed{F_{EX} = 182.4\text{ lb}}$

$\Sigma F_x = 0 = 182.4\text{ lb} + F_{BX} \rightarrow \boxed{F_{Bx} = -182.4\text{ lb}}$

For ACE:



$\Sigma M_C = 0 = -72.0\text{lb}(1.50\text{in}) - F_{EY}(5.00\text{in}) + 182.4\text{lb}(3.75\text{in})$

$\rightarrow \boxed{F_{EY} = 115.2\text{ lb}}$

For body: $\Sigma F_y = 0 = -72.0\text{lb} + F_{EY} + F_{BY}$

$\rightarrow \boxed{F_{BY} = -43.2\text{ lb}}$

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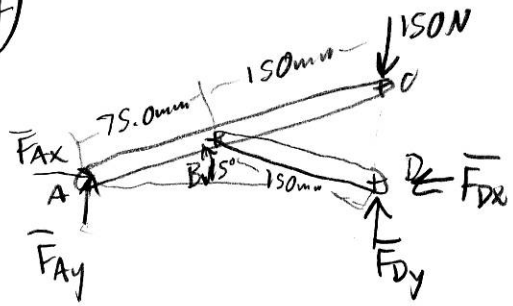
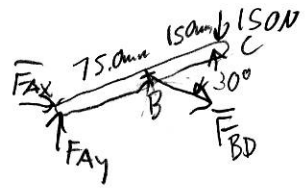
(4)



$F_{DX} = ?$ for ABC: $\Sigma M_A = 0 = +150N[225(\cos 15°)\text{mm}] = F_{BD}(\sin 30°)(75.0\text{mm})$



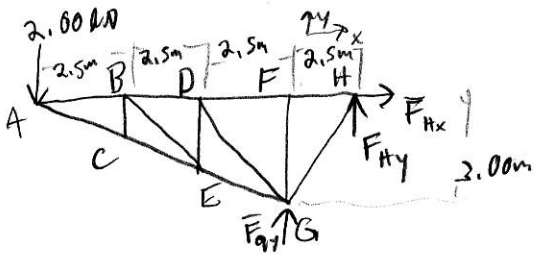
$\rightarrow F_{BD} = \dfrac{-450N(\cos 15°)}{\sin(30°)}$

at D: $\Sigma F_x = -F_{BD}(\cos 15°) - F_{DX}$

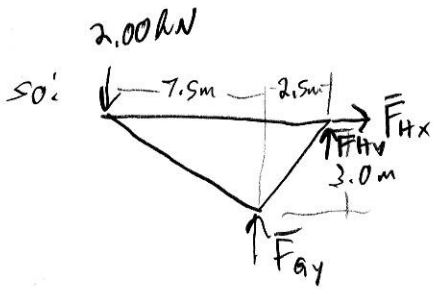
so $\boxed{F_{DX} = 839.7\text{N}}$

so 840N is exerted on blade E

5



Zero force members: BC
BE
DE
DG
FG



so:

body: $\Sigma M_H = 0 = F_{Gy}(2.50m) + 2.00\,kN(10.00m)$

$F_{Gy} = 8.00\,kN$

$\Sigma F_y = 0 = -2.00\,kN + 8.00\,kN + F_{Hy}$

$\rightarrow F_{Hy} = -6.00\,kN$

$\Sigma F_x = 0 = F_{Hx}$

at H:

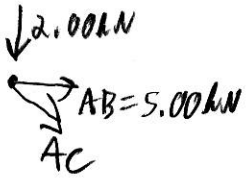
$\Sigma F_y = 0 = F_{Hy} - \left(\frac{3.00}{\sqrt{15.25}}\right) HG \rightarrow$ **$HG = -2\sqrt{15.25}\,kN$ $(-7.81\,kN)$**

$\Sigma F_x = 0 = -FH - \left(\frac{2.5}{\sqrt{15.25}}\right) HG$

$\rightarrow$ **$FH = 5.00\,kN$**

$AB = BD = DF = FH = 5.00\,kN$

at A:



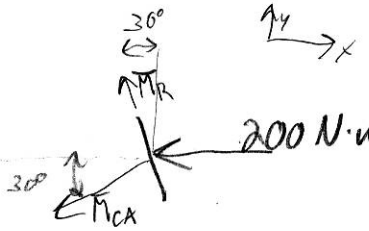
$\Sigma F_y = 0 = -2.00\,kN - \left(\frac{1.00}{\sqrt{7.25}}\right) AC$

$\rightarrow$ **$AC = 2.00\sqrt{7.25}\,kN$ $(5.39\,kN)$**

$EG = CE = AC = -2.00\sqrt{7.25}\,kN$ $= (-5.39\,kN)$

6

at C:



(a)

$\bar{u}_{CA} = -\cos(30°)\hat{i} - \sin(30°)\hat{j}$

$\Sigma M_x = 0 = -200\,N\cdot m - (\cos 30°)M_{CA} - M_R(\sin 30°)$

$\Sigma M_y = 0 = -\sin(30°)M_{CA} + \cos(30°)M_R$

$M_R = M_{CA}\frac{\sin 30°}{\cos 30°}$

$200\,N\cdot m = -\cos 30° M_{CA} - M_{CA}\frac{\sin^2 30°}{\cos 30°}$

$= -\frac{M_{CA}}{\cos 30°}(\sin^2 30° + \cos^2 30°)$

$M_{CA} = \cos 30°(-200\,N\cdot m)$

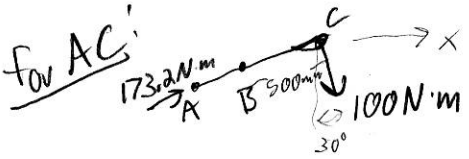
$M_{CA} = -173.2\,N\cdot m$

So a moment of 173.2 N·m applied at A

(b) $\bar{M}_R$ also applied to C, transmitted to AC

$M_R = M_{CA}\frac{\sin 30°}{\cos 30°} = -100\,N\cdot m$

for AC:



about normal to $\overline{AC}$

$\Sigma M_C = 0 = 100\,N\cdot m - F_{BZ}(500\,mm)$

$\rightarrow \boxed{F_{BZ} = 200\,N}$

$\Sigma F_Z = 0 = F_{BZ} + F_{CZ}$

$\rightarrow F_{CZ} = -200\,N$

so for CE:

$F_{CZ} = 200\,N(\hat{k})$

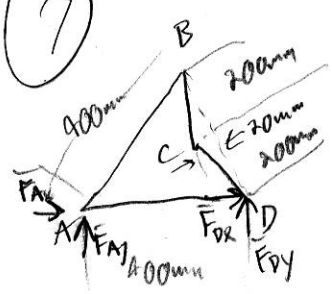
$\Sigma M_{Dy} = 0 = 200\,N(400\,mm) - F_{EZ}(600\,mm)$

$\rightarrow \boxed{F_{EZ} = \frac{400}{3}\,N}$

$\Sigma F_Z = 0 = 200\,N + F_{EZ} + F_{DZ}$

$\rightarrow \boxed{F_{DZ} = -\frac{1000}{3}\,N}$

(7)



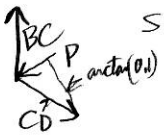
for body: $\sum M_A = 0 = 300N(\cos 30° \cdot 400mm) + F_{Dy}(400mm)$

$\rightarrow F_{Dy} = -150\sqrt{3}\ N$

at D: $\sum F_y = 0 = -150\sqrt{3}\,N + CD\cos\left[30° + \arctan\left(\frac{20}{200}\right)\right]$

$\rightarrow CD = 319.9697N$

at C:



symmetry implies $CD = BC$

so $\sum F_{along\ p} = P - 2\{CD\sin[\arctan(0.1)]\}$

$\rightarrow \boxed{P = 63.7\ N}$

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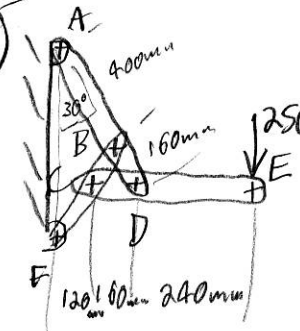
(8)

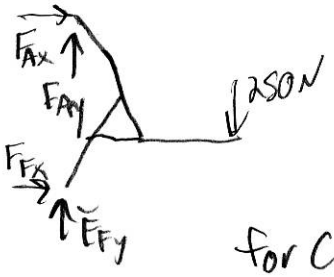


Find forces on CDE at C, D

for body: $\sum M_A = 0 = -250N(520mm) + F_{Fx}(400\sqrt{3}mm)$

$\rightarrow F_{Fx} = \frac{325}{\sqrt{3}}N$

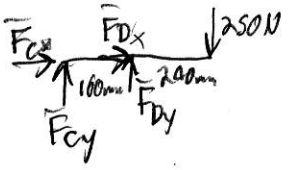
$\sum F_y = F_{Ay} + F_{Fy} - 250N = 0$



$\sum F_x = 0 = F_{Fx} + F_{Ax} \rightarrow F_{Ax} = -\frac{325}{\sqrt{3}}N$

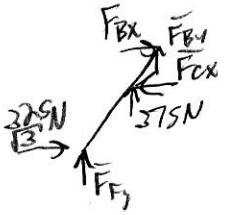
for CDE: $\sum M_D = 0 = -F_{Cy}(160mm) - 250N(240mm)$

$\rightarrow \boxed{F_{Cy} = -375N}$



$\sum F_y = 0 = F_{Cy} + F_{Dy} - 250N$

$\rightarrow \boxed{F_{Dy} = 625N}$



$\sum F_x = 0 = F_{Cx} + F_{Dx} \rightarrow F_{Cx} = -F_{Dx}$

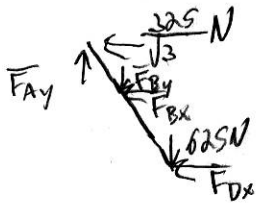
for BCF: $\sum M_B = 0 = F_{Fy}(200mm) + F_{Cx}(80\sqrt{3}mm) + 375N(80mm) - \frac{325}{\sqrt{3}}N(200\sqrt{3}mm)$

$= F_{Fy}(200mm) + F_{Cx}(80\sqrt{3}mm) - 35\ N\cdot m$

9 (cont.) For ABD: $\Sigma M_B = 0 = -F_{Ay}(200\text{mm}) + \left(\frac{325}{\sqrt{3}}\text{N}\right)(200\sqrt{3}\text{mm})$

$$- 625\text{N}(80\text{mm}) + F_{Dx}(80\sqrt{3}\text{mm})$$

$$= -F_{Ay}(200\text{mm}) + F_{Dx}(80\sqrt{3}\text{mm}) + 15\,\text{N}\cdot\text{m}$$



set $\Sigma M_B = 0$ for ABD = to $\Sigma M_B = 0$ for BCF and substitute $F_{Cx} = -F_{Dx}$ from $\Sigma F_x = 0$ from BDE and $F_{Ay} = 250\text{N} - F_{Fy}$ from $\Sigma F_y = 0$ (body)

$$F_{Fy}(200\text{mm}) + F_{Cx}(80\sqrt{3}\text{mm}) - 35\,\text{N}\cdot\text{m} = -F_{Ay}(200\text{mm}) + F_{Dx}(80\sqrt{3}\text{mm}) + 15\,\text{N}\cdot\text{m}$$

$$F_{Fy}(200\text{mm}) + F_{Cx}(80\sqrt{3}\text{mm}) - 50\,\text{N}\cdot\text{m} = (F_{Fy} - 250\text{N})(200\text{mm}) - F_{Cx}(80\sqrt{3}\text{mm})$$

$$F_{Cx}(160\sqrt{3}\text{mm}) = 100\,\text{N}\cdot\text{m} \rightarrow \boxed{F_{Cx} = \frac{625}{\sqrt{3}}\text{N} (= 360.844\text{N})}$$

$$F_{Dx} = -F_{Cx} = \boxed{-\frac{625}{\sqrt{3}}\text{N} = F_{Dx} \quad (-360.8\text{N})}$$

$F_{Cx} = 361\text{N}$	$F_{Dx} = -361\text{N}$
$F_{Cy} = -375\text{N}$	$F_{Dy} = 625\text{N}$